Lightweight Scheduling for the PRAGMA Cloud Testbed

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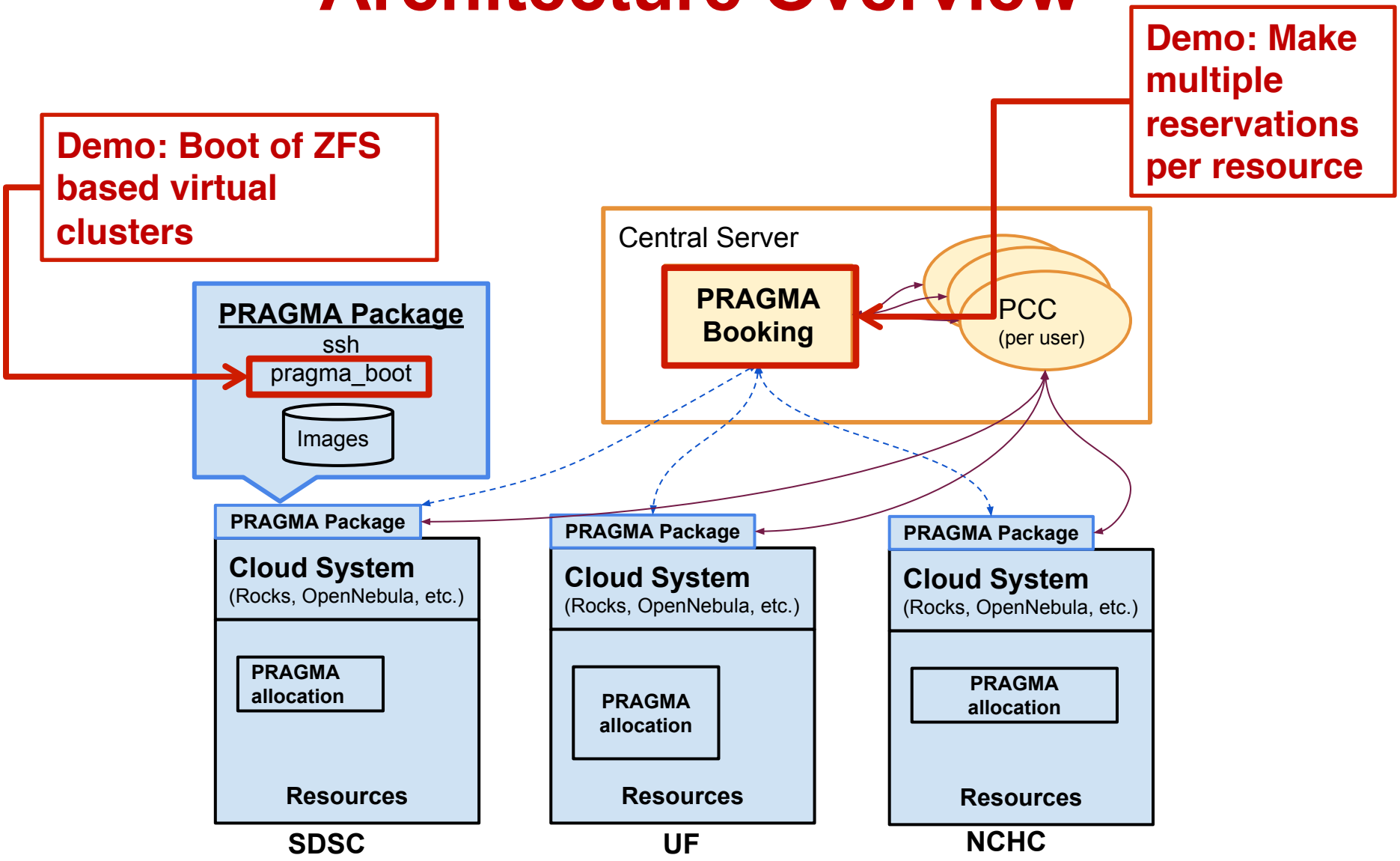
PRAGMA29

