Cross-Institute Virtual Cluster Management in PRAGMA

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DATA TO INSIGHT CENTER
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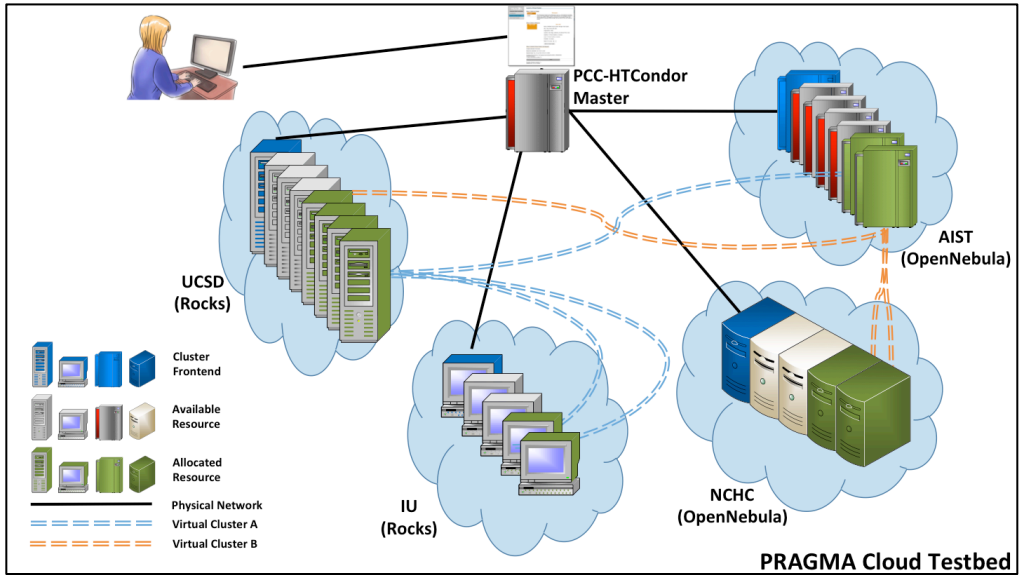
Goals of Personal Cloud Controller (PCC)

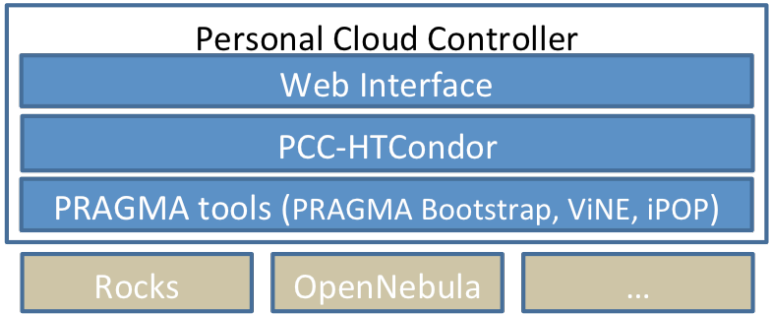
- Enable lab/group to easily manage **application virtual clusters** on available resources
- Leverage PRAGMA Cloud tools: PRAGMA Bootstrap, IPOP, ViNE, Rocks.
- Lightweight, extends HTCondor from U Wisc.
- Provide command-line and Web interfaces



