

Virtualization of Infrastructure as a Service (IAAS): Redundancy Mechanism of the Controller Node in OpenStack Cloud Computing Platform

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Abstract

In last twenty years IT world has come across a dramatic change particularly in the field of communications and IT Infrastructure. The Infrastructure as a Service (IaaS) service of cloud computing is becoming more popular day by day due to its overwhelming technical and financial offerings. OpenStack Networking is a standalone service. The main process of the OpenStack Networking server is quantum-server that is responsible for managing user requests to Compute Node, Storage Node and to other components in the entire network. Therefore, a pin-point in an OpenStack network platform is that after received the instruction through the dashboard the entire instruction set is directed in the network developed only through the Controller Node. It is considered a crucial point in the whole network as if for any reason the link is broken to the Controller Node no instruction to pass through to the intended node. This will result in a complete downtime of the network. Keeping this point in mind a standby Controller Node is proposed with addition of a Link Node for managing the controllers and thus maximum uptime is ensured.

Introduction

Over the past few years, there have been significant development achieved in the IT industry especially in the field of virtualization techniques which triggered to more reliable services in cloud computing. Cloud computing concept and virtualization techniques together ensured Infrastructure as a Service (IaaS) more affordable and as a result many organizations are leaning to this cloud service. IaaS is a service where the service provider deliver the computer infrastructure as a service. Infrastructure as a service offers computing capabilities and basic storage as standardized services over the network. Servers, storage systems, switches, routers, and other systems are reserved and made available to the user through the internet. In this norm there have been evolved quite a few IaaS Service Providers providing services with its unique architectural infrastructure. Out of the few cloud operating systems available at this time one is the OpenStack Cloud OS. In the OpenStack Cloud OS the Network Architecture involves one Network node. The concentration of this article is to introduce redundancy option of the Network Node in the OpenStack cloud computing platform to ensure minimal service downtime.

The OpenStack platform is a virtual network and the network connectivity and addressing is managed by a set of API. OpenStack Networking is a standalone service. The main process of the OpenStack Networking server is quantum-server that is responsible for managing user requests to Compute Node, Storage Node and to other components in the entire network. Therefore, a pin-point I feel in an OpenStack network platform is that after received the instruction through the dashboard the entire instruction set is directed in the network developed only through the controller Node. It is considered a crucial point in the whole network as if for any reason the link is broken to the controllernode no instruction to pass through to the intended node. This will result in a complete downtime of the network. Keeping this point in mind it is proposed that a redundant controller Node is to be added in the structure instead of one available now which will ensure minimal network downtime.

Cloud computing

Since the early nineties till present days the IT world has come across a drastic change especially in the field of communications and IT Infrastructure. First we observed the introduction of distributed computing followed by grid computing and until recently the evolution of cloud computing. When it comes to cloud computing in parallel comes the term Internet. There have been enormous development occurred in the internet technology particularly the way it is made available to the use and mostly now the price of making it available to grass root level. All these factors made it possible for even a small company to think about adopting cloud for their day to day IT operations regardless it is SaaS, PaaS or IaaS, which implies to more or less all of the cloud services available in the market.

In a general term, cloud computing is considered as a process of storing and accessing data and programs over the Internet instead of in a hard drive of a computer. The cloud is just a metaphor for the Internet. Cloud technology replaces the conventional gigantic server-frame infrastructure with a set of devices arranged in a way that the devices are not dedicated but used as per requirement of the user floating in the cloud network. Cloud is not about having a dedicated network attached to a storage hardware or server in residence. For it to be considered as cloud computing it is necessary that to access any data or application it needs to be done over the Internet, or at the very least, have that data synced with other information over the Web. In a large server-frame based network it is that the mapping of whole network are known upfront. The end result is the same: with an online connection, cloud computing can be done anywhere, anytime.

Cloud computing architecture

Cloud computing architecture refers to the components and subcomponents required for cloud computing. (fat client, thin client, mobile device), back end platforms When comes the discussion on cloud computing system, it can be divided in two parts - the front end platform (fat client, thin client, mobile device) and the back end platform (servers, storage). These two parts in general are linked through the Internet. The front end of the system is the user (the computer from which the client access to the cloud system).

Depending on the cloud computing systems there exist different types of user interfaces. Say in one system the client can log in to the cloud portal through web browsers like Google Chrome, Internet Explorer etc. where in the same time some providers provide customized applications that provide network access to clients. In general, a central server is responsible for managing the whole system structure. The components involved in the network are managed with a set of network protocols. The network protocols which can be considered as a set of instructions control and ensure communication of different components within the network. In the process of server virtualization it takes numerous sets of instructions among the controller node, network node, compute node and of course block storage and object storage.