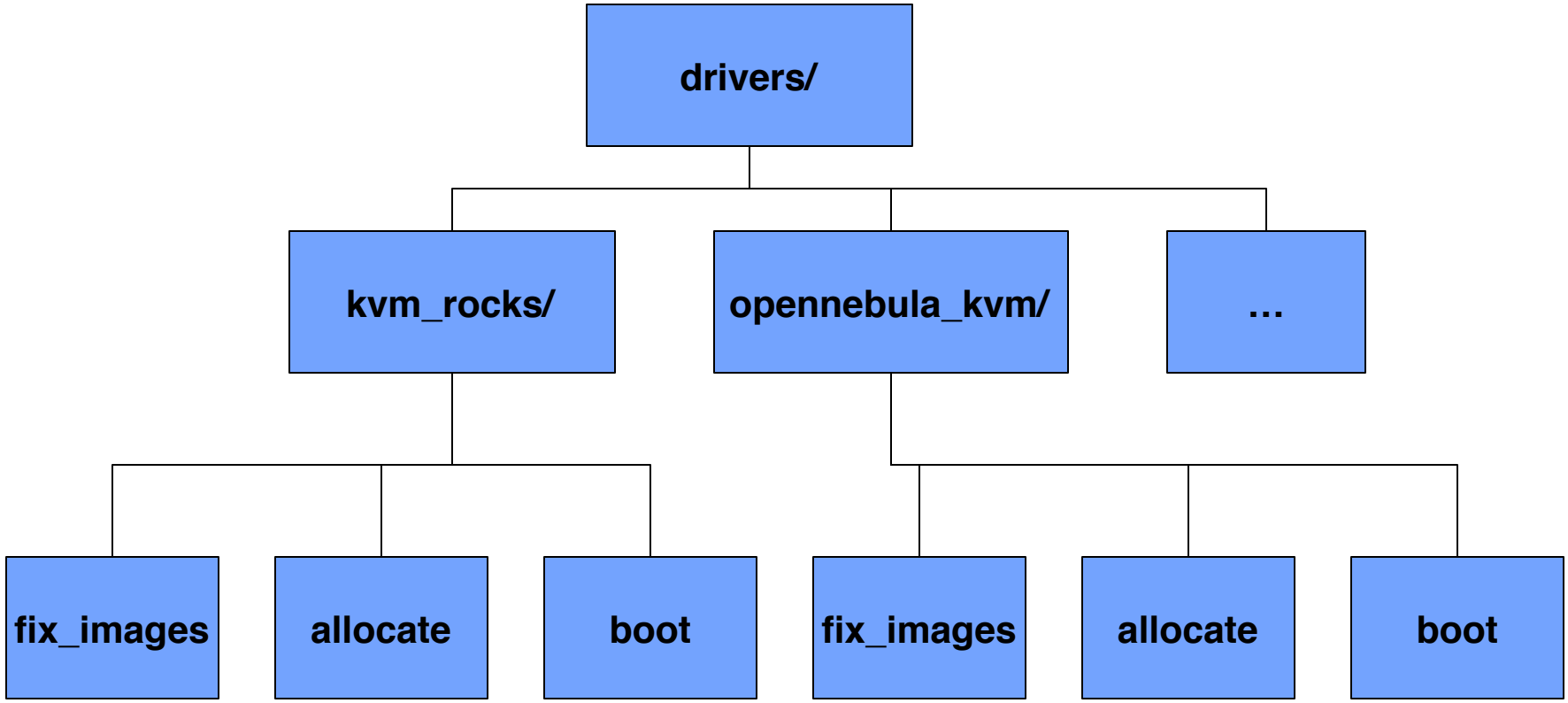
PRAGMA Cloud Scheduler

- **Goal: Leverage a simple web-based calendar scheduler for sharing of PRAGMA resources.**
- **Leverages the following tools:**
  - **pragma_boot**: Boots virtual clusters for users across PRAGMA institutions using local VM provisioner. Currently supports Rocks and OpenNebula.
  - **Personal Cloud Controller**: Manages startup, status monitoring, and shutdown of a virtual cluster. Built on top of pragma boot and HTCondor.

Architecture Overview



pragma_boot


drivers/
kvm_rocks/
opennebula_kvm/
…
fix_images
allocate
boot
fix_images
allocate
boot

pragma_boot process (kvm_rocks)

```
$ pragma_boot --vcname rocks-localdisk-basic –key id_rsa.pub --num_cpus 2
```

Step 1: fix_images

- Finds the locations of FE and compute images from vc-in.xml in the repository
- Uncompresses images if zipped; images must be **dynip** enabled
- **Copies (cp)** frontend and compute images to local temp dir

Step 2: allocate

- Finds unused public IP and vlan and # of compute nodes
- Creates cluster (rocks add cluster") and vc-out.xml

Step 3: Boot FE

- Guestmounts image and installs FE vc-out.xml snippet
- **Copies (cp)** image to local KVM directory and boots VM

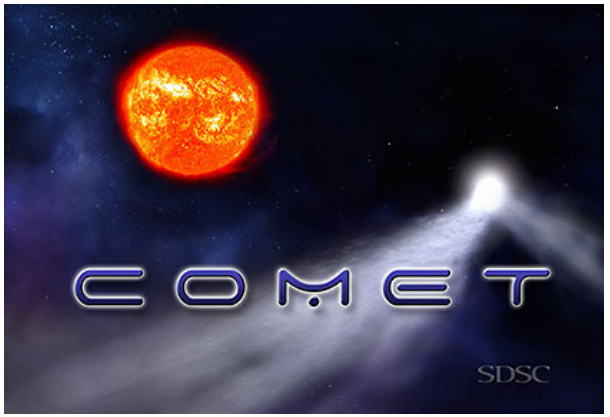
Step 4: Boots compute(s)

- Guestmounts image and copies over compute vc-out.xml
- **Transfers (scp)** image to VM container and boots VM

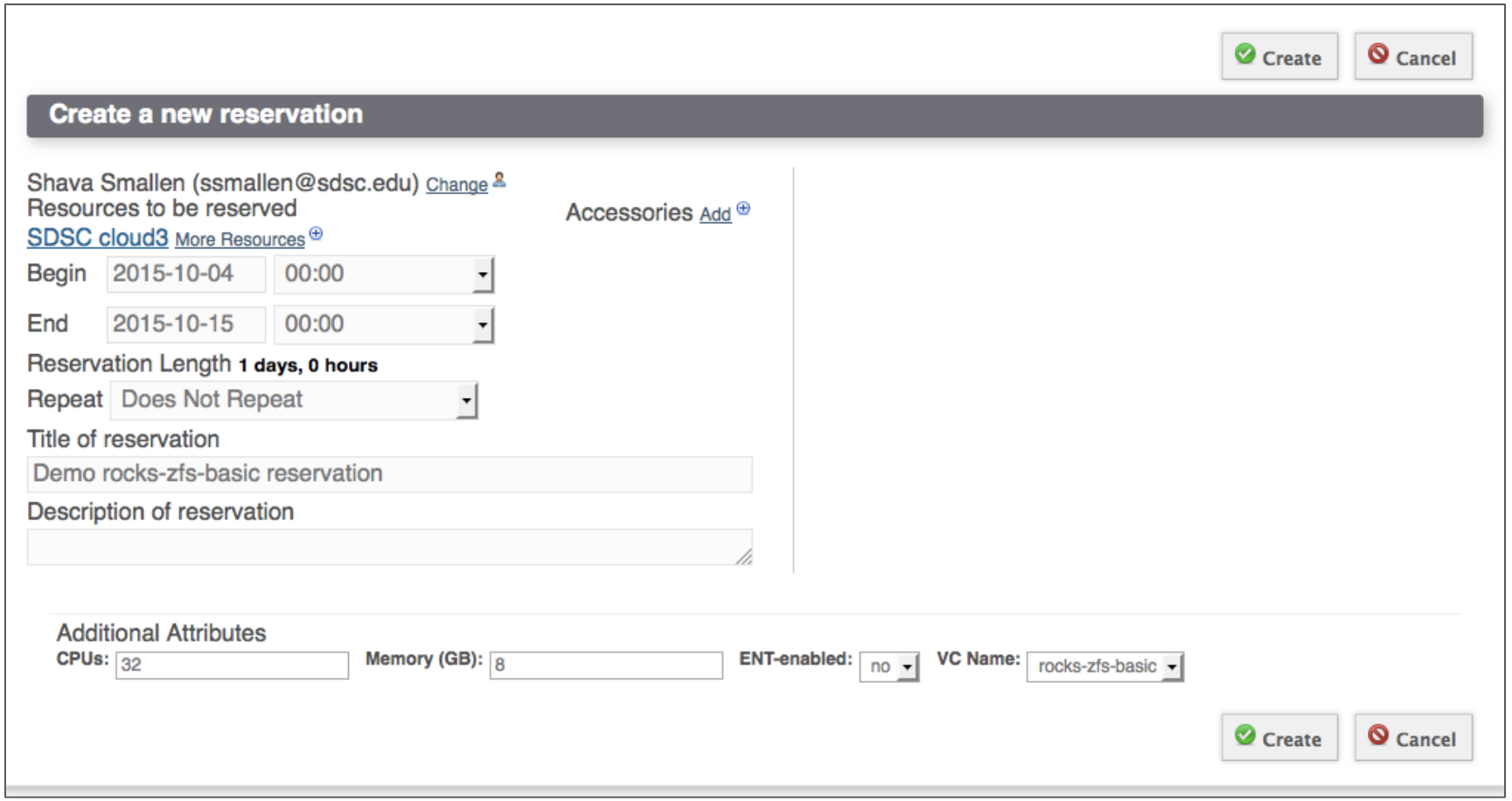
Takes about ~20 minutes to boot basic 2-node rocks cluster

