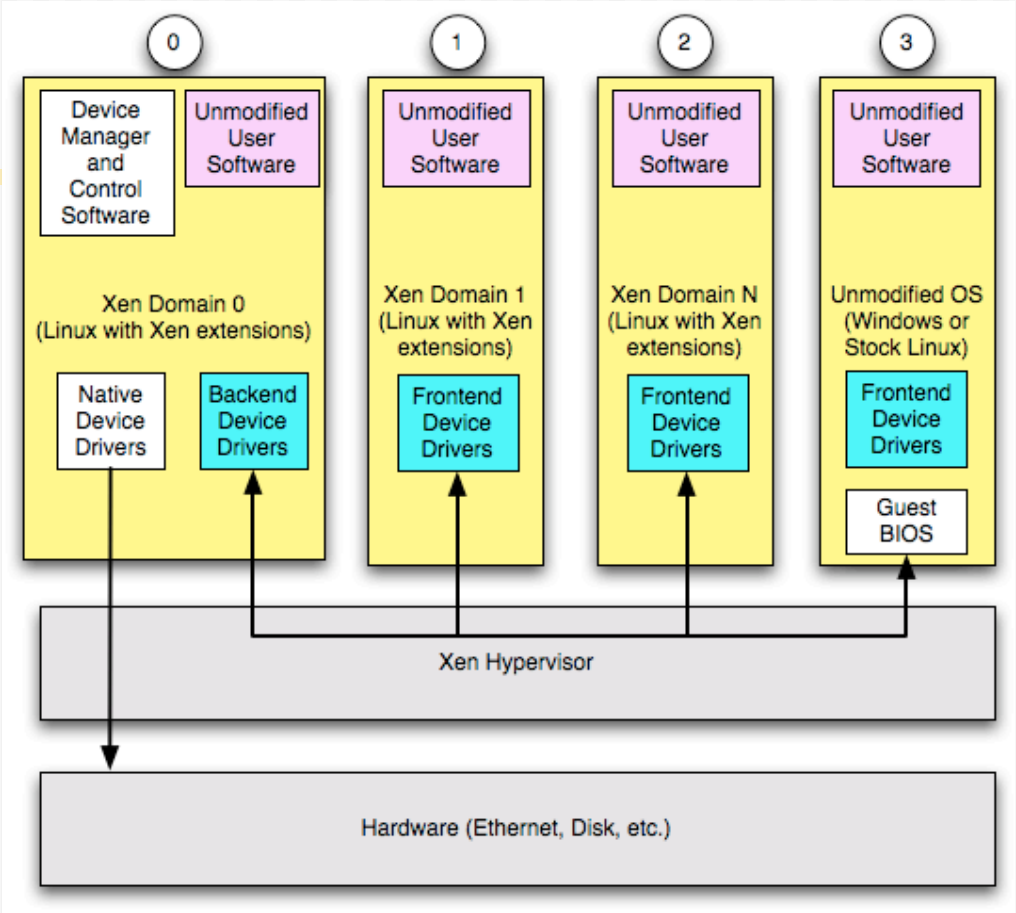
Xen VMs, Virtual Clusters and Programmatic Partitioning

Xen Overview

What is Xen

- Xen is “virtual machine monitor” (VMM) used to control VMs
- Xen VMM is called the “hypervisor”
- Xen VMs are called “guests”

What is Xen



- Guest traps and exceptions are passed to and handled by hypervisor

But Xen in HPC?

- The performance issues are with I/O
- Interconnects
  - With Myrinet, one can assign the card to one domain at a time
  - With IB, 'VMM-bypass' for RDMA support
    - Mellanox has alpha version software that attains "near-native I/O performance"
- Using disk partitions or logical block devices can increase disk I/O