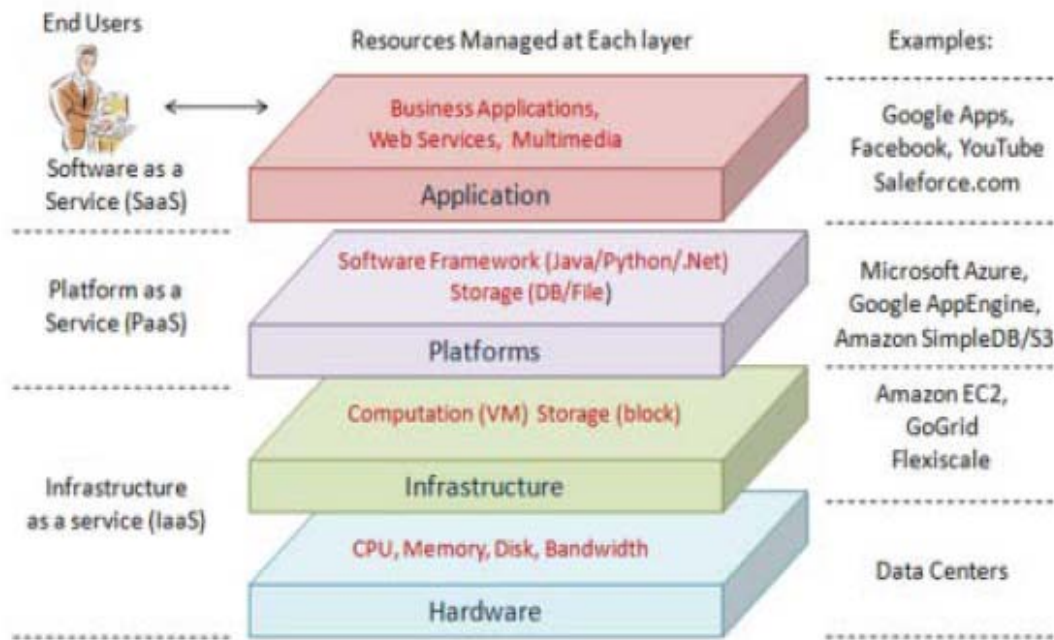


Figure 1. A Cloud Computing Architecture Diagram

Cloud infrastructure software services

The benefits of IAAS include fast seamless provisioning of resources, ability to scale amount of services received and service billable is only as per use. For any organization regardless its size one of the most important and challenging task is to keep capital expenditures under control. The IaaS service could be the solution by migrating in house IT infrastructure to the cloud. The biggest vendors like Amazon AWS, Microsoft, IBM, VMware, HP, EMC, RackSpace Hosting, Red Hat, and Salesforce are few to mentions that are providing IaaS services. Different vendors have adopted different types of Network Infrastructures, however, most of those mentioned have adopted the network infrastructure based on OpenStack Cloud Platform. There exist quite a few cloud softwares in the market and below is a brief overview of the most common cloud software services:

Amazon web services (AWS): AWS is considered as a highly scalable complete cloud platform. Amazon Web Services (AWS) is a suite of cloud computing services offered by Amazon. AWS offers scalable and flexible IAAS, PAAS, storage, networking, and management platforms. It is supported by a global 12-region infrastructure.

Microsoft azure: When it comes to IAAS and PAAS computing for development, deployment, and management Microsoft Azure comes to the top as an option. This is an open, flexible cloud platform that enables users to build, deploy and manage apps across a global network of Microsoft-managed datacenters. Azure offers both PaaS and IaaS services, it supports Multi-language environment and it also offers a strong controlling tools and frameworks.

Google cloud platform: Google has a private cloud that it uses for delivering many different services to its users, including email access, document applications, text translations, maps, web analytics, and much more. It is considered as a developer products and cloud technologies hosted by Google. Google Cloud Platform is a computing platform that provides developers with products to build structures, including simple websites and complex web applications. Google Cloud Platforms offers hosting, computing, cloud storage, Big Data, and API services.

IBM cloud: An unparalleled software for business operations. The IBM Cloud includes IaaS, SaaS, and PaaS offerings on public, private and hybrid cloud platforms. Softlayer partnered with the

IBM Cloud offers a comprehensive cloud ecosystem, offering management, virtualization, storage, and computing platforms.

Rackspace: Well known for dedicated servers and infrastructure services. The Rackspace provides cloud computing product and services in different categories and all the services are billed on utility computing basis. They have a very robust platform which does a good job of making the process simple and keeps the client's solution functional. Rackspace products and services are: Cloud Files, Cloud Servers, Cloud Sites.

