Microsoft Cloud Workshop

Cloud-native applications - Developer edition
Hands-on lab step-by-step
August 2020

Contents

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Abstract and learning objectives

This hands-on lab is designed to guide you through the process of building and deploying Docker images to the Kubernetes platform hosted on Azure Kubernetes Services (AKS), in addition to learning how to work with dynamic service discovery, service scale-out, and high-availability.

At the end of this lab you will be better able to build and deploy containerized applications to Azure Kubernetes Service and perform common DevOps procedures.

Overview

Fabrikam Medical Conferences (FabMedical) provides conference website services tailored to the medical community. They are refactoring their application code, based on node.js, so that it can run as a Docker application, and want to implement a POC that will help them get familiar with the development process, lifecycle of deployment, and critical aspects of the hosting environment. They will be deploying their applications to Azure Kubernetes Service and want to learn how to deploy containers in a dynamically load-balanced manner, discover containers, and scale them on demand.

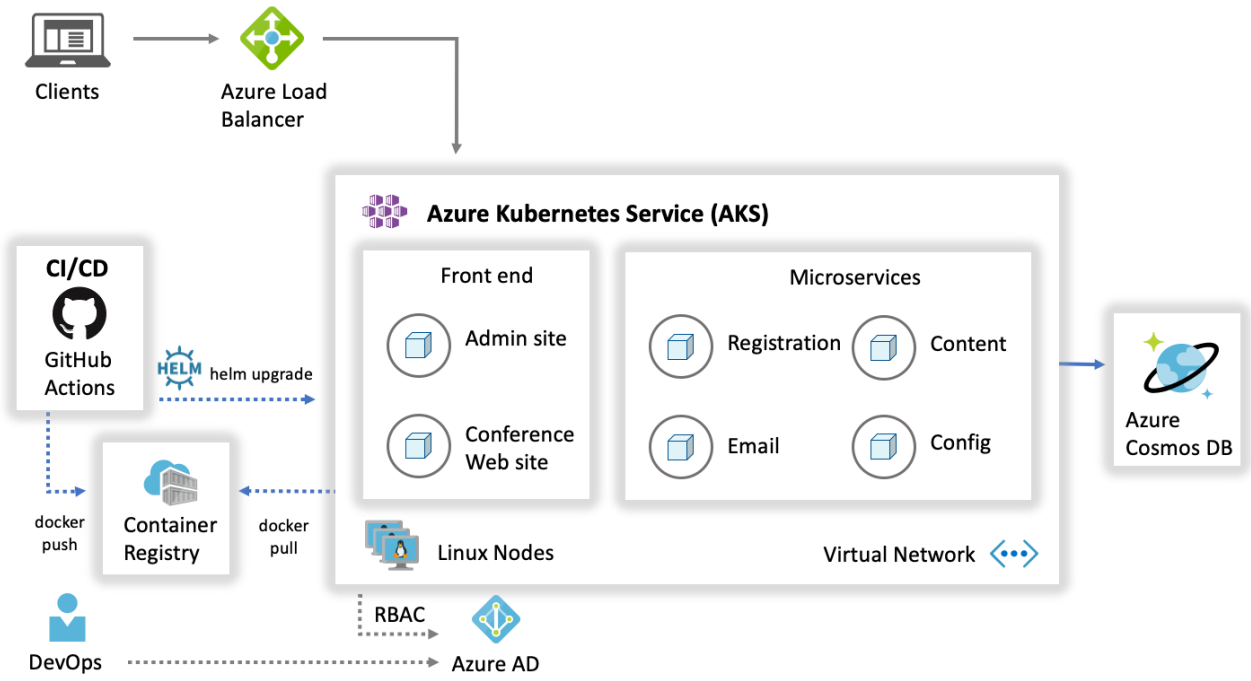
In this hands-on lab, you will assist with completing this POC with a subset of the application codebase. You will create a build agent based on Linux, and an Azure Kubernetes Service cluster for running deployed applications. You will be helping them to complete the Docker setup for their application, test locally, push to an image repository, deploy to the cluster, and test load-balancing and scale.

> **Important**: Most Azure resources require unique names. Throughout these steps, you will see the word "SUFFIX" as part of resource names. You should replace this with a unique handle (like your Microsoft Account email prefix) to ensure unique names for resources.

Solution architecture

Below is a diagram of the solution architecture you will build in this lab. Please study this carefully, so you understand the whole of the solution as you are working on the various components.

The solution will use Azure Kubernetes Service (AKS), which means that the container cluster topology is provisioned according to the number of requested nodes. The proposed containers deployed to the cluster are illustrated below with Cosmos DB as a managed service:



Each tenant will have the following containers:

- **Conference Web site**: The SPA application that will use configuration settings to handle custom styles for the tenant.
- **Admin Web site**: The SPA application that conference owners use to manage conference configuration details, manage attendee registrations, manage campaigns, and communicate with attendees.
- **Registration service**: The API that handles all registration activities creating new conference registrations with the appropriate package selections and associated cost.
- **Email service**: The API that handles email notifications to conference attendees during registration, or when the conference owners choose to engage the attendees through their admin site.
- **Config service**: The API that handles conference configuration settings such as dates, locations, pricing tables, early-bird specials, countdowns, and related.
- **Content service**: The API that handles content for the conference such as speakers, sessions, workshops, and sponsors.

Requirements

1. Microsoft Azure subscription must be pay-as-you-go or MSDN.
    - Trial subscriptions will *not* work.
    - To complete this lab, ensure your account has the following roles:
        - The Owner
          built-in role for the Azure Subscription you will use.

        - Is a Member user in the Azure AD tenant you will use. (Guest users will not have the necessary permissions).

    > **Note** If you do not meet these requirements, you may have to ask another member user with subscription owner rights to login to the portal and execute the create service principal step ahead of time.

    - You must have enough cores available in your subscription to create the build agent and Azure Kubernetes Service cluster in Before the Hands-on Lab. You will need eight cores if following the exact instructions in the lab, or more if you choose additional cluster nodes or larger VM sizes. If you execute the steps required before the lab, you will be able to see if you need to request more cores in your sub.

2. Local machine or a virtual machine configured with:

    - A browser, preferably Chrome for consistency with the lab implementation tests.

3. You will install other tools throughout the exercises.

> **Very important**: You should be typing all the commands as they appear in the guide. Do not try to copy and paste to your command windows or other documents when instructed to enter the information shown in this document, except where explicitly stated in this document. There can be issues with Copy and Paste that result in errors, execution of instructions, or creation of file content.

Exercise 1: Create and run a Docker application

Duration: 40 minutes

In this exercise, you will take the starter files and run the node.js application as a Docker application. You will create a Dockerfile, build Docker images, and run containers to execute the application.

Task 1: Test the application

The purpose of this task is to make sure you can run the application successfully before applying changes to run it as a Docker application.

1. From Azure Cloud Shell, connect to your build agent if you are not already connected. (If you need to reconnect, please review the instructions in the "Before the HOL" document.)

2. Type the following command to create a Docker network named `fabmedical`:

```
docker network create fabmedical
```

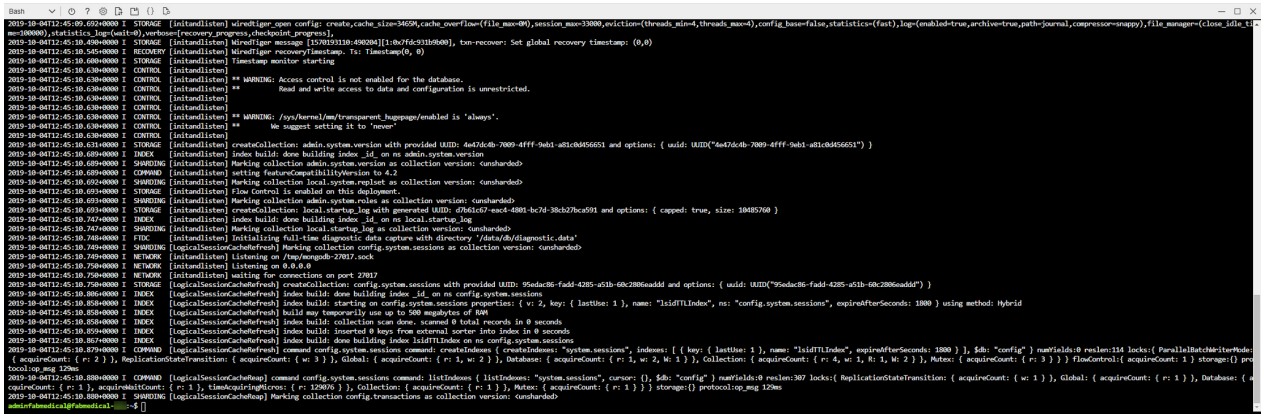
3. Run an instance of mongodb to use for local testing.

```
docker container run --name mongo --net fabmedical -p 27017:27017 -d mongo
```

> **Note**: With the existing source code written for MongoDB, it can be pointed towards the Azure Cosmos DB MongoDB API endpoint. The Azure Cosmos DB Emulator could be used for local development on Windows, however, the Cosmos DB emulator does not support Linux. As a result, when using Linux for development, MongoDB is still needed for local development environments; with Azure Cosmos DB used for data storage in the cloud. This allows existing source code written for MongoDB storage to be easily migrated to using Azure Cosmos DB backend.

4. Confirm that the mongo container is running and ready.

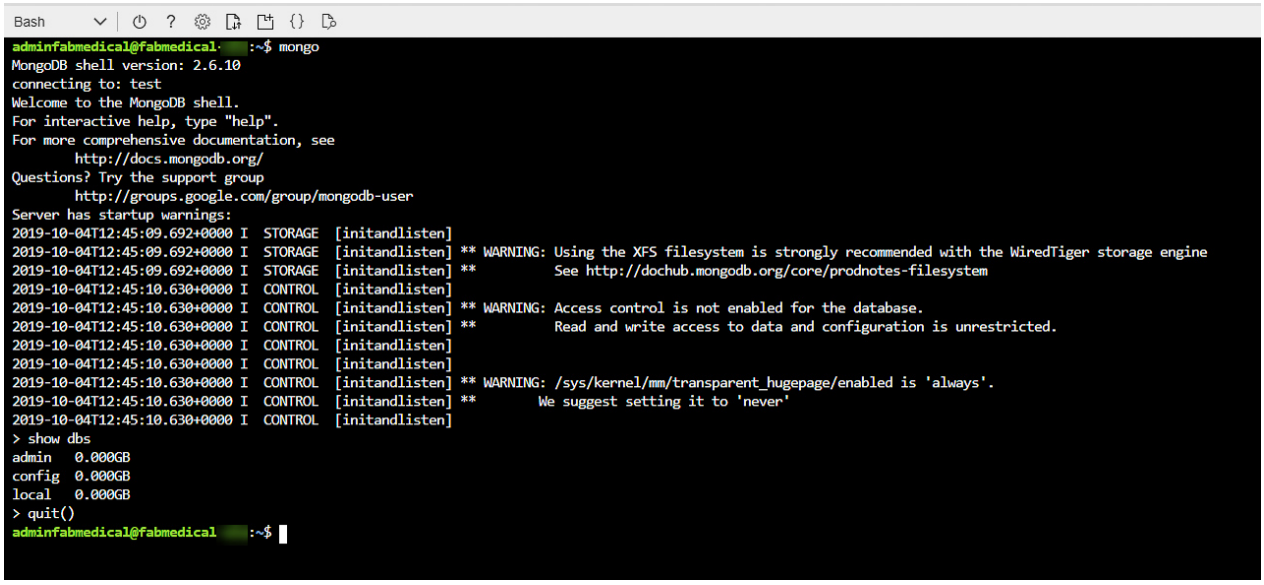
```
docker container list
docker container logs mongo
```



5. Connect to the mongo instance using the mongo shell and test some basic commands:

```
mongo
```

```
show dbs
quit()
```



6. To initialize the local database with test content, first navigate to the content-init directory and run npm install.

```
cd ~/Fabmedical/content-init
npm install
```

> **Note**: In some cases, the `root` user will be assigned ownership of your user's `.config` folder. If this happens, run the following command to return ownership to `adminfabmedical` and then try `npm install` again:

```
sudo chown -R $USER:$(id -gn $USER) /home/adminfabmedical/.config
```

7. Initialize the database.

```
nodejs server.js
```

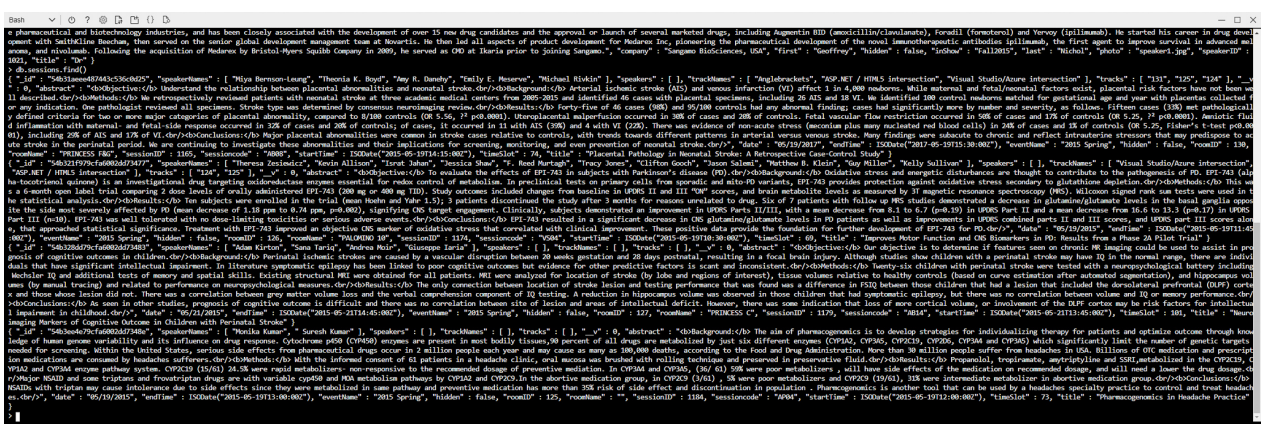
```
Bash
adminfabmedical@fabmedical-    :~$ cd content-init/
adminfabmedical@fabmedical-    :~/content-init$ npm install
npm WARN content-init@1.0.0 No description
npm WARN content-init@1.0.0 No repository field.

added 28 packages from 17 contributors and audited 35 packages in 1.61s
found 0 vulnerabilities

adminfabmedical@fabmedical     :~/content-init$ nodejs server.js
Clean Sessions table
(node:9955) DeprecationWarning: collection.remove is deprecated. Use deleteOne, deleteMany, or bulkWrite instead.
Connected to MongoDb
All Sessions deleted
Load sessions from JSON file
Session saved successfully
Session saved successfully
Session saved successfully
Session saved successfully
Clean Speakers table
All Speakers deleted
Load Speakers from JSON file
Speaker saved successfully
Speaker saved successfully
Speaker saved successfully
Speaker saved successfully
adminfabmedical@fabmedical-    :~/content-init$
```

8. Confirm that the database now contains test data.

```
mongo
```

```
show dbs
use contentdb
show collections
db.speakers.find()
db.sessions.find()
quit()
```

This should produce output similar to the following:



9. Now navigate to the `content-api` directory and run npm install.

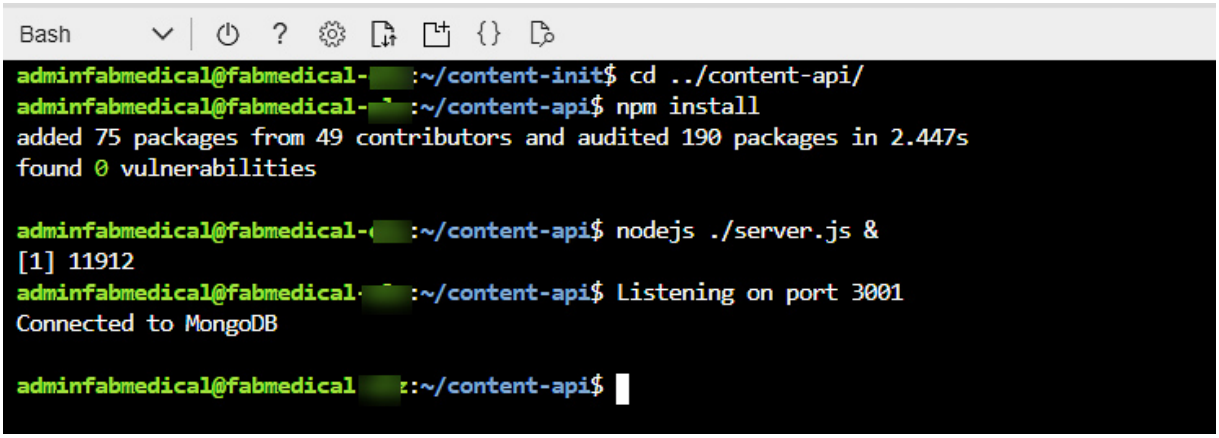
```
cd ../content-api
npm install
```

> **Note**: In some cases, the `root` user will be assigned ownership of your user's `.config` folder. If this happens, run the following command to return ownership to `adminfabmedical` and then try `npm install` again:

```
sudo chown -R $USER:$(id -gn $USER) /home/adminfabmedical/.config
```

10. Start the API as a background process.

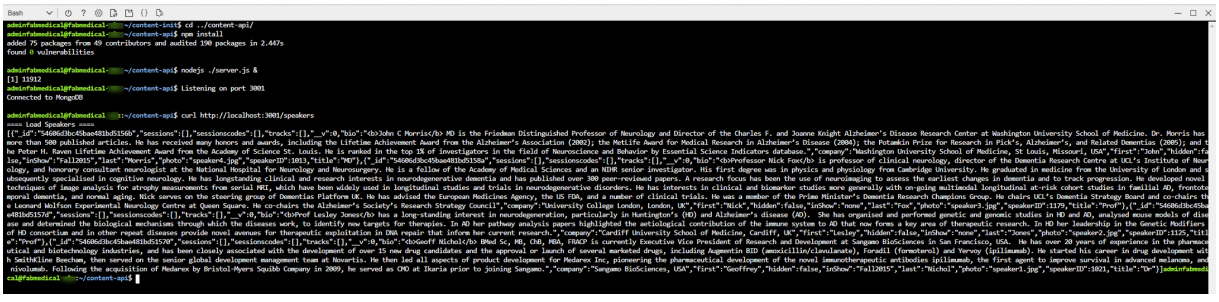
```
nodejs ./server.js &
```



11. Press ENTER again to get to a command prompt for the next step.

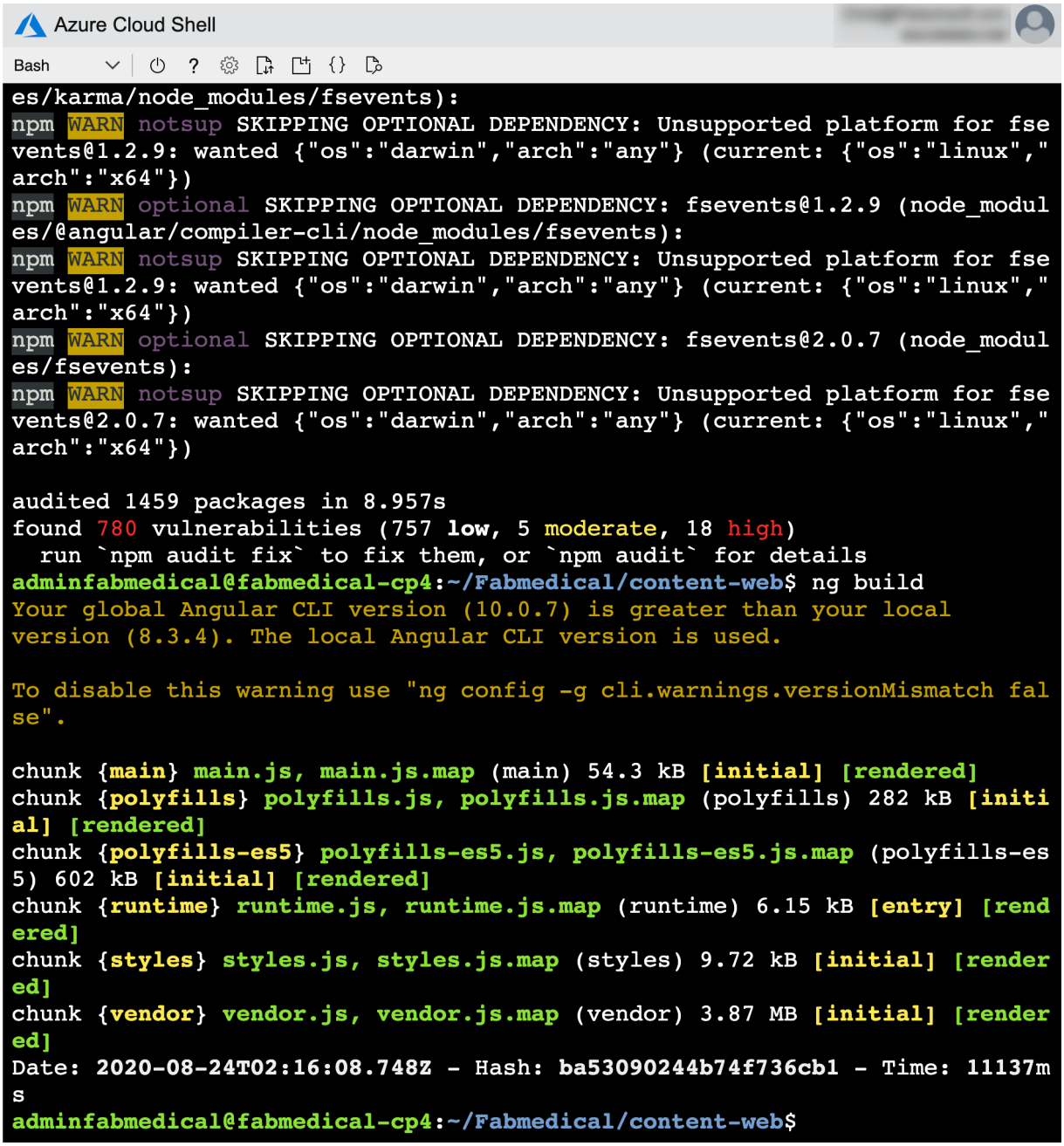
12. Test the API using curl. You will request the speaker's content, and this will return a JSON result.

```
curl http://localhost:3001/speakers
```



