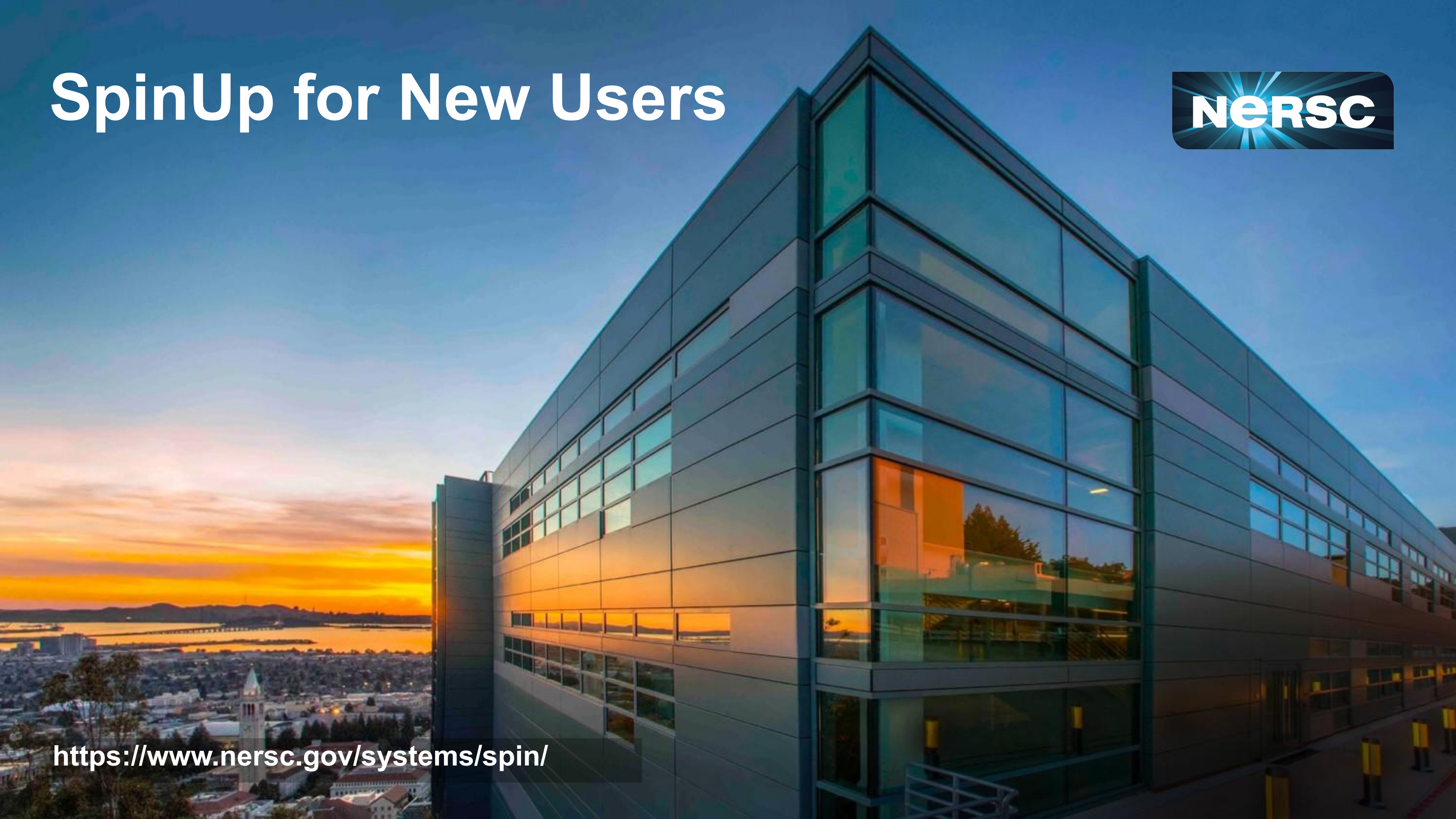
SpinUp for New Users



https://www.nersc.gov/systems/spin/

Welcome

This workshop will prepare you to design, build, and manage your own apps using the Spin platform.

Those might be:

- *database-backed web apps that access project data*
- *workflow orchestration tools running outside of HPC*
- *API servers for real-time or distributed projects*
- *or something else!*

Remember, though: Spin is for *apps*, not computation.

Spin is a Powerful System...

...and with great power comes great responsibility!

- **Keep software updated; fix vulnerabilities promptly.**
  - *NERSC scans regularly to find problems quickly.*
- **Encrypt anything accessible over the network.**
  - *These are strict DOE and DHS requirements!*
- **Produce logs to stdout/stderr.**
  - *This is Docker convention anyway.*

Don’t worry. Spin helps make these best practices easy!

Workshop Structure and Content

Seminar *(today)*

Learn concepts and terms. Build an example application. Store and access credentials. Configure storage and networking. Discuss the design and development process.

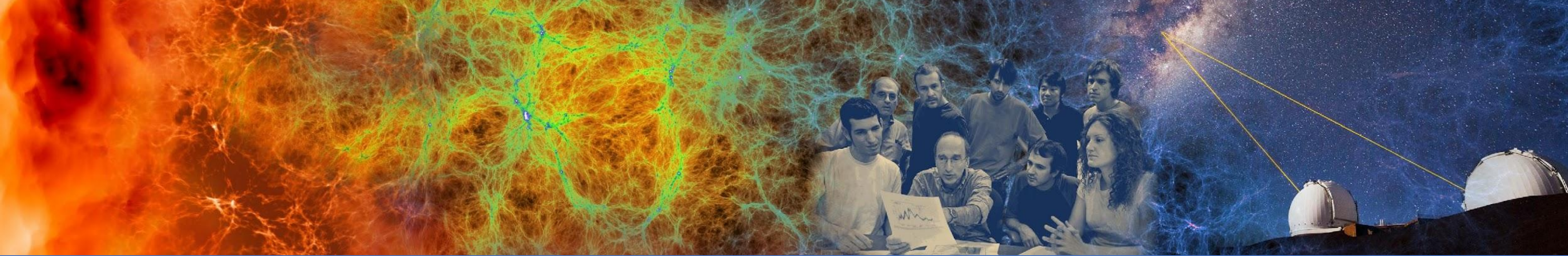
Hack-a-thon *(choose A or B)*

Try what you learned, in small groups, with hands-on help. Review. Q&A.

Ask questions here and on NERSC Users Slack (in #spin).

We welcome your feedback. Please complete our survey afterward.

Have a great workshop!



Concepts and Terminology

Why Do We Need Spin?

Your project is more than batch jobs and data files; it's science gateways, databases, and other services.

Spin is a supported platform designed to help:

- *Cloud-style flexibility*
- *Create new apps yourself on demand*
- *Redundancy / uptime (97% in 2022)*
- *Direct access to HPC file systems and networks*

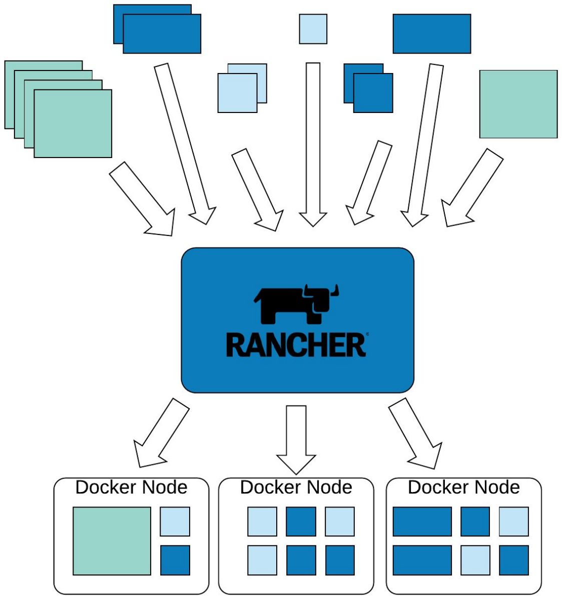
Docker, Kubernetes, and Rancher

Spin is based on the Rancher *orchestration* system, which is built on Docker and Kubernetes.

How do they all fit together?

- Docker is great for just you on a laptop.
- For lots of applications, you need a whole Kubernetes *cluster*.
- For lots of projects, each with lots of applications, we need *orchestration*.
- With Rancher orchestration, you get *virtual private* access to the *multiple* Kubernetes clusters running in Spin.

Without orchestration, a pool of servers and no coordination for users



Managed and assigned to Docker nodes, enabling holistic management, failover, service ownership.

(Some of the) Terminology

Container image: blueprint for a container; like a tarball

Container: running instance of an image; like a process

Image Registry: versioned repository for container images

Pod: one or more very-closely-coupled containers

Workload: set of parameters and rules that define how to create a *particular* pod

Deploy: create a workload

Ingress: proxy service that exposes a web service in a workload externally using a DNS name (layer 7)

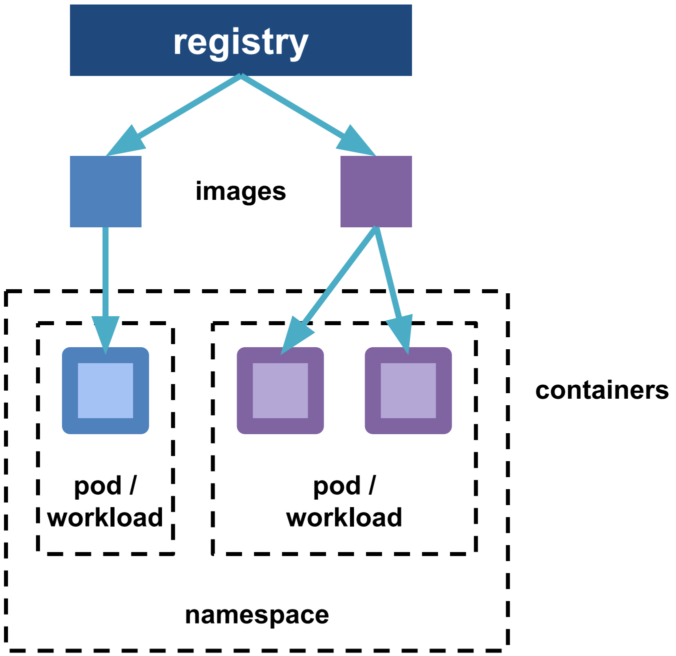
Load Balancer: proxy service that exposes a non-web service in a workload using a DNS name (layer 2)

Namespace: group of workloads, ingresses, load balancers, volumes, config maps, secrets, etc

