

Overview of OpenStack

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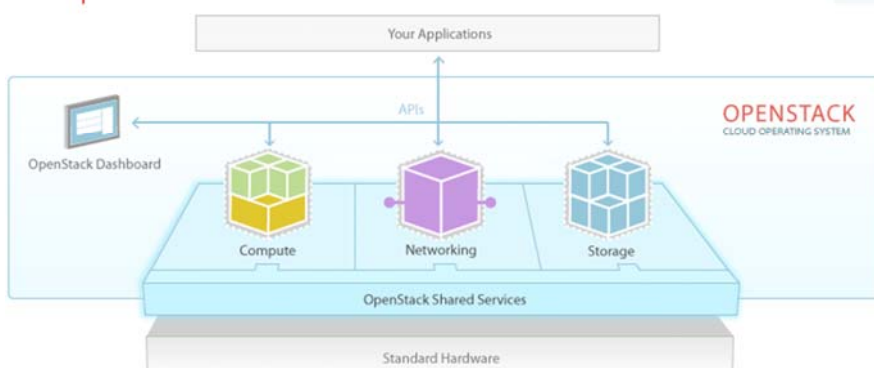
National Chiao Tung Univ.

OpenStack

- The NIST definition of cloud computing identifies
 - On-demand self-service
 - Broad network access
 - Resource pooling
 - Rapid elasticity
 - Measured service

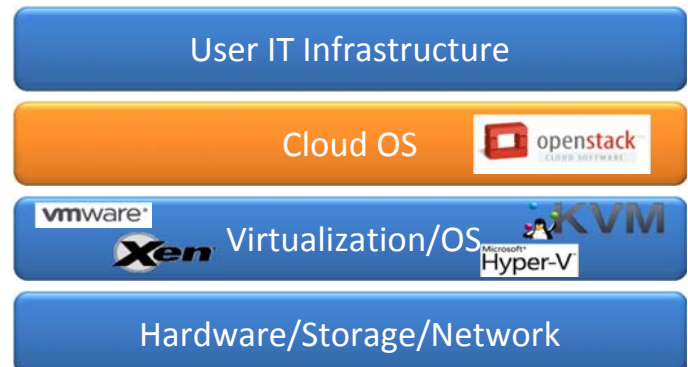


openstack
LOUD SOFTWARE



What is OpenStack

- Open Source Cloud Software
 - Foundation for IaaS, PaaS, and SaaS
- Controls large pools of compute, storage, and networking resources
 - Web portal for cloud admins and self-service users
 - Cloud services exposed through APIs
- Single Management Pane



Cloud system

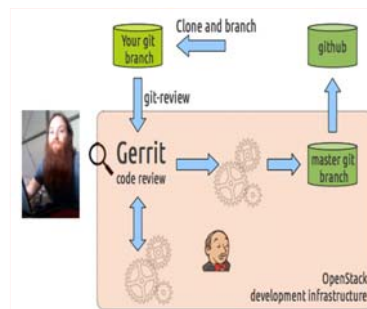
Beyond Open, Incredibly Flexible

Open Source

- Open Design Processes
- Open Source Community
- Open Source Development
- Available Under Apache 2.0 license

Flexible

- Built With Python
- Highly Modular
- Technical Meritocracy
- Hypervisor Flexibility

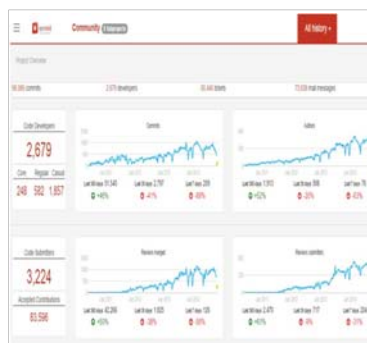


How Code Is Merged

Zuul: OpenStack's pipelining gating system

Jenkins: Runs tests

Gerrit: Manages approvals/rejections



OpenStack Development Activity Board @
activity.openstack.org

Stackalytics.com

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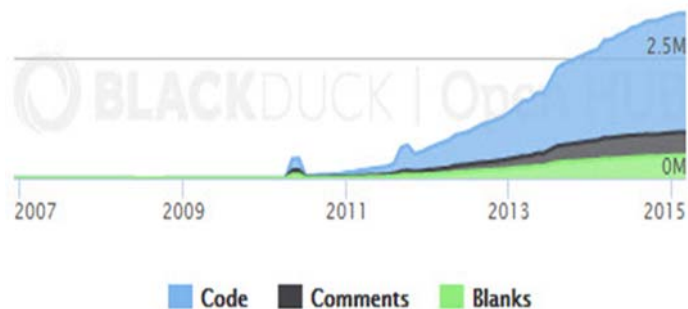
In a nutshell, OpenStack...

- **24M+ lines of code** is mostly written in **Python**
- has a **well-established, mature code base** maintained by a **very large development team**
- took an estimated **711 years of effort** (COCOMO model) starting from its first commit in December 2006