13. Navigate to the web application directory, run `npm install` and `ng build`.

```
cd ../content-web
npm install
ng build
```



> **Note**: In some cases, the `root` user will be assigned ownership of your user's `.config` folder. If this happens, run the following command to return ownership to `adminfabmedical` and then try `npm install` again:

```
sudo chown -R $USER:$(id -gn $USER) /home/adminfabmedical/.config
```

14. From Azure cloud shell, run the following command to find the IP address for the build agent VM provisioned when you ran the ARM deployment.

```
az vm show -d -g fabmedical-[SUFFIX] -n fabmedical-[SHORT_SUFFIX] --query publicIps -o tsv
```

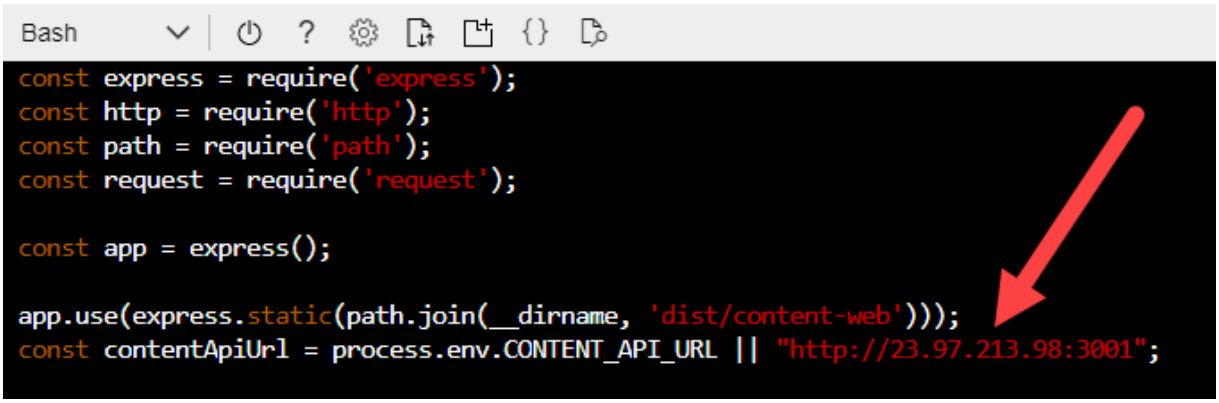
Example:

```
az vm show -d -g fabmedical-sol -n fabmedical-SOL --query publicIps -o tsv
```

15. From the cloud shell in the build machine edit the `app.js` file using vim.

```
vim app.js
```

Then press ***i*** to get into the edit mode, after that replace localhost with the build machine IP address.



Then press ***ESC***, write ***:wq*** to save you changes and close the file.

16. Now run the content-web application in the background.

```
node ./app.js &
```

Press `ENTER` again to get a command prompt for the next step.

17. Test the web application using curl. You will see HTML output returned without errors.

```
curl http://localhost:3000
```

18. Leave the application running for the next task.

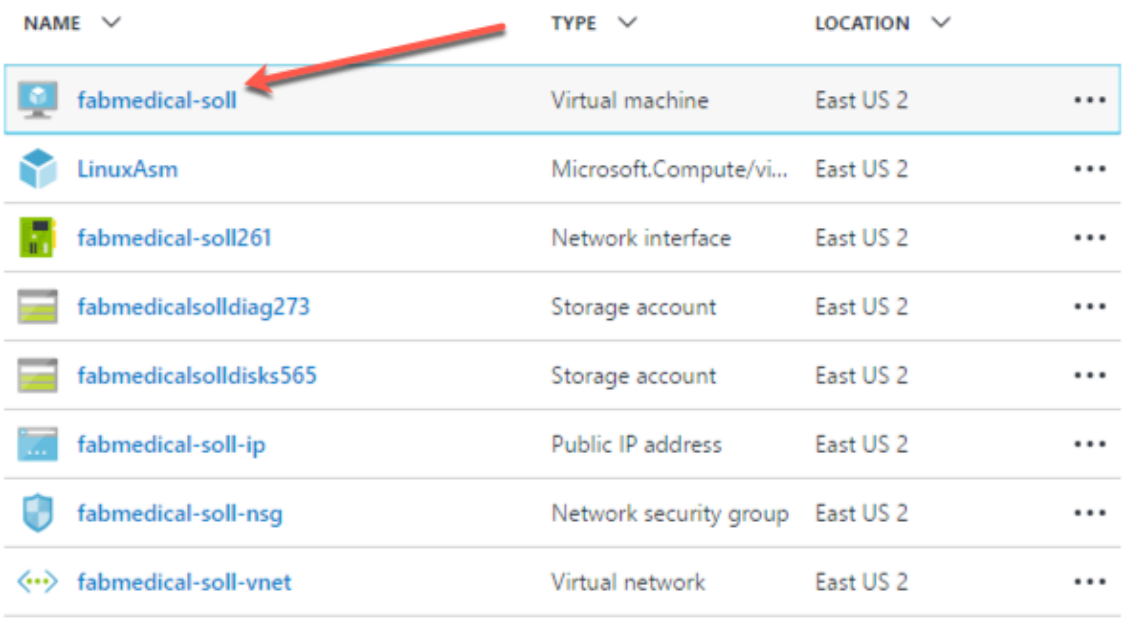
19. If you received a JSON response to the /speakers content request and an HTML response from the web application, your environment is working as expected.

Task 2: Browsing to the web application

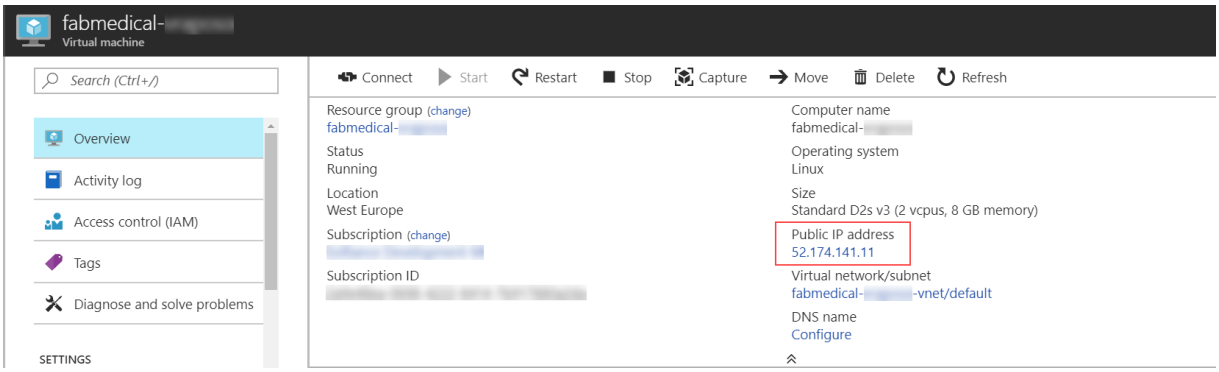
In this task, you will browse to the web application for testing.

1. From the Azure portal select the resource group you created named `fabmedical-SUFFIX`.

2. Select the build agent VM named `fabmedical-SUFFIX` from your list of available resources.



3. From the Virtual Machine blade overview, find the IP address of the VM.



4. Test the web application from a browser. Navigate to the web application using your build agent IP address at port `3000`.

```
http://[BUILDAGENTIP]:3000

EXAMPLE: http://13.68.113.176:3000
```

5. Select the Speakers and Sessions links in the header. You will see the pages display the HTML version of the JSON content you curled previously.

6. Once you have verified the application is accessible through a browser, go to your cloud shell window and stop the running node processes.

```
killall nodejs
killall node
```

Task 3: Create a Dockerfile

In this task, you will create a new Dockerfile that will be used to run the API application as a containerized application.

> **Note**: You will be working in a Linux VM without friendly editor tools. You must follow the steps very carefully to work with Vim for a few editing exercises if you are not already familiar with Vim.

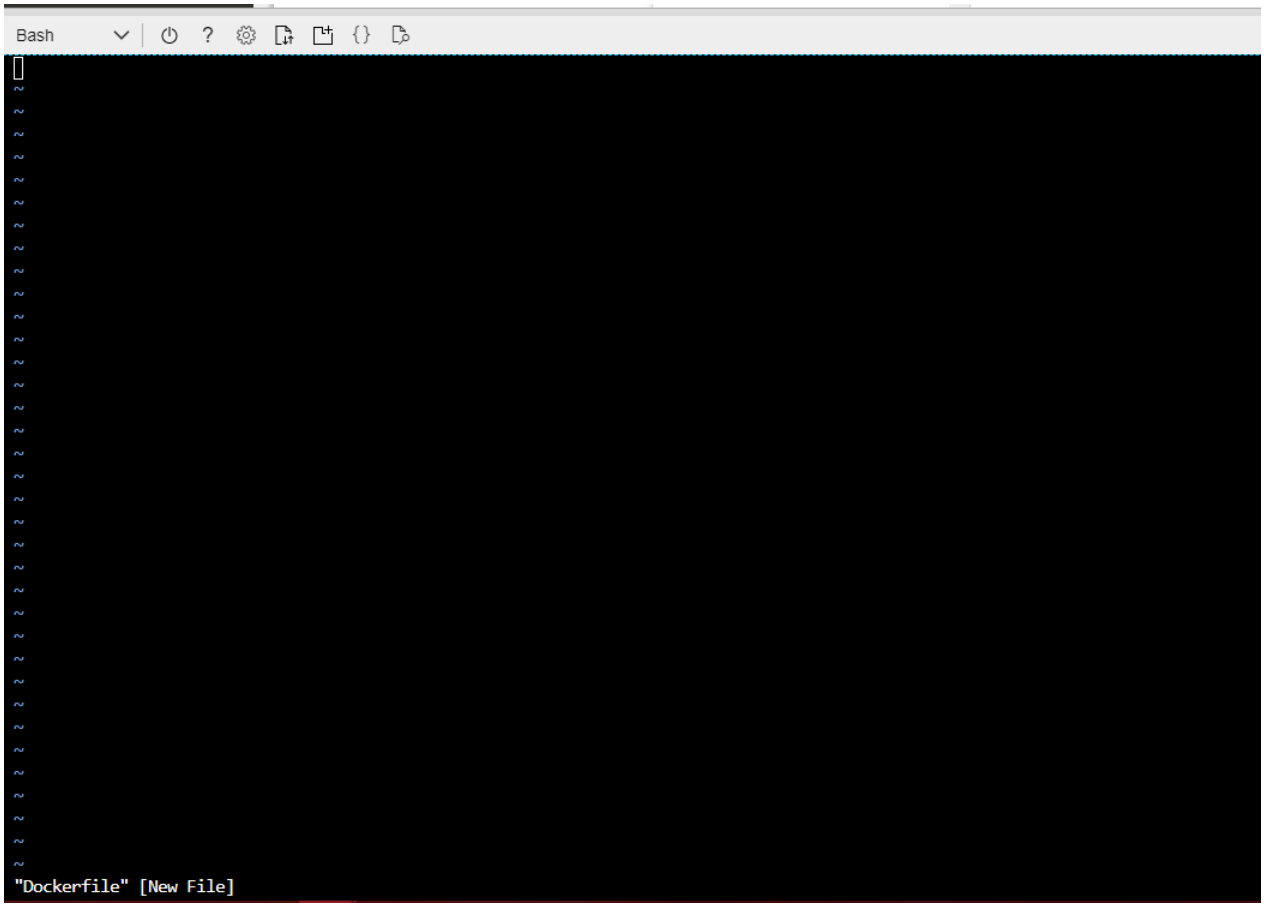
1. From cloud shell, navigate to the `content-api` folder. List the files in the folder with this command. The output should look like the screenshot below.

```
cd ../content-api
ll
```

```
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-api$ ll
total 72
drwxrwxr-x  6 adminfabmedical adminfabmedical  4096 Aug 24 01:57 ./
drwxrwxr-x  6 adminfabmedical adminfabmedical  4096 Aug 24 01:25 ../
-rw-rw-r--  1 adminfabmedical adminfabmedical   926 Aug 24 01:25 azure-pipelines.yml
drwxrwxr-x  2 adminfabmedical adminfabmedical  4096 Aug 24 01:25 config/
drwxrwxr-x  2 adminfabmedical adminfabmedical  4096 Aug 24 01:25 controllers/
-rwxrwxr-x  1 adminfabmedical adminfabmedical   980 Aug 24 01:25 .dockerignore*
-rwxrwxr-x  1 adminfabmedical adminfabmedical   980 Aug 24 01:25 .gitignore*
drwxrwxr-x  2 adminfabmedical adminfabmedical  4096 Aug 24 01:25 models/
drwxrwxr-x 75 adminfabmedical adminfabmedical  4096 Aug 24 01:57 node_modules/
-rwxrwxr-x  1 adminfabmedical adminfabmedical   273 Aug 24 01:25 package.json*
-rwxrwxr-x  1 adminfabmedical adminfabmedical 21512 Aug 24 01:25 package-lock.json*
-rwxrwxr-x  1 adminfabmedical adminfabmedical   376 Aug 24 01:25 routes.js*
-rwxrwxr-x  1 adminfabmedical adminfabmedical  1812 Aug 24 01:25 server.js*
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-api$
```

2. Create a new file named `Dockerfile` and note the casing in the name. Use the following Vim command to create a new file. The cloud shell window should look as shown in the following screenshot.

```
vi Dockerfile
```



3. Select `i` on your keyboard. You will see the bottom of the window showing INSERT mode.

4. Type the following into the file. These statements produce a Dockerfile that describes the following:

    - The base stage includes environment setup which we expect to change very rarely, if at all.
        - Creates a new Docker image from the base image node:alpine. This base image has node.js on it and is optimized for small size.
        - Add `curl` to the base image to support Docker health checks.
        - Creates a directory on the image where the application files can be copied.
        - Exposes application port `3001` to the container environment so that the application can be reached at port `3001`.
    - The build stage contains all the tools and intermediate files needed to create the application.
        - Creates a new Docker image from `node:argon`.
        - Creates a directory on the image where the application files can be copied.
        - Copies `package.json` to the working directory.
        - Runs npm install to initialize the node application environment.

        - Copies the source files for the application over to the image.
    - The final stage combines the base image with the build output from the build stage.
        - Sets the working directory to the application file location.
        - Copies the app files from the build stage.
        - Indicates the command to start the node application when the container is run.

> **Note**: Type the following into the editor, as you may have errors with copying and pasting:

```
FROM node:alpine AS base
RUN apk -U add curl
WORKDIR /usr/src/app
EXPOSE 3001

FROM node:argon AS build
WORKDIR /usr/src/app

# Install app dependencies
COPY package.json /usr/src/app/
RUN npm install

# Bundle app source
COPY . /usr/src/app

FROM base AS final
WORKDIR /usr/src/app
COPY --from=build /usr/src/app .
CMD [ "npm", "start" ]
```

5. When you are finished typing, hit the Esc key and type `:wq` and hit the Enter key to save the changes and close the file.

```
<Esc>
:wq
<Enter>
```

6. List the contents of the folder again to verify that the new Dockerfile has been created.

```
ll
```

```
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-api$ ll
total 76
drwxrwxr-x  6 adminfabmedical adminfabmedical  4096 Aug 24 02:29 ./
drwxrwxr-x  6 adminfabmedical adminfabmedical  4096 Aug 24 01:25 ../
-rw-rw-r--  1 adminfabmedical adminfabmedical   926 Aug 24 01:25 azure-pipelines.yml
drwxrwxr-x  2 adminfabmedical adminfabmedical  4096 Aug 24 01:25 config/
drwxrwxr-x  2 adminfabmedical adminfabmedical  4096 Aug 24 01:25 controllers/
-rw-rw-r--  1 adminfabmedical adminfabmedical   339 Aug 24 02:29 Dockerfile
-rwxrwxr-x  1 adminfabmedical adminfabmedical   980 Aug 24 01:25 .dockerignore*
-rwxrwxr-x  1 adminfabmedical adminfabmedical   980 Aug 24 01:25 .gitignore*
drwxrwxr-x  2 adminfabmedical adminfabmedical  4096 Aug 24 01:25 models/
drwxrwxr-x 75 adminfabmedical adminfabmedical  4096 Aug 24 01:57 node_modules/
-rwxrwxr-x  1 adminfabmedical adminfabmedical   273 Aug 24 01:25 package.json*
-rwxrwxr-x  1 adminfabmedical adminfabmedical 21512 Aug 24 01:25 package-lock.json*
-rwxrwxr-x  1 adminfabmedical adminfabmedical   376 Aug 24 01:25 routes.js*
-rwxrwxr-x  1 adminfabmedical adminfabmedical  1812 Aug 24 01:25 server.js*
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-api$
```

7. Verify the file contents to ensure it was saved as expected. Type the following command to see the output of the Dockerfile in the command window.

```
cat Dockerfile
```

Task 4: Create Docker images

In this task, you will create Docker images for the application --- one for the API application and another for the web application. Each image will be created via Docker commands that rely on a Dockerfile.

1. From cloud shell connected to the build agent VM, type the following command to view any Docker images on the VM. The list will only contain the mongodb image downloaded earlier.

```
docker image ls
```

2. From the content-api folder containing the API application files and the new Dockerfile you created, type the following command to create a Docker image for the API application. This command does the following:

   - Executes the Docker build command to produce the image
   - Tags the resulting image with the name `content-api` (-t)
   - The final dot (`.`) indicates to use the Dockerfile in this current directory context. By default, this file is expected to have the name `Dockerfile` (case sensitive).

```
docker image build -t content-api .
```

3. Once the image is successfully built, run the Docker images listing command again. You will see several new images: the node images and your container image.

```
docker image ls
```

Notice the untagged image. This is the build stage which contains all the intermediate files not needed in your final image.

```
adminfabmedical1@fabmedical-[redacted]:~/Fabmedical/content-api$ docker image ls
REPOSITORY          TAG                 IMAGE ID            CREATED              SIZE
content-api         latest              798d89b8f0aa        About a minute ago   129MB
<none>              <none>              8a86289adce3        About a minute ago   674MB
mongo               latest              409c3f937574        4 days ago           493MB
node                alpine              0f2c18cef5d3        11 days ago          117MB
node                argon               ef4b194d8fcf        2 years ago          653MB
adminfabmedical1@fabmedical-[redacted]:~/Fabmedical/content-api$
```

4. Commit and push the new Dockerfile before continuing.

```
git add .
git commit -m "Added Dockerfile"
git push
```

Enter credentials if prompted.

5. Navigate to the content-web folder again and list the files. Note that this folder already has a Dockerfile.

```
cd ../content-web
ll
```

6. View the Dockerfile contents -- which are similar to the file you created previously in the API folder. Type the following command:

```
cat Dockerfile
```

> Notice that the `content-web` Dockerfile build stage includes additional tools for a front-end Angular application in addition to installing npm packages.

7. Type the following command to create a Docker image for the web application.

```
docker image build -t content-web .
```

8. Navigate to the content-init folder again and list the files. Note that this folder already has a Dockerfile.

```
cd ../content-init
ll
```

9. View the Dockerfile contents -- which are similar to the file you created previously in the API folder. Type the following command:

```
cat Dockerfile
```

10. Type the following command to create a Docker image for the init application.

```
docker image build -t content-init .
```

11. When complete, you will see seven images now exist when you run the Docker images command.

```
docker image ls
```

```
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-web$ docker image ls
REPOSITORY          TAG                 IMAGE ID            CREATED              SIZE
content-web         latest              6e333b5cd0ae        About a minute ago   354MB
<none>              <none>              440be66d5b98        2 minutes ago        1.31GB
content-api         latest              798d89b8f0aa        10 minutes ago       129MB
<none>              <none>              8a86289adce3        10 minutes ago       674MB
mongo               latest              409c3f937574        4 days ago           493MB
node                alpine              0f2c18cef5d3        11 days ago          117MB
node                dubnium             5ebbf4bb3837        2 weeks ago          911MB
node                dubnium-alpine      8e473595b853        4 weeks ago          83.5MB
node                argon               ef4b194d8fcf        2 years ago          653MB
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-web$
```

Task 5: Run a containerized application

The web application container will be calling endpoints exposed by the API application container and the API application container will be communicating with mongodb. In this exercise, you will launch the images you created as containers on the same bridge network you created when starting mongodb.