Project: group of namespaces; corresponds to a NERSC project

Kubernetes: container *scheduling* system to run it all

Rancher: *orchestration* system for Kubernetes clusters



Canonical Development Workflow

Build

images on your laptop with your custom software, and when they run reliably, …

Ship

them to a registry for version control and safekeeping

- DockerHub: share with the public
- NERSC: keep private to your project

HARBOR

Run

your workloads

Spin

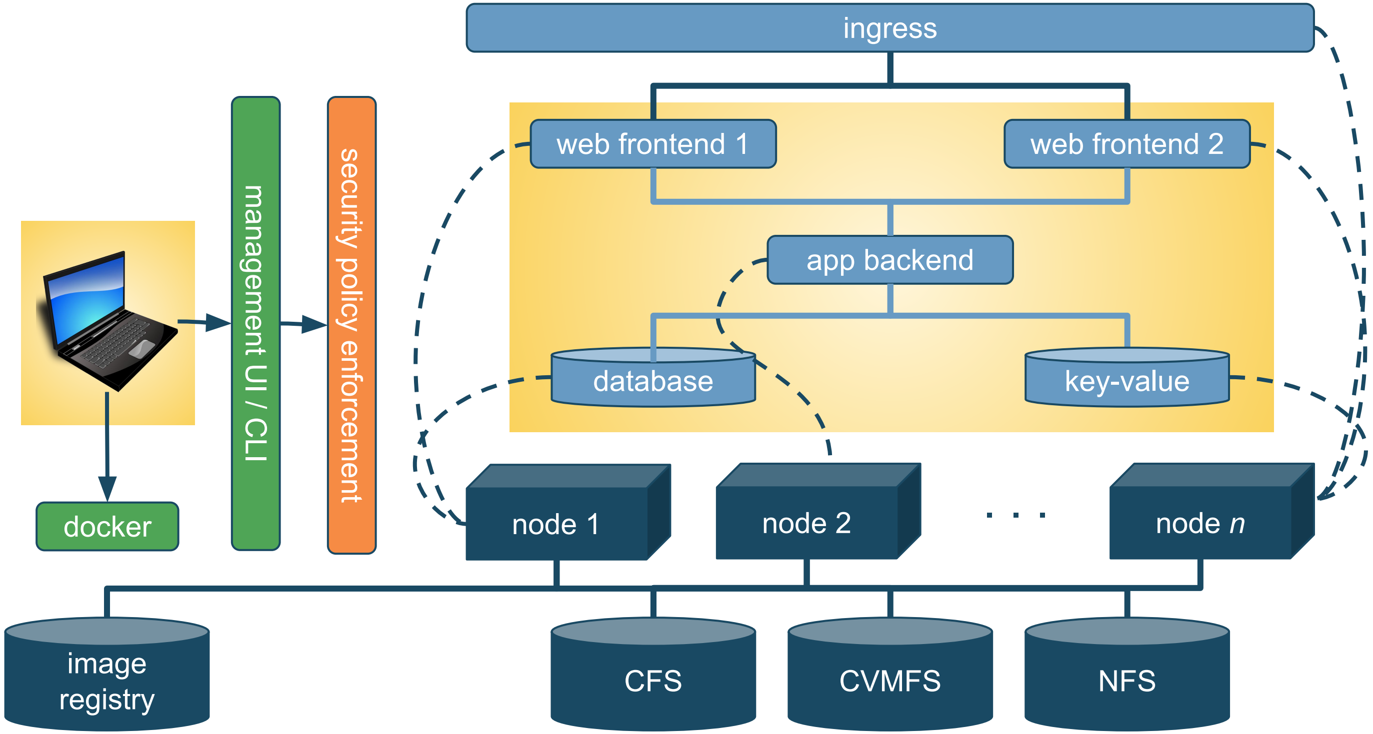
RANCHER

kubernetes

High-Level Spin Architecture

Yours to manage

NERSC handles the rest!



Interactive Exercises: Let's Create an App!

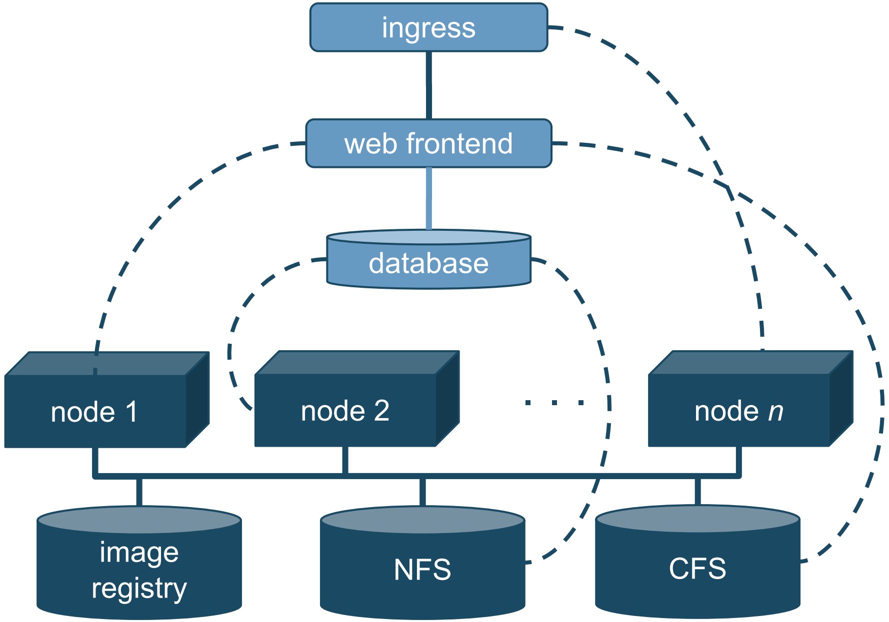
Our example app:

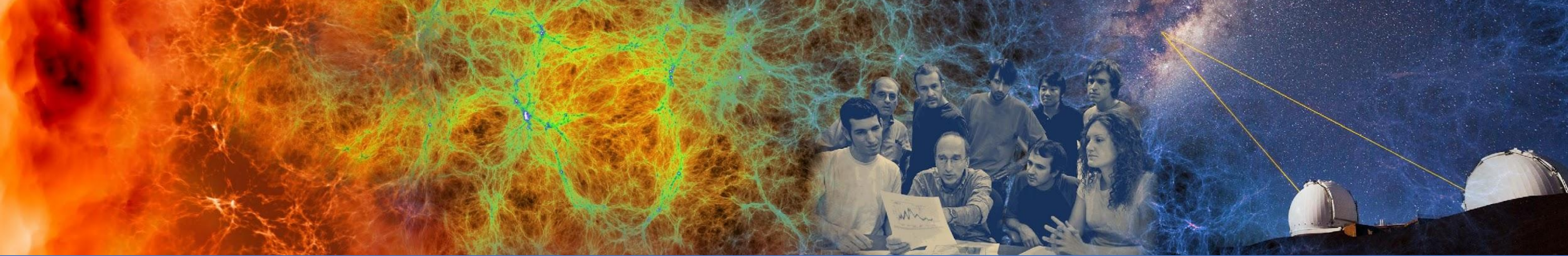
- Python-based
- Uses static files in CFS
- Database backend

We will build the app from the bottom up, database first.

Along the way, we will

- Use variables and config maps to customize behavior
- Attach storage
- Store passwords securely
- Make it available on the network

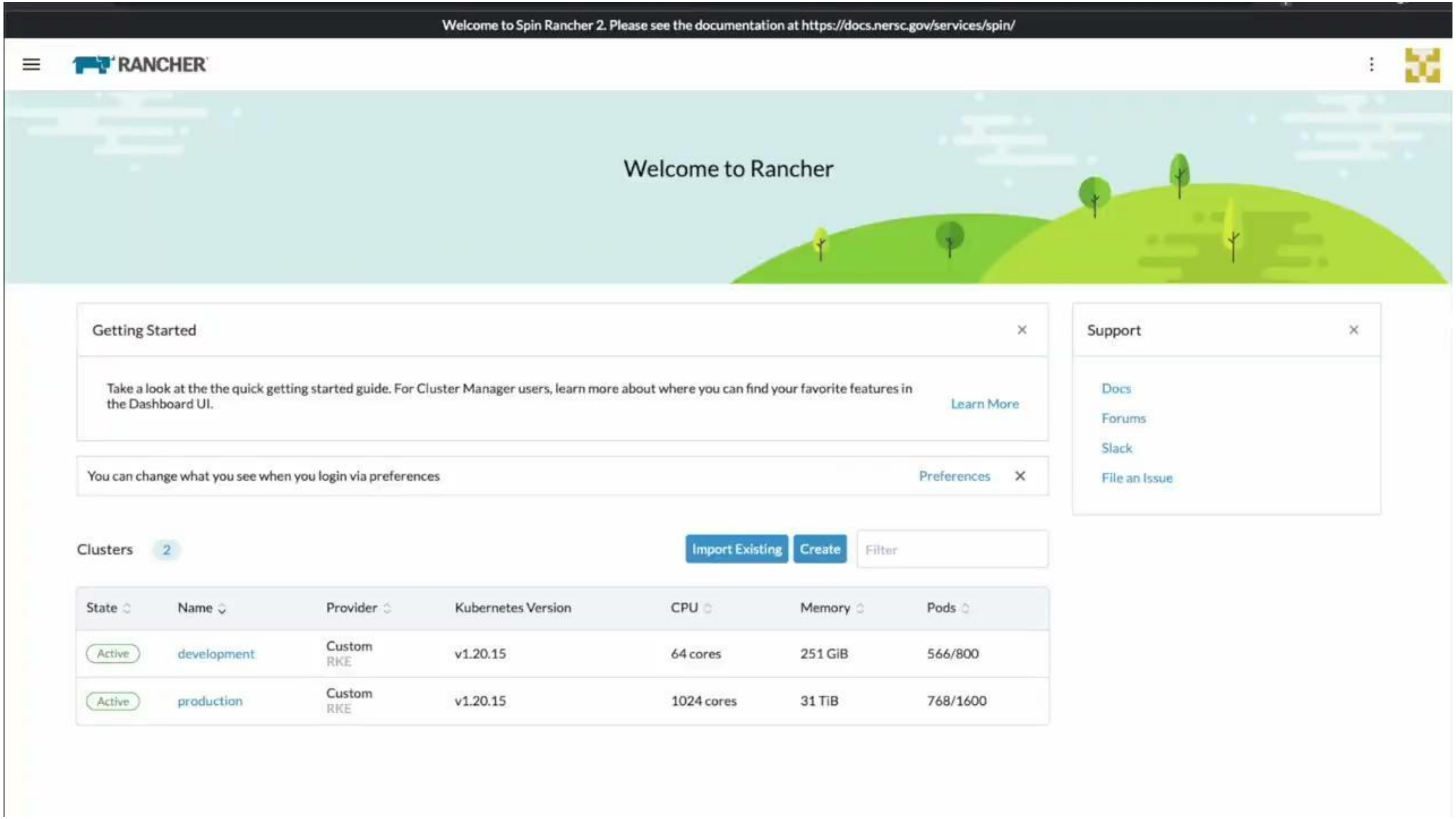




Exercise 1: Create a Database

Exercise 1: Create a Database

- Databases often underlie web apps, so let's start there.
- In Spin, you can access an external database or create your own, as we'll do now.
- We recommend using stock images from DockerHub for MongoDB, MySQL, PostgreSQL, Redis, and others.
    - Frequently updated, easy to customize...less work!
- Look at the README: https://hub.docker.com/_/mysql
    - Customize by setting variables; no custom image needed


Welcome to Spin Rancher 2. Please see the documentation at https://docs.nersc.gov/services/spin/
RANCHER
Welcome to Rancher
Getting Started
Take a look at the the quick getting started guide. For Cluster Manager users, learn more about where you can find your favorite features in the Dashboard UI.
Learn More
You can change what you see when you login via preferences
Preferences
Support
Docs
Forums
Slack
File an Issue
Clusters
2
Import Existing
Create
Filter
State
Name
Provider
Kubernetes Version
CPU
Memory
Pods
Active
development
Custom
RKE
v1.20.15
64 cores
251 GiB
566/800
Active
production
Custom
RKE
v1.20.15
1024 cores
31 TiB
768/1600

Try It Yourself!

