OpenStack Cloud Storage

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HP Storage
What is OpenStack®

Free open source (Apache license) software governed by a non-profit foundation (corporation) with a mission to produce the ubiquitous Open Source Cloud Computing platform that will meet the needs of public and private clouds regardless of size, by being simple to implement and massively scalable.

- **Massively scalable** cloud operating system that controls large pools of compute, storage, and networking resources
- **Community open source** with contributions from 1000+ developers and 180+ participating organizations
- **Open** web-based API *Programmatic Infrastructure* as a Service
- **Plug-in architecture**; allows different hypervisors, block storage systems, network implementations, hardware agnostic, etc.
What is OpenStack®

A series of interrelated projects that control pools of compute, storage, and networking infrastructure exposed as a consistent and open layer (API) for a heterogeneous Infrastructure as a Service (IaaS) environment.
OpenStack® programs (13 Integrated; 2 supporting)

- 13 packages with 200+ configuration items

Image source: http://docs.openstack.org
OpenStack® releases

6-Month Release Cycles
• Spring and fall releases for predictable availability
• Release names use alphabetic naming

Planning
• Developers plan the next release at the Design Summit
• Sessions are selected by projects leads and are generally driven by blueprint topics
• Project Technical Leads (PTLs) accept a number of blueprints into the release plan

Development & Testing
• Milestone iterations (commonly 5 weeks) are defined and followed
• Development/documentation occurs per the blueprints and plan
• End of cycle testing with a defined Release Criteria process

Release
• Release Candidate is made available
• Next release is open for development
• After hardening, release occurs
Cloud Storage 101

**Block Storage**
- Generally SCSI protocol based, organized by volumes
- Boot volumes for VMs
- Ephemeral vs. Persistent
- Not directly consumed by applications, usually used to hold a filesystem
- Low level storage abstraction upon which file and object storage is built

**File Storage**
- Files organized in directory hierarchy and accessed by pathname
- File-based NAS protocols like NFS and CIFS
- Rich and complex application support: random access, multiple readers, in-place file updates, locking, etc.

**Object Storage**
- Efficient flat namespace: objects organized by accounts, containers, object keys, and metadata
- HTTP / REST / URL based – easily scriptable, many language choices
- Relatively simple interface compared to file storage
- Scalable to very high object counts
- More easily scaled across multiple geographies
- Ideal for relatively static data
Cloud Storage 101

Cinder
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Types of block storage

- **Ephemeral storage**
  - Usually used as a boot disk
  - Backed by VM Host local disk
  - Disappears when a VM is deleted or if a VM host fails

- **Persistent block storage**
  - Boot or additional storage volume
  - Not tied to the VM host, doesn’t go away if VM disappears
  - Accessed over a network
  - Must be provisioned first, and then attached to a VM
OpenStack Block Storage - Cinder

- Nova Volume
  - Originally OpenStack Compute (Nova) included support for ephemeral volumes
    - Used for boot/runtime storage of VMs
    - Volumes were typically backed by VM server files
  - Nova Volume had limited support persistent volumes on iSCSI
- Beginning with the Folsom release, a separate persistent block storage service, Cinder, was created
  - Cinder is a core part OpenStack project
  - Consists of a plug-in interface for supporting various block storage devices
Cinder Core Functionality

- **Volumes**
  - Create, Show, Update, Extend, Delete Volume
  - List Volume Summaries/Details

- **Snapshots**
  - Create, Show, Update, Delete Snapshot
  - List Snapshot Summaries/Details

- **Volume types**
  - List/Show volume types
  - Volume types defined in cinder.conf file, “extra specs” for advanced features

- **Other features**
  - Backup to swift
  - Volume migration
  - QoS – extended specs
Cinder Supported Devices

- Drivers are available for
  - Ceph RADOS Block Device
  - Coraid AoE driver configuration
  - Dell EqualLogic volume driver
  - EMC SMI-S iSCSI driver
  - GlusterFS driver
  - HDS iSCSI volume driver
  - HP 3Par StoreServ Fibre Channel and iSCSI drivers
  - HP StoreVirtual (LeftHand)
  - Huawei storage driver
  - IBM XIV/DS8K volume driver
  - IBM GPFS volume driver
  - IBM Storwize family and SVC volume driver
  - NetApp unified driver
  - Nexenta drivers
  - NFS driver
  - SolidFire
  - VMware VMDK driver
  - Windows
  - XenAPINFS
  - XenAPI Storage Manager volume driver
  - Zadara
Cinder volume attachment