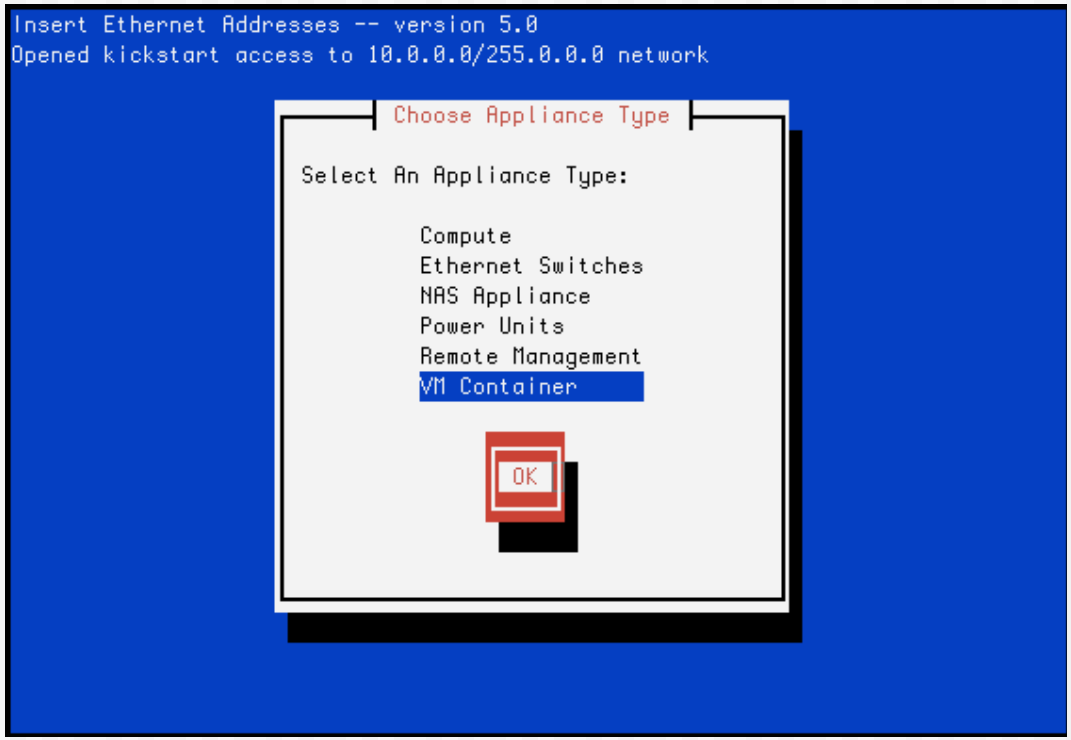
Xen in Rocks 5.0

Step 0

- You must install a Rocks 5.0 frontend with the Xen Roll

Step 0.5

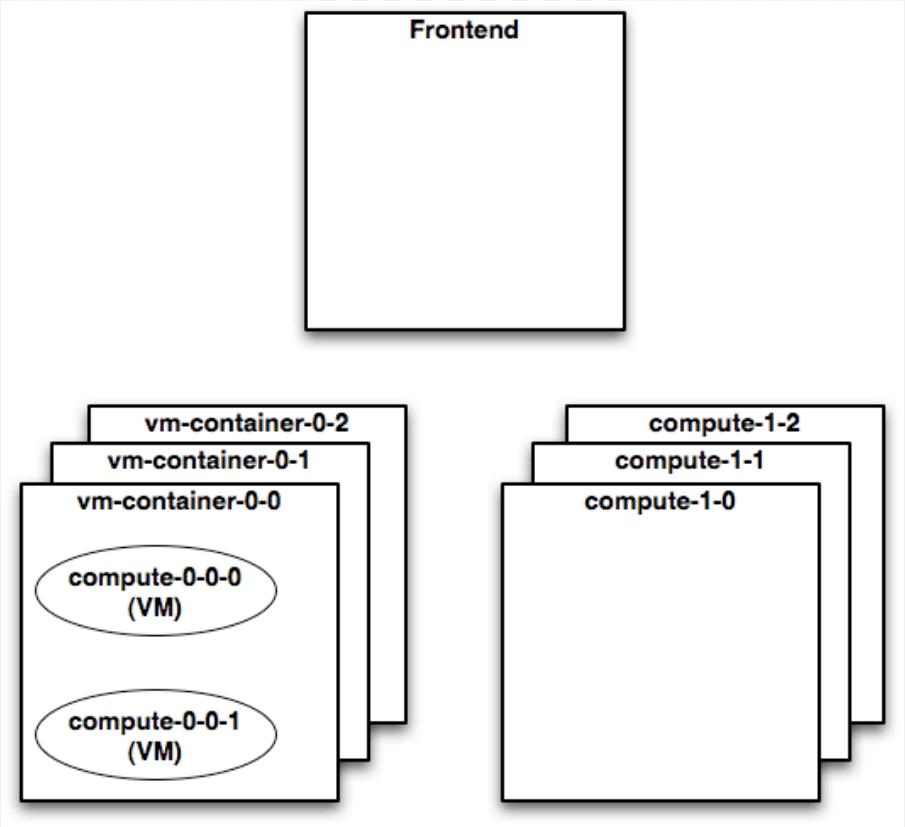
- You must install at least one cluster node as a “VM Container”