VMware: It is considered for virtualization public cloud with hybrid capabilities. vCloud of VMware offers users a platform to run, manage, and secure applications. vCloud Air is VMware's flagship infrastructure public cloud platform. IBM has partnered with VMware for virtualization and hybrid cloud management solutions with SoftLayer providing the cloud infrastructure to enterprise level demands.

Red hat: They are one of the leader of open cloud technology for enterprise clients. Red Hat provides cloud offerings on their open-source software platforms and is easily integrated with other major cloud services. Red Hat has offerings for infrastructure creation and deployment, cloud management, and platform development.

Oracle cloud: This is an integrated public cloud solution for business applications. The Oracle cloud offers a variety of cloud computing and networking tools. The Oracle Cloud IaaS offers a set of core infrastructure capabilities, such as elastic compute and storage for enterprise clients.

Verizon cloud: This is a Managed enterprise solution through Verizon's global network. Verizon Cloud, formerly Terremark, is a cloud platform offering managed hosting, disaster recovery, data storage, and cloud computing services. The Verizon Cloud is supported by the Verizon infrastructure for enterprise clients.

Openstack

OpenStack is a collection of open-source software projects developed by individual groups which are used to develop and manage the IT infrastructure of an organization. These are the individual set of project also responsible for virtualization aspects of both private and public clouds and as well as hybrid clouds practiced by different organizations. The OpenStack software controls large pools of server sets, computes, storages and as well all other networking resources involved within a large network architecture. All the components involved in the network are managed through a controller known as Dashboard in the OpenStack Platform through a set of APIs. OpenStack is considered as a heterogeneous infrastructure due to its ability to adopt with many open source technologies.

OpenStack software controls large pools of compute, storage, and networking resources throughout a datacenter, managed through a dashboard or via the OpenStack API. OpenStack works with popular enterprise and open source technologies making it ideal for heterogeneous infrastructure.

The OpenStack platform is a virtual network and the network connectivity and addressing is managed by a set of API. The operation is ensured though a very powerful set of APIs (Network, Subnet and Port). It allows the user to use different types of network technologies to setup the cloud network. A network is developed using different categories of network topologies and the instruction sets are sued to attach different types of virtual devices to build a complete network as per requirement of the user-group. It is a very difficult task to convert a conventional network to a cloud network. Conventional networks are not designed in a way that it will configured automatically when switched to could. In the OpenStack platform a set of networking APIs are used to implement a complete IP table.

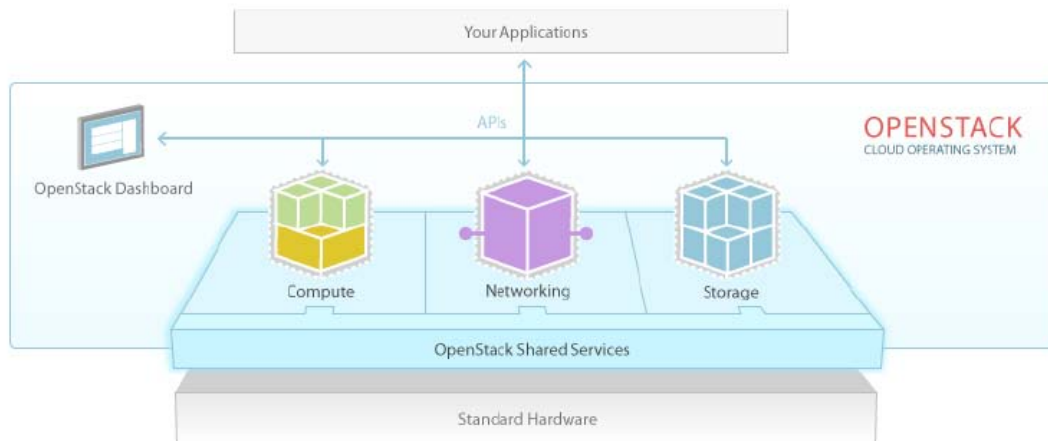


Figure 2. OpenStack Cloud operating System Architecture

Networking option 2: Self-service networks

Out of the few cloud architectures adopted by the industry the OpenStack Cloud Platform is the one got some more edge and as a result it is widely accepted by the providers and as well the users. The self-service networks option increases the provider networks option with routing services (layer-3) which ensures that self-service networks are enabled using VXLAN overlay segmentation method. Basically what happens here is using NAT it routes virtual networks to physical networks and also it builds the foundation for advanced services such as LBAAS and FWAAS. The network is built on concentric to the controller node as shown in figure 3. All the nodes involved in the network are interconnected through network components

