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Universidade
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OpenStack: Infrastructure as a Service

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openstack
CLOUD SOFTWARE

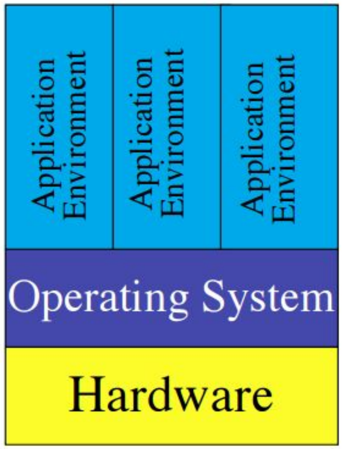
Outline

- Virtualization
  - Definition
  - Types of virtualization
  - CPU Virtualization techniques
- Cloud computing
  - Definition
  - Essential characteristics
  - Service Models
  - Deployment Models
- OpenStack
  - Definition
  - Project characteristics / Community
  - Main projects / Logical architecture / Conceptual Architecture;
- Computing as a Service (OpenStack-Nova)
  - Nova / Launch instance
  - Deployment architecture / tools / API - Examples
- OpenStack video Demo

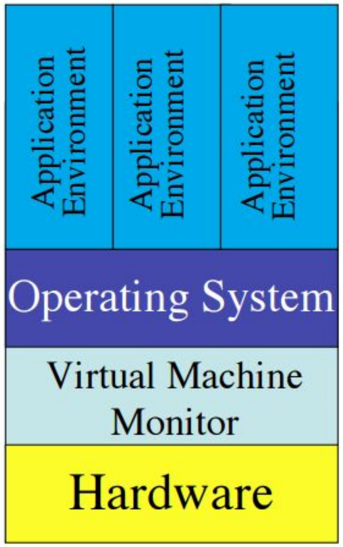
Virtualization - Definition

“... act of creating a **virtual** (rather than actual) **version of something**, including virtual computer **hardware platforms, operating systems**, **storage devices**, and **computer network resources**” - Wikipedia

“...By **decoupling the physical hardware from the operating system**, virtualization provides more operational **flexibility** and **increases the utilization rate** of the underlying physical hardware.” - IBM Global Education

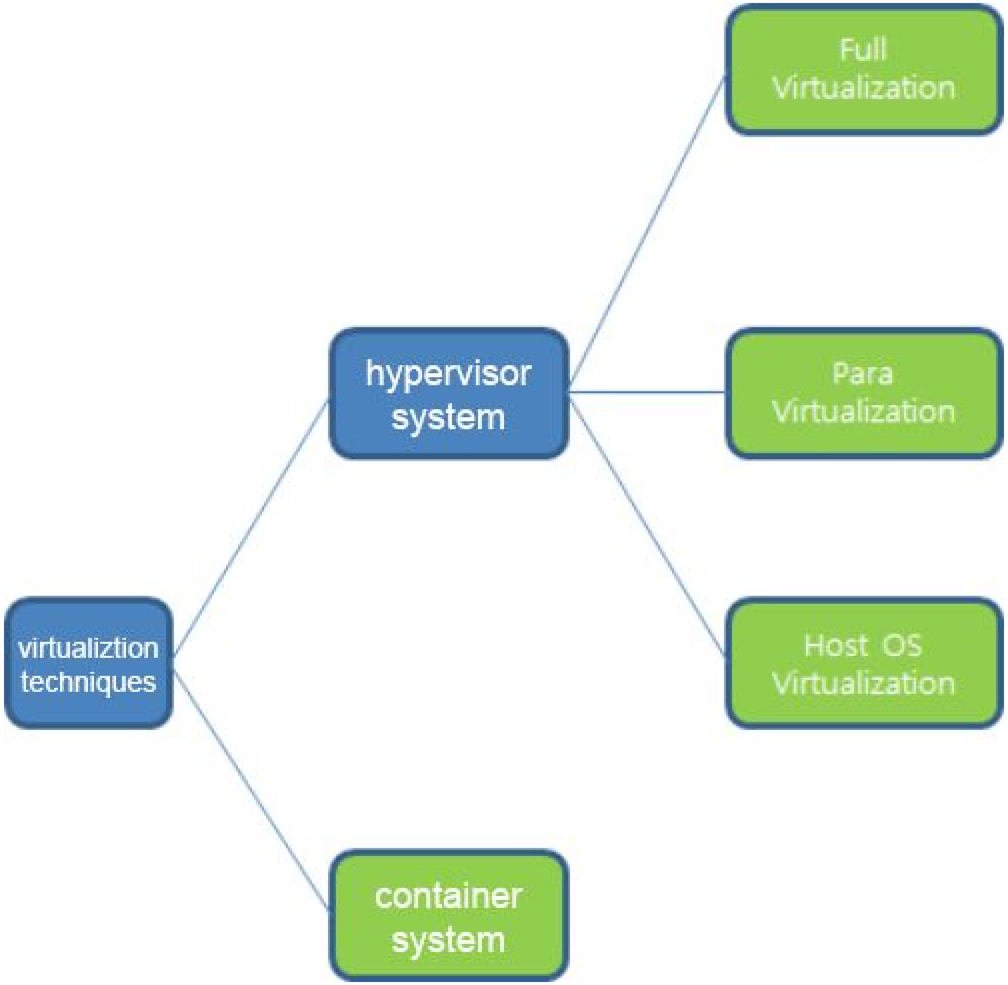


Non-virtualized system



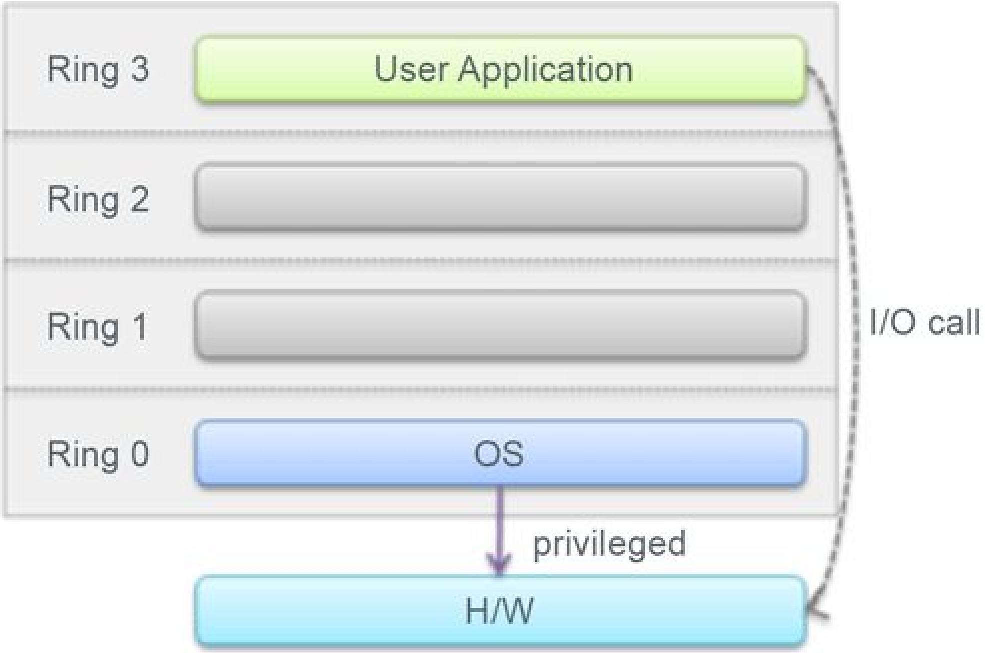
Virtualized system

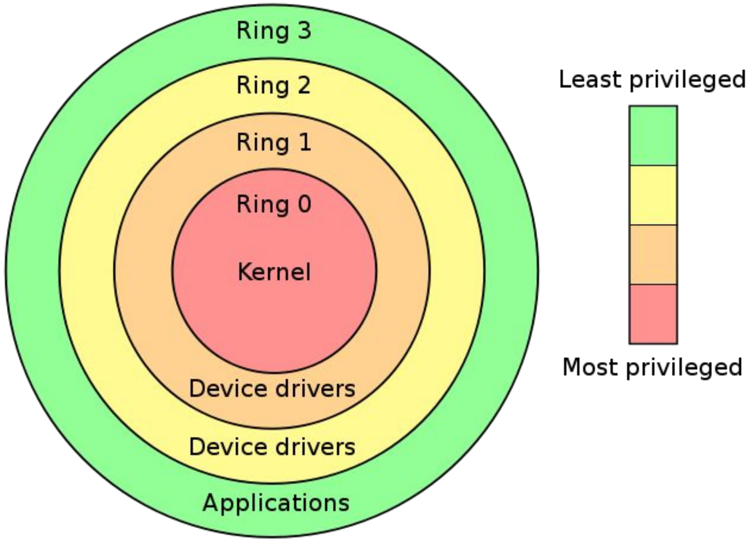
Types of Virtualization



CPU Virtualization - x86 Privileged Architecture.

