
VC3

Virtual Clusters for Community Computation



Ben Tovar <btovar@nd.edu> for the VC3 team



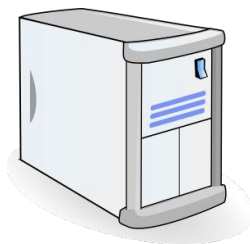
Where our users are



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



one
task



submit node
campus cluster,
HPC center, etc.

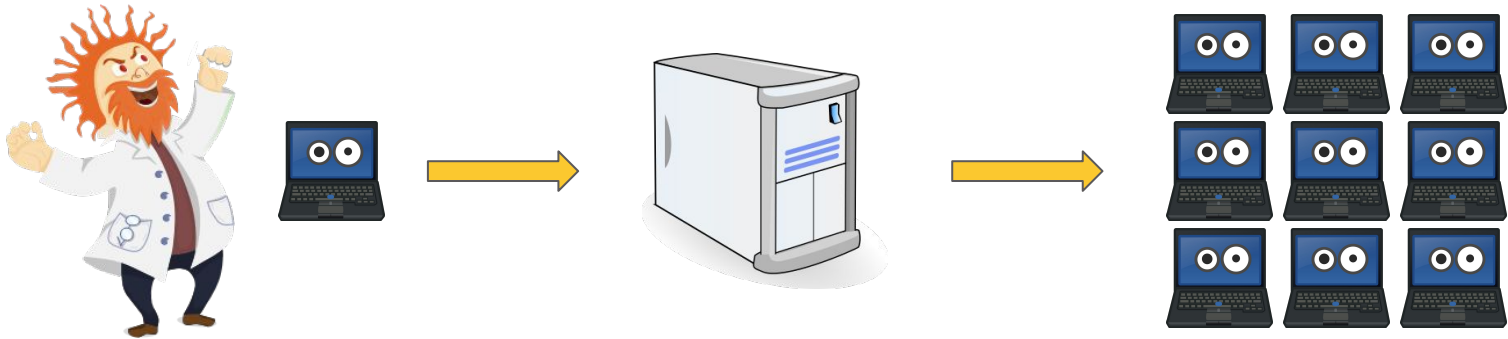
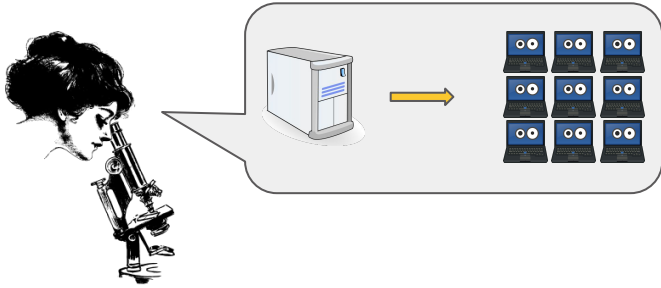


many task running on many
computational nodes

Where our users want to be



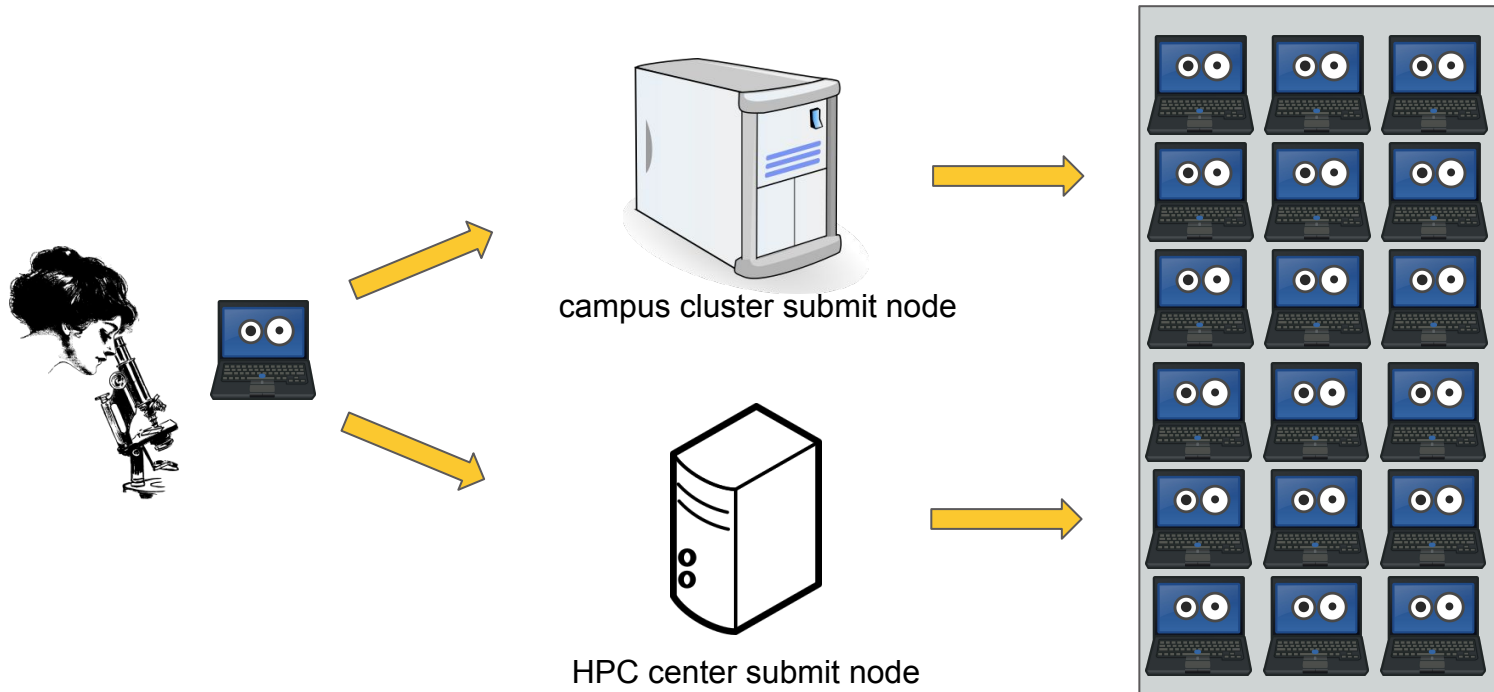
Communicate working setups to colleagues.