Supported Configuration

- Frontend
  - Normal “physical” frontend
    - No xen kernel or xen tools are installed
- “VM Container” appliance houses Xen VMs
  - VM Container is dom0

Supported Configuration



Key VM Functions

- “add”
  - Add a new VM to the cluster
- “create”
  - Install a VM
- “start”
  - Boot a VM

Adding a VM

- "rocks add host vm" command

```
# rocks add host vm {physical machine} \
  membership={rocks membership}
```

- "rocks membership" is one of:

```
# rocks list membership
MEMBERSHIP          APPLIANCE
Frontend:           frontend
Ethernet Switches:  network
Power Units:        power
Remote Management:  manager
NAS Appliance:      nas
Compute:            compute
VM Container:       vm-container
```

Adding a VM

- Example

```
# rocks add host vm vm-container-0-0 \
  membership="Compute"
```

- Output:

```
added VM on node "vm-container-0-0" slice "0" with vm_name "compute-0-0-0"
```

Adding a VM

- "rocks add host vm" command adds entries to the nodes and networks tables
- Allocates a unique MAC address for the VM
  - Using the Xen reserved prefix: 00:16:3e
- Adds an entry to the vm_nodes table
  - Keep track of which physical host houses the VM
- Adds an entry to the vm_disks tables
  - Allocates disk space for the VM
    - Uses the Xen "file" virtual block device
    - Puts file on the largest partition of the physical host

Install a VM

- "rocks create host vm" command

```
# rocks create host vm compute-0-0-0
```

- This starts a standard Rocks installation on the VM

Install a VM

- After the networking stack is initialized and anaconda is up, you can monitor the install with “rocks-console”

```
# rocks-console compute-0-0-0
```

- Just like a physical compute node!

Boot a VM

- After the VM is installed, boot it:

```
# rocks start host vm compute-0-0-0
```

- About 30 seconds later, login to it with "ssh".
  - Just like a physical compute node!

Other Rocks Xen Commands

list

- List info about all configured VMs

```
# rocks list host vm
VM-HOST         SLICE MEM  CPUS MAC                HOST              STATUS
compute-1-4-0: 0     900  1    00:16:3e:00:00:08 vm-container-1-4 active
compute-1-3-1: 1     900  1    00:16:3e:00:00:07 vm-container-1-3 active
```

set

- Change VM parameters

```
# rocks set host vm {host} [disk=string] [disksize=string] \
  [mem=string] [physnode=string] [slice=string] \
  [virt-type=string]
```

- Example, allocate 4 GB of memory to a VM:

```
# rocks set host vm compute-0-0-0 mem=4096
```

pause/resume

- Execute the “pause” and “resume” Xen commands on a VM

```
# rocks pause host vm compute-0-0-0
# rocks resume host vm compute-0-0-0
```

save/restore

- Execute the “save” and “restore” Xen commands on a VM

```
# rocks save host vm compute-0-0-0
# rocks restore host vm compute-0-0-0
```

- What’s the difference between “pause” and “save”?
  - “pause” keeps the VM in memory
  - “save” writes VM state to a file and releases memory and CPU

stop

- Destroy a VM

```
# rocks stop host vm compute-0-0-0
```

- This is equivalent to pulling the power cord on a physical machine

move

- Move a VM from one physical node to another

```
# rocks move host vm compute-0-0-0 vm-container-1-0
```