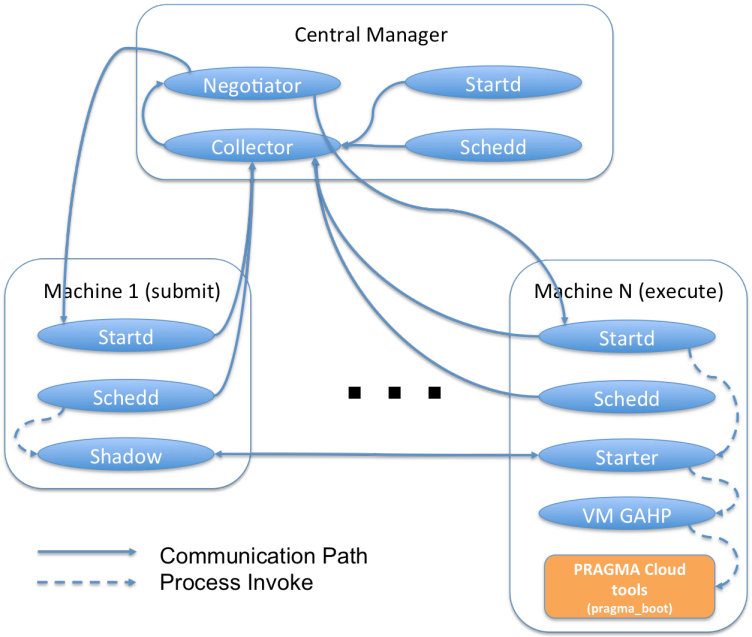
Working Group: Resources

Previous work

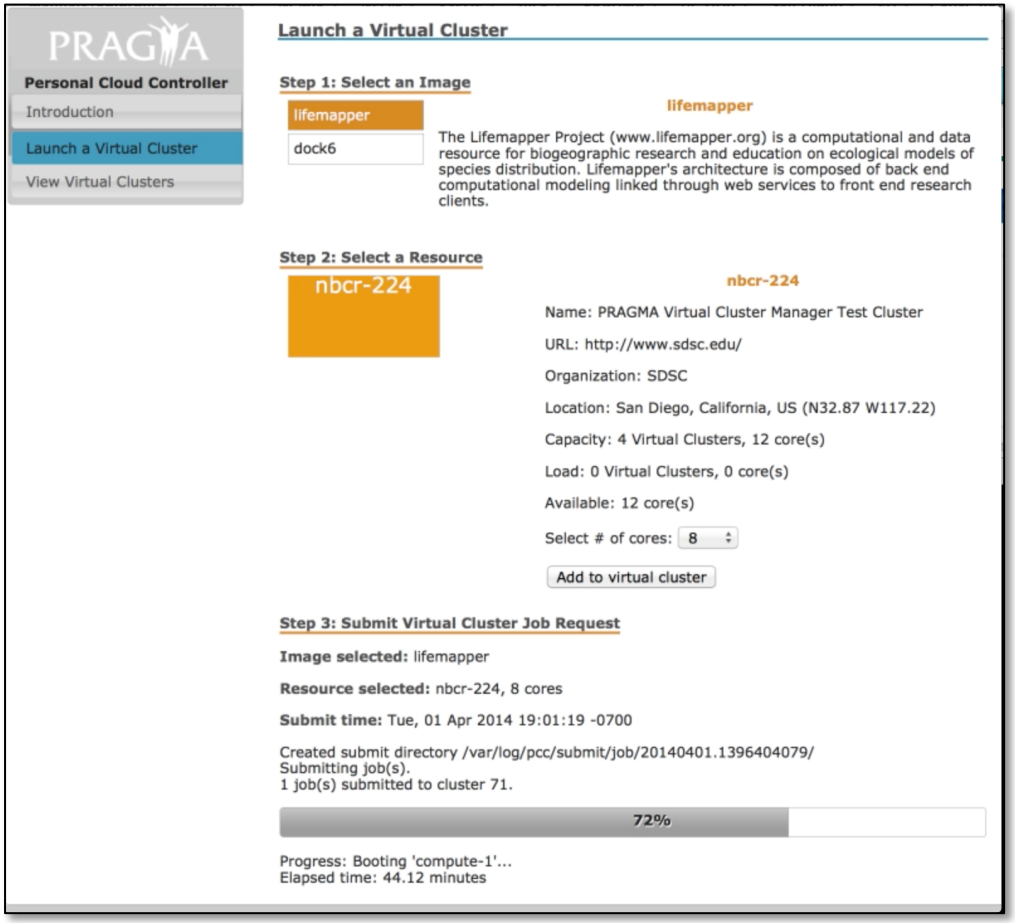
Demoed single site virtual cluster prototype at PRAGMA 26