ZFS based virtual clusters

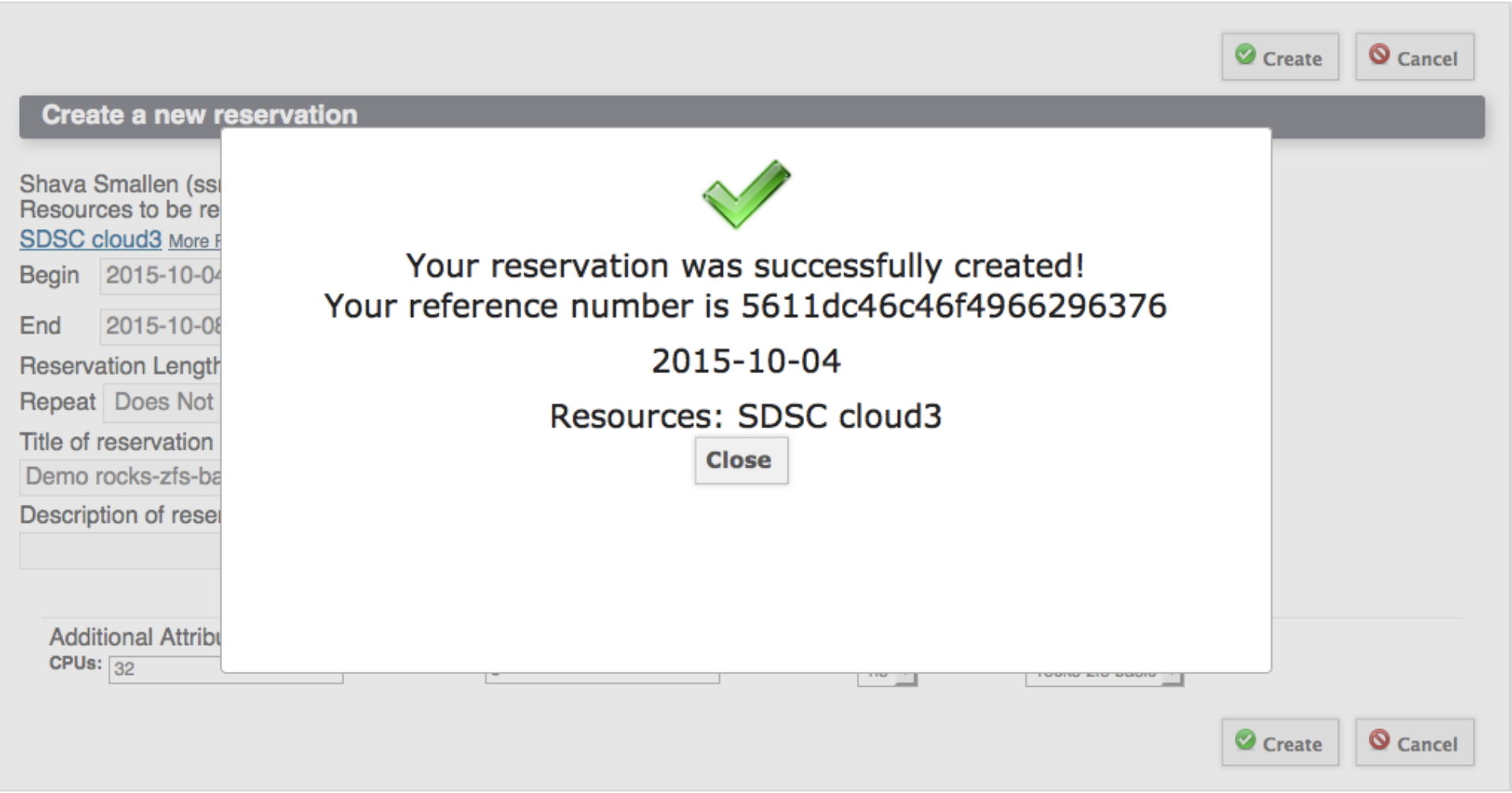
- **Leverages recent Rocks virtual cluster image management development work for SDSC's Comet resource.**
- **Based on ZFS with two modes for VM containers:**
  - img_sync=false: Mounts ZFS volume from NAS storage
  - img_sync=true: Snapshots ZFS volume from NAS storage and sends it local VM container; Snapshots regularly to sync the two volumes.
- **Phil described in more detail during resources-wg update**



