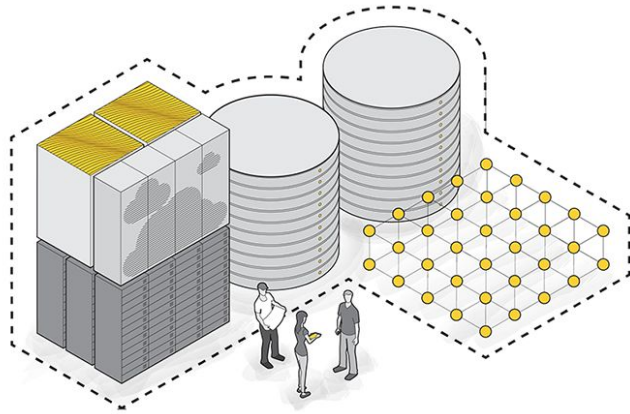

VC3

A Virtual Cluster Service for Community Computation



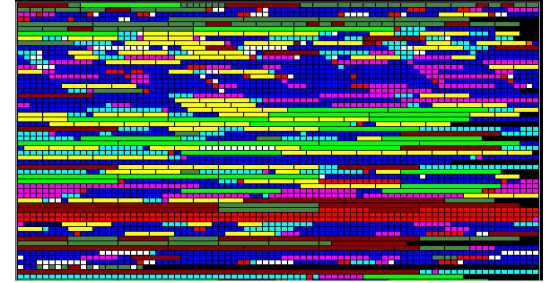
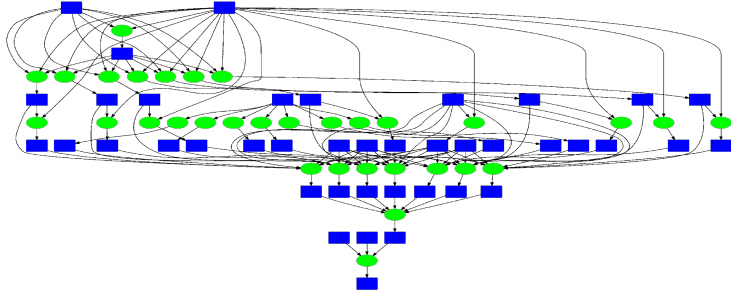
Lincoln Bryant, Jeremy Van, Benedikt Riedel, Robert Gardner,
Jose Caballero Bejar, John Hover, Ben Tovar, and Douglas Thain

<http://www.virtualclusters.org>



VC3: A platform for provisioning cluster frameworks over heterogeneous resources for collaborative science teams

You have developed a complex workload which runs successfully at one site, perhaps your home university.



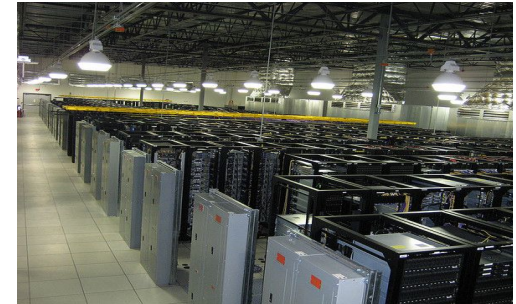
Now, you want to migrate and expand that application to national-scale infrastructure.
And allow others to easily access and run similar workloads.