1. Log in to **https://rancher2.spin.nersc.gov**.
2. In the sidebar under ≡, select **development**, then click **Projects/Namespaces**.
3. Under your project (or if attending the SpinUp Workshop, under the **spinup** project), click **Create Namespace**. Enter a unique name, then click **Create**. *Note: underscores (_) are not allowed!*
4. In the sidebar under **Workload**, click **Deployments** and click **Create**. Select the namespace you just created and enter
   Name: **db**
   Container Image: **mysql:5**
5. Under Networking, click **Add Port** and enter
   Service Type: **Cluster IP**
   Name: **mysql**
   Private Container Port: **3306**
   Protocol: **TCP**
6. Scroll down to **Environment Variables,** click **Add Variable**, and enter
```
MYSQL_DATABASE = science
MYSQL_USER = user
MYSQL_PASSWORD = password1234
MYSQL_RANDOM_ROOT_PASSWORD = yes
TZ = US/Pacific
```
7. In the left panel, click **Security Context** and select
   Privilege Escalation: **No**
   Add Capabilities: **`CHOWN, DAC_OVERRIDE, FOWNER, SETGID, SETUID`**
   Drop Capabilities: **`ALL`**
8. Click **Create.**
9. Under the ⋮ menu to the right of your workload, select **Execute Shell** and enter
```
# mysql -u user -D science -p
(enter password from above)
mysql> create table t(n integer);
```

Discussion

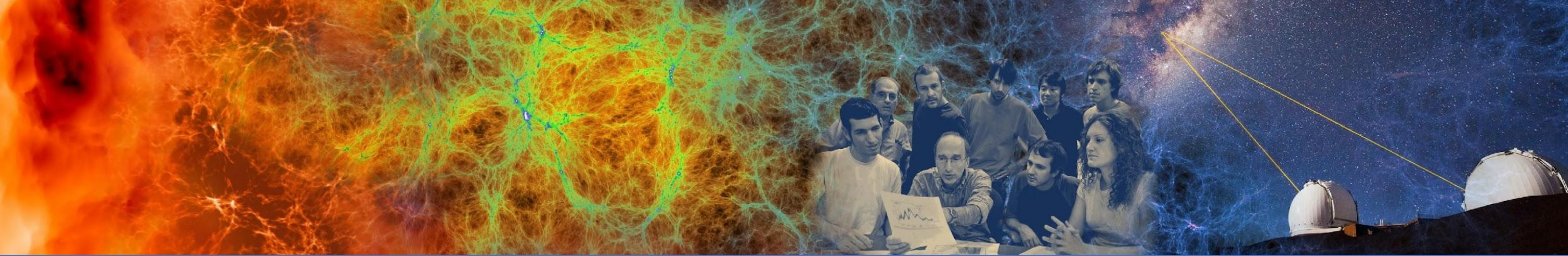
- Terminology: You **deployed** a new **workload** in a new **namespace** in a **project** on the *development* **cluster.** It has one **pod** running one **container** based on the stock MySQL **image**.
- Good stock images make life easy, but be prepared to
  - Read the READMEs for how to set variables
  - Look inside with `docker exec -it` *`image`* `/bin/bash`
- Shell access is easy; no ssh daemon required.

Discussion

Capabilities are root powers; Spin allows them selectively.

Later, we'll discuss how capabilities are limited even further when using global file systems.

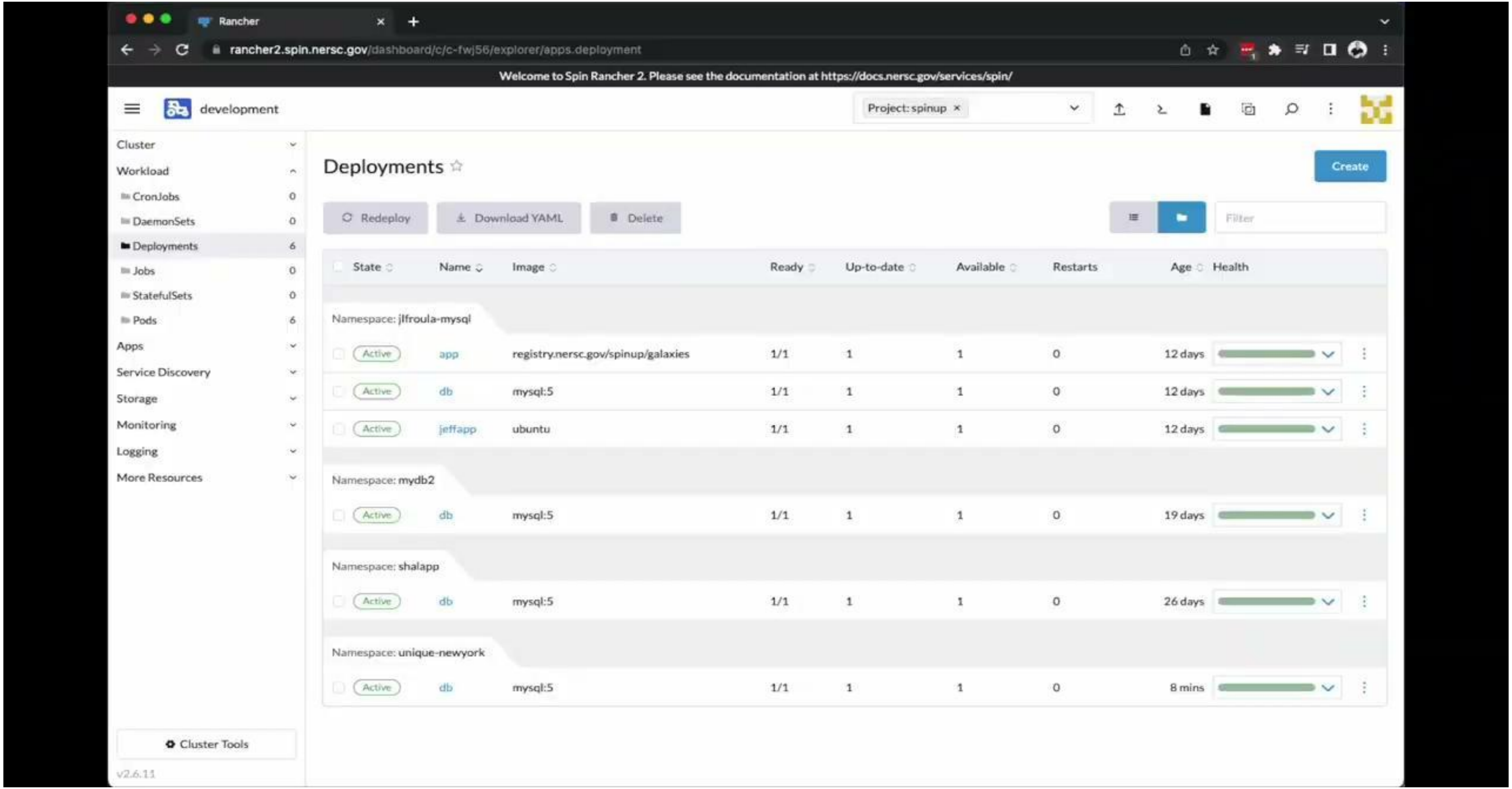
Capability	Meaning
CHOWN	Change the owner of files and directories
DAC_OVERRIDE	Override file permissions
FOWNER	Override owner permissions
NET_BIND_SERVICE	Open network ports numbered < 1024
SETGID	Change the group of a running process
SETUID	Change the user of a running process



Exercise 2: Add a Secret

Exercise 2: Add a Secret

- The password seems a little too exposed. Is there a better way to handle things I want to keep secret?
- How can I see what's happening with my service? How can I see logs?
- What happens when I change a workload? Are there any gotchas I should watch out for?


Rancher
rancher2.spin.nersc.gov/dashboard/c/c-fwj56/explorer/apps.deployment
Welcome to Spin Rancher 2. Please see the documentation at https://docs.nersc.gov/services/spin/
development
Project: spinup
Cluster
Workload
CronJobs 0
DaemonSets 0
Deployments 6
Jobs 0
StatefulSets 0
Pods 6
Apps
Service Discovery
Storage
Monitoring
Logging
More Resources
Cluster Tools
v2.6.11
Deployments
Create
Redeploy
Download YAML
Delete
Filter
State
Name
Image
Ready
Up-to-date
Available
Restarts
Age
Health
Namespace: jlfroula-mysql
Active app registry.nersc.gov/spinup/galaxies 1/1 1 1 0 12 days
Active db mysql:5 1/1 1 1 0 12 days
Active jeffapp ubuntu 1/1 1 1 0 12 days
Namespace: mydb2
Active db mysql:5 1/1 1 1 0 19 days
Namespace: shalapp
Active db mysql:5 1/1 1 1 0 26 days
Namespace: unique-newyork
Active db mysql:5 1/1 1 1 0 8 mins

Try It Yourself!

Create the secret

1. In the sidebar, select **Storage > Secrets**. Click **Create**.
2. Select **Opaque.**
3. Set Values:
   Namespace: Choose the namespace you created earlier.
   Name: `db-password`
   Key: `password`
   Value: `<make-something-up>`
4. Click **Create.**

Attach the secret

1. Click on **Workload > Deployments,** open the ⋮ menu to the right of your workload, and select **Edit Config**.
2. Click **Pod** (to the left of "container-0")**,** then **Storage**; click **Add Volume**; select **Secret.**
3. Set Values:
   Volume Name: `vol-db-password`
   Secret: select `db-password`
4. **DO NOT** click **Save** yet!
5. Click **container-0,** then **Storage.** Click **Select Volume** and choose **vol-db-password.**
6. Set **Mount Point** to `/secrets`.
7. Click **Save**.

Use the secret

1. In the ⋮ menu for your workload, choose **Execute Shell** to look at the results:
   ```
   # cat /secrets/password
   ```
2. In the ⋮ menu, select **Edit Config**, expand **Environment Variables,** and replace `MYSQL_PASSWORD: password1234` with `MYSQL_PASSWORD_FILE: /secrets/password`
3. Click **Save**
4. To test the secret, click on your workload (**db**), select **Execute Shell**, and connect using the new password:
   ```
   # mysql -u user -D science -p
   ```
5. Notice: starting a new pod re-inited the database!
   ```
   mysql> show tables;
   Empty set (0.00 sec)
   ```
6. To view logs, click on name of the pod "db", and then select ⋮ > **View Logs**

Discussion

- Secrets are a good way to manage and protect passwords, tokens, etc
- View Logs can help you understand and monitor your deployments
- Containers are ephemeral unless you use other storage methods (next)

Exercise 3: Add NFS Storage

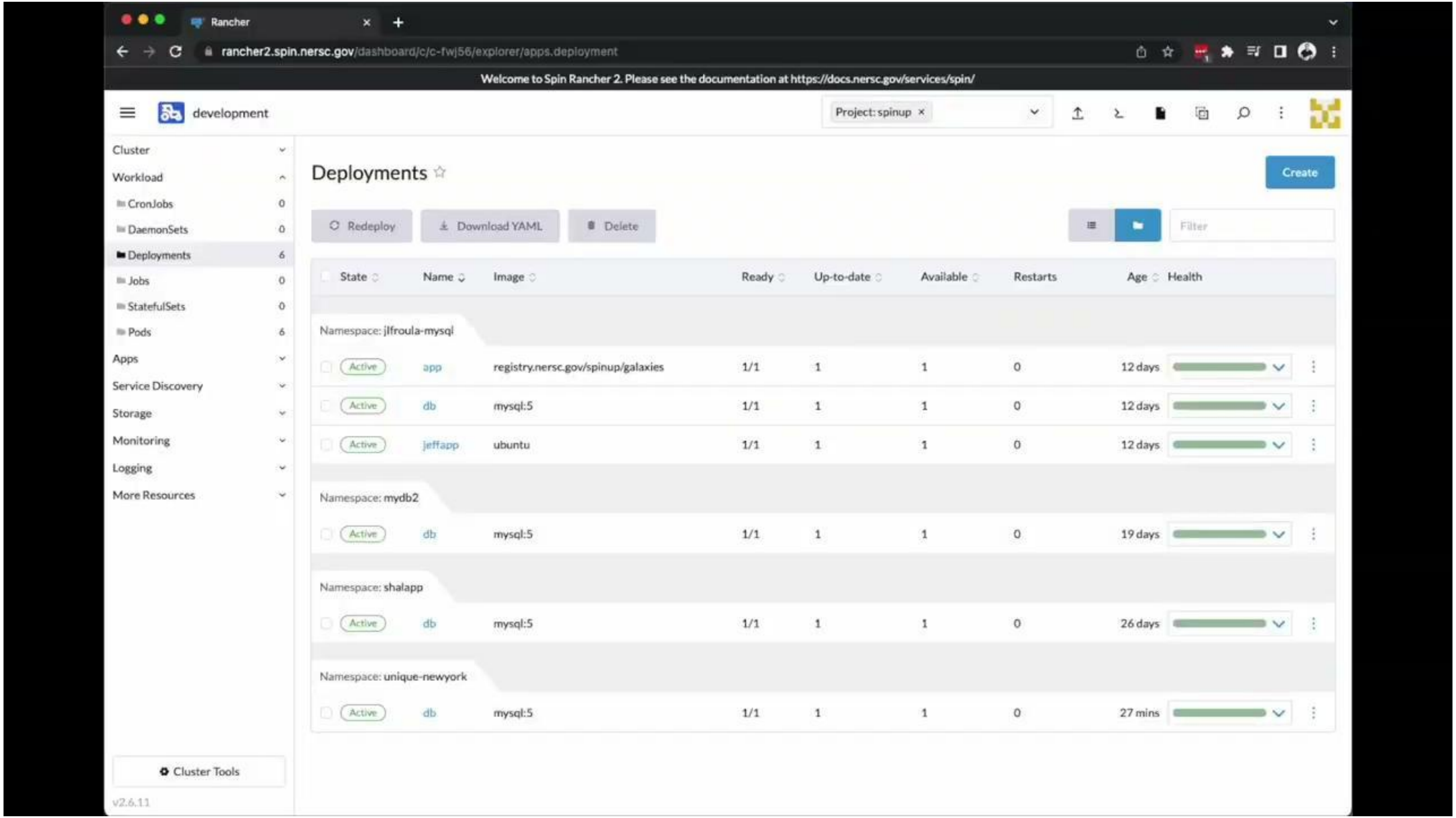
Exercise 3: Add NFS Storage

Remember, Docker containers are ephemeral. Your changes go away when a new container is started. Persistent storage can allow you to make changes stick.

