Application development with Docker, Kubernetes, and OpenShift

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Slides Used in Class

Application development with Docker, Kubernetes, and OpenShift

Welcome

Greetings and welcome to the workshop. By the time you leave today you will have gotten your hands nice and dirty playing with OpenShift and PostgreSQL in containers. Our overall goal for today is to:

1. Introduce you to running applications in containers
2. Seeing some cool things you can now have with PostgreSQL and Application development

FYI

- We have a full day of class ahead of us
- Use the bathroom when you want
- We are here to help you, please ask questions and interrupt us
- You can keep using this VM when you get home to play with
    1. Docker
    2. Kubernetes
    3. OpenShift
    4. PostgreSQL with some advanced features

Installing the Vagrant Box

Let's go ahead and install the Vagrant box file and get everything up and running.

Hardware Requirements

1. 10 gigs of disk to start but may need up to 30
2. At least 8 gigs of RAM by default. Our VM will use 6 by default so we want to leave 2 gigs for the OS and others

Software Requirements

WARNING	You must do this **BEFORE** the class - we will not have time to do this in class.

1. Install VirtualBox - I have pointed you to the past release because Vagrant doesn't work with 5.1 yet.
2. Install Vagrant - I have pointed you at 1.8.4 because the current version has a nasty SSH bug.

VirtualBox is a requirement. I know some of you have parallels and vmware and other virtualization tech but I only built the image for VirtualBox. My reasoning for doing this is that it is the only cross-platform FOSS VM software out there. Sorry but that's the breaks.

Account requirements

WARNING	You must do this **BEFORE** the class - we will not have time to do this in class.

1. GitHub account, if you don't have one

Github Repos to bring to your machine

These repos may not be finished or even available until right before the class, so we will be doing this in class.

Put these in a directory titled *os_workshop* (not required but then it is on you to translate to your directory name in the rest of the instructions)

Clone the Crunchy DB code https://github.com/CrunchyData/crunchy-containers (optionally you can fork and then clone if you think you are going to want to make your own changes).

Getting the Vagrant box on your local machine

In the *os_workshop* directory make a directory titled *vagrant* and change into it.

Using the box on Atlas

If you are doing this at home (which I hope you did before the class) do the following commands

WARNING	You must do this **BEFORE** the class - we will not have time to do this in class.

```
C:\_os_workshop\vagrant> vagrant init thesteve0/pgopen-origin
C:\_os_workshop\vagrant> vagrant up --provider=virtualbox
```

There is a **5.5 Gig** file that needs to be downloaded so it may take a while. After that is download Vagrant will bring everything up.

Go ahead and download the OpenShift client tools for your laptop OS. There will be a single binary in the archive - for convenience you should put it somewhere in your path. But it is also fine to place it somewhere else, you will just need to prefix you calls with the path to binary.

https://github.com/openshift/origin/releases/tag/v1.3.0-alpha.3

Manually copying the box off of a USB drive

If you are doing this in the class we are going to manually bring the box to your machine.

WARNING	You need to have access to your USB drive to choose this method to bring up your Vagrant box

Please try to come 15 minutes early to class so we can try to do the copying and installing before the class starts.

Copy the *Vagrantfile* and *+ _ *file from the USB stick into the _vagrant* directory created above. OR just modify the *vagrant box add* command below to read from your USB disk directly

Then in that directory do the following commands:

```
C:\_os_workshop\vagrant> vagrant box add --name pgopen-origin pgopen-openshift-
origin.box
C:\_os_workshop\vagrant> vagrant init pgopen-origin
C:\_os_workshop\vagrant> vagrant up --provider=virtualbox
```

Final step

When "vagrant up" is done you should see a message that ends with:

```
==> default: Successfully started and provisioned VM with 2 cores and 4 G of memory.
==> default: To modify the number of cores and/or available memory modify your local
Vagrantfile
==> default:
==> default: You can now access the OpenShift console on:
https://10.2.2.2:8443/console
==> default:
==> default: Configured users are (<username>/<password>):
==> default: admin/admin
==> default: But, you can also use any username and password combination you would
like to create
==> default: a new user.
==> default:
==> default: You can find links to the client libraries here:
https://www.openshift.org/vm
==> default: If you have the oc client library on your host, you can also login from
your host.
==> default:
==> default: To use OpenShift CLI, run:
==> default: $ vagrant ssh
==> default: $ oc login https://10.2.2.2:8443
```

If this doesn't happen raise your hand or, if you are a good student and did this at home, email me. If you see this then you have installed everything properly.

I know some of you are going to be curious and are going to start playing with this VM. That's OK!

Right before class (or if you break it) you just need to do the following steps:

```
C:\_os_workshop\vagrant>vagrant destroy --force
C:\_os_workshop\vagrant>rm -rf .vagrant #basically delete the .vagrant dir - I do it
bc I am superstitious
C:\_os_workshop\vagrant>vagrant up --provider=virtualbox
```

You don't even need to be online for this command to work! Welcome to the future.

Troubleshooting

1. To reduce amount of memory. Edit Vagrantfile:

```
config.vm.provider "virtualbox" do |vb|
   vb.memory = "4096"
 end
```

2. If you have ssh authentication issues while starting the machine. Just skip ahead. You don't need to log into the machine.

3. http/ssl problems when doing login try these (in order of what to start with):
    - oc login --insecure-skip-tls-verify=true
    - Reboot the machine
4. If you have issues with builds not resolving hosts (like when building v3simplespatial):
    - Check /etc/resolv.conf in the VM (vagrant ssh and cat /etc/resolv.conf)
    - If the nameserver you have is in 10.x.x.x, change it to 8.8.8.8
    - Restart origin from within the VM (sudo systemctl restart origin)
5. If must run VirtualBox 5.1 then there are instructions here on how to workaround
    - https://github.com/mitchellh/vagrant/issues/7588

Brief Introduction to OpenShift

OpenShift is Red Hat's Container Application Platform. What this means in plain English is OpenShift helps your run Docker containers in an orchestrated and efficient way on a fleet of machines. OpenShift will handle all the networking, scheduling, services, and all the pieces that make a up a modern application.

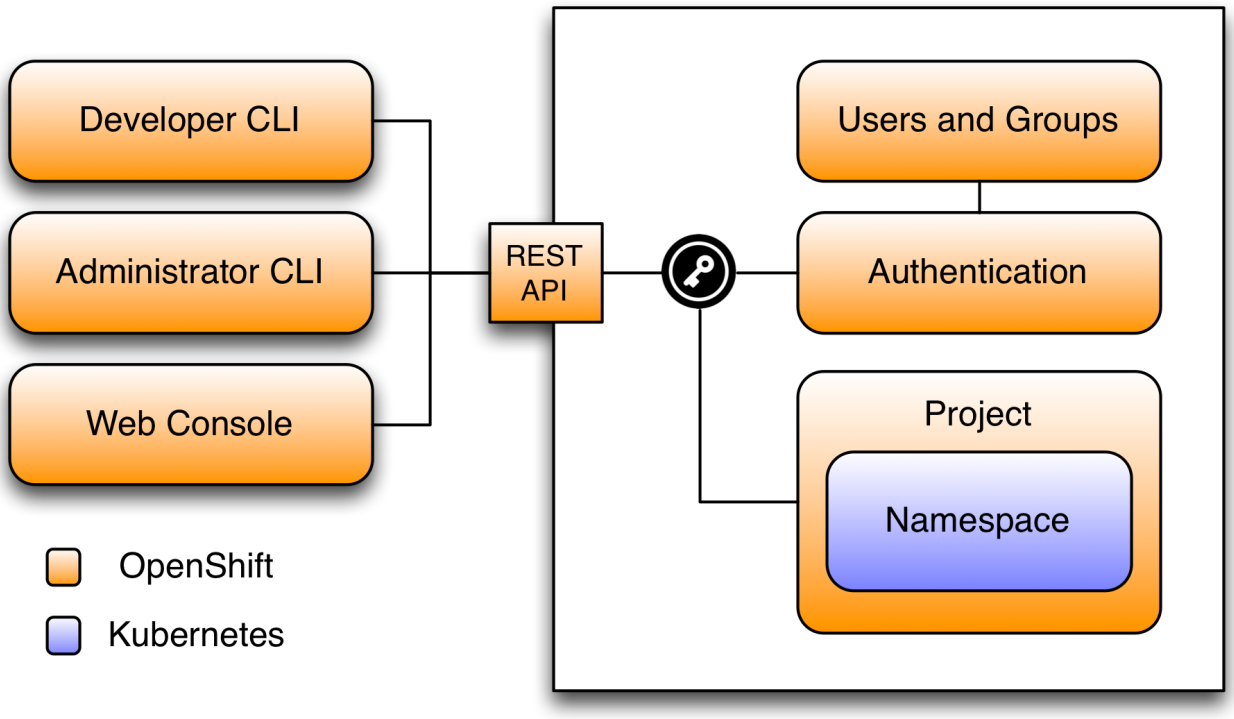
To accomplish this there are required pieces to the platform. We use the Docker container engine to handle just the running of the containers. Above that there is Kubernetes, the Open Source project for orchestrating, scheduling, and other tasks for actually building real applications out of Docker containers. Finally, we layer on top of this the engineering work of OpenShift to build a developer and system adminstrator experience that allows for ease of use when developer and administering containerized applications.

For both Docker and Kubernetes, OpenShift does not do any forking or proprietary extensions. With an OpenShift cluster you can use the OpenShift interfaces OR you can always use the Docker and Kubernetes interfaces. Granted, those interfaces will only support operations possible in that part of the stack.

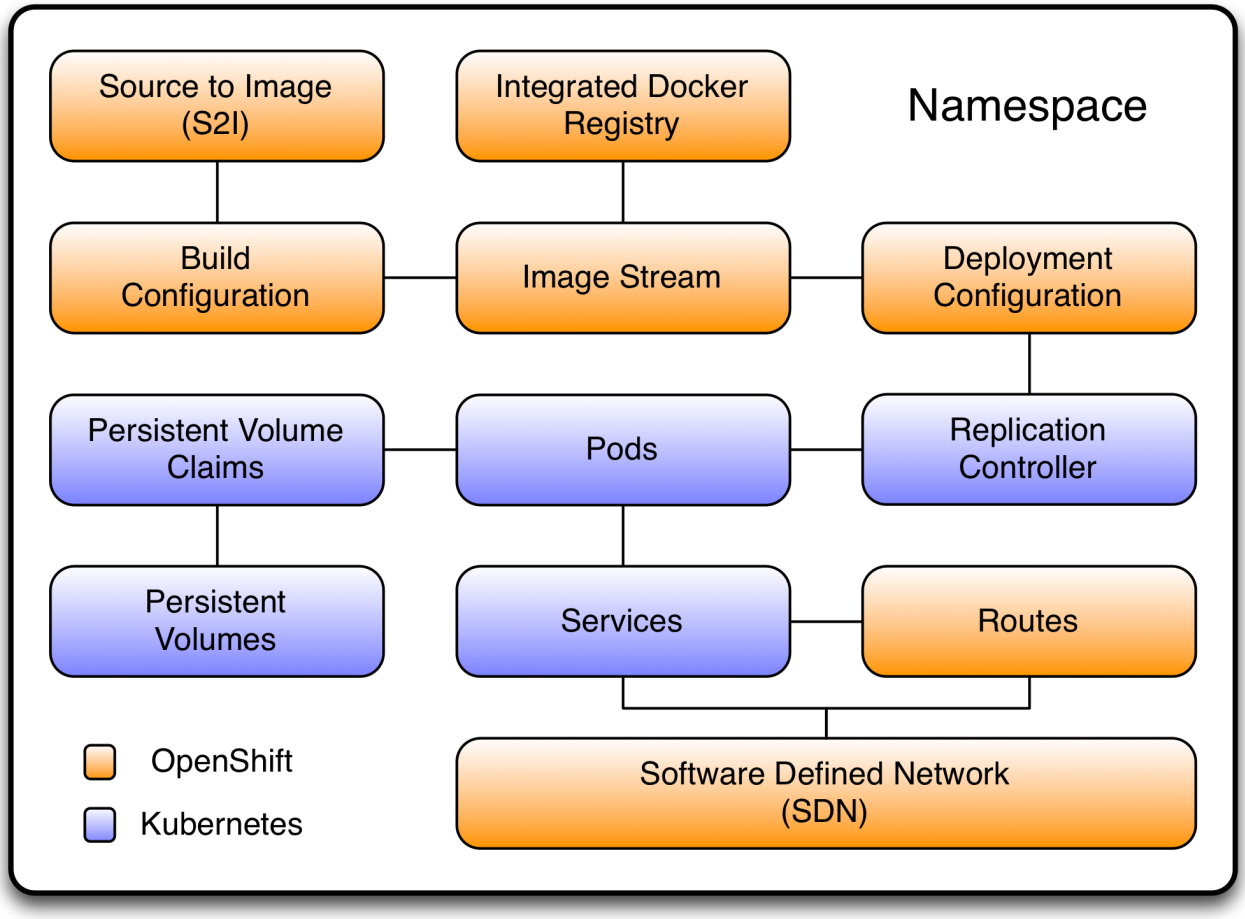
I am going to put two diagrams here that we will be discussing in class. You can refer back to these diagrams while you do the exercices. The key points for these diagrams are:

1. You can look and see how all the pieces fit together
2. You can see which pieces are core Kubernetes (blue) and which pieces are OpenShift (gold).