Leadership HPC Facility



Distributed Computing Facility

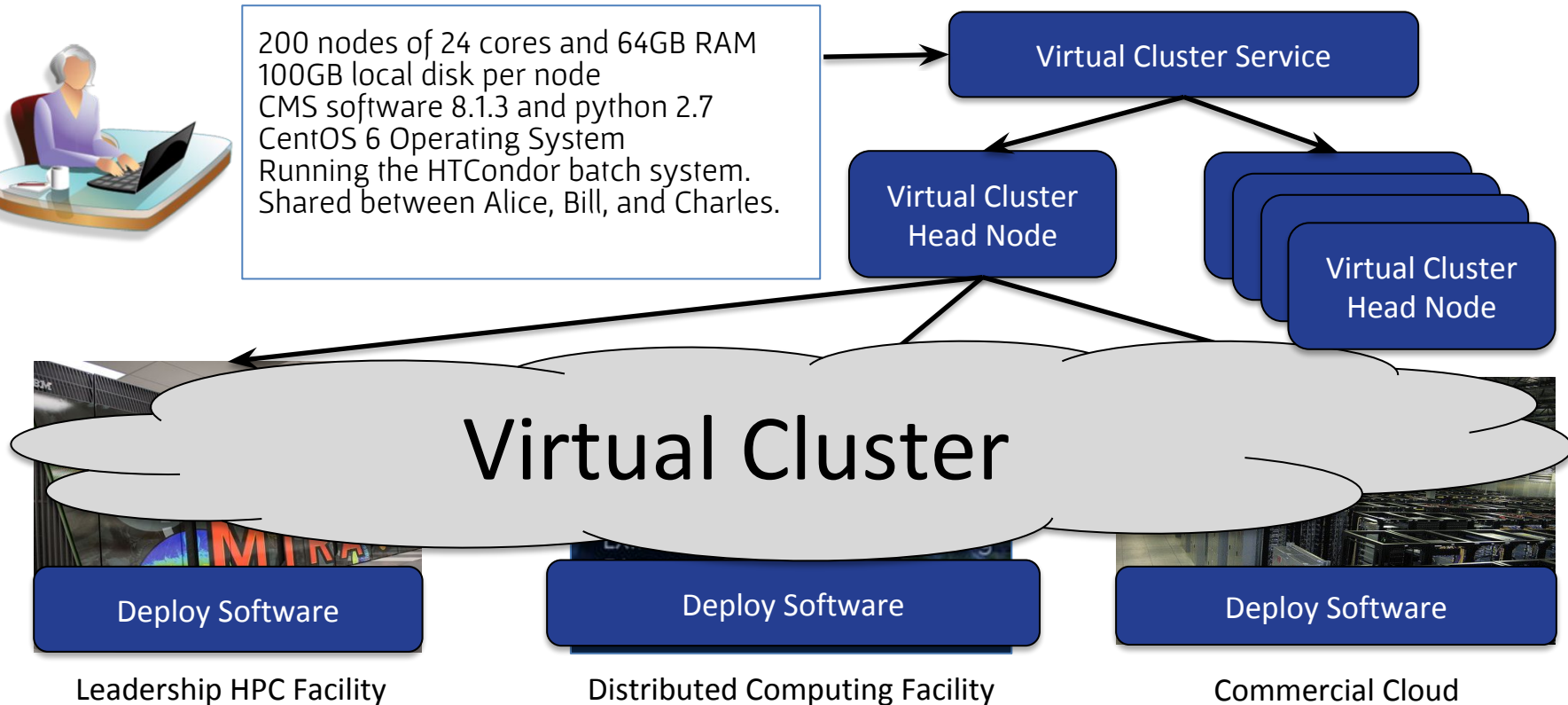


Commercial Cloud

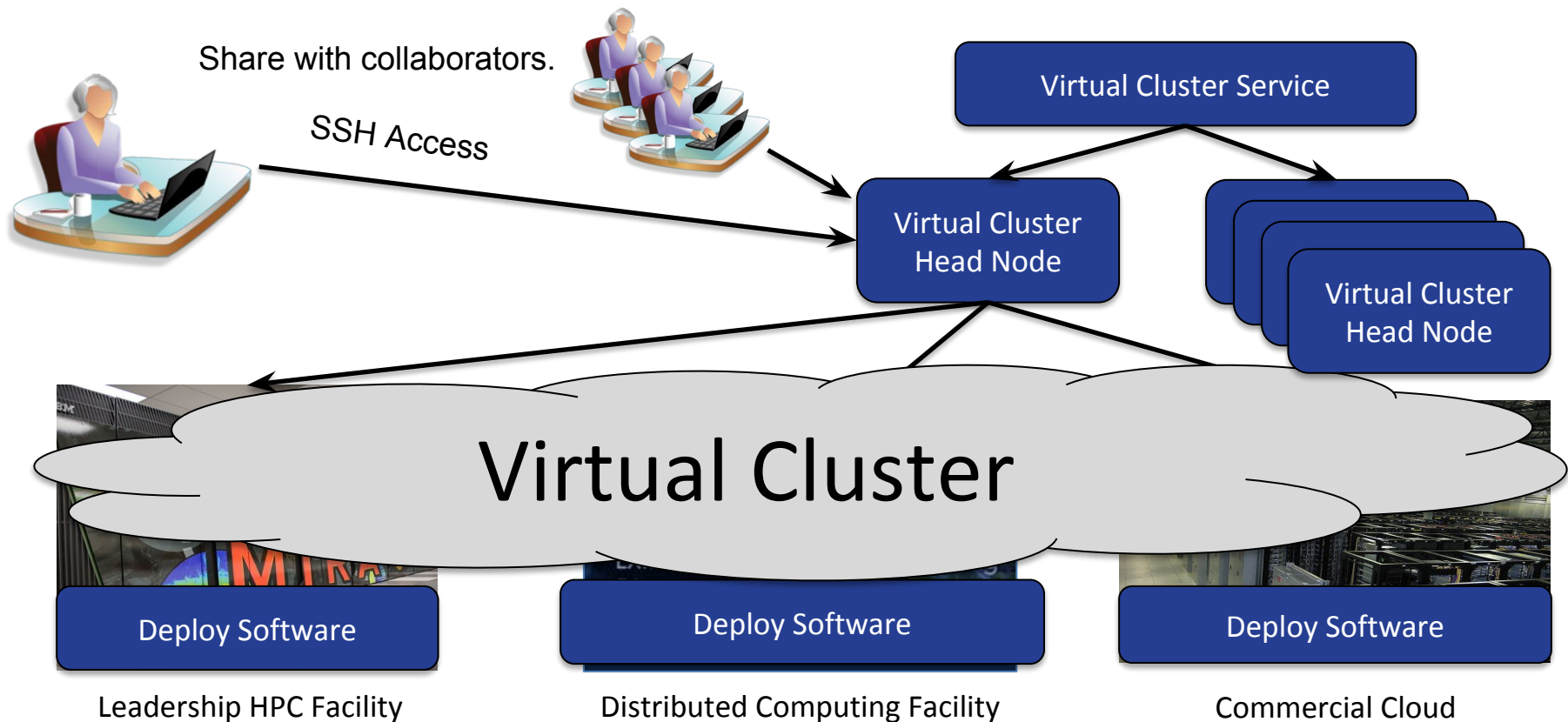
Concept: Virtual Cluster



200 nodes of 24 cores and 64GB RAM
100GB local disk per node
CMS software 8.1.3 and python 2.7
CentOS 6 Operating System
Running the HTCondor batch system.
Shared between Alice, Bill, and Charles.



Concept: Virtual Cluster



VC3: Virtual Clusters for Community Computation



- **VC3 is an interactive service for creating/sharing/using virtual clusters.**
- A virtual cluster consists of:
 - 1 x head node for interactive access to the cluster.
 - N x worker nodes for executing your workload.
 - Middleware to manage the cluster. (HTCondor, Makeflow, Spark, ...)
 - Application software to do real work. (BLAST, Python, etc...)
- A virtual cluster is created using:
 - Your standard accounts/credentials on existing facilities.
 - Plain ssh/qsub access on each facility.
 - Container technology (if available) or user-level software builds (otherwise).
 - (No special privileges or admin access required on the facility.)

Limited Beta Release



Current status: **limited beta release!** We are **looking** for **collaborators** to help us work through bugs and offer feedback.