Where our users want to be



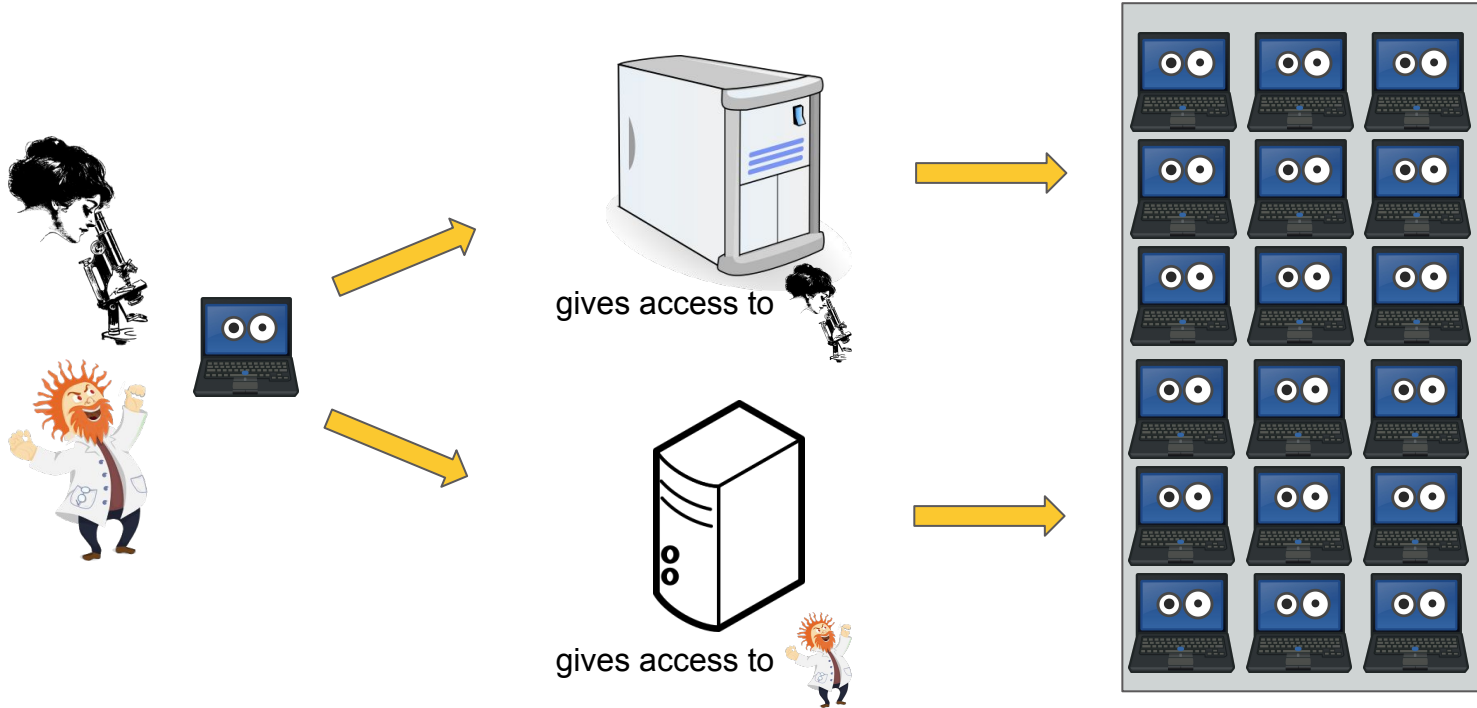
Pool resources together

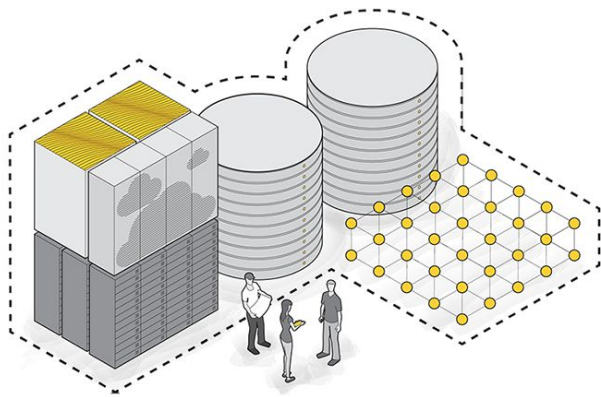


Where our users want to be



Share resources





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

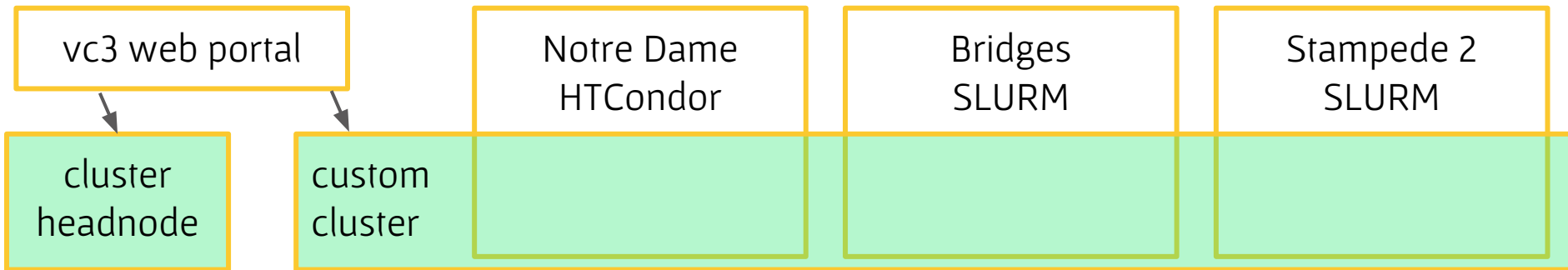
Bridges
SLURM

Stampede 2
SLURM

VC3 in a nutshell



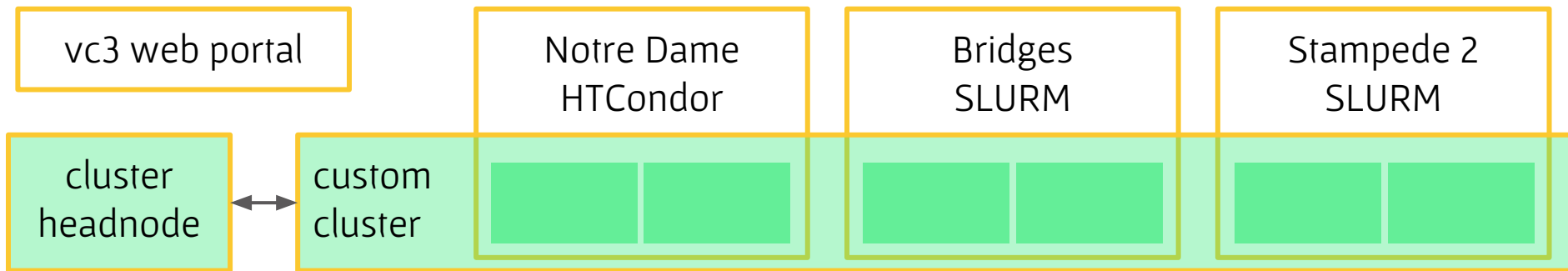
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VC3 in a nutshell



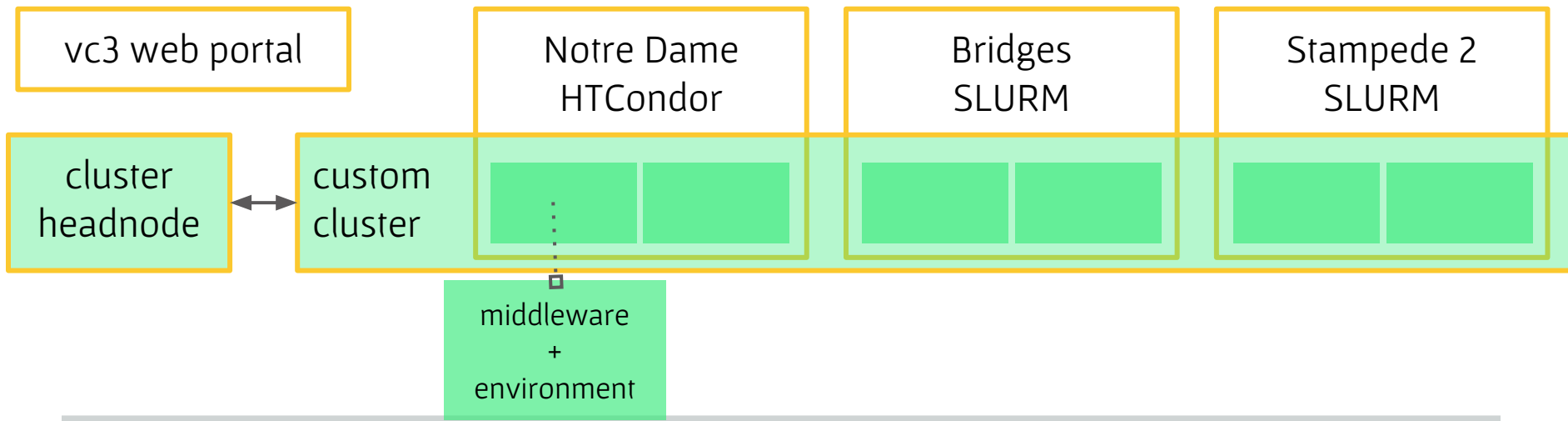
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VC3 in a nutshell