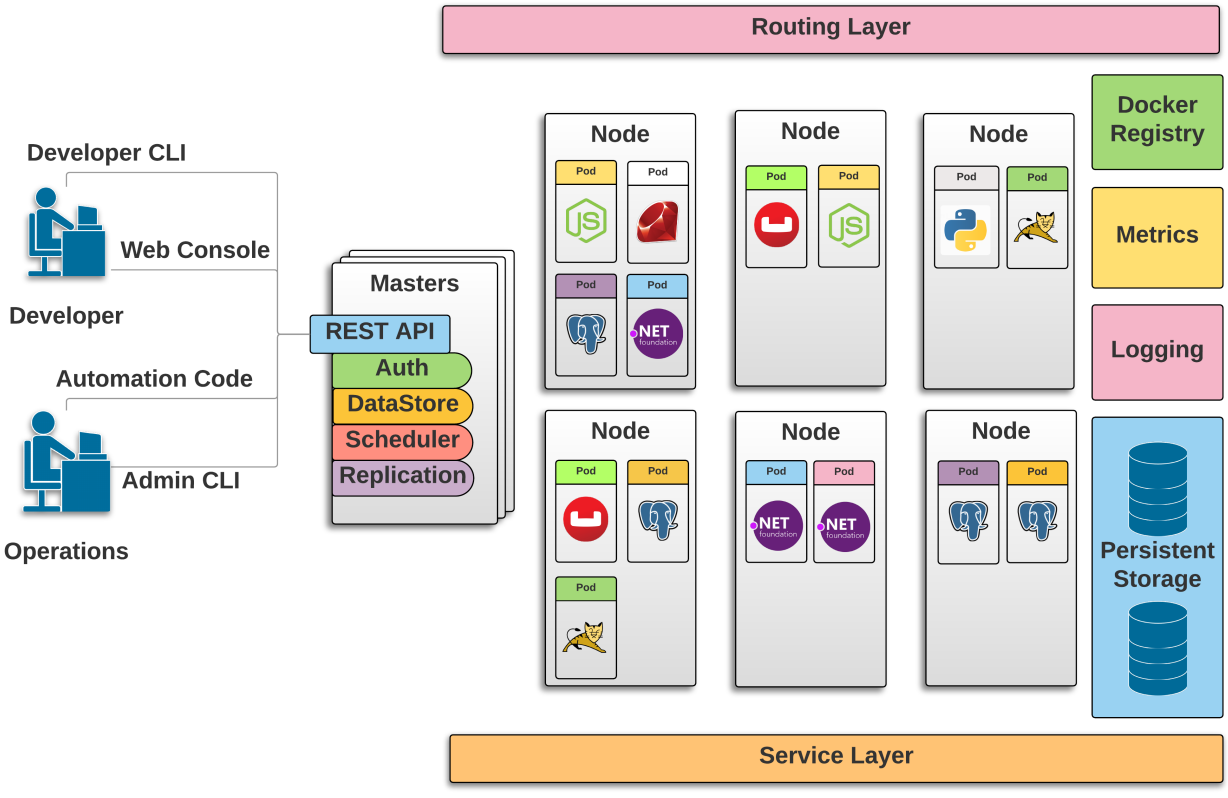
Here is the top level, showing the pieces in the interfaces and authentication:



And here are the lower level pieces that make up the core objects.



Finally, here is a diagram showing how an OpenShift/Kubernetes cluster is put together from different data center "pieces"



Now that we have done enough talking - the rest of the class will be action!

Introduction to the OpenShift All-In-One VM

Before we get started, it is assumed that you have already installed the OpenShift All-In-One VM and command line tools.

The all-in-one VM (A1VM) is intended for a developer or sysadmin to have a quick and easy way to use OpenShift (which also is a great way to use Kubernetes). The focus of the A1VM is:

1. Works right out of the box
2. Relaxes security restrictions so you can run Docker images that run as root
3. Give developers a means to carry out rapid development without needing an external server
4. Give the OpenShift evangelists an easy way to run workshops - like this one

WARNING

We wanted to allow developers to use any Docker image they want, which required us turning off some security in OpenShift. By default, OpenShift will not allow a container to run as root or even a non-random container assigned userid. Most Docker images in Dockerhub do not follow this best practice and instead run as root. Further multiplying this error, a large majority of Dockerhub images are not patched for well known vulnerabilities. Therefore, please use images from Dockerhub with caution. We think some of the risk is mitigated because you are running OpenShift in a VM, but still - be careful which Docker images you run.

TIP

If you want to run the VM with same permissions as in the Enterprise or Online products you can do the following command inside the Vagrant machine:

```
$ oc login #username admin #password any password you want
$ oc adm policy remove-scc-from-group anyuid system:authenticated
```

This commands removes the ability to for any OpenShift UID from running as system:authenticated and resets it to the default which is only allow that permission for random UID.

Your VM now behaves like Online or Enterprise in terms of not letting Docker images run as root user.

The command line

And with that we begin the journey. Our first step will be to login to the VM both from the command line (cli) and the web console (console). Open a terminal and type in:

```
> oc login https://10.2.2.2:8443

# on windows or if you get a cert. error do the following

> oc login https://10.2.2.2:8443 --insecure-skip-tls-verify=true
```

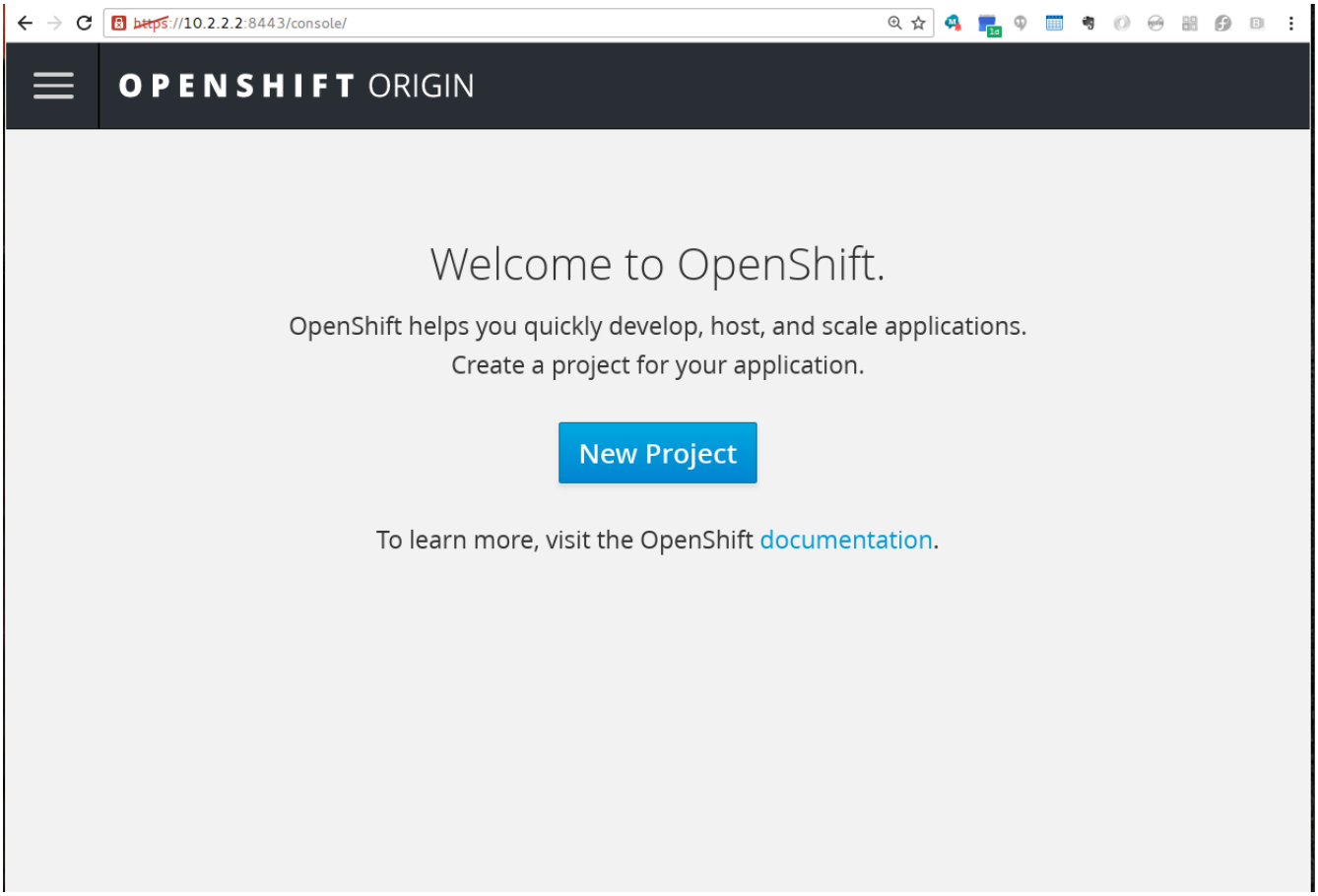
You should be prompted for a username and passsword. For ease of use, in the workshop, we will use username *user* password *password*. You can actually use any password you want with the admin or user account. You can also use any username and password you want. The username will "matter" in that any project created in that username can only be seen by that username - but these are not secure accounts. Remember - the focus of this VM is ease of use.

After logging in you should see the following message

```
Login successful.

You don't have any projects. You can try to create a new project, by running

    oc new-project <projectname>
```

Web Console

Now in your browser go to https://10.2.2.2:8443 . You will get a warning about the certificate and this is to be expected since we are using self-signed certificates throughout the installation - so we will need to work around this. You will then get to the login screen. Again use the *user* and *password* username password combination and you should see something that looks like this (except for the red box):



Now go ahead and login as the account we will use for most of the remaining exercises. In the username and password prompt go ahead and type *user* and *user* in both fields (again the password can really be anything you want).

And with that we are ready to get down to business. Let's start by just using a plain Docker container image from Docker hub!

Running a Docker Container Image

Let's start by just running a plain ole' Apache HTTPD server in OpenShift. By way of doing this I will also introduce you to many of the major pieces in an OpenShift project.

We are going to move back and forth between the command line and the web UI so please have them both ready to go and logged in as the user.

Create a Project

In order to get going we need to create a *project* to hold all of the pieces of our application(s). A *project* is a materialized *namespace* in Kubernetes to provide permissions and access control between different users resources.

The first thing we need to do as a user is create the *project*

```
> oc new-project webpages
Now using project "webpages" on server "https://10.2.2.2:8443".
...
```

We created a *project* named webpages and all subsequent commands will be executed against this *project*.

There is a special *project* that admins have access to in the cluster named "openshift". Any templates (explained later) or other objects placed in this project are available to all users of the cluster with read permissions.

To see all the projects that you have permissions to see go ahead and:

```
> oc get projects
```