Languages



Lines of Code



Source: ohloh.net/p/openstack, March 2, 2015

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5

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Openstack Release History

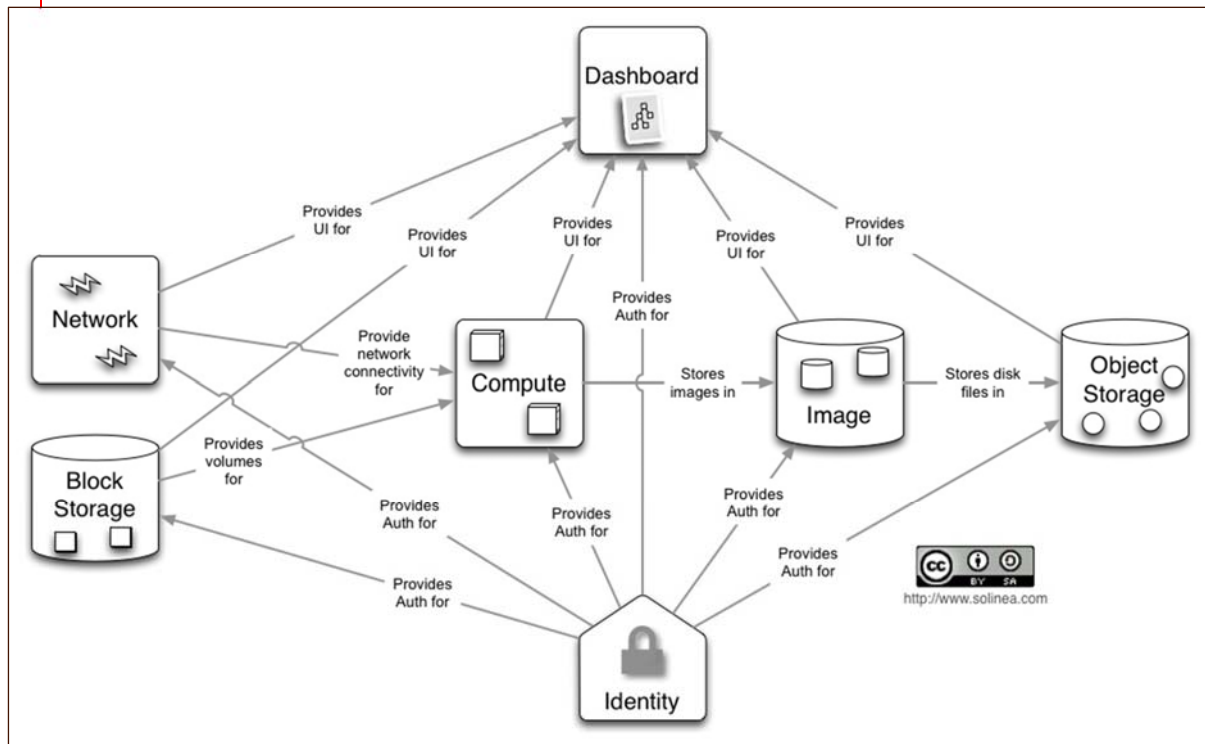
- ❖ Austin → 21 October 2010
- ❖ Bexar → 3 February 2011
- ❖ Cactus → 15 April 2011
- ❖ Diablo → 22 September 2011
- ❖ Essex → 5 April 2012
- ❖ Folsom → 27 September 2012
- ❖ Grizzly → 4 April 2013
- ❖ Havana → 17 October 2013
- ❖ Icehouse → 17 April 2014
- ❖ Juno → October 2014
- ❖ K-series → April 2015

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6

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OpenStack Conceptual Architecture

