Linux Storage Stack for the Cloud

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Who am I
Agenda

- Storage virtualization – Why, What and How?
- Challenges & Solutions in the enterprise
- oVirt Design and Implementation
- Q&A
Why storage virtualization?

- Limited physical disk interfaces
- Fixed size
- Can’t join disks
  - Performance
  - Storage array limitations
  - Multiple arrays
Storage virtualization

Create virtual devices with disk behavior

- Partition table
- Storage arrays
- LVM
Storage with benefits

- Space flexibility
- Create devices ‘on the fly’
- Snapshots
A virtual disk for a vm

- One image is worth many volumes
- Volume:
  - YABS – Yet Another Block Sequence
- Volume types:
  - File
  - Block
What is the problem?
Enterprise storage needs

Multiple **data centers**
  
  x

hundreds of **hosts**
  
  x

hundreds of **VMs**
  
  x

multiple **disks**
  
  x

potentially dozens of **snapshots**

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**VERY BIG HEADACHE**
Storage challenges

- Host independent VMs
- Quantity of volumes
- Size of storage
Host independent VMs

KVM Forum, Oct 2013
Solutions

- **Host independent VMs**
  - Shared storage

- **Quantity**
  - Creation on the fly
  - Templates
  - Centralized DB

- **Size**
  - Over-commitment
  - Thin provisioning
  - Templates (Shared data, same OS)
oVirt Implementation
oVirt snapshot

- Use *qcow2*
- file and block volumes
- provides COW volumes
- Thin volumes
File
File volumes

- **Quantity**
  - create and manage files using the file system
  - “Unlimited”

- **Size**
  - Dynamic sizing
  - Sparse files

- **Shared storage**
  - NAS
  - Synchronizing access
Block
Block volumes

- **Quantity**
  - How do we create a block device?
  - How many block devices are supported?

- **Size**
  - How can we resize a block volume?
  - Is thin provisioning possible?

- **Shared storage**
Using remote storage. But...

- Different storage vendors, models
- No standard interface

Why Block?

- File system performance overhead
- Customer requirements
Using SAN

- Initiator, Target, LUN = GUID

- **Transport** for the SCSI commands
  - FC
  - iSCSI

- **Redundancy**
  - Multiple targets for the same LUN
  - How can we tell if it’s the same LUN?
Redundancy and Multipath

• **Using Multipath**
  - Query the storage to obtain the GUID
  - A new GUID is mapped through `device-mapper`
  - Use rules to choose the preferred path for the device

• Fail fast
• Pause VM
• I/O failure never reaches guest OS
• Auto resume
Why device-mapper?

- mapping block devices onto virtual block devices
- Used by multiple Linux storage stack components
- Multipath, RAID, LVM, crypt, etc...
Creating and managing block images

- LVM provides a unified interface
- Volume is implemented as an LV
- Easy provisioning: `lvcreate`, `lvremove`
- Thin provisioning: `lvextend`

* [http://www.markus-gattol.name/ws/lvm.html](http://www.markus-gattol.name/ws/lvm.html)
Very specialized use of LVM
Thin provisioning

- No use of LVM native thin provisioning
- LV initial size – 1GB
- Extend LV when:
  - VM paused due to ENOSPC
  - High watermark (monitoring qemu) identified
Need a clustered solution

- create, remove, extend are VG MD writes
- Simultaneous writes will cause MD corruption
- cLVM did not scale
- No synchronization mechanisms
LVM configuration

- **Hybrid mode and compartmentalization**
  - Runtime config, separate for vdsm
    - to avoid affecting anything else on the host
    - Allow admin to make changes outside of vdsm
  - LVM short filters
    - Speed up operations (by default LVM scans all devices)
    - Compartmentalize problems
    - Avoid accessing host ‘owned’ devices

- **Activate / deactivate**
  - Keep number of devices lower
  - Avoid refresh
Clustering LVM

- LVM MDA per PV by default
  - Problems
    - In clustered environment with more than 1 PV will cause corruption
    - Requires update of multiple areas to commit transaction
  - Solution
    - only 1 active MDA
    - oVirt MD as LV and VG tags
    - Lock type 4 (patches upstream)
• Storage Pool Manager
• A role assigned to one host
• Can be migrated to any host in a data center
• Creation, deletion and manipulation of volumes
• Single meta data writer
SPM algorithm

- Cluster membership based on
  - Light-weight leases for storage-centric coordination (Chockler and Malkhi 2004)
- Single recoverable leader
- Primitives: lease and renew
- Uniform
- Simple and efficient
SANLock

- Cluster membership, like SPM, based on
  - Light-weight leases for storage-centric coordination (Chockler and Malkhi 2004)
- Leases based on
  - Disk Paxos (modified for leases)
Summary

- Storage virtualization
- oVirt implementation
- oVirt snapshot
- File implementation
- Block implementation
- Multipath
- Device-mapper
- LVM
- SPM
THANK YOU!

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