High level architecture diagram of PCC



Architecture diagram of PCC-HTCondor



Web interface to launch and view status of virtual cluster

Progress for PRAGMA 27

Cross-institute virtual cluster using IPOP

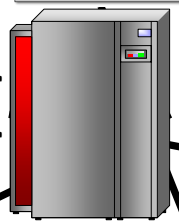
Accomplished

- ✓ Setup Rocks with KVM roll on 3-node cluster at IU
- ✓ Experimented with IPOP and measured initialization and bandwidth performance between IU and SDSC
- ✓ Drafted a paper "A Personal Cloud Controller Framework" for submission
- ✓ Developed new IPOP Rocks roll for easy installation of IPOP to any Rocks virtual cluster
- ✓ Added automated IPOP server/client initialization to PRAGMA Bootstrap
- ✓ Enabled multi-site virtual cluster creation via enhanced PCC-HTCondor (VM GAHP) and Condor DAG capabilities
- ✓ Part-way thru setup of OpenNebula/ PRAGMA Bootstrap on 4-node cluster at AIST

TODO

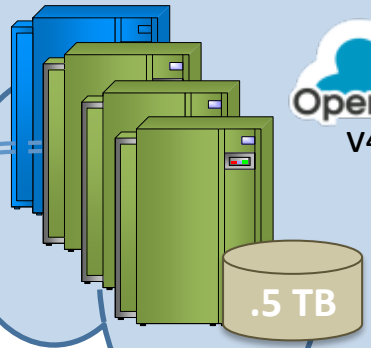
- ❑ Automated reconfiguration of Rocks DB
- ❑ Debug OneNebula/PRAGMA Bootstrap issues
- ❑ Integrate changes into Web interface
- ❑ Rocks rolls for PCC-HTCondor and enhanced PRAGMA Bootstrap
- ❑ Live application demo with Lifemapper

PCC-HTCondor Master



163.220.56.77 (AIST)

(4) Dell PowerEdge M610
- (2) Quad-Core 2.4 GHz Intel Xeon
- 24 GB Memory)

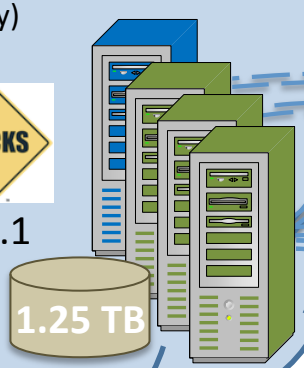


OpenNebula v4.8.0

nbcr-224.ucsd.edu

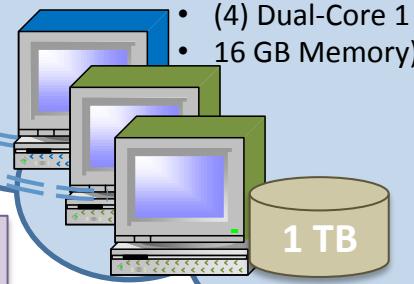
(4) Dell PowerEdge SC1435
- (2) Dual-Core 2.4 GHz AMD Opteron
- 8 GB Memory)

ROCKS v6.1

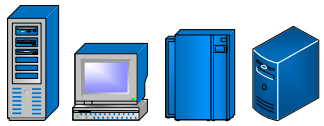


pragma8.cs.indiana.edu

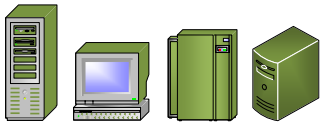
(3) Dell PowerEdge 6950
- (4) Dual-Core 1 GHz AMD Opteron
- 16 GB Memory)