1. Create and start the API application container with the following command. The command does the following:

    - Names the container `api` for later reference with Docker commands.
    - Instructs the Docker engine to use the `fabmedical` network.
    - Instructs the Docker engine to use port `3001` and map that to the internal container port `3001`.
    - Creates a container from the specified image, by its tag, such as content-api.

```
docker container run --name api --net fabmedical -p 3001:3001 content-api
```

2. The `docker container run` command has failed because it is configured to connect to mongodb using a localhost URL. However, now that content-api is isolated in a separate container, it cannot access mongodb via localhost even when running on the same docker host. Instead, the API must use the bridge network to connect to mongodb.

```
> content-api@0.0.0 start /usr/src/app
> node ./server.js

Listening on port 3001
Could not connect to MongoDB!
MongoTimeoutError: Server selection timed out after 30000 ms
npm ERR! code ELIFECYCLE
npm ERR! errno 255
npm ERR! content-api@0.0.0 start: `node ./server.js`
npm ERR! Exit status 255
npm ERR!
npm ERR! Failed at the content-api@0.0.0 start script.
npm ERR! This is probably not a problem with npm. There is likely additional logging output above.

npm ERR! A complete log of this run can be found in:
npm ERR!     /root/.npm/_logs/2019-12-04T22_39_38_815Z-debug.log
```

3. The content-api application allows an environment variable to configure the mongodb connection string. Remove the existing container, and then instruct the docker engine to set the environment variable by adding the `-e` switch to the `docker container run` command. Also, use the `-d` switch to run the api as a daemon.

```
docker container rm api
docker container run --name api --net fabmedical -p 3001:3001 -e MONGODB_CONNECTION=mongodb://mongo:27017/contentdb
```

4. Enter the command to show running containers. You will observe that the `api` container is in the list. Use the docker logs command to see that the API application has connected to mongodb.

```
docker container ls
docker container logs api
```

```
adminfabmedical@fabmedical-cp4:~/Fabmedical/content-web$ docker container ls
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS              PORTS                     NAMES
122437f5a5c4        content-api         "docker-entrypoint.s…"   27 seconds ago      Up 26 seconds       0.0.0.0:3001->3001/tcp    api
ef8d527320a1        mongo               "docker-entrypoint.s…"   58 minutes ago      Up 58 minutes       0.0.0.0:27017->27017/tcp  mongo
adminfabmedical@fabmedical-cp4:~/Fabmedical/content-web$ docker container logs api

> content-api@0.0.0 start /usr/src/app
> node ./server.js

Listening on port 3001
Connected to MongoDB
adminfabmedical@fabmedical-cp4:~/Fabmedical/content-web$
```

5. Test the API by curling the URL. You will see JSON output as you did when testing previously.

```
curl http://localhost:3001/speakers
```

6. Create and start the web application container with a similar `docker container run` command -- instruct the docker engine to use any port with the `-P` command.

```
docker container run --name web --net fabmedical -P -d content-web
```

7. Enter the command to show running containers again, and you will observe that both the API and web containers are in the list. The web container shows a dynamically assigned port mapping to its internal container port `3000`.

```
docker container ls
```

```
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-web$ docker container ls
CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS              PORTS                     NAMES
aa76f2d69b38        content-web         "docker-entrypoint.s…"   18 seconds ago      Up 17 seconds       0.0.0.0:32768->3000/tcp   web
122437f5a5c4        content-api         "docker-entrypoint.s…"   2 minutes ago       Up 2 minutes        0.0.0.0:3001->3001/tcp    api
ef8d527320a1        mongo               "docker-entrypoint.s…"   About an hour ago   Up About an hour    0.0.0.0:27017->27017/tcp  mongo
adminfabmedical@fabmedical-[redacted]:~/Fabmedical/content-web$
```

8. Test the web application by fetching the URL with curl. For the port, use the dynamically assigned port, which you can find in the output from the previous command. You will see HTML output, as you did when testing previously.

```
curl http://localhost:[PORT]/speakers.html
```

Task 6: Setup environment variables

In this task, you will configure the **web** container to communicate with the API container using an environment variable, similar to the way the mongodb connection string is provided to the api.

1. From cloud shell connected to the build agent VM, stop and remove the web container using the following commands.

```
docker container stop web
docker container rm web
```

2. Validate that the web container is no longer running or present by using the `-a` flag as shown in this command. You will see that the `web` container is no longer listed.

```
docker container ls -a
```

3. Review the `app.js` file.

```
cd ../content-web
cat app.js
```

4. Observe that the `contentApiUrl` variable can be set with an environment variable.

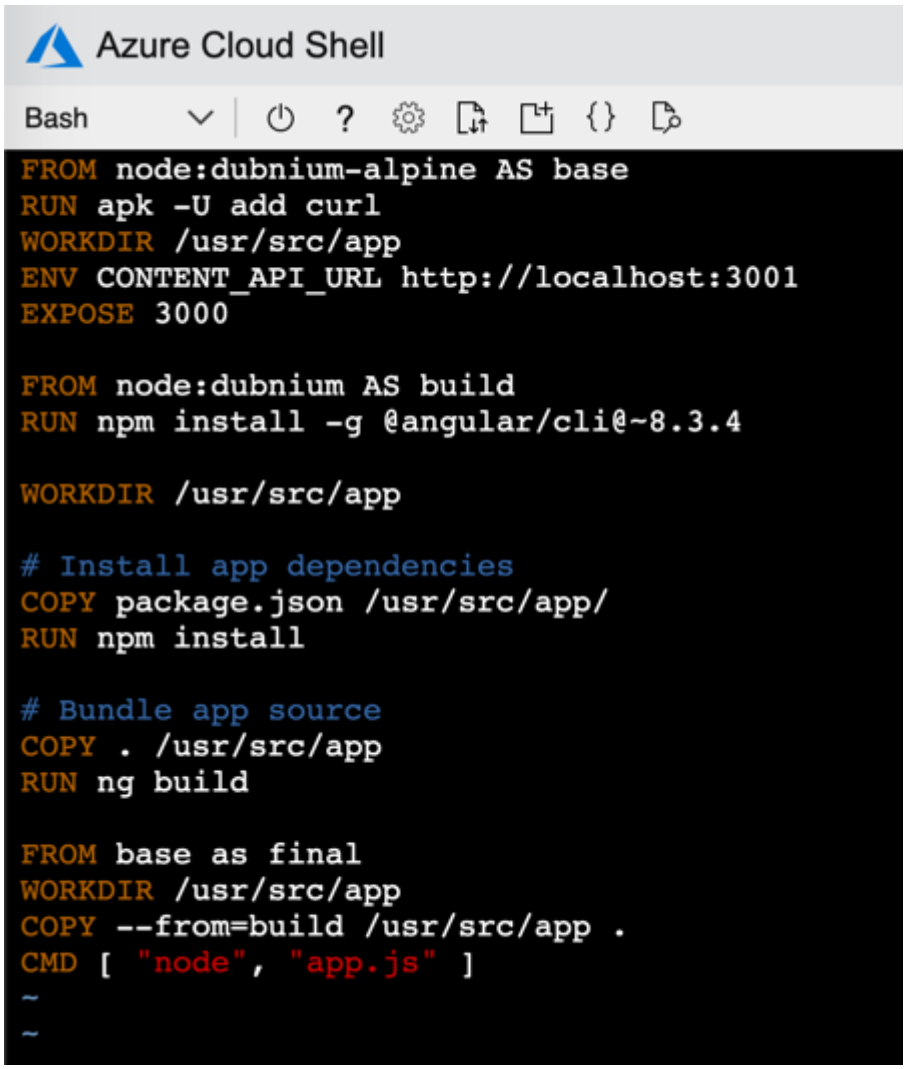
```
const contentApiUrl = process.env.CONTENT_API_URL || "http://localhost:3001";
```

5. Open the Dockerfile for editing using Vim and press the `i` key to go into edit mode.

```
vi Dockerfile
<i>
```

6. Locate the `EXPOSE` line shown below and add a line above it that sets the default value for the environment variable, as shown in the screenshot.

```
ENV CONTENT_API_URL http://localhost:3001
```



7. Press the Escape key and type `:wq` and then press the Enter key to save and close the file.

```
<Esc>
:wq
<Enter>
```

8. Rebuild the web application Docker image using the same command as you did previously.

```
docker image build -t content-web .
```

9. Create and start the image passing the correct URI to the API container as an environment variable. This variable will address the API application using its container name over the Docker network you created. After running the container, check to see the container is running and note the dynamic port assignment for the next step.

```
docker container run --name web --net fabmedical -P -d -e CONTENT_API_URL=http://api:3001 content-web
docker container ls
```

10. Curl the speakers path again, using the port assigned to the web container. Again, you will see HTML returned, but because curl does not process javascript, you cannot determine if the web application is communicating with the api application. You must verify this connection in a browser.

```
curl http://localhost:[PORT]/speakers.html
```

11. You will not be able to browse to the web application on the ephemeral port because the VM only exposes a limited port range. Now you will stop the web container and restart it using port `3000` to test in the browser. Type the following commands to stop the container, remove it, and run it again using explicit settings for the port.

```
docker container stop web
docker container rm web
docker container run --name web --net fabmedical -p 3000:3000 -d -e CONTENT_API_URL=http://api:3001 content-web
```

12. Curl the speaker path again, using port `3000`. You will see the same HTML returned.

```
curl http://localhost:3000/speakers.html
```

13. You can now use a web browser to navigate to the website and successfully view the application at port `3000`. Replace `[BUILDAGENTIP]` with the **IP address** you used previously.

```
http://[BUILDAGENTIP]:3000

EXAMPLE: http://13.68.113.176:3000
```

14. Commit your changes and push to the repository.

```
git add .
git commit -m "Setup Environment Variables"
git push
```

    Enter credentials if prompted.

Task 7: Run several containers with Docker compose

Managing several containers with all their command line options can become difficult as the solution grows. `docker-compose` allows us to declare options for several containers and run them together.

1. First, cleanup the existing containers.

```
docker container stop web && docker container rm web
docker container stop api && docker container rm api
docker container stop mongo && docker container rm mongo
```

2. Navigate to your home directory (where you checked out the content repositories) and create a docker compose file.

```
cd ~
vi docker-compose.yml
<i>
```

Type the following as the contents of `docker-compose.yml`:

```
version: "3.4"

services:
  mongo:
    image: mongo
    restart: always

  api:
    build: ./Fabmedical/content-api
    image: content-api
    depends_on:
      - mongo
    environment:
      MONGODB_CONNECTION: mongodb://mongo:27017/contentdb

  web:
    build: ./Fabmedical/content-web
    image: content-web
    depends_on:
      - api
    environment:
      CONTENT_API_URL: http://api:3001
    ports:
      - "3000:3000"
```

Press the Escape key and type `:wq` and then press the Enter key to save and close the file.

```
<Esc>
:wq
<Enter>
```

3. Start the applications with the `up` command.

```
docker-compose -f docker-compose.yml -p fabmedical up -d
```

```
adminfabmedical@fabmedical-[redacted]:~$ docker-compose -f docker-compose.yml -
p fabmedical up -d
Creating network "fabmedical_default" with the default driver
Creating fabmedical_mongo_1 ... done
Creating fabmedical_api_1   ... done
Creating fabmedical_web_1   ... done
adminfabmedical@fabmedical-[redacted]:~$
```

4. Visit the website in the browser; notice that we no longer have any data on the speakers or sessions pages.

5. We stopped and removed our previous mongodb container; all the data contained in it has been removed. Docker compose has created a new, empty mongodb instance that must be reinitialized. If we care to persist our data between container instances, docker has several mechanisms to do so. First, we will update our compose file to persist mongodb data to a directory on the build agent.

```
mkdir data
vi docker-compose.yml
```

Update the mongo service to mount the local data directory onto to the `/data/db` volume in the docker container.

```
mongo:
  image: mongo
  restart: always
  volumes:
    - ./data:/data/db
```

The result should look similar to the following screenshot:

Bash

```
version: "3.4"

services:
  mongo:
    image: mongo
    restart: always
    volumes:
      - ./data:/data/db

  api:
    build: ./Fabmedical/content-api
    image: content-api
    depends_on:
      - mongo
    environment:
      MONGODB_CONNECTION: mongodb://mongo:27017/contentdb

  web:
    build: ./Fabmedical/content-web
    image: content-web
    depends_on:
      - api
    environment:
      CONTENT_API_URL: http://api:3001
    ports:
      - "3000:3000"
~
~
~
```

6. Next, we will add a second file to our composition so that we can initialize the mongodb data when needed.

```
vi docker-compose.init.yml
```

Add the following as the content:

```
version: "3.4"

services:
  init:
    build: ./Fabmedical/content-init
    image: content-init
    depends_on:
      - mongo
    environment:
      MONGODB_CONNECTION: mongodb://mongo:27017/contentdb
```

7. To reconfigure the mongodb volume, we need to bring down the mongodb service first.

```
docker-compose -f docker-compose.yml -p fabmedical down
```

```
adminfabmedical@fabmedical-[redacted]:~$ docker-compose -f docker-compose.yml -p fabmedical d
own
Stopping fabmedical_web_1   ... done
Stopping fabmedical_api_1   ... done
Stopping fabmedical_mongo_1 ... done
Removing fabmedical_web_1   ... done
Removing fabmedical_api_1   ... done
Removing fabmedical_mongo_1 ... done
Removing network fabmedical_default
adminfabmedical@fabmedical-[redacted]:~$
```

8. Now run `up` again with both files to update the mongodb configuration and run the initialization script.

```
docker-compose -f docker-compose.yml -f docker-compose.init.yml -p fabmedical up -d
```

9. Check the data folder to see that mongodb is now writing data files to the host.

```
ls ./data/
```

```
adminfabmedical@fabmedical-sol:~$ docker-compose -f docker-compose.yml -f docker-compose.init.yml -p fabmedical up -d
Creating network "fabmedical_default" with the default driver
Creating fabmedical_mongo_1 ... done
Creating fabmedical_api_1    ... done
Recreating fabmedical_init_1 ... done
Creating fabmedical_web_1    ... done
adminfabmedical@fabmedical-sol:~$ ls ./data/
collection-0--7350346735947181636.wt  index-1--7350346735947181636.wt  _mdb_catalog.wt  WiredTigerLAS.wt
collection-2--7350346735947181636.wt  index-3--7350346735947181636.wt  mongod.lock      WiredTiger.lock
collection-4--7350346735947181636.wt  index-5--7350346735947181636.wt  sizeStorer.wt    WiredTiger.turtle
collection-6--7350346735947181636.wt  index-7--7350346735947181636.wt  storage.bson     WiredTiger.wt
diagnostic.data                       journal                          WiredTiger
adminfabmedical@fabmedical-sol:~$
```

10. Check the results in the browser. The speaker and session data are now available.

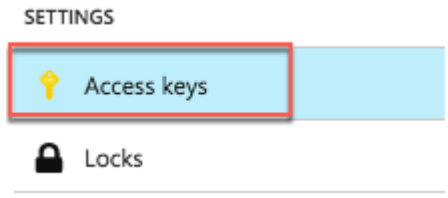
Task 8: Push images to Azure Container Registry

To run containers in a remote environment, you will typically push images to a Docker registry, where you can store and distribute images. Each service will have a repository that can be pushed to and pulled from with Docker commands. Azure Container Registry (ACR) is a managed private Docker registry service based on Docker Registry v2.

In this task, you will push images to your ACR account, version images with tagging, and setup continuous integration (CI) to build future versions of your containers and push them to ACR automatically.

1. In the Azure Portal, navigate to the ACR you created in Before the hands-on lab.

2. Select **Access keys** under **Settings** on the left-hand menu.



3. The Access keys blade displays the Login server, username, and password that will be required for the next step. Keep this handy as you perform actions on the build VM.

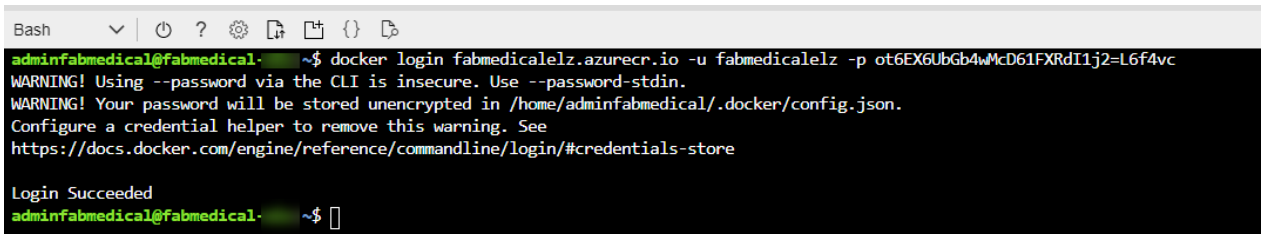
> **Note**: If the username and password do not appear, select Enable on the Admin user option.

4. From the cloud shell session connected to your build VM, login to your ACR account by typing the following command. Follow the instructions to complete the login.

```
docker login [LOGINSERVER] -u [USERNAME] -p [PASSWORD]
```

For example:

```
docker login fabmedicalsoll.azurecr.io -u fabmedicalsoll -p +W/j=l+Fcze=n07SchxvGSlvsLRh/7ga
```



> **Tip**: Make sure to specify the fully qualified registry login server (all lowercase).

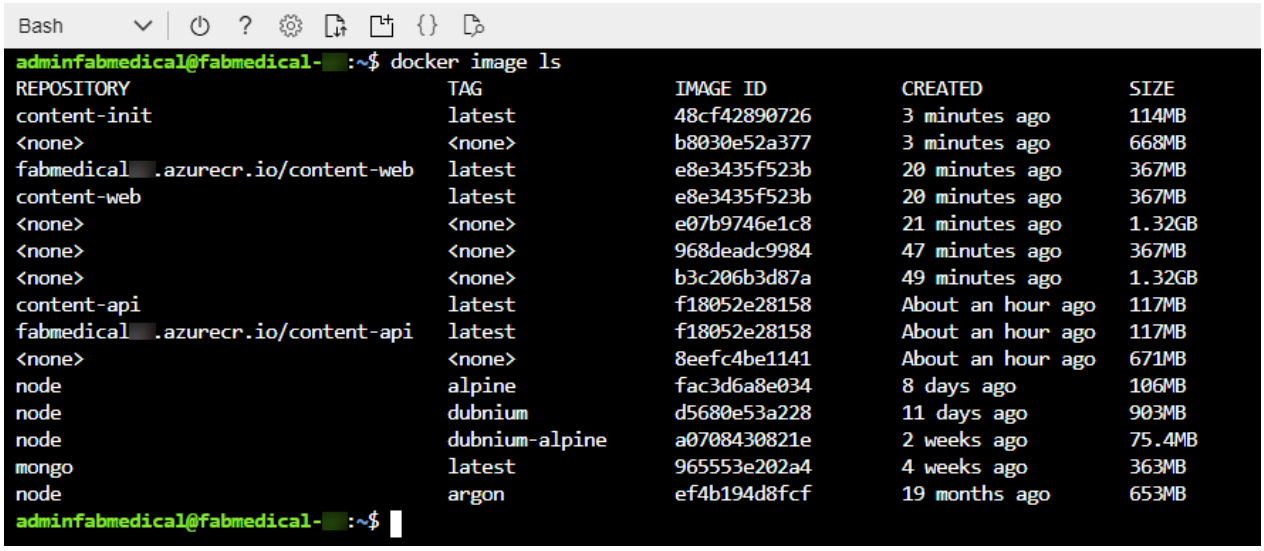
5. Run the following commands to properly tag your images to match your ACR account name.

```
docker image tag content-web [LOGINSERVER]/content-web
docker image tag content-api [LOGINSERVER]/content-api
docker image tag content-init [LOGINSERVER]/content-init
```

> **Note**: Be sure to replace the `[LOGINSERVER]` of your ACR instance.