<http://virtualclusters.org>

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:

<http://bit.ly/vc3-signup>



The screenshot shows the homepage of the VC3 website. At the top left is the VC3 logo. To its right is a dark navigation bar with white text links: News, Resources, Team, Community, Documentation, and Login. The main content area has a dark background with a server rack and cloud imagery. In the center is a large yellow and orange VC3 logo. Below it, the text reads "Virtual Clusters for Community Computation" in white, followed by "Deploy HTCondor and WorkQueue clusters" in a lighter gray. At the bottom are two white buttons with black text: "ABOUT VC3" and "SIGN UP".

login with a vc3
account

Globus Authentication



globus

Globus Account Log In

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



Resource Profiles								Filter
Name	Organization	Description	Cores	Memory	Storage	Native OS	Features	
Cori	National Energy Research Scientific Computing Center (NERSC)	Cori Supercomputer at NERSC	32	4000 MB	10000 MB	suse.v12	Shifter	
MWT2	Midwest Tier 2	ATLAS Midwest Tier 2 Center job gateway (UChicago)	4	1000 MB	1000 MB	scientificlinux.v6.9	N/A	
Midway	University of Chicago Research Computing Center (RCC)	Midway cluster at the University of Chicago Research Computing Center (RCC)	64	4000 MB	10000 MB	scientificlinux.v6.7	N/A	
Stampede 2	Texas Advanced Computing Center (TACC)	Stampede 2 Super Computer	96	2000 MB	10000 MB	centos.v7.4	Singularity	
CoreOS	University of Chicago	CoreOS Cluster	4	1000 MB	1000 MB	scientificlinux.v6.9	Singularity	
UCT3	University of Chicago	UChicago ATLAS Tier 3	4	1000 MB	1000 MB	scientificlinux.v6.9	N/A	
ND CCL	University of Notre Dame Cooperative Computing Lab	ND-CCL login none	4	1000 MB	10000 MB	redhat.v7	Singularity	
Bridges	Pittsburgh Supercomputing Center	Bridges Supercomputer at PSC	28	4000 MB	35000 MB	centos.v7.3	Singularity	
VC3 Test Pool	VC3	VC3 Test Pool	4	1000 MB	1000 MB	centos.v6.9	N/A	
UCLA Hoffman2	University of California, Los Angeles	UCLA Hoffman2	8	1000 MB	10000 MB	centos.v6.9	N/A	
OSG Connect	Open Science Grid	Open Science Grid (SL7)	4	1000 MB	1000 MB	Unknown	N/A	

Allocations



Step 1: Log Into Resource

In a terminal, type:

```
ssh btovar@cc1vm05.crc.nd.edu
```

Step 2: Access Resource

Enter your password for `cc1vm05.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.


```
s*00rwwcGmkkubdkwMkCngcawCRvz7anlgf7w0wccdq9f9c13904r0c9g7e9k  
/GTjh8YrCyX6UhqG+S3nOxOf+ewxx3RSIMf9lsFzPDNdXwJl1YD1dyRCYy8TwNhBggGikCxEKMqfOgo  
L6ROpicuUhFY6yT9apKGoX1mPSM  
/94ETHxIkBmNK8Phg26fuT+F+QQToSQVovgoghWLGidNoztW8OUkSFzZ6uZE5zfPp0xq45a4*FYE  
TorlJRappSjmsjmsB7TeD+qs1ECilwrrg3JPoRBOEMMeLf7rwxjxtzkBUQ7zlkq5lXTUAYeuoCbGgll  
Q7ZHGHRNTyKkSPL7rXEI7nnz6ofgUJCU3L7hr2VKKy84RcHPsfep64qV3jIocw1o6SPvu6iwRYeqhfe  
Aoo  
/yKp1vapyfM7Ptuy+6yWZ7grZlb9AtBolcoBColpig64MR8T4D8RKp1960nCG5ltXwC4mmPSgffQofOL  
WJom7TudG+yTWouWikipoieObZX5w8SKFcoH
```

