OpenNebula’s LXD driver development: LXDoNe

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https://github.com/opennebula/addon-lxdone
Our old compute room

IT services
- Some running on bare metal
- Some running on unmanaged hypervisors

Legacy hardware
- Some units lacking virtualization extensions
- Low computing power per unit
Users complain a lot
Requirements

How to achieve a lower OPEX without incurring in CAPEX?
Hypervisors in the Cloud

- HVM has become the standard for data-center virtualized environments

- Our initial compute resources wouldn’t allow to deploy these technologies datacenter-wide
Operating System Level Virtualization

- Lightweight OSes
- No hardware support required
- No hardware emulation
- Fast boot times
- Low memory footprint
- High instance density
Application containers vs machine containers

**LXC**

- Host
  - VM1: Debian 64, PHP
  - VM2: Ubuntu 64, Ruby, PostgreSQL, Nginx, Discourse
  - VM3: CentOS 64, Nginx, Redis, Nginx, Ghost

- Filesystem neutral
- Containers are like VMs with a fully functional OS
- Data can be saved in a container or outside
- Build loosely coupled or composite stacks

**Docker**

- Host
  - VM1: Ubuntu
  - VM2: PHP
  - VM3: Nginx
  - VM4: Wordpres

- Container
  - Container storage volume
  - Layers to build app container
  - Layers to build app container

- Loosely coupled single app containers

- Containers are made up of read only layers via AUFS/Devicemapper
- Containers are designed to support a single application.
- Instances are ephemeral, persistent data is stored in bind mounts to host or data volume containers
System containers

A LXC container runs a full Linux system, exactly as it would be when run on metal or in a VM

- Easy migration from VM/bare metal running services
- Keeps the same system perspective for IT sysadmins
LXD vs KVM

Ubuntu Image Density - Single Intel Server

LXD has 14.5 times greater Density than KVM
LXD vs KVM

Time to Reach Capacity - Single Intel Server

LXD created 14.5 times more instances in 13% less time
LXC/LXD support on Private Clouds

- LXC group C (not recommended)
  - Relies on libvirt
  - Dropped support on Icehouse

- nova-lxd
  - Very far from being production ready
  - Not included on OpenStack's hypervisor support matrix
LXC/LXD support on Private Clouds
OpenNebula

**Simplicity**
You do not need an army of administrators to build and maintain your cloud

**Openness**
You will run production-ready software that is fully open-source without proprietary extensions that lock you in

**Reliability**
Your cloud will run for years with little maintain

**Flexibility**
You can easily build a cloud to fit into your data center and policies
Companies using OpenNebula

- BlackBerry
- Dell
- Harvard School of Engineering and Applied Sciences
- NBC
- Unity
- China Mobile
- IBM
- NASA
- SURF
- SARA
- CentOS
- Telefonica
- Telecom SudParis
- produban
- Akamai
- bit
OpenNebula interfaces
Driver development: LXCoNe

- Our initial approach
  - Did the work 3 years ago!
  - Direct LXC management
  - Poor implementation
  - Unmaintained project

https://github.com/opennebula/addon-lxcone
Driver development: LXDoNe

- Interacts with LXD lightervisor
- Active development
- Ceph ready
- Contextualization ready
- OpenNebula Marketplace virtual appliance
- Great Documentation
- Community acceptance and contributions

https://github.com/opennebula/addon-lxdone
Outreach

- Code contributions
- Doc enhancements
- Tests made by enthusiasts
- Github issues

https://github.com/opennebula/addon-lxdone
## Deployment

### Hosts

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Cluster</th>
<th>RVMs</th>
<th>Allocated CPU</th>
<th>Allocated MEM</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>palpatine.cujaec.edu.co</td>
<td>KVM</td>
<td>2</td>
<td>400 / 400 (100%)</td>
<td>10GB / 11.7GB (86%)</td>
<td>ON</td>
</tr>
<tr>
<td>6</td>
<td>chewie.cujaec.edu.co</td>
<td>LXD</td>
<td>14</td>
<td>2200 / 3200 (78%)</td>
<td>53GB / 62.8GB (84%)</td>
<td>ON</td>
</tr>
<tr>
<td>5</td>
<td>leia.cujaec.edu.co</td>
<td>LXD</td>
<td>18</td>
<td>2500 / 3200 (78%)</td>
<td>52GB / 62.8GB (63%)</td>
<td>ON</td>
</tr>
<tr>
<td>4</td>
<td>han.cujaec.edu.co</td>
<td>LXD</td>
<td>14</td>
<td>2600 / 3200 (81%)</td>
<td>48.5GB / 62.8GB (77%)</td>
<td>ON</td>
</tr>
<tr>
<td>3</td>
<td>organa.cujaec.edu.co</td>
<td>LXD</td>
<td>6</td>
<td>1000 / 800 (125%)</td>
<td>220GB / 157GB (140%)</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>watto.cujaec.edu.co</td>
<td>LXD</td>
<td>6</td>
<td>700 / 800 (88%)</td>
<td>17GB / 15.7GB (108%)</td>
<td>ON</td>
</tr>
<tr>
<td>1</td>
<td>koon.cujaec.edu.co</td>
<td>KVM_LaaS</td>
<td>3</td>
<td>800 / 800 (100%)</td>
<td>11GB / 15.7GB (70%)</td>
<td>ON</td>
</tr>
<tr>
<td>0</td>
<td>rogueone.cujaec.edu.co</td>
<td>KVM_LaaS</td>
<td>2</td>
<td>600 / 800 (75%)</td>
<td>12GB / 15.7GB (77%)</td>
<td>ON</td>
</tr>
</tbody>
</table>