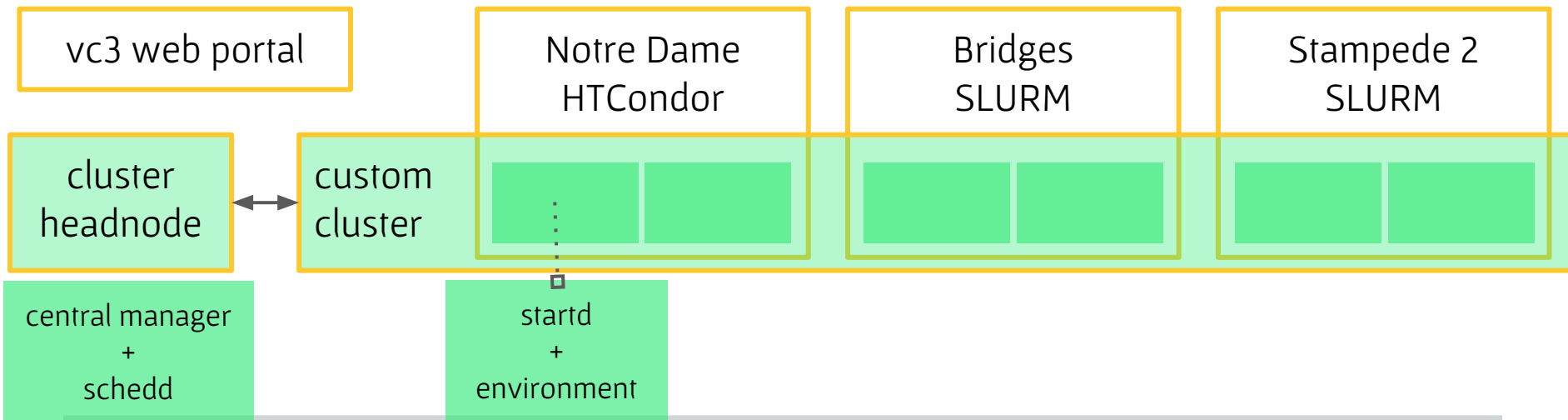
Users go to a **website** and create **short lived clusters** across **heterogeneous resources**.



VC3 in a nutshell



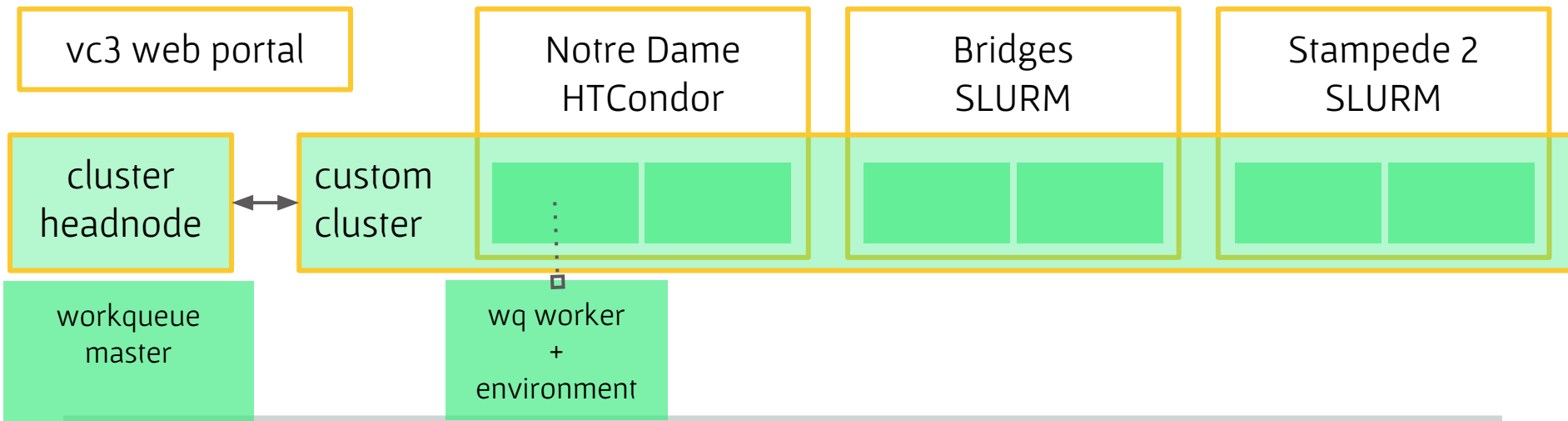
Users go to a **website** and create **short lived clusters** across **heterogeneous resources**.



VC3 in a nutshell



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



What is a Virtual Cluster?



- 1 headnode
 - + n middleware workers running on m sites
 - k environments to run user tasks
-

Web portal



www.virtualclusters.org



login with a vc3
account

Globus login 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 |

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
lincolnb-midway

Currently no description

btovar

Benjamin Tovar (Owner) - btovar@nd.edu
Benjamin Tovar (University of Notre Dame)

btovar-ndccl

Currently no description

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.

```
sT00rWwCjUmrUdKwMlCngCawCRVx7anGfRwI0wCdq9t9c13g04r0qg7e9K  
/GTjh8YrCyX6UhqG+S3nOxOf+ewxx3RSIMf9lsFZpDNdXwJl1YD1dyRCYy8TwNhBg9GkCxEKmqfOgo  
L6ROpicuUhfY6yT9apKGox1mPSM  
/g4ETHxIkBmNK8Ph926fuT+F+QQT0SQV0vgoghW/LGiGdNoztW/8OUkSFzZ6uZE5zfPp0xq45a4*FYE  
TorlJRapgPsjmSjmSB7TeD+qs1ECilwrrg3JP0RBOEMMeL7rwgDxjxtZkBUQ72lkq5lXTUAYeu0CbGgll  
Q7ZHGHRnTyKkSPLl7rXEi7nnz6ofgUJCU3L7hr2VKKy84RcHPsfep64qV3ilOCw1o6SPvu6lwRYeqhfe  
Aoo  
/yKp1lvapyfM7Ptuy+6yW/Z7grZlb9AtBolcoBColpig64MR8T4D8RKp1960nCG5ltXwC4mmPSgffQofOl  
WJom7TudG+yTWouWikupoieObZX5w8SKFcoH
```

Copy to Clipboard

Step 4: Validate Allocation

Launching a Virtual Cluster



VIRTUAL CLUSTER NAME

my-virtual-cluster

CLUSTER TEMPLATE *

lincolnb-htcondor-10-workers

ENVIRONMENT

btovar-oasis-osg

ALLOCATIONS *

Nothing selected

Select Allocations for Virtual Cluster

Select All Deselect All

btovar-ndccl

khurtado-osgconnect

lincolnb-midway

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>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 | 0 | 10 | 0 | 0 |
|--------------|----|---|---|----|---|---|

| | | | | | | |
|-------|----|---|---|----|---|---|
| Total | 10 | 0 | 0 | 10 | 0 | 0 |
|-------|----|---|---|----|---|---|

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

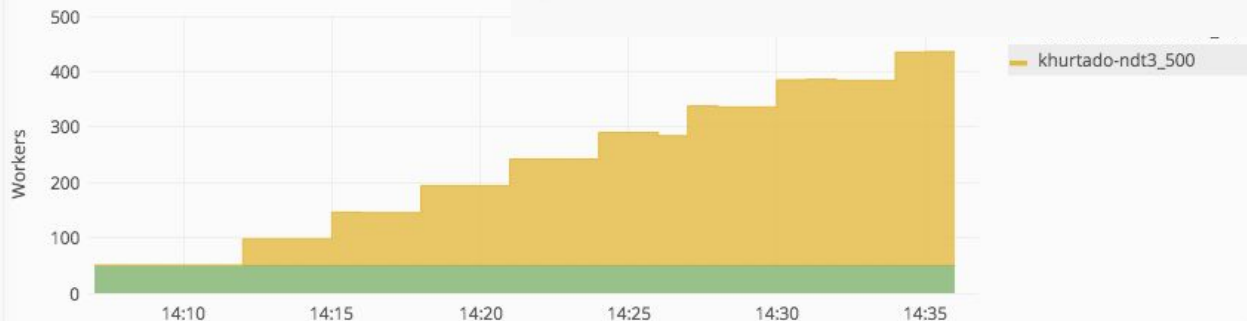


VC3 Monitoring

Virtual Cluster Size (queued)



