VC3
Virtual Clusters for Community Computation

Ben Tovar <btovar@nd.edu> for the VC3 team
Where our users are

A scientist that knows how to scale their computation in a particular site.

one task

submit node campus cluster, HPC center, etc.

many task running on many computational nodes
Where our users want to be

Communicate working setups to colleagues.
Where our users want to be

Pool resources together
Where our users want to be

Share resources

gives access to

gives access to
VC3: A platform for provisioning customized short-lived clusters over heterogeneous resources for collaborative science teams
VC3 in a nutshell

Users go to a **website** and create **short lived clusters** across heterogeneous resources.

- vc3 web portal
- Notre Dame HTCondor
- Bridges SLURM
- Stampede 2 SLURM
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What is a Virtual Cluster?

1. headnode

+ n middleware workers running on m sites

k environments to run user tasks
Web portal
Login with a vc3 account
Globus login authentication

Log in to use VC3

Use your existing organizational login

- e.g., university, national lab, facility, project

University of Notre Dame

Didn't find your organization? Then use Globus ID to sign in. (What's this?)

Continue

Globus uses CILogon to enable you to Log In from this organization. By clicking Continue, you agree to the CILogon privacy policy and you agree to share your username, email address, and affiliation with CILogon and Globus. You also agree for CILogon to issue a certificate that allows Globus to act on your behalf.

Or

Sign in with Google

Sign in with ORCID iD
## Curated Resources

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Description</th>
<th>Cores</th>
<th>Memory</th>
<th>Storage</th>
<th>Native OS</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cori</td>
<td>National Energy Research Scientific Computing Center (NERSC)</td>
<td>Cori Supercomputer at NERSC</td>
<td>12</td>
<td>4000 MB</td>
<td>10000 MB</td>
<td>slesv12</td>
<td>Shifter</td>
</tr>
<tr>
<td>MWT2</td>
<td>Midwest Tier 2 Center job gateway (UChicago)</td>
<td>ATLAS Midwest Tier 2 Center job gateway (UChicago)</td>
<td>4</td>
<td>1000 MB</td>
<td>1000 MB</td>
<td>scientificlinuxv6.9</td>
<td>N/A</td>
</tr>
<tr>
<td>Midway</td>
<td>University of Chicago Research Computing Center (RCC)</td>
<td>Midway cluster at the University of Chicago Research Computing Center (RCC)</td>
<td>64</td>
<td>4000 MB</td>
<td>10000 MB</td>
<td>scientificlinuxv6.7</td>
<td>N/A</td>
</tr>
<tr>
<td>Stampede 2</td>
<td>Texas Advanced Computing Center (TACC)</td>
<td>Stampede 2 Super Computer</td>
<td>96</td>
<td>2000 MB</td>
<td>10000 MB</td>
<td>centosv74</td>
<td>Singularity</td>
</tr>
<tr>
<td>CoreOS</td>
<td>University of Chicago</td>
<td>CoreOS Cluster</td>
<td>4</td>
<td>1000 MB</td>
<td>1000 MB</td>
<td>scientificlinuxv6.9</td>
<td>Singularity</td>
</tr>
<tr>
<td>UCT3</td>
<td>University of Chicago</td>
<td>UChicago ATLAS Tier 3</td>
<td>4</td>
<td>1000 MB</td>
<td>1000 MB</td>
<td>scientificlinuxv6.9</td>
<td>N/A</td>
</tr>
<tr>
<td>ND CCL</td>
<td>University of Notre Dame Cooperative Computing Lab</td>
<td>ND-CCL login name</td>
<td>4</td>
<td>1000 MB</td>
<td>10000 MB</td>
<td>redhatv7</td>
<td>Singularity</td>
</tr>
<tr>
<td>Bridges</td>
<td>Pittsburgh Supercomputing Center</td>
<td>Bridges Supercomputer at PSC</td>
<td>28</td>
<td>4000 MB</td>
<td>35000 MB</td>
<td>centosv73</td>
<td>Singularity</td>
</tr>
<tr>
<td>VC3 Test Pool</td>
<td>VC3</td>
<td>VC3 Test Pool</td>
<td>4</td>
<td>1000 MB</td>
<td>1000 MB</td>
<td>centosv6.9</td>
<td>N/A</td>
</tr>
<tr>
<td>UCLA Hoffman2</td>
<td>University of California, Los Angeles</td>
<td>UCLA Hoffman2</td>
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<td>1000 MB</td>
<td>10000 MB</td>
<td>centosv6.9</td>
<td>N/A</td>
</tr>
<tr>
<td>OSG Connect</td>
<td>Open Science Grid</td>
<td>Open Science Grid (SL7)</td>
<td>4</td>
<td>1000 MB</td>
<td>1000 MB</td>
<td>Unknown</td>
<td>N/A</td>
</tr>
</tbody>
</table>
ALLOCATIONS