Showing 1 to 8 of 8 entries

8 TOTAL  8 ON  0 OFF  0 ERROR
### Deployment

#### Datastores

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Owner</th>
<th>Group</th>
<th>Capacity</th>
<th>Cluster</th>
<th>Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>system</td>
<td>onadmin</td>
<td>onadmin</td>
<td>320.6GB / 832.9GB (38%)</td>
<td>0.100.101.102</td>
<td>SYSTEM</td>
<td>ON</td>
</tr>
<tr>
<td>1</td>
<td>default</td>
<td>onadmin</td>
<td>onadmin</td>
<td>320.6GB / 832.9GB (38%)</td>
<td>0.100.101.102</td>
<td>IMAGE</td>
<td>ON</td>
</tr>
<tr>
<td>2</td>
<td>files</td>
<td>onadmin</td>
<td>onadmin</td>
<td>320.6GB / 832.9GB (38%)</td>
<td>0.100.101.102</td>
<td>FILE</td>
<td>ON</td>
</tr>
<tr>
<td>100</td>
<td>Cash</td>
<td>onadmin</td>
<td>onadmin</td>
<td>1.3TB / 4.1TB (31%)</td>
<td>10.101.102</td>
<td>IMAGE</td>
<td>ON</td>
</tr>
</tbody>
</table>

Showing 1 to 4 of 4 entries

4 TOTAL 4 ON 0 OFF
Live Demo
We are not alone
Cloud Computing adoption state

Public cloud adoption increased to 92 percent in 2018 from 89 percent in 2017 according to Right Scale.

96% of Respondents Are Using Cloud

- Public Cloud Only: 21%
- Hybrid: 71%
- Private Cloud Only: 4%

Public = 92%
Private = 75%

Source: RightScale 2018 State of the Cloud Report
## Public Cloud Disadvantages

<table>
<thead>
<tr>
<th>Benefits and Disadvantages</th>
<th>Private Cloud</th>
<th>Public Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full control</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Total customization</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Scalability</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Low entry level price</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Uninterrupted performance</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Less complex environment</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Entry level solution</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Monitoring</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>No hardware cost</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Reliable security</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>
Why Public Clouds instead of Private Clouds?

- Initial costs
- High complexity compared to Public Cloud

- High OPEX
- High CAPEX
Decreasing costs

Elements with improvement margin on current Private Cloud deployments:
- Server's cost
- High Availability
- High power consumption
- Initial installation complexity
- Failure detection and recovery
CloX  http://clox.cloud

A state of the art completely free Open Source solution to provide a simple, cost-effective and efficient ARM-based Private Cloud.
CloX Features

- LXD virtualization
- OpenNebula orchestration
- Powered by ARM architecture
- Pre-made, ready to deploy based images for
  - Pine64
  - Raspberry Pi 3
Boxes

http://clox.cloud
Boxes

http://clox.cloud
HPC

<table>
<thead>
<tr>
<th>Rank</th>
<th>System</th>
<th>Cores</th>
<th>Rmax (TFlop/s)</th>
<th>Rpeak (TFlop/s)</th>
<th>Power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sunway TaihuLight - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway , NRCPC National Supercomputing Center in Wuxi China</td>
<td>10,649,600</td>
<td>93,014.6</td>
<td>125,435.9</td>
<td>15,371</td>
</tr>
<tr>
<td>2</td>
<td>Tianhe-2 (MilkyWay-2) - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P , NUDT National Super Computer Center in Guangzhou China</td>
<td>3,120,000</td>
<td>33,862.7</td>
<td>54,902.4</td>
<td>17,808</td>
</tr>
</tbody>
</table>

Current supercomputers are reaching the 20KWatts power consumption and the race towards achieving exaflop/s-capable systems is forecasting to reach several MWatts.
Valentin Plugaru's cluster

- ARM cluster built with Calxeda EnergyCore ECX-1000 servers
- OpenStack and LXC
- At least a drop of 20% on average for compute-intensive tasks
- 65.6% drop in communication capacity
Our approach
Benchmarks results

Container/bare metal correlation

LXDoNe efficiency on ARM SBC
Other use cases and applications

- Cloud Simulations Testbeds
- Edge and Fog computing
Roadmap

- Full integration with OpenNebula VM actions
- Better LXD-like interaction
- Support a wider variety of guest and host OS
- Enterprise support for containers on OpenNebula
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