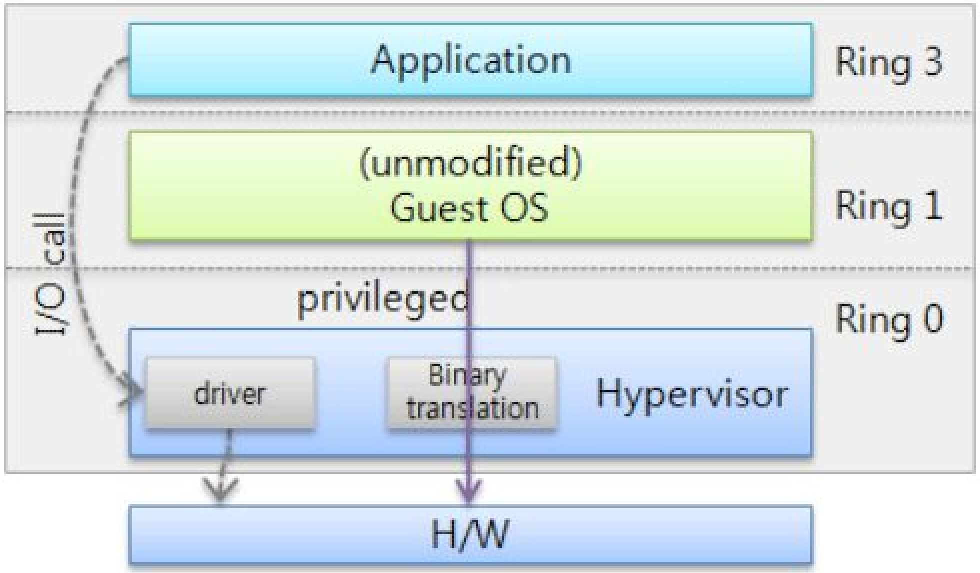
An OS that runs on x86 is designed on the assumption that it has **all access/control authority for hardware**.





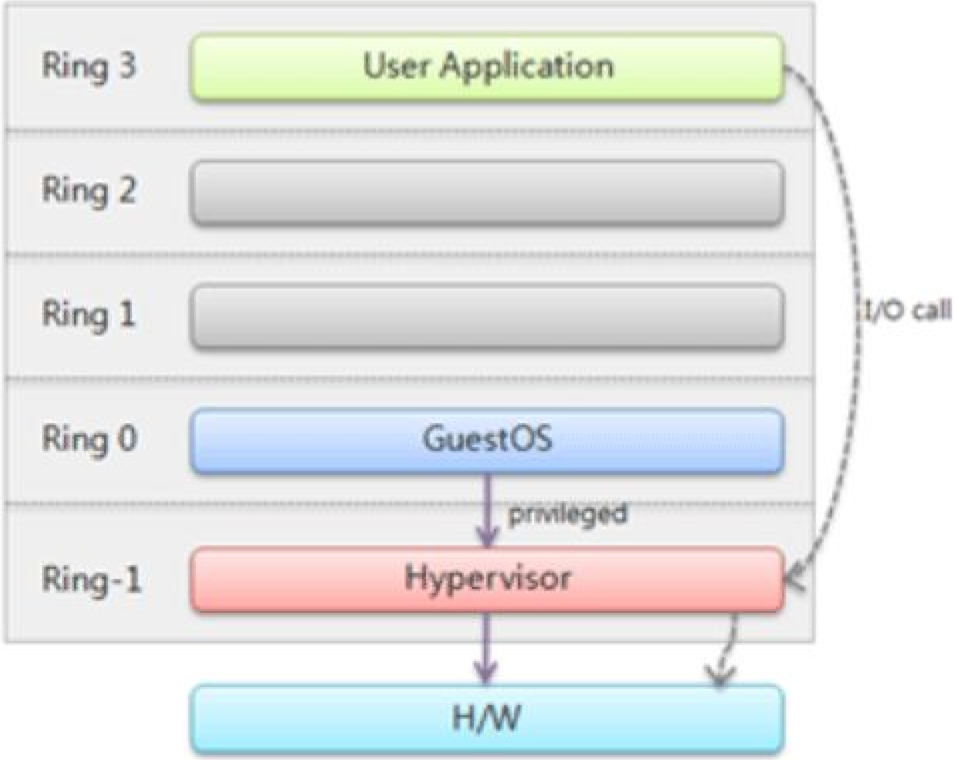
CPU Virtualization - Full Virtualization

Machine language codes of the guest OS are **converted** into the machine language codes of the host through **binary translation process**.



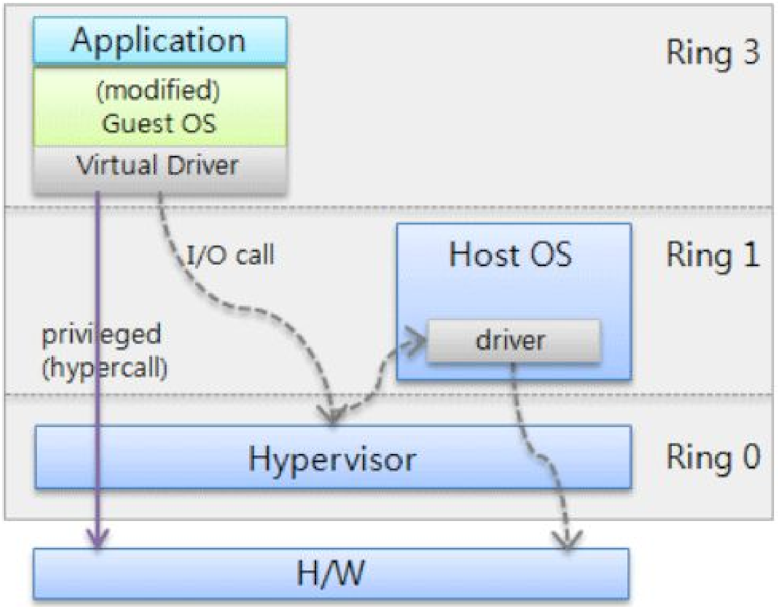
CPU Virtualization - HW-assisted Virtualization.

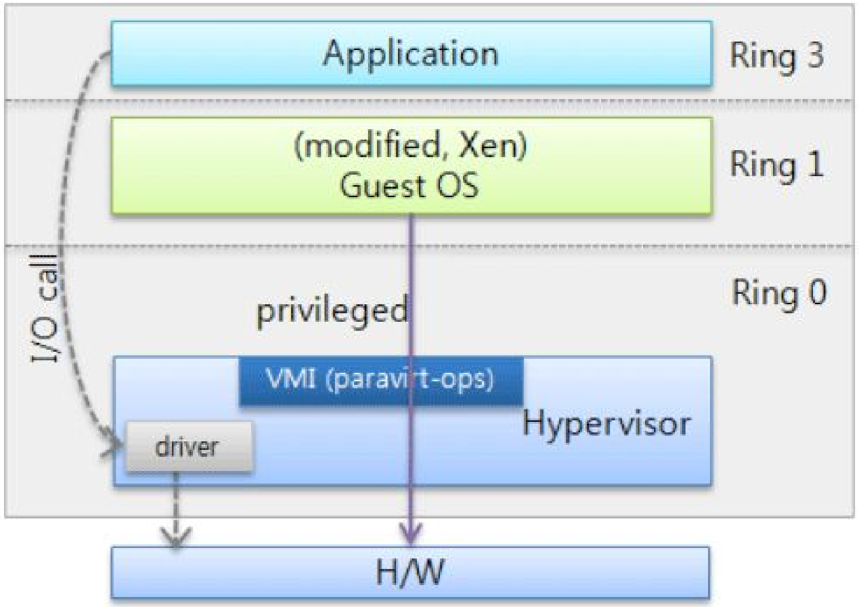
It does not require the process of binary translation for privileged commands, and a command is executed directly to hardware via the hypervisor