- This operation will take some time
  - It “saves” the current VM
  - Copies the VMs disk file to the new VM container
    - If your diskfile is 36 GB, it will move 36 GB across the network
  - Then “restores” the VM

Other “Internal” Commands

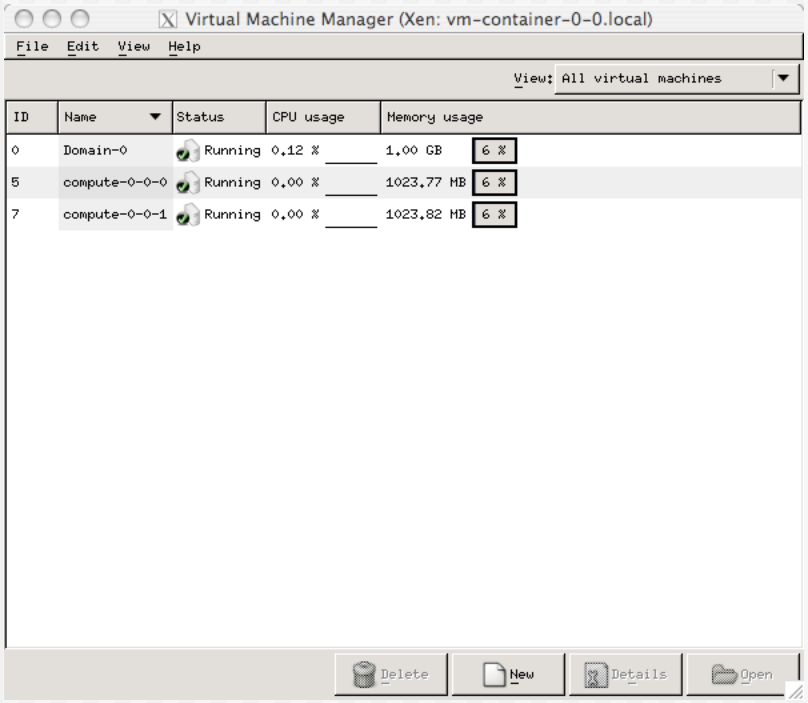
- “dump”
  - Used on the restore roll to capture VM configuration
- “report”
  - Called by “rocks create host vm” and “rocks start host vm” to create Xen VM configuration files
- “remove”
  - Called by “rocks remove host” to remove the VM specific info for a host

Xen Debugging Tool

- Use “virt-manager”
- Login to VM container and execute:

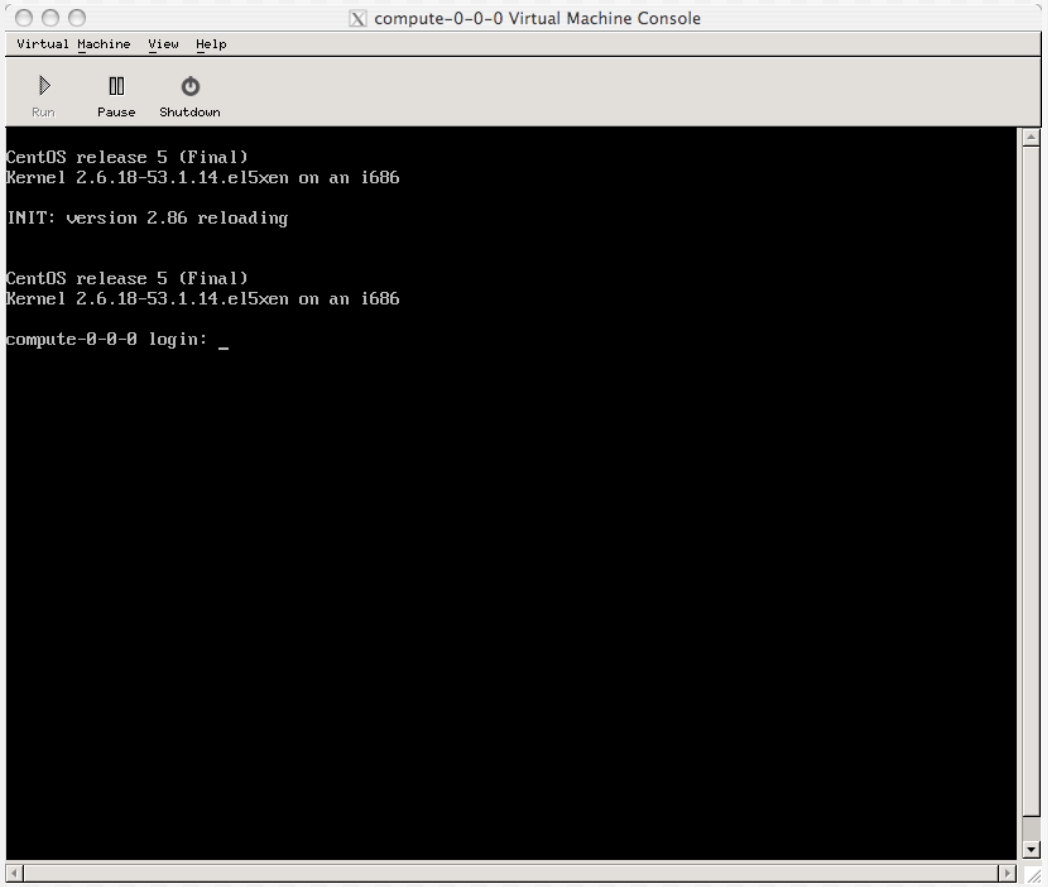
```
# virt-manager
```

Virt-manager



- Double click on ‘compute-0-0-0’ to bring up console

Virt-manager



Xen in Rocks Futures

Futures

- Run Xen on the frontend
  - The frontend physical machine is a VM Container
  - Frontend functionality runs within domU
- Support multiple virtual clusters on one physical cluster
  - Need to add VLAN support to Rocks Xen support
- Hardware virtualization support
  - Can run any OS within a domU

Programmatic Partitioning

How I Feel About Partitioning

The Problem With Rocks Partitioning In The Past

- Too hard to enforce user-specified partitioning onto nodes
  - Rocks defined ‘<part>’ XML tags
- Too hard to define different partitioning schemes for different nodes or appliance types
  - Had to build new appliance types, had to build new distributions, etc.

Goals of Rocks Partitioning

- Don't lose user data
  - Save partitions in database
  - Mark 'seen' disks (.rocks-release)
- Write partitioning specification once
  - In the past, you'd:
    - Write an XML file with <part> tags
    - Rebuild distro
    - Reinstall nodes
    - Remove XML file
    - Rebuild distro

Goals of Rocks Partitioning

- Make it easy for the user to reason about the partitioning scheme
- Flexible framework that allows fine-grained control

How It Works

- In a <pre> section, the user populates RedHat-specific partitioning directives into a file named:

```
/tmp/user_partition_info
```

Example 1

- Create an XML file:

```
# cd /home/install/site-profiles/5.0/nodes/
# cp skeleton.xml replace-partition.xml
```

Example 1

- Create a <pre> section:

```
<pre>
echo "clearpart --all --initlabel --drives=hda
part / --size 8000 --ondisk hda
part swap --size 1000 --ondisk hda
part /mydata --size 1 --grow --ondisk hda" > \
     /tmp/user_partition_info
</pre>
```

Example 1

- Rebuild the distribution:

```
# cd /home/install
# rocks-dist dist
```

- Remove old partitioning from database:

```
# rocks remove host partition compute-0-0
```

- Remove ‘seen’ marker on compute node
  - Rocks will not reformat a disk that has .rocks-release on any partition in that disk

```
# ssh compute-0-0
# rm /.rocks-release
```

- Reinstall:

```
# shoot-node compute-0-0
```

Software Raid Example

- Create a <pre> section:

```
<pre>
echo "clearpart --all --initlabel --drives=hda,hdb
part / --size 8000 --ondisk hda
part swap --size 1000 --ondisk hda

part raid.00 --size=10000 --ondisk hda
part raid.01 --size=10000 --ondisk hdb

raid /mydata --level=1 --device=md0 raid.00 raid.01" \
    > /tmp/user_partition_info
</pre>
```

Yeah, But …

- What if I don't know the name of the disk devices?
  - Or, what if I have a mix of disk devices in my cluster (e.g., hda, sda, cciss, etc.)?
- What if I want to apply different partitioning schemes to different nodes?