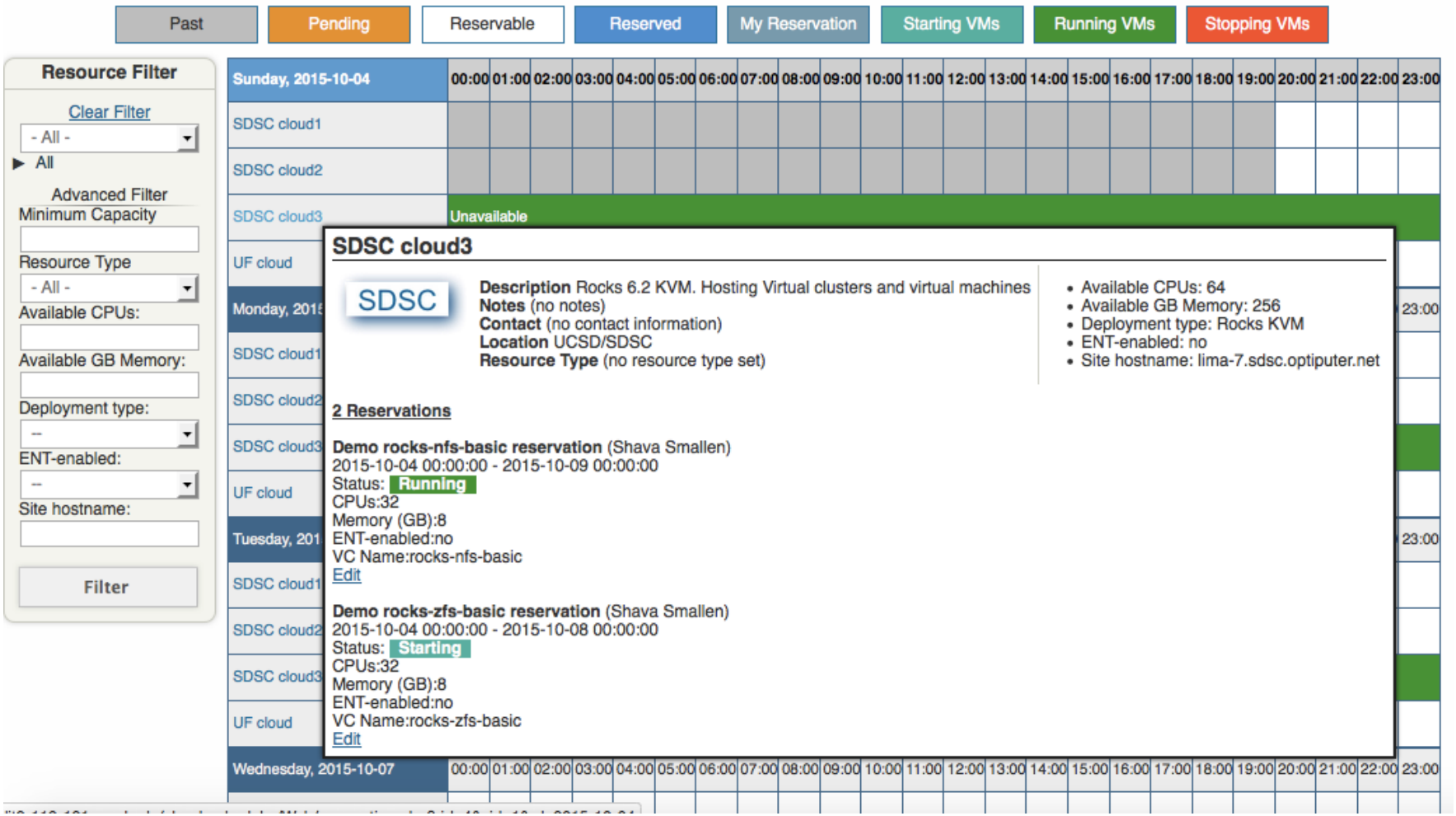
Start ZFS Reservation

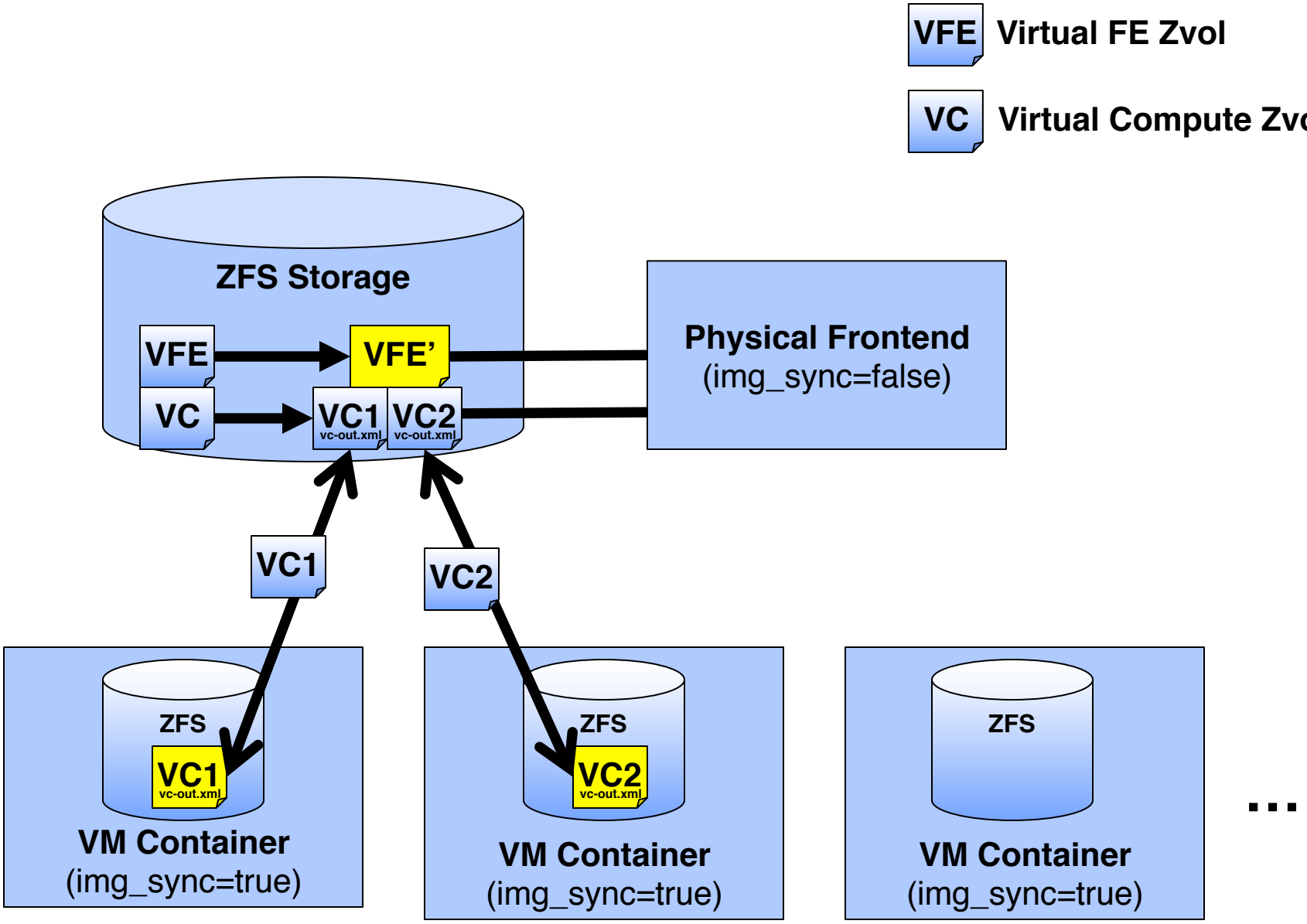


ZFS Reservation Confirmed



Confirm ZFS Reservation




VFE Virtual FE Zvol
VC Virtual Compute Zvol
ZFS Storage
VFE
VFE'
VC
VC1
vc-out.xml
VC2
vc-out.xml
Physical Frontend
(img_sync=false)
VC1
VC2
ZFS
VC1
vc-out.xml
VM Container
(img_sync=true)
ZFS
VC2
vc-out.xml
VM Container
(img_sync=true)
ZFS
VM Container
(img_sync=true)
...

pragma_boot process (rocks) for ZFS images

Step 1: fix_images

- No action

Step 2: allocate

- Finds unused public IP and vlan and # of compute nodes