CPU Virtualization - Para Virtualization

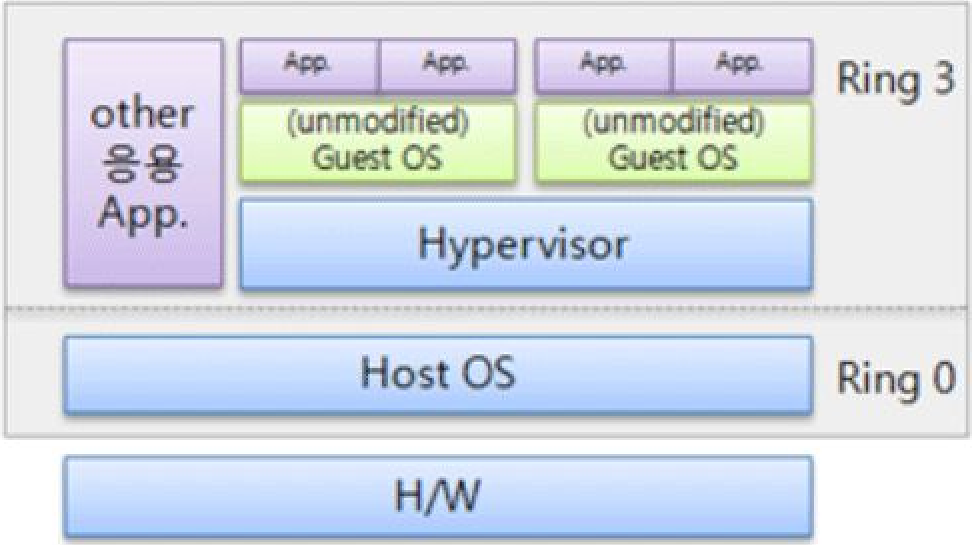
Privileged command guest OS calls are delivered to the hypervisor by using a hypercall, instead of OS. The guest OS is able to have the authority for direct control of resources, such as CPU and memory.





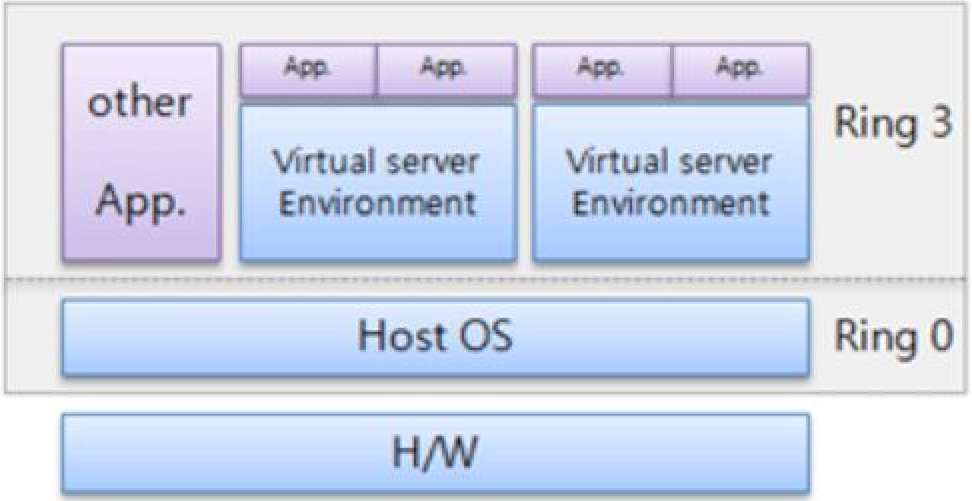
CPU Virtualization - Host OS Virtualization

Host OS virtualization is a method in which an OS itself provides the hypervisor functionality



CPU Virtualization - Container-based Virtualization

Instead of trying to run an entire guest OS, container virtualization isolates the guests, but doesn't try to virtualize the hardware. The kernel provides process isolation and performs resource management. This means that even though all the virtual machines are running under the same kernel, they effectively have their own filesystem, processes, memory, devices, etc.



Cloud Computing - Definition

“Cloud computing is a model for enabling ubiquitous, convenient, **on-demand** network access to a **shared pool of configurable computing resources** (e.g., networks, servers, storage, applications, and services) that can be **rapidly provisioned and released** with **minimal management effort** or **service provider interaction**.”

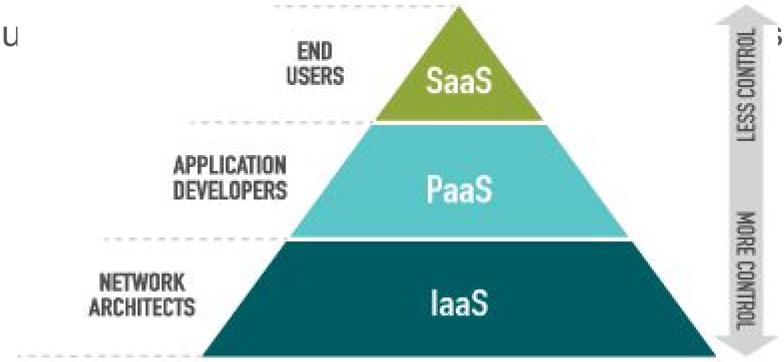
The NIST Definition of Cloud Computing

Cloud Computing - Essential characteristics

- On-demand self-service.
  - A consumer can unilaterally provision computing capabilities as needed automatically without requiring human interaction...
- Broad network access.
  - Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms….
- Resource pooling.
  - The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model and location independence...
- Rapid elasticity.
  - Capabilities can be elastically provisioned and released…
- Measured service.
  - Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Cloud Computing - Service Models

- Software as a Service (SaaS);
  - … **use the provider's applications** running on a cloud infrastructure. The consumer controls **limited user specific application settings** ...;
- Platform as a Service (PaaS);
  - … **deploy** onto the cloud infrastructure **consumer-created or acquired applications** created using programming languages, libraries, services, and tools supported by the provider. The consumer has control over **the deployed applications**...
- Infrastructure as a Service (IaaS).
  - … **provision processing, storage, networks**, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer operating systems, storage, and deployed applications etc bu structure.



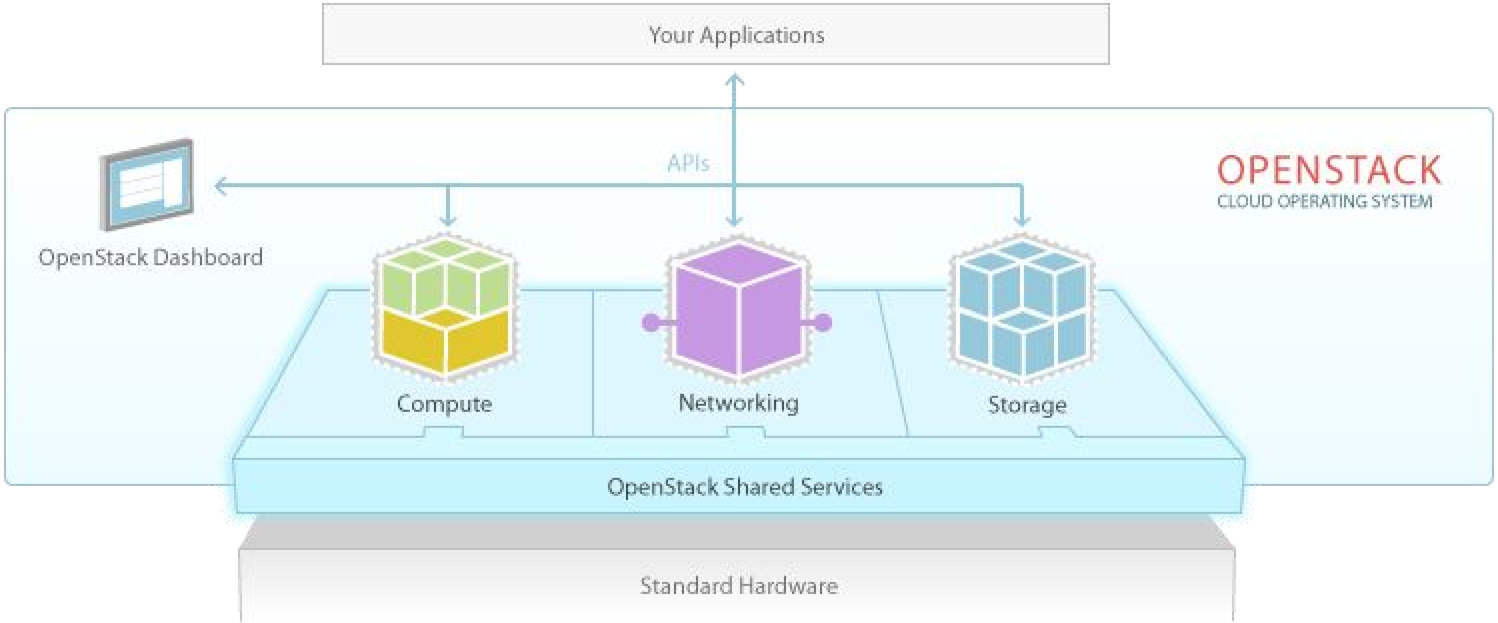
Cloud Computing - Deployment Models

- Private cloud
  - It may be owned, managed, and operated by the **organization, a third party**, or some **combination of them**, and it may exist **on or off premises**.
- Community cloud.
  - Exclusive use by a specific community of consumers from organizations that have **shared concerns.**
- Public cloud.
  - **Open use by the general public**. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the **premises of the cloud provider**.
- Hybrid cloud.
  - Composition of two or more distinct cloud infrastructures (private, community, or public) **as unique entities**, but are bound together by standardized or proprietary technology that enables data and **application portability**

OpenStack - Definition

“**Open source** software for creating **private and public clouds**”.