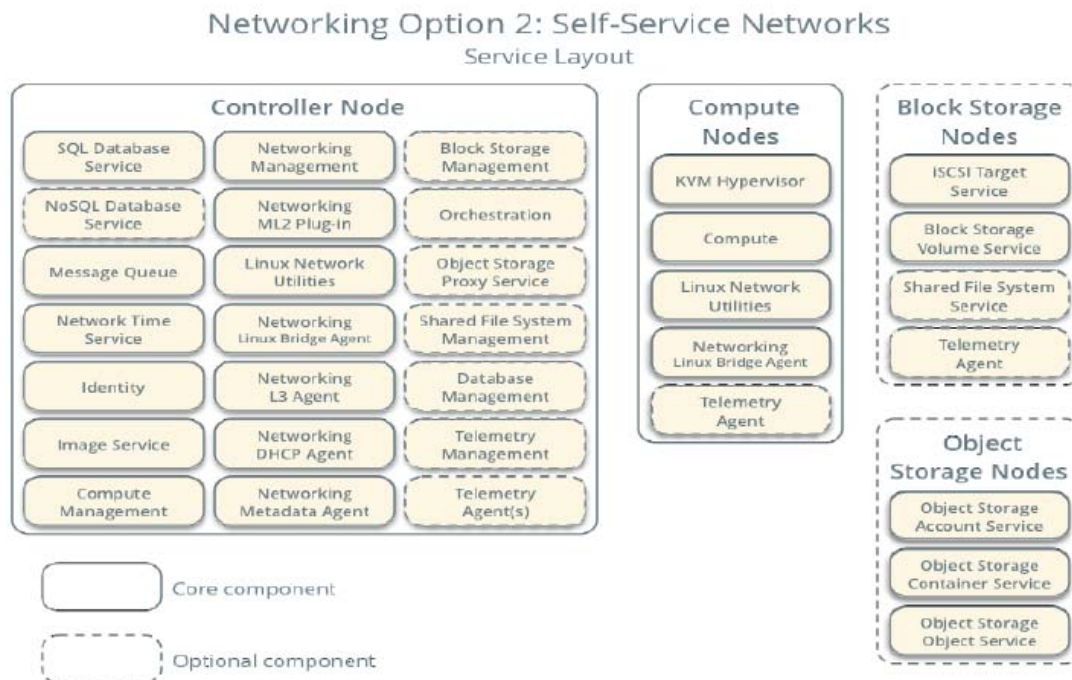


Figure 3. Networking Option 2: Self-Service Networks

known as switch and router. Switches are used to enable packets to be sent from node to node. Switches are Multi-Input Multi-Output (MIMO) devices that connect hosts that belong to the same layer-2 network. Packets are received in one port as input and directed to another desired node

through another port as output. Switches enable forwarding of the packet received on one port as input to another port as output. Packets forward the traffic based on the destination Ethernet address in the packet header. Routers are used to enable packets to travel from one layer-3 network to another. Routers enable communication between two nodes on different layer-3 networks that are not directly connected to each other. Packets forward the traffic based on the destination IP address in the packet header.

When it comes to cloud environment it is obvious that there exist a lots of mix-matches and in this point the OpenStack got the advantage as it is adoptable more or less with all types of architectures and applications.. In this platform as shown in the figure 3 that all the instruction flow is centralized to the controller node. For some reason if any instruction is failed through this node that will result in a downtime of one of the components associated in the network. That may result in a temporary outage of service and depending on the severity it could result in to a complete network connectivity breakdown. This situation may trigger to complete service outage which could be disastrous to an organization running its day to day operation depending on the service provided by that particular cloud IAAS service provider.

Proposed architecture for openstack networking

It is observed that with the current approach there may occur downtime in the network which will result in cloud service outage. We have put an effort to bring out a logic which will ensure a redundancy mechanism for the controller node to make the platform more reliable and fast and robust. The research was concentric to the current version of the OpenStack Cloud Platform which is known as NEWTON.

There is a minimal requirement of hardware setup required for a scalable network. It could be set up even with two custom made computers to create the OpenStack environment, standard recommendation though is to use sixteen computers for a scalable network. However, in our proposed solution we have used seven custom made computers involved which found to be sufficient to implement the logic. Two computers are used for the Controller Node, two computers are used for Compute Node, and one router is used as the link node which is considered for the monitoring of the controller nodes. Apart from these there are two computers used as Blocks Storage and two computers used as Object Storage respectively. Virtualization of the components has been ensured with KVM technology which is an embedded part of the OpenStack OS.