Let's Write a Program!

- We'll write a program to populate:

  `/tmp/user_partition_info`

- The program will have access to:
  - The node's name
  - The node's membership
  - The names of the discovered disks

```
<pre arg="--interpreter /opt/rocks/bin/python">

import rocks_partition

membership = '<var name='Node_Membership'/>'
nodename = '<var name="Node_Hostname"/>'

def doDisk(file, disk):
        file.write('clearpart --all --initlabel --drives=%s\n' % disk)
        file.write('part / --size=6000 --fstype=ext3 --ondisk=%s\n' % disk)
        file.write('part /var --size=2000 --fstype=ext3 --ondisk=%s\n' % disk)
        file.write('part swap --size=2000 --ondisk=%s\n' % disk)
        file.write('part /mydata --size=1 --grow --fstype=ext3 --ondisk=%s\n'
                % disk)

#
# main
#
p = rocks_partition.RocksPartition()
disks = p.getDisks()

if len(disks) == 1:
         file = open('/tmp/user_partition_info', 'w')
         doDisk(file, disks[0])
         file.close()
</pre>
```

One or Two Disk Partitioning

```
#
# main
#
p = rocks_partition.RocksPartition()
disks = p.getDisks()

file = open('/tmp/user_partition_info', 'w')

if len(disks) == 2:
      doRaid(file, disks)
elif len(disks) == 1:
      doDisk(file, disks[0])

file.close()
```


```
def doRaid(file, disks):
        file.write('clearpart --all --initlabel --drives=%s\n'
                % ','.join(disks))

        raidparts = []

        for disk in disks:
                if disk == disks[0]:
                        part = 'part / --size=6000 --fstype=ext3 ' + \
                                '--ondisk=%s\n' % disk
                        file.write(part)

                        part = 'part /var --size=2000 --fstype=ext3 ' + \
                                '--ondisk=%s\n' % disk
                        file.write(part)

                part = 'part raid.%s --size=5000 --ondisk=%s\n' % (disk, disk)
                file.write(part)

                raidparts.append('raid.%s' % disk)

        raid = 'raid /bigdisk --fstype=ext3 --device=md0 --level=1 %s\n' \
                % ' '.join(raidparts)
        file.write(raid)
```


```
<pre arg="--interpreter /opt/rocks/bin/python">
import rocks_partition

membership = '<var name='Node_Membership'/>'
nodename = '<var name="Node_Hostname"/>'

def doRaid(file, disks):
        file.write('clearpart --all --initlabel --drives=%s\n'
                % ','.join(disks))

        raidparts = []

        for disk in disks:
                if disk == disks[0]:
                        part = 'part / --size=6000 --fstype=ext3 ' + \
                                '--ondisk=%s\n' % disk
                        file.write(part)

                        part = 'part /var --size=2000 --fstype=ext3 ' + \
                                '--ondisk=%s\n' % disk
                        file.write(part)

                part = 'part raid.%s --size=5000 --ondisk=%s\n' % (disk, disk)
                file.write(part)

                raidparts.append('raid.%s' % disk)

        raid = 'raid /bigdisk --fstype=ext3 --device=md0 --level=1 %s\n' \
                % ' '.join(raidparts)
        file.write(raid)

def doDisk(file, disk):
        file.write('clearpart --all --initlabel --drives=%s\n' % disk)
        file.write('part / --size=6000 --fstype=ext3 --ondisk=%s\n' % disk)
        file.write('part /var --size=2000 --fstype=ext3 --ondisk=%s\n' % disk)
        file.write('part swap --size=2000 --ondisk=%s\n' % disk)
        file.write('part /mydata --size=1 --grow --fstype=ext3 --ondisk=%s\n'
                % disk)

#
# main
#
p = rocks_partition.RocksPartition()
disks = p.getDisks()

file = open('/tmp/user_partition_info', 'w')

if len(disks) == 2:
               doRaid(file, disks)
elif len(disks) == 1:
               doDisk(file, disks[0])

file.close()
</pre>
```