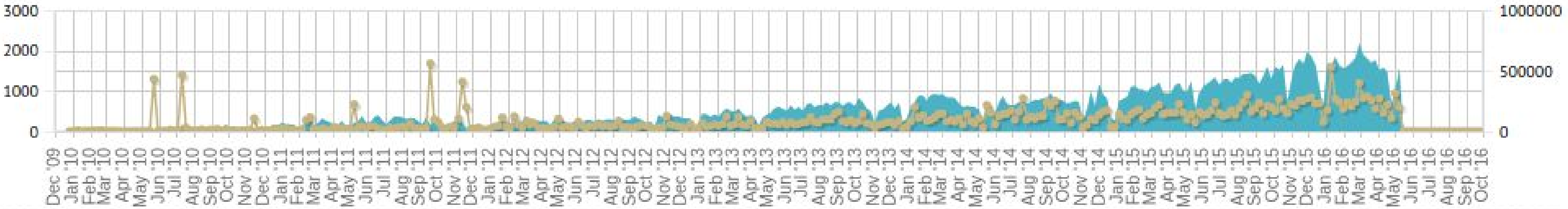
“OpenStack software controls **large pools of compute**, **storage**, and **networking resources** throughout a datacenter, managed through a **dashboard** or via the **OpenStack API**. OpenStack works with **popular enterprise** and **open source technologies** making it ideal for heterogeneous infrastructure.”



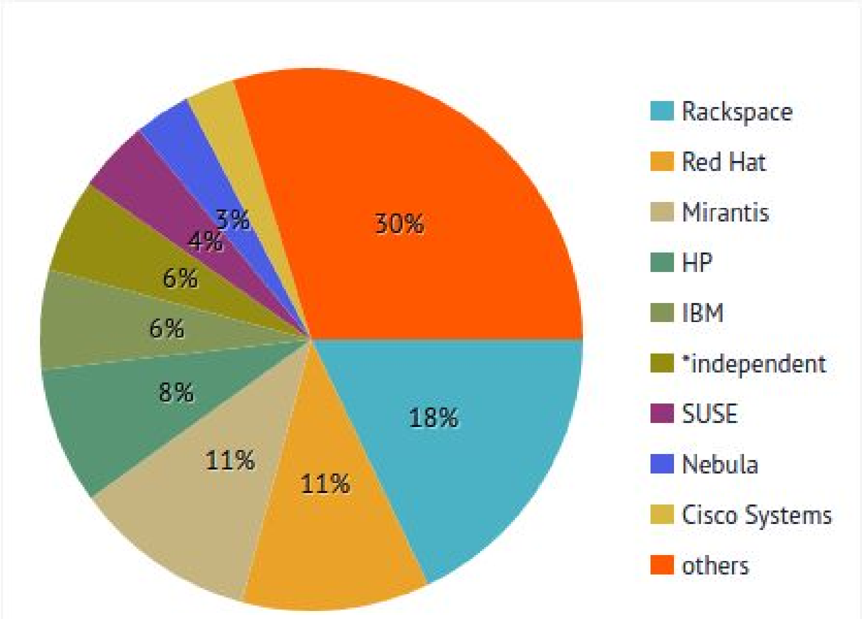
OpenStack - Project Characteristics

- OpenStack began in 2010 as a joint open-source project of **Rackspace Hosting** and **NASA**;
- It is managed by the OpenStack Foundation, a non-profit corporate entity to promote OpenStack software and its community;
- More than 500 companies have joined the project;
- Six-month time-based for release cycle and summit;
- Written in Python;
- License: Apache License 2.0;