Vi



My Virtual Clusters

Filter

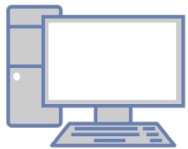
| Name | State | Cluster Template | Workers | Head Node |
|----------|--|------------------------------|--|-----------------|
| ndt3_500 | <div>Running</div> <div>Requesting 114 more compute worker(s).</div> | khurtado-htcondor-500workers | Requested: 500 Running: 386 Queued: 48 Error: 0 | 128.135.158.178 |

Architecture

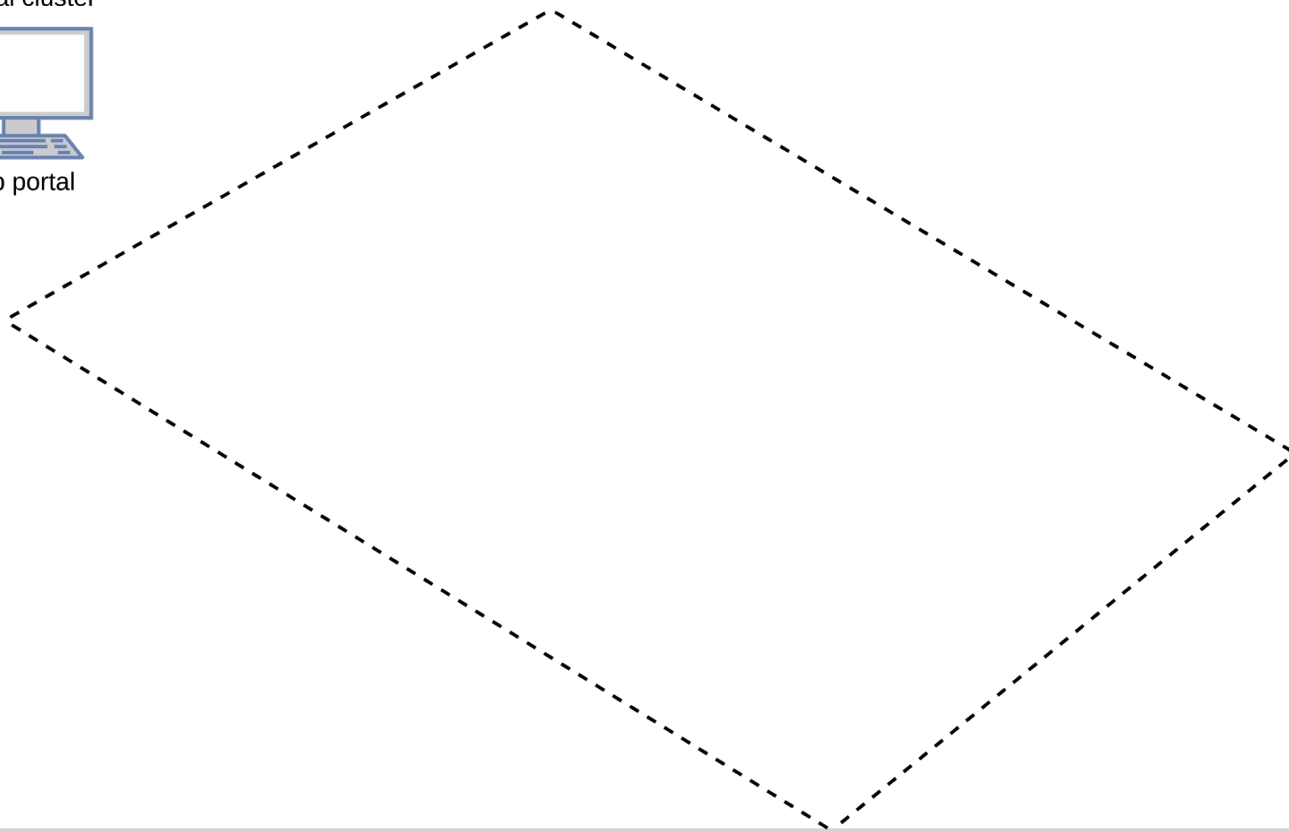