**Step 1: Log Into Resource**

In a terminal, type:

```
ssh btovar@cclvlme5.crc.nd.edu
```

**Step 2: Access Resource**

Enter your password for cclvlme5.crc.nd.edu for access.

**Step 3: Add Allocation SSH Public Key to Resource**

Once the SSH key is generated below, click 'Copy to Clipboard' and paste the following line into your SSH session. You will only need to do this once per allocation.

```
ssh btovar@cclvlme5.crc.nd.edu
```

**Step 4: Validate Allocation**
# Projects

## Project Profiles

<table>
<thead>
<tr>
<th>Name</th>
<th>Members</th>
<th>Allocations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vc3-team</td>
<td>Benjamin Tovar (Owner) - <a href="mailto:btovar@nd.edu">btovar@nd.edu</a></td>
<td>btovar-ndccl</td>
<td>Currently no description</td>
</tr>
<tr>
<td></td>
<td>Lincoln Bryant (UChicago)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jeremy Van (UChicago)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Robert Gardner (UChicago)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kenyi Hurtado (University of Notre Dame)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>khurtado-osgconnect</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lincolnb-midway</td>
<td></td>
</tr>
<tr>
<td>btovar</td>
<td>Benjamin Tovar (Owner) - <a href="mailto:btovar@nd.edu">btovar@nd.edu</a></td>
<td>btovar-ndccl</td>
<td>Currently no description</td>
</tr>
<tr>
<td></td>
<td>Benjamin Tovar (University of Notre Dame)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Launching a Virtual Cluster

Shared cluster definition

Workers will have this environment installed

Allocations available in this project
## Cluster status

### My Virtual Clusters

<table>
<thead>
<tr>
<th>Name</th>
<th>State</th>
<th>Cluster Template</th>
<th>Workers</th>
<th>Head Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>my-virtual-cluster</td>
<td>Running</td>
<td>lincoln-b-h-tcondor-10-workers</td>
<td>Requested: 10</td>
<td>128.135.158.187</td>
</tr>
</tbody>
</table>

