KVM, OpenStack, and the Open Cloud

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Agenda

• A Brief History of Virtualization
• KVM Architecture
• OpenStack Architecture
• KVM and OpenStack
• Case Studies
  – NTT Com
  – Intel IT
  – CERN
• Additional Resources
A Brief History of Virtualization

- 1960s: Virtualization on Unix systems
- 1980s: Virtualization on mainframes
- 1990s: VMware hypervisor for x86
- 2000s: Xen hypervisor for x86
- 2010s: KVM hypervisor
- 2014: LXC / Docker

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Open Virtualization Alliance
Conceptual Framework

User Interface

Management Tools

Applications

Storage

Compute

Networking

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Introduction to KVM

User Interface
- oVirt
- Kimchi
- libvirt

Management Tools
- KVM

Applications

Compute

Storage

Networking
KVM Architecture

Open source hypervisor based on Linux

KVM
• Kernel module that turns Linux into a Virtual Machine Monitor
• Merged into the Linux kernel

QEMU
• Emulator used for I/O device virtualization

Processors supported
• x86 with virtualization extensions
  • Intel VT-x
  • AMD (AMD-V)
• POWER8
• IBM z Systems
• ARM64
KVM Performance

SPECvirt_sc2013

VMware (ESX 5.1), Intel Xeon E5 - 16 cores (HP)
KVM (RHEL 6.2), Intel Xeon E5 - 32 cores (HP)
KVM (RHEL 6.4), Intel Xeon E5 - 16 cores (IBM)
KVM (RHEL 6.4), Intel Xeon E5 - 24 cores (IBM)
KVM (RHEL 6.4), Intel Xeon E5 - 24 cores (IBM)
KVM (RHEL 6.5), Intel Xeon E5 - 60 cores (IBM)
KVM (RHEL 6.5), Intel Xeon E5 - 60 cores (IBM)
KVM (RHEL 6.5), Intel Xeon E7 - 120 cores (Lenovo)
KVM (RHEL 7), Intel Xeon E5 - 36 cores (HP)
KVM (Huawei FusionSphere), Intel Xeon E5 - 16 cores (HP)
KVM (Huawei FusionSphere), Intel Xeon E5 - 60 cores (Huawei)
PowerVM (IBM), IBM POWER8 - 24 cores (IBM)

Source: SPECvirt_2013 Published Results - http://www.spec.org/virt_sc2013/results/specvirt_sc2013_perf.html

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KVM Security

**SELinux**
- Mandatory Access Control (MAC) integrated into Linux
- Provides “need to know” security between processes

**sVirt**
- Combines SELinux and KVM
- Delivers “need to know” security between virtual machines

**Certifications**
- EAL4+ certification for KVM in RHEL 6 and SLES 11 SP 2 on various x86 64-bit Intel and AMD64-based hardware from Dell, HP, IBM and SGI
KVM Management - libvirt

User Interface

- Library
  - Open Source project
  - Manages multiple hypervisors

- Command Line
  - Powerful
  - Complex to use

- Network Daemon
  - Enables remote management

Base for other management tools
- virt-manager, Kimchi, oVirt
- OpenStack

KVM
Xen
LXC
...

Compute
KVM Management - Kimchi

**Kimchi**
- Open Source project
- Manages KVM on x86, Power

**User Interface**
- Easy to use
- Access from HTML5 web browser

**Servers managed**
- Single digits
KVM Management - oVirt

- oVirt
  - Open Source project
  - Manages KVM on x86

- User Interface
  - Web portals
  - Command line, API

- oVirt Engine
  - Manages VMs
  - Configures storage, network

- oVirt Nodes
  - Run virtual machines

- Servers managed
  - Tens to hundreds

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KVM Futures

• Heterogeneous processor support
  – ARM
  – POWER
  – System z
  – GPUs

• Network Function Virtualization

• Additional Performance Improvements
  – Minimizing locks
  – Multi-threaded device model

• Nested Virtualization
Building Open Clouds

- Security
- Resilience
- Performance
- Scalability – thousands of nodes
- Heterogeneity
- Interoperability
Introduction to OpenStack

OpenStack

User Interface
- Horizon
- Command Line

Management Tools
- Ceilometer
- Cinder
- Swift
- Glance
- Keystone
- Nova
- Neutron
- Horizon
- Glance
- Nova
- Neutron

Applications
- Heat
- Sahara
- Trove

OpenStack Components
- Choice of hypervisor
- Choice of storage
- Choice of network

Open Virtualization Alliance
OpenStack Design Principles

• Open
  – Open Development Model
  – Open Design Process
  – Open Community

• General Purpose
  – Balancing Compute, Storage, Network

• Massively Scalable

• Multi-site

• Resilient and recoverable
Nova – Compute Service

Manages VM lifecycle
- Starting and stopping VMs
- Scheduling and monitoring VMs

Key Components
- API
- Database
- Scheduler
- Compute node and plug-ins

Authentication
- Keystone

Access to VM images
- Glance
- Swift
OpenStack and Hypervisor Usage

Keystone – Authentication Service

**Manages security**
- Service for all other modules
- Authentication
- Authorization

**Key components**
- API
- Backends
  - Token
  - Catalog
  - Policy
  - Identity
Cinder – Block Storage Service

- Manages persistent block storage
  - Provides volumes to running instances
  - Pluggable driver architecture
  - High Availability