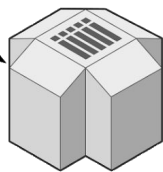


user requests
virtual cluster

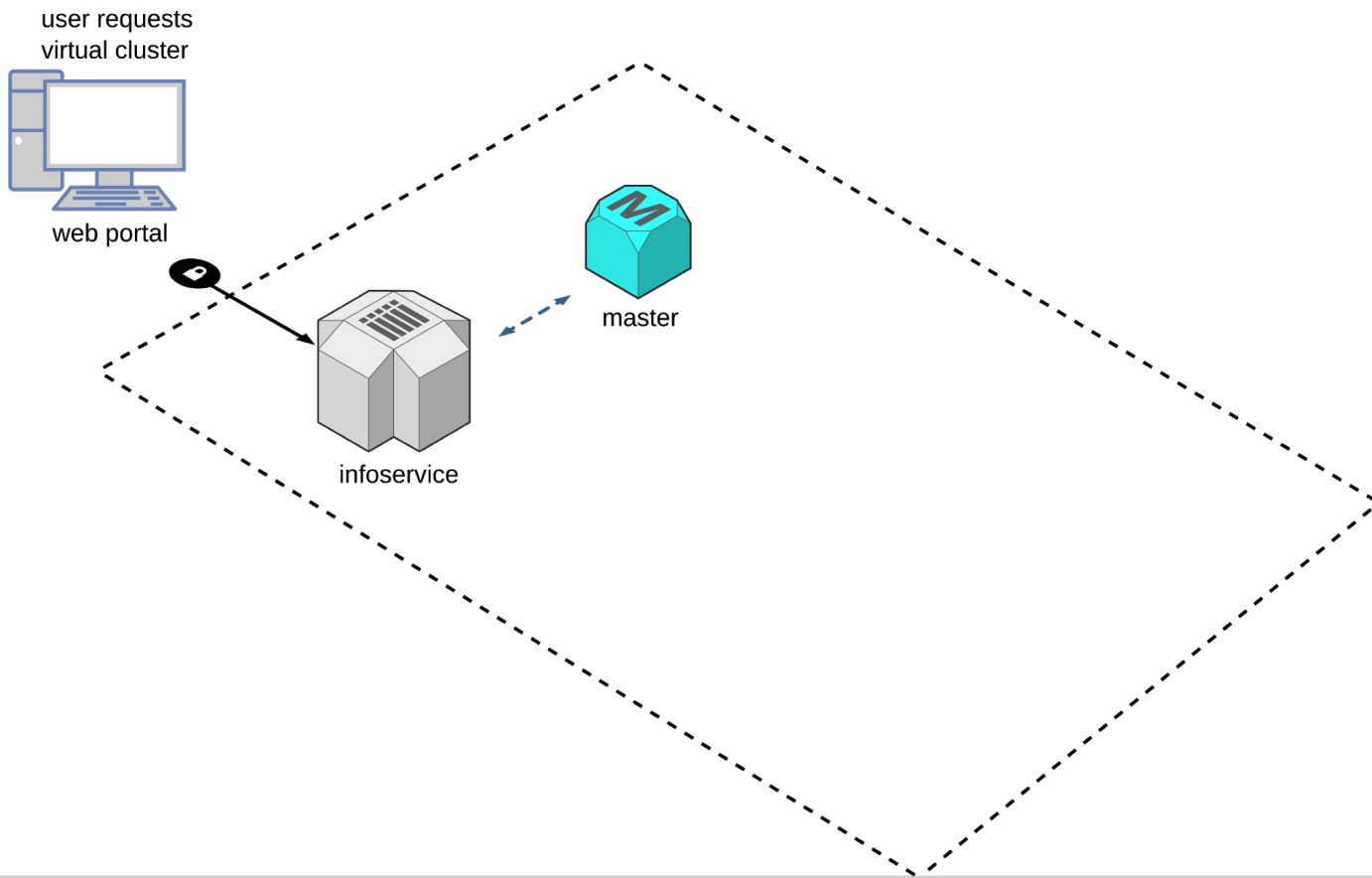


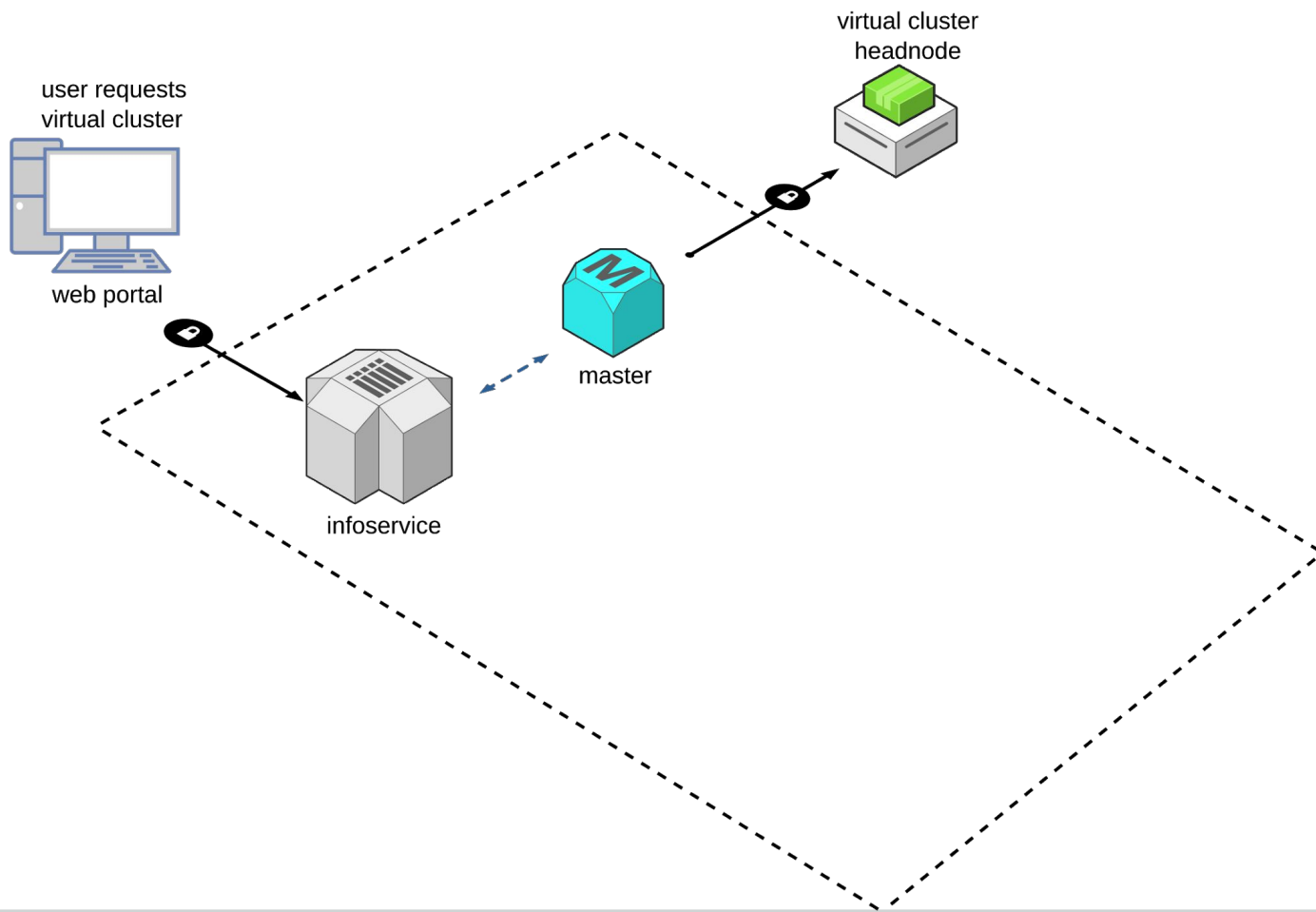
web portal

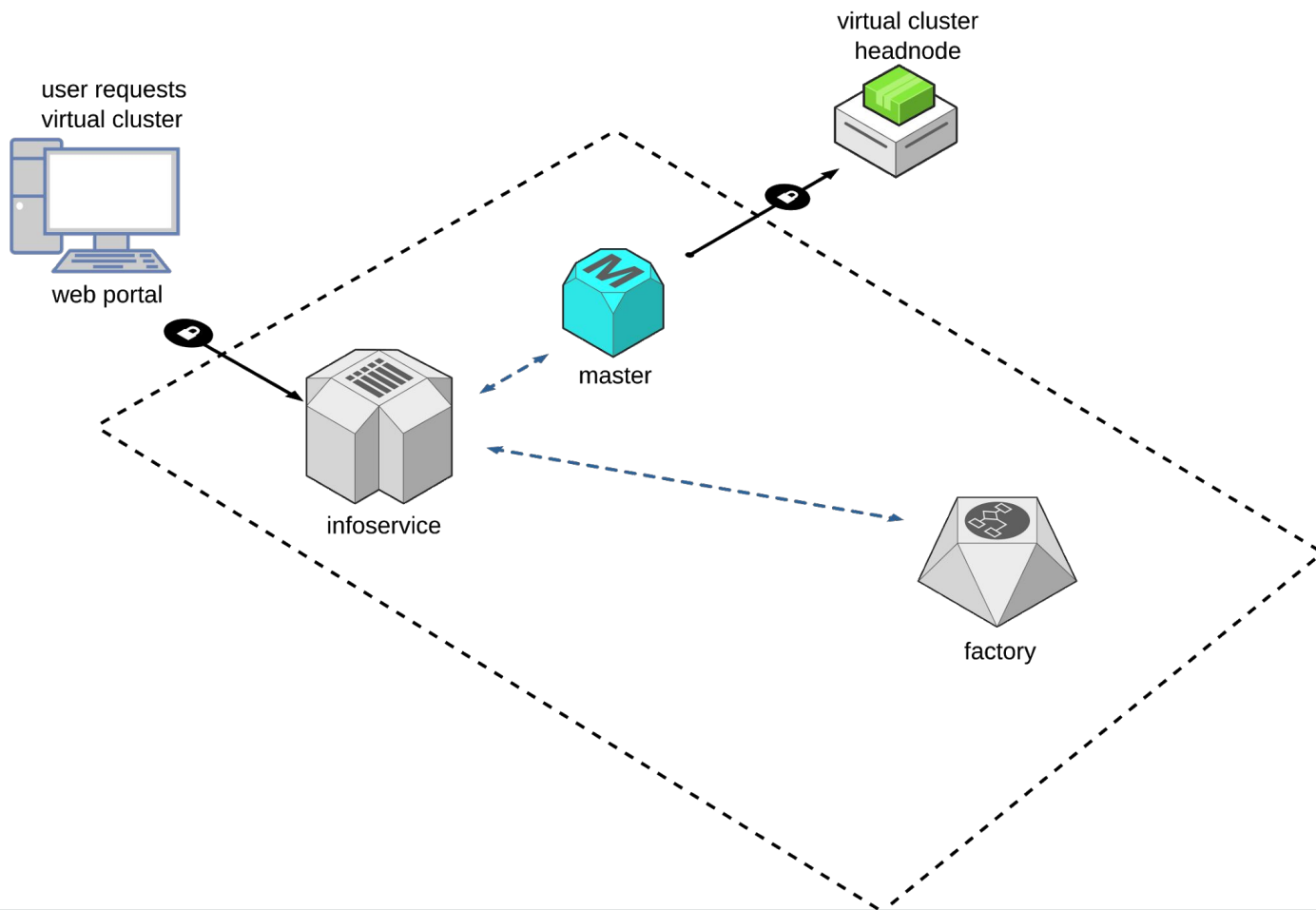


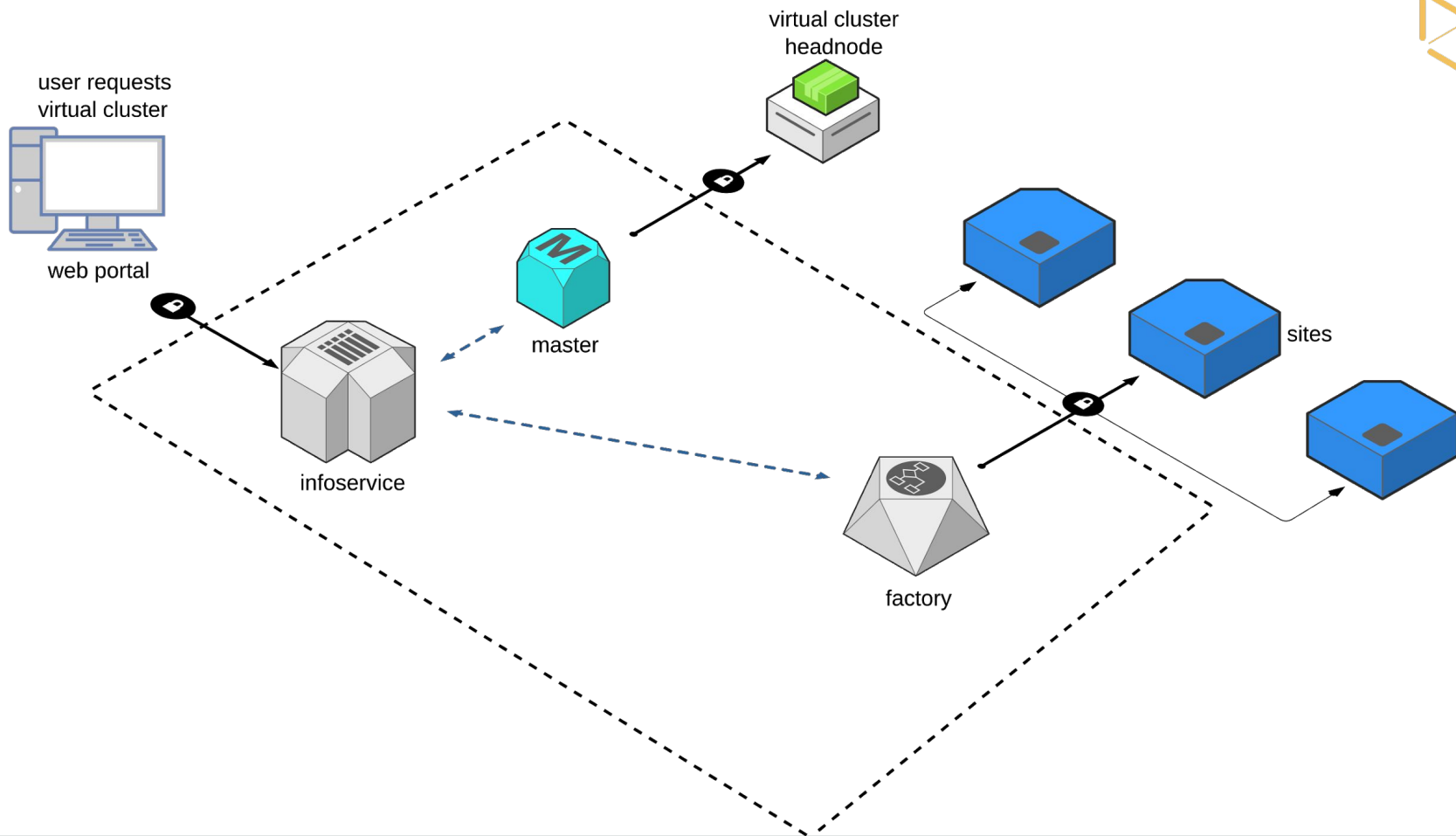


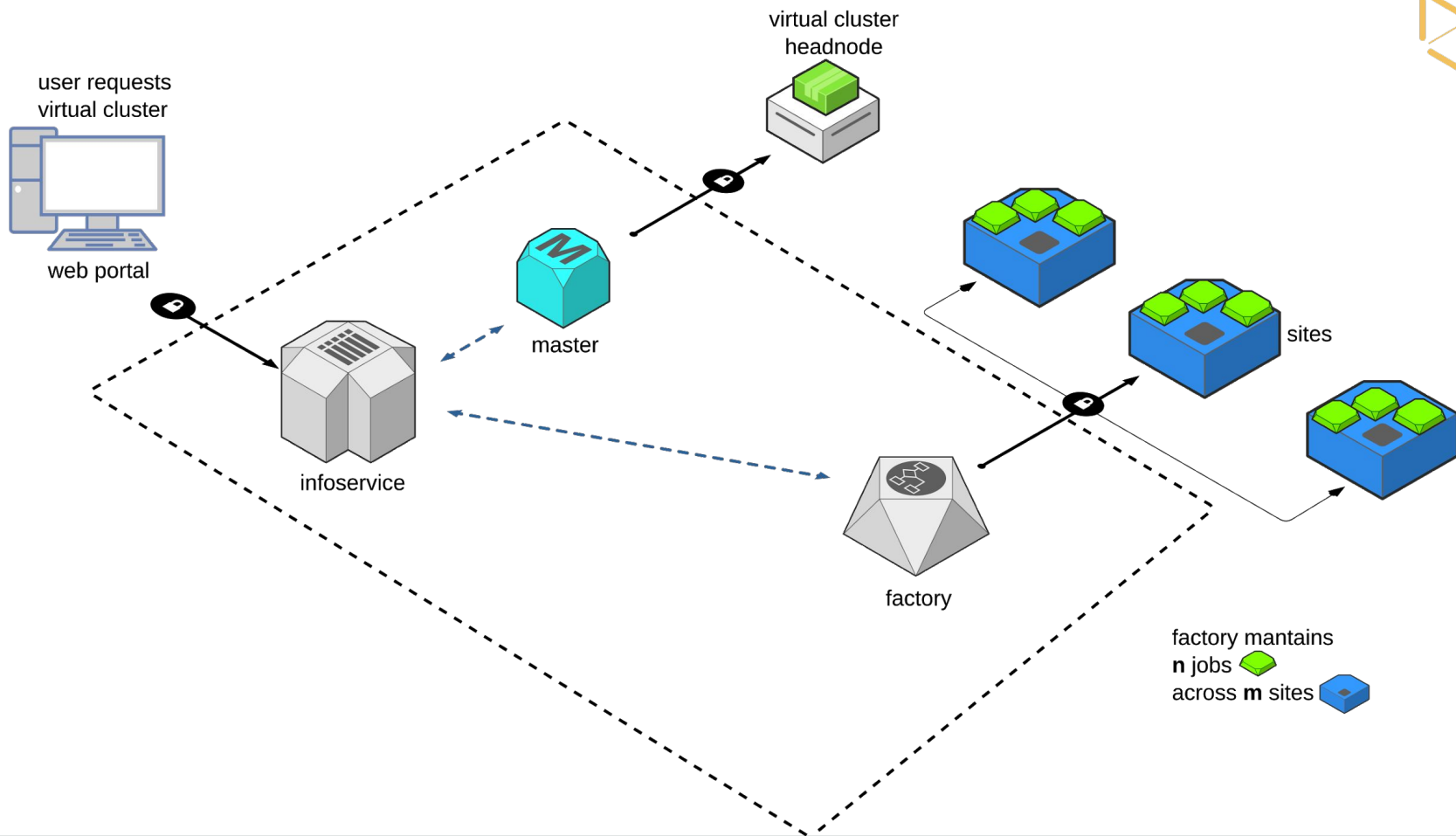
infoservice

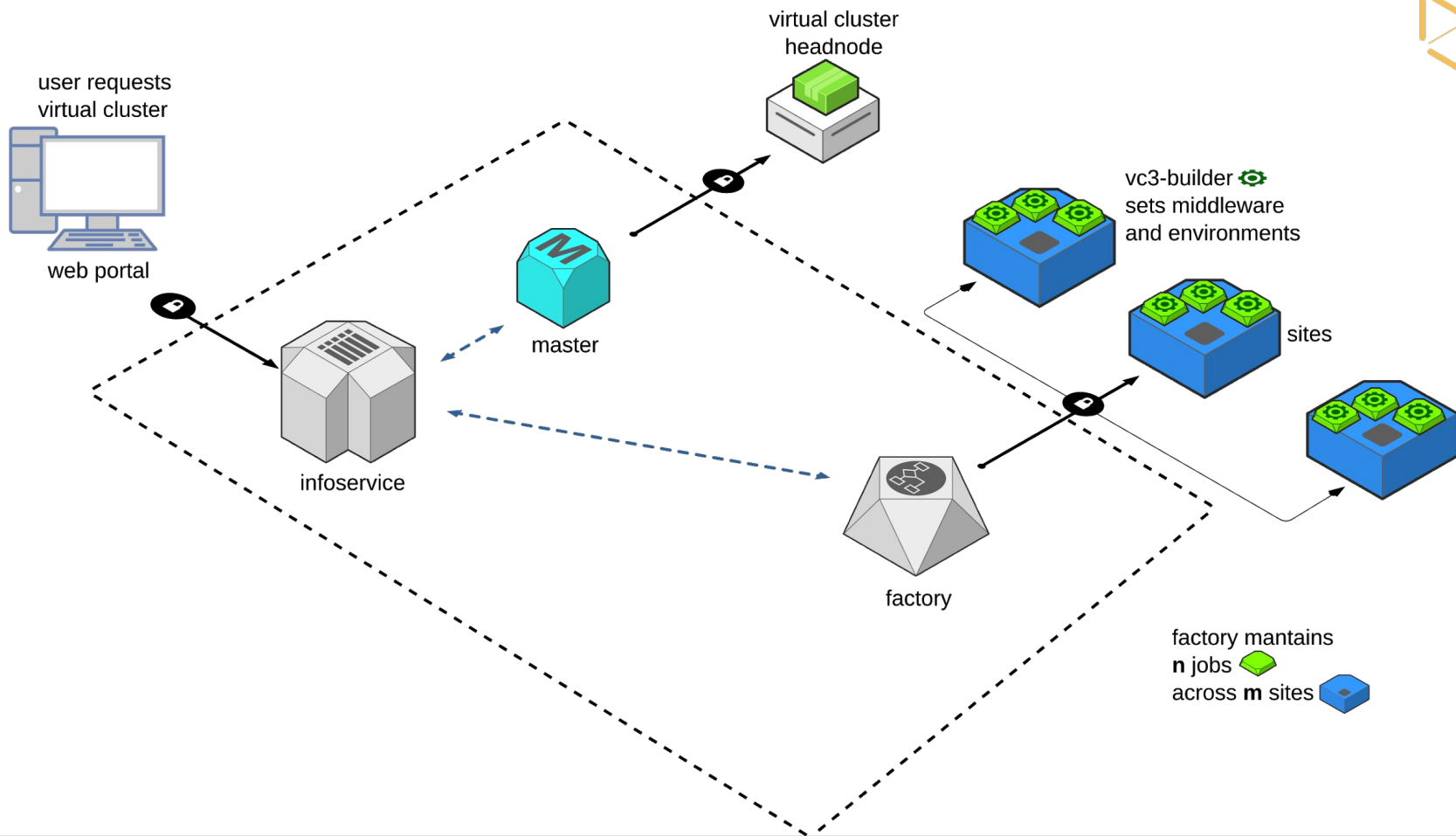


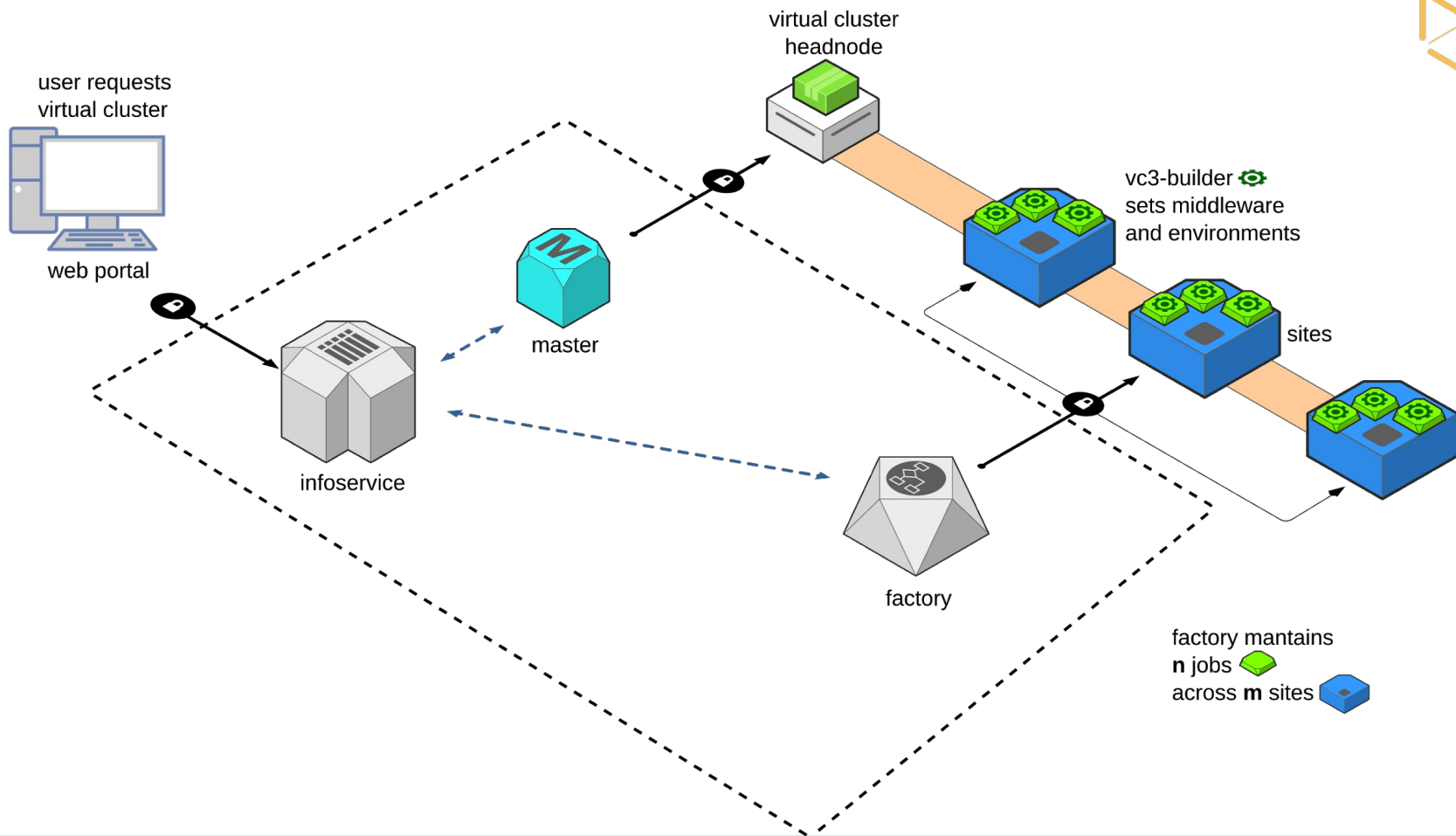