Bringing in Docker Container Image from DockerHub

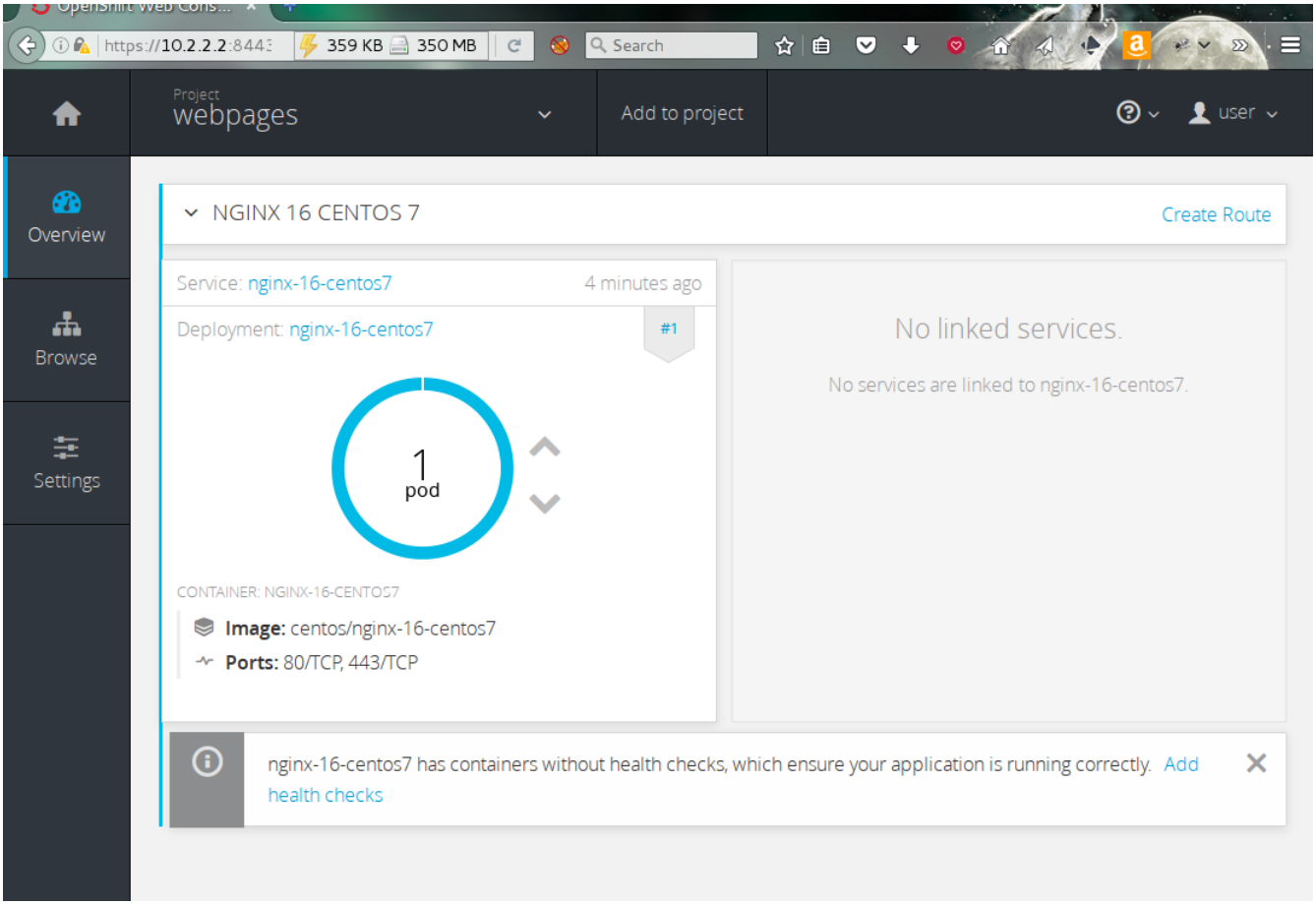
Typically you will not bring in images directly from DockerHub because of the numerous flaws and vulnerabilities in DockerHub images. One big probem for many images on DockerHub is that they run as *root* user when it is not even required. By default, an OpenShift cluster will not let you run images as *root*. In the case of the A1VM we turn off this security to allow for ease of use.

Let's go ahead and start with an NGINX image put out by the CentOS group. Bringing this into our OpenShift environment is as simple as

```
> oc new-app centos/nginx-16-centos7
--> Found Docker image 32eebae (13 days old) from Docker Hub for "centos/nginx-16-
centos7"

    * An image stream will be created as "nginx-16-centos7:latest" that will track
this image
    * This image will be deployed in deployment config "nginx-16-centos7"
    * Ports 443/tcp, 80/tcp will be load balanced by service "nginx-16-centos7"
      * Other containers can access this service through the hostname "nginx-16-
centos7"
    * This image declares volumes and will default to use non-persistent, host-local
storage.
      You can add persistent volumes later by running 'volume dc/nginx-16-centos7
--add ...'
    * WARNING: Image "centos/nginx-16-centos7" runs as the 'root' user which may not
be permitted by your cluster administrator

--> Creating resources with label app=nginx-16-centos7 ...
    imagestream "nginx-16-centos7" created
    deploymentconfig "nginx-16-centos7" created
    service "nginx-16-centos7" created
--> Success
    Run 'oc status' to view your app.
```

The command 'oc new-app' actually does a lot of things for you. The idea behind new-app is to "do the right thing" when given a non-OpenShift artifact, I like to call it 'oc translate'. So in this case we are telling OpenShift, "here is a docker image, do you best to make all the pieces needed to make this run as a user would expect in OpenShift.

If you go back to the Web UI and look in the webpages project you should see something like this (may take a while depending on the time it takes to download the Docker image):



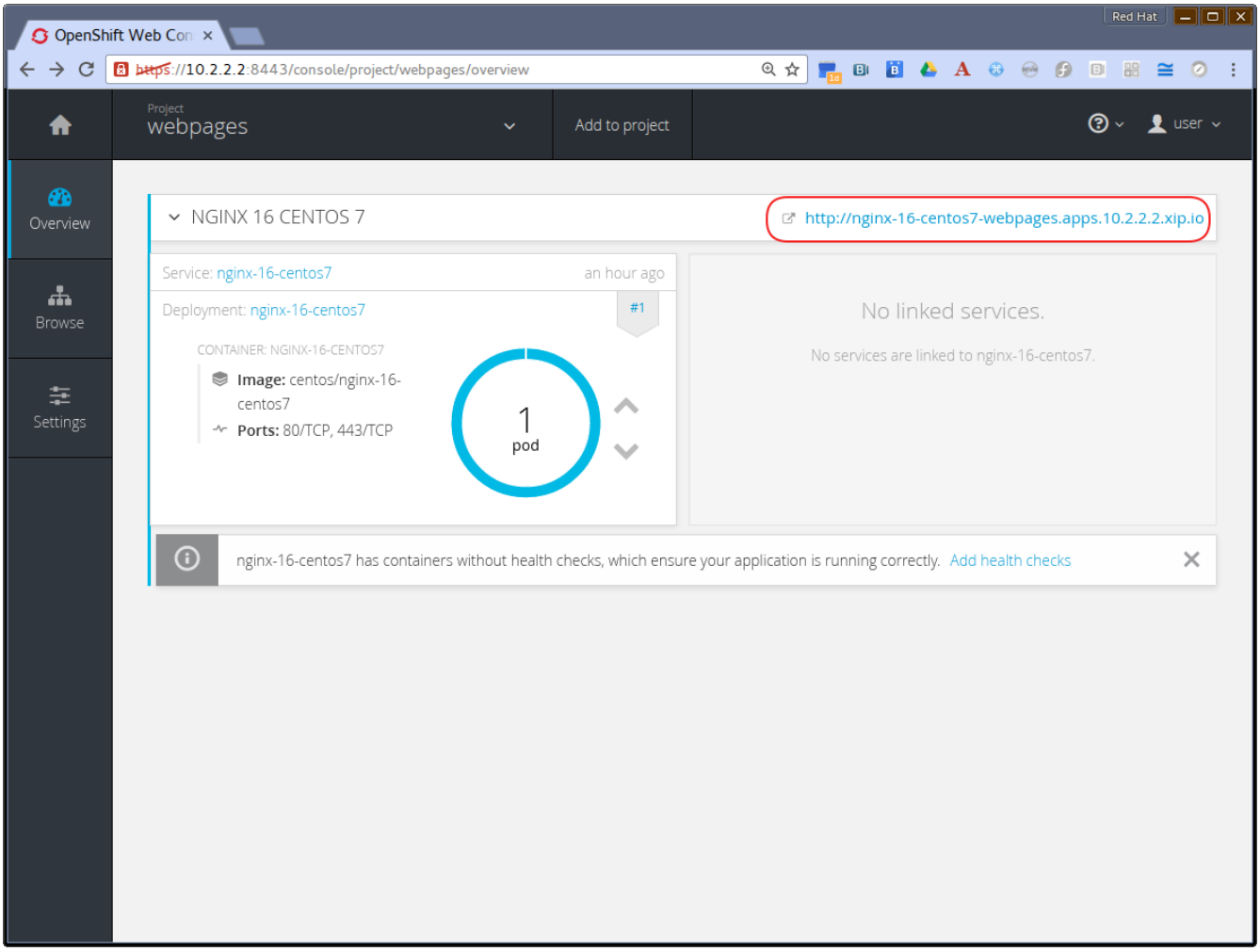
Now is a good time to reflect back on the the architecture diagram I explained earlier and think about the objects created above. Start from the pod and work our way up to *Services* and *Deployment Configurations*

Making a Route to our Service

It's all well and fine that we have this pod running and fronted by a service to do load balancing and proxying, but how do we actually expose this to the outside world? This is where the OpenShift Route can be used to expose our service with a URL.

In the Web UI, there is a link in the top right of NGINX 16 CENTOS7 titled "Create Route". Go ahead and click it and accepts all the defaults.

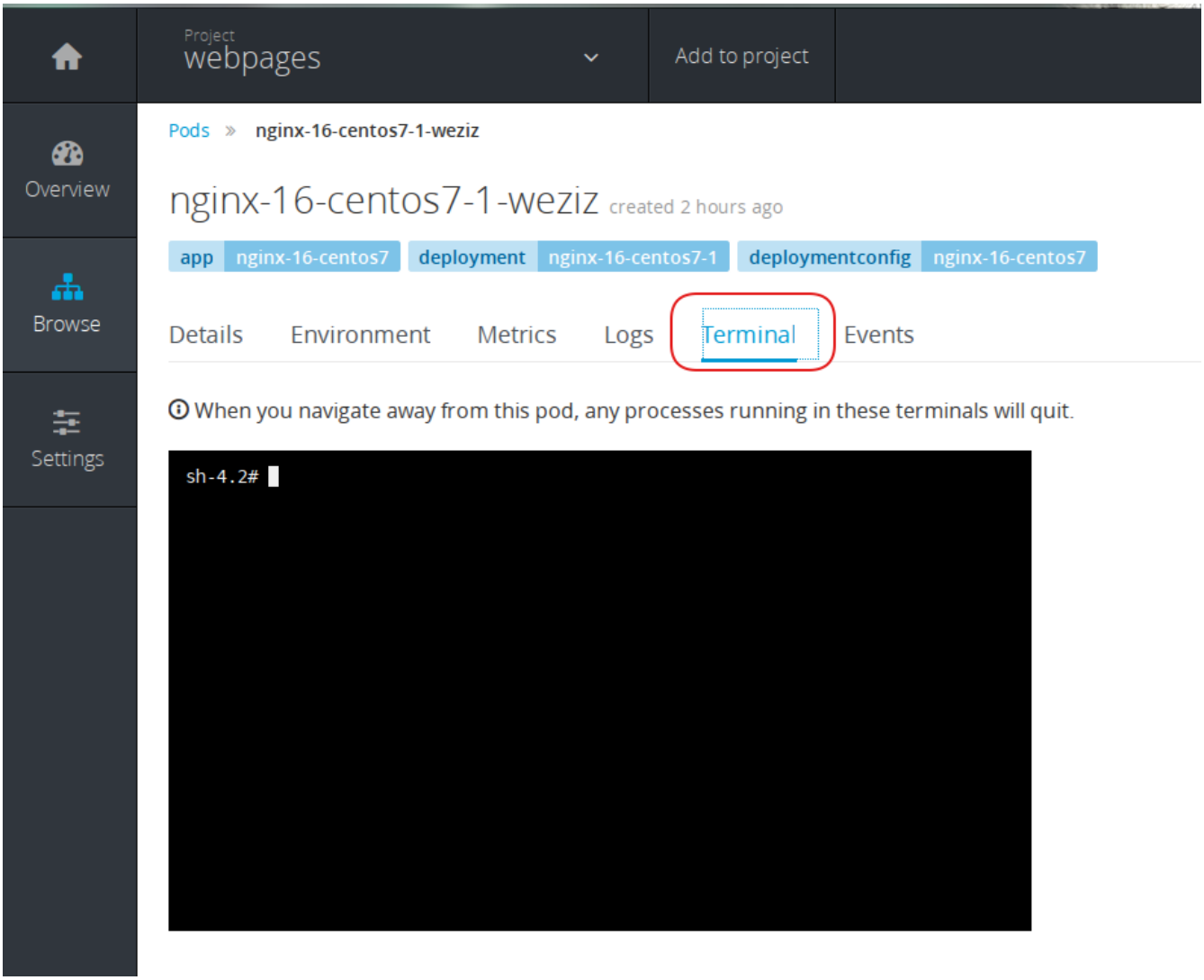
When you get back to the overview screen you will now have a URL up in the top of the box, go ahead and click (but be ready for sadness).



The resulting page gives you a 403 error message because there is no html content in the mapped volume. This docker container specified a mapped volume to hold its HTML content and we never populated it with files. For this exercise we will go in manually to the image and create some content.

Opening a Terminal Into the Pod

In the web UI click on the circle that says 1 pod, then click on the only pod in the list. This will bring you to the detailed description page for the pod. On that page please click on the we Terminal tab.



What you have in front of you is a shell inside the running container. For some reason you have to click twice inside the terminal to get a prompt where you can type. To create a HTML page that will be served up by NGINX just do the following command (you can use tab completion to fill in the elements on the path):

```
# echo  "hello world" > /opt/rh/nginx16/root/usr/share/nginx/html/index.html
```

Now if you go back and reload the URL you will see "hello world" in your browser. But since Docker containers are immutable and the path we mounted for storage was a host path, this page will go away if we deploy a new image or the image is destroyed.