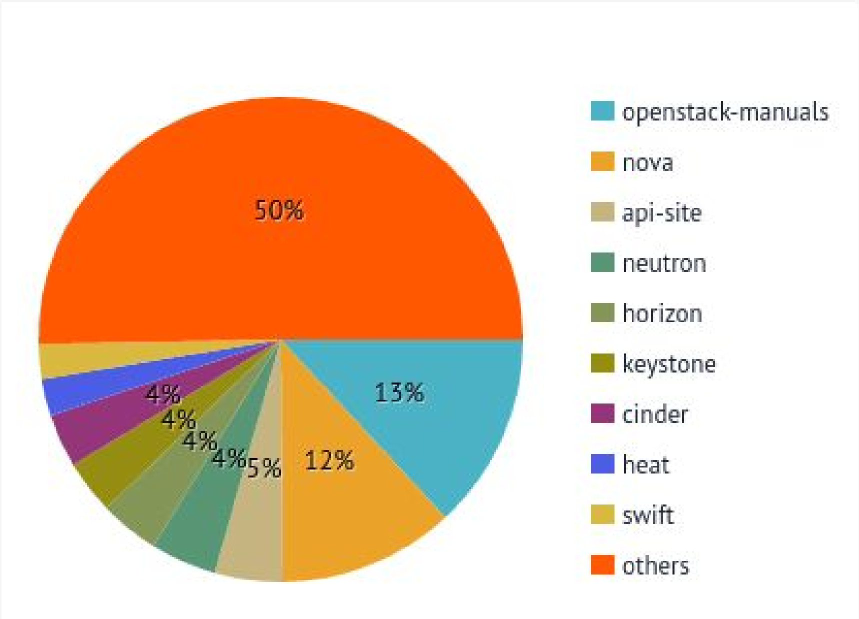
OpenStack - Community



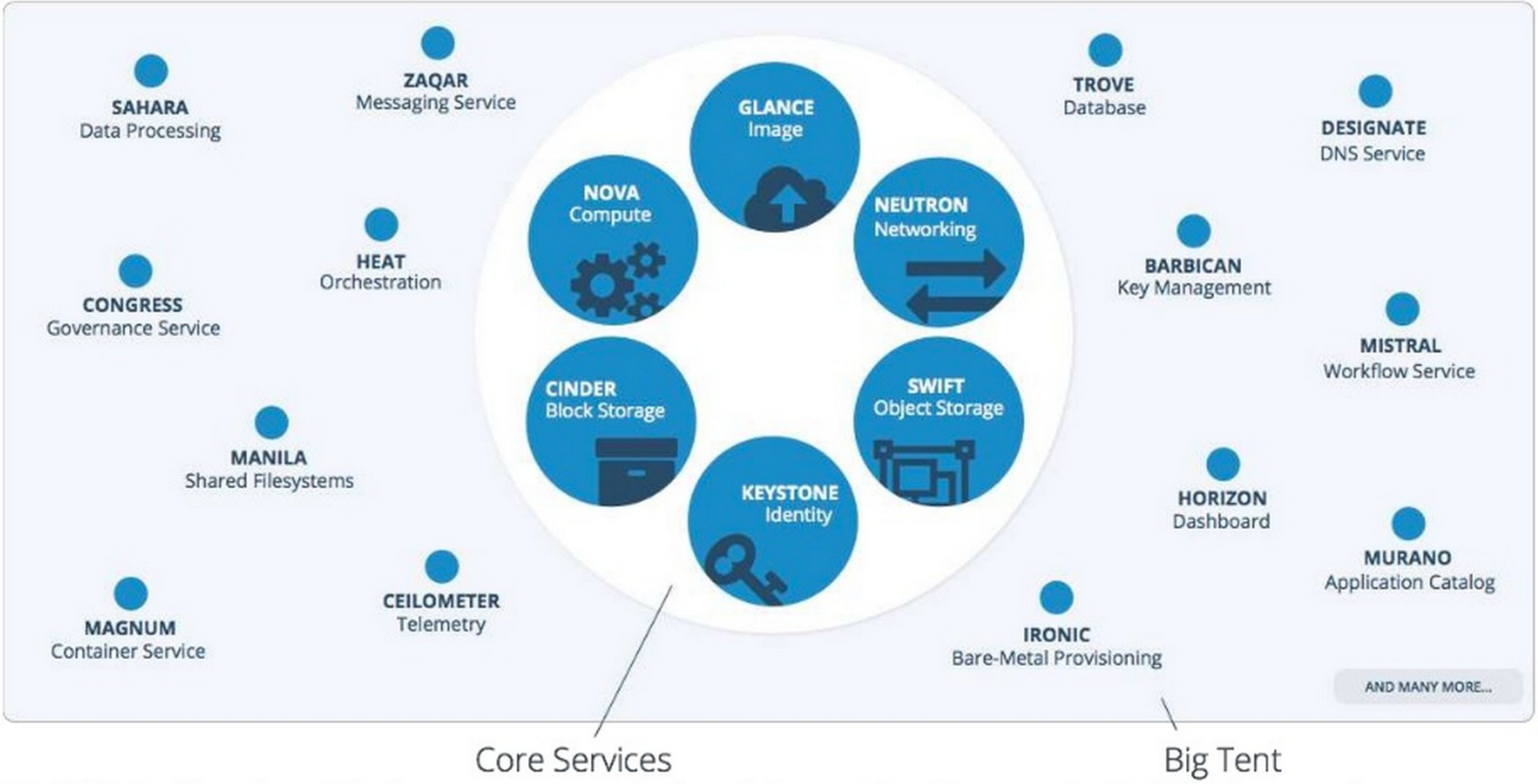
Contribution by companies



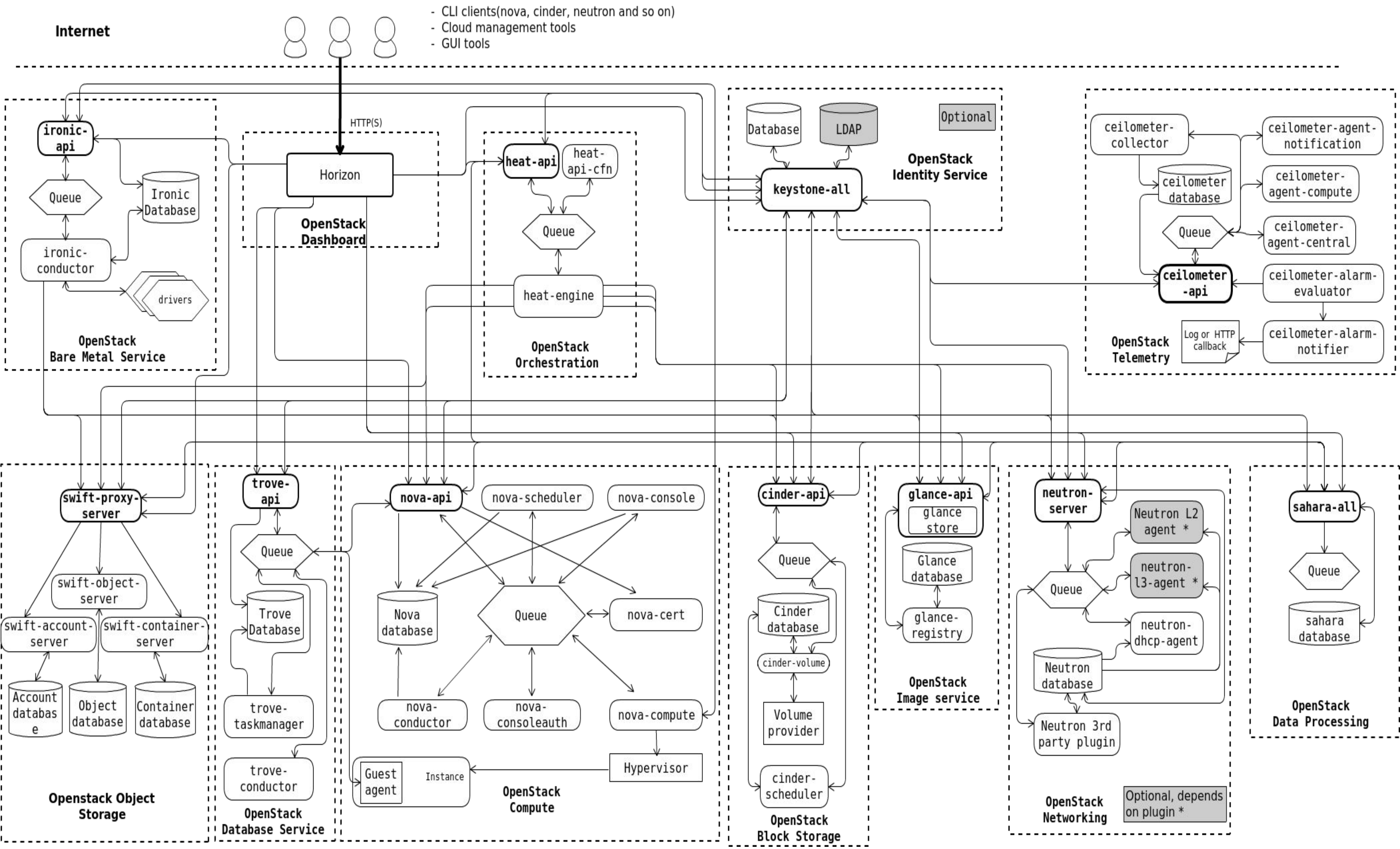
Contribution by modules



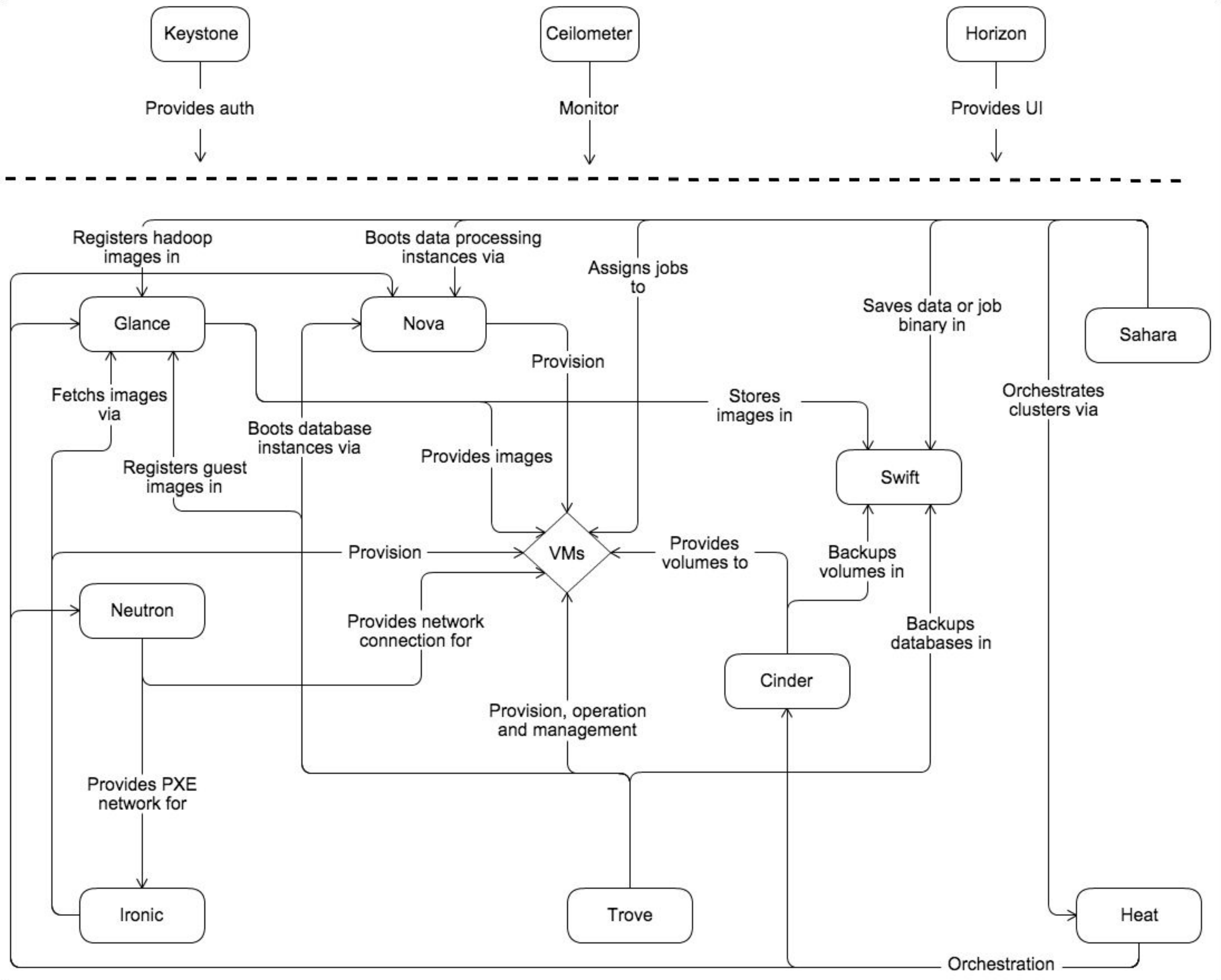
OpenStack - Over 1000 meters high



Logical Architecture

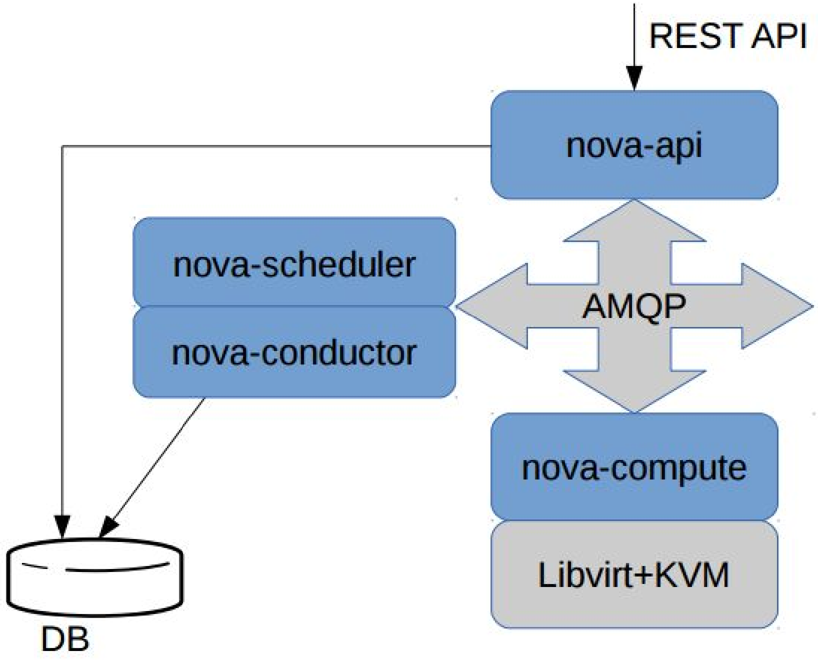


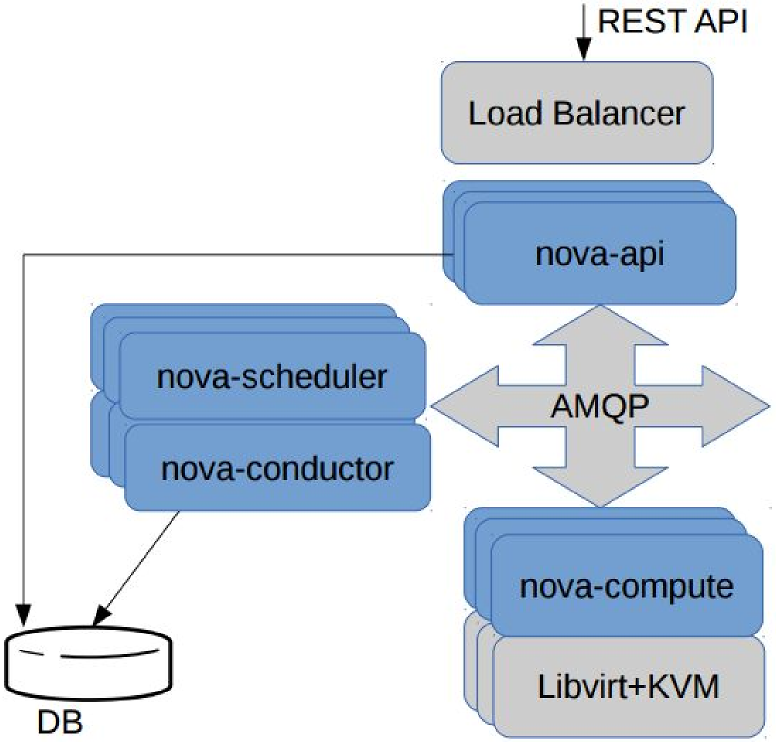
Conceptual Architecture



Computing as a Service - Nova