ROCKS v6.1.1



Cluster Frontend



Allocated Resource

Physical Network

Virtual Cluster nbcr-227.ucsd.edu

PCC Software

HTCondor High Throughput Computing v8.0.6

PRAGMA Bootstrap

IPOP

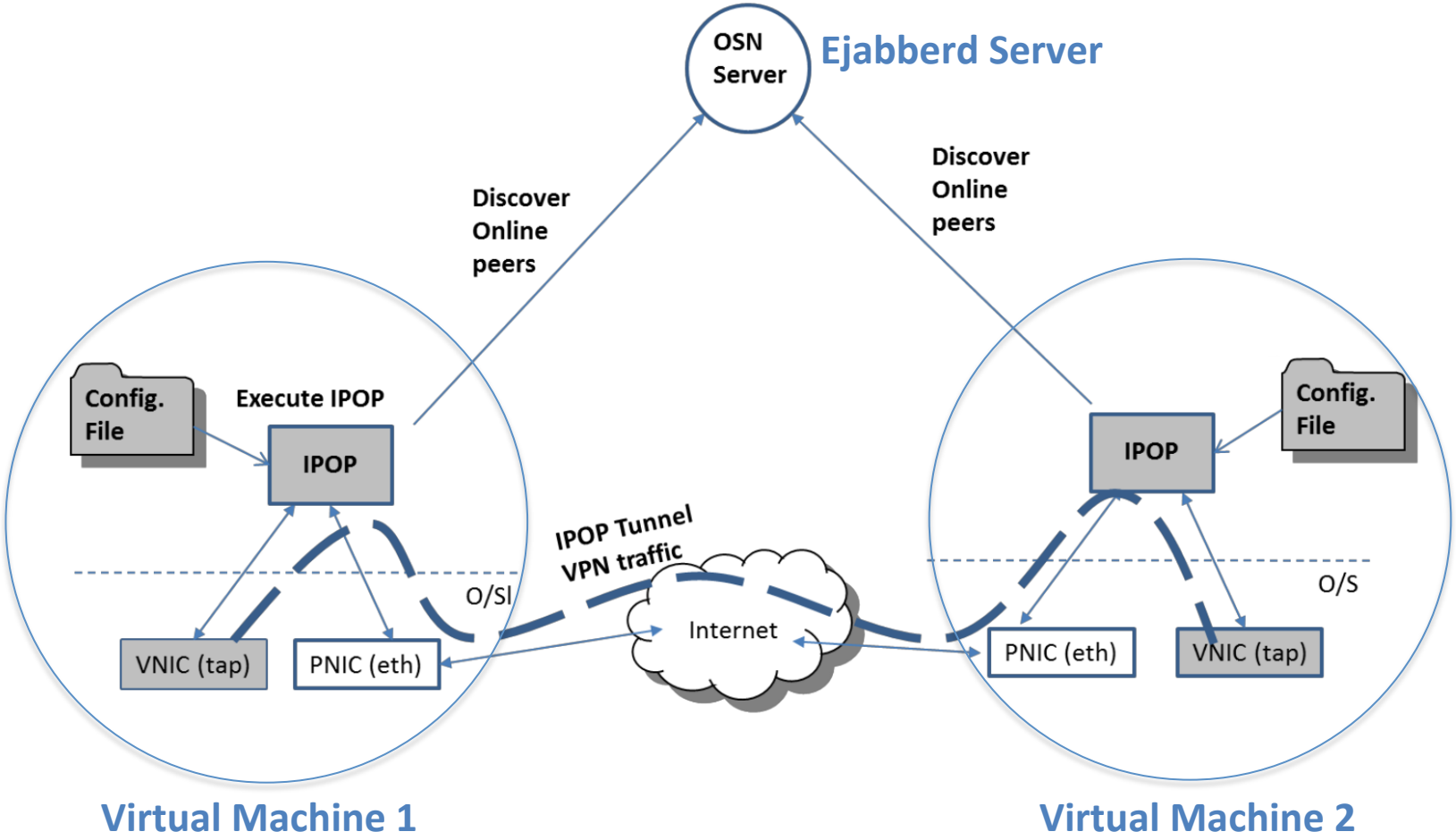


Image from IPOP White Paper, http://ipop-project.org/wp-content/uploads/2014/07/IPOP-WhitePaper-1407.pdf