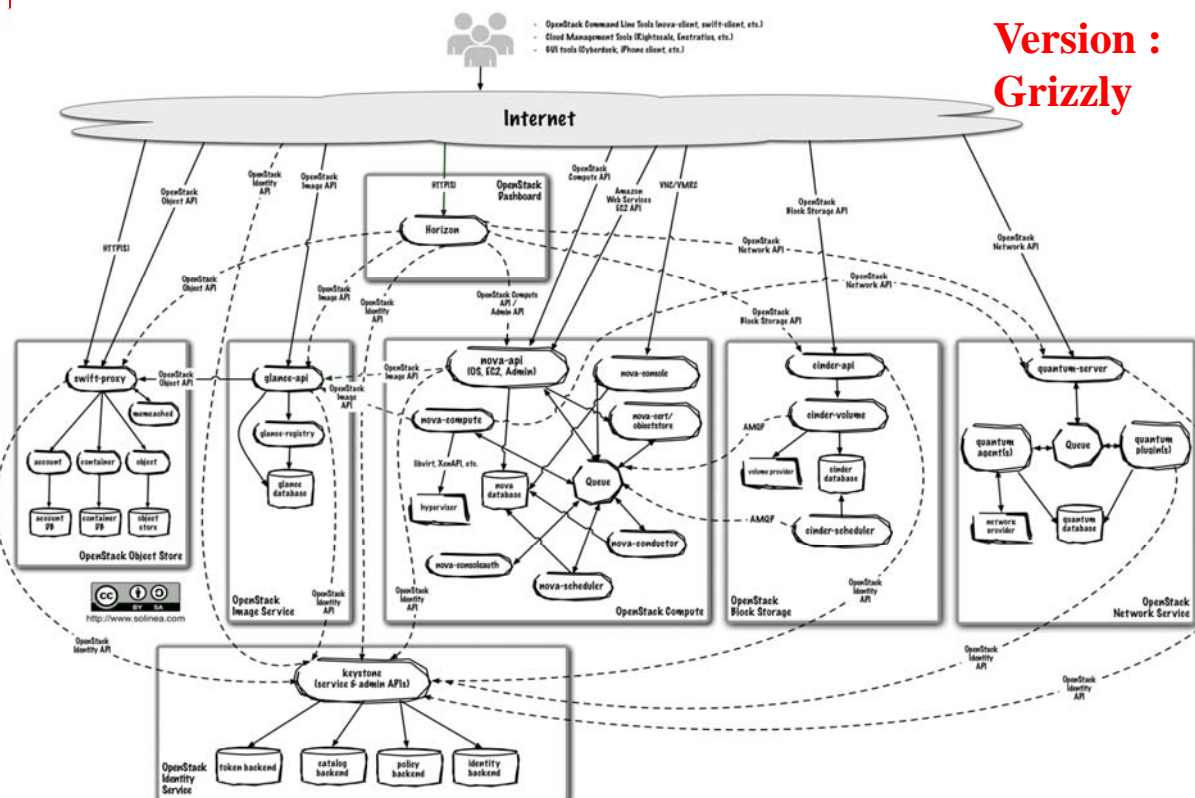


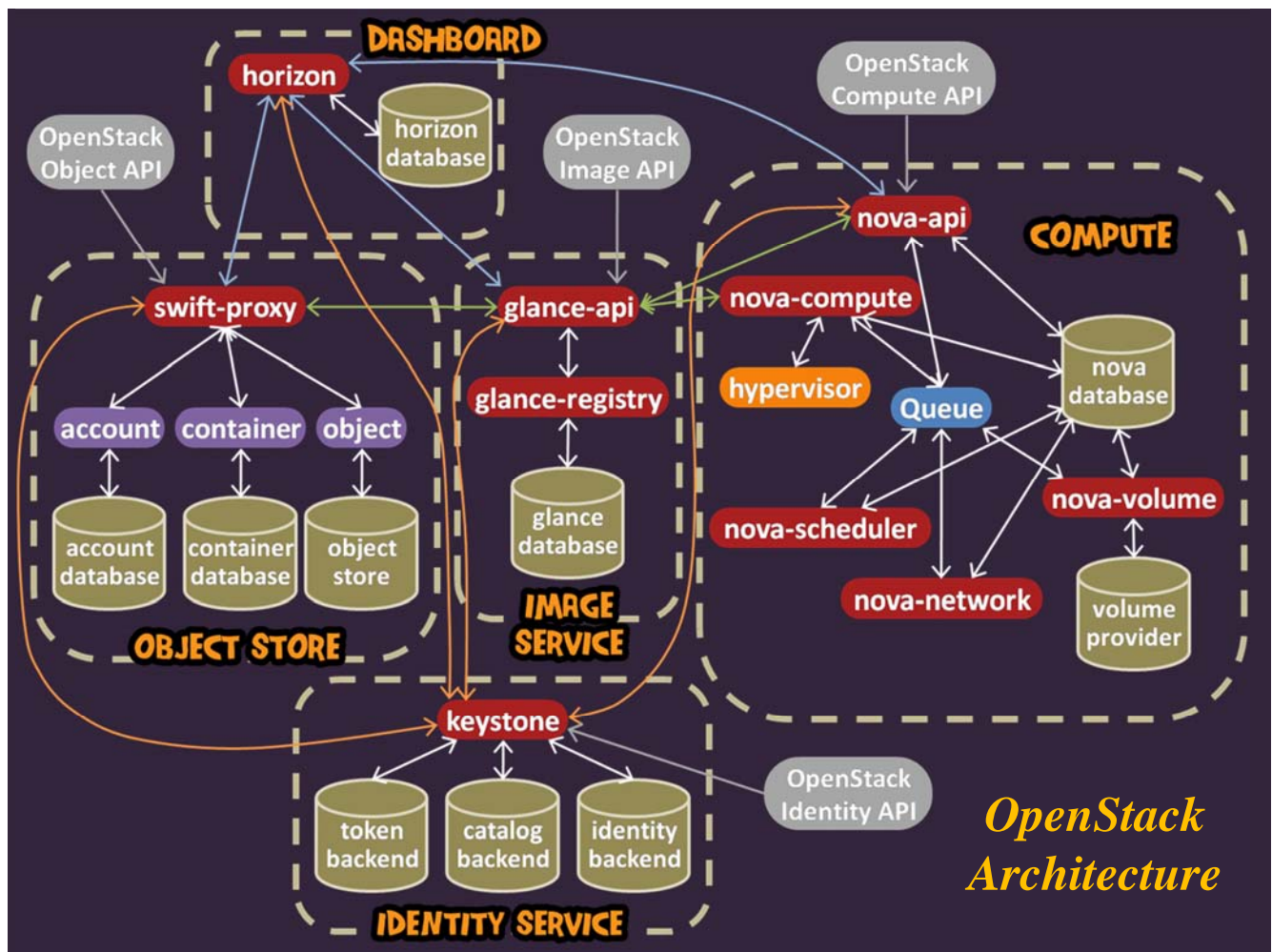
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7

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OpenStack Logical Architecture