NFS Storage in Spin is

- High performance
- High availability (same as Spin itself)
- Mountable into >1 workload (even across namespaces)
- Mounted only on Spin (not other NERSC systems)

Another option: NERSC Global Filesystems (coming up)


Rancher
rancher2.spin.nersc.gov/dashboard/c/c-fwj56/explorer/apps.deployment
Welcome to Spin Rancher 2. Please see the documentation at https://docs.nersc.gov/services/spin/
development
Project: spinup
Cluster
Workload
CronJobs 0
DaemonSets 0
Deployments 6
Jobs 0
StatefulSets 0
Pods 6
Apps
Service Discovery
Storage
Monitoring
Logging
More Resources
Cluster Tools
v2.6.11
Deployments
Create
Redeploy
Download YAML
Delete
Filter
State Name Image Ready Up-to-date Available Restarts Age Health
Namespace: jlfroula-mysql
Active app registry.nersc.gov/spinup/galaxies 1/1 1 1 0 12 days
Active db mysql:5 1/1 1 1 0 12 days
Active jeffapp ubuntu 1/1 1 1 0 12 days
Namespace: mydb2
Active db mysql:5 1/1 1 1 0 19 days
Namespace: shalapp
Active db mysql:5 1/1 1 1 0 26 days
Namespace: unique-newyork
Active db mysql:5 1/1 1 1 0 27 mins

Try It Yourself!

Create and Mount the NFS Volume

1. In the sidebar under **Workload**, click **Deployments**, find your namespace, and click your **db** workload.
2. Under the ⋮ menu at the top right, click **Edit Config**; click **Pod**; in the left panel, click **Storage.**
3. Click **Add Volume**, select **Create Persistent Volume Claim**, and enter or select
   Persistent Volume Claim Name: *any name*
   Select **Use a Storage Class to provision…**
   Storage Class: **nfs-client**
   Access Modes: **Single-Node Read/Write**
   Capacity: **1 GiB**
   Volume Name: *any name, all lowercase*
4. Click **container-0**; in the left panel, click **Storage.**
5. Click **"Select Volume"** and choose the volume claim you just created.
6. Under **Mount Point**, enter `/var/lib/mysql` .
7. Leave **Sub Path in Volume** blank.
8. Click **Save**.

Test the Persistent Volume

1. Under the ⋮ menu, select **Execute Shell,** and create a table like you did before:

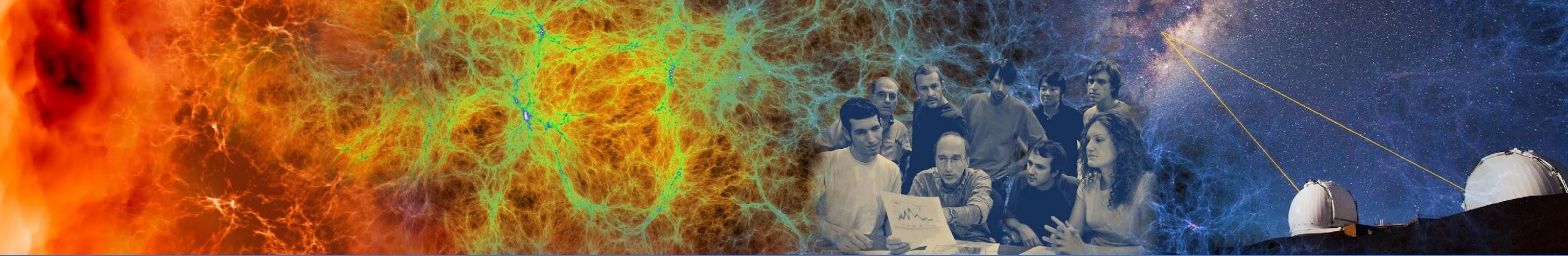
```
# mysql -u user -D science -p
mysql> create table t(n integer);
```

2. Under the ⋮ menu, click **Redeploy** and wait for the new container to be started.
3. Select **Execute Shell** again and check whether your changes persisted:

```
# mysql -u user -D science -p
mysql> show tables;
```

Discussion

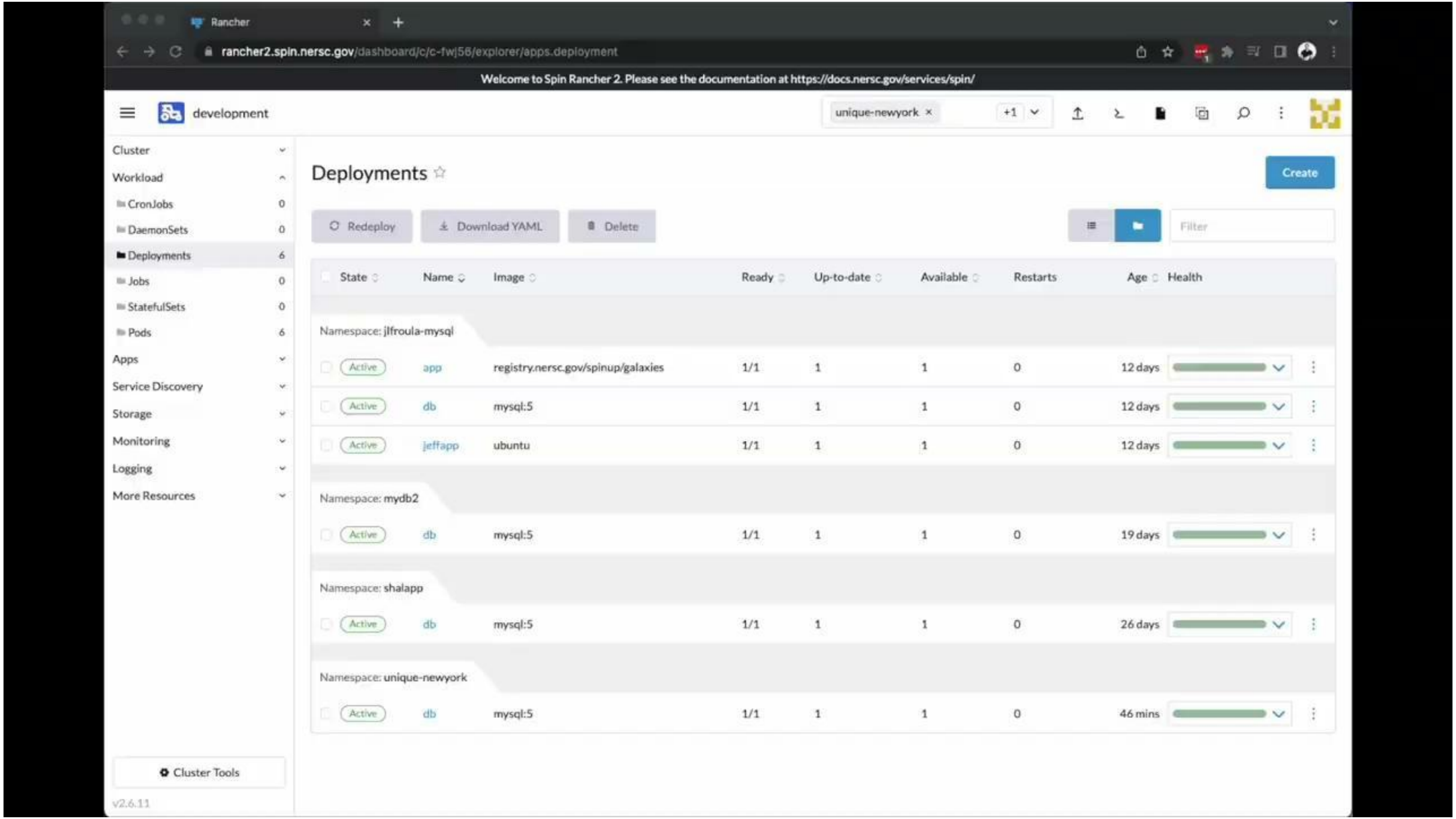
- NFS Storage enables data to persist across container instances.
- They allow persistent, performant, read-write storage.
- They are not mounted elsewhere, so you may need to set up a utility container for backups, permission changes.
- They are best used when the data are not needed across NERSC systems.



Exercise 4: Add a Web Front-end and CFS

Exercise 4: Add a Web Front-end and CFS

- Most use cases for Spin are apps that expose data on CFS or functionality at NERSC over the web.
- We've created one in a Docker image that uses:
  - Flask to handle HTTP requests, routing, responses
    - Pretty simple galaxy cluster gallery app
  - Config map for setting some environment variable
  - Database for content and metadata
    - Stored on NFS
  - Image files for web front-end to serve up
    - Stored on CFS


Rancher
rancher2.spin.nersc.gov/dashboard/c/c-fwj56/explorer/apps.deployment
Welcome to Spin Rancher 2. Please see the documentation at https://docs.nersc.gov/services/spin/
development
unique-newyork
+1
Cluster
Workload
CronJobs 0
DaemonSets 0
Deployments 6
Jobs 0
StatefulSets 0
Pods 6
Apps
Service Discovery
Storage
Monitoring
Logging
More Resources
Cluster Tools
v2.6.11
Deployments
Create
Redeploy
Download YAML
Delete
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State
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Namespace: mydb2
Active db mysql:5 1/1 1 1 0 19 days
Namespace: shalapp
Active db mysql:5 1/1 1 1 0 26 days
Namespace: unique-newyork
Active db mysql:5 1/1 1 1 0 46 mins

Try It Yourself!

1. Storage > ConfigMaps then ***click*** "Create" then ***set:***

```
Namespace: <your namespace>
Name:      any name
```

2. *Set* "Data" key/value pair:

```
banner_message = something hilarious
```

3. *Click* "Create" button

Config Map

1. Workload > Deployments then ***click*** "Create" then ***set***

```
Namespace:    <your namespace>
Name:         app
```

Under "container-0" tab in bottom middle ***set***

```
Container Image: registry.nersc.gov/spinup/galaxies
```

2. *Scroll down* to "Environment Variables" to add 2 variables:

Click "Add Variable," and ***set***

```
Type:              Key/Value Pair
Variable Name:     MYSQL_PASSWORD_FILE
Value:             /secrets/password
```

Click "Add Variable," and ***set***

```
Type:              ConfigMap Key
Variable Name:     BANNER_MESSAGE
ConfigMap:         <your config map>
Key:               banner_message
```

3. *Scroll up* and ***click*** "Pod" *tab and then* ***click*** *"Storage"* to configure two new volumes:

Open "Add Volume" dropdown, ***select*** "Bind-Mount" and ***set***

```
Volume Name:                  vol-galaxydata
Path on the Node:
   /global/cfs/cdirs/mpccc/rthomas/spin-demo/static
The Path on the Node must be:     An existing directory
```

Open "Add Volume" dropdown, ***select*** "Secret" and ***set***

```
Volume Name:  vol-dbsecret          Secret: db-password
```

4. *Click* "container-0" tab and then **click** "Storage" to attach new volumes to the Deployment

Open "Select Volume" dropdown, **select** "vol-galaxydata", and ***set***

```
Mount Point:  /srv/static         Read-Only:  [✔]
```

Open "Select Volume" dropdown, **select** "vol-dbsecret", and ***set***

```
Mount Point:  /secrets            Read-Only:  [✔]
```

5. At "container-0" tab ***click*** "Security Context" and ***set***

```
Run as User ID:       <numeric user ID>
Drop Capabilities:    ALL
```

6. *Click* "Pod" tab and then "Security Context" and ***set***

```
Filesystem Group:    <numeric group ID>
```

7. *Click* "Create" button

To find your numeric user ID and a suitable numeric group ID, use the `id` command on a login node or go to Iris and check the Profile and Groups tabs.

