Testing the OSG Software Stack Using VM Universe

HTCondor Week 2015

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22 May 2015
Topics

• Testing OSG Software
• Using VM Universe
• What We Learned
Testing OSG Software
OSG Software Testing

• Integrated stack of middleware (RPMs) used in variety of deployment scenarios (e.g., CE, XRootD)

• Want light integration testing on “normal” installs, mimicking what admins do:
  install RPMs · config · start services · run clients/jobs · clean up

• Works best on virtual machine (VM): need root, avoid conflicts with other software, can trash host

• One run tests all installed components in a single environment; want many runs, each with unique:
  Operating system, Installed package(s), Repositories used
Using VM Universe
2 Disk Images Give Flexibility

Base OS Image (~6 GB)
(basic OS install, plus start-up config)

Input-Output Image (10 MB)
(input, payload, output)
Making a Base OS Image

- Use Oz to create images from ISO images (https://github.com/clalancette/oz)
- Use text file to describe image, install, and files

```xml
<template>
  <name>sl_6_x86_64_htcondor</name>
  <description>Scientific Linux 6 base OS</description>
  <os>
    <name>ScientificLinux-6</name>
    <version>6</version>
    <arch>x86_64</arch>
    <install type="url">
      <url>http://.../linux/scientific/6x/x86_64/os/</url>
    </install>
    <rootpw>...</rootpw>
  </os>
  <disk><size>6G</size></disk>
  <files> ... </files>
  <commands> ... </commands>
</template>
```
Making an Input-Output Image

- Use tool from `libguestfs-tools` RPM
- Makes image (RAW, qcow2, …) with filesystem and, optionally, adds files from directory

```bash
virt-make-fs --size=10M --format=qcow2 DIRECTORY FILENAME
```

```
/
  run-job
  input/
  ...
  output/
```
Launching the VM Payload

Wanted clean separation between boot and payload

/etc/rc.d/rc.local

```sh
#!/bin/sh
mount /dev/... /mnt/user
at -f /root/run-user-payload now + 1 minute
```

/root/run-user-payload

```bash
/bin/env - \
   PATH=/sbin:/usr/sbin:/bin:/usr/bin \ 
   USER=root \ 
   PWD=/ \ 
   LANG=en_US.UTF-8 \ 
   /mnt/user/run-job >> /mnt/user/run-job.log 2>&1
/sbin/poweroff
```
Extracting Output From a Run

Use Python library from libguestfs-tools RPM

```python
import guestfs
g = guestfs.GuestFS()
g.add_drive_opts(image_filename, readonly=1)
g.launch()
filesystems = g.list_filesystems()
g.mount(filesystems[0][0], '/
for image_path in g.find('/
    full_image_path = os.path.join('/', image_path)
    if not g.is_dir(full_image_path):
        image_dir = os.path.dirname(image_path)
        local_dir = os.path.join(output_dir, image_dir)
        if not os.path.exists(local_dir):
            os.makedirs(local_dir)
        g.download(full_image_path,
                   os.path.join(output_dir, image_path))
```
Submitting One VM Universe Job

universe = vm
executable = osg-test
vm_type = kvm
vm_memory = 2048
vm_networking = true
vm_no_output_vm = false
vm_vnc = true
request_disk = 6GB
log = osg-test.log

should_transfer_files = YES
transfer_input_files = .../$(platform)_htcondor.dsk, 
                        \input-image-$(serial).qcow2
vm_disk = $(platform)_htcondor.dsk:vda:w:raw, 
         \input-image-$(serial).qcow2:vdb:w:qcow2
when_to_transfer_output = ON_EXIT
transfer_output_files = input-image-$(serial).qcow2
transfer_output_remaps = "input-image-$(serial).qcow2 = result-image-$(serial).qcow2"
queue
DAG Structure

Prepare Workflow

VM test → Extract

VM test → Extract

VM test → Extract

VM test → Extract

Report Results

⋯
What We Learned
Benefits of Using VM Universe

• All the benefits of VMs + HTCondor management
  - Job runs as root
  - Job controls software and runtime environment
  - Job can do anything
  - VMs run on (nearly) all CHTC resources

• Current use:
  - Running 1 DAG of 420 test runs daily
  - Developers can easily initiate workflow runs, too

• Mostly just works … now
Documentation Was Inadequate

- Useful VM universe settings were not documented
- There was little explanation of the bigger picture
  - How to create images
  - How to handle input and output
  - Pros and cons of the different VM hosts
- At the time, there was no way we could have used VM universe without extensive help from CHTC developers and system administrators
- Today?
Initial Configuration Was Hard

• Settling on host and guest configs was difficult
  - Lack of documentation
  - Host and guest must agree on certain things
  - Lots of trial and error with sysadmins

• Networking, in particular, was very painful

```bash
# cat > /etc/sysconfig/network-scripts/ifcfg-eth0
DEVICE=eth0
TYPE=Ethernet
BOOTPROTO= dhcp
ONBOOT=yes

# rm -f /etc/udev/rules.d/70-persistent-net.rules
```
Base OS Images Are Large

Each job sandbox needs copy of 6 GB OS image

1. Direct transfer from submit host
   - Failures started at ≥10 simultaneous transfers
   - Resulted in transfer timeouts and job failures

2. Tried caching on execute nodes, but that’s a pain

3. Tried Squid, but failed to handle huge images

4. Eventually settled on Gluster shared filesystem

requirements = (HasGluster == True)
Execution Problems I

Failure to launch

- Used to happen a lot, has gotten better (why?)
- Once KVM goes bad, all VMs on that host will fail
- Added automated email to support queue 😈
- So admins added a machine attribute for this

```python
requirements = (HasVirshDefaultNetwork == True)
```
Execution Problems II

Launch, then hang (early in boot)

- Rare, but causes job to run forever
- No way to detect from outside (and inside is hung)
- We added a way to hold and release hung VMs

```
periodic_hold = (time() - JobCurrentStartDate > 28800)
periodic_release = (HoldReasonCode == 3) || 
                  ((HoldReasonCode == 6) && 
                   regexp("VMGAHP_ERR_INTERNAL", HoldReason))
```
Execution Problems III

• Launch cleanly but no network
  - Used to happen a lot, has gotten better (why?)
  - We catch this in the payload and bail, but…

• NO EXIT STATUS CODES!!!!
  - Cannot tell whether payload succeeded without unpacking output disk and looking there
  - HTCondor developers … ?
Debugging is Hard

• Throw away base OS image after run
  - Too big to transfer and retain
  - However, all run-time state is gone

• What we do
  - Log a LOT of things
  - Copy all interesting files to output image
  - Trial and error!
Conclusions

• VM universe makes possible broad testing in OSG
  - We run $O(10)$ times more test scenarios than before, in hours instead of all day – big win!
  - We can manually start test runs and they typically finish on same work day – big win, too!

• Mostly worked through / around issues

• Needed and still need strong support from admins

• Future of VM universe
  - Little interest in community
  - Waning interest from developers
  - Curse you, Docker! 😏
Credits

• Brian Lin – OSG Software developer
• Todd Miller – HTCondor developer
• Jaime Frey – HTCondor developer
• Nate Yehle – CHTC lead sysadmin
• Aaron Moate – CHTC sysadmin

• Tim Cartwright – OSG Software manager
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