6. List your docker images and look at the repository and tag. Note that the repository is prefixed with your ACR login server name, such as the sample shown in the screenshot below.

```
docker image ls
```

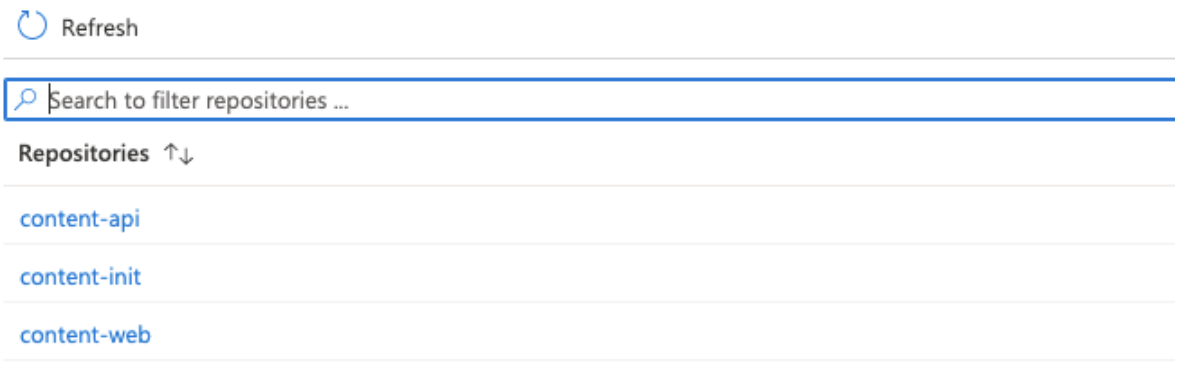


7. Push the images to your ACR account with the following command:

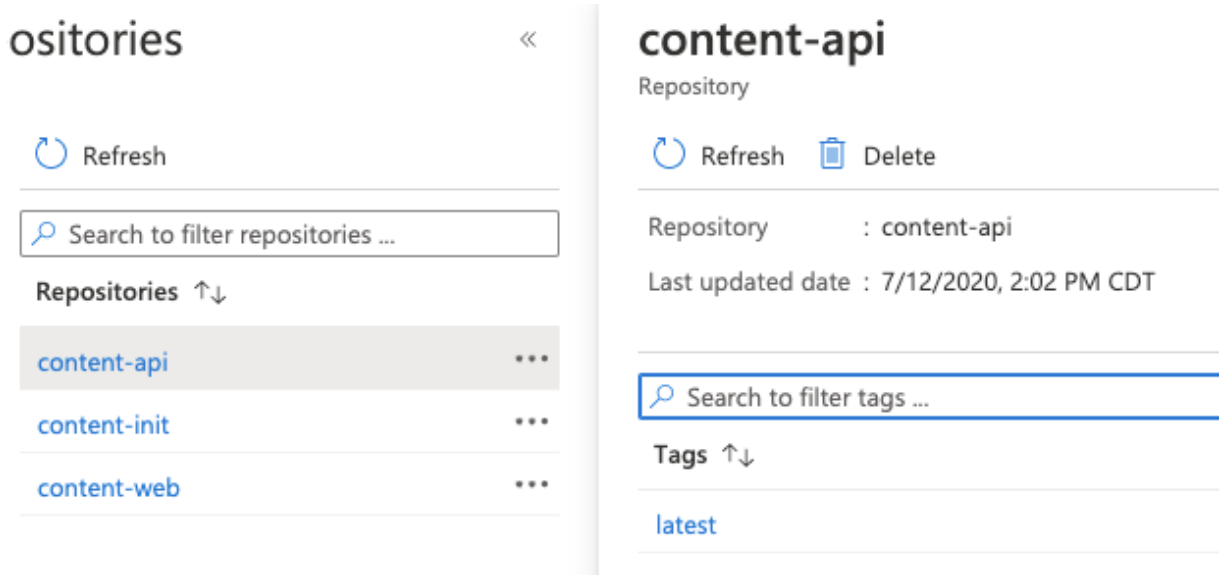
```
docker image push [LOGINSERVER]/content-web
docker image push [LOGINSERVER]/content-api
docker image push [LOGINSERVER]/content-init
```

!In this screenshot of the console window, an example of images being pushed to an ACR account results from typing and running the following at the command prompt: docker push [LOGINSERVER]/content-web.

8. In the Azure Portal, navigate to your ACR account, and select Repositories under Services on the left-hand menu. You will now see two, one for each image.



9. Select `content-api`. You will see the latest tag is assigned.

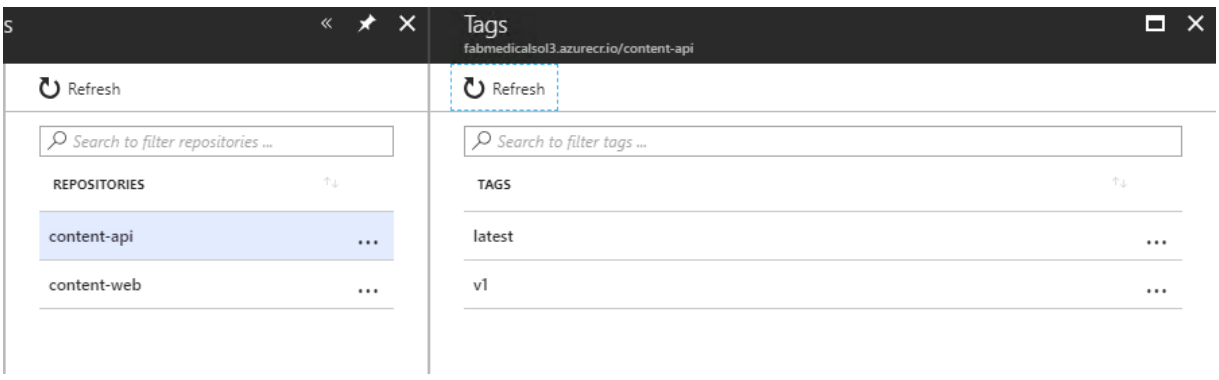


10. From the cloud shell session attached to the VM, assign the v1 tag to each image with the following commands. Then list the Docker images to note that there are now two entries for each image: showing the latest tag and the `v1` tag. Also note that the image ID is the same for the two entries, as there is only one copy of the image.

```
docker image tag [LOGINSERVER]/content-web:latest [LOGINSERVER]/content-web:v1
docker image tag [LOGINSERVER]/content-api:latest [LOGINSERVER]/content-api:v1
docker image tag [LOGINSERVER]/content-init:latest [LOGINSERVER]/content-init:v1
docker image ls
```

```
adminfabmedical@fabmedical-cp4:~$ docker image ls
REPOSITORY                                TAG                 IMAGE ID            CREATED             SIZE
content-init                              latest              4418620e6a4e        8 minutes ago       125MB
fabmedicalcp4.azurecr.io/content-init     latest              4418620e6a4e        8 minutes ago       125MB
fabmedicalcp4.azurecr.io/content-init     v1                  4418620e6a4e        8 minutes ago       125MB
<none>                                    <none>              127d2e1f0417        8 minutes ago       671MB
content-web                               latest              f8a5a30d7e01        25 minutes ago      354MB
fabmedicalcp4.azurecr.io/content-web      latest              f8a5a30d7e01        25 minutes ago      354MB
fabmedicalcp4.azurecr.io/content-web      v1                  f8a5a30d7e01        25 minutes ago      354MB
<none>                                    <none>              1d065e18aaef        26 minutes ago      1.31GB
<none>                                    <none>              6e333b5cd0ae        35 minutes ago      354MB
<none>                                    <none>              440be66d5b98        36 minutes ago      1.31GB
content-api                               latest              798d89b8f0aa        44 minutes ago      129MB
fabmedicalcp4.azurecr.io/content-api      latest              798d89b8f0aa        44 minutes ago      129MB
fabmedicalcp4.azurecr.io/content-api      v1                  798d89b8f0aa        44 minutes ago      129MB
<none>                                    <none>              8a86289adce3        45 minutes ago      674MB
mongo                                     latest              409c3f937574        4 days ago          493MB
node                                      alpine              0f2c18cef5d3        11 days ago         117MB
node                                      dubnium             5ebbf4bb3837        2 weeks ago         911MB
node                                      dubnium-alpine      8e473595b853        4 weeks ago         83.5MB
node                                      argon               ef4b194d8fcf        2 years ago         653MB
adminfabmedical@fabmedical-cp4:~$
```

11. Repeat Step 7 to push the images to ACR again so that the newly tagged `v1` images are pushed. Then refresh one of the repositories to see the two versions of the image now appear.



12. Run the following commands to pull an image from the repository. Note that the default behavior is to pull images tagged with `latest`. You can pull a specific version using the version tag. Also, note that since the images already exist on the build agent, nothing is downloaded.

```
docker image pull [LOGINSERVER]/content-web
docker image pull [LOGINSERVER]/content-web:v1
```

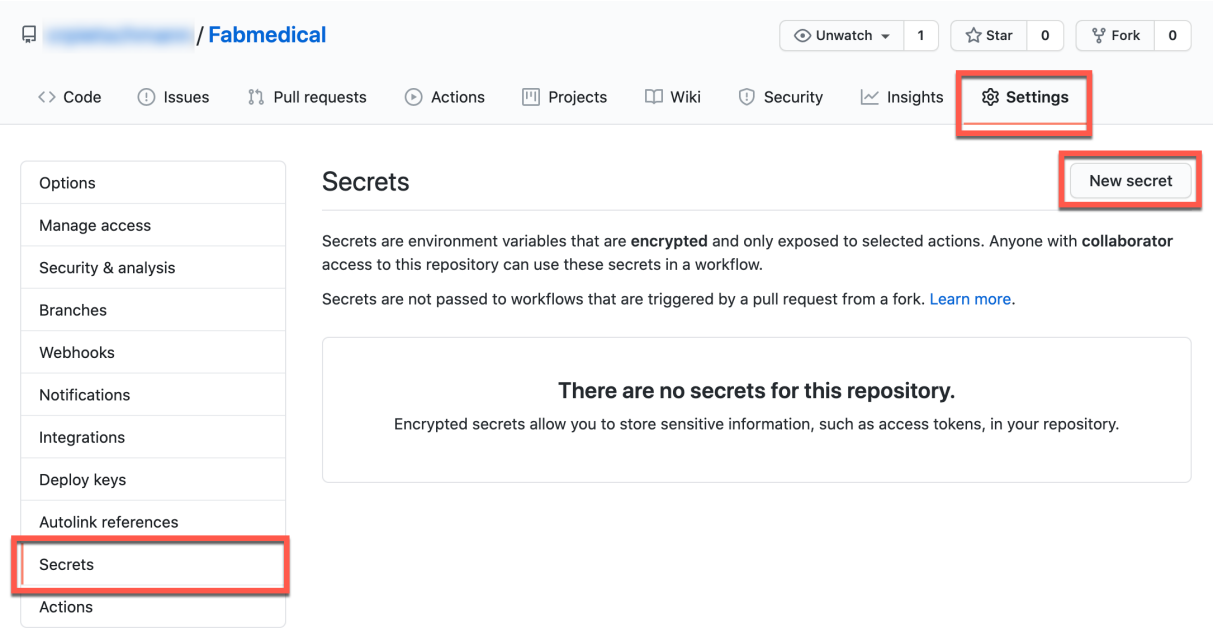
Task 9: Setup CI Pipeline to Push Images

In this task, you will use YAML to define a GitHub Actions workflow that builds your Docker image and pushes it to your ACR instance automatically.

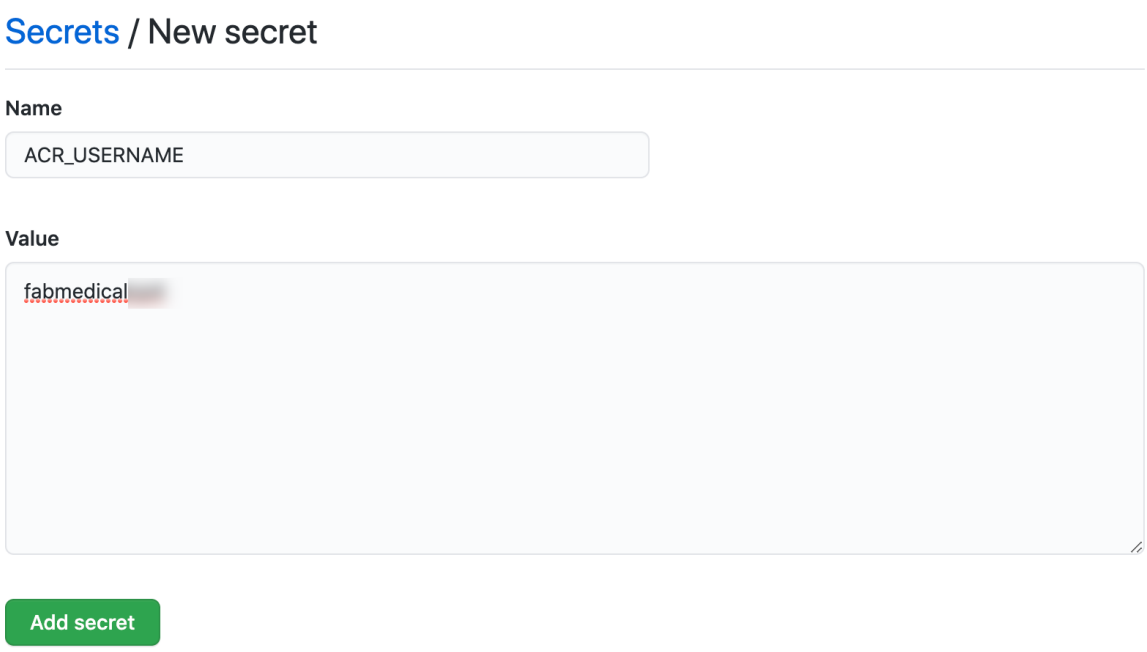
1. In GitHub, return to the **Fabmedical** repository screen, and select the **Settings** tab.

2. From the left menu, select **Secrets**.

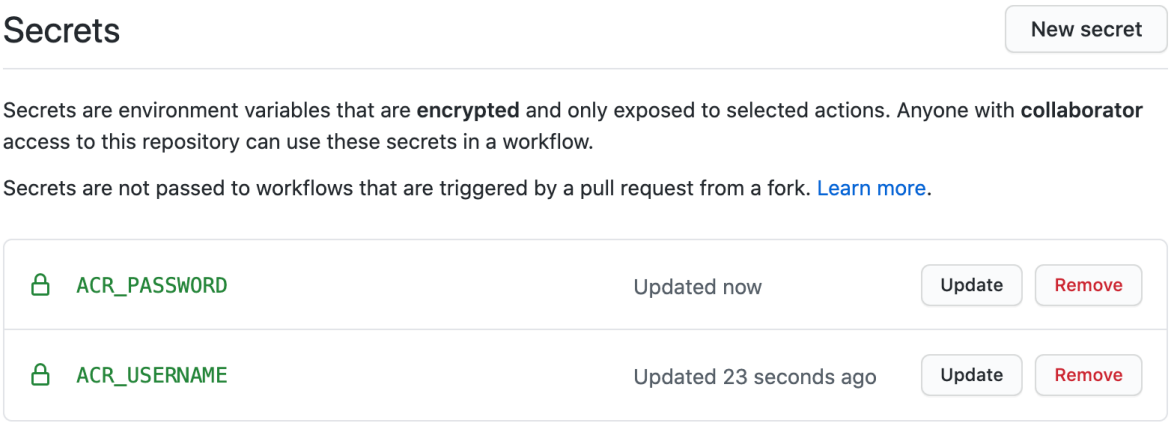
3. Select the **New secret** button.



4. In the **New secret** form, enter the name `ACR_USERNAME` and for the value, paste in the Azure Container Registry **Username** that was copied previously. Select **Add secret**.



5. Add another Secret, by entering the name `ACR_PASSWORD` and for the value, paste in the Azure Container Registry **Password** that was copied previously.



6. In your Azure Cloud Shell session connected to the build agent VM, navigate to the `~/Fabmedical` directory:

```
cd ~/Fabmedical
```

7. Before the GitHub Actions workflows can be setup, the `.github/workflows` directory needs to be created. Do this by running the following commands:

```
mkdir ~/Fabmedical/.github
mkdir ~/Fabmedical/.github/workflows
```

8. Navigate to the `.github/workflows` directory:

```
cd ~/Fabmedical/.github/workflows
```

9. Next create the workflow YAML file.

```
vi content-web.yml
```

Add the following as the content. Be sure to replace the following placeholders:

- replace `[SHORT_SUFFIX]` with your short suffix such as `SOL`.

```
name: content-web

# This workflow is triggered on push to the 'content-web' directory of the  master branch of the repository
on:
   push:
      branches:
         - master
      paths:
         - 'content-web/**'

   # Configure workflow to also support triggering manually
   workflow_dispatch:
      inputs:
         logLevel:
            description: 'Log level'
            required: true
            default: 'warning'

# Environment variables are defined so that they can be used throughout the job definitions.
env:
   imageRepository: 'content-web'
   resourceGroupName: 'fabmedical-[SHORT_SUFFIX]'
   containerRegistryName: 'fabmedical[SHORT_SUFFIX]'
   containerRegistry: 'fabmedical[SHORT_SUFFIX].azurecr.io'
   dockerfilePath: './content-web'
   tag: '${{ github.run_id  }}'

# Jobs define the actions that take place when code is pushed to the master branch
jobs:
   build-and-publish-docker-image:
      name: Build and Push Docker Image
      runs-on: ubuntu-latest
      steps:
      # Checkout the repo
      - name: Checkout
      uses: actions/checkout@master

      - name: Set up Docker Buildx
      uses: docker/setup-buildx-action@v1

      - name: Login to ACR
      uses: docker/login-action@v1
      with:
            registry: ${{ env.containerRegistry }}
            username: ${{ secrets.ACR_USERNAME }}
            password: ${{ secrets.ACR_PASSWORD }}

      - name: Build and push an image to container registry
      uses: docker/build-push-action@v2
      with:
            context: ${{ env.dockerfilePath  }}
            file: "${{ env.dockerfilePath }}/Dockerfile"
            pull: true
            push: true
            tags: |
               ${{ env.containerRegistry }}/${{ env.imageRepository }}:${{ env.tag }}
               ${{ env.containerRegistry }}/${{ env.imageRepository }}:latest
```

10. Save the file and exit VI by pressing `<Esc>` then `:wq`.

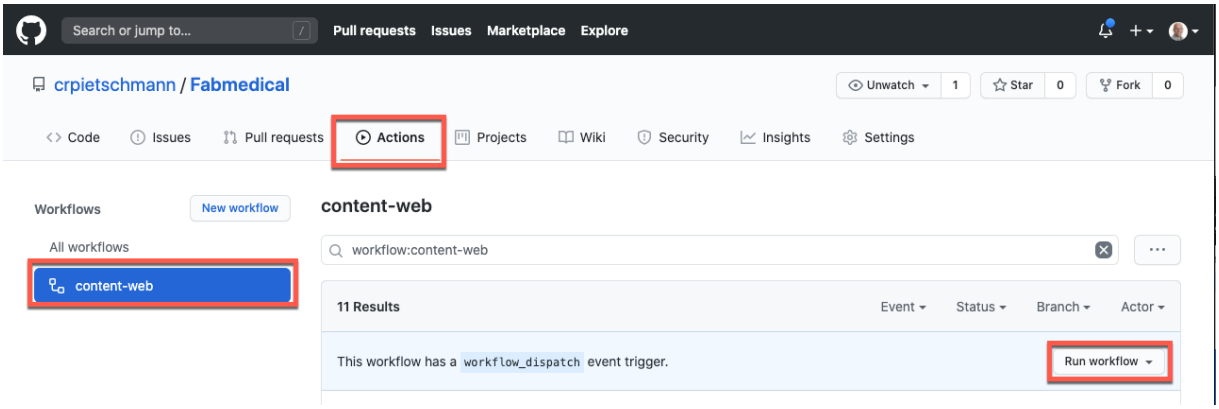
11. Save the pipeline YAML, then commit and push it to the Git repository:

```
git add .
git commit -m "Added workflow YAML"
git push
```

12. In GitHub, return to the **Fabmedical** repository screen, and select the **Actions** tab.

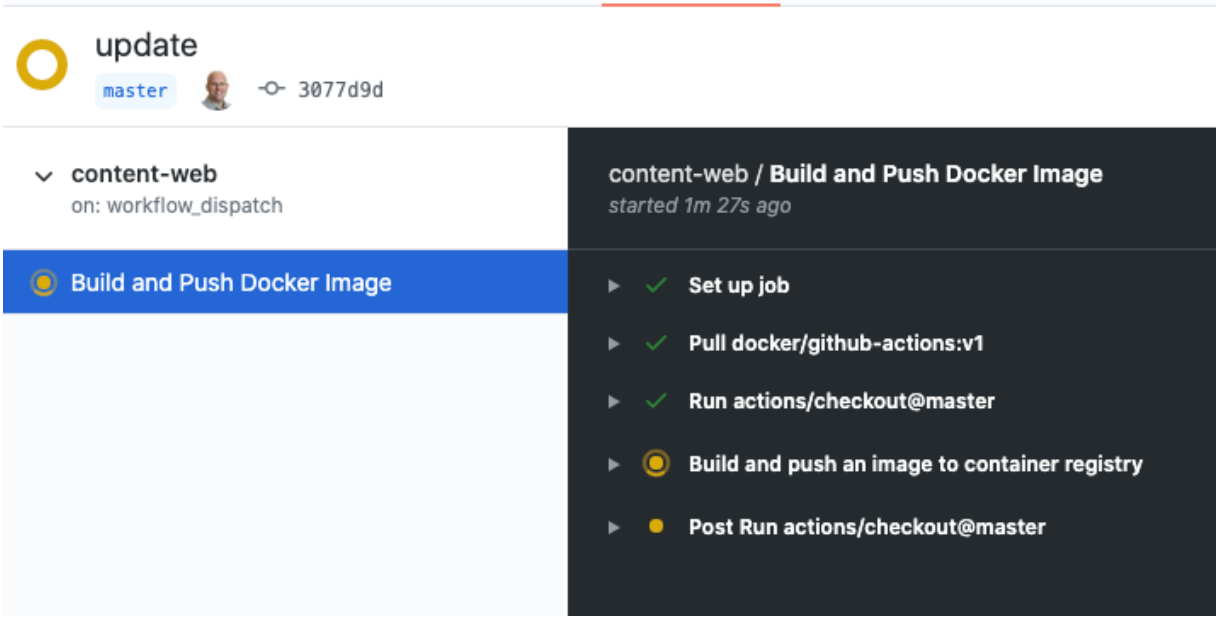
13. On the **Actions** page, select the **content-web** workflow.