PCC Evaluation

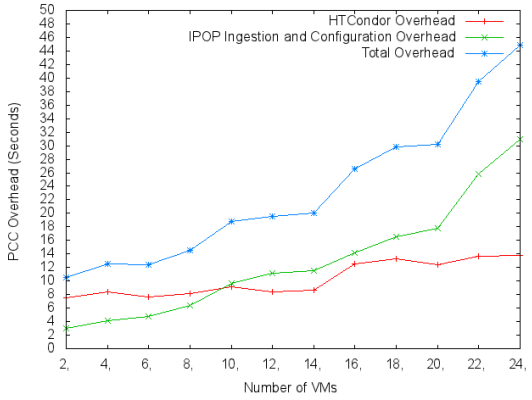
- We measure overhead of PCC as captured by overhead during the resource provisioning phase and overhead of application running over VPN.
- Testbed. Two clusters were selected: one at Indiana University(IU) and the other at the San Diego Supercomputer Center (SDSC).

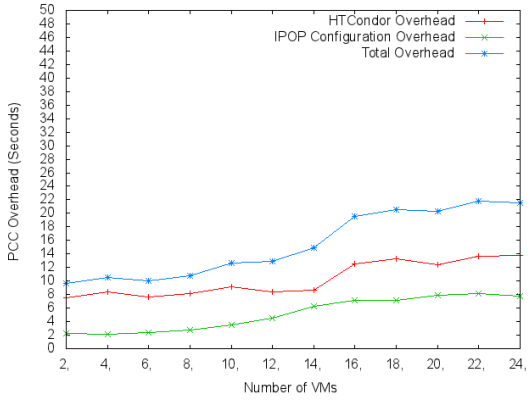
Table 1. Testbed Specifications

Cluster	Nodes	CPU	Cores	Mem	Ethernet	OS	VMM	Cloud Platform
SDSC	4	2.4GHZ	4	8GB	1000Base-T	CentOS 6	KVM	Rocks 6.1
IU	3	2.4GHZ	8	16GB	1000Base-T	CentOS 6	KVM	Rocks 6.1