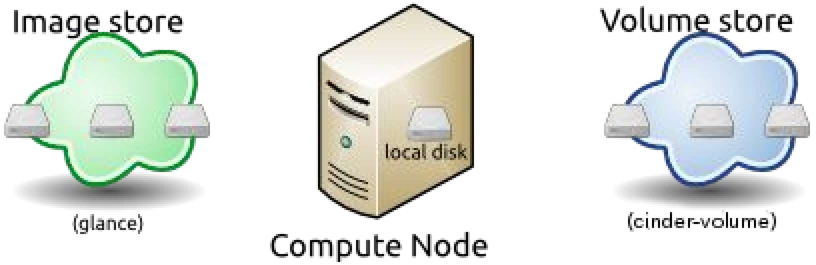
Manages the lifecycle of compute instances in an OpenStack environment. Responsibilities include spawning, scheduling and decomissioning of machines on demand.

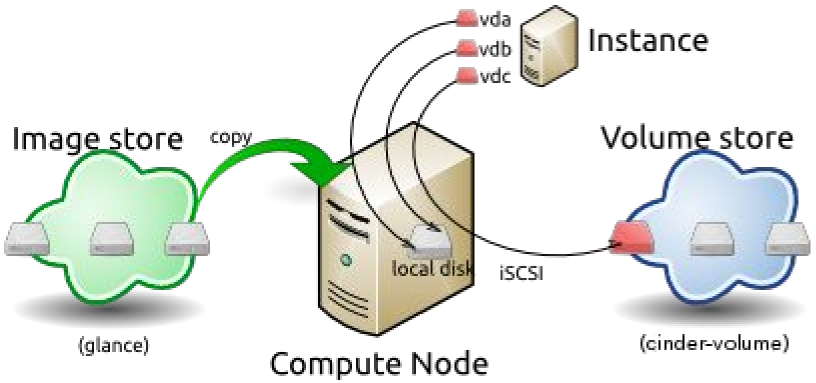




Computing as a Service - Nova - launch instance

Manages the lifecycle of compute instances in an OpenStack environment. Responsibilities include spawning, scheduling and decomissioning of machines on demand.