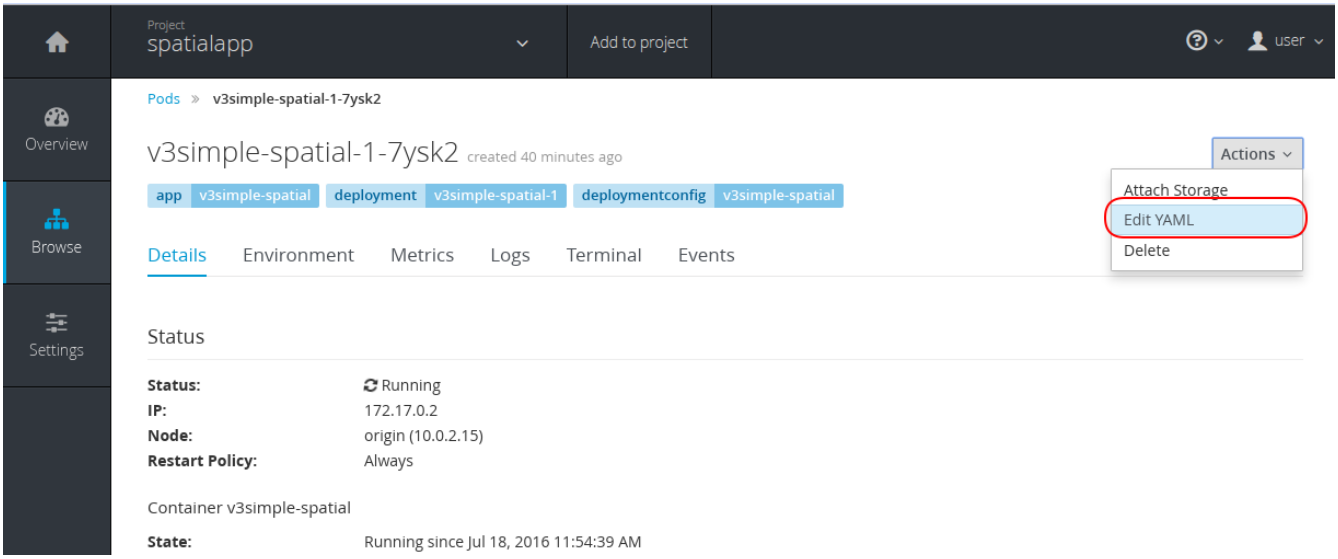
You may have noticed on this page that there was a warning about "No health checks defined". In the next section we will discuss what these warnings mean and how to fix it.

Templates and OpenShift/Kubernetes Declarative Syntax

As I explained before, Kubernetes and OpenShift use a declarative model of the world - you tell the cluster what the truth is and the cluster then goes about making it so. OpenShift let's you declare the truth in a file, either YAML or JSON syntax, whichever you prefer. In this section we are going to VERY briefly look at some of these files and leave with pointers to more information if you want to dive in more.

The OpenShift Master exposes a Swagger API if you want to really dig in and see what is exposed. You can hit this URL https://10.2.2.2:8443/swaggerapi/api/v1

You can also look at any of the YAML for any of the resources in your names space by clicking on the top right drop down and selecting "Edit". This will let you live edit the YAML for any of your resources and apply the changes immediately. Here is an example showing you how to open the YAML for your pod:



We are not going to change any of the YAML right now but you can look at it. You will see a *labels* section, these are the labels for the pods that can be used by selectors on other resources.

The main docs for understanding more about the OpenShift/Kubernetes Objects starts on the OpenShift Documentation but then links out for further explanation on Kubernetes native objects.

Simple Examples

In the OpenShift Origin GitHub repository there is an example called "Hello OpenShift". I will walk through this with you in the class.

Inside this is probably the simplest JSON you can find, which defines a project:

https://github.com/openshift/origin/blob/master/examples/hello-openshift/hello-project.json

And there is also one to define a pod:

https://github.com/openshift/origin/blob/master/examples/hello-openshift/hello-pod.json

After talking through these you should have a fairly basic understanding of how these files are structured.

Full Templates

Templates take this basic structure and allow you the ability to create much more complete and interesting collection of resources, including full applications.

We don't have time in this workshop to really cover all that you can do with the a template, but one of the most interesting things is parameterized input. As a template developer you can make certain variables in your template, say database username and password, to parameters. This way you can do two things:

1. You can allow users to input their own values when they process the template. If you enable this feature then the user is required to input a value to make sure the template actually works.
2. If you want to provide an autogenerated default value for the paramterized field you can specify a generating expression to create a value. For example:

```
{
    "name": "ADMIN_PASSWORD",
    "description": "administrator password",
    "generate": "expression",
    "from": "[a-zA-Z0-9]{8}"
},
```

Back in GitHub there are different template examples put together by the OpenShift team. There are two which are particularly helpful:

1. **sample-app** - this template provides an example of setting up a Ruby application with a MongoDB database. It shows how to parameterize everything and wire things together. It also shows how to do different build types in OpenShift. If we are good on time I will quickly walk us through the S2I build example.
2. **Django-ex** - this a quickstart put together to help you get started with Django very quickly. Inside this project there is a template to get Django and PostgreSQL up and running in an OpenShift cluster. There are more of these templates, such as Node.js and Rails. Just look in the openshift/templates directory to see more example templates.

If you want to learn more about templates, there is documentation on them in the architecture section and in the developer guide.

Import/Export

One of the really useful byproducts of having a declarative API mean import and export becomes very easy. Let's go ahead and export our simple application and then import it into a new namespace.

First we need to export the JSON (my preferred format) for our existing application. This is quite simple:

1. Export our current application as a template text file:

```
oc export is,dc,svc,bc,route --as-template=json -o json > simple_spatial.json
```

We have now created a template that lists all of our project resources, except pods, as a template. We do not export the pods because we actually want our project to recreate the new pods. If we wanted to move the pods over exactly then we would have to put the containers we created into a registry our new project will have access to and then name the containers by name.

2. Create a new project to import our project into

```
oc new-project newproject
```

3. Open simple_spatial.json in your favorite text editor. After you do that do a global search and replace of "spatialapp" with "newproject". And remove the Sha signature from the item that looks like:

```
BEFORE
  - image: 172.30.182.216:5000/spatialapp/simple-
spatial@sha256:b0379d1e921087aa267a9bb5e4602d1ec51948f88dfd83c4d65f24c133654102

AFTER

- image: 172.30.182.216:5000/newproject/simple-spatial
```

4. Make sure you are in the newproject project and then just do the new-app command on simple-spatial.json

```
oc new-app simple_spatial.json
```

5. PROFIT!!!

You can use these steps to move between any OpenShift instances as well - as long as they can see the same git repos and Docker registries.

Now with that business done, let’s add a database to our application!

Adding a Database

Now it's time to get to the part of the workshop you have all been waiting for - getting PostGIS up and running!

Making a project

Let's make a new project for this application:

```
> oc new-project spatialapp
Now using project "spatialapp" on server "https://10.2.2.2:8443"...
```

That's it - you now a project "spatialapp" and all the subsequent commands will affect this project until you swith to another project.

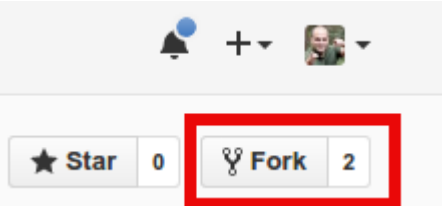
Preparing your GitHub repository

The only reason we are working with the GitHub repository here and not in the code pieces is because we need to get the DDL files to our machine. If we weren't using these DDL files you could skip right to the "Generating Database Pieces" section.

The source code for this project can be found here:

https://github.com/thesteve0/v3simple-spatial

Now **BEFORE** you go and *git clone* it down to your machine, you need to fork it. See that button up towards the top right that says fork on it - click it (you did login with your github account right?)



Now you should be looking at URL that replaces *thesteve0* with your github userid:

https://github.com/<your_userid>/v3simple-spatial

This repository is set up for several different learning paths and so it has several different versions of app.py (the file that runs in a web app for Python). We need to rename the current app.py to 1_app.py. It's very easy to do from the web interface:

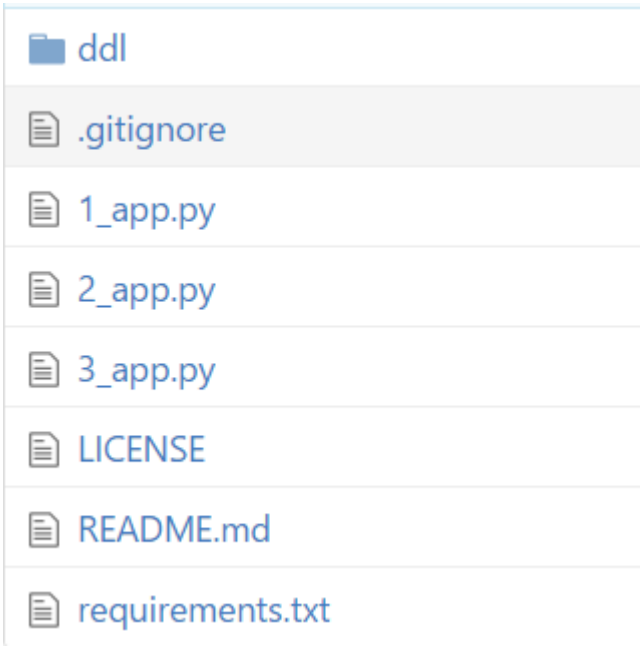
1. click on the app.py file
2. click on the pencil icon on the far right of the page
3. change the name of the file to 1_app.py (a box right above the edit file box)
4. Scroll down to the **Commit changes** area on the bottom of the page and enter a message

5. Hit the Commit Changes button

There, you just changed the name of the file in your repository.

Now go back to the top level of your repository and follow the same process to rename *3_app.py* to *app.py*.

In the end your repository should look this:



Go ahead and clone this repository to your machine.

Generating the Database Pieces

In the terminal, please go to the location on your machine where you cloned the Crunchy Solutions repository. Go to the *\examples\openshift\workshop* directory. We are going to use a bunch of files in this directory but let's go ahead by creating our master instances:

```
> oc new-app -p CCP_IMAGE_TAG=centos7-9.5-1.2.2 -f master.json
> oc new-app -p CCP_IMAGE_TAG=centos7-9.5-1.2.2 -f replicas.json
```

That's it - thanks to the work by Jeff you now have a master-replica PostGIS database setup. You can see it in the web overview for the project now. One of the cool things besides the replica is Jeff added some other containers to the master pod (log collection and metric collection). I will talk through the pieces in class.

Loading the Database

Let's go ahead and load up the database in the master with some DDL. In the v3simple-spatial repository https://github.com/thesteve0/v3simple-spatial.git there is already a SQL file with all our DDL statements. Please clone the repository and then change into the root of the repository.

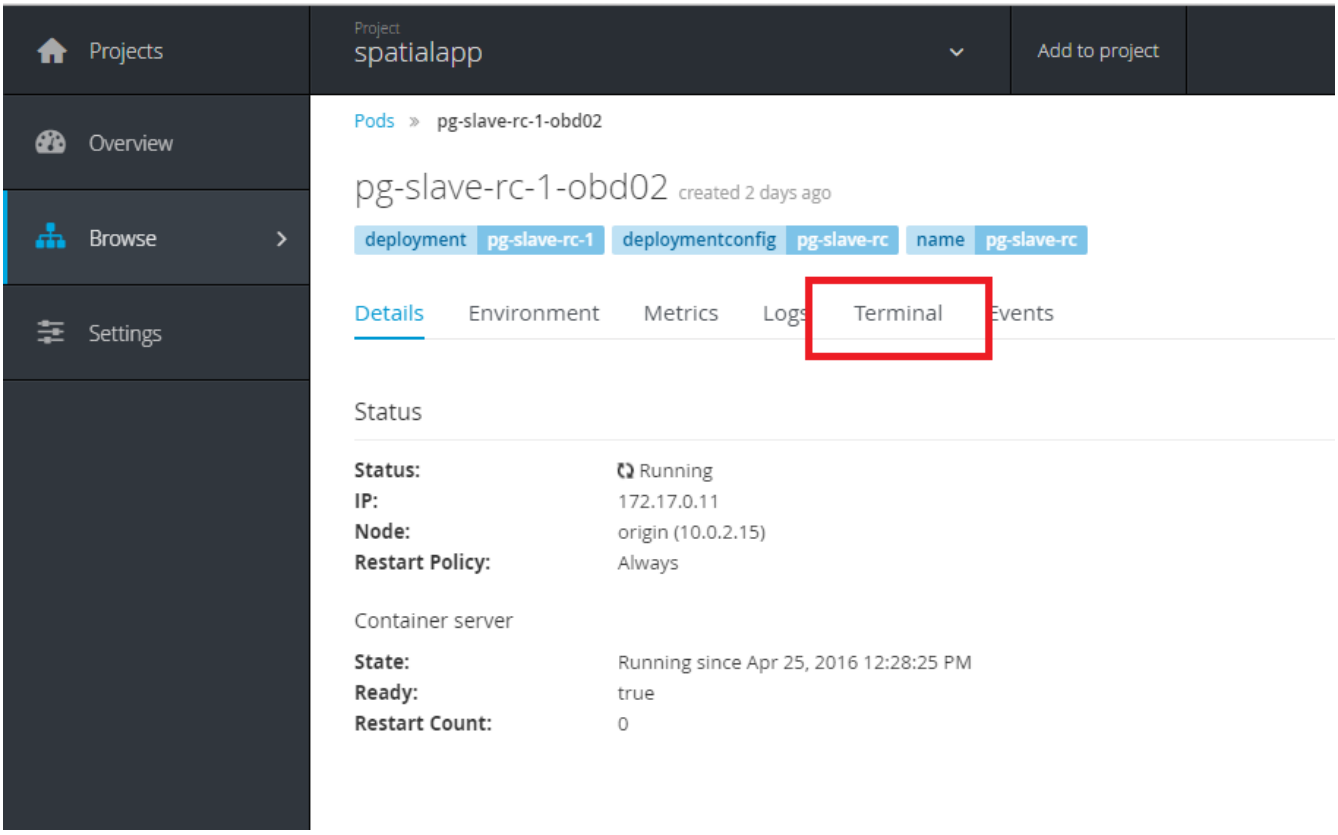
```
# we need to get the master pod - it will have a different name on your machine
> oc get pods
NAME                 READY     STATUS    RESTARTS   AGE
master             3/3       Running   0          13m
replica-dc-1-m46ri   1/1       Running   0          4m

#Look for the container named pg - we will need this below
> oc describe pods pgmaster

 > oc rsync ./ddl master:/tmp/. -c pg
```

You may receive a warning that rsync is not found on your machine but the command line tool will fall back to other methods to try and copy the files over. We have now put the DDL file in */tmp/ddl* in the Master postgis pod.