14. On the **content-web** workflow, select **Run workflow** and manually trigger the workflow to execute.



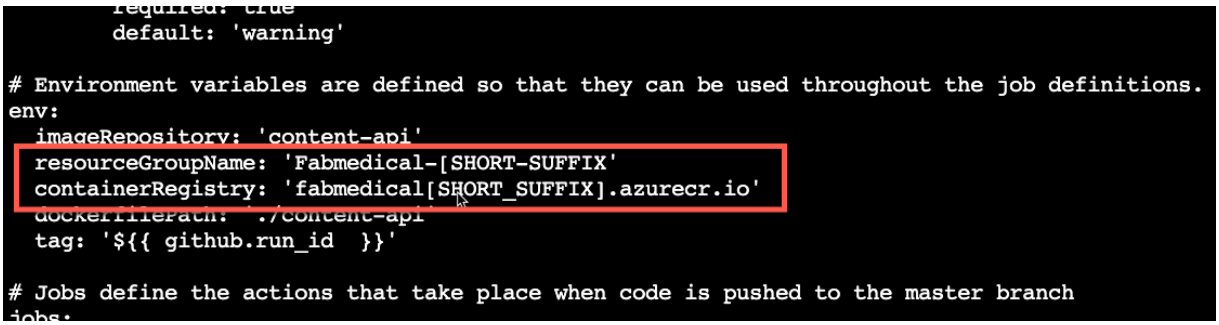
15. After a second, the newly triggered workflow execution will display in the list. Select the new **content-web** execution to view its status.

16. Selecting the **Build and Push Docker Image** job of the workflow will display its execution status.



17. Next, setup the `content-api` workflow. This repository already includes `content-api.yml` located within the `.github/workflows` directory. Open the `.github/workflows/content-api.yml` file for editing.

18. Edit the `resourceGroupName` and `containerRegistry` environment values to replace `[SHORT_SUFFIX]` with your own three-letter suffix so that it matches your container registry's name and resource group.



19. Save the file, then navigate to the repositories in GitHub, select Actions, and then manually run the **content-api** workflow.

20. Next, setup the **content-init** workflow. Follow the same steps as the previous `content-api` workflow for the `content-init.yml` file, remembering to update the `[SHORT_SUFFIX]` value with your own three-letter suffix.

21. Commit and push the changes to the Git repository:

```
git add .
git commit -m "Updated workflow YAML"
git push
```

Exercise 2: Deploy the solution to Azure Kubernetes Service

Duration: 30 minutes

In this exercise, you will connect to the Azure Kubernetes Service cluster you created before the hands-on lab and deploy the Docker application to the cluster using Kubernetes.

Task 1: Tunnel into the Azure Kubernetes Service cluster

In this task, you will gather the information you need about your Azure Kubernetes Service cluster to connect to the cluster and execute commands to connect to the Kubernetes management dashboard from cloud shell.

> **Note**: The following tasks should be executed in cloud shell and not the build machine, so disconnect from build machine if still connected

1. Verify that you are connected to the correct subscription with the following command to show your default subscription:

```
az account show
```

- If you are not connected to the correct subscription, list your subscriptions and then set the subscription by its id with the following commands (similar to what you did in cloud shell before the lab):

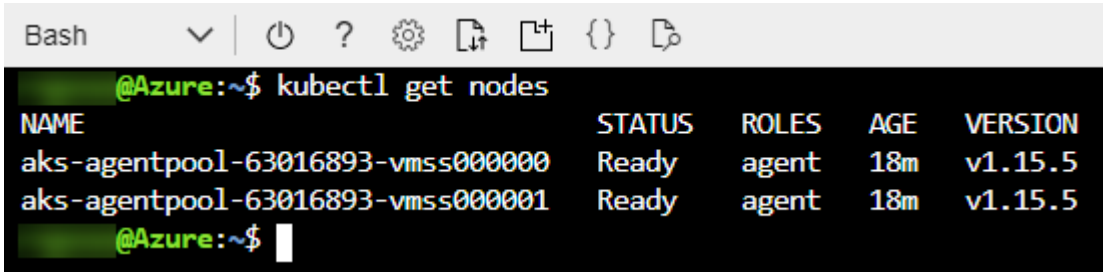
```
az account list
az account set --subscription {id}
```

2. Configure kubectl to connect to the Kubernetes cluster:

```
az aks get-credentials -a --name fabmedical-SUFFIX --resource-group fabmedical-SUFFIX
```

3. Test that the configuration is correct by running a simple kubectl command to produce a list of nodes:

```
kubectl get nodes
```



4. Since the AKS cluster uses RBAC, a ClusterRoleBinding must be created before you can correctly access the dashboard. To create the required binding, execute the command bellow:

```
kubectl create clusterrolebinding kubernetes-dashboard --clusterrole=cluster-admin --serviceaccount=kube-system:kube
```

> **Note**: If you get an error saying `error: failed to create clusterrolebinding: clusterrolebindings.rbac.authorization.k8s.io "kubernetes-dashboard" already exists` just ignore it and move on to the next step.

5. Before you can create an SSH tunnel and connect to the Kubernetes Dashboard, you will need to download the **Kubeconfig** file within Azure Cloud Shell that contains the credentials you will need to authenticate to the Kubernetes Dashboard.

   Within the Azure Cloud Shell, use the following command to download the Kubeconfig file:

   ```
   download /home/<username>/.kube/config
   ```

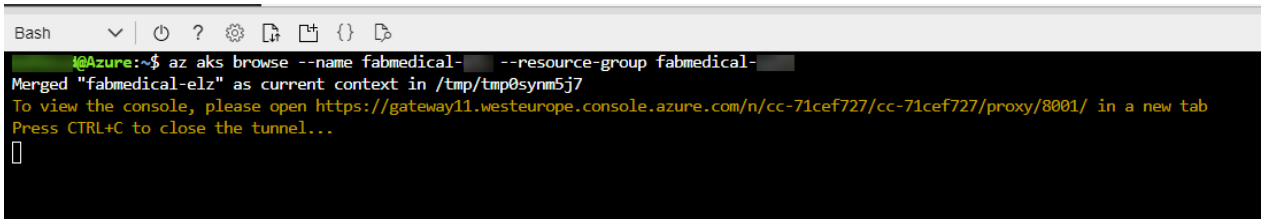
   Make sure to replace the `<username>` placeholder with your name from the command-line in the Azure Cloud Shell.

   > **Note**: You can find the `<username>` from the first part of the Azure Cloud Shell command-line prompt; such as `<username>@Azure:~$`.
   >
   > You can also look in the `/home` directory and so see the directory name that exists within it to find the correct username directory where the Kubeconfig file resides:
   >
   > ```
   > ls /home
   > ```

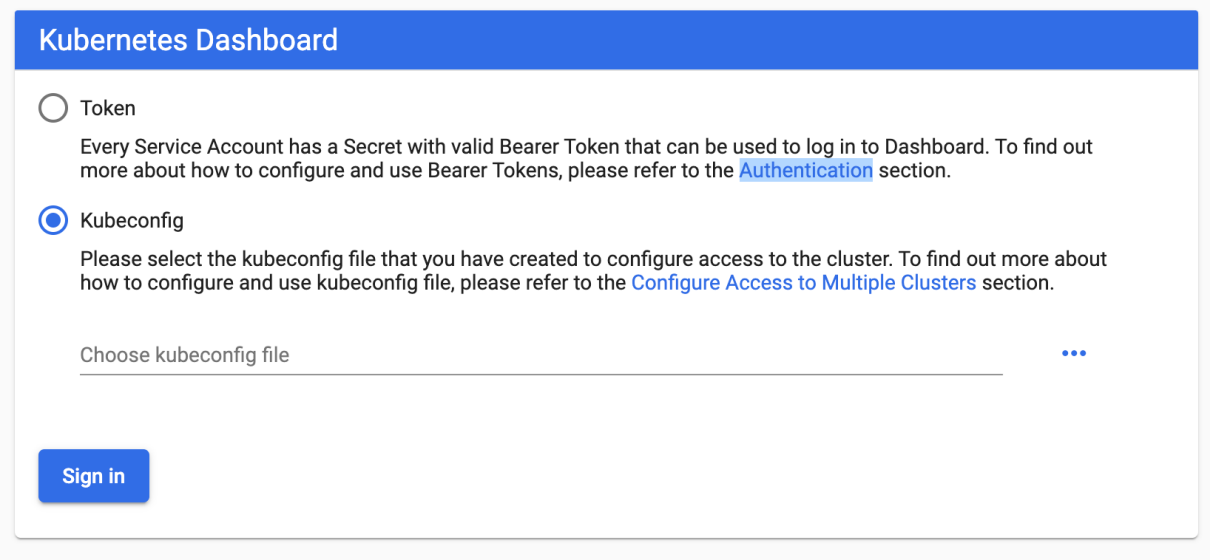
6. Create an SSH tunnel linking a local port (8001) on your cloud shell host to port 443 on the management node of the cluster. Cloud shell will then use the web preview feature to give you remote access to the Kubernetes dashboard. Execute the command below replacing the values as follows:

> **Note**: After you run this command, it may work at first and later lose its connection, so you may have to run this again to reestablish the connection. If the Kubernetes dashboard becomes unresponsive in the browser this is an indication to return here and check your tunnel or rerun the command.

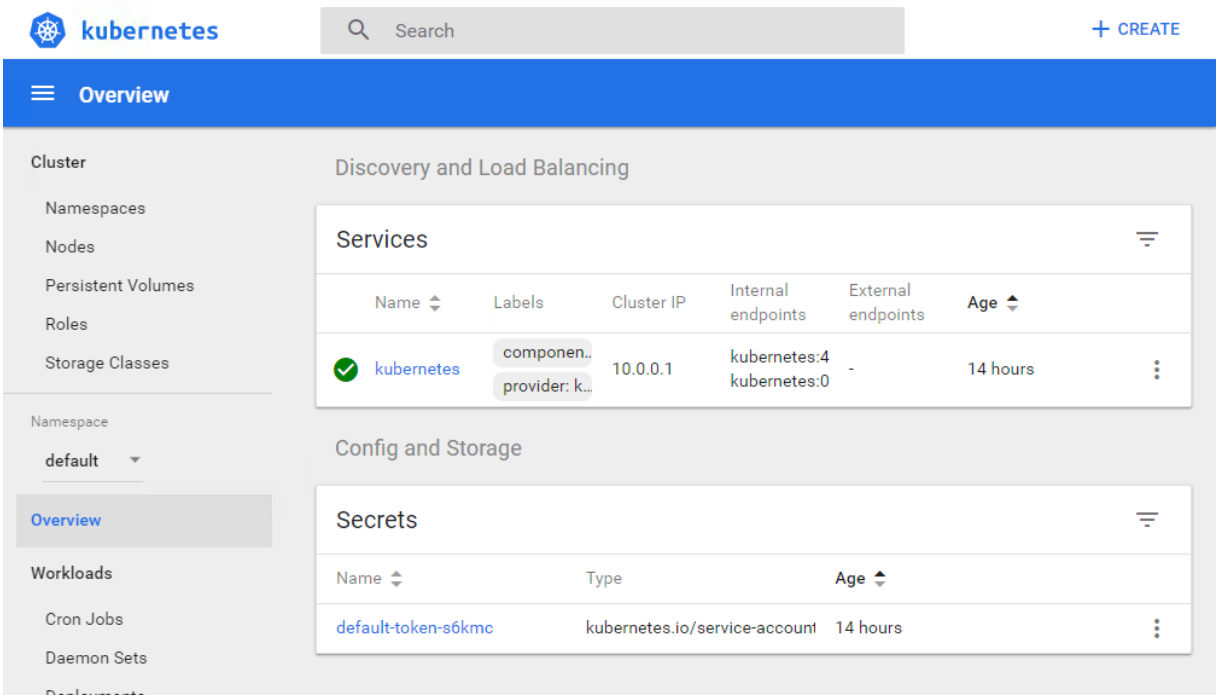
```
az aks browse --name fabmedical-SUFFIX --resource-group fabmedical-SUFFIX
```



7. If the tunnel is successful, you will see the Kubernetes Dashboard authentication screen. Select the **Kubeconfig** option, select the ellipsis (`...`) button, select the **Kubeconfig** file that was previously downloaded, then select **Sign in**.



8. Once authenticated, you will see the Kubernetes management dashboard.



> **Note**: If the tunnel is not successful (if a JSON output is displayed), execute the command below and then return to task 5 above:

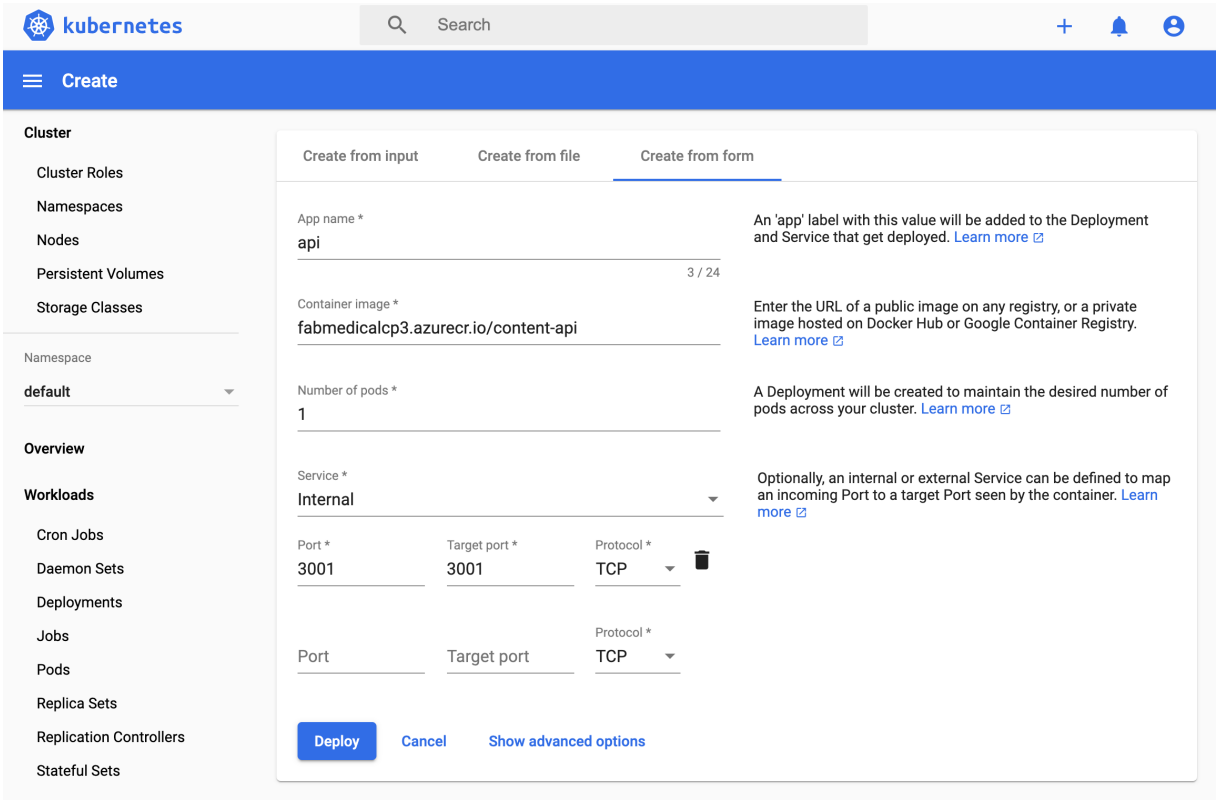
```
az extension add --name aks-preview
```

Task 2: Deploy a service using the Kubernetes management dashboard

In this task, you will deploy the API application to the Azure Kubernetes Service cluster using the Kubernetes dashboard.

1. From the Kubernetes dashboard, select **Create** in the top right corner.

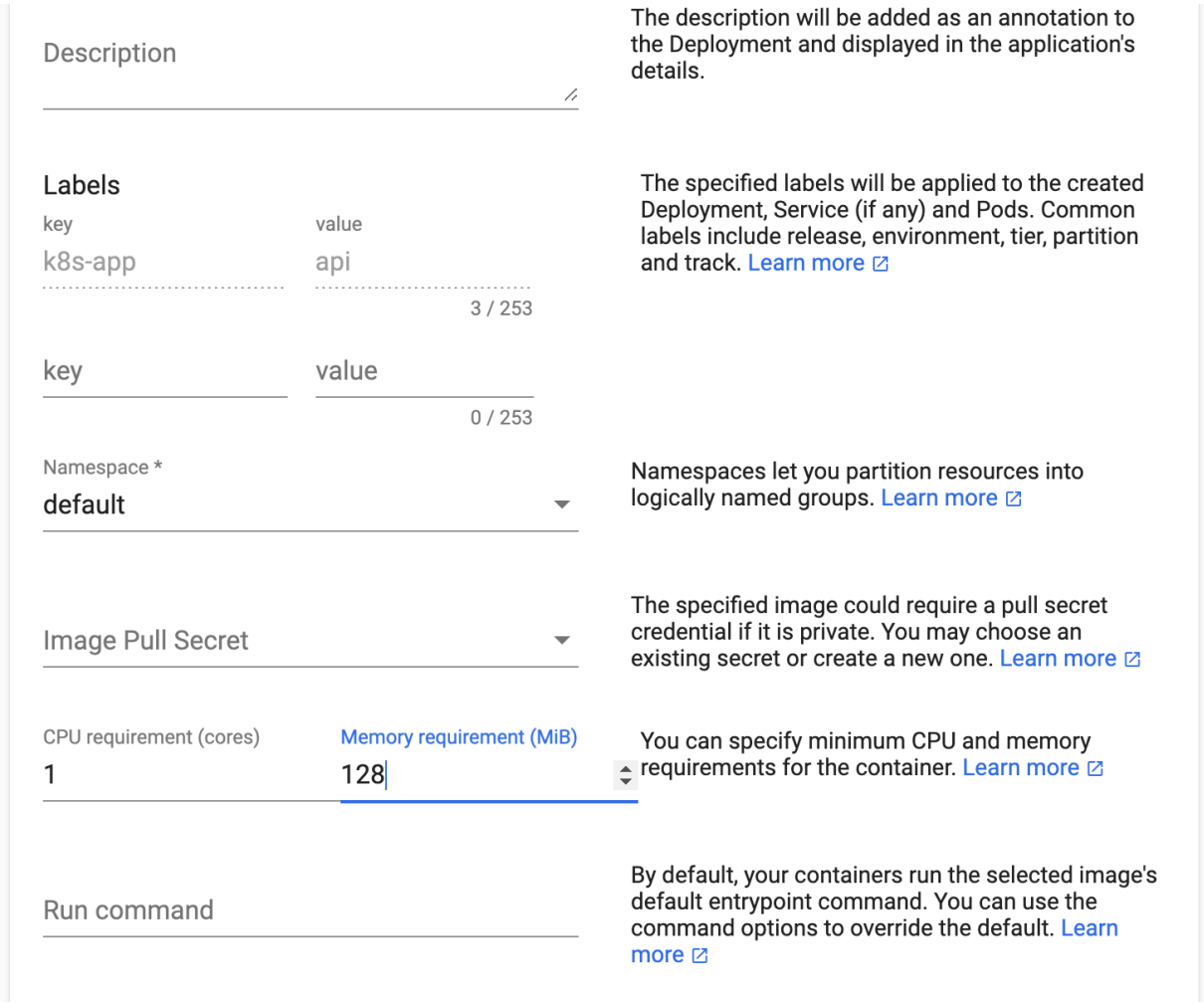
2. From the Resource creation view, select **Create from form**.



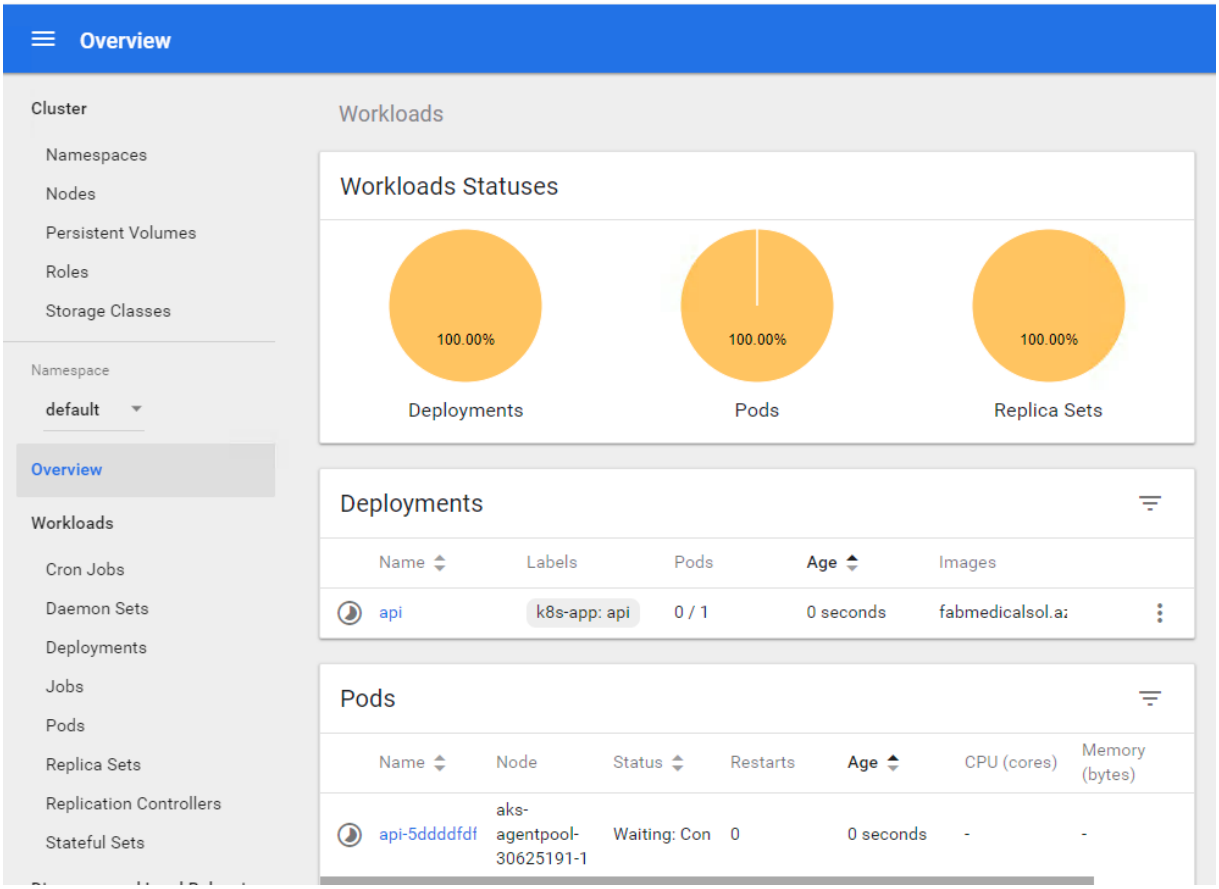
   - Enter `api` for the App name.
   - Enter `[LOGINSERVER]/content-api` for the Container Image, replacing `[LOGINSERVER]` with your ACR login server, such as `fabmedicalsol.azurecr.io`.
   - Set Number of pods to `1`.
   - Set Service to `Internal`.
   - Use `3001` for Port and `3001` for Target port.