Copy to Clipboard

Step 4: Validate Allocation

Projects



Project Profiles				Filter
Name	Members	Allocations	Description	
vc3-team	Benjamin Tovar (Owner) - btovar@nd.edu Lincoln Bryant (UChicago) Jeremy Van (UChicago) Robert Gardner (UChicago) Kenyi Hurtado (University of Notre Dame)	 btovar-ndccl khurtado-osgconnect lincoln-midway	Currently no description	
btovar	Benjamin Tovar (Owner) - btovar@nd.edu Benjamin Tovar (University of Notre Dame)	btovar-ndccl	Currently no description	

Launching a Virtual Cluster



VIRTUAL CLUSTER NAME

CLUSTER TEMPLATE *

ENVIRONMENT

ALLOCATIONS *

Nothing selected

Select Allocations for Virtual Cluster

Select All Deselect All

- btovar-ndccl
- khurtado-osgconnect
- lincoln-btcondor-10-workers
- lincoln-midway

A brief description...

shared cluster definition

workers will have this environment installed

allocations available in this project

Cluster Status



My Virtual Clusters Filter				
Name	State	Cluster Template	Workers	Head Node
my-virtual-cluster	<div style="background-color: #28a745; color: white; padding: 2px 5px; display: inline-block;">Running</div> <p>All requested compute workers are running.</p>	lincolnb-htcondor-10-workers	Requested: 10 Running: 7 Queued: 3 Error: 0	128.135.158.187