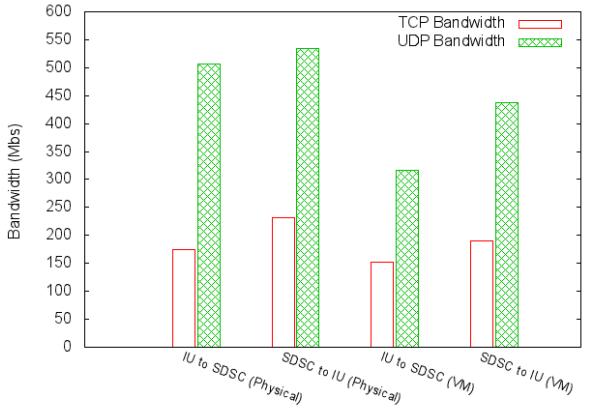
PCC Evaluation – *cont'd*

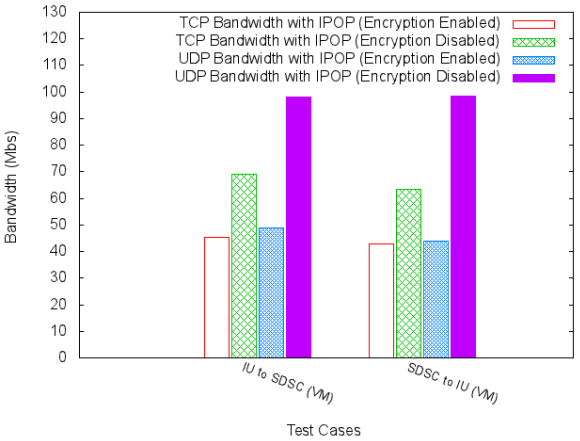
PCC Overhead Evaluation

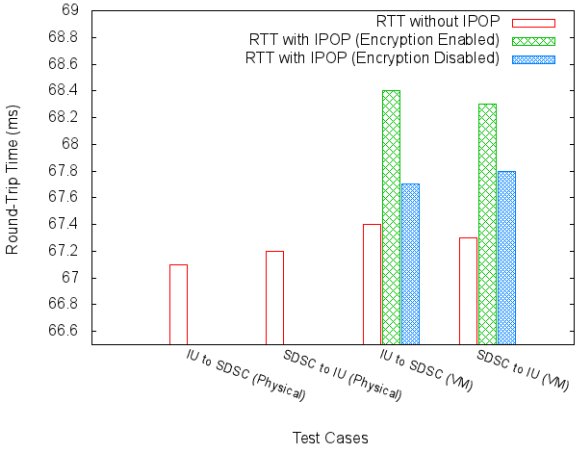




Network Overhead Evaluation



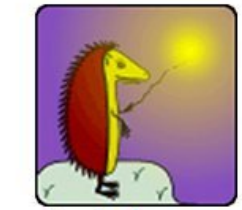




IPOP Rocks Roll

https://github.com/pragmagrid/ipop

ERLANG v17.0



v14.07

IPOP v14.07

File	IPOP Server	IPOP Client	Purpose
/opt/ipop/ejabberd/bin/initEjabberd	X		(Re-)initializes Ejabberd for IPOP usage and produces ipopserver.info file.
/etc/init.d/ejabberd	X		Optionally initializes (via initEjabberd) and then starts Ejabberd
/var/www/html/ipop/ip.php	X		Distributes unique IP addresses to IPOP clients
/opt/ipop/bin/updateConfJson	X	X	Populates IPOP config.json file with ipopserver.info contents
/etc/init.d/ipop	X	X	Optionally initializes then starts IPOP

Many thanks to Nadya Williams!!

IPOP-enabled PRAGMA Bootstrap

PRAGMA Bootstrap

- Instantiates dynip-enabled virtual clusters within a single cluster
  - Utilizes “drivers” to support multiple cloud platforms (current support for Rocks and OpenNebula)
  - Allocates IP addresses, installs vc-out.xml (for dynip), and boots VMs

IPOP Enhancements

- **--enable-ipop-server=<URL>**

  Starts up IPOP-enabled virtual cluster with the frontend serving as the IPOP server; fetches IPOP server info once initialization is complete

- **--enable-ipop-client=<URL>**

  Start up the IPOP-enabled virtual cluster as an IPOP client (to another virtual cluster).

Enhanced PCC-HTCondor

(Leveraged HTCondor DAG capabilities to create multi-site virtual cluster)

```
# File name: vc-ipop.dag
#
JOB  A  vc1.sub
JOB  B  vc2.sub
JOB  C  vc3.sub
```

HTCondor DAG

```
universe                        = vm
executable                      = rocks_vc_1
requirements                    = Machine =="nbcr-224.ucsd.edu"
log                             = vc1.log.txt
vm_type                         = rocks
vm_memory                       = 64
rocks_job_dir                     = /tmp/dag_vm
RequestMemory = 64
rocks_should_transfer_files = Yes
RunAsOwner=True
queue
```

ROCKS

```
universe                        = vm
executable                      = rocks_vc_2
requirements                    = Machine =="pragma8.cs.indiana.edu"
log                             = vc2.log.txt
vm_type                         = rocks
vm_memory                       = 64
rocks_job_dir                     = /tmp/dag_vm
RequestMemory = 64
rocks_should_transfer_files = Yes
RunAsOwner=True
queue
```

ROCKS

```
--executable      = pragma_boot
--basepath        = /opt/pragma_boot/vm-images
--key             = ~/.ssh/id_rsa.pub
--num_cores       = 2
--vcname          = lifemapper
--logfile         = shava_pragma_boot.log
--ipop-enable-server=${COLLECTOR_HOST_STRING}/ipop/register.php?jobid=${DAGManJobId}
--ipop-enable-cient=${COLLECTOR_HOST_STRING}/ipop/register.php?jobid=${DAGManJobId}
```