3. Select **SHOW ADVANCED OPTIONS**

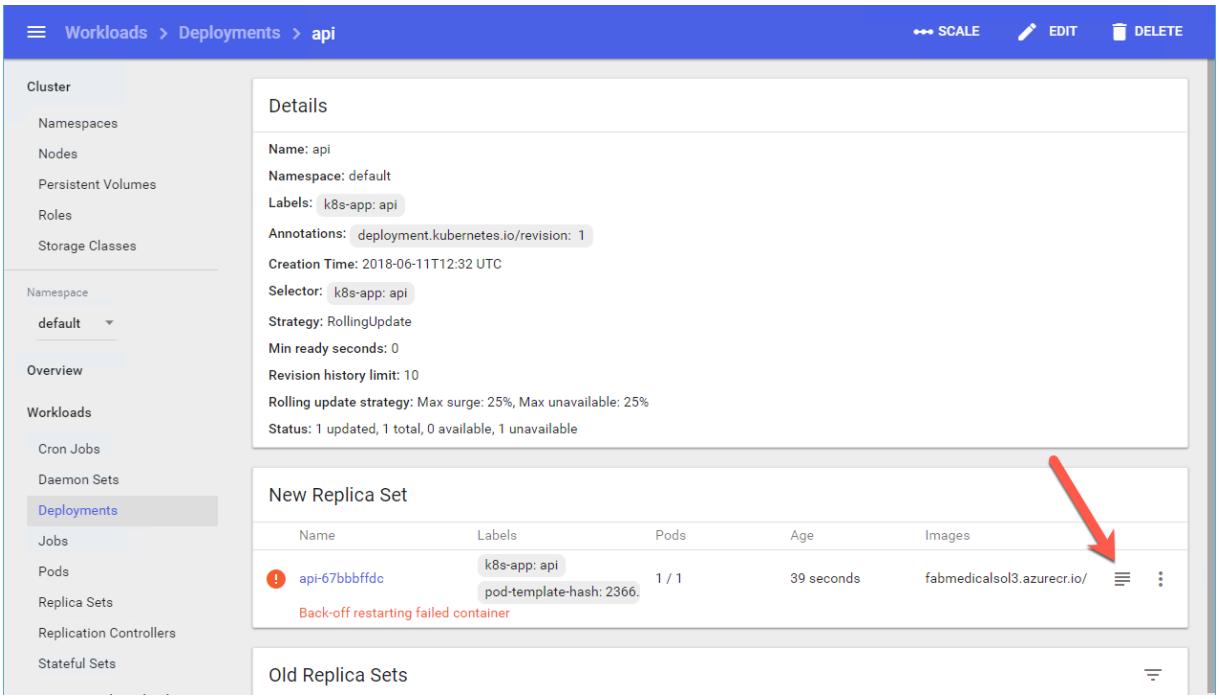
   - Enter `1` for the CPU requirement (cores).
   - Enter `128` for the Memory requirement (MiB).



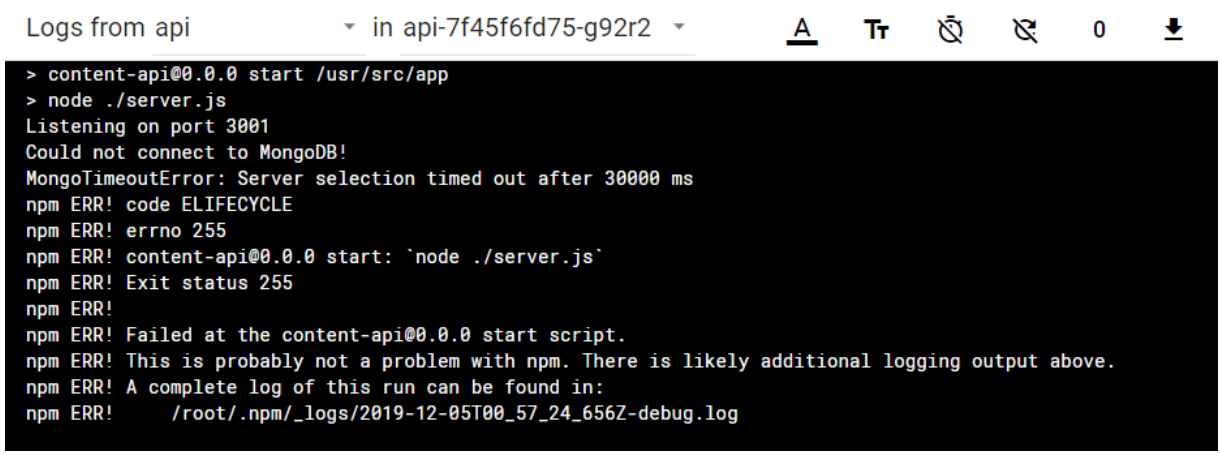
4. Select **Deploy** to initiate the service deployment based on the image. This can take a few minutes. In the meantime, you will be redirected to the Overview dashboard. Select the **API** deployment from the Overview dashboard to see the deployment in progress.



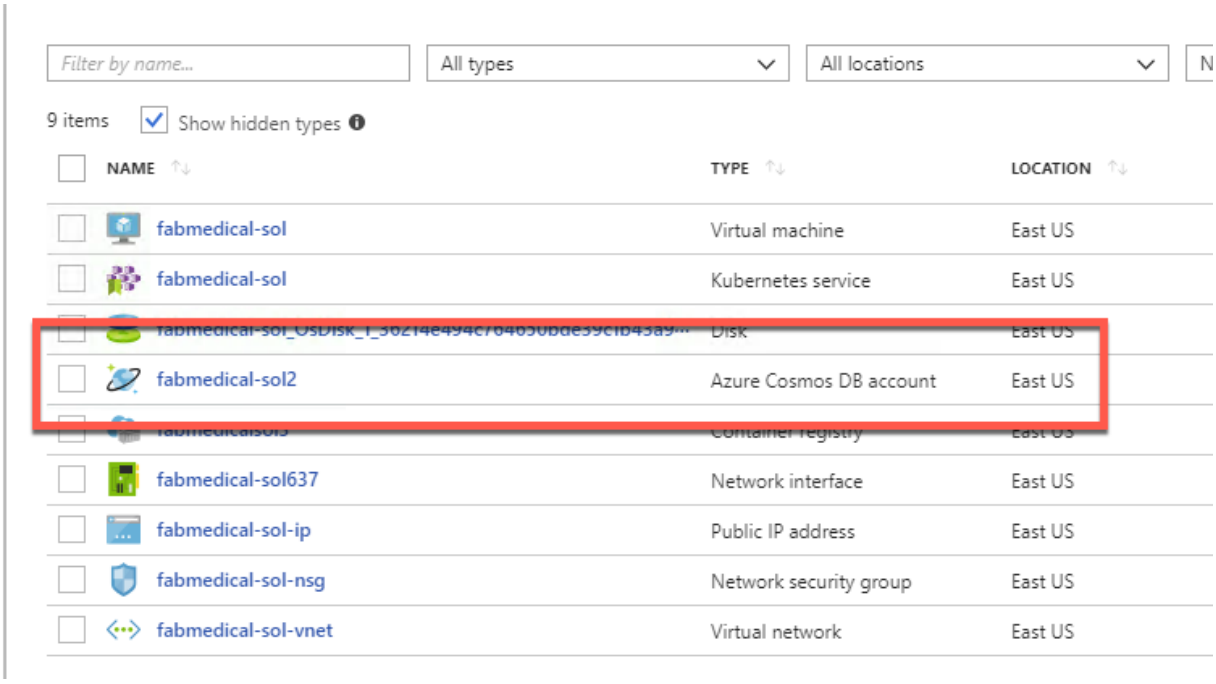
5. Kubernetes indicates a problem with the api Replica Set after some seconds. Select the log icon to investigate.



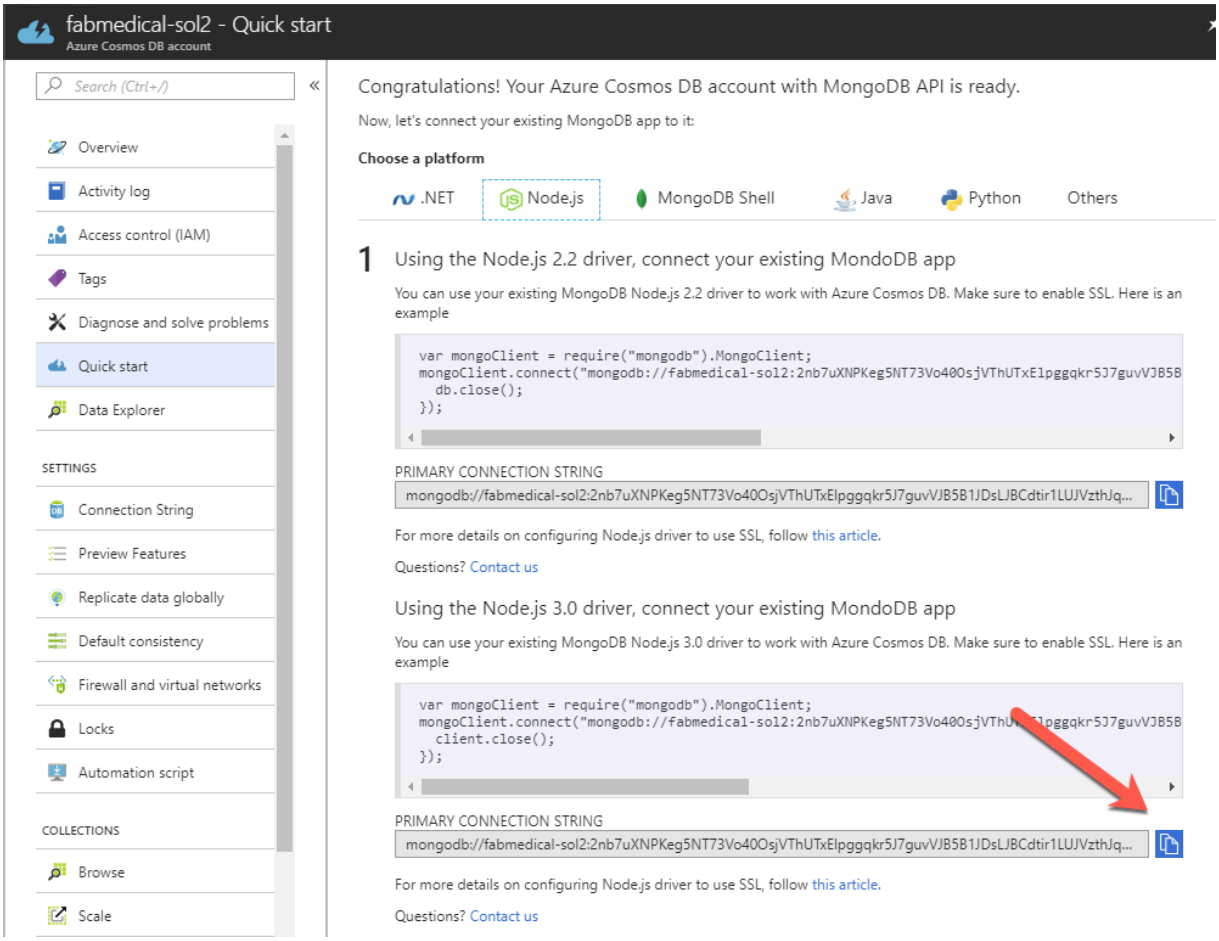
6. The log indicates that the content-api application is once again failing because it cannot find a mongodb api to communicate with. You will resolve this issue by connecting to Cosmos DB.



7. Open the Azure portal in your browser and navigate to your resource group and find your Cosmos DB resource. Select the Cosmos DB resource to view details.



8. Under **Quick Start** select the **Node.js** tab and copy the **Node.js 3.0 connection string**.

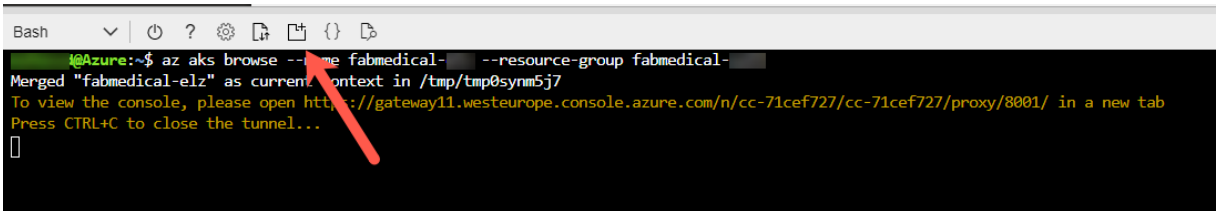


9. Update the provided connection string with a database `contentdb` and a replica set `globaldb`.

> **Note**: Username and password redacted for brevity.

```
mongodb://<USERNAME>:<PASSWORD>@fabmedical-<SUFFIX>.documents.azure.com:10255/contentdb?ssl=true&replicaSet=globaldb
```

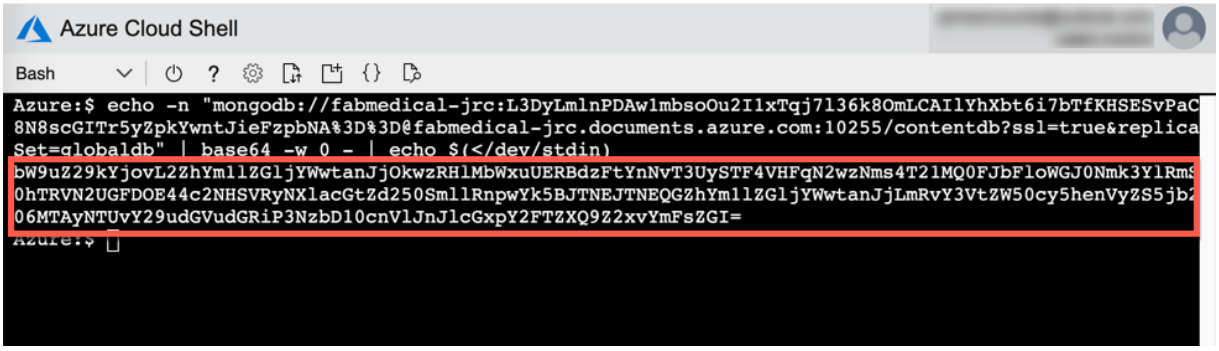
10. To avoid disconnecting from the Kubernetes dashboard, open a **new** Azure Cloud Shell console.



11. You will setup a Kubernetes secret to store the connection string and configure the "content-api" application to access the secret. First, you must base64 encode the secret value. Open your Azure Cloud Shell window and use the following command to encode the connection string and then, copy the output.

> **Note**: Double quote marks surrounding the connection string are required to successfully produce the required output.

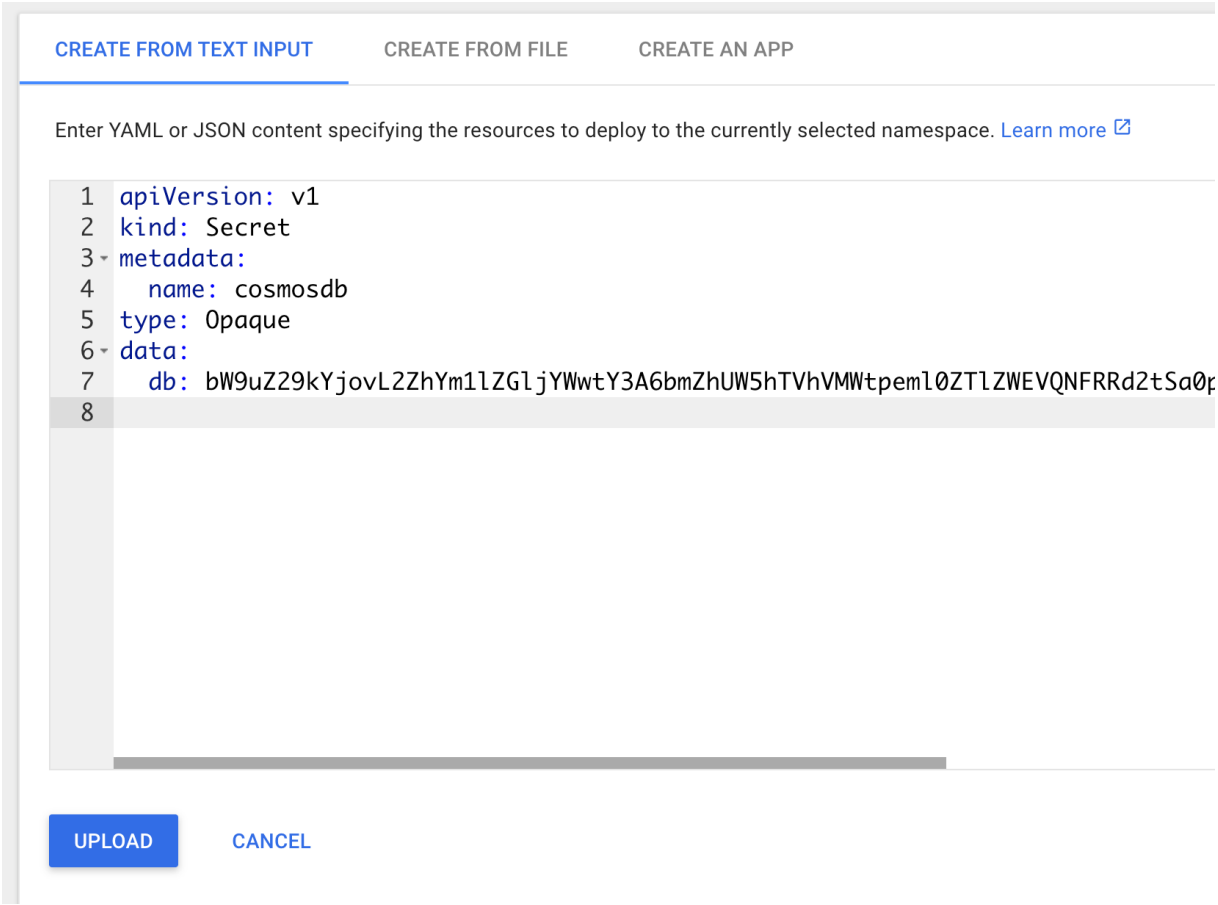
```
echo -n "[CONNECTION STRING VALUE]" | base64 -w 0 - | echo $(</dev/stdin)
```



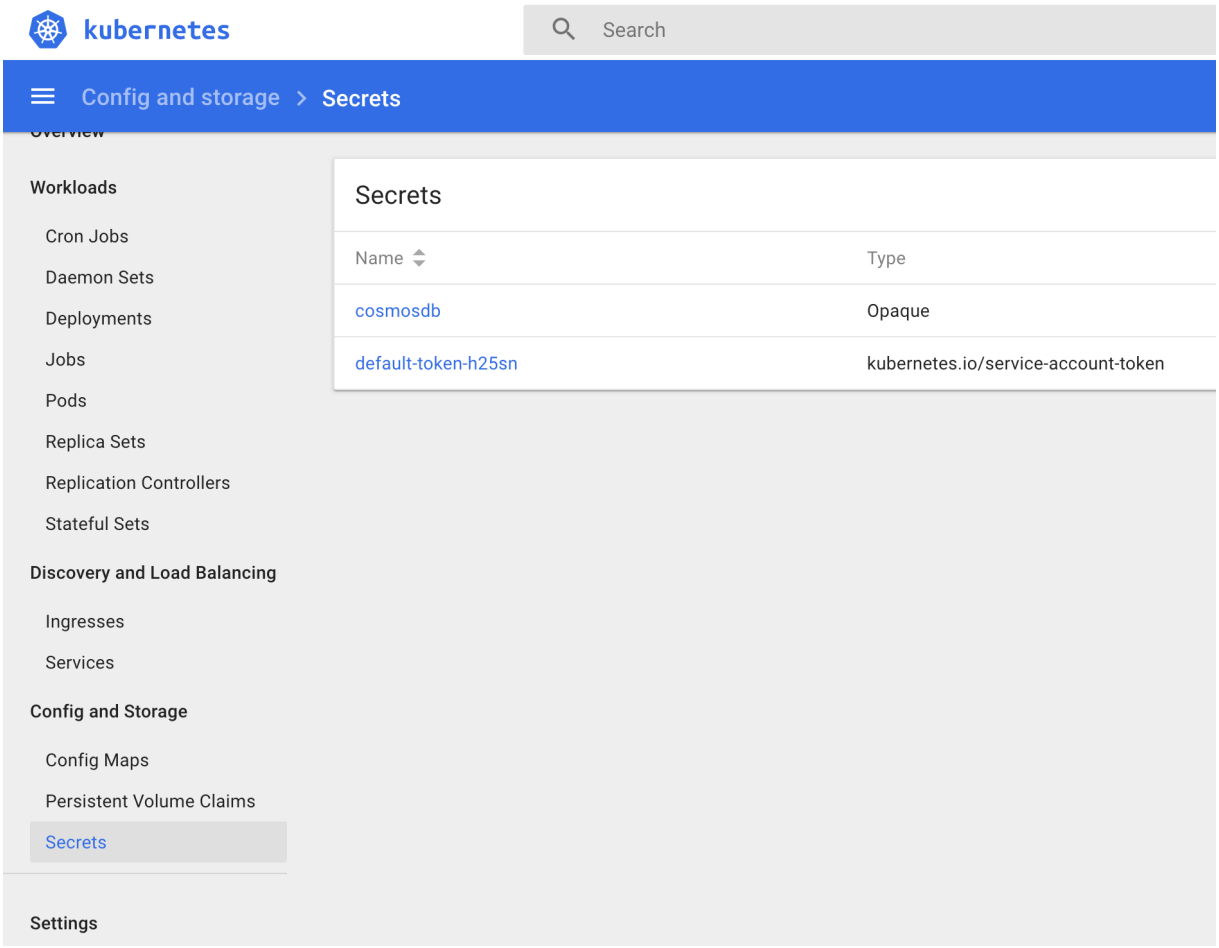
12. Return to the Kubernetes UI in your browser and select **+ Create**.