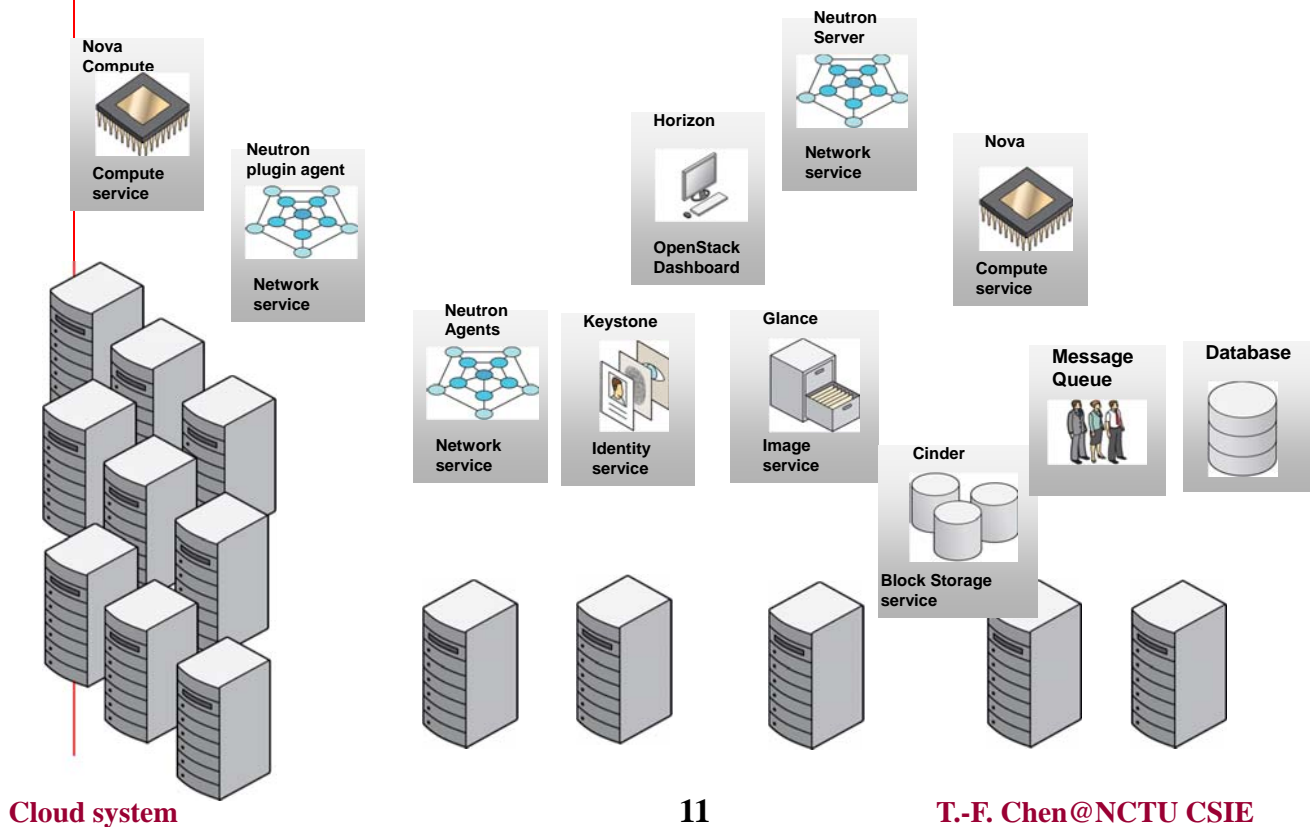




Components

Component name	Description
Compute (Nova)	allows the user to create and manage virtual servers using the machine images. It is the brain of the Cloud. OpenStack compute provisions and manages large networks of virtual machines
Networking (Neutron)	pluggable, scalable and API-driven system for managing networks (VLAN, IP address, firewalls etc)
Block Storage (Cinder)	provides persistent block storage to running instances
Object Storage (Swift)	stores and retrieves unstructured data objects through the HTTP based APIs, fault tolerant due to its data replication and scale out architecture
Image Service (Glance)	provides the discovery, registration and delivery services for the disk and server images
Identity Service (Keystone)	provides a central directory of users mapped to the OpenStack services, provides an authentication and authorization service for other services
Dashboard (Horizon)	provides a web-based portal to interact with all the underlying services
Telemetry Service (Ceilometer)	monitors the usage of the Cloud services and decides the billing accordingly
Orchestration Heat	manages multiple Cloud applications through an OpenStack-native REST API and a CloudFormation-compatible Query API
Database as a Service (Trove)	allows users to quickly and easily utilize the features of a relational database without the burden of handling complex administrative tasks
Messaging as a Service (Marconi)	cloud messaging and notification service for developers building applications on top of OpenStack

Deploying OpenStack Services



OpenStack Components

- **Computing**
 - OpenStack Compute (**Nova**)
 - OpenStack Image service (**Glance**)
- **Networking**
 - OpenStack Networking (**Quantum**)
- **Storing**
 - OpenStack Object Storage (**Swift**)
 - OpenStack Block Storage (**Cinder**)
- **Identity** : **Keystone**
- **Dashboard** : **Horizon**

OpenStack Components (Cont.)

- **Nova Compute**
 - Compute resource management and Scheduler
 - VM life cycle management and VNC proxy
- **Glance**
 - Discovering, registering, and retrieving VM images
- **Quantum**
 - Manage VM's Network, assign floating IP, Iptables, openvswitch

OpenStack Components (Cont.)

- **Swift**
 - Object Storage (ex. Amazon S3)
- **Cinder**
 - Provides persistent block storage to VM
- **Keystone**
 - User Identity
 - Components need register to keystone
- **Horizon**
 - Web dashboard ◦ (ex. user login, VM create and terminate, volume create, security group and etc.)

OpenStack Compute (Nova)

- ❑ Component based architecture enabling quicker additions of new features;
- ❑ Fault tolerant, recoverable and provides API-compatibility with systems like Amazon EC2;
- ❑ Built on a messaging architecture and all of its components can typically be run on several servers; enable communications among components through message queue;
- ❑ Nova together with its components share a centralized SQL-based database; for larger deployments an aggregation system will be in place to manage the data across multiple data stores;
- ❑ Supports virtualization technology: KVM, XenServer, Linux Container (LXC);
- ❑ Supports ARM and x86 etc hardware architectures.

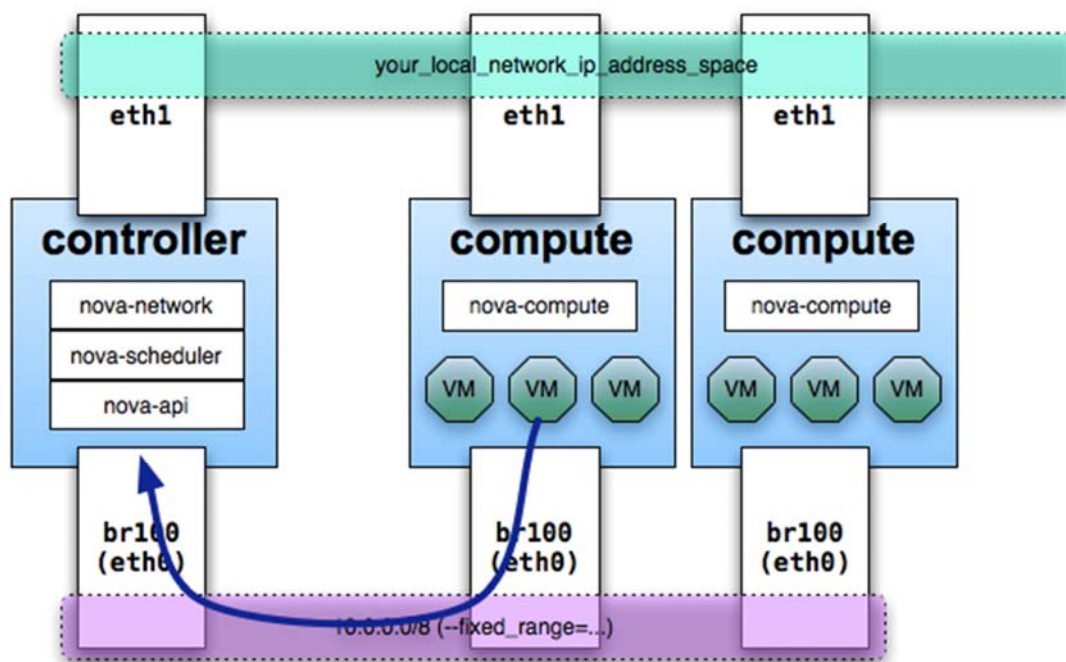
Source: <http://blog.flux7.com/blogs/openstack/tutorial-what-is-nova-and-how-to-install-use-it-openstack>