Let's shell into that same pod and load the data (you can also do this from the terminal in the web browser but then you can use copy and paste)

```
> oc rsh -c pg gmaster
sh-4.2$ psql -l
                              List of databases
   Name    |  Owner   | Encoding  | Collate | Ctype |   Access privileges
-----------+----------+-----------+---------+-------+-----------------------
 postgres  | postgres | SQL_ASCII | C       | C     |
 template0 | postgres | SQL_ASCII | C       | C     | =c/postgres          +
           |          |           |         |       | postgres=CTc/postgres
 template1 | postgres | SQL_ASCII | C       | C     | =c/postgres          +
           |          |           |         |       | postgres=CTc/postgres
 userdb    | postgres | SQL_ASCII | C       | C     | =Tc/postgres         +
           |          |           |         |       | postgres=CTc/postgres+
           |          |           |         |       | testuser=CTc/postgres
(4 rows)

sh-4.2$ psql -h 127.0.0.1 -f /tmp/ddl/parkcoord.sql  userdb
CREATE TABLE
CREATE INDEX
INSERT 0 1
INSERT 0 1
INSERT 0 1
INSERT 0 1
INSERT 0 1...

sh-4.2$ psql -h 127.0.0.1 userdb
userdb=# select count(*) from parkpoints;
 count
--
   547
(1 row)

userdb=# \q
```

You have now loaded your database with a bunch of points for national parks in the US and Canada. The really amazing part comes next. Go ahead and go to the overview for the project. Go ahead and click on the circle for the *pg-slave-rc* which will bring you to a listing with a single pod. Go ahead and click on that link. On the page for the pod, click on the terminal tab:



On the resulting page you need to click twice on the terminal area to give it focus BUT you are now in terminal in the running pod - slick.

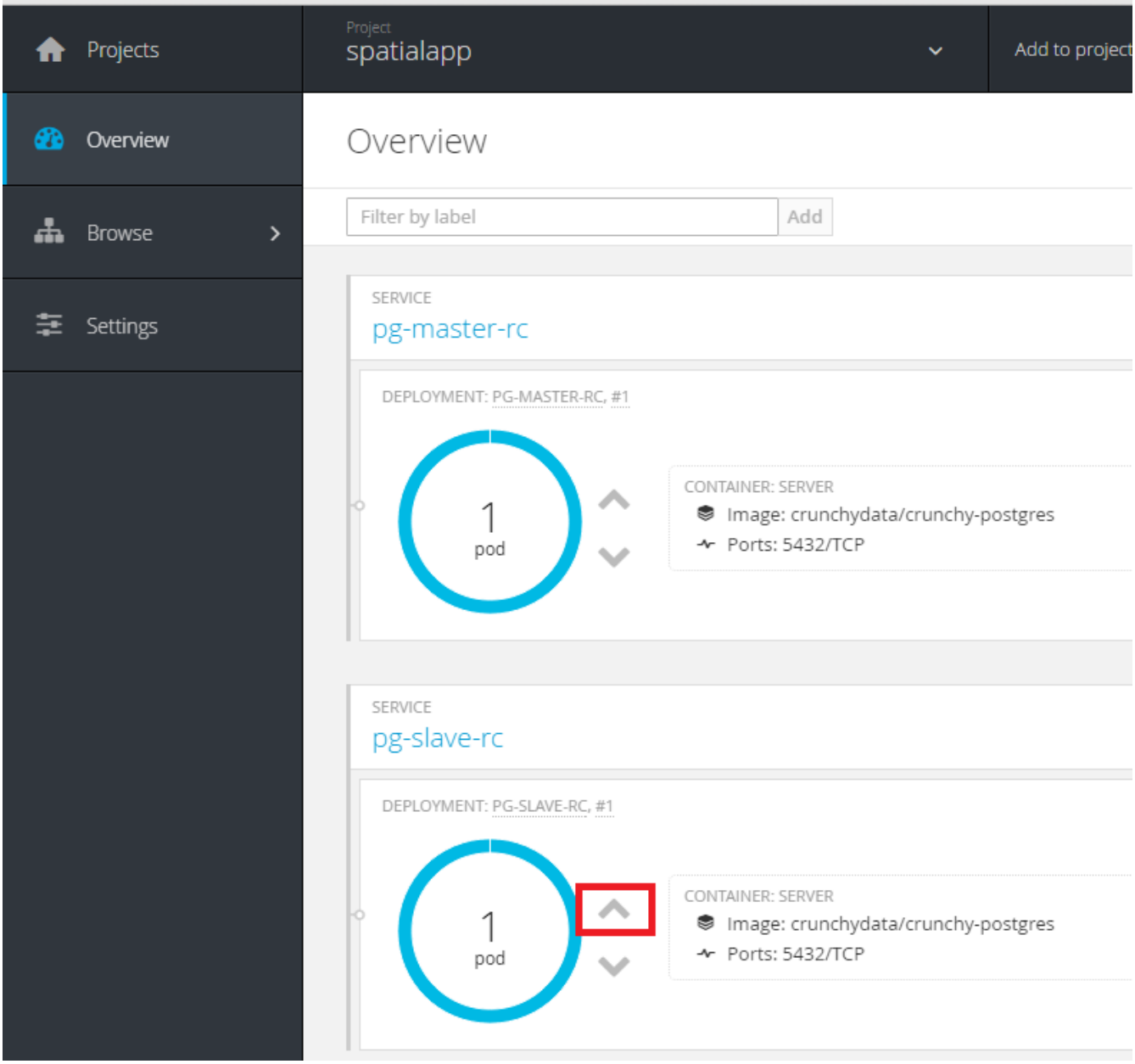
In that terminal go ahead and type the following commands:

```
sh-4.2$ psql -h 127.0.0.1 userdb
psql (9.5.2)
Type "help" for help.

userdb=# select count(*) from parkpoints;
count
---
547
(1 row)
```

Do you REALIZE what just happened. We entered data into the Master DB and it was automatically replicated over to the slave DB and did 0 work to make sure that would happen.

Time for More Replication Magic

Let's take this to even another level. In the web console, go back to the overview again and then click on the little up arrow next to the slave pods:



The number inside the circle will increment to 2 and then the blue circle will fill in the rest of the circle. You now have 2 replicas running. If you click on the circle again you will see the list of the two pods. If you click on the new pod and then do the commands above you will see that it has already been replicated to the new replica.

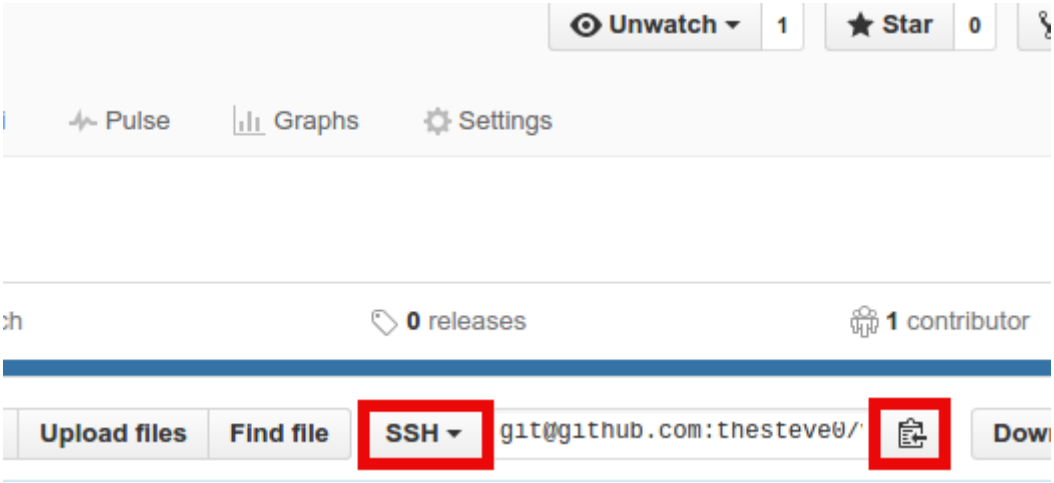
In the next section we will write an application to use the master and the replicas. Make sure you have cloned the v3simple-spatial repo. to the local machine.

Beginning Your Application

Let's go ahead and start our own project using Python. I chose Python for this workshop because I thought it would be easiest for you folks to understand regardless of your coding background. The development pattern you are going to use today will apply to any language you use for development in OpenShift.

Adding Code and Doing a Build

Go back to your fork of *v3simple-spatial* repository on GitHub. In the middle of the page you will see a button that may say **SSH** on it. If it does, please change that to HTTPS and then click the clipboard to copy the URL in the box.



Our code is ready to use in a build on OpenShift. Let's fire off the build and deploy. In your terminal enter the following command:

WARNING	Remember to change the GitHub URL below to point to your fork of the repository

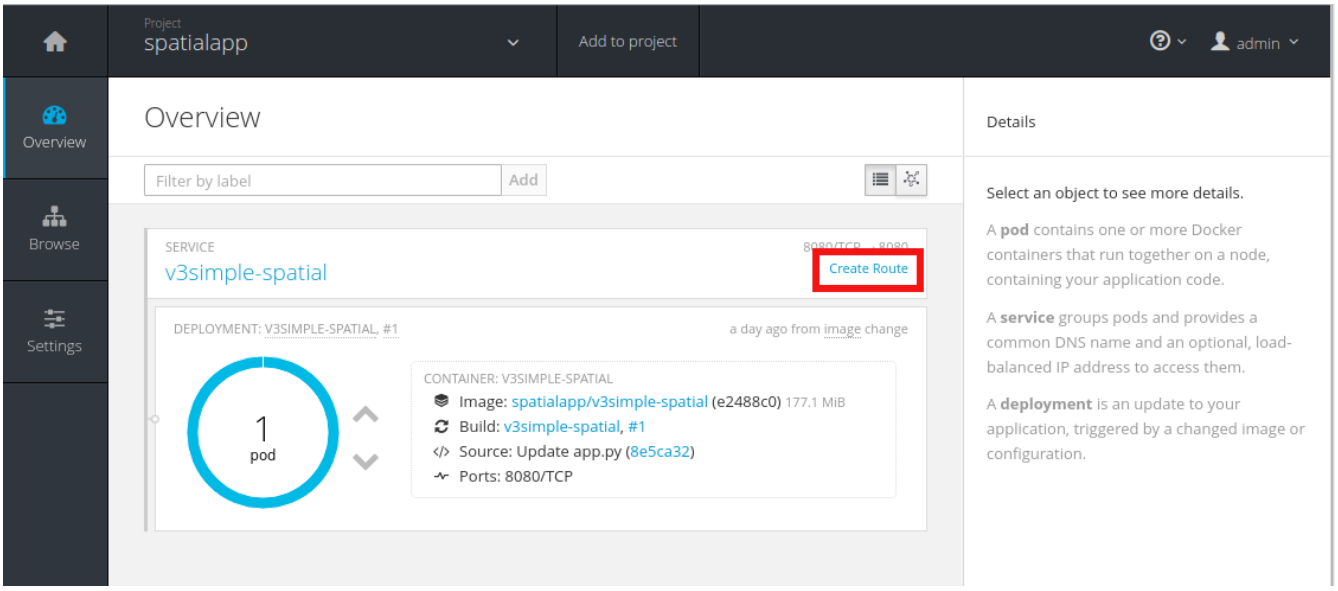
```
> oc new-app python:3.5~https://github.com/thesteve0/v3simple-spatial.git --env
PG_DATABASE=userdb,PG_USER=postgres,PG_PASSWORD=password
--> Found image aa7b3ba (8 days old) in image stream "python" in project "openshift"
under tag "3.5" for "python:3.5"

    Python 3.5
    ----------
    Platform for building and running Python 3.5 applications

    Tags: builder, python, python35, rh-python35

    * A source build using source code from https://github.com/thesteve0/v3simple-
spatial.git will be created
      * The resulting image will be pushed to image stream "v3simple-spatial:latest"
      * Use 'start-build' to trigger a new build
    * This image will be deployed in deployment config "v3simple-spatial"
    * Port 8080/tcp will be load balanced by service "v3simple-spatial"
      * Other containers can access this service through the hostname "v3simple-
spatial"

--> Creating resources with label app=v3simple-spatial ...
    imagestream "v3simple-spatial" created
    buildconfig "v3simple-spatial" created
    deploymentconfig "v3simple-spatial" created
    service "v3simple-spatial" created
--> Success
    Build scheduled, use 'oc logs -f bc/v3simple-spatial' to track its progress.
    Run 'oc status' to view your app.
```

What we just did is told OpenShift - take this Docker Image that knows how to build a standard Python application layout and combine it with this source code and produce a new Docker Image. As part of this process the *new-app* command knows we will need some other OpenShift objects to actually run that resulting image. The command goes ahead and makes those objects as well.