- NFS/shared file system
  - Volume file created on file share, attached through libvirt or other VM specific mechanism
  - All VM hosts must already be attached to file share
- iSCSI
  - Attach to iSCSI volume over TCP/IP network
  - Cinder provisions volumes on target, coordinates initiator and target connection
- FC
  - Pre-zoned/flat – Grizzly-Havana
  - Zoning – Icehouse-Juno
- Other options
  - Ceph RBD, ATAoE, …
Key new Cinder features - Icehouse

- Ability to change the type of an existing volume (retype)
- Add volume metadata support to the Cinder Backup Object
- Implement Multiple API workers
- Add ability to delete Quota
- Add ability to import/export backups in to Cinder
- Added Fibre Channel Zone manager for automated FC zoning during volume attach/detach
- Ability to update a volume type encryption
- Ceilometer notifications on attach/detach
Cinder Futures

- Better testing – continuous integration
- Better backup support - incrementals
- HA
  - LVM driver – DRBD
- Bare metal boot
- Volume manage/unmanage
- Consistency groups
- Storage Pools
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OpenStack Object Storage - Swift

- Swift was one of the original components of OpenStack
  - Originally developed by RackSpace
  - Distributed scale-out shared-nothing object storage
- Web APIs for data access
  - HTTP Put, Get, Post, Delete, ...
- Swift is open source code, not an API standard
  - There is no compatibility suite and the API is subject to change
  - Enhanced direct implementations
    - SwiftStack, HP (StoreAll), etc.
  - Some vendors implement Swift compatible APIs
    - Ceph, Cleversafe, etc.
  - Some vendors have swift plugins – diskfile layer
    - Gluster, Seagate Kinetic, etc.
Swift Storage Model

- Users authenticate with Keystone
- Each account owns a set of containers
- Containers hold a set of objects
  - Containers have metadata
  - Access permissions at container
- Objects contain data
  - Size is limited, composite objects supported for larger objects
  - Objects also have metadata
  - User specifies object name
  - Name can contain pseudo-paths
Swift Operation

1. Users and applications request to store and retrieve data through the native OpenStack API or the Amazon S3 compatible API

2. Each data object is stored redundantly by making multiple copies to different nodes (hardware devices). There are no size limits on the objects stored.

3. Just by adding more nodes, clusters are massively scalable to multi-petabyte size and billions of objects

Image source: http://rogerluethy.wordpress.com
Swift Details

- **The Ring**
  - hash map between names and physical location
  - separate rings for accounts, containers, and objects
  - uses zones, devices, partitions, and replicas.
  - Partitions are replicated, by default, 3 times

- **Proxy Server**
  - responsible for tying together the Object Storage architecture.
  - for each request, it looks up the location and routes the request.
  - public developer API is exposed through Proxy Server.

- **Container Server**
  - primary job is to handle listings of objects
  - doesn’t know where those object’s are
  - listings are stored as SQLite files, replicated across cluster
Swift Details (cont.)

- **Account Server**
  - similar to the Container Server, responsible for list of containers
  - list are stored as replicated sqlite database files

- **Object Server**
  - simple server that can store, retrieve and delete objects
  - objects are stored as binary files on the filesystem
  - metadata stored in extended attributes
  - DiskFile API can be used to access external stores
Swift Details (cont.)

- Replication
  - keeps the system in a consistent state through temporary errors
  - compares local data with remote copies to maintain the latest version.
  - replication updates are push based, updating is rsync or ssync
  - pushes records over HTTP or rsync/ssync database files.