Nova Components

- ❑ **DB:** SQL database for storing data
- ❑ **Web Dashboard:** External component to communicate with the API
- ❑ **API:** Component that uses the queue or http to communicate with other components and to receive http requests
- ❑ **Auth Manager:** A python class used by all components to communicate with the backend DB or LDAP. Also, this component is responsible for users, projects and roles.
- ❑ **Object Store:** Replication of S3 API allowing storage and retrieval of images
- ❑ **Scheduler:** Allocates hosts to the appropriate VMs
- ❑ **Network:** Responsible for IP forwarding, bridges and vlans
- ❑ **Compute:** Controls the communication between the hypervisor and VMs

Source: <http://blog.flux7.com/blogs/openstack/tutorial-what-is-nova-and-how-to-install-use-it-openstack>

Example Nova configurations (1/2)



17

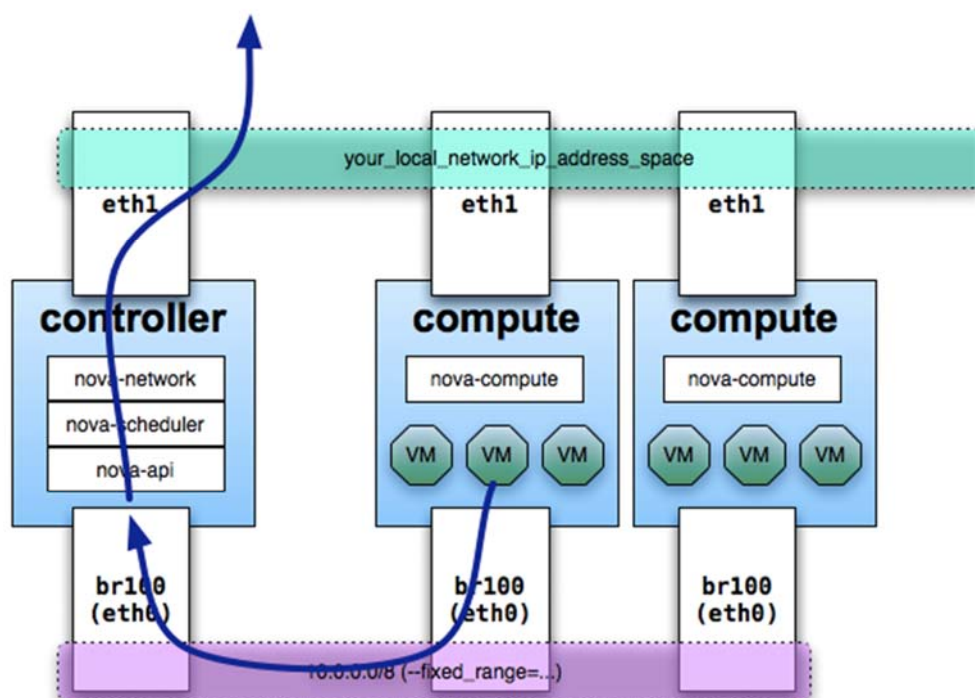
Source: <https://wiki.openstack.org/wiki/UnderstandingFlatNetworking>

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17

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Example Nova configurations (2/2)



Source: <https://wiki.openstack.org/wiki/UnderstandingFlatNetworking>

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OpenStack - Compute

- **API**

- nova-api : supports OpenStack Compute API, Amazon's EC2 API and a special Admin API
- nova-api-metadata : accepts metadata requests from instances

- **Computing core**

- nova-compute : creates and terminates virtual machine instances(KVM, qemu, XEN and etc)
- nova-schedule : schedule the VM to run on a host
- nova-conductor : “mediator” between nova-compute and the database

OpenStack – Compute(Cont.)

- **Networking for VMs**

- nova-network : setting up bridging interfaces or changing iptables rules -> quantum
- nova-dhcpbridge : tracks IP address leases and records -> quantum

- **Console Interface**

- nova-consoleauth : authorizes user's tokens that console proxies provide
- nova-novncproxy : provides a proxy for accessing running instances through a VNC connection

- **Image Management (EC2 scenario)**

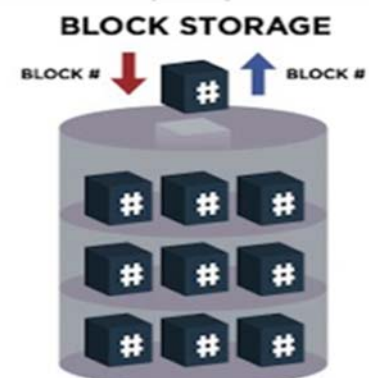
- Web dashboard ◦

OpenStack – Compute(cont.)

- **Image Management (EC2 scenario)**
 - nova-objectstore : provides an S3 interface for registering images onto the image management service
 - euca2ools client : euca2ools can be used to issue cloud management commands
- **Command Line Interpreter/Interfaces**
 - nova client
 - nova-manage client
 - Queue service : RabbitMQ
 - Database : sqlite3, MySQL and PostgreSQL

Object Storage vs Block Storage

- **Object Storage** the way in which we organize and work with units of storage, called objects
 - Every object contains three things data itself, metadata and unique identifier
 - Static Web content, data backups and archival images, and multimedia (videos, pictures, or music) files are best stored as objects
- **Block Storage** files are split into evenly sized blocks of data
 - each with its own address but with no additional information (metadata) to provide more context for what that block of data is



Storage at glance

❑ Block storage

- ❖ Assign virtual drives/volumes to virtual servers to grow their storage capacity, beyond the boot volume.
- ❖ Snapshots and backups of virtual servers.
- ❖ necessary for expandable file systems, maximum performance, and integration with enterprise storage services as well as applications that require access to raw block-level storage.