Looking at what we built.

At this point we are going to switch back to the web terminal since it is easier to look at web sites in a browser. Go ahead and go into your browser and go to the projects page. Once you are looking at all your projects go ahead and click on *spatialapp*.

Your screen should look something like this:



You can see that we have the 1 pod running our image that was derived from our source code and our builder image. There is also other metadata in the box for the pod that we can return to later. For now I want you to click on the *Create Route* button that is highlighted in red. This will create a URL where we can see the web page for our pod. By default, nothing is exposed to the outside world and you have to choose to expose it.

Just click *Create* on the next page that comes up - all the defaults are fine for our us. You could have also done this at the command line with

```
> oc expose service v3simple-spatial
```

Now when you come back to the Overview page there is a URL for the service ending in .xip.io, go ahead and click it! You will be greated by the following amazing web content:

hello OpenShift Ninja without DB

You have now all built and deployed containers with a working URL - give yourselves a pat on the back.

Looking at the Database Parts

Reading From the Database

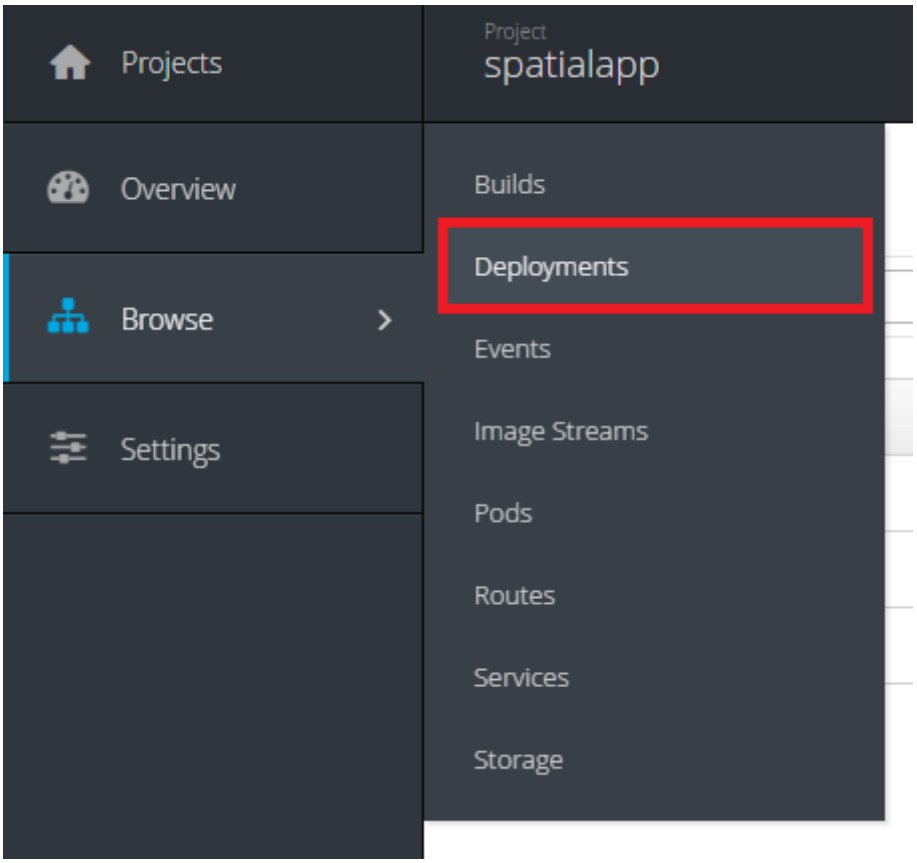
To exercise the database some more we are going to change our python web application to read and write from the PostGIS master and slave services. When using OpenShift the way to handle the connection parameters to the DB are handled through environment variables. Rather than hard coding in IP addresses or username/passwords we set environment variables that actually point to those values.

Some of these are set by the platform "automagically" - these are usually network type variables like hosts to IP and port mappings. The others, that we need to handle manually right now are database name, username, and password. At the end of this section I will explain how we could

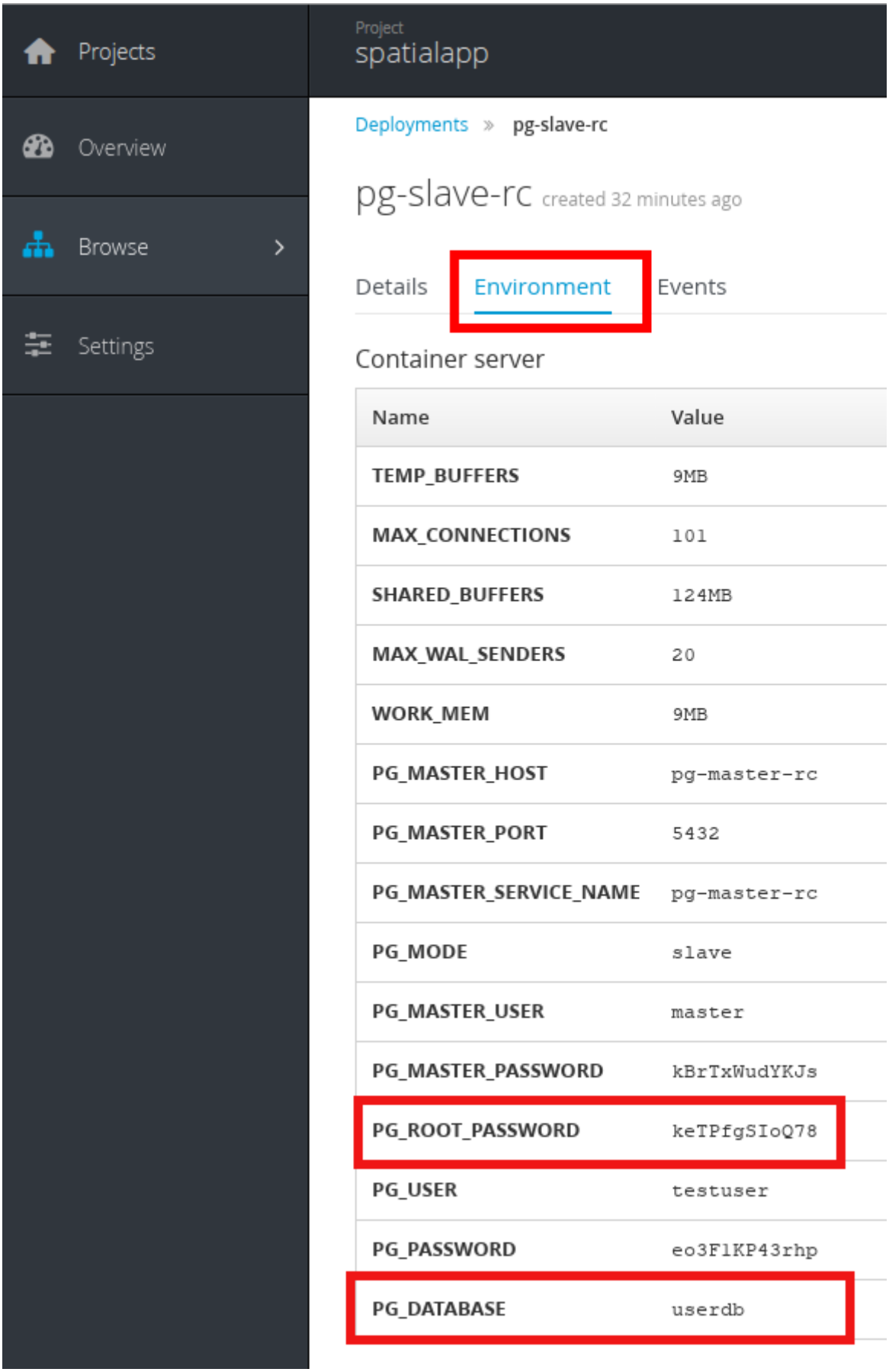
have avoided having to manually do this.

So as I explained above we got the network pieces for free. We added env variables to the deployment configuration (dc) for the python code when used them in the *new-app* command at the beginning. We add it to the dc so it becomes available to all pods controlled by the dc. We will start with the read operations from the DB so we will use the slave pods for those operations.

In your browser go to the Browse → Deployments



From there click on the deployment for the *pg-slave-rc* then click on the environment tab. From there you should see all the environment variables defined on the dc. We are interested in 3 of the variables: PG_USER, PG_PASSWORD, and PG_DATABASE. This is where we got the information to put in the *new-app* command.



We also added some Python packages to our requirements.txt so they could get pulled in at build time. * Added the library to requirements.txt

```
psycopg2==2.6.1
```

WARNING	This code is in NO WAY production type code. This code is trying to be as simple as possible so you learn the basic patterns. In a real app you would not load a DB connection on every request, you would check for exceptions, and you would have more optimized queries.

Writing to Master

The great part of what we have set up is we can isolate our writes to master and our reads from the replica - which is why people usually set up replicas in the first place. We have already set all the environment variables we needed but in a more production ready app you would probably use two different Postgresql accounts, one for reading and one for writing, which would require new environment variables.

I added code to randomly generate a name and the coords for a new point whenever you HTTP POST to the /db URL. Again this is really hacky code for a workshop - not production code. I will talk you through the code in class.

Finally, to hit this URL you can either install a plugin for your browser or you can use cURL. By default browsers do an HTTP GET but we need a POST. There are plenty of plugins for Chrome and Firefox to help you do a HTTP Post - most of them have the word REST in them. Here is cURL syntax that will exercise the end point:

```
# -d says to do a POST and we leave the payload blank
curl 'http://v3simple-spatial-spatialapp.apps.10.2.2.2.xip.io/db' -d ''

# if you want to look at the output in a nicer format you can save it to HTML
curl 'http://v3simple-spatial-spatialapp.apps.10.2.2.2.xip.io/db' -d ''  > index.html
```

If you use a browser plugin the URL stays the same and you just tell the plugin to use a POST.

The response will be the last 10 entries in the DB - which will include your latest entry. You can go ahead and POST several items and watch the new entries show up.

That's all we are going to do with the code for now. The rest of the workshop will be focusing on the advanced features you can get when you combine container, Kubernetes, OpenShift, and smart engineering.

Using pgadmin4 - A Web Based Admin Console

Many of you have probably used the older PGAdmin 3, which provided a desktop interface to your PostgreSQL database. We could still do that here by using *oc port-forward* and port forwarding from the pg container in the master pod. But instead we are going to enable a pgadmin4 web application allows to view a database and execute queries in a web user interface. Again we have a template ot make this simple and easy for you to set up through containers and templates.

Provisioning the container

To put the container into your application is as simple as (again in the workshop directory):

```
> oc new-app .\pgadmin4.json -p CCP_IMAGE_TAG=centos7-9.5-1.2.2
```

After this run you should not see a new service with a URL for pgadmin4

mage::images/postgresql/pg_admin_overview.png[]

Go ahead and click the URL and you will be presented with the login screen

The default admininstrative user ID is **admin@admin.org**. The password is **password**.

Creating a Server

In the left-side tree, right-click then select the Create→Server button from the menu.

Enter a name for the database server you wish to connect to such as **pgmaster**. On the Connection tab, enter the service name **pgmaster** within the Host Name/Address text field, and enter **postgres** in the User Name field, and **password** in the Password field, then select the Save button.

You should now see the **pgmaster** value within the tree on the left side and a Dashboard showing various metrics collected by pgadmin4.

Expand the tree under the server name and click on the **postgres** database. Next, click on the Tools menu item and select the Query Tool button to expose the SQL query tool screen. From here, you can enter SQL commands and execute them on the server. The button with the lighting bolt on it will execute the SQL command.

Have fun and play around for a little bit.

Postgresql Metrics

Sometimes when you are running your database you want to collect and visualize metrics on the instance. Now we are going to set up infrastructure to collect and visualize the data. We already added a container to the master pod called pgcollect. The pgcollect container collects 30+ metrics and sends them to the Prometheus time series data store. From there we hook up the grafana visualization tools so we can look at the metrics.