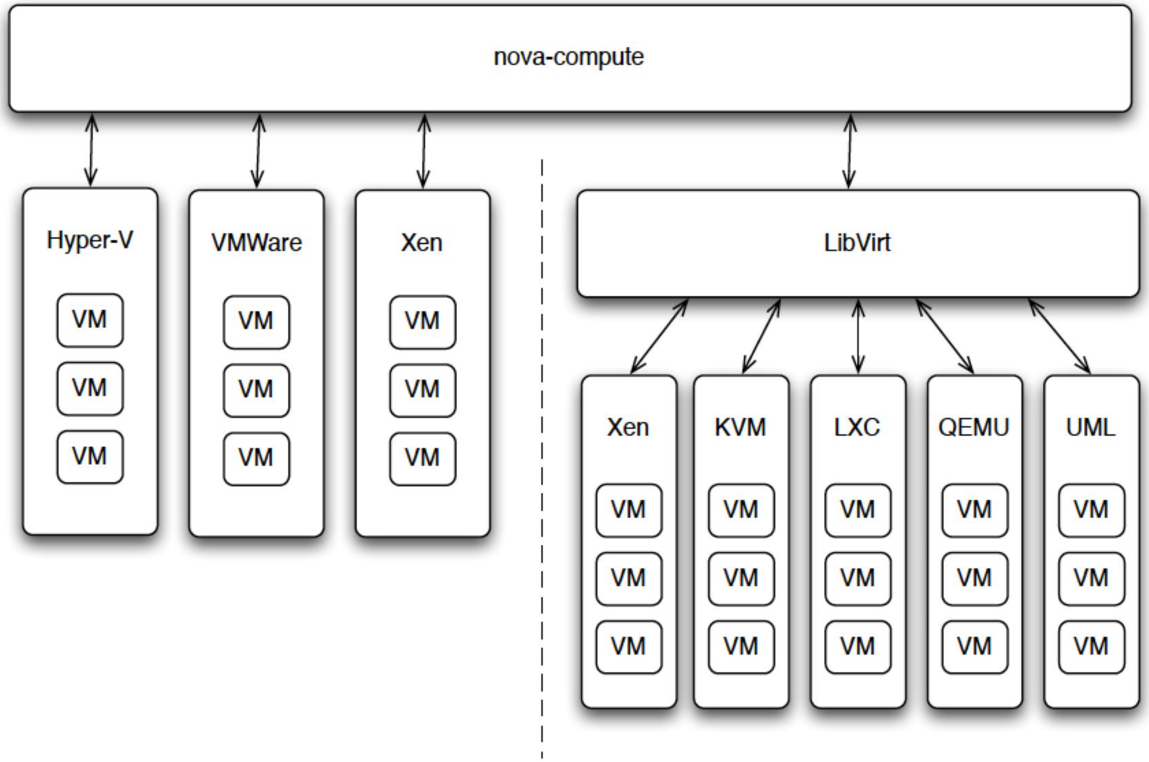




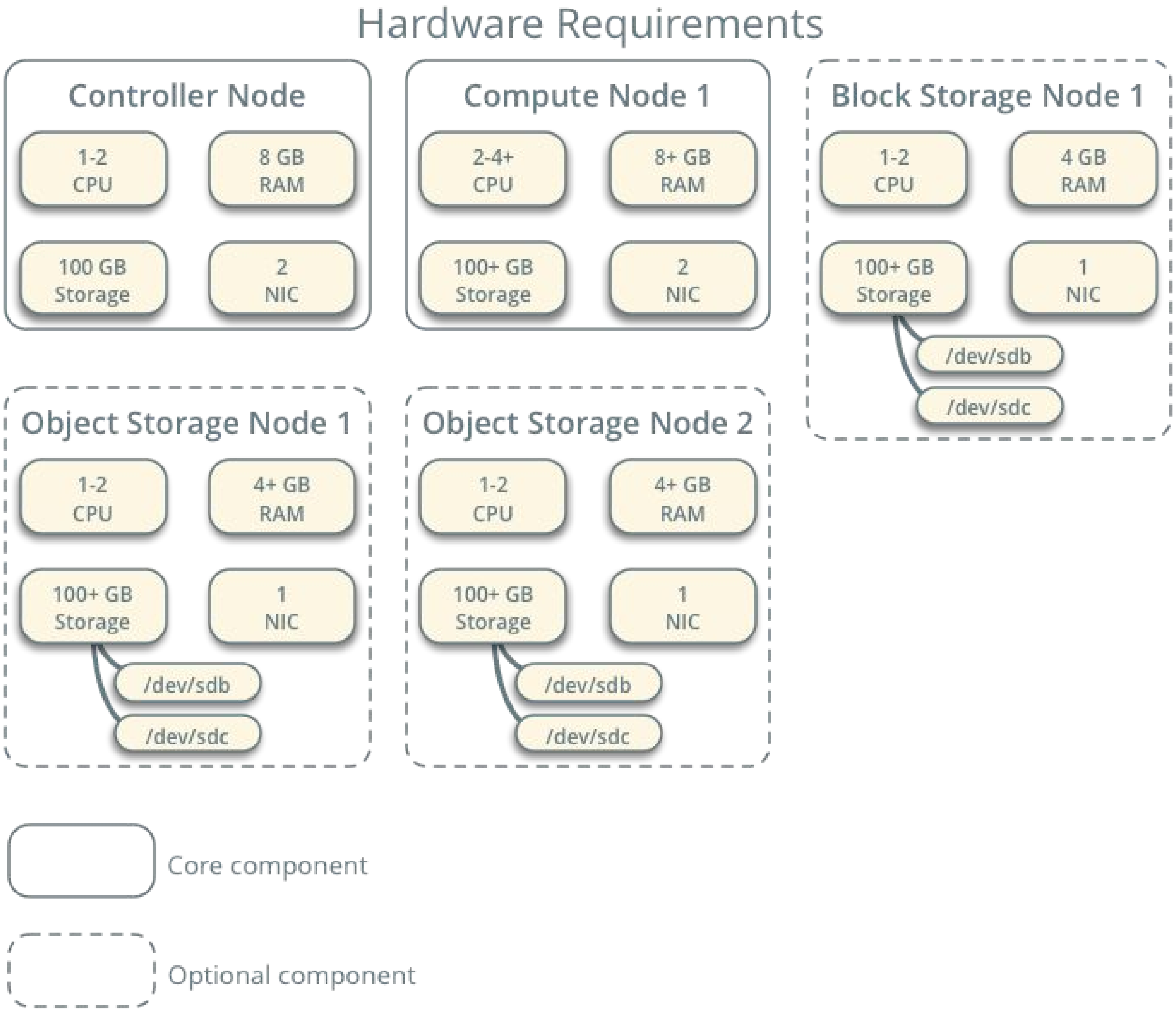
Computing as a Service - Nova

Technology agnostic – Virtual machine or container virtualization

Virtualization agnostic – Libvirt (KVM, QEMU, Xen, LXC), XenAPI, Hyper-V, VMware ESX, PowerVM, Docker, Bare-metal