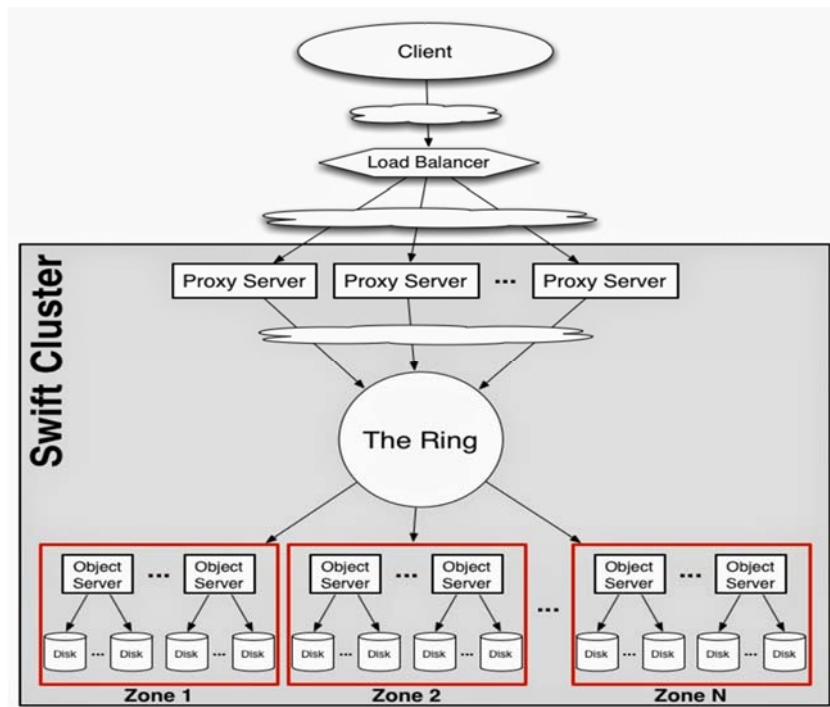
❑ Object storage

- ❖ Housing objects (any kinds such as files, media, images...)
- ❖ Suitable for storing large files

OpenStack – Object Store (swift)

- Distributed file system and prevent any single point of failure
- swift-proxy-server) accepts incoming requests via the OpenStack Object API or HTTP
- ❑ Object storage system provided under the Apache 2 open source license;
- ❑ Powering the largest object storage clouds, including Rackspace Cloud Files, the HP Cloud, IBM Softlayer Cloud and countless private object storage clusters;
- ❑ Like Amazon S3, has an eventual consistency architecture;
 - Which is in contrast against strong consistency in filesystems and block storage
- ❑ All objects, or files, stored in Swift have a URL;
- ❑ Applications store and retrieve data in Swift via an industry-standard RESTful http API;

OpenStack Swift Architecture



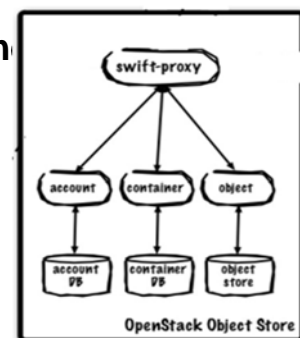
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Swift Overview - Server processes

- ❑ Proxy server
 - Responsible for tying together the rest of the Swift architecture
 - Looking up the location of the account, container or object in the ring and route the request accordingly
 - Handling failure cases
- ❑ Account server
 - Responsible for listings of containers
- ❑ Container server
 - Handling listings of objects
 - It doesn't know where those object's are, just what objects are in a specific container
- ❑ Object server
 - Simple blob storage server that can store, retrieve and delete objects stored on local devices
 - Objects are stored as binary files on the filesystem with metadata stored in the file's extended attributes (xattrs)



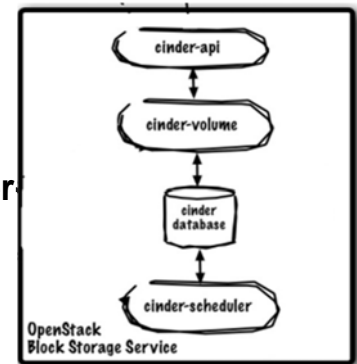
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26

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OpenStack – Block Storage: cinder

- **cinder-api**
 - accepts API requests and routes them to cinder-volume for action
- **cinder-volume**
 - maintain Cinder database state
 - interacting with other processes (like cinder-scheduler) through a message queue
 - access upon block storage
- **cinder-scheduler**
 - picks the optimal block storage provider node to create the volume on
- **Messaging queue: Routes information between Block Storage Service processes**

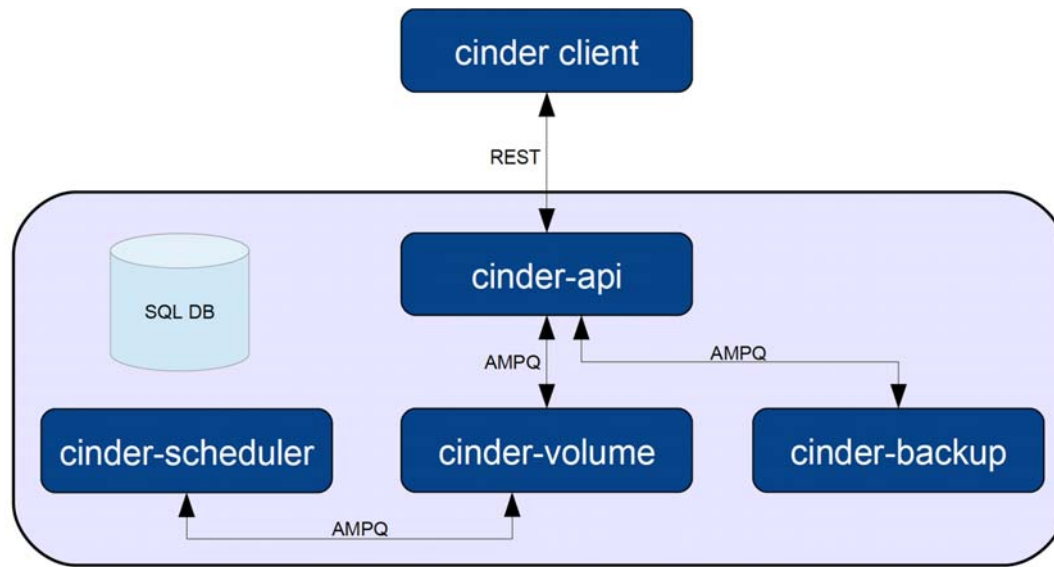


OpenStack Cinder

- ❑ Persistent block level storage device for use with OpenStack compute instances;
- ❑ Managing the creation, attachment and detachment of block devices to servers;
- ❑ Providing unified storage support for numerous other storage platforms, including Ceph, NetApp, Nexenta, SolidFire and Zadara;
- ❑ Providing snapshot management functionality for backing up data stored on block storage volumes that can be restored or used to create new block storage volumes.