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
```

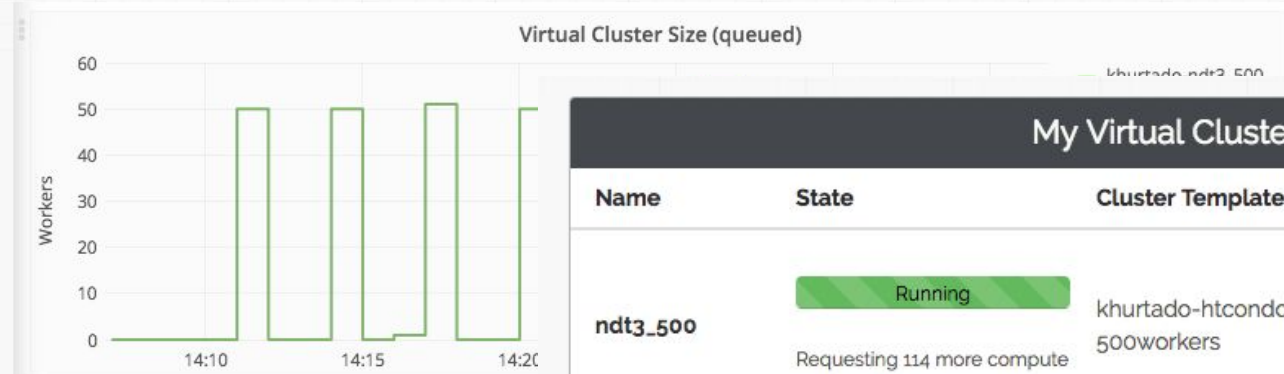
Name	OpSys	Arch	State	Activity	LoadAv	Mem	ActvtyTime
slot1@glidein_21791@camd01.crc.nd.edu	LINUX	X86_64	Unclaimed	Idle	5.120	4013	0+00:19:37
slot1@glidein_29106@camd01.crc.nd.edu	LINUX	X86_64	Unclaimed	Idle	5.120	4013	0+00:19:37
slot1@glidein_91802@camd05.crc.nd.edu	LINUX	X86_64	Unclaimed	Idle	5.260	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+00:19:35
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	10	0	0	0
Total	10	0	10	0	0	0

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



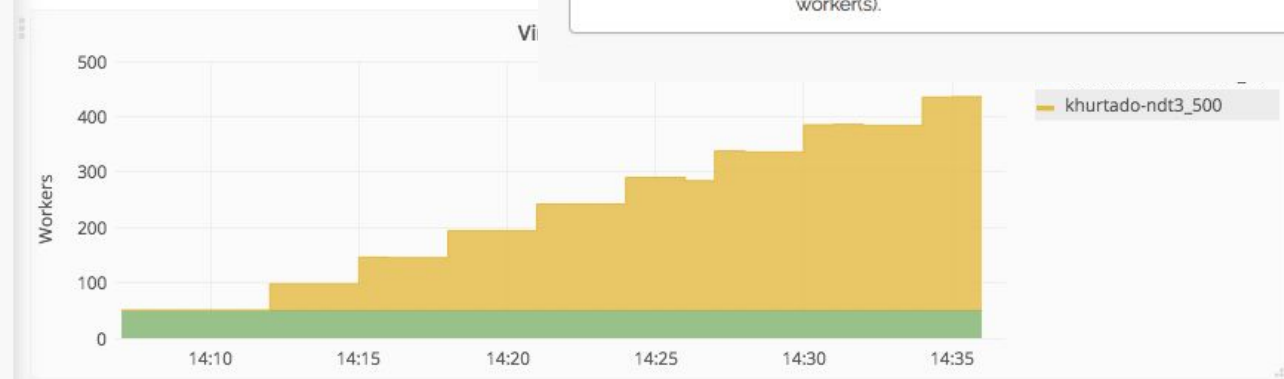
VC3 Monitoring



My Virtual Clusters

Filter

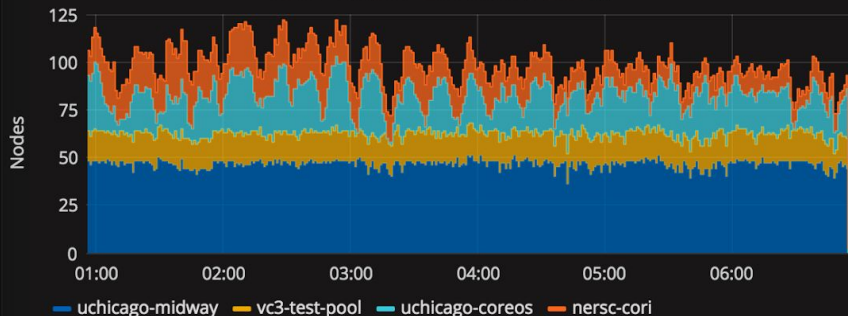
Name	State	Cluster Template	Workers	Head Node
ndt3_500	Running	khurtado-htcondor-500workers	Requested: 500 Running: 388 Queued: 48 Error: 0	128.135.158.178



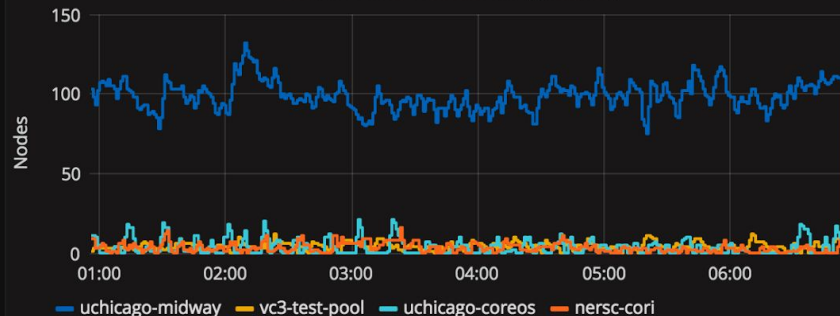
Details: System Monitoring



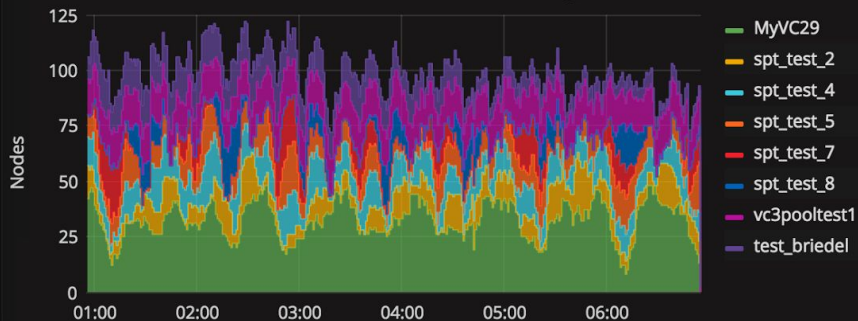
Virtual Cluster Resources (running)



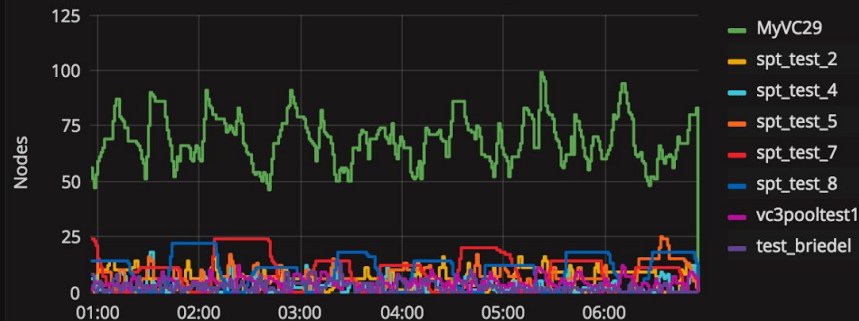
Virtual Cluster Resources (queued)



Virtual Cluster Size (running)



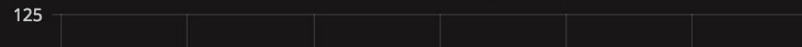
Virtual Cluster Size (queued)



Virtual Cluster by User (running)



Virtual Cluster by User (queued)



Deploying Software Environments