Core Component

Optional Component

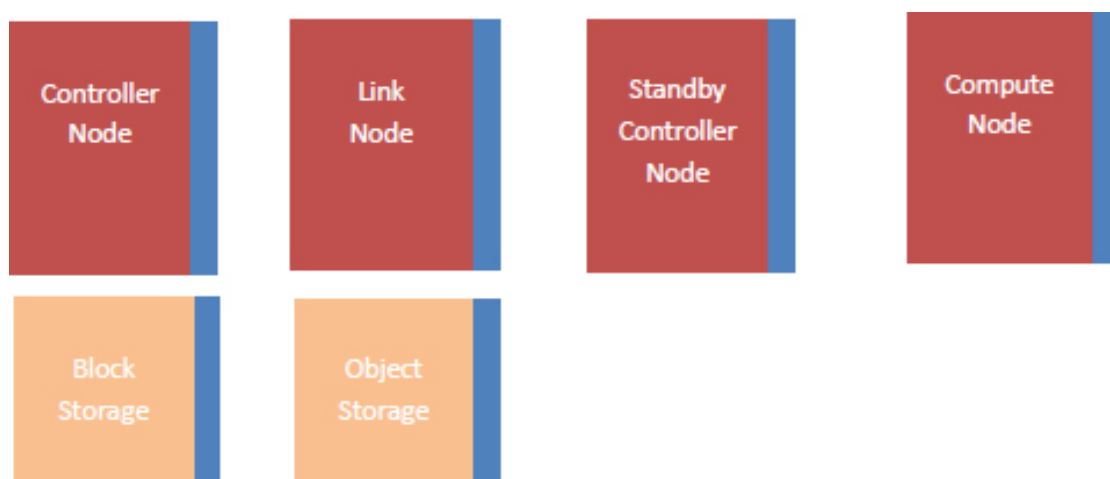


Figure 4. Proposed Minimal Architecture – Hardware Requirements OpenStack Networking

The research was concentric to the development of the Controller Node redundancy of the OpenStack Cloud Platform. From this consideration concentration was on the applications involved in the Controller Node and Compute Node respectively.

Physical diagram of the proposed OpenStack architecture

The architecture proposed has made the OpenStack architecture more reliable as with this approach network downtime will be minimal and this approach have ensured maximum uptime. When all the components are connected together the complete network comes as shown in figure 5 below. The components used are as stated below:

Mikrotik Router

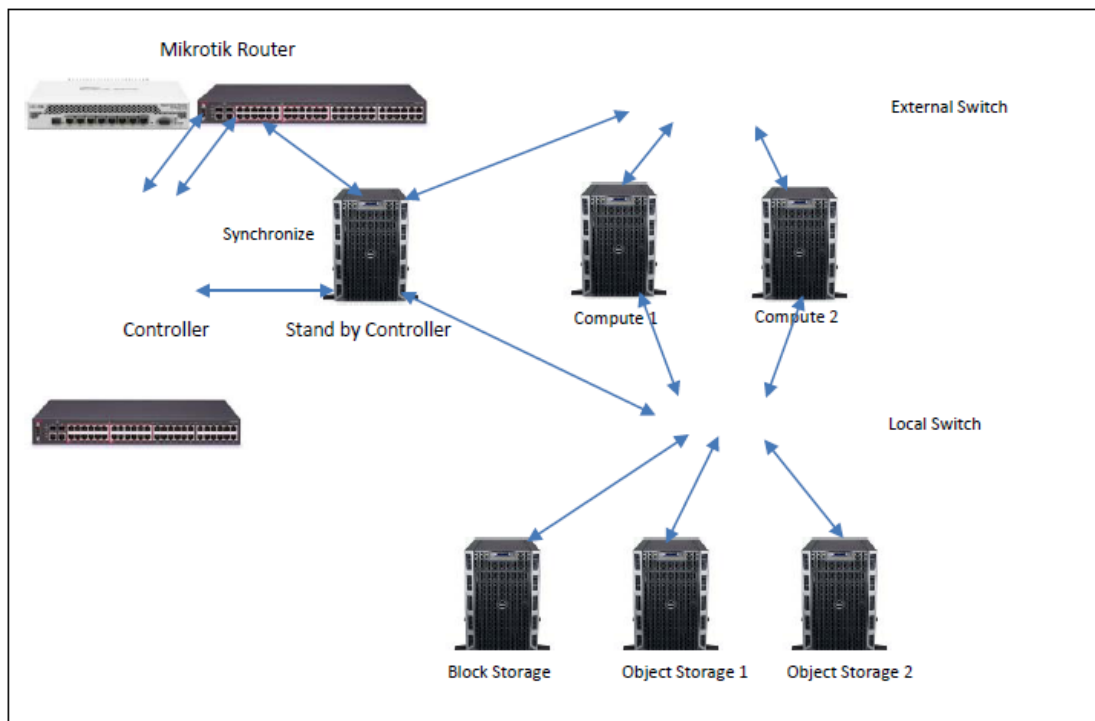
Controller Node CPU 1-2, 8 RAM GB, 100 GB Storage, 2 NIC