Source: <http://blog.flux7.com/blogs/openstack/tutorial-what-is-cinder-and-how-to-install-and-use-it>

OpenStack Cinder Architecture



Source: <http://blog.flux7.com/blogs/openstack/tutorial-what-is-cinder-and-how-to-install-and-use-it>

Overview about OpenStack Storage

	Ephemeral storage	Block storage	Object storage
Used to...	Run operating system and scratch space	Add additional persistent storage to a virtual machine (VM)	Store data, including VM images
Accessed through...	A file system	A block device that can be partitioned, formatted, and mounted (such as, /dev/vdc)	The REST API
Accessible from...	Within a VM	Within a VM	Anywhere
Managed by...	OpenStack Compute (nova)	OpenStack Block Storage (cinder)	OpenStack Object Storage (swift)
Persists until...	VM is terminated	Deleted by user	Deleted by user
Sizing determined by...	Administrator configuration of size settings, known as <i>flavors</i>	User specification in initial request	Amount of available physical storage
Example of typical usage...	10 GB first disk, 30 GB second disk	1 TB disk	10s of TBs of dataset storage

Compare with Amazon Storage

Amazon Elastic Block Store (EBS)

High-performance block storage device

1 GB to 16 TB in size

Mount as drives to instances with
snapshot/cloning functionalities

Magnetic and General Purpose SSD



Very fast
'instance' disks

Amazon Simple Storage Service (S3)

Highly scalable object storage

1 byte to 5 TB in size

99.99999999% durability



Fast web object
storage

Amazon Glacier

Long-term object archive

Extremely low cost per gigabyte

99.99999999% durability



Slow, rare access



OpenStack

AWS

Object storage

Swift

S3 – Simple Storage Service

Block storage

Cinder

EBS – Elastic Block Storage

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31

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OpenStack – Image Store

- **glance-api**
 - accepts Image API calls for image discovery, image retrieval and image storage
- **glance-registry**
 - stores, processes and retrieves metadata about images (size, type, etc.)
- **A database to store the image metadata**
 - sqlite3, MySQL and PostgreSQL
- **image repository**
 - Swift, normal filesystems, RADOS block devices, Amazon S3 and HTTP

OpenStack – Identity

- **keystone**
 - handles API requests as well as providing configurable catalog, policy, token and identity services
- **pluggable backend**
 - LDAP or SQL and Key Value Stores

OpenStack – Network

- **quantum-server**
 - accepts API requests and then routes them to the appropriate OpenStack Networking plugins for action
- **Networking plugins and agents**
 - Plugins : Cisco virtual and physical switches, Nicira NVP product, NEC OpenFlow products, Open vSwitch, Linux bridging and the Ryu Network Operating System
 - Agents : L3 (layer 3), DHCP (dynamic host IP addressing)

OpenStack – Dashboard

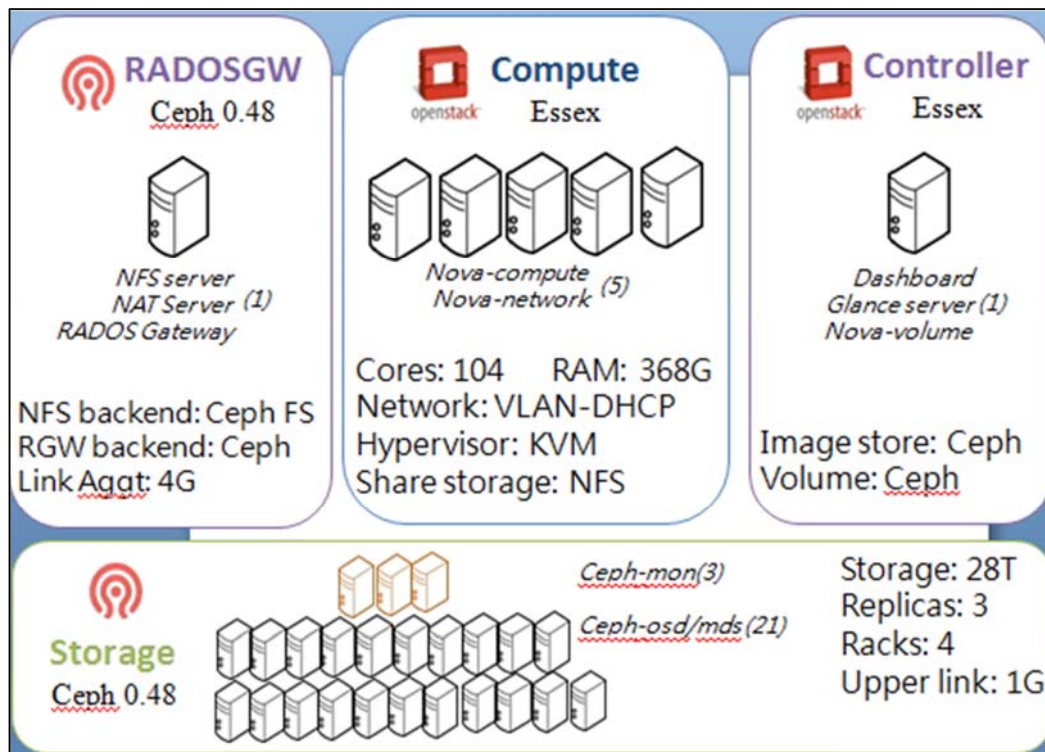
■ Horizon

- Horizon is a modular Django web application that provides an end user and administrator interface to OpenStack services