The Components and Installing Them

We are about to add the following pieces to our application

- prometheus (pod and service)
- prometheus push gateway (pod and service)
- grafana (pod, service, and route)

Again, there is a template to add all the pieces we need:

```
> oc new-app .\metrics.json -p CCP_IMAGE_TAG=centos7-9.5-1.2.2
```

You can access grafana web application by browsing the following URL:

http://grafana-spatialapp.apps.10.2.2.2.xip.io/

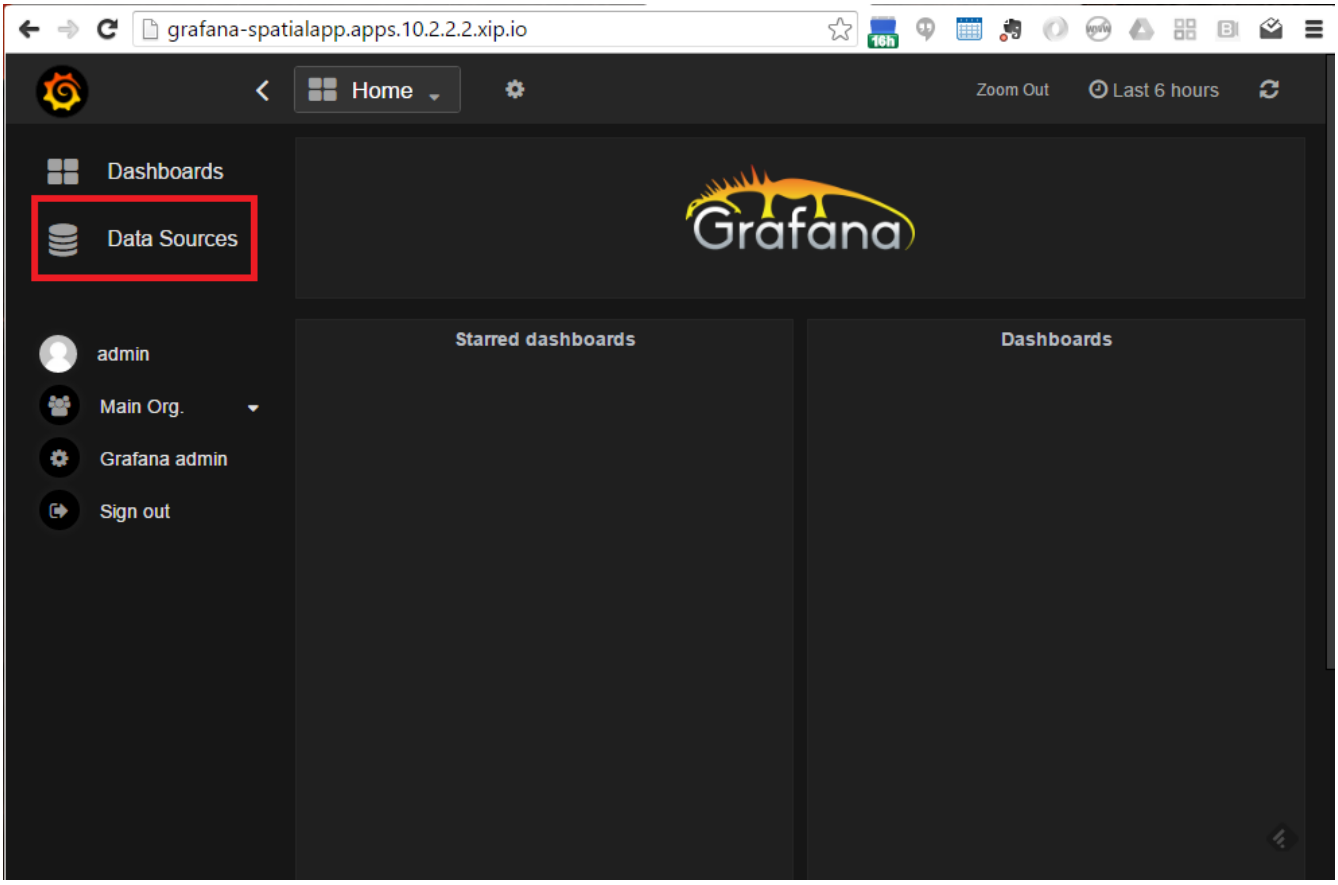
Which is also available as a route to click on.

The default admininstrative user ID is **admin**. The password is **admin**.

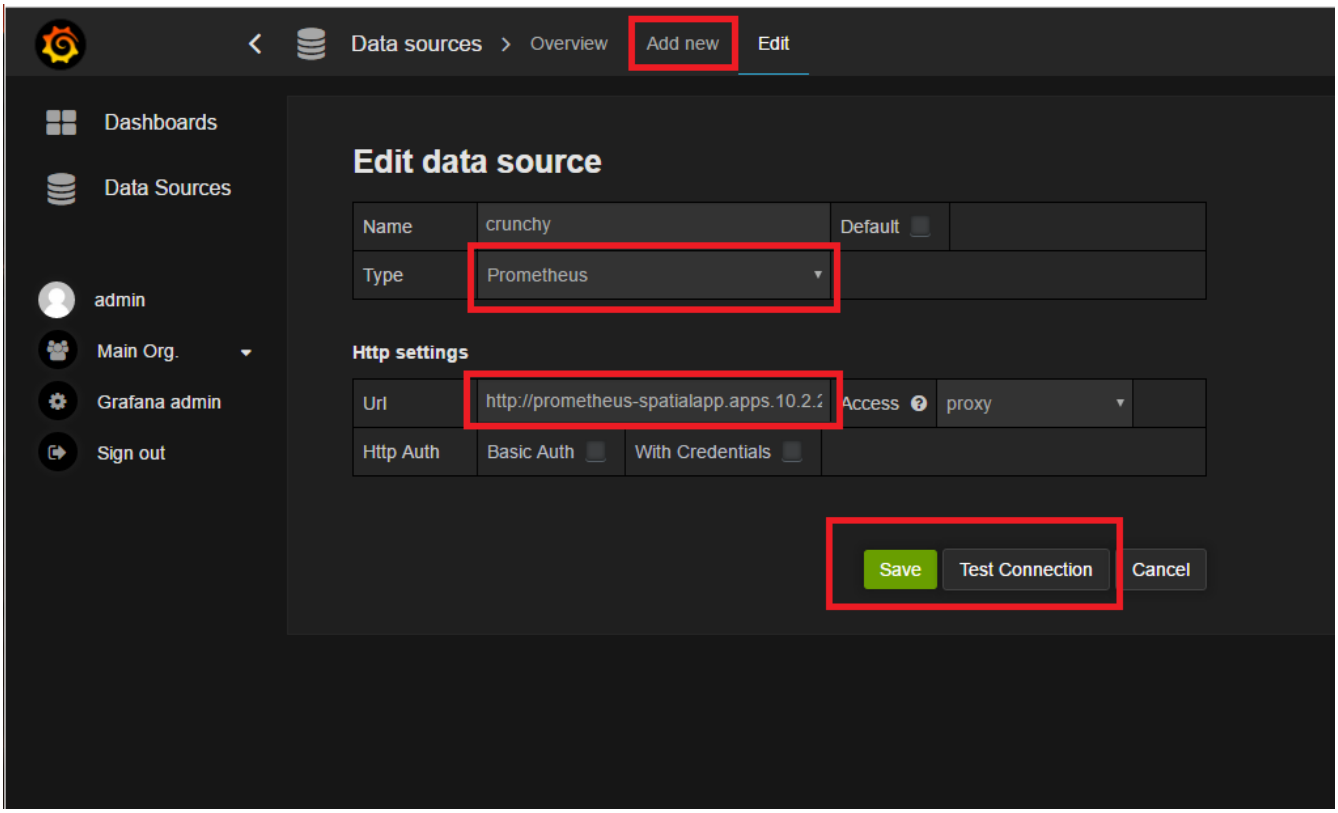
Creating a Datasource

In the upper left-side of the application, click on the dropdown and select the Data Sources button to add a new data source.

Click on the Add Data Source button on the next screen.

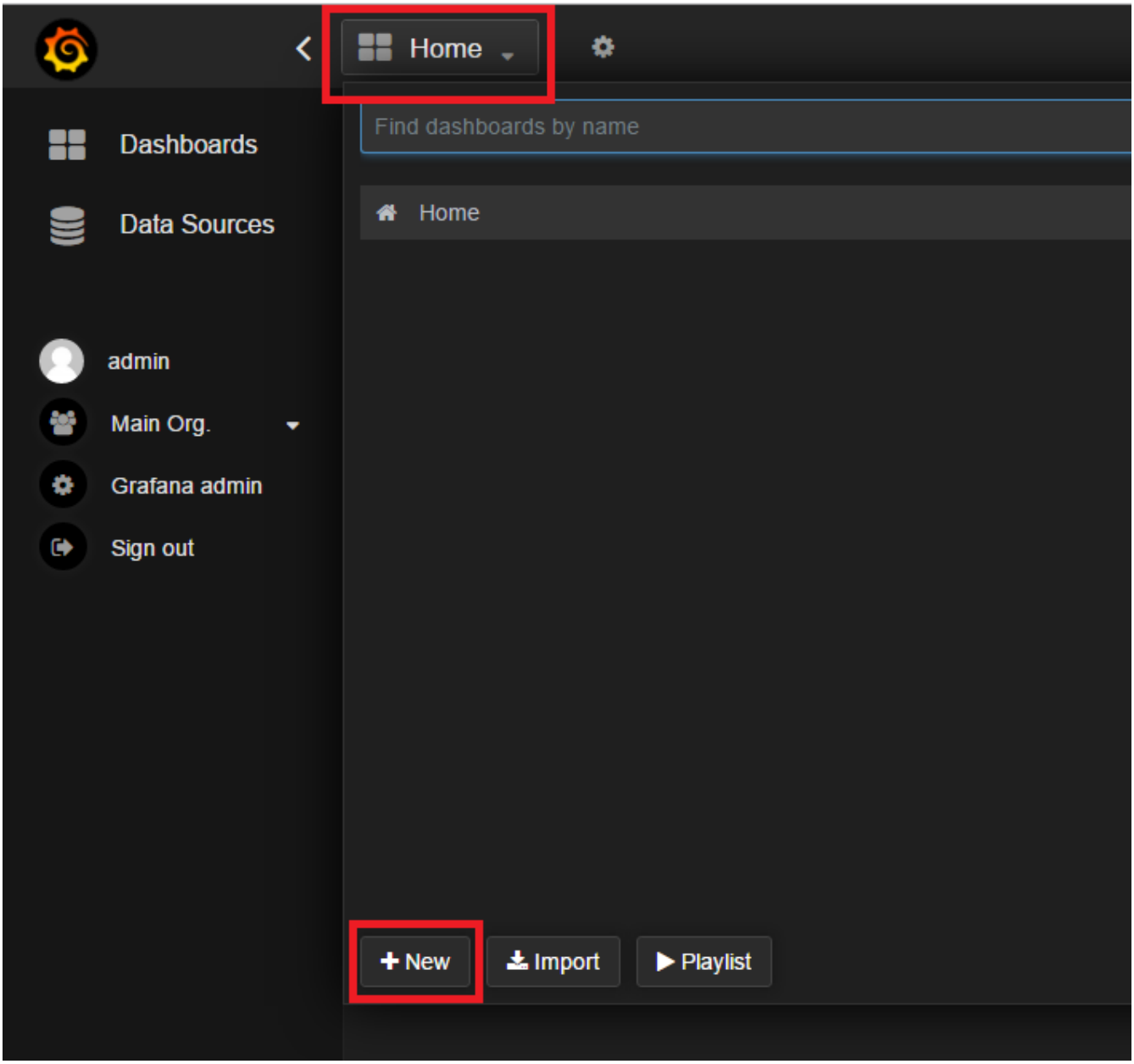


Select **Prometheus** for the data source Type, enter a name of **crunchy** for the Name field, enter http://prometheus-spatialapp.apps.10.2.2.2.xip.io for the URL field and click the Add button. Click the "test connection" button and you should get a green box to show up saying success. Then you can click save. If not then please call one of us over to help troubleshoot.