App Workload

Discussion: App, Behind-the-Scenes

- Where did the image come from?
    - Built image locally
    - https://github.com/NERSC/spin-docker-compose-example
        - Contains the app.py code, Dockerfile, entrypoint, etc.
        - Image data included too though this is for demonstration only
    - Push to registry.nersc.gov/<project>/<image-name>:<tag>
- How was the database initialized?
    - "Before first request" Flask decorator:
        - Connect to the database
        - Try to create the data table and fill with data
        - Not a robust error check here, it's a demo
        - Do this because the app container might restart

Discussion: Global File Systems

- **Using global file systems such as CFS triggers stricter security!**
  - Set User ID to yourself or a collab user;
  - Set Filesystem Group to one you belong to
    Otherwise, projects' files could be exposed
  - Only one capability allowed: `NET_BIND_SERVICE`
    Otherwise, file system permissions could be bypassed
- **Set `o+x` permissions from file system root to mount point**
- **Best practices**
  - use read-only access unless you *specifically* need read/write
  - mount as deep into the path as possible
  - use collab users
  - use setgid (`chmod g+s`) and a group-friendly umask (eg, `007`)

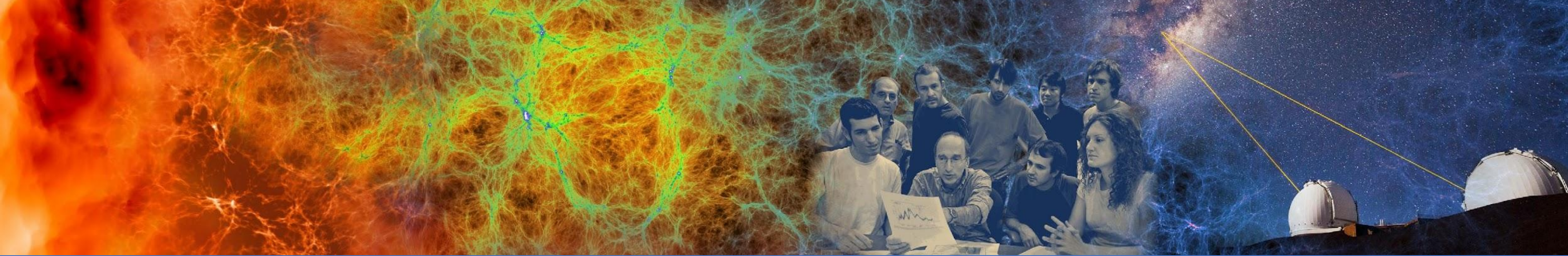
Discussion: Storage Options

Storage Type	Persistent	On HPC	Size	Best Use
Global File Systems (CFS, Common)	✓	✓	O(quota)	sequential
NFS	✓		O(10GB)+	random
CVMFS (read-only) *always mount at root!*	✓	✓	n/a	CERN software
in-container			O(1GB)	temporary

Discussion: Storage Options

Storage Need	Best Option
Data produced by compute jobs and used by science gateway	Global file system
Static web content or config files that require occasional updates	Global file system*
Web service access logs to analyze and save for record-keeping	Global file system*
Database tablespace or key-value backing store files	NFS
Static application code and web style sheets	in-container
Small, ephemeral application cache files	in-container

What other examples? What are some exceptions?



Exercise 5: Networking

Exercise 5: Networking (Internal / Overlay)

Traffic between containers uses a **private overlay network.**

- Each container gets an IP within 10.42.*.*
- IPs change when new containers are created!
- DNS names are automatically created (and updated)

  <*workload*>[.<*namespace*>[`.svc.cluster.local`]]

  => 10.42.x.y

For example, the database in our example app:

`db.`<*namespace*>`.svc.cluster.local`, or simply

`db`

Exercise 5: Networking (External Inbound)

HTTP traffic requires an *Ingress.*

- When you create an ingress, a dynamic DNS name is associated with it; the workload(s) you specify become accessible on port 80.

  <*ingress name*>`.`<*namespace*>`.`<*cluster*>`.svc.spin.nersc.org`
  => ingress controller IP address(es)

- You must add a friendly name and matching web certificate.
- Redirection to HTTPS happens automatically.
- Many aspects can be configured with *annotations*.

Exercise 5: Networking (External Inbound)

Non-HTTP traffic requires a *Load Balancer.*

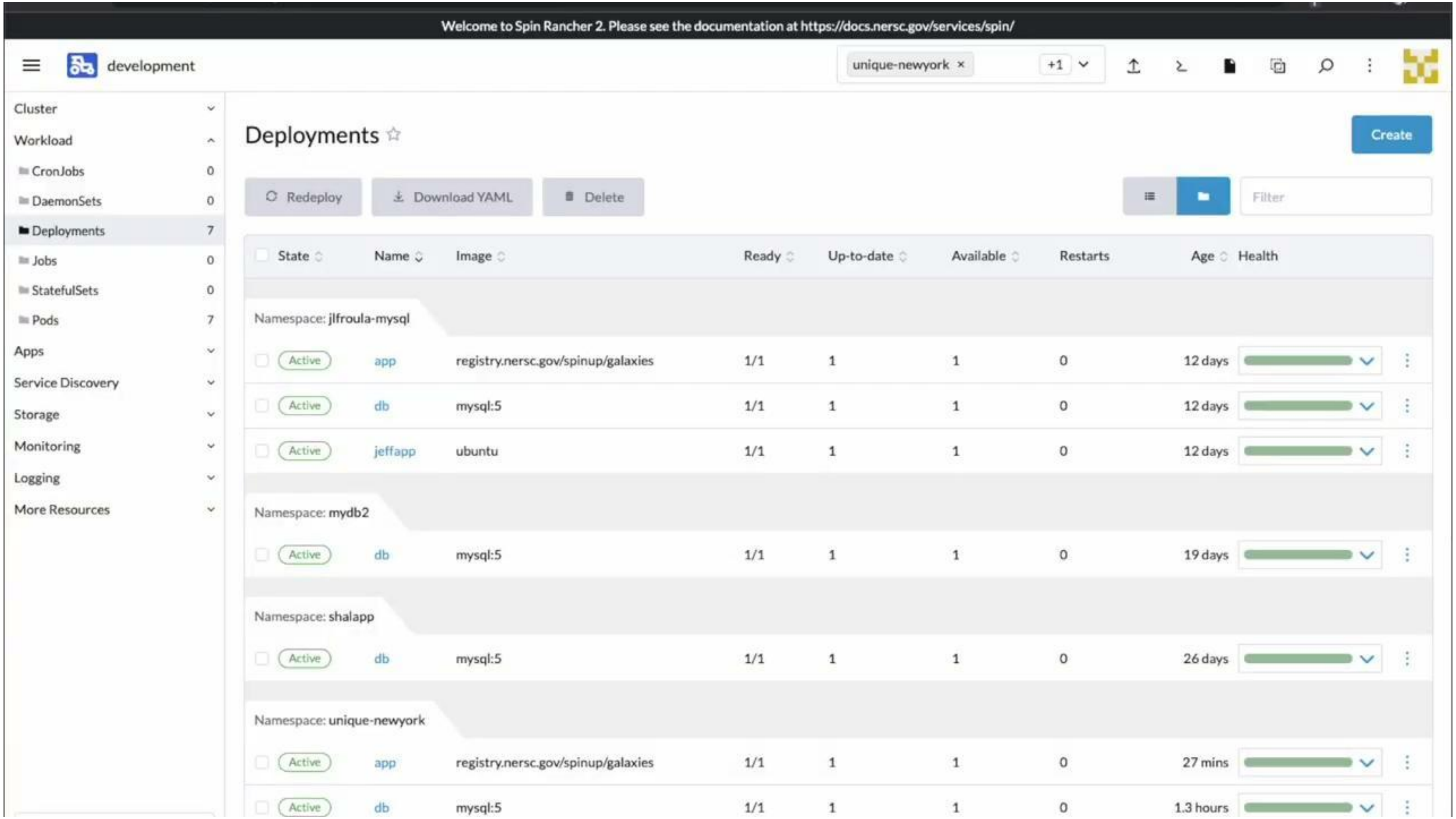
- A dynamic DNS name is associated with the workload; it becomes accessible at the port you specify

  `<`*workload*`>-loadbalancer.<`*namespace*`>.<`*cluster*`>.svc.spin.nersc.org`
  `=> 128.55.212.*` (dedicated IP for this load balancer)

- Only accessible from NERSC networks.
- Common ports are allowed; let us know if you need others:

  3306, 4873, 5432, 5672, 5984, 15672, 27017

Outbound external traffic just works (via NAT).


Welcome to Spin Rancher 2. Please see the documentation at https://docs.nersc.gov/services/spin/
development
unique-newyork ×
+1
Cluster
Workload
CronJobs 0
DaemonSets 0
Deployments 7
Jobs 0
StatefulSets 0
Pods 7
Apps
Service Discovery
Storage
Monitoring
Logging
More Resources
Deployments
Create
Redeploy
Download YAML
Delete
Filter
State Name Image Ready Up-to-date Available Restarts Age Health
Namespace: jlfroula-mysql
Active app registry.nersc.gov/spinup/galaxies 1/1 1 1 0 12 days
Active db mysql:5 1/1 1 1 0 12 days
Active jeffapp ubuntu 1/1 1 1 0 12 days
Namespace: mydb2
Active db mysql:5 1/1 1 1 0 19 days
Namespace: shalapp
Active db mysql:5 1/1 1 1 0 26 days
Namespace: unique-newyork
Active app registry.nersc.gov/spinup/galaxies 1/1 1 1 0 27 mins
Active db mysql:5 1/1 1 1 0 1.3 hours

Try It Yourself!

Create a service

1. **Workload > Deployments** in left navigation menu
2. **Click** the ⋮ menu to the right of your “app” workload. and **select** “Edit Config”
3. In “container-0” tab, **scroll down, click** “Add Port” button and **set**

```
Service Type:            Cluster IP          Name:        flask
Private Container Port:  5000                Protocol:    TCP
```

4. **Click** “Save” button in the lower left to redeploy “app”.

Create the ingress

1. **Service Discovery > Ingresses** in left navigation menu
2. **Click** the “Create” button in the upper right
3. **Set** these values

```
Namespace:        <Namespace from previous exercise>
Name:             ingress
Request Host:     ingress.<namespace>.development.svc.spin.nersc.org
Path:
    Prefix:           /          Watch out for leading or trailing spaces
    Target Service:   app
    Port:             5000
```

4. **Click** “Create” button in the lower left.