- **All requested compute workers are running.**
Workers from many sites

```
[btovar@btovar-my-virtual-cluster ~]$ ip addr | grep 128.135.158.187
  inet 128.135.158.187/25 brd 128.135.158.255 scope global dynamic eth0

[btovar@btovar-my-virtual-cluster ~]$ condor_status

Name                          OpSys  Arch  State       Activity  LoadAv  Mem  ActvtyTime
slot1@glidein_21791@camd01.crc.nd.edu  LINUX  X86_64 Unclaimed Idle  5.120  4013  0+00:19:37
slot1@glidein_29106@camd01.crc.nd.edu  LINUX  X86_64 Unclaimed Idle  5.120  4013  0+00:19:37
slot1@glidein_91802@camd05.crc.nd.edu  LINUX  X86_64 Unclaimed Idle  5.260  4013  0+00:19:37
slot1@glidein_39133@iut2-c257.iu.edu  LINUX  X86_64 Unclaimed Idle  34.620  3223  0+00:19:48
slot1@glidein_61297@lnxfarm275.colorado.edu  LINUX  X86_64 Unclaimed Idle  6.990  3002  0+00:14:36
slot1@glidein_28373@midway091.rcc.local  LINUX  X86_64 Unclaimed Idle  8.170  2013  0+00:19:36
slot1@glidein_71179@midway098.rcc.local  LINUX  X86_64 Unclaimed Idle  7.480  2013  0+00:19:36
slot1@glidein_46364@midway260.rcc.local  LINUX  X86_64 Unclaimed Idle  8.040  2013  0+00:19:36
slot1@glidein_39282@midway324.rcc.local  LINUX  X86_64 Unclaimed Idle  8.750  2013  0+00:19:36
slot1@glidein_39133@uct2-c373.mwt2.org  LINUX  X86_64 Unclaimed Idle  34.080  2415  0+00:19:33

Machines     Owner   Claimed  Unclaimed  Matched   Preempting   Drain
X86_64/LINUX  10      0       0        10        0           0

Total         10      0       0        10        0           0
```

ND: National Diamond
OSG: Open Science Grid
UChicago: University of Chicago
Architecture
user requests
virtual cluster

web portal

infoservice
The \texttt{vc3-builder}, a command-line tool for deploying software environments on clusters.

\texttt{vc3-builder}

\begin{itemize}
  \item \texttt{--require-os centos:7}
  \item \texttt{--mount /scratch=/data}
  \item \texttt{--require /cvmfs}
  \item \texttt{--require python:2.7 -- myapp ...my args...}
\end{itemize}

https://github.com/vc3-project/vc3-builder
How Condor makes VC3 possible

factory
(autoppyfactory)
schedd

vc3
resource
manager

(gahp +
blahp)

HPC site
campus cluster
etc.

slurm, condor, sge, etc.

(like bosco-install, but using an ssh library)
Working Middleware and Applications

● Various Bioinformatics Workflows
  ○ Makeflow + HTCondor + BWA, Shrimp, BLAST
● Lobster CMS Data Analysis
  ○ Work Queue + Builder + CVMFS
● South Pole Telescope (SPT–3G) Analysis Framework
  ○ HTCondor Jobs + Docker/Shifter + CVMFS
● XENON1T Analysis Framework
  ○ Pegasus + HTCondor + CVMFS
● MAKER Bioinformatics Pipeline
  ○ Work Queue + Builder
● IceCube Simulation Framework
  ○ HTCondor
Major challenges

Idiosyncrasies of each site

Multi-factor authentication

Communicate delays/errors from sites to portal
Today we are announcing our limited beta release! We are looking for collaborators to help us work through the bugs and offer feedback.

If you have an ambitious goal and feel VC3 may help you get there, please fill out the form below and we’ll send an invite:


btovar@nd.edu
khurtado@nd.edu
VC3 Funding and Team

Funded by DOE Office of Advanced Scientific Computing Research (ASCR) and NSF Next Generation Networking Services (NGNS)

PIs: Rob Gardner (UC), Douglas Thain (ND), and John Hover (BNL)

cô-PIs: David Miller (UC), Paul Brenner (ND), Mike Hildreth (ND), Kevin Lannon (ND)

dev-team: Lincoln Bryant (UC), Benedikt Riedel (UC), Suchandra Thapa (UC), Jeremy Van (UC), Kenyi Hurtado Anampa (ND), Ben Tovar (ND), Jose Caballero (BNL).

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Rich Carlson, Program Manager
VC3 thanks

Thank you to other sponsors and the technology providers that made this possible.
VC3

Virtual Clusters for Community Computation

https://www.virtualclusters.org
https://www.virtualclusters.org/community
@virtualclusters


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