OpenStack corresponding to AWS

Service	OpenStack	Project Name	Amazon
Virtual Machines	Compute	Nova	EC2
Virtual Block Devices	Block Storage	Cinder	EBS
Object Storage	Object Storage	Swift	S3
Virtual Networks	Networking	Neutron (formerly Quantum)	VPC
App Orchestration	Orchestration	Heat	CloudFormation
App Monitoring	Measurement	Ceilometer	CloudWatch
Tenant Auth / Namespace	Identity	Keystone	IAM
Boot Images	Image Service	Glance	AMI
Dashboard	Dashboard	Horizon	Management Console

NCTU OpenStack - Essex

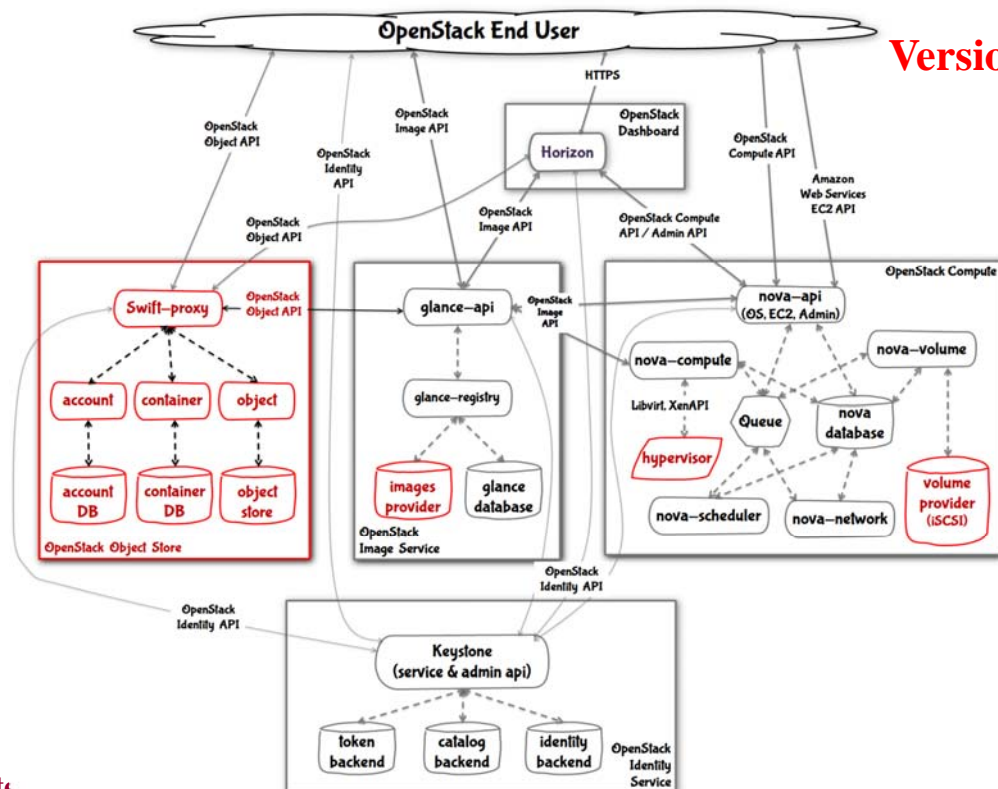


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37

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OpenStack(Essex) with Swift

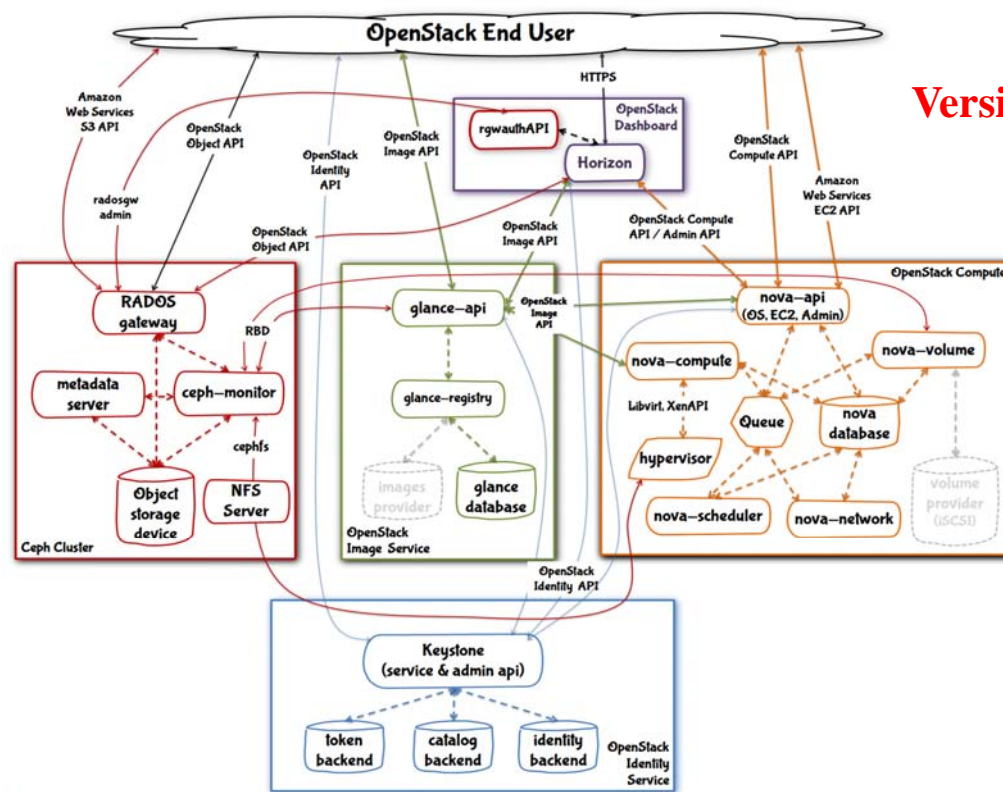


Version : Essex

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NCTU OpenStack(Essex) with Ceph



Version : Essex

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