Use the ingress

You are back at the **Service Discovery > Ingresses** screen

1. **Wait** for state tag to change to **Active**
2. **Wait** for DNS to propagate to the LBL/NERSC and other DNS servers (**Usually 1-5 minutes**)
3. **Access** your app at: `http://ingress.<namespace>.development.svc.spin.nersc.org`

Exercise 5: Add a Friendly Hostname

Example: **www.cosmosgallery.org**

1. Request a DNS CNAME record in this format from your DNS provider:

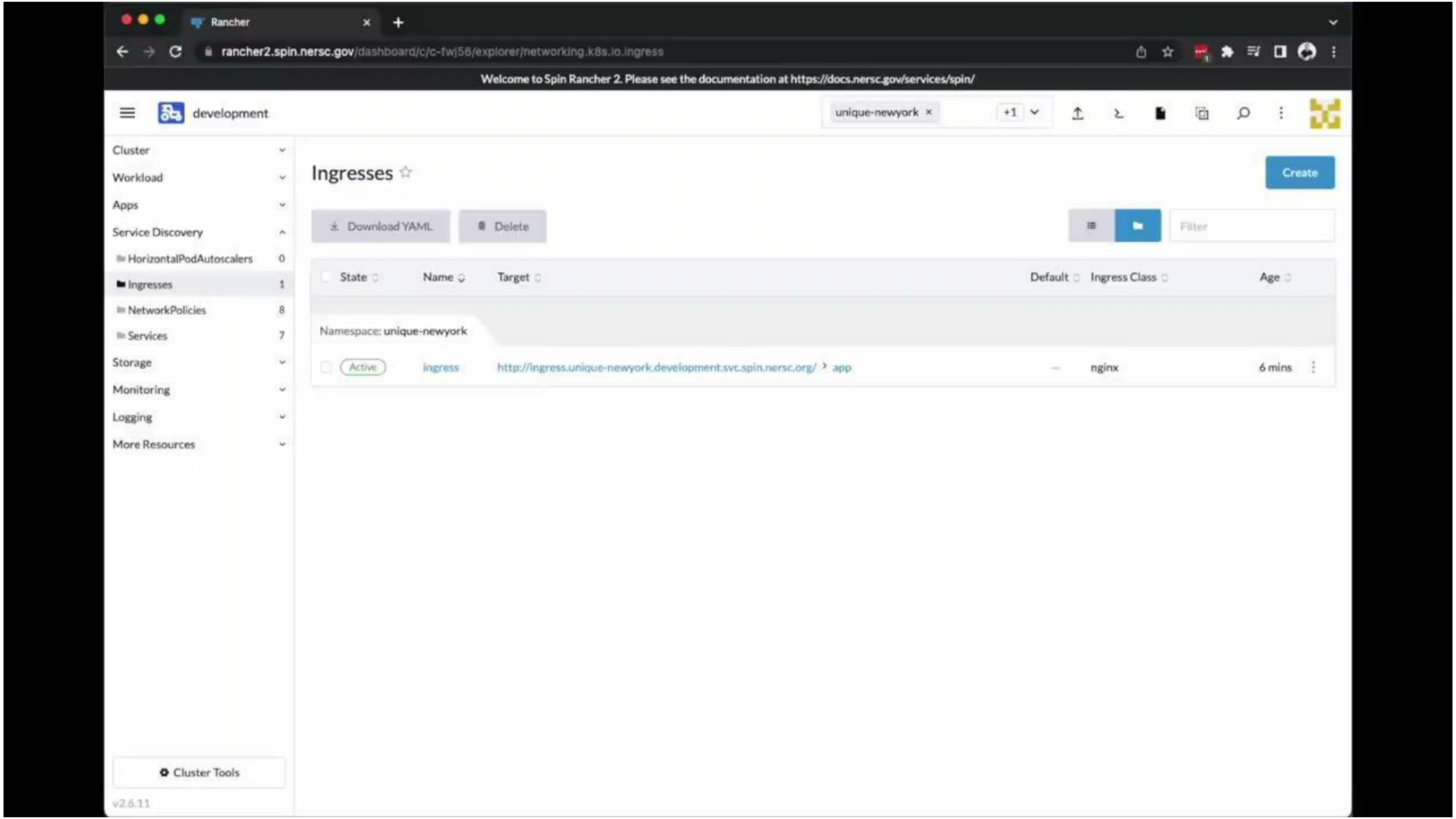
```
<friendly name> CNAME
    <ingress>.<namespace>.<development or production>.svc.spin.nersc.org.
```

For example,

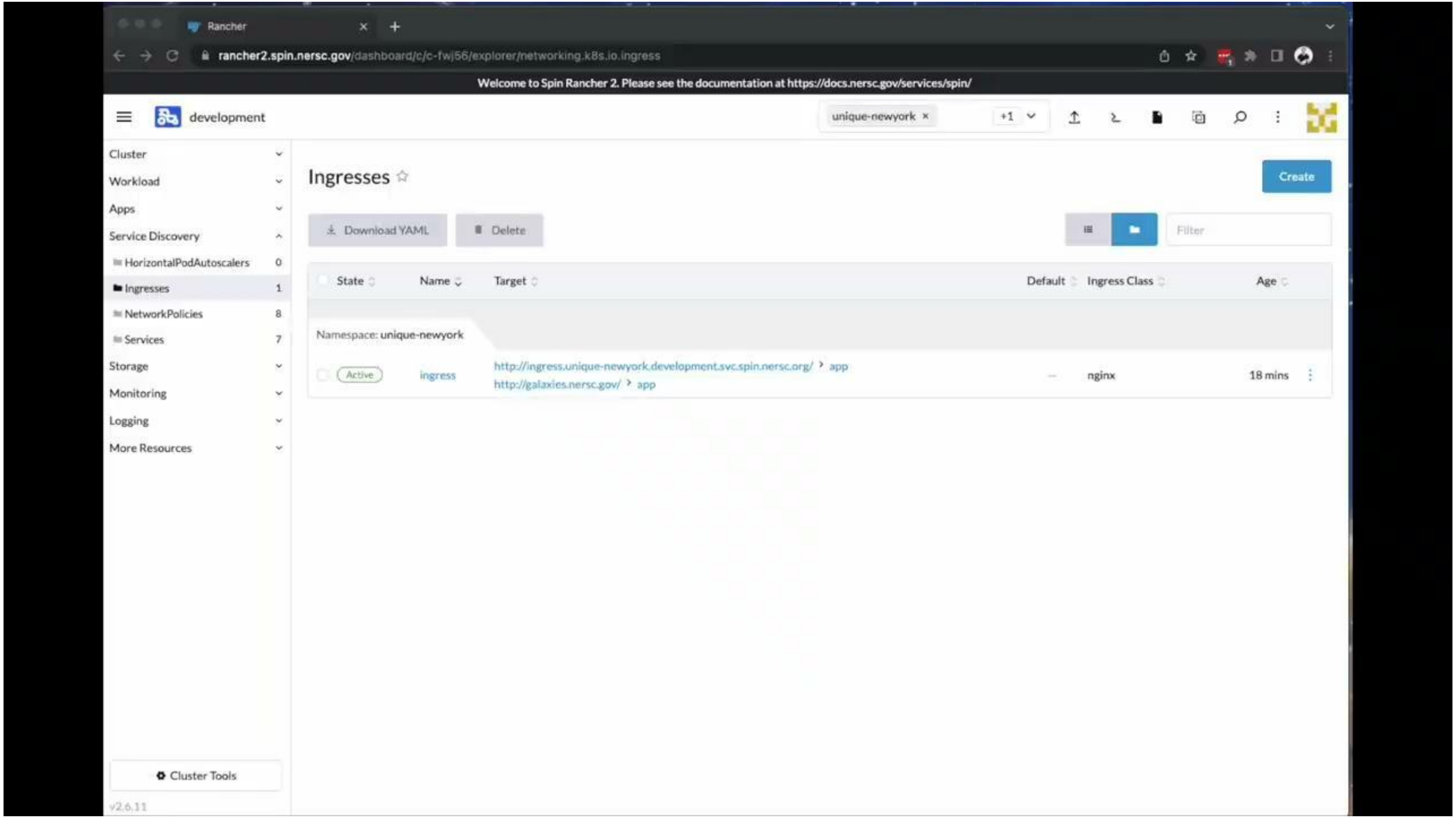
```
www.cosmosgallery.org CNAME lb.cosmosapp.production.svc.spin.nersc.org.
```

This will typically take a day or more.

2. Configure Ingress to accept traffic destined for that hostname:
    a. In your Ingress => Add Rule
    b. Add the friendly hostname as a second "rule"
        - For HTTPS, the hostname **must** match name in certificate



Rancher
rancher2.spin.nersc.gov/dashboard/c/c-fwj56/explorer/networking.k8s.io.ingress
Welcome to Spin Rancher 2. Please see the documentation at https://docs.nersc.gov/services/spin/
development
unique-newyork
+1
Cluster
Workload
Apps
Service Discovery
HorizontalPodAutoscalers 0
Ingresses 1
NetworkPolicies 8
Services 7
Storage
Monitoring
Logging
More Resources
Cluster Tools
v2.6.11
Ingresses
Create
Download YAML
Delete
Filter
State
Name
Target
Default
Ingress Class
Age
Namespace: unique-newyork
Active
ingress
http://ingress.unique-newyork.development.svc.spin.nersc.org/
app
nginx
6 mins


Rancher
rancher2.spin.nersc.gov/dashboard/c/c-fwj56/explorer/networking.k8s.io.ingress
Welcome to Spin Rancher 2. Please see the documentation at https://docs.nersc.gov/services/spin/
development
unique-newyork
+1
Cluster
Workload
Apps
Service Discovery
HorizontalPodAutoscalers 0
Ingresses 1
NetworkPolicies 8
Services 7
Storage
Monitoring
Logging
More Resources
Cluster Tools
v2.6.11
Ingresses
Create
Download YAML
Delete
Filter
State
Name
Target
Default
Ingress Class
Age
Namespace: unique-newyork
Active
ingress
http://ingress.unique-newyork.development.svc.spin.nersc.org/ › app
http://galaxies.nersc.gov/ › app
nginx
18 mins

Try It Yourself Later: Add a Friendly Name and SSL

Friendly Hostname

1. Get a CNAME entry from your DNS provider that points at your ingress. For instance:

```
<friendly name> CNAME
lb.<namespace>.<cluster>.svc.spin.nersc.org
```

2. When it is ready (hours or days later), navigate to **Service Discovery > Ingresses** in Rancher.
3. **Click** the ⋮ icon next to your ingress, and **select** “Edit Config” from the dropdown
4. Click **Add Rule.**
5. For **Request Host** enter the friendly name. Do not alter the existing rule.
6. Select the same **Path**, **Target Service** and **Port** as in the existing ingress rule, then click **Save**.

SSL/TLS (HTTPS)

1. Get a web certificate from your provider. There are many tutorials on how to do this.
2. Navigate to **Storage > Secrets**, click the **Create** button, then click **TLS Certificate.**
3. Enter a meaningful **Name** and select a **Namespace** scope.
4. Upload your **Private Key** and **Certificate** using “Read from File” buttons and click **Create**.
5. Navigate to **Service Discovery > Ingresses**.
6. **Edit** the ingress, select **Certificates** panel, click **Add Certificate**, select your certificate from the list, add your hostname, and **Save.**

Try It Yourself Later: Add a Load Balancer

1. Under **Workload**, click **Deployments** and click your **db** workload; under the ⋮ menu, click **Edit Config**; in the header, click **container-0**; in the left panel, click **General**. Scroll down to **Ports**.

2. Modify the existing port

Service Type:	**Load Balancer**
Name:	**mysql**
Private Container Port:	**3306**
Protocol:	**TCP**
Listening Port:	**3306**

Only common ports are exposed!
(Don't pick your "favorite" port here)

3. Click **Save.**

4. Under **Service Discovery**, click **Services** and find your namespace; your load balancer will be named **db-loadbalancer**.

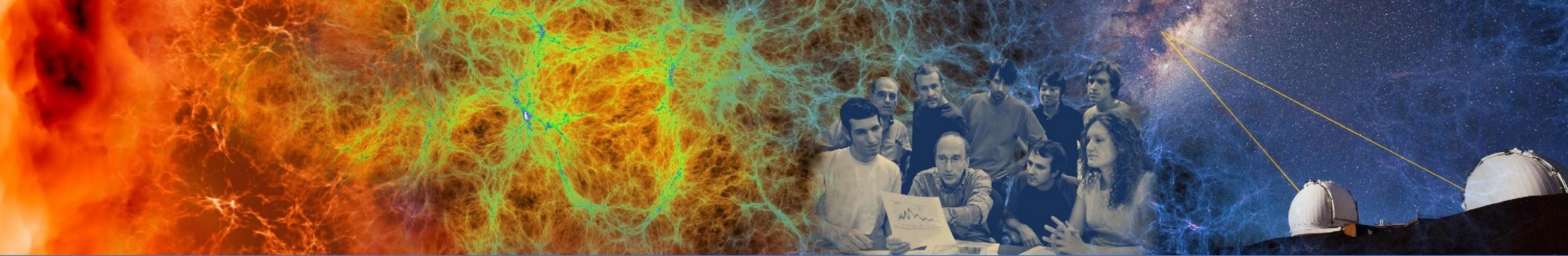
5. Just like an ingress, Rancher will create a DNS name for the load balancer based on the workload name, namespace, and cluster name. To see this generated name, click **db-loadbalancer**, then **Show # annotations** near the top of the page.