The **vc3-builder**, a command-line tool for deploying software environments on clusters.

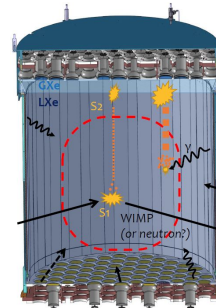
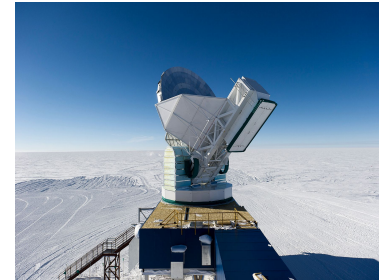
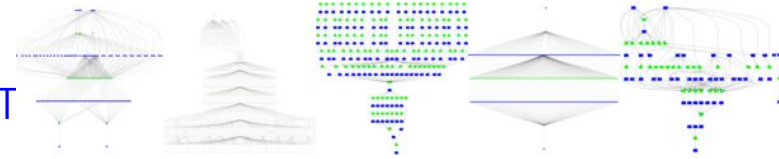
```
vc3-builder
  --require-os centos:7
  --mount /scratch=/data
  --require /cvmfs
  --require python:2.7 -- myapp ...my args...
```

<https://github.com/vc3-project/vc3-builder>

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**



In Progress...



Current Work

- Dynamic reconfiguration of cluster.

- Adding new middleware: Jupyter, Spark, Parsl.

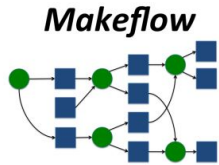
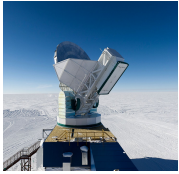
Perennial Challenges

- Idiosyncrasies of each site

- Multi-factor authentication

- Communicate delays/errors from sites to portal

Collaborators and Connections



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)

co-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 Bejar (BNL).



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Supported by the Department of Energy Office of Advanced Scientific Computing Research and Next Generation Networking Services, Solicitation DE--FOA--0001344 (DDRM), Proposal 0000219942
Rich Carlson, Program Manager

VC3

Virtual Clusters for Community Computation

<https://www.virtualclusters.org>

@virtualclusters

Limited beta signup: <http://bit.ly/vc3-signup>

Register your HPC: <http://bit.ly/vc3-new-resource>