- Creates cluster (rocks add cluster") and vc-out.xml
- **Clones** frontend zvol and makes N clones of compute zvol on NAS

Step 3: Boot FE

- Temporarily mounts zvol to physical FE and installs FE vc-out.xml snippet
- Boots VM from NAS (img_sync=false)

Step 4: Boots compute(s)

- Temporarily mounts zvol to physical FE and installs compute vc-out.xml snippet
- Zvol is **synced** to remote ZFS pool on VM Container and booted (img_sync=true)
- Zvol is regularly **snapshot** and **synced** between pools

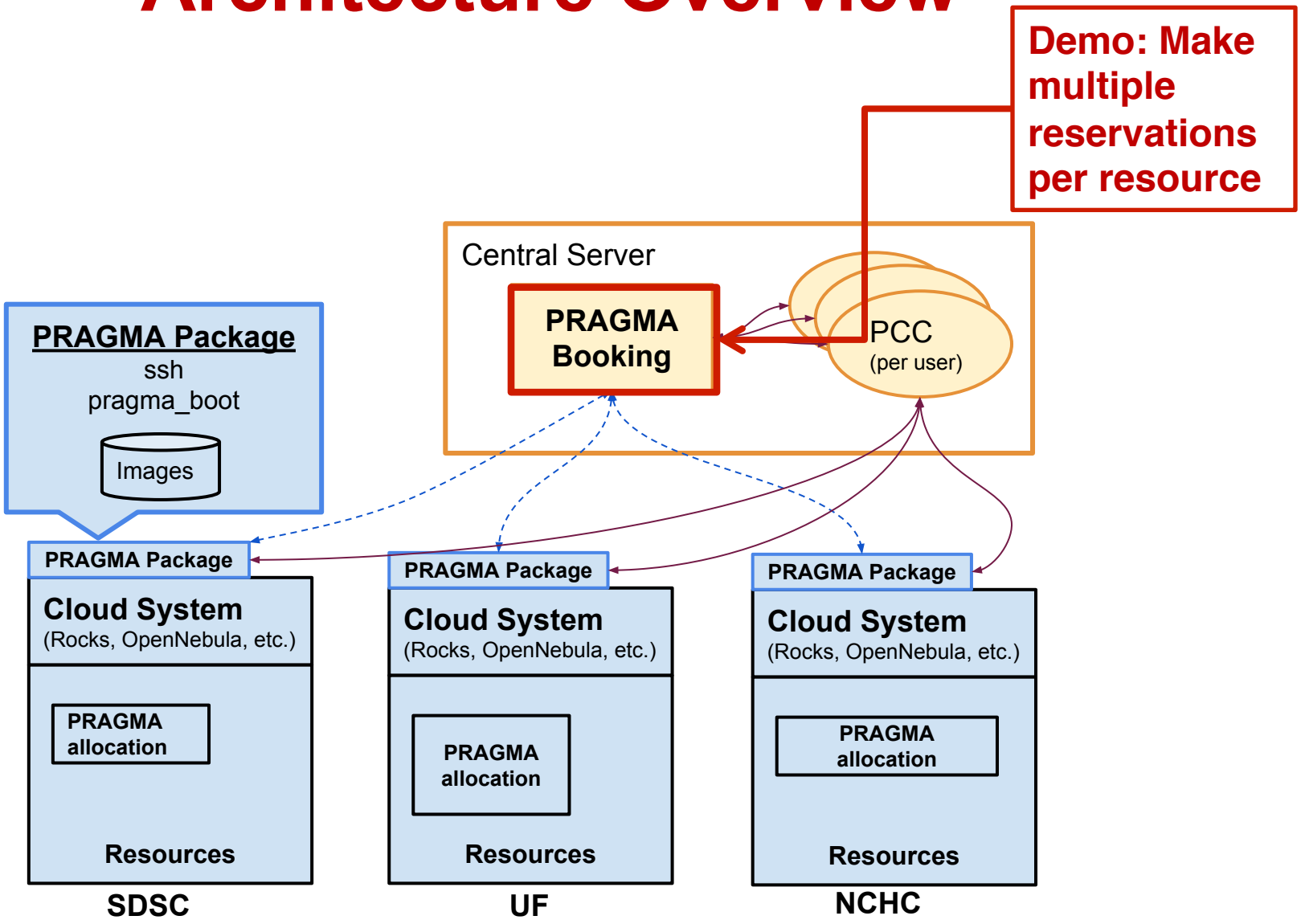
Takes about ~8 minutes to boot basic 2-node rocks cluster