Deployment architecture - Example



Hardware Requirements

Controller Node

1-2 CPU

8 GB RAM

100 GB Storage

2 NIC

Compute Node 1

2-4+ CPU

8+ GB RAM

100+ GB Storage

2 NIC

Block Storage Node 1

1-2 CPU

4 GB RAM

100+ GB Storage

1 NIC

/dev/sdb

/dev/sdc

Object Storage Node 1

1-2 CPU

4+ GB RAM

100+ GB Storage

1 NIC

/dev/sdb

/dev/sdc

Object Storage Node 2

1-2 CPU

4+ GB RAM

100+ GB Storage

1 NIC

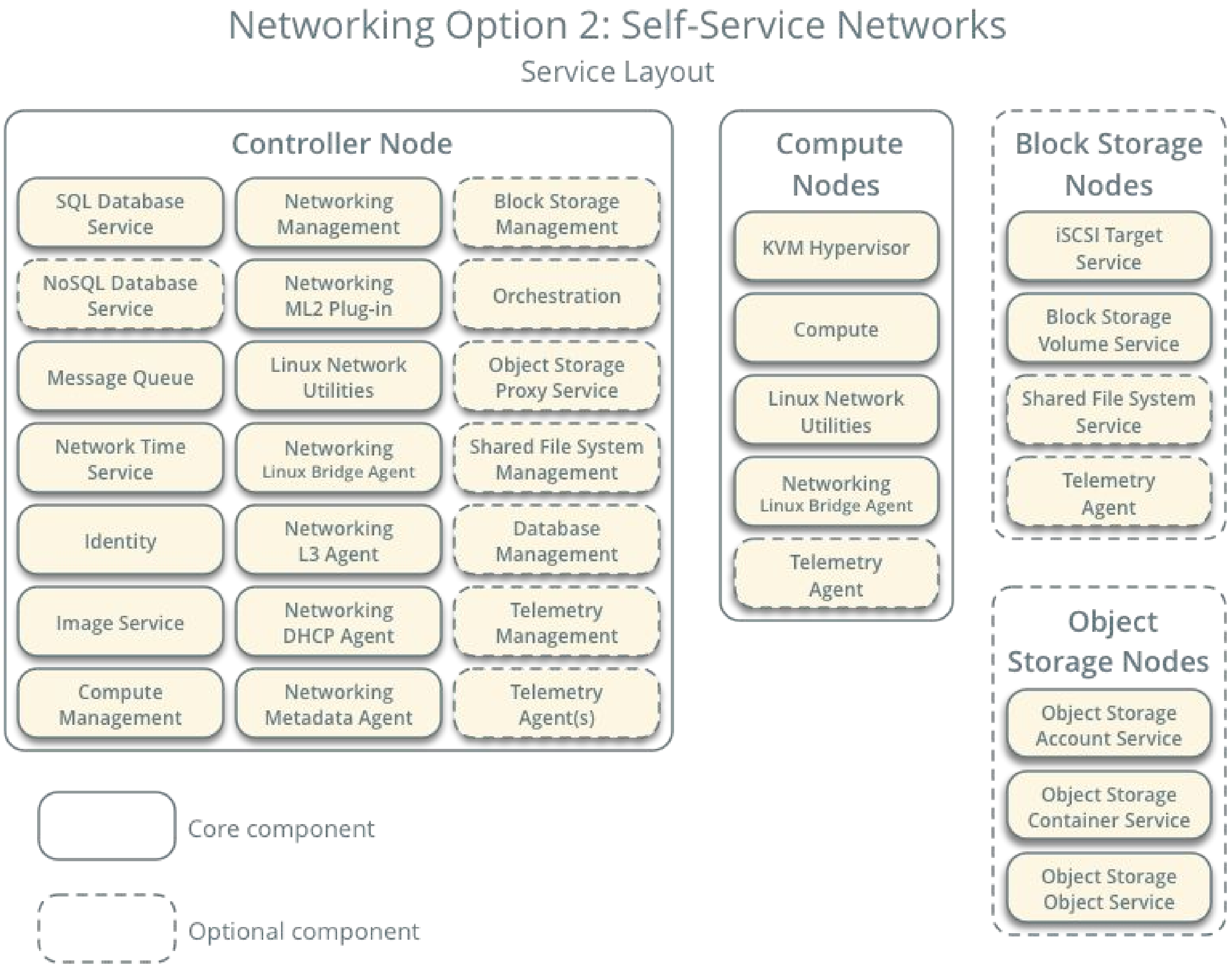
/dev/sdb

/dev/sdc

Core component

Optional component

Deployment architecture - Example



Networking Option 2: Self-Service Networks

Service Layout

Controller Node

- SQL Database Service
- NoSQL Database Service
- Message Queue
- Network Time Service
- Identity
- Image Service
- Compute Management
- Networking Management
- Networking ML2 Plug-in
- Linux Network Utilities
- Networking Linux Bridge Agent
- Networking L3 Agent
- Networking DHCP Agent
- Networking Metadata Agent
- Block Storage Management
- Orchestration
- Object Storage Proxy Service
- Shared File System Management
- Database Management
- Telemetry Management
- Telemetry Agent(s)

Compute Nodes

- KVM Hypervisor
- Compute
- Linux Network Utilities
- Networking Linux Bridge Agent
- Telemetry Agent

Block Storage Nodes

- iSCSI Target Service
- Block Storage Volume Service
- Shared File System Service
- Telemetry Agent

Object Storage Nodes

- Object Storage Account Service
- Object Storage Container Service
- Object Storage Object Service

Core component

Optional component

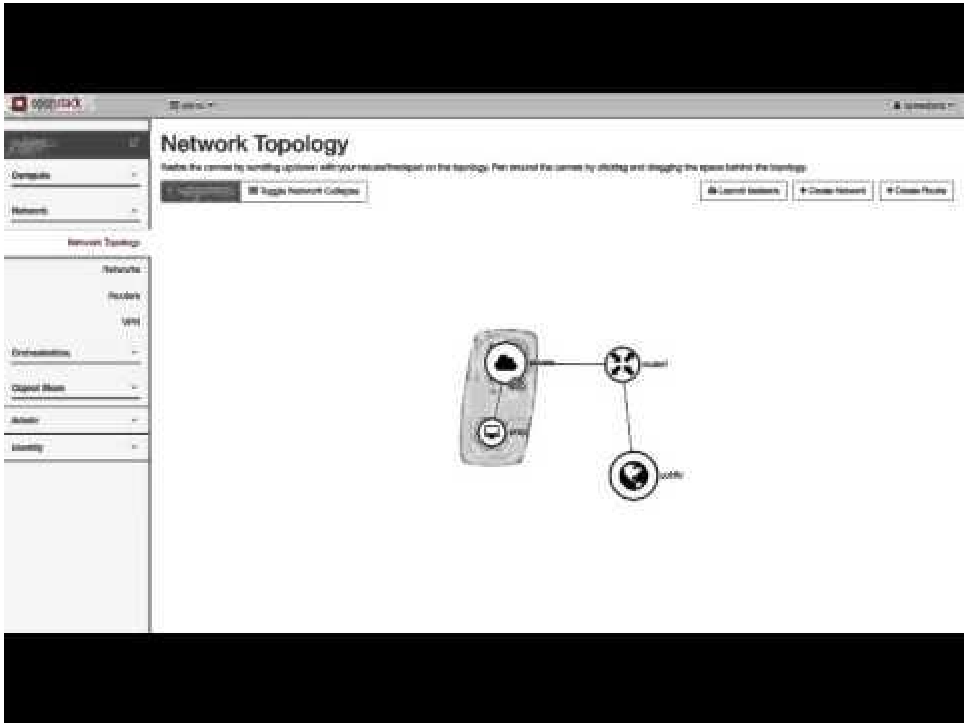
Deployment tool - Examples

- Automatic deployment used by community contributors:
  - Devstack: http://docs.openstack.org/developer/devstack/
- Manual deployment (Mitaka):
  - Ubuntu: http://docs.openstack.org/mitaka/install-guide-ubuntu/index.html
  - Redhat: http://docs.openstack.org/mitaka/install-guide-rdo/
  - Suse: http://docs.openstack.org/mitaka/install-guide-obs/
- Enterprise Deployment:
  - Distributions: Mirantis, RDO, SuSe Cloud, Ubuntu autopilot...

OpenStack Python API Example

```
import os
from novaclient import client

username = os.environ['OS_USERNAME']
api_key = os.environ['OS_PASSWORD']
auth_url = os.environ['OS_AUTH_URL']
project_id = os.environ['OS_TENANT_NAME']

nova = client.Client("2", username, api_key, project_id, auth_url)

nova.images.list()
[<Image: cirros-0.3.4-x86_64-uec>, <Image: cirros-0.3.4-x86_64-uec-ramdisk>, <Image: cirros-0.3.4-x86_64-uec-kernel>]

nova.flavors.list()
[<Flavor: m1.tiny>, <Flavor: m1.small>, <Flavor: m1.medium>, <Flavor: m1.large>, <Flavor: m1.nano>, <Flavor: m1.xlarge>]
image = nova.images.find(name="cirros-0.3.4-x86_64-uec")

flavor = nova.flavors.find(name="m1.tiny")
flavor.ram
512

instance = nova.servers.create(name="test", image=image, flavor=flavor)

nova.servers.list()
[<Server: test>]
```

OpenStack Dashboard - Demo



Network Topology

Resize the canvas by scrolling up/down with your mouse/trackpad on the topology. Pan around the canvas by clicking and dragging the space behind the topology.

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References

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- https://varchitectthoughts.files.wordpress.com/2013/06/screen-shot-2013-06-24-at-1-19-41-pm.png
- http://www.cmg.org/publications/measureit/2007-2/mit46/measureit-issue-5-11-the-performance-implications-of-container-based-os-virtualization/#
- http://referaat.cs.utwente.nl/conference/21/paper/7449/virtualization-andcontainerization-of-application-infrastructure-a-comparison.pdf
- Container?http://i.stack.imgur.com/a5Neb.png
- https://github.com/opencontainers/runc
- http://broadcast.rackspace.com/hosting_knowledge/whitepapers/Revolution_Not_Evolution-Whitepaper.pdf
- https://www.vmware.com/files/pdf/VMware_paravirtualization.pdf
- http://www.cubrid.org/blog/dev-platform/x86-server-virtualization-technology/
- https://goldmann.pl/blog/2014/09/11/resource-management-in-docker/
- http://docs.openstack.org/mitaka/install-guide-ubuntu/overview.html
- http://www.linux-kvm.org/images/7/7b/Kvm-forum-2013-openstack.pdf
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- https://fawzi.wordpress.com/2009/05/24/virtualization-and-protection-rings-welcome-to-ring-1-part-i/
- http://www-07.ibm.com/solutions/in/education/download/Virtualization%20in%20Education.pdf
- https://fawzi.wordpress.com/2009/05/24/virtualization-and-protection-rings-welcome-to-ring-1-part-i/
- http://www.gta.ufrj.br/ensino/eel879/trabalhos_vf_2010_2/fernando/caracteristicas.html
- http://www.redcentricplc.com/resources/articles/what-is-saas/
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