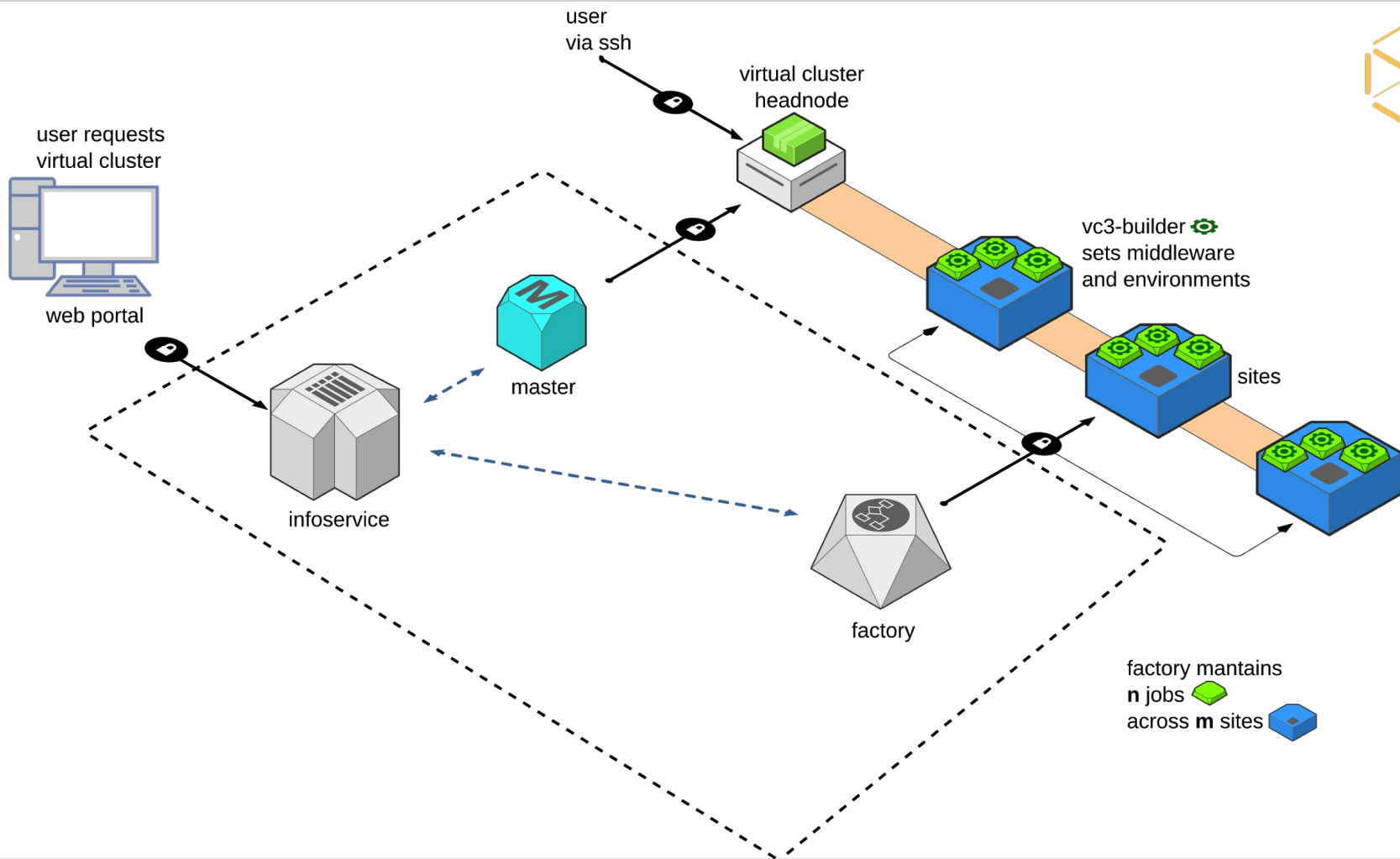












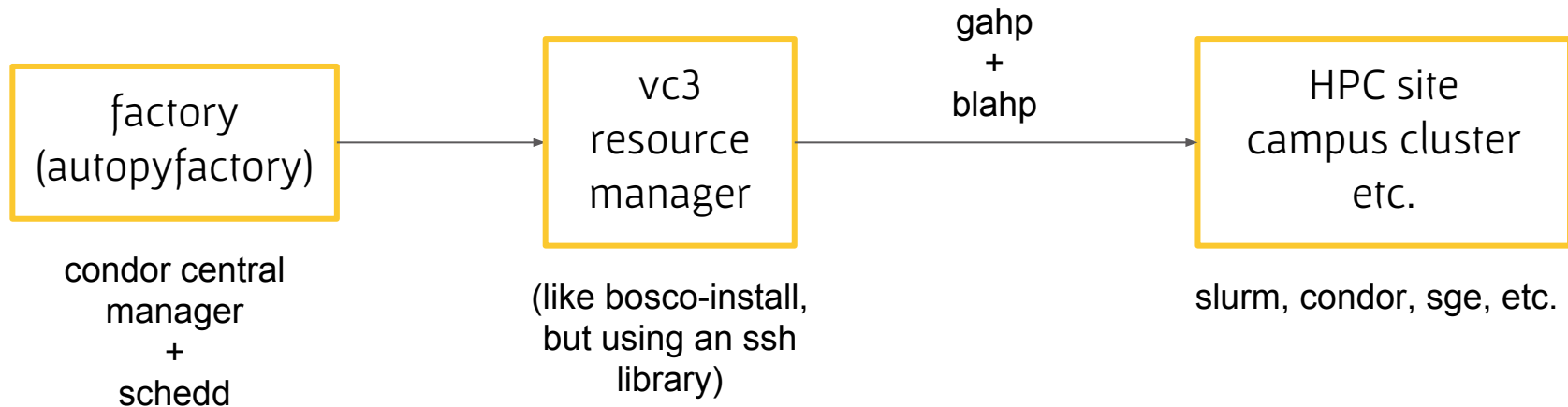
VC3 builder



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...
```

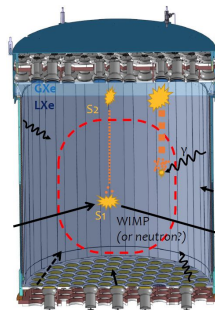
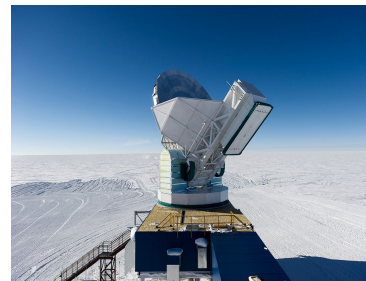
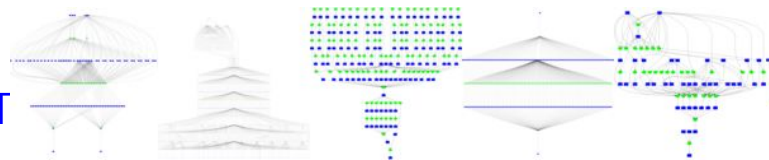
How Condor makes VC3 possible



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 site to portal

Restricted Beta



We are **looking** for users in a restricted **beta**, willing to **collaborate** with us.

If you have an ambitious goal, and you would like to improve your current cluster infrastructure, please **answer** the following **survey** to **apply**:

<https://tinyurl.com/vc3-beta-survey>

btovar@nd.edu

VC3 Funding and Team



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

Primary Investigators: Rob Gardner (UC), Douglas Thain (ND), and **John Hover** (BNL)

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

Development Team: Lincoln Bryant (UC), Benedikt Riedel (UC), Suchandra Thapa (UC), Jeremy Van (UC), **Kenyi Hurtado Anampa** (ND), **Ben Tovar** (ND), **Jose Caballero** (BNL).

(at condor week)

VC3

Virtual Clusters for Community Computation



<http://www.virtualclusters.org>

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

btovar@nd.edu