- Updaters
  - sometimes container or account can not be immediately updated.
  - if an update fails, it is queued locally, the updater will process it
  - eventual consistency

- Auditors
  - Auditors crawl the local server checking integrity
  - If corruption found, file is quarantined, replication will replace
  - other errors are logged
Other Features

- **ACLs**
  - Account ACLs supported at container level

- **Global clusters**
  - Support for geo-dispersed zones – region tier
  - Differing replica counts per region
  - Read from closest replica – based on timing
  - Write affinity

- **Bulk requests**
  - Auto extract of archive files (e.g., tar)
  - Bulk delete

- **Quotas**
  - Allows admin to set per account limits (bytes)
Swift Futures - Policies

- **Policies (Juno)**
  - Allows user to specify how they want data stored
    - Hardware, encoding, # copies
    - Based on multiple ring architecture
  - Precursor for erasure codes or other differentiated storage

![Diagram](http://blog.swiftstack.com)
- Erasure coding has been used widely in RAID for years
  - Can yield improved storage efficiency and/or reliability
  - Objects broken into data and parity “shards” by proxy servers,
  - Shards stored like objects, reconstruction at proxy when retrieved

Put:  
Data:  
Parity:  
Fragments, schematically:
Swift Futures – Erasure Codes

- Project status
  - Driven by Intel, SwiftStack, Box and EVault
  - Still in progress, probably won’t make Juno

Image source: http://blueprints.Launchpad.net
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OpenStack Shared File Storage

- Not originally planned for OpenStack,
  - Clouds like AWS don’t have shared file storage
  - Security and networking issues are difficult
- Demand has continued for this type of a service
  - For legacy applications that are not object storage enabled
  - Other options like running NFS on a VM or Gluster across nodes are complex to get right
- Originally proposed as an extension to Cinder
  - Implemented in Grizzly Cinder
  - Split into a new project “Manila” in Havana

Image source: http://wiki.openstack.org/wiki/Manila
Manila vs. Cinder

- Shared Filesystems
  - Instances are able to communicate directly with the storage backend over the network
  - Uses NFS or CIFS to talk to shares, multiple readers/writers are expected
  - Storage backend is able to serve multiple tenants while maintaining secure separation between them

- Block storage
  - Usually iSCSI or FC, like a disk
  - Exposed through the hypervisor, actual “mount” is to VM host
  - Typically single attach (or if multiple attach coordination is required to corruption)

- Additional work is needed for the networking portion of Manila
  - Attaching a shared filesystem to one or more instances in a tenant network
  - Setup of security domains and other features that exist in a NAS environment but not a SAN environment
Manila core functionality

- **Back-ends**
  - Generic – creates a VM running SMB or NFS
  - Vendor drivers

- **Functions**
  - Create or delete a share
  - Show or list shares
  - Allow/deny access to a share
  - Create/delete share snapshots, list snapshots
Manila Project

- Manila emerged as a separate project over Summer 2013
  - Recently promoted to “Incubator” project for Juno
  - Goal is to make core in Kilo (or later)
- Still in development, and looking for more participation
Manila Roadmap

- **Icehouse**
  - full multitenancy so that drivers are able to automatically create virtual instances
  - "generic" driver which implements multitenancy by layering on top of Nova and Cinder
  - Drivers for hardware that can't support secure multitenancy still allowed to exist in single tenant mode.

- **Juno**
  - Broaden driver support
  - Create a mechanism to provide gateway-based secure multitenancy
    - To support storage backends that only support single tenant mode.

- **Kilo**
  - Progress towards inclusion in core
  - Hardening, broader support
Summary

- OpenStack is free open source software for implementing public and private clouds
  - Many companies and individuals are involved in development
  - Products and services based on OpenStack exist today, and more are appearing as it matures
- OpenStack has support for block, object, and file storage
  - Both open source and commercial storage products supported
  - These provide basic and advanced functionality
  - More features, drivers, implementations are in the works
- OpenStack is maturing quickly
  - Give it a try – multiple free and commercial source distributions
  - There is plenty more work to do
  - The development process is open to anyone who wants to help
Questions?

- More Information
  - [http://openstack.org](http://openstack.org)
  - [http://docs.openstack.org](http://docs.openstack.org)
  - [https://launchpad.net/cinder](https://launchpad.net/cinder)
  - [https://launchpad.net/swift](https://launchpad.net/swift)
  - [https://launchpad.net/manila](https://launchpad.net/manila)

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