Partitioning Based on Node Name and Disk Count

```
#
# main
#
p = rocks_partition.RocksPartition()
disks = p.getDisks()

if nodename in [ 'compute-0-0' ]:
        file = open('/tmp/user_partition_info', 'w')

         if len(disks) == 2:
                 doRaid(file, disks)
         elif len(disks) == 1:
                 doDisk(file, disks[0])

        file.close()
```

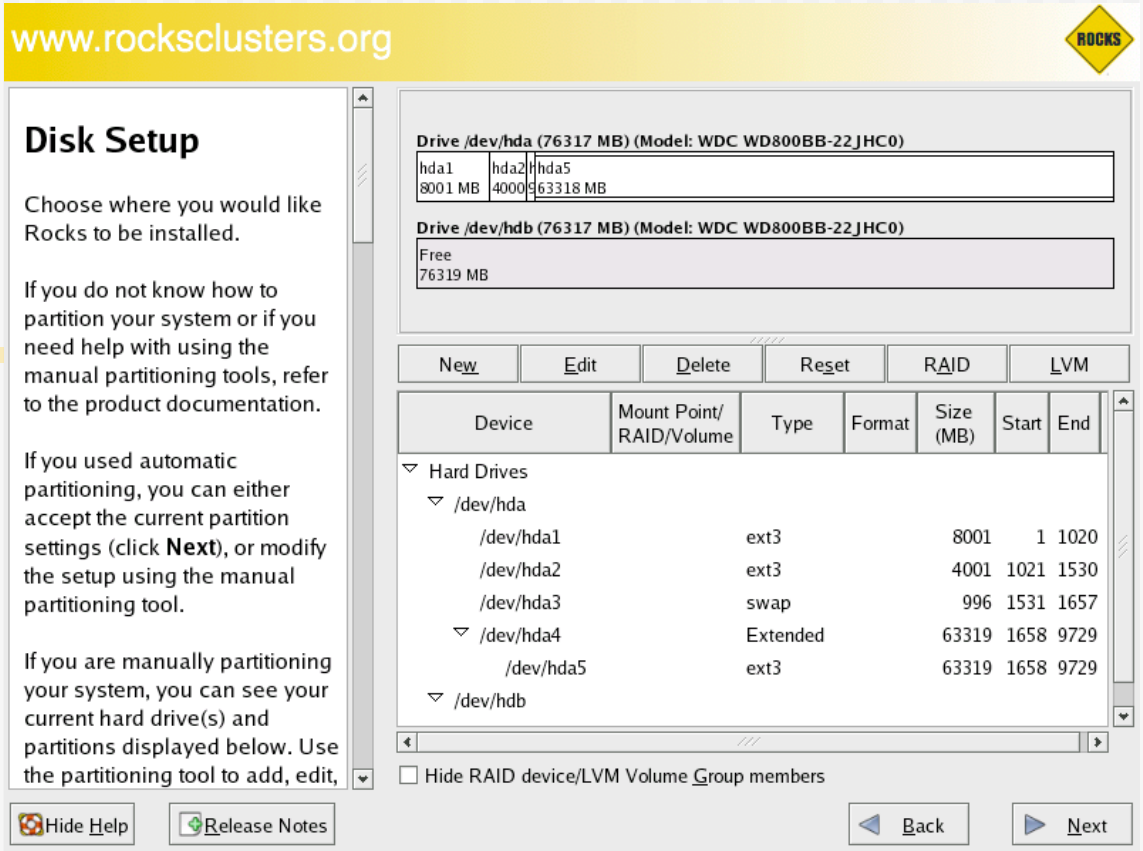
Force Rocks Default Partitioning

```
<pre>
echo "rocks force-default" > /tmp/user_partition_info
</pre>
```

Force Manual Partitioning

```
<pre>
echo "rocks manual" > /tmp/user_partition_info
</pre>
```

- This will cause the RedHat partitioning screen to appear on an installing node



- You can interact with this screen by executing on the frontend:

```
# rocks-console compute-0-0
```