Describing ZFS volumes

- **Repository**
  - vcdb.txt
  - <vcdir>
    - vc-in.xml (based on libvirt XML syntax)
    - <FE image file>
    - <compute image file>
  - <vcdir>
    - **vc-in.xml**

```
<vc type='Local Beowulf'>
  …
  <frontend> …
      <devices> …
        <disk type='volume' device='disk'>
          <source volume='pragma/lima-vc-3-vol'
                  pool='pragma' host='nas-0-0'/>
          <target dev='vda' bus='virtio'/>
        </disk> …
      </devices>
    </domain>
  </frontend>
  <compute> …
      <devices> …
        <disk type='volume' device='disk'>
          <source volume='pragma/vm-lima-vc-3-1-vol'
                  pool='pragma' host='nas-0-0'/>
          <target dev='vda' bus='virtio'/>
        </disk> ….
      </devices>
    </domain>
 </compute>
 …
</vc>
```

Architecture Overview



PRAGMA Booking

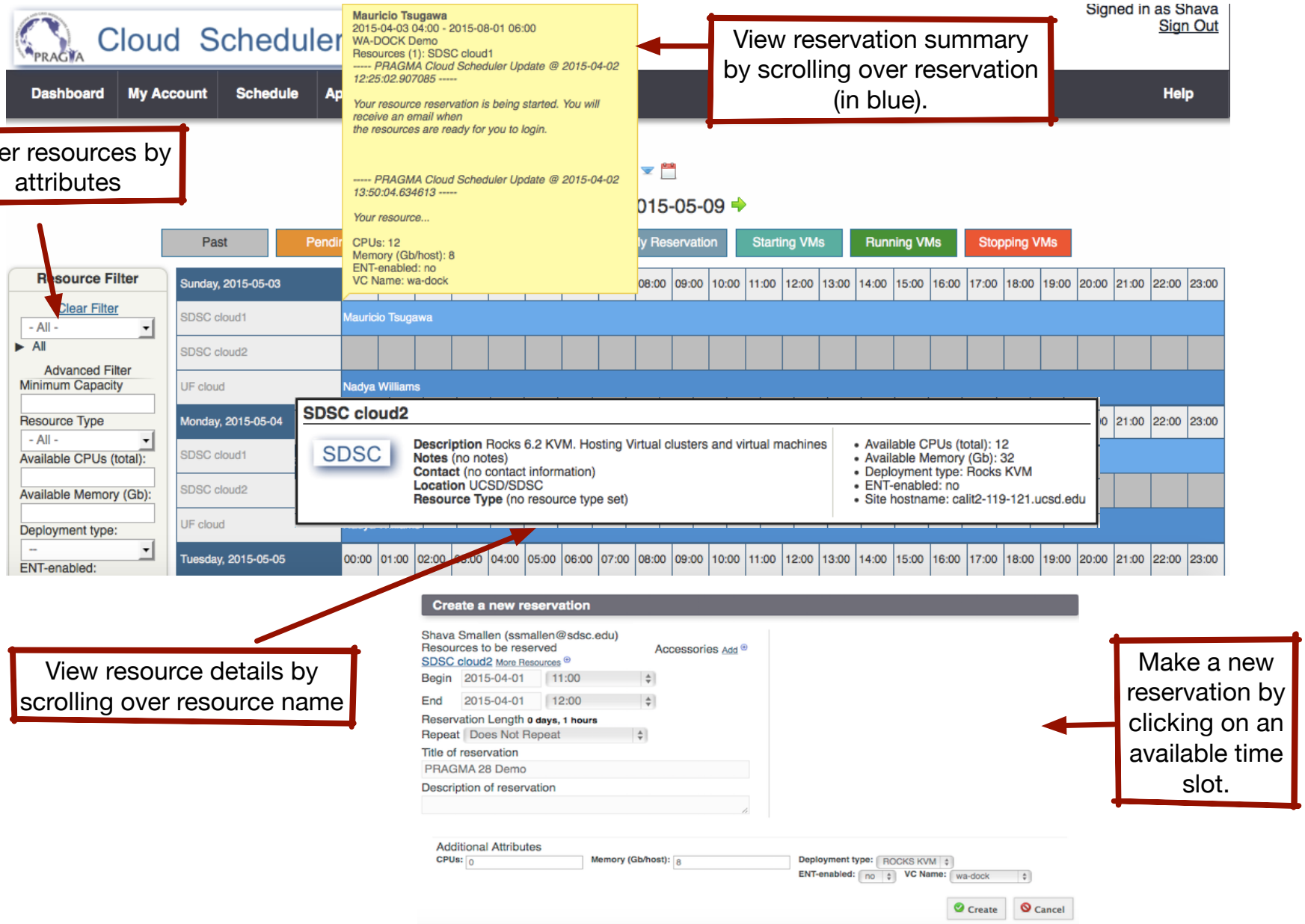
Pros:

- ✓ Open source
- ✓ Easy to setup
- ✓ Nice GUI interface
- ✓ Usage reporting
- ✓ REST API
- ✓ Customizable-ish
- ✓ LDAP and Active Directory support.
- ✓ Fine tuned roles and permissions.
- ✓ User and group quotas.

http://www.bookedscheduler.com

Cons:

- ❖ **Can only handle one reservation per resource at a time**
- ❖ PHP changes can be painful (heavy OO makes it hard to find right files)
- ❖ Doc is sparse


Cloud Scheduler
Signed in as Shava
Sign Out
Dashboard
My Account
Schedule
Help
Mauricio Tsugawa
2015-04-03 04:00 - 2015-08-01 06:00
WA-DOCK Demo
Resources (1): SDSC cloud1
----- PRAGMA Cloud Scheduler Update @ 2015-04-02 12:25:02.907085 -----
Your resource reservation is being started. You will receive an email when the resources are ready for you to login.
----- PRAGMA Cloud Scheduler Update @ 2015-04-02 13:50:04.634613 -----
Your resource...
CPUs: 12
Memory (Gb/host): 8
ENT-enabled: no
VC Name: wa-dock
View reservation summary by scrolling over reservation (in blue).
Filter resources by attributes
015-05-09
Past
Starting VMs
Running VMs
Stopping VMs
Resource Filter
Clear Filter
- All -
All
Advanced Filter
Minimum Capacity
Resource Type
Available CPUs (total):
Available Memory (Gb):
Deployment type:
ENT-enabled:
Sunday, 2015-05-03
SDSC cloud1
SDSC cloud2
UF cloud
Mauricio Tsugawa
Nadya Williams
Monday, 2015-05-04
Tuesday, 2015-05-05
00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
SDSC cloud2
SDSC
Description Rocks 6.2 KVM. Hosting Virtual clusters and virtual machines
Notes (no notes)
Contact (no contact information)
Location UCSD/SDSC
Resource Type (no resource type set)
Available CPUs (total): 12
Available Memory (Gb): 32
Deployment type: Rocks KVM
ENT-enabled: no
Site hostname: calit2-119-121.ucsd.edu
View resource details by scrolling over resource name
Create a new reservation
Shava Smallen (ssmallen@sdsc.edu)
Resources to be reserved
Accessories Add
SDSC cloud2 More Resources
Begin 2015-04-01 11:00
End 2015-04-01 12:00
Reservation Length 0 days, 1 hours
Repeat Does Not Repeat
Title of reservation
PRAGMA 28 Demo
Description of reservation
Additional Attributes
CPUs: 0
Memory (Gb/host): 8
Deployment type: ROCKS KVM
ENT-enabled: no
VC Name: wa-dock
Create
Cancel
Make a new reservation by clicking on an available time slot.