6. To try connecting to the database via the load balancer, log into Perlmutter and run

```
% mysql -p -u user -D science -h db-loadbalancer.namespace.development.svc.spin.nersc.org
```

Discussion: Networking

- **Beware of DNS propagation delays**
  - Wait a minute for the DNS name of a *brand new* ingress or load balancer to be created; Rancher uses an internal queue.
  - Accessing either too early can negative cache for five minutes.
- **Custom hostnames and web certificates**
  - Processes vary for obtaining a hostname and certificate.
  - Check with your institution or PI.
- **Web certificate chain ordering**
  - If your certificate requires a chain, use nginx ordering: your certificate first, then that of its issuer, etc, but omitting the root.



Viewing Logs and Performance Data

Viewing Logs, Events & Conditions

Log Type	Content	Where	Best Use
Container	All stdout and stderr from container processes	***Option #1: Workload > Deployments,*** click on the **name** to view the pods, select **View Logs** under (⋮) menu next to pod ***Option #2: Workload > Pods,*** select **View Logs** under (⋮) menu next to pod	Application problem, but container runs Container produces error at startup, exits, and restarts
Workload Events, Pod Conditions	Scheduler activity (start, stop, scale), node failure	***Workload > Deployments > (Your Deployment)*** and choose one of: • ***Recent Events*** • ***Conditions***	Workload will not start or scale at all Container restarts continuously Denied due to security policy

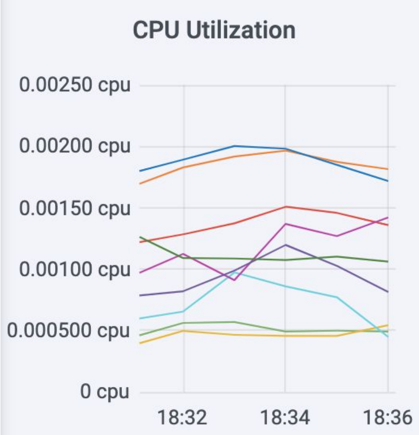
Performance Analytics

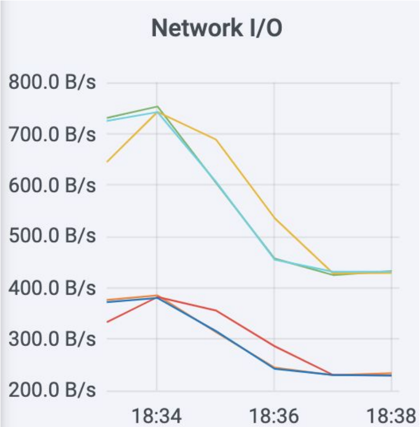
Rancher provides live Grafana plots of Kubernetes Resource Metrics:

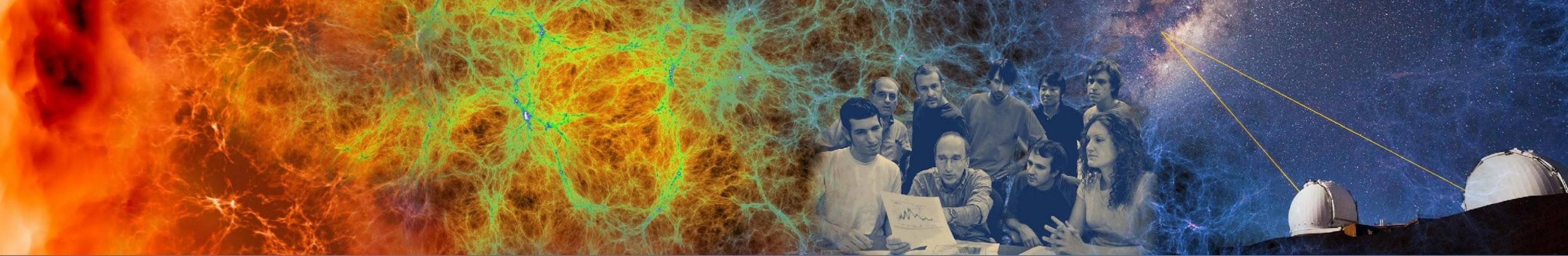
- CPU Utilization
- Memory Utilization
- Network packets and throughput
- Disk throughput

Where:

- ***Workload > Deployment,*** click ***Metrics*** tab







Building Your Own Microservices App

Microservices

Services (Workloads/Pods)

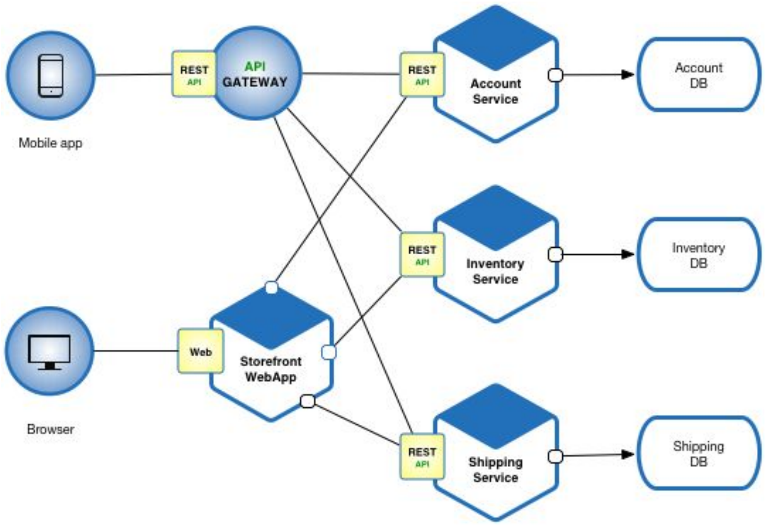
- Valuable actions that fulfill a demand
- One or more containers

Microservice Architecture

- How services are combined

Service Principles

- Modular and loosely coupled
- Composable
- Platform and language independent
- Self-describing



Starting Your Microservice Design

Why should you think about your app in terms of microservices?

What are some examples of microservice components?

What does Spin take care of or make easy for you?

Draw a microservices picture of your use case!

How does your app get on the web?

What conventions do we recommend?