13. In the **Create from input** tab, update the following YAML with the encoded connection string from your clipboard, paste the YAML data into the create dialog, and choose **Upload**.

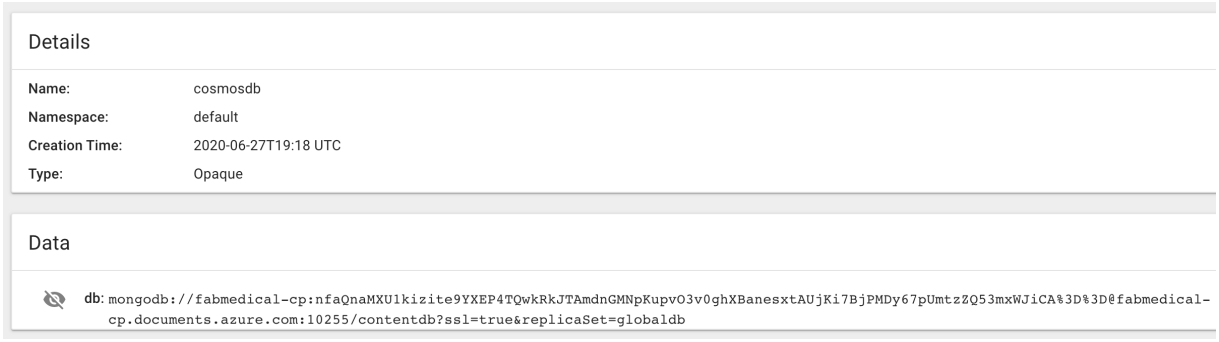
```
apiVersion: v1
kind: Secret
metadata:
  name: cosmosdb
type: Opaque
data:
  db: <base64 encoded value>
```



14. Scroll down in the Kubernetes dashboard until you can see **Secrets** in the left-hand menu. Select it.



15. View the details for the **cosmosdb** secret. Select the eyeball icon to show the secret.



16. Next, download the api deployment configuration using the following command in your Azure Cloud Shell window:

```
kubectl get -o=yaml deployment api > api.deployment.yml
```

17. Edit the downloaded file using cloud shell code editor:

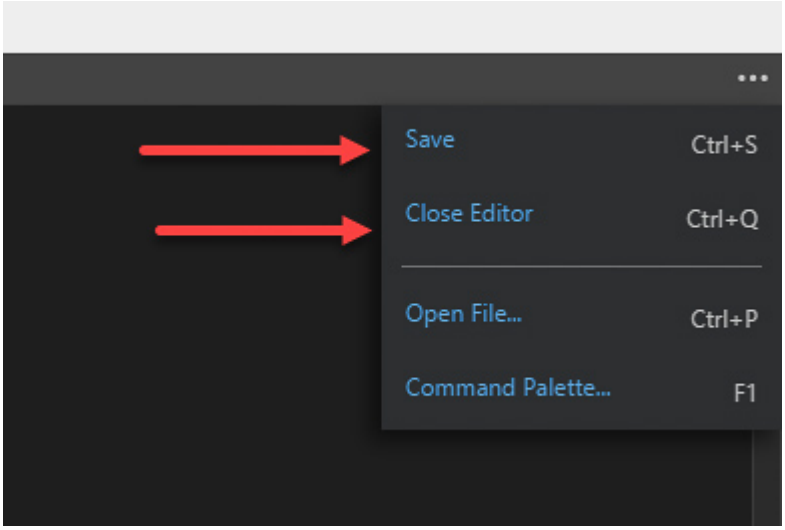
```
code api.deployment.yml
```

Add the following environment configuration to the container spec, below the `image` property:

```
env:
  - name: MONGODB_CONNECTION
    valueFrom:
      secretKeyRef:
        name: cosmosdb
        key: db
```

```
20        rollingUpdate:
21          maxSurge: 25%
22          maxUnavailable: 25%
23        type: RollingUpdate
24      template:
25        metadata:
26          creationTimestamp: null
27          labels:
28            k8s-app: api
29          name: api
30        spec:
31          containers:
32          - image: fabmedicalcp.azurecr.io/content-api
33            env:
34            - name: MONGODB_CONNECTION
35              valueFrom:
36                secretKeyRef:
37                  name: cosmosdb
38                  key: db
39            imagePullPolicy: Always
40            name: api
41            resources:
42              requests:
43                cpu: 125m
44                memory: 128Mi
45            securityContext:
46              privileged: false
47            terminationMessagePath: /dev/termination-log
48            terminationMessagePolicy: File
49          dnsPolicy: ClusterFirst
```

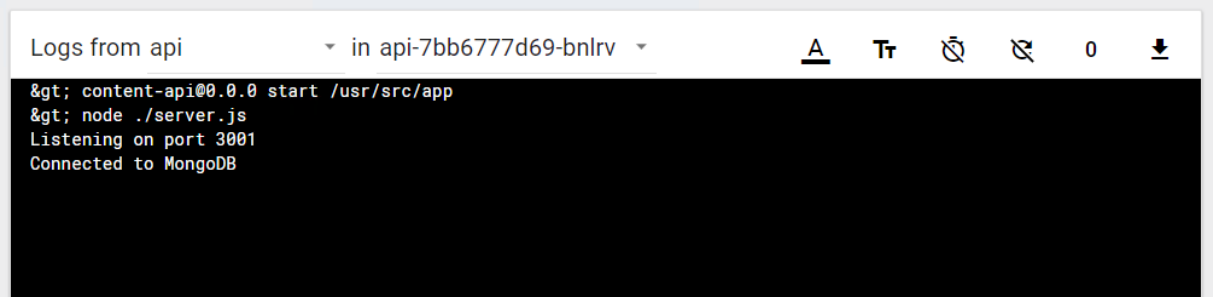
18. Save your changes and close the editor.



19. Update the api deployment by using `kubectl` to apply the new configuration.

```
kubectl apply -f api.deployment.yml
```

20. Select **Deployments** then **api** to view the api deployment. It now has a healthy instance and the logs indicate it has connected to mongodb.



Task 3: Deploy a service using kubectl

In this task, deploy the web service using `kubectl`.

1. Open a **new** Azure Cloud Shell console.

2. Create a text file called `web.deployment.yml` using the Azure Cloud Shell Editor.

```
code web.deployment.yml
```

3. Copy and paste the following text into the editor:

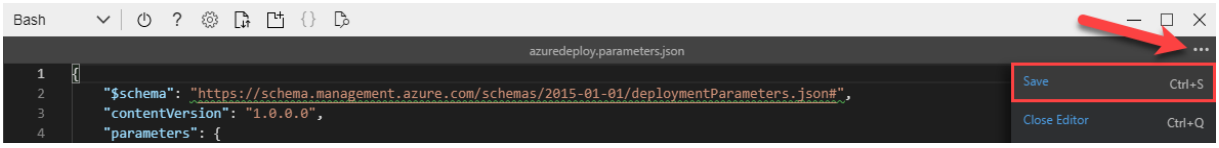
> **Note**: Be sure to copy and paste only the contents of the code block carefully to avoid introducing any special characters.

```
apiVersion: apps/v1
kind: Deployment
metadata:
  labels:
      app: web
  name: web
```

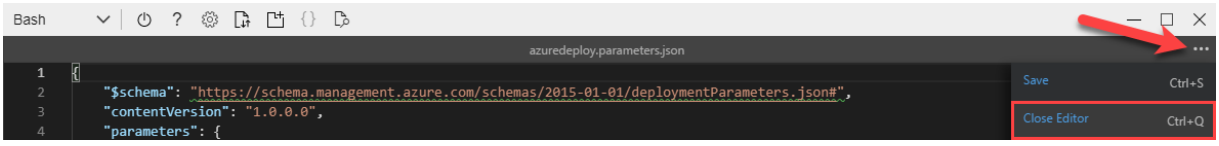
```
spec:
  replicas: 1
  selector:
      matchLabels:
        app: web
  strategy:
      rollingUpdate:
        maxSurge: 1
        maxUnavailable: 1
      type: RollingUpdate
  template:
      metadata:
        labels:
            app: web
        name: web
      spec:
        containers:
        - image: [LOGINSERVER].azurecr.io/content-web
          env:
            - name: CONTENT_API_URL
              value: http://api:3001
          livenessProbe:
            httpGet:
                path: /
                port: 3000
            initialDelaySeconds: 30
            periodSeconds: 20
            timeoutSeconds: 10
            failureThreshold: 3
          imagePullPolicy: Always
          name: web
          ports:
            - containerPort: 3000
              hostPort: 80
              protocol: TCP
          resources:
            requests:
                cpu: 1000m
                memory: 128Mi
          securityContext:
            privileged: false
          terminationMessagePath: /dev/termination-log
          terminationMessagePolicy: File
        dnsPolicy: ClusterFirst
        restartPolicy: Always
        schedulerName: default-scheduler
        securityContext: {}
        terminationGracePeriodSeconds: 30
```

4. Update the `[LOGINSERVER]` entry to match the name of your ACR Login Server.

5. Select the **...** button and choose **Save**.



6. Select the **...** button again and choose **Close Editor**.



7. Create a text file called web.service.yml using the Azure Cloud Shell Editor.

```
code web.service.yml
```

8. Copy and paste the following text into the editor:

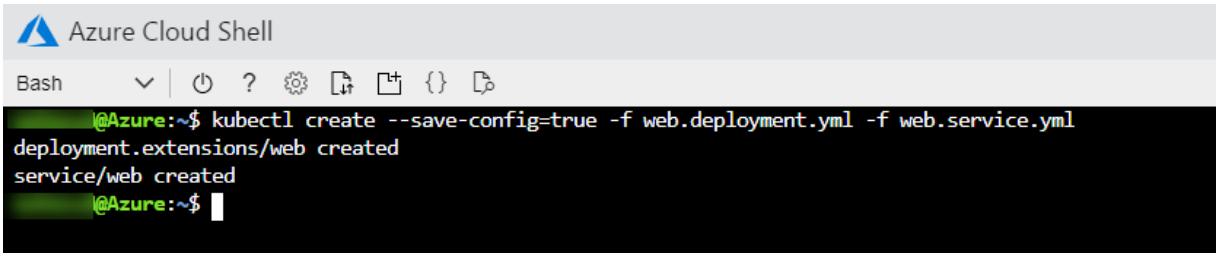
> **Note**: Be sure to copy and paste only the contents of the code block carefully to avoid introducing any special characters.

```
apiVersion: v1
kind: Service
metadata:
  labels:
    app: web
  name: web
spec:
  ports:
    - name: web-traffic
      port: 80
      protocol: TCP
      targetPort: 3000
  selector:
    app: web
  sessionAffinity: None
  type: LoadBalancer
```

9. Save changes and close the editor.

10. Type the following command to deploy the application described by the YAML files. You will receive a message indicating the items kubectl has created a web deployment and a web service.

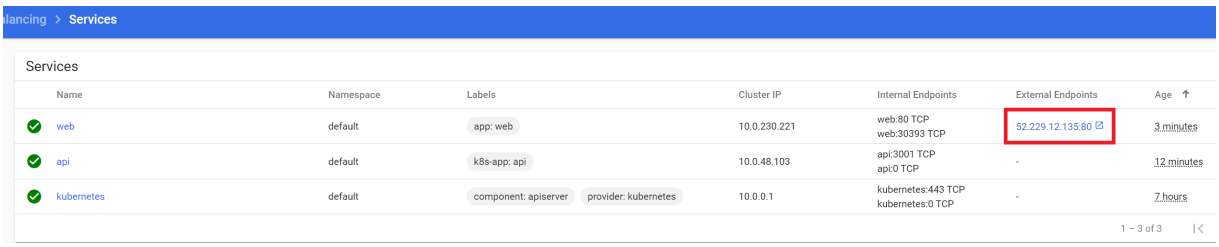
```
kubectl create --save-config=true -f web.deployment.yml -f web.service.yml
```



11. Return to the browser where you have the Kubernetes management dashboard open. From the navigation menu, under **Discovery and Load Balancing**, select the **Services** view.

12. From the Services view, select the `web` service, and from this view, you will see the web service deploying. This deployment can take a few minutes.

13. When it completes, navigate to the main services link, you should be able to access the website via an external endpoint.



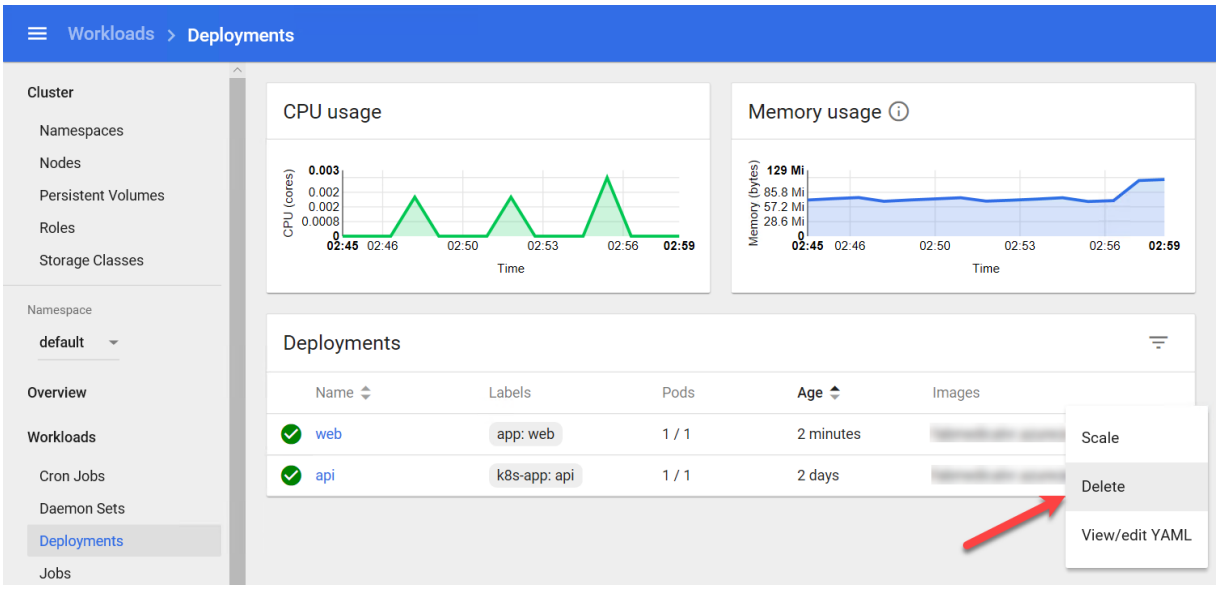
14. In the top navigation, select the `speakers` and `sessions` links. Note that no data is displayed, although we have connected to our Cosmos DB instance, there is no data loaded. You will resolve this by running the content-init application as a Kubernetes Job in Task 5.

Task 4: Deploy a service using a Helm chart

In this task, you will deploy the web service using a Helm chart to streamline the installing and managing the container-based application on the Azure Kubernetes cluster.

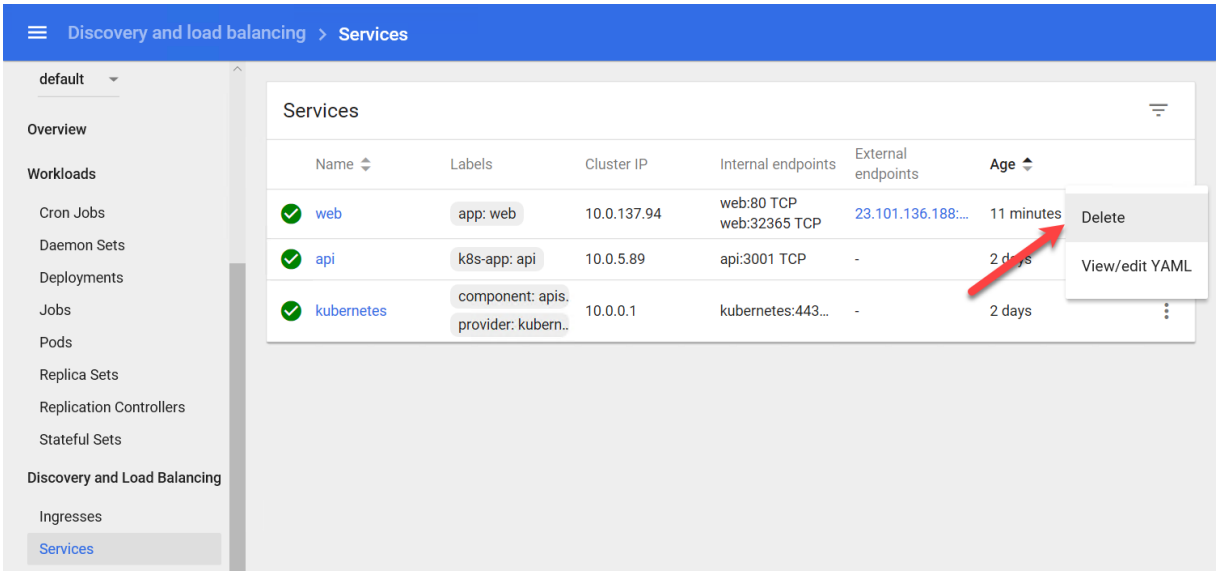
1. From the Kubernetes dashboard, under **Workloads**, select **Deployments**.

2. Select the triple vertical dots on the right of the **web** deployment and then choose **Delete**. When prompted, select **Delete** again.



3. From the Kubernetes dashboard, under **Discovery and Load Balancing**, select **Services**.

4. Select the triple vertical dots on the right of the **web** service and then choose **Delete**. When prompted, select **Delete** again.



5. Open a **new** Azure Cloud Shell console.

6. Update your starter files by pulling the latest changes from the Git repository:

```
cd ~/MCW-Cloud-native-applications/Hands-on\ lab/lab-files/developer/content-web
git pull
```

7. We will use the `helm create` command to scaffold out a chart implementation that we can build on. Use the following commands to create a new chart named `web` in a new directory:

```
mkdir charts
cd charts
helm create web
```

8. We now need to update the generated scaffold to match our requirements. We will first update the file named `values.yaml`.

```
cd web
code values.yaml
```

9. Search for the `image` definition and update the values so that they match the following:

```
image:
  repository: [LOGINSERVER].azurecr.io/content-web
  pullPolicy: Always
```

10. Search for `nameOverride` and `fullnameOverride` entries and update the values so that they match the following:

```
nameOverride: "web"
fullnameOverride: "web"
```

11. Search for the `service` definition and update the values so that they match the following:

```
service:
  type: LoadBalancer
  port: 80
```

12. Search for the `resources` definition and update the values so that they match the following. You are removing the curly braces and adding the `requests`:

```
resources:
  # We usually recommend not to specify default resources and to leave this as a conscious
  # choice for the user. This also increases chances charts run on environments with little
  # resources, such as Minikube. If you do want to specify resources, uncomment the following
  # lines, adjust them as necessary, and remove the curly braces after 'resources:'.
  # limits:
  #  cpu: 100m
  #  memory: 128Mi
  requests:
    cpu: 1000m
    memory: 128Mi
```

13. Save changes and close the editor.

14. We will now update the file named `Chart.yaml`.

```
code Chart.yaml
```

15. Search for the `appVersion` entry and update the value so that it matches the following:

```
appVersion: latest
```

16. We will now update the file named `deployment.yaml`.

```
cd templates
code deployment.yaml
```

17. Search for the `metadata` definition and update the values so that they match the following. You are replacing the line under annotations:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  (...)
spec:
  (...)
  template:
    metadata:
      (...)
      annotations:
        rollme: {{ randAlphaNum 5 | quote }}
```

18. Search for the `containers` definition and update the values so that they match the following. You are changing the containerPort, livenessProbe port and adding the env variable:

```
containers:
  - name: {{ .Chart.Name }}
    securityContext:
      {{- toYaml .Values.securityContext | nindent 12 }}
    image: "{{ .Values.image.repository }}:{{ .Chart.AppVersion }}"
    imagePullPolicy: {{ .Values.image.pullPolicy }}
    ports:
      - name: http
        containerPort: 3000
        protocol: TCP
    env:
      - name: CONTENT_API_URL
        value: http://api:3001
    livenessProbe:
      httpGet:
        path: /
        port: 3000
```

19. Save changes and close the editor.

20. We will now update the file named `service.yaml`.