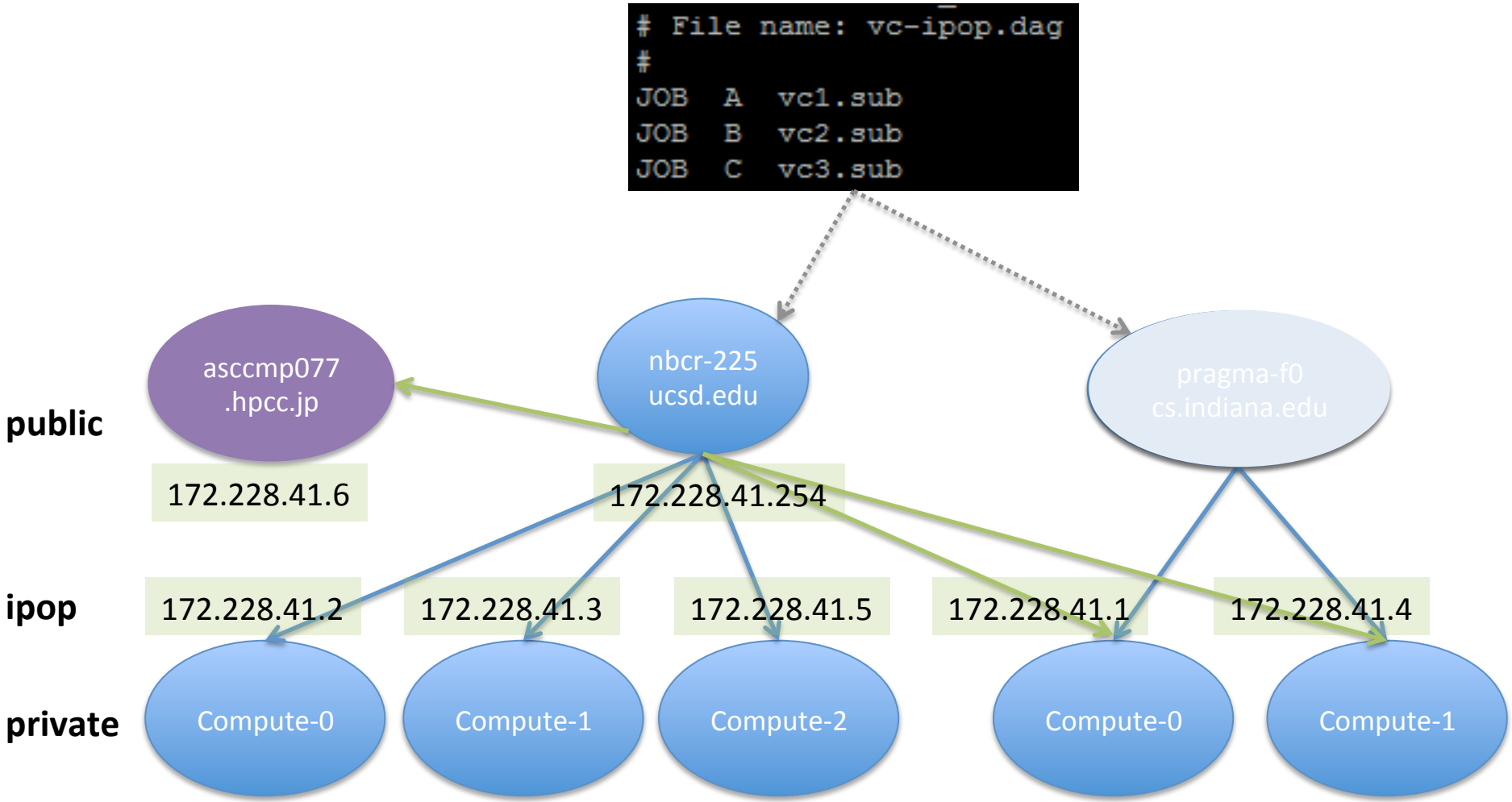
VC configuration file

```
universe                        = vm
executable                      = rocks_vc_3
requirements                    = Machine =="163.220.56.77"
log                             = vc3.log.txt
vm_type                         = rocks
vm_memory                       = 64
rocks_job_dir                     = /tmp/dag_vm
RequestMemory = 64
rocks_should_transfer_files = Yes
RunAsOwner=True
queue
```

