Virtualization on Comet
XSEDE Service Provider Forum – October 13, 2017

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Virtualization Three Ways

General VM
eg ESXi

General Container
eg Docker

HPC Container
Singularity

Source: Greg Kurtzer keynote at HPC Advisory Council 2017 @ Stanford
Comet Virtual Clusters

- KVM based Full Virtualization
- Full root access, PXE install, persistent disk images, near-native Infiniband performance
- Nucleus Rest API and Cloudmesh MGMT
- Consume SUs from XSEDE allocations
Comet VC Use Cases

- **CAIDA Hackathon**
  - Root access to nodes for custom OS and software stack.
  - Full control of network stack inside virtual compute nodes by attendees and easy ‘repair’ by CAIDA admins.
  - Full isolation of virtual cluster from production resources and filesystems.

- **Open Science Grid**
  - Simple install using existing management infrastructure (PXE, Foreman, Puppet).
  - Multiple XSEDE allocations consuming SUs via OSG VC with no effort from allocated projects.
  - Largest OSG provider of resources (> 2x) for last LIGO run.
Comet Gateway Frontend Hosting

- KVM based Full Virtualization
- Full root access, PXE install, persistent disk images, modest resource requirements
- Nucleus Rest API and Cloudmesh management
- Appropriate for Gateways running compute jobs on Comet
- Possibilities for SDSC onsite storage outside of Comet
Comet Singularity

- HPC Application Containerization
  - Userspace only (with namespaces and minimal SetUID)
- Singularity v.2.3.2 is available now
  - support for ‘pull’ from Docker and Singularity Hub
- Singularity v.2.4 is being tested
- Utilization growing quickly...
Comet Singularity Use Cases

• **Special Requirements**
  - Frequently updated or requested application installs that are difficult in Comet OS (TensorFlow, Torch, CAFFE, Keras)
  - Commercial application binaries incompatible with Comet base OS

• **Neuroscience Gateway**
  - Custom software stack difficult to install or support in Comet OS (TensorFlow, GENESIS, Neuron)
  - NSG allows some custom user codes... constrain user codes from modifications of NSG environment.
Comet Kubernetes

• **Generalized Container Orchestration**
  • Currently in development testing
  • Not (currently) for users

• **Use Cases Under Investigation**
  • Backend Services (MySQL, RabbitMQ)
  • User facing Services (Slurm, GridFTP)
Comet Allocations for Virtualization

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<tr>
<th></th>
<th>Trial</th>
<th>Startup</th>
<th>XRAC</th>
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<tbody>
<tr>
<td>Virtual Cluster</td>
<td>- na -</td>
<td>50 K SUs</td>
<td>50 K – 7,000 K SUs</td>
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<tr>
<td>Singularity</td>
<td>1000 SUs</td>
<td>50 K SUs</td>
<td>50 K – 6,000 K SUs</td>
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*Trial requests typically handled in 1 business day.*  
*Startup requests reviewed locally. Can be approved in a few days.*  
*XRAC requests reviewed by standard XSEDE process.*
Comet User Support

• **Virtual Cluster Support**
  • Frontend support to Virtual Cluster Admins by Indiana University team which interfaces with HPC Operations for backend issues
  • Basic installation assistance, Cloudmesh support, Nucleus API and Cloudmesh feature requests

• **Singularity Support**
  • SDSC HPC User Services Staff via XSEDE and local ticketing systems
  • Building and testing containers on Comet hardware (ie. P100)
  • Integration of containers with Scheduler (ie. example containers)
Resources

- Cloudmesh Comet CLI for Comet VC
- Singularity – Containers for Science
- Docker vs Singularity vs Shifter vs UGE Container Edition
  - https://tin6150.github.io/psg/blogger_container_hpc.html
- Performance Evaluation of Container-based Virtualization for High Performance Computing Environments (paper)
- Comet Singularity Examples
  - https://github.com/mkandes/naked-singularity