Categories of Microservices

Web Front-end

Web App • Authentication • Access Control

Application Logic

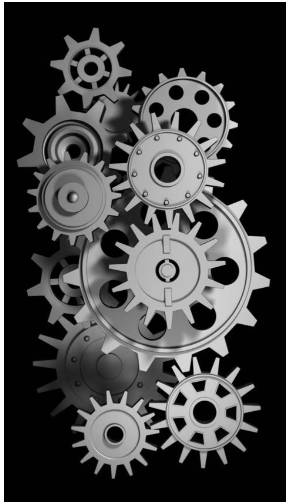
REST API • Workflow Engine

Metadata, Application State, or Science Data

SQL • NoSQL • XML

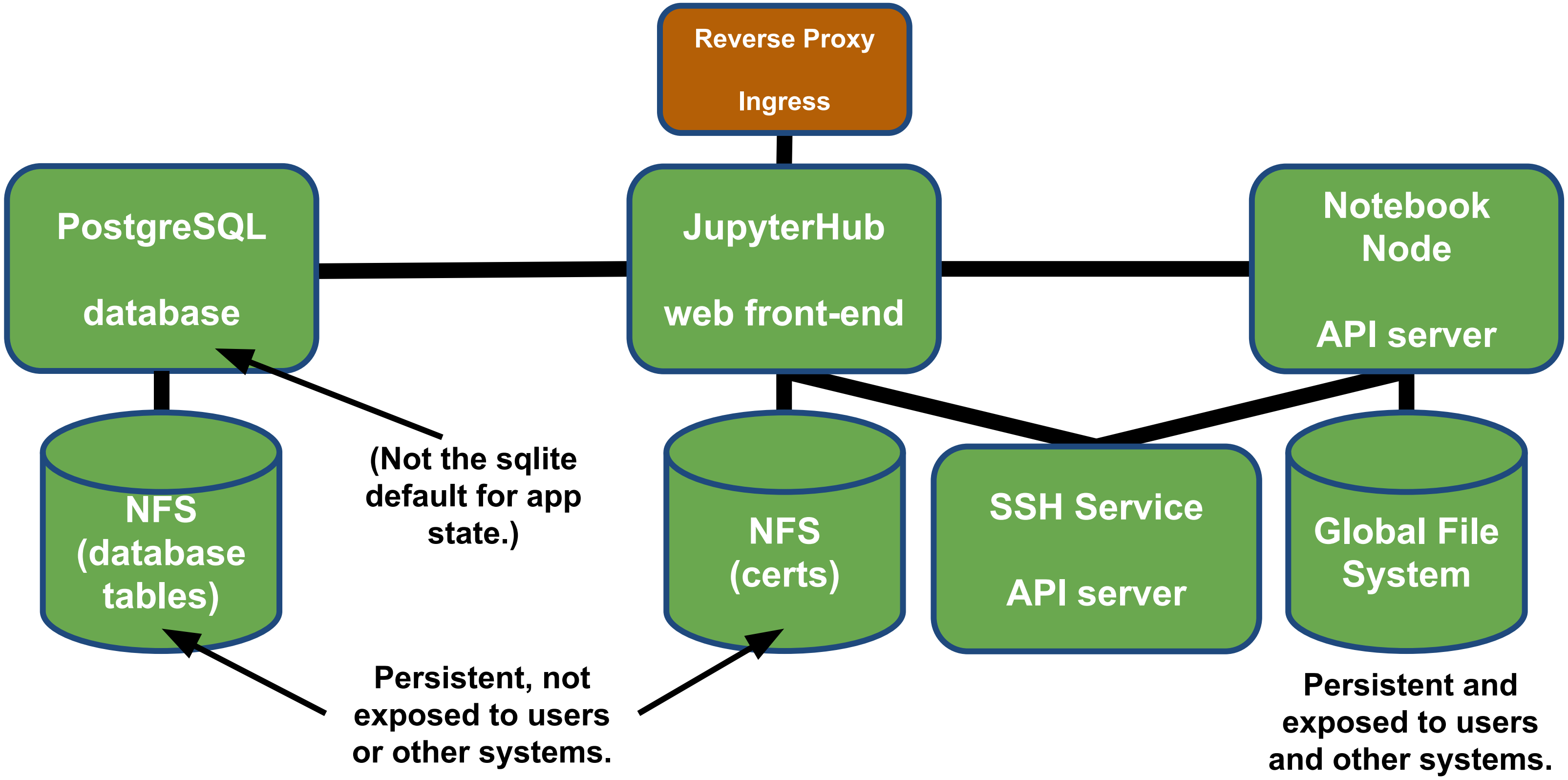
File Storage for Science Data

Ephemeral or Persistent • Open or Closed

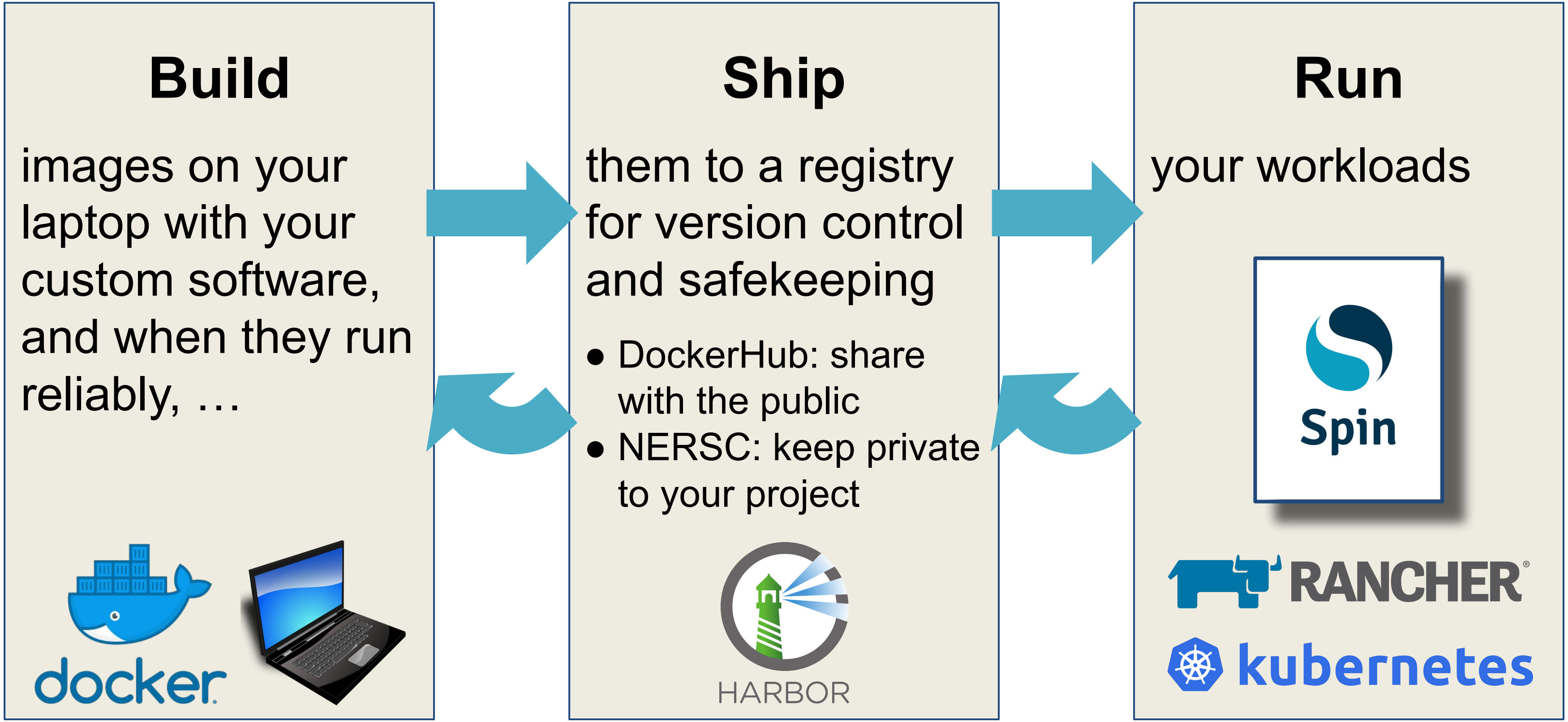


What are some others?

Real-World Example: jupyter-test



Recall: Container Development Workflow



“Classic” Development Model

1. Build your app on your laptop like in the big picture.
2. Run and test containers locally.
3. Use mock APIs or mock volume mounts with a subset of data on your laptop.
4. For the brave: mount larger data sets over sshfs, but…

“Classic” Development Model

Pros:

- Testing on your laptop is a tight loop.
- No deployment to Spin until things are working reliably.

Cons:

- Pushing big images with small bandwidth is slow.
- Complex apps can be difficult to build in a simple local setup.

“On Ramp” Development Model

(This applies mostly to web front-ends.)

1. Docker image houses your application dependencies and runs with your UID and GID.
2. Deploy “app.py” code to some path on CFS with appropriate permissions.
3. Mount app.py’s directory and run it with “reload on source change” turned on.
4. Now you can hack in traditional fashion. (Eventually move “app.py” into container.)

“On Ramp” Development Model

Pros:

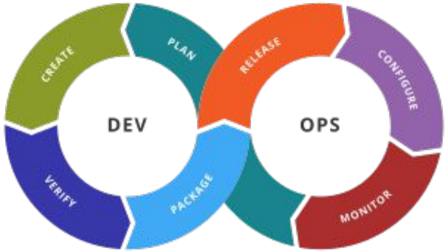
- Less pushing images from your laptop.
- No setting up of mocks APIs or mounts/sshfs.

Cons:

- You depend on a “data” filesystem for hosting code.
- Tendency to build up technical debt especially as new deps arise.

"DevOps" Model is Ideal

1. Starts out like classic model.
2. Leverage continuous integration to automate image build, test, and push to registry.
3. Trigger re-deployment on successful image push and test.
4. Not all features available yet.



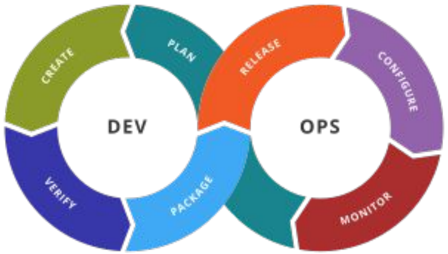
“DevOps” Model is Ideal

Pros:

- Most efficient and reliable.
- Promotes inner peace.
- Keep computers busy; delay the singularity. (ahem)

Cons:

- Requires setup and commitment from team.
- Not all the tools available (yet) in Spin.



Encouragements and Admonishments

We most extremely *strongly* admonish you not to use `docker commit`.

It enables changes that go untracked and are not easily reproduced.
Changes to your Dockerfile should be under source control.
It should feel *wrong* to you.

Iterating a lot on an image build?

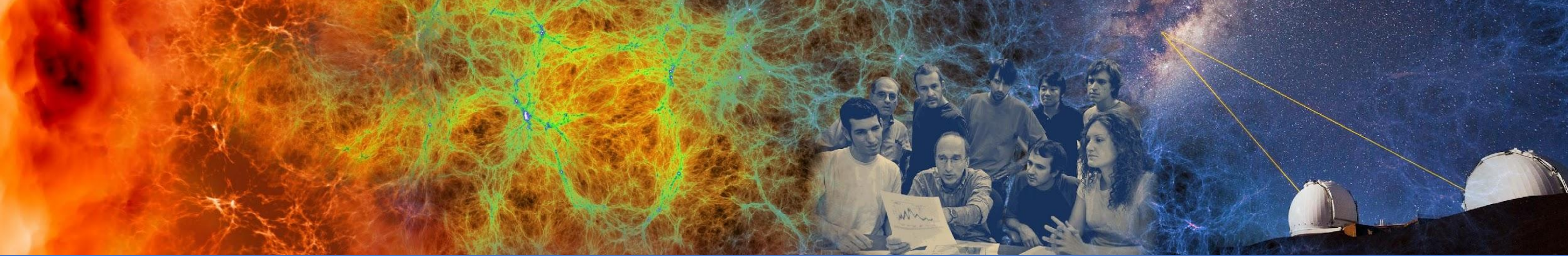
To force rebuilds from a point just insert `RUN env` or `RUN pwd` to force the build from that point (c.f. multi-stage builds).

Want to start all over with a clean slate?

Use the `--no-cache` option in your docker build.

Need to clean out containers and images?

```
docker rm -f $(docker ps -aq)
docker rmi -f $(docker images -q)
docker container prune
docker image prune
docker system prune
```

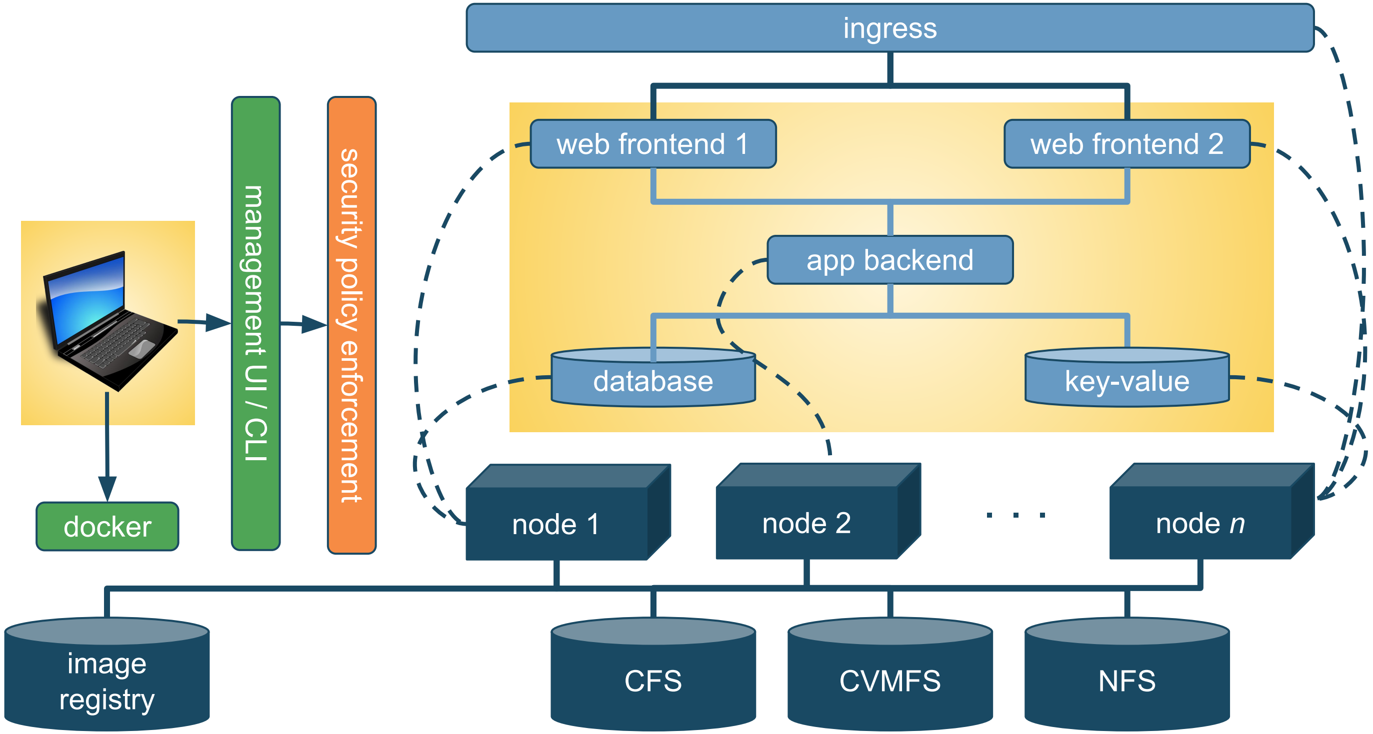


Wrap-Up

High-Level Spin Architecture

Yours to manage

NERSC handles the rest!



Roles and Responsibilities

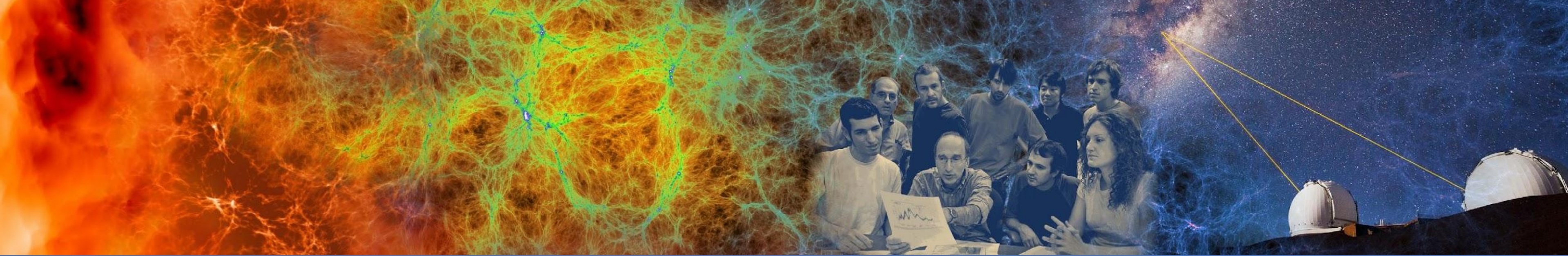
You bring...

- **Your own microservice design**
- **Your own services based in Docker images**
- **Lifecycle management**
  - maintain at least one owner for every application
  - track Docker build files with git
  - minimize image customizations
- **Security management**
  - produce logs to stdout / stderr
  - use trustworthy public images; keep custom images updated
    - NERSC will scan images and network ports

Roles and Responsibilities

NERSC brings...

- **Stable infrastructure**
  - redundancy: 2x power, 2x network
  - dedicated storage
  - access to global file systems
- **Management practices for high uptime**
  - rolling upgrades
  - pre-scheduled quarterly maintenance
- **Support via the usual channels**
  - Spin team spans NERSC groups
  - NERSC staff are also Spin users!



Questions and Hack-a-thon Prep