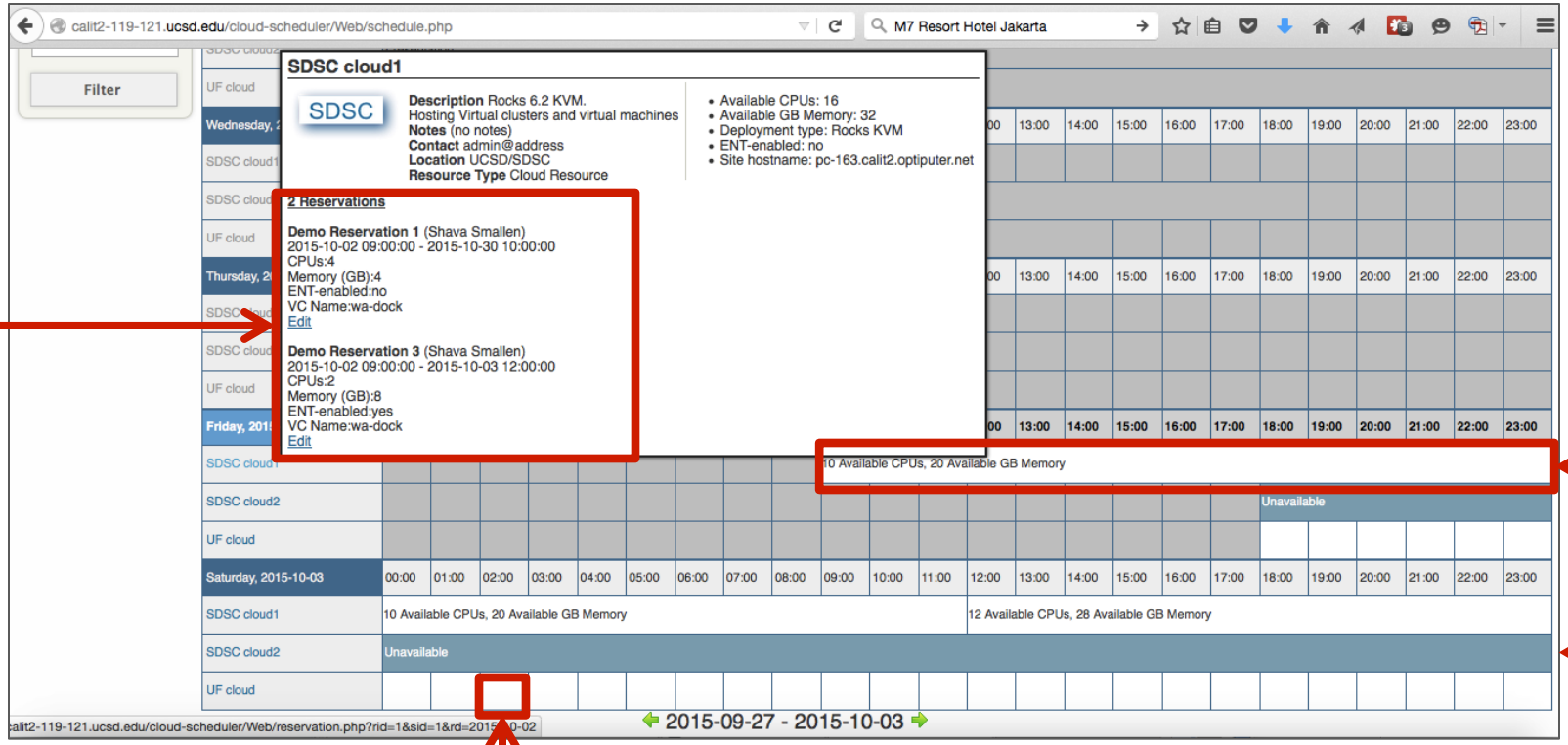
Changes to Booked

X

- **Reservations stored in MySQL database**
  - No backend changes needed
- **PHP object changes**
  - **Domain/Values/CustomAttributes.php**: Get capacity left based on existing reservations in hour time slot
  - **Domain/Values/CustomAttributes.php**: Find overlapping reservations and calculate capacity for every hour time slot
  - **lib/Application/Schedule/ScheduleReservationList.php**: Read data from db and create slots
  - **lib/Application/Schedule/ReservationSlot.php**: Modified to take array of reservations instead of single value
- **Schedule display**
  - **Pages/SchedulePage.php**: Get capacity left info for a time slot
  - **tpl/Schedule/schedule.tpl**: Display of Schedule pages
- **Add reservation info to resource detail popup**
  - **Pages/Ajax/ResourceDetailsPage.php**: Resource detail popup
  - **tpl/Ajax/resourcedetails.tpl**: Display active reservations in popup
- **Error checking**
  - **lib/Application/Reservation/Validation/CustomAttributeValidationRule.php**: Verifies capacity of new reservation with overlapping reservations

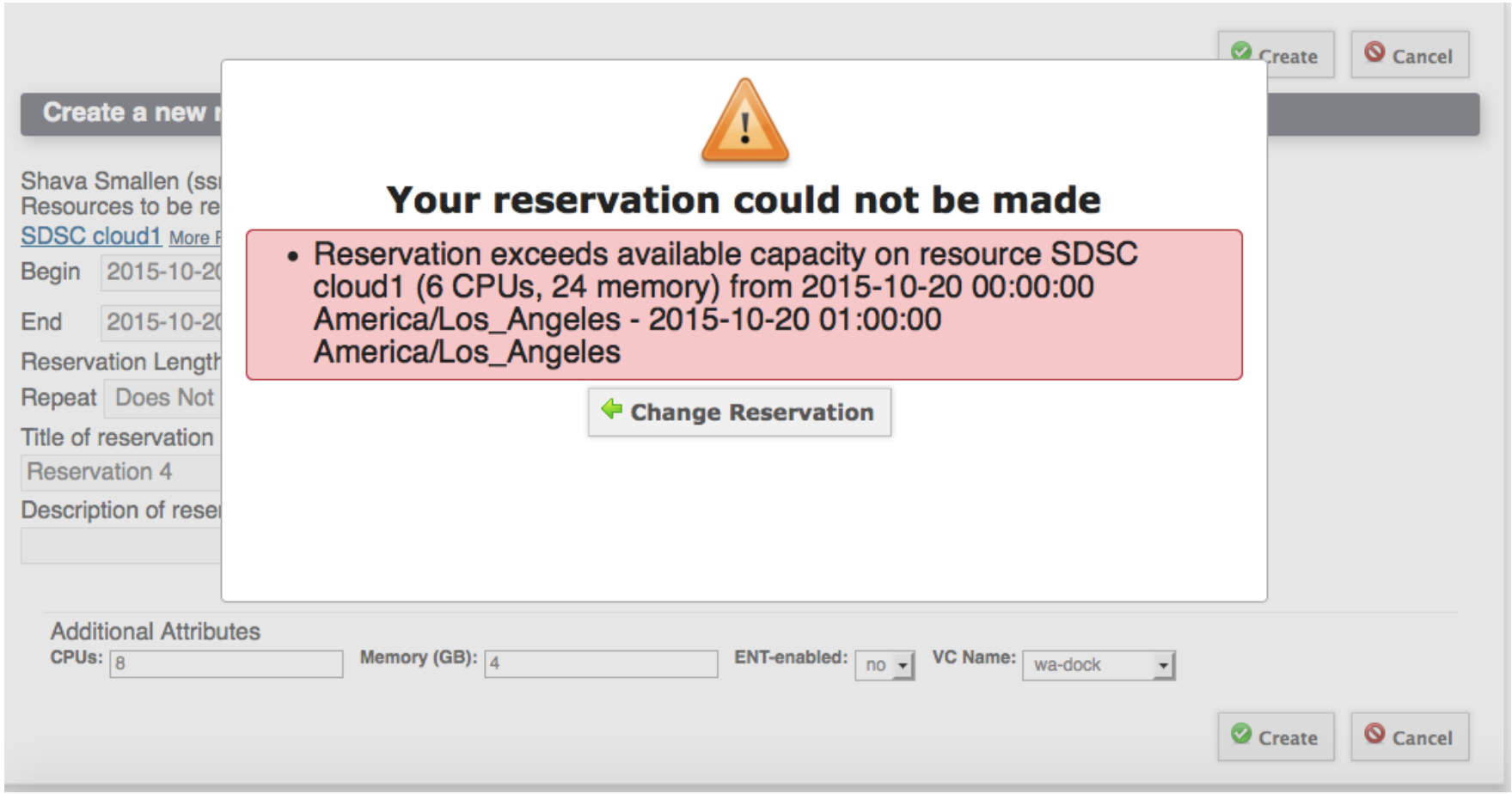
View reservations by mousing over resource name

2 reservations already
10 CPUs, 20GB memory still available



Available (empty)

Not available (full)


Create
Cancel
Create a new r
Shava Smallen (ss
Resources to be re
SDSC cloud1 More F
Begin 2015-10-20
End 2015-10-20
Reservation Length
Repeat Does Not
Title of reservation
Reservation 4
Description of rese
Your reservation could not be made
Reservation exceeds available capacity on resource SDSC cloud1 (6 CPUs, 24 memory) from 2015-10-20 00:00:00 America/Los_Angeles - 2015-10-20 01:00:00 America/Los_Angeles
Change Reservation
Additional Attributes
CPUs: 8
Memory (GB): 4
ENT-enabled: no
VC Name: wa-dock
Create
Cancel

Future Work

- Integrate IPOP and PRAGMA-ENT
- Rework PCC and integrate HTCondor so it's used in personal mode
- Leverage CloudFront option in pragma_boot to manage application virtual cluster images and staging them to each of the sites.
- Package and document for easy installation at sites