Compute Node 1 2-4+ CPU, 8+ GB RAM Storage 100 + GB 2 NIC

Block Storage Node 1 1-2 CPU, 4 GB RAM, Storage 100+ GB 1 NIC

Object Storage Node 1 1-2 CPU, 4 + GB RAM, Storage 100 + GB 1 NIC

Object Storage Node 1 1-2 CPU, 4 + GB RAM, Storage 100 + GB 1 NIC

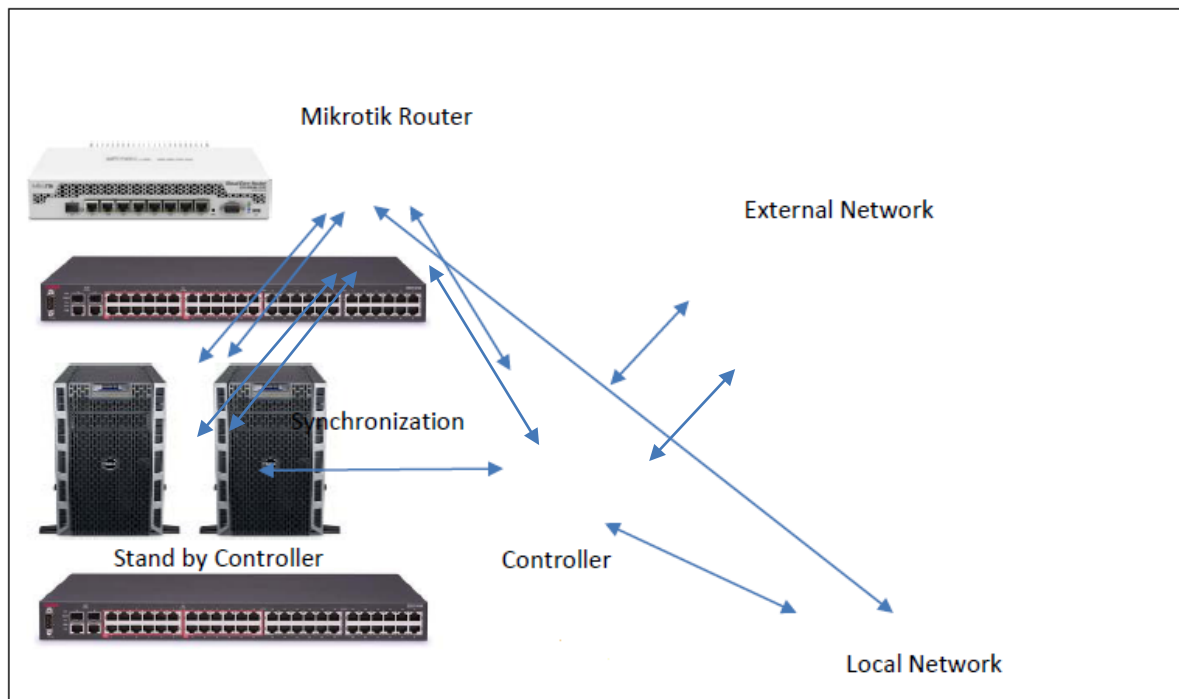


How does our proposed physical system works

OpenStack Networking is considered as a standalone servicelike other OpenStack services such as Compute, Image Service, Identity service, and the OpenStack Dashboard. An OpenStack Networking often involves deploying several processes on a variety of hosts. In OpenStack networking architecture a quantum-server is the main process which consists of a set of OpenStack Networking API that are responsible for defining network connectivity and addressing of the resources through plug-in. In our deployment a controller host is considered to run centralized Openstack Compute components and the OpenStack Networking server is managed within the controller node. Therefore, in our system controller is the key point for total system integration. A dashboard is installed from which a user can operate the different services of cloud system such as Image create, network create, instance create and customize etc. In our system, we have introduced an additional stand by controller as backup. The purpose of the standby controller is in the case the first controller is down then the standby controller will give support and synchronization of both node in running for data update. The

Mikrotic router is introduced to monitor both the controllers and it acts based on signals from the controllers. With such a setup, it is ensured that no downtime is experienced. In the compute node, the scheduler service decides how to dispatch requests for more or less resources necessary by a user. The compute node maintains a queue through which the scheduler obtains the data and takes a decision for resource allocation. In block storage service, a user can create a volume and take a snapshot of instances. In object storage, a user can use storage service and can store a large scale of data. Link Node

In our proposed system, we add a standby controller node that can be used for redundancy of the controller node. We have added an additional standby controller in the system. For some reason, if the first controller becomes unavailable, then the standby controller gives support and synchronization of both nodes for data update, and the Mikrotik router will always monitor which controller is up. Hence, maximum data connectivity is ensured.