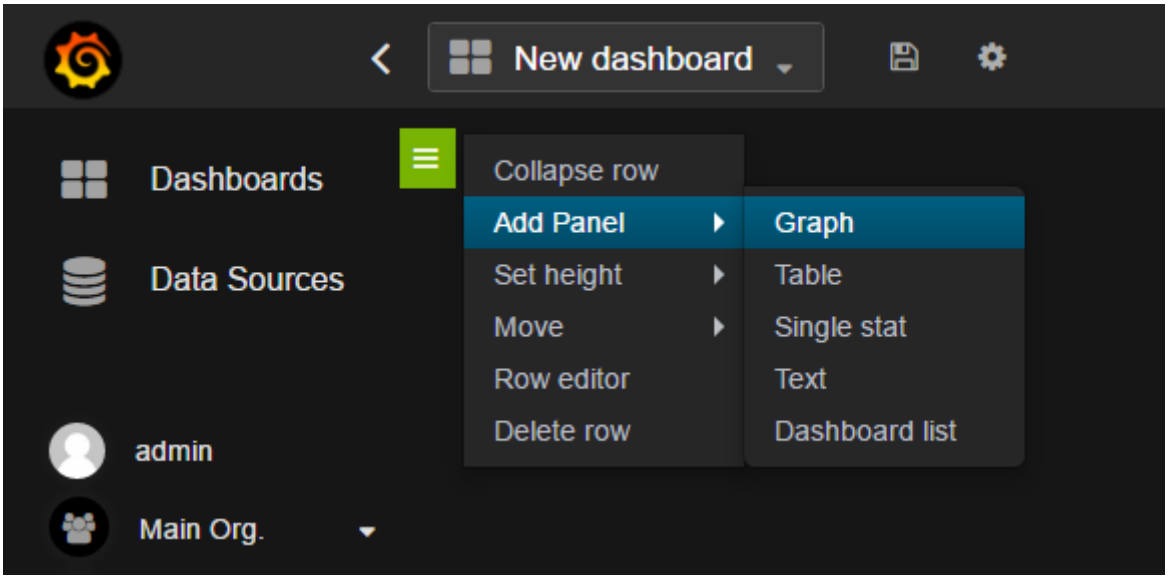


In the upper left-side of the application, click on the dropdown and select the Dashboard→New

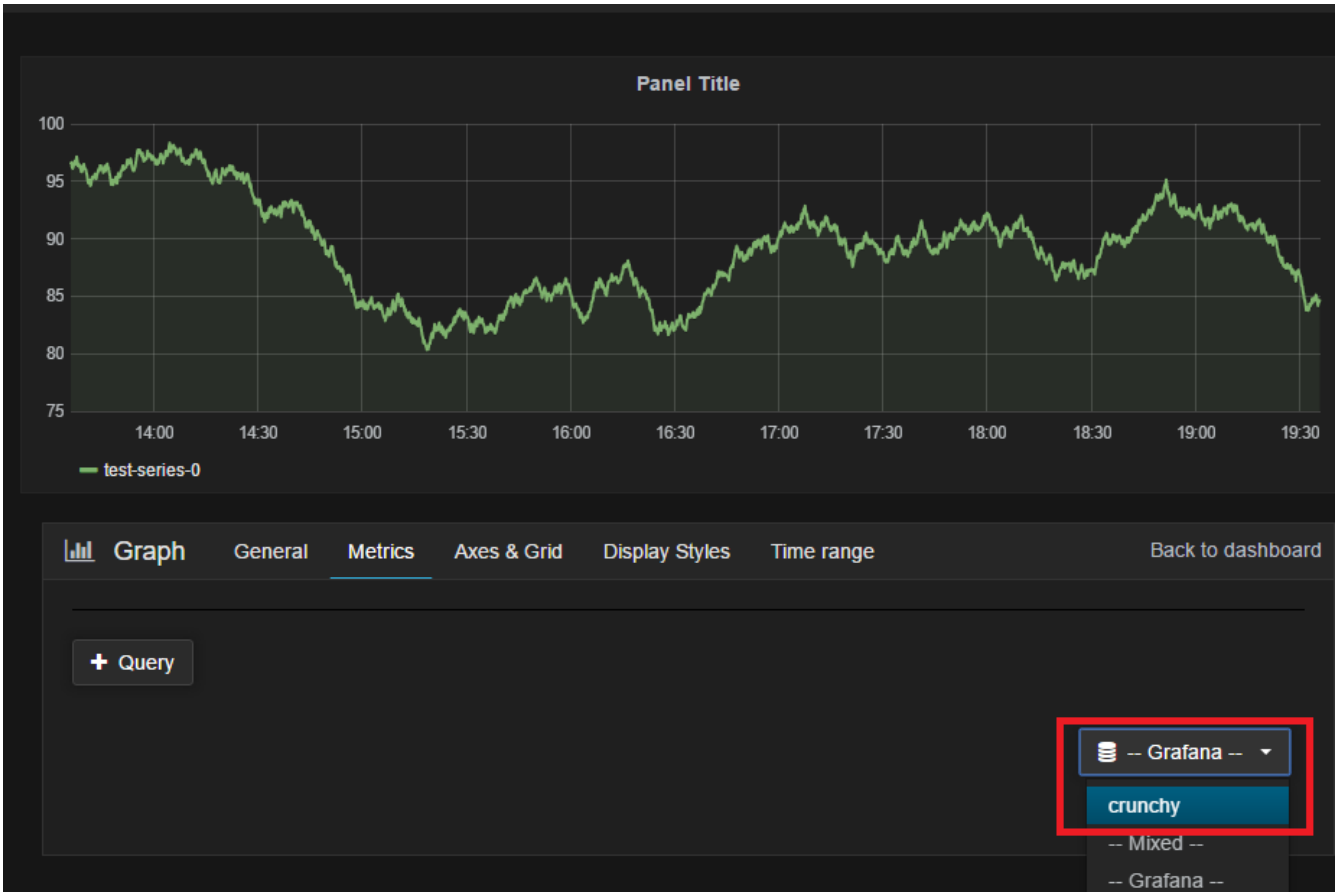
button to add a new dashboard.



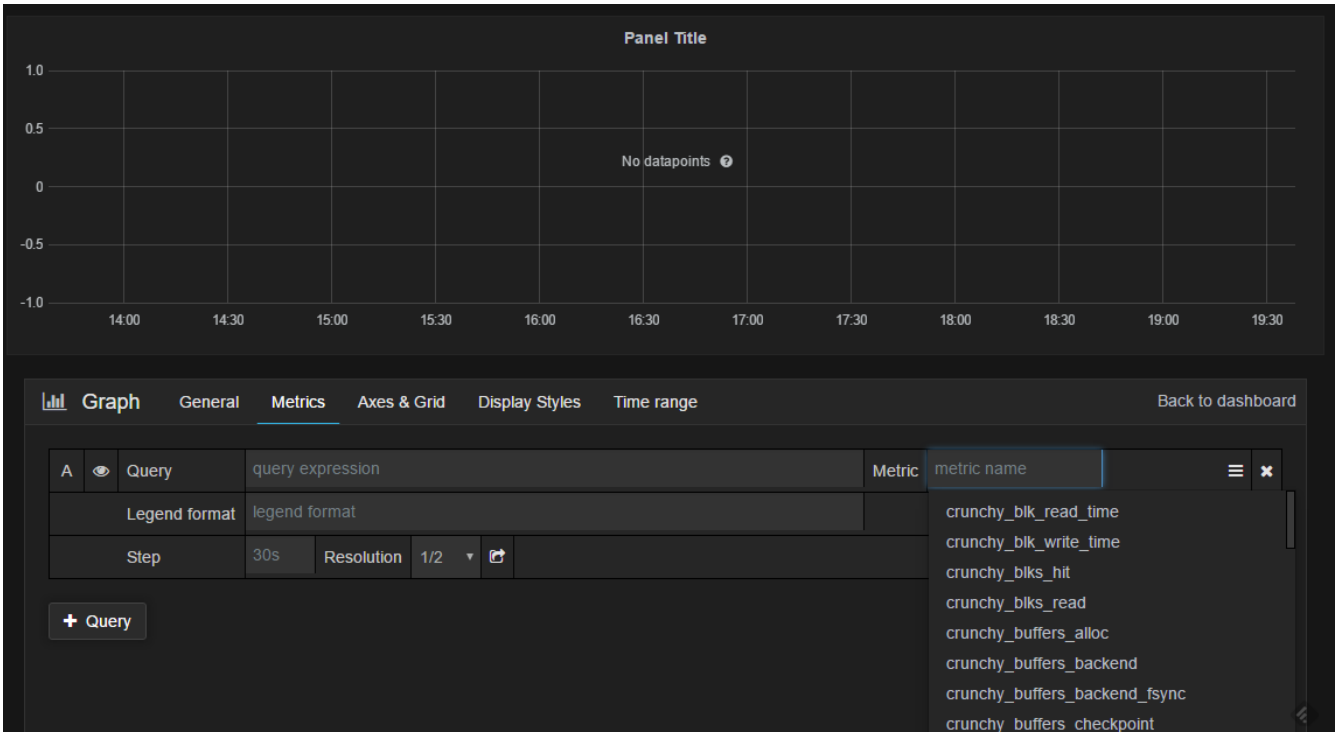
On the next screen, click on the small green tab button in the upper left of the screen, select Add Panel→Graph to add a graph.



On the graph, select the **crunchy** data source on the bottom right of the screen.



Finally click on the Metric Lookup field to see the available metrics being collected. Select a metric and it should display on the graph.



Don't expect to see any data right away. You need to go exercise the database to get metrics to show up. You can do this by doing a bunch of work using our web application. You could also load up the DDL file a couple of times.

The master container has pgbench in the image so we can use that as well.

```
# instead of this command you can use the terminal in web console for the master pod
oc exec -it master bash -c pg

export PGHOST=/tmp;psql -c 'create database pgbench'
    /usr/pgsql-9.5/bin/pgbench --host=master --username=postgres --scale=5
--initialize pgbench
    /usr/pgsql-9.5/bin/pgbench --host=master --username=postgres --time=10 --client=15
pgbench
```

pgbadger

The pgbadger container provides a HTML/Javascript application which presents PostgreSQL log file data. The crunchy-pgbadger container wraps the pgbadger utility in a small HTTP service that can be invoked using curl or your browser. As opposed to Grafana and Prometheus, which provide statistics that update as the metrics are collected, PGBadger goes through the log files and provides statistics on how things have been running.

Components

The pod to run pgbadger and the lightweight web server was already spun up when we processed master.json. So there is nothing to "spin up" but we do need to make a route to the web server. We have already created a JSON template to make the route. If you look at the JSON you will also see we refer to the port by name. This is possible because we actually name the service port when we made the master.json file. This can be useful if you want to allow arbitrary ports to be assigned at runtime without affecting the ability to bind to them.

```
oc new-app -f .\pgbadger-route.json
```

You can access the pgbadger web application by browsing the following URL:

http://pgmaster-testworkshop.apps.10.2.2.2.xip.io/api/badgergenerate

or just click on on the link in the OpenShift web console.

It’s that simple!

crunchy-watch

The crunchy-watch container does a health check on a PostgreSQL master container and will trigger a failover onto a replica container if the master can not be reached. As part of the failover sequence, the replica chosen as the new master will have its labels updated to become the new master.

Because images are immutable, we can not restart the master pod because it will not have any of the data or accounts created since it started running. To prevent the master from just restarting we created a pod with no DeploymentConfig so there is nothing to insure that a new pod will be spun back up. Instead we had to write an external pod that could watch the status of the master and then use the Kubernetes API to properly promote one of the replicas to the new master. As we have seen before, labels in addition to the pod itself help Kubernetes, which is also why we need to update all the labels to make the transition complete.

Starting the container

There are two steps to getting things started. Because the watch container needs to call the Kubernetes API we have a different deployment flow:

1. Create a service account
2. Grant privileges to the account
3. Bring in the template to create the Watch pod

Let's go ahead and get it going:

```
> oc create -f ./watch-sa.json
serviceaccount "pg-watcher" created

# login as an admin
> oc login
Authentication required for https://10.2.2.2:8443 (openshift)
Username: admin
Password:
Login successful.

# adjust the policies
oc policy add-role-to-group edit system:serviceaccounts -n spatialapp
# login as an user again
> oc login
Authentication required for https://10.2.2.2:8443 (openshift)
Username: user
Password:
Login successful.

> oc new-app .\watch.json -p CCP_IMAGE_TAG=centos7-9.5-1.2.2
```

Accessing the Watch Container

To keep tabs on the watch container go ahead and bring up the pod in the web console and then click on the log tab. You can see the log output showing the watch utility checking to make sure there is a pod with the label master.

Testing

Scale up the PostgreSQL replicas to 3 pods to make this fun and exciting.

You can delete the **pgmaster** pod to cause a failover to occur.

```
> oc delete pod master
```

After the failover, a new replica will be created by Openshift and the replica chosen as the master have its labels updated.

Any applications using the master might see an error as the failover proceeds but normal querying should pick back up quickly.

Wrap up

And with that we have finished exploring all the functionality for today. We hope you have seen how easy it can be to enable advanced functionality for Postgresql. Between containers for immutable binaries with configuration, Kubernetes for orchestration, and OpenShift for user experience both for admins and developers.

Please feel free to keep using this VM to explore the technology. If you want the latest VM, without all the Docker images cached, you can always install the standard Vagrant image using the following commands

```
vagrant init openshift/origin-all-in-one
vagrant up
```

We usually release a new version within a week of a new release OpenShift Origin

Thanks for participating today and please send feedback (for the class and anything else for the VM) to thesteve0@redhat.com

Appendix: Here are some basic commands I found useful

How to build the documentation

```
asciidoctor -S unsafe ~/git/workshops/index.asciidoc
```

How to delete the application pieces but not the DB pieces

```
oc delete is,dc,svc,bc v3simple-spatial
```

How to do a web request with cURL

```
curl 'curl 'http://v3simple-spatial-spatialapp.apps.10.2.2.2.xip.io/db' -d ''
' -d ''
```

How to insert a value into the table

```
Insert into parkpoints (name, the_geom) VALUES ('ASteve', ST_GeomFromText('POINT(-
85.7302 37.5332)', 4326));
```