OpenNebula.org

Parallel pragma_boot jobs

Instantiated virtual cluster



Demo: View Ejabberd interface

```
[root@nbcr-225 ~]# sh show-ipop

========= 172.228.41.1 =========
ping -c 1 172.228.41.1
PING 172.228.41.1 (172.228.41.1) 56(84) bytes of data.
64 bytes from 172.228.41.1: icmp_seq=1 ttl=64 time=69.9 ms

--- 172.228.41.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 70ms
rtt min/avg/max/mdev = 69.905/69.905/69.905/0.000 ms
ssh 172.228.41.1 hostname
compute-0

========= 172.228.41.2 =========
ping -c 1 172.228.41.2
PING 172.228.41.2 (172.228.41.2) 56(84) bytes of data.
64 bytes from 172.228.41.2: icmp_seq=1 ttl=64 time=0.977 ms

--- 172.228.41.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 1ms
rtt min/avg/max/mdev = 0.977/0.977/0.977/0.000 ms
ssh 172.228.41.2 hostname
compute-0

========= 172.228.41.3 =========
ping -c 1 172.228.41.3
PING 172.228.41.3 (172.228.41.3) 56(84) bytes of data.
64 bytes from 172.228.41.3: icmp_seq=1 ttl=64 time=0.872 ms

--- 172.228.41.3 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 1ms
rtt min/avg/max/mdev = 0.872/0.872/0.872/0.000 ms
ssh 172.228.41.3 hostname
compute-1

========= 172.228.41.4 =========
ping -c 1 172.228.41.4
PING 172.228.41.4 (172.228.41.4) 56(84) bytes of data.
64 bytes from 172.228.41.4: icmp_seq=1 ttl=64 time=68.8 ms

--- 172.228.41.4 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 69ms
rtt min/avg/max/mdev = 68.816/68.816/68.816/0.000 ms
ssh 172.228.41.4 hostname
compute-1

========= 172.228.41.5 =========
ping -c 1 172.228.41.5
PING 172.228.41.5 (172.228.41.5) 56(84) bytes of data.
64 bytes from 172.228.41.5: icmp_seq=1 ttl=64 time=0.892 ms

--- 172.228.41.5 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 1ms
rtt min/avg/max/mdev = 0.892/0.892/0.892/0.000 ms
ssh 172.228.41.5 hostname
compute-2

========= 172.228.41.6 =========
ping -c 1 172.228.41.6
PING 172.228.41.6 (172.228.41.6) 56(84) bytes of data.
64 bytes from 172.228.41.6: icmp_seq=1 ttl=64 time=117 ms

--- 172.228.41.6 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 117ms
rtt min/avg/max/mdev = 117.393/117.393/117.393/0.000 ms
ssh ssmallen@172.228.41.6 hostname
asccmp077.hpcc.jp
```

Future Work

Near-term goals

- **Oct-Dec**
  - Automated reconfiguration of Rocks DB
  - Integrate changes into Web interface
  - Rocks rolls for PCC-HTCondor and enhanced PRAGMA Bootstrap
  - Live application demo with Lifemapper
- **Jan – April**
  - Work with Aimee to develop load model for LM
  - Develop PCC auto-sizing capabilities

Longer-term goals

- Improve resource allocation algorithms.
- Enable resource to application information sharing.
- Extend the Hierarchical MapReduce model to support distributed sensitive data processing.
- Schedule application jobs based on VC topologies, and VM provenance.