Virtualization components with KVM in OpenStack OS

Virtualization is the creation of a virtual -- rather than actual -- version of something, such as an operating system, a server, a storage device or network resources.

TRADITIONAL AND VIRTUAL ARCHITECTURE

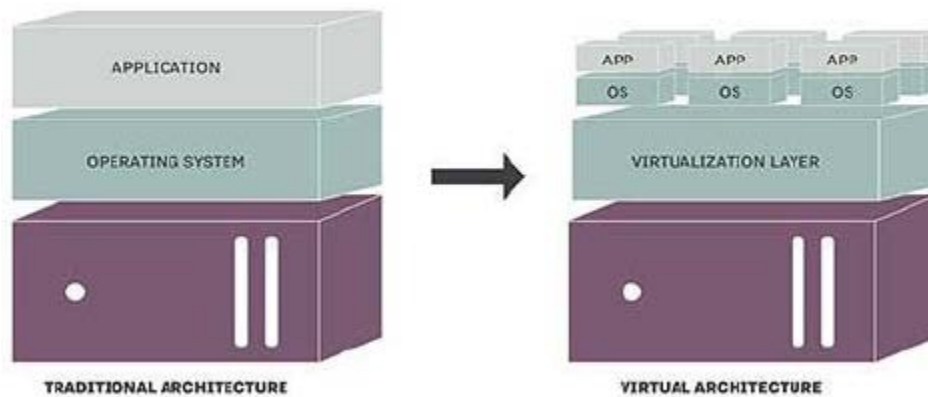


Figure 7. Traditional and Virtual Architecture

OpenStack Compute to host and manage cloud computing systems. OpenStack Compute is a major part of an Infrastructure-as-a-Service (IAAS) system. The main modules are implemented in Python.

OpenStack Compute interacts with OpenStack Identity for authentication; OpenStack Image service for disk and server images; and OpenStack dashboard for the user and administrative interface. Image access is limited by projects, and by users; quotas are limited per project (the number of instances, for example). OpenStack Compute can scale horizontally on standard hardware, and download images to launch instances.

A worker daemon that creates and terminates virtual machine instances through hypervisor APIs. For example:

- XenAPI for XenServer/XCP
- libvirt for KVM or QEMU
- VMwareAPI for VMware

Processing is fairly complex. Basically, the daemon accepts actions from the queue and performs a series of system commands such as launching a KVM instance and updating its state in the database.

XenAPI for XenServer/XCP

Hypervisor provides the fundamental isolation between virtual machines. Xen is open source hypervisor system. Xen is a component of many different products and projects. The hypervisor itself is very similar across all these projects, but the way that it is managed can be different, which can cause confusion if you're not clear which toolstack you are using. Make sure you know what toolstack you want before you get started.

XenAPI is the API provided by XAPI. This name is also used by the python library that is a client for XAPI.

An Open Source virtualization software which includes the Xen hypervisor and XAPI for the management.

Libvirt for KVM or QEMU

Hypervisor provides the fundamental isolation between virtual machines. KVM is open source hypervisor system. KVM turns the Linux kernel into a hypervisor, and comes standard with many Linux distributions. OpenStack is also a Linux distribution, so the marriage of OpenStack with KVM makes sense. When using the KVM hypervisor with libvirt on OpenStack Compute nodes, live migration of instances from one Compute server to another requires that the libvirt daemon is configured for remote network connectivity. The libvirt daemon configuration recommended in the

OpenStack Configuration Reference manual configures libvirtd to listen for incoming TCP connections on all network interfaces without requiring any authentication or using any encryption. This insecure configuration allows for anyone with network access to the libvirt daemon TCP port on OpenStack Compute nodes to control the hypervisor through the libvirt API.

VMware API for VMware

Hypervisor provides the fundamental isolation between virtual machines. VMware vSphere is open source hypervisor system. VMware vSphere Hypervisor is a free bare-metal hypervisor that virtualizes servers so you can consolidate your applications on less hardware. OpenStack Compute supports the VMware vSphere product family and enables access to advanced features such as vMotion, High Availability, and Dynamic Resource Scheduling (DRS).