```
code service.yaml
```

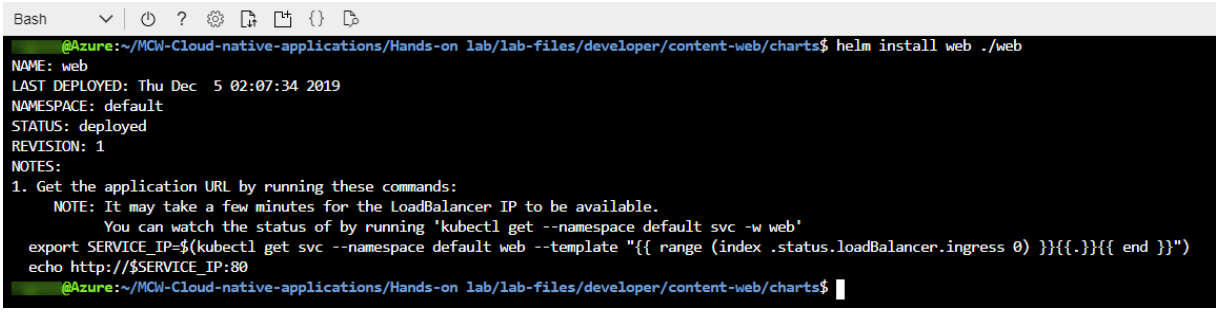
21. Search for the `ports` definition and update the values so that they match the following:

```
ports:
  - port: {{ .Values.service.port }}
    targetPort: 3000
    protocol: TCP
    name: http
```

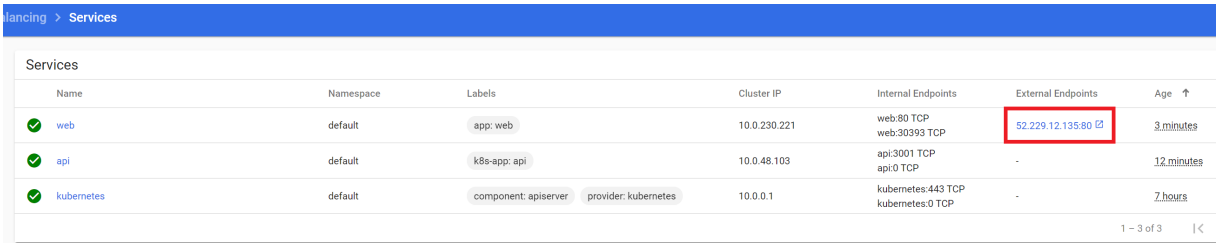
22. Save changes and close the editor.

23. The chart is now setup to run our web container. Type the following command to deploy the application described by the YAML files. You will receive a message indicating that helm has created a web deployment and a web service.

```
cd ../..
helm install web ./web
```



24. Return to the browser where you have the Kubernetes management dashboard open. From the navigation menu, select **Services** view under **Discovery and Load Balancing**. From the Services view, select the **web** service, and from this view, you will see the web service deploying. This deployment can take a few minutes. When it completes, you should be able to access the website via an external endpoint.



25. Select the speakers and sessions links. Note that no data is displayed, although we have connected to our Cosmos DB instance, there is no data loaded. You will resolve this by running the content-init application as a Kubernetes Job.

26. We will now persist the changes into the repository. Execute the following commands:

```
cd ..
git pull
git add charts/
git commit -m "Helm chart added."
git push
```

Task 5: Initialize database with a Kubernetes Job

In this task, you will use a Kubernetes Job to run a container that is meant to execute a task and terminate, rather than run all the time.

1. Create a text file called `init.job.yml` using the Azure Cloud Shell Editor.

```
code init.job.yml
```

2. Copy and paste the following text into the editor:

> **Note**: Be sure to copy and paste only the contents of the code block carefully to avoid introducing any special characters.

```
apiVersion: batch/v1
kind: Job
metadata:
```

```
    name: init
  spec:
    template:
      spec:
        containers:
        - name: init
          image: [LOGINSERVER]/content-init
          env:
            - name: MONGODB_CONNECTION
              valueFrom:
                secretKeyRef:
                  name: cosmosdb
                  key: db
        restartPolicy: Never
    backoffLimit: 4
```

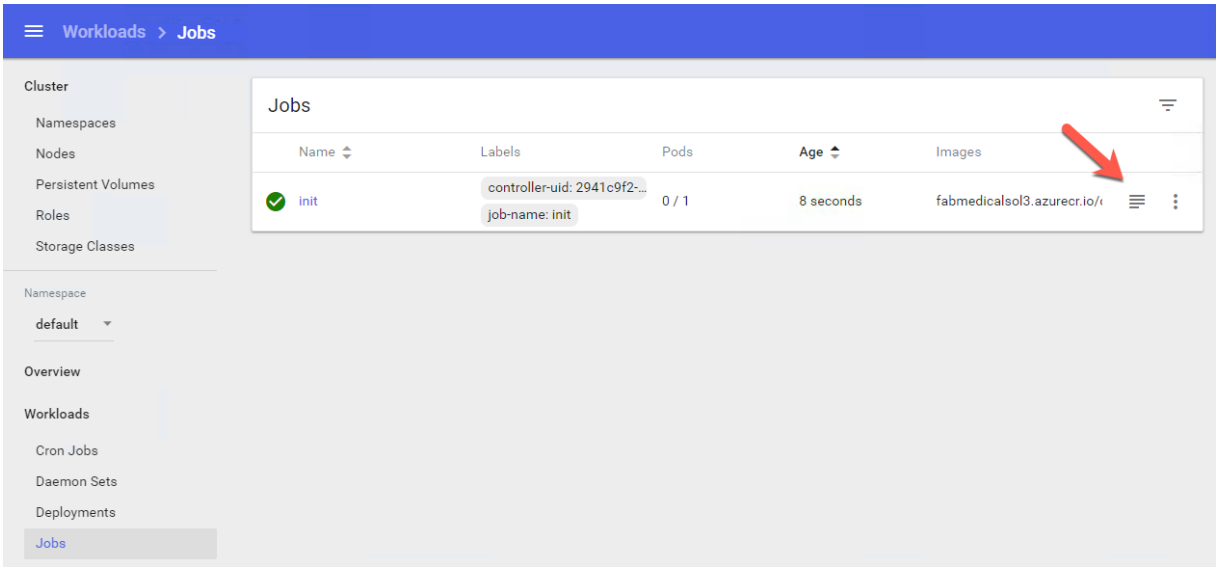
3. Edit this file and update the `[LOGINSERVER]` entry to match the name of your ACR Login Server.

4. Save changes and close the editor.

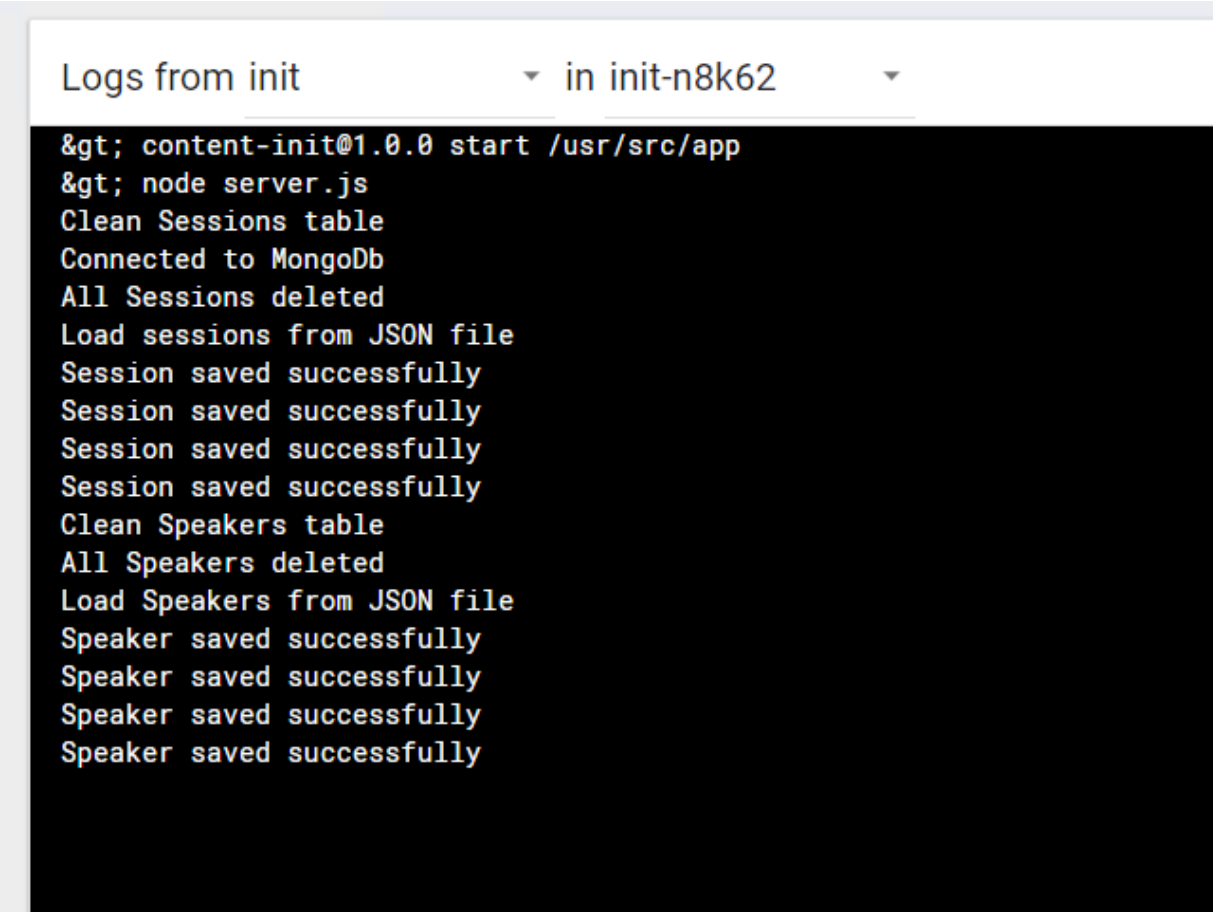
5. Type the following command to deploy the job described by the YAML. You will receive a message indicating the kubectl has created an init "job.batch".

```
kubectl create --save-config=true -f init.job.yml
```

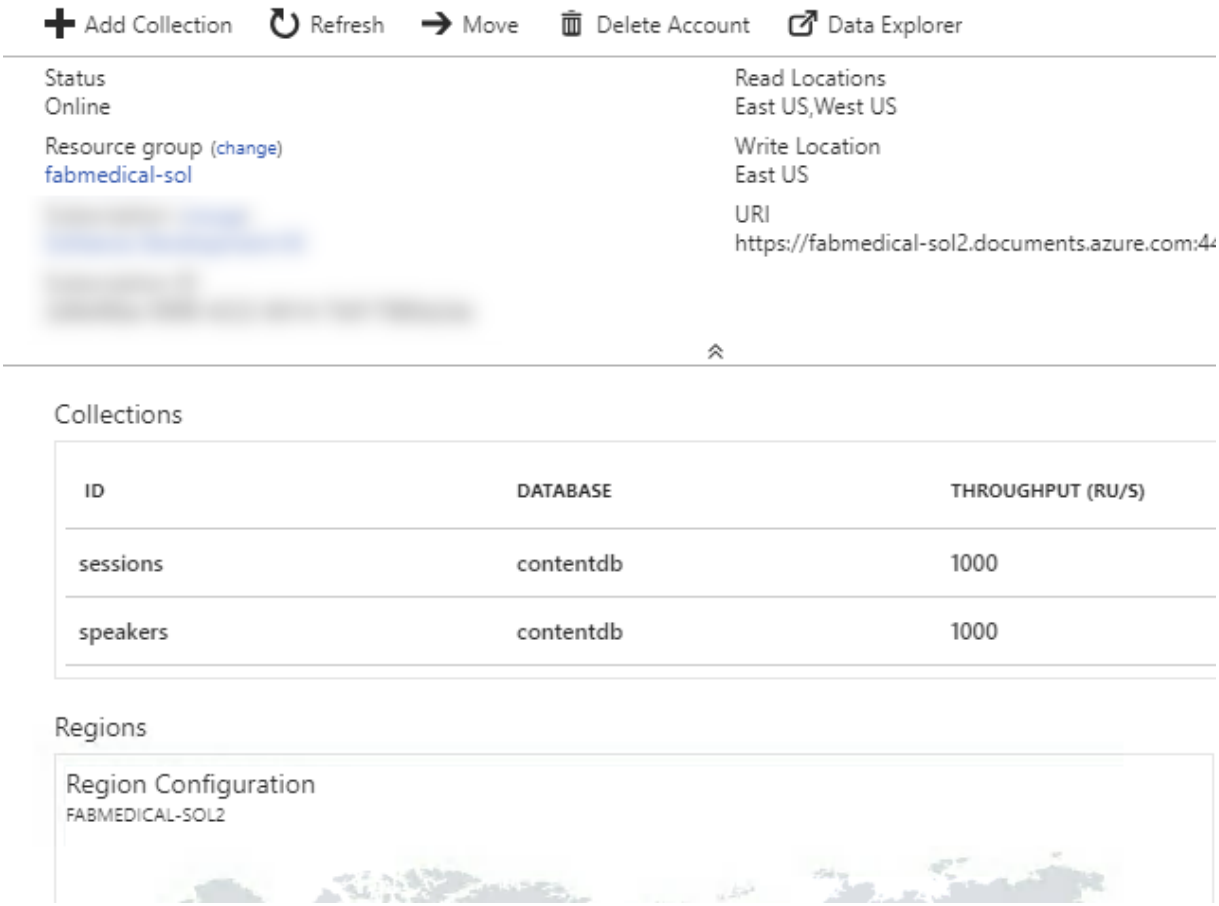
6. View the Job by selecting **Jobs** under **Workloads** in the Kubernetes UI.



7. Select virtual ellipses and then select **Logs**.



8. Next view your Cosmos DB instance in the Azure portal and see that it now contains two collections.

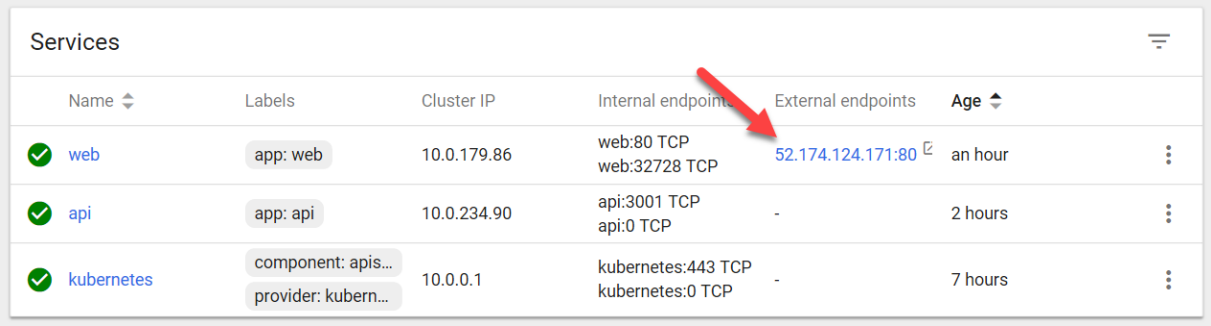


Task 6: Test the application in a browser

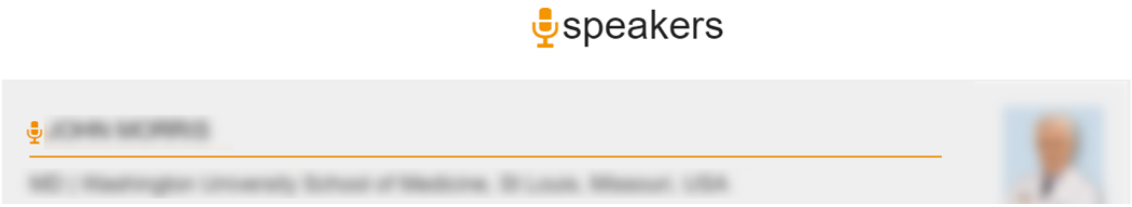
In this task, you will verify that you can browse to the web service you have deployed and view the speaker and content information exposed by the API service.

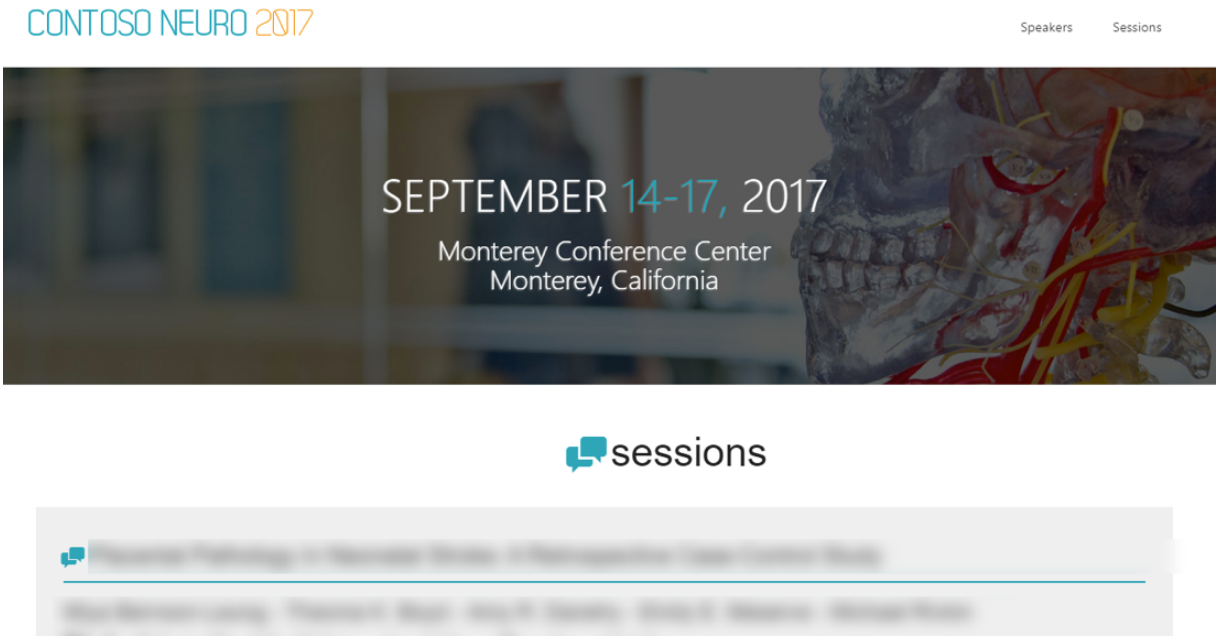
1. From the Kubernetes management dashboard, in the navigation menu, select the **Services** view under **Discovery and Load Balancing**.

2. In the list of services, locate the external endpoint for the `web` service and select this hyperlink to launch the application.



3. You will see the `web` application in your browser and be able to select the Speakers and Sessions links to view those pages without errors. The lack of errors means that the web application is correctly calling the API service to show the details on each of those pages.





Task 7: Configure Continuous Delivery to the Kubernetes Cluster

In this task, you will use GitHub Actions workflows to automate the process for deploying the web image to the AKS cluster. You will update the workflow and configure a job so that when new images are pushed to the ACR, the pipeline deploys the image to the AKS cluster.

1. Navigate to the `.github/workflows` folder of the git repository, and open the `content-web.yml` workflow using `vi`:

```
cd ~/MCW-Cloud-native-applications/Hands-on\ lab/lab-files/developer/.github/workflows
vi content-web.yml
```

2. You will add a second job to the bottom of the `content-web.yml` workflow. Paste the following at the end of the file:

> **Note**: Be careful to check your indenting when pasting. The `build-and-push-helm-chart` node should be indented with 2 spaces and line up with the node for the `build-and-publish-docker-image` job.

```
  build-and-push-helm-chart:
    name: Build and Push Helm Chart
    runs-on: ubuntu-latest
    needs: [build-and-publish-docker-image]
    steps:
    # Checkout the repo
    - uses: actions/checkout@master

    - name: Helm Install
      uses: azure/setup-helm@v1

    - name: Helm Repo Add
      run: |
        helm repo add ${{ env.containerRegistryName }} https://${{ env.containerRegistry }}/helm/v1/repo --username ${{ secrets.ACR_
      env:
        HELM_EXPERIMENTAL_OCI: 1

    - name: Helm Chart Save
      run: |
        cd ./content-web/charts/web

        helm chart save . content-web:v${{ env.tag }}
        helm chart save . ${{ env.containerRegistry }}/helm/content-web:v${{ env.tag }}

        # list out saved charts
        helm chart list
      env:
```

```
        HELM_EXPERIMENTAL_OCI: 1

    - name: Helm Chart Push
      run: |
        helm registry login ${{ env.containerRegistry }} --username ${{ secrets.ACR_USERNAME }} --password ${{ secrets.ACR_PASSWORD
        helm chart push ${{ env.containerRegistry }}/helm/content-web:v${{ env.tag }}
      env:
        HELM_EXPERIMENTAL_OCI: 1</code></pre></li>
```