- Key components
  - API
  - Queue
  - Database
  - Scheduler
  - Storage plug-ins

- Authentication
  - Keystone

Horizon
Command Line
Keystone
Cinder
Choice of Block Storage
Storage
Neutron – Networking Service

**(Manages networking connectivity)**
- Provides volumes to running instances
- Pluggable driver architecture
- Support for range of networking technologies

**Key components**
- API
- Queue
- Database
- Scheduler
- Agent
- Networking plug-ins

**Authentication**
- Keystone
Glance – Image Service

Manages VM images
- Catalog of images
- Search and registration
- Fetch and delivery

Key components
- API
- Registry
- Database

Authentication
- Keystone

Storage of VM images
- Swift
- Local file system

VM Images
Storage
Keystone
Glance
Swift
Command Line
Horizon
Swift – Object Storage Service

**Manages unstructured object storage**
- Highly scalable
- Durable – three times replication
- Distributed

**Key components**
- Proxy / API
- Rings
  - Accounts
  - Containers
  - Objects
- Data stores

**Authentication**
- Keystone
Provisioning a VM

User Interface
- Horizon
- Command Line

Management Tools
- Cinder
- Swift
- Glance
- Nova
- Keystone

Applications
- Neutron

Storage
- Compute
- Networking

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OpenStack Futures – Kilo

• Horizon
  – Updated user interface
• Glance
  – Additional artifacts beyond just images
• Ironic
  – Bare Metal Provisioning
• Zaqar
  – Messaging and Queuing System
KVM and OpenStack

• KVM excels at choice criteria for Hypervisor
  – Cost
  – Scale & Performance
  – Security
  – Interoperability

• Development Affinity
  – Both open source projects
  – KVM is default hypervisor for OpenStack development

• Deployment Affinity
  – KVM is best supported, easiest to deploy, with most full-featured driver
NTT Com’s OpenStack Deployment

• NTT Com
  – Leading global carrier headquartered in Japan
  – Early adopter of both KVM and OpenStack
  – Basing one of its public cloud offerings on OpenStack and KVM

• NTT involvement
  – Actively involved with the OpenStack and KVM communities
  – Continues to contribute to the development of both projects, with an emphasis on the cloud service provider use case

• Use of OpenStack
  – Flexible plug-in infrastructure used as a unified orchestrator of both computing and networking resources
  – Integrate software-defined-networking (SDN)-powered enterprise VPN service, allowing customers to create virtual datacenters that can span two or more physical ones
  – GUI portal for its cloud services using OpenStack native APIs, letting customers provision and manage virtual machines, networks, and storage without having to know the OpenStack APIs

Source: IDC white paper – “KVM – Open Source Virtualization for the Enterprise and OpenStack Clouds”
Intel IT & OpenStack/KVM

Deployment History

- OpenStack Essex
- ~1000 virtual instances for external services
- qemu-system-x86_64 1.0

- OpenStack Grizzly
- ~3500 instances for multiple services (~40:1, ~100 vCPU)
- qemu-system-x86_64 1.4.2

Source: Open Virtualization Alliance presentation by IBM and Intel at LinuxCon Europe 2014

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Open Virtualization Alliance
# Intel IT & OpenStack/KVM

## KVM Benefits

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<th>Performance</th>
<th>Stability</th>
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| • 2012 Study on ‘standard’ cloud workloads (database)  
  • Par or better vs. marketplace  
  • HV realm is seemingly near-stable on straight performance | • Open Source, tight OpenStack and Linux kernel integration  
  • Hypervisor efficiency  
  • Drinking our own champagne - we’ve got a few KVM devs :-) |

## KVM Lessons Learned

<table>
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<th>Performance</th>
<th>Stability</th>
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| • Check flags – lots of features/options  
  • Windows guest updates  
  • Keep your images current | • Oversubscribing & big multi-vCPU instances  
  • Windows guest can be sensitive IO interruptions |

*Source: Open Virtualization Alliance presentation by IBM and Intel at LinuxCon Europe 2014*
CERN Private Cloud

• CERN
  – Fundamental research into particle physics
  – Large Hadron Collider seeking to find new particles
  – Massive need for scalable computing resource on demand

• CERN Private Cloud
  – Production since July 2013 with OpenStack using KVM, MySQL and RabbitMQ
  – Currently 3,200 hypervisors with 83,000 cores
  – Expected to reach over 100,000 cores by 2Q 2015

• Key Requirements
  – Scale
  – Technology and Developer ecosystem
  – Interaction with existing IT services

Source: CERN OpenStack public reference on www.openstack.org
Additional Resources

- Open Virtualization Alliance
  - https://openvirtualizationalliance.org
- IDC White Paper
  - “KVM – Open Source Virtualization for the Enterprise and Open Stack Clouds”
- New Linux Foundation Training Course
  - LFS540 – “Linux KVM Virtualization”
- OpenStack Foundation
  - http://www.openstack.org