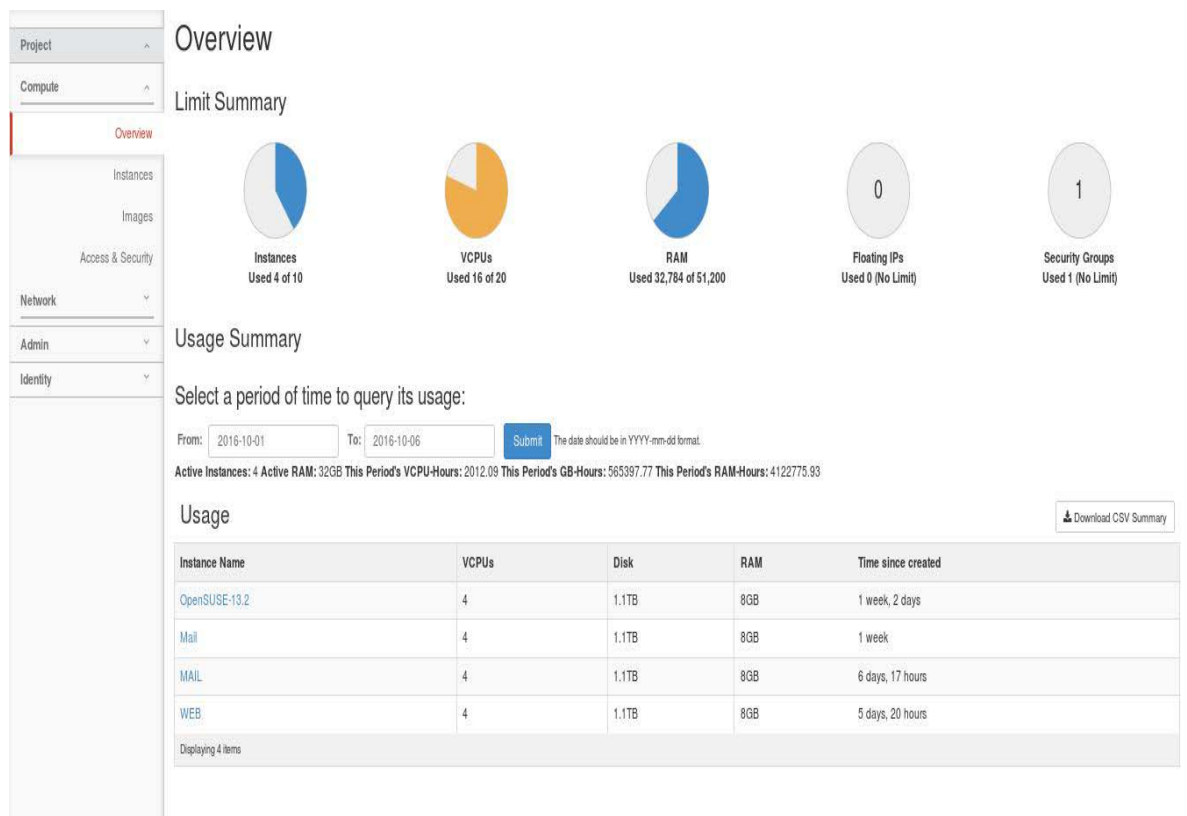
The VMware vCenter driver enables the nova-compute service to communicate with a VMware vCenter server that manages one or more ESX host clusters. The driver aggregates the ESX hosts in each cluster to present one large hypervisor entity for each cluster to the Compute scheduler. Because individual ESX hosts are not exposed to the scheduler, Compute schedules to the granularity of clusters and vCenter uses DRS to select the actual ESX host within the cluster. When a virtual machine makes its way into a vCenter cluster, it can use all vSphere features.

Virtualization challenge in OpenStack open Source technology

1. Open source application version challenge
2. Messaging service challenge
3. KVM virtualization challenge
4. Scalable Database challenge
5. Network challenge
6. Storage challenge

Cloud performance load analysis

When user logged in OpenStack dash board user can monitor total systems load such as how many VMs Running, how much VCPU's, How much memory used how many IPs are activated etc.



Conclusion

In the current IAAS cloud technology model the network is build concentric to the Controller Node of the platform and the network is developed mostly by depending on VM migration or horizontal scaling techniques. However, addressing technique is managed using a set of APIs which guarantees the construction of the network along with elastic provisioning of the components required in nascent stage. The resources needed are allocated based on the instruction sent to compute node from the Controller Node. The IAAS user has to prepare the list of applications and resource to be used with varying requirement and based on this profile intended resources are allocated along with policies for the virtual machines where it hosts the application. In the OpenStack Cloud Platform all the connectivity is managed concentric to the Controller Node as we know. In this article the OpenStack architecture that has been introduced has ensured a redundancy mechanism for the Controller Node to make the platform more reliable and fast and robust. It has been observed that all applications are running properly with the system developed. However, we admit that there is still room for more investigation in the system developed but overall we can say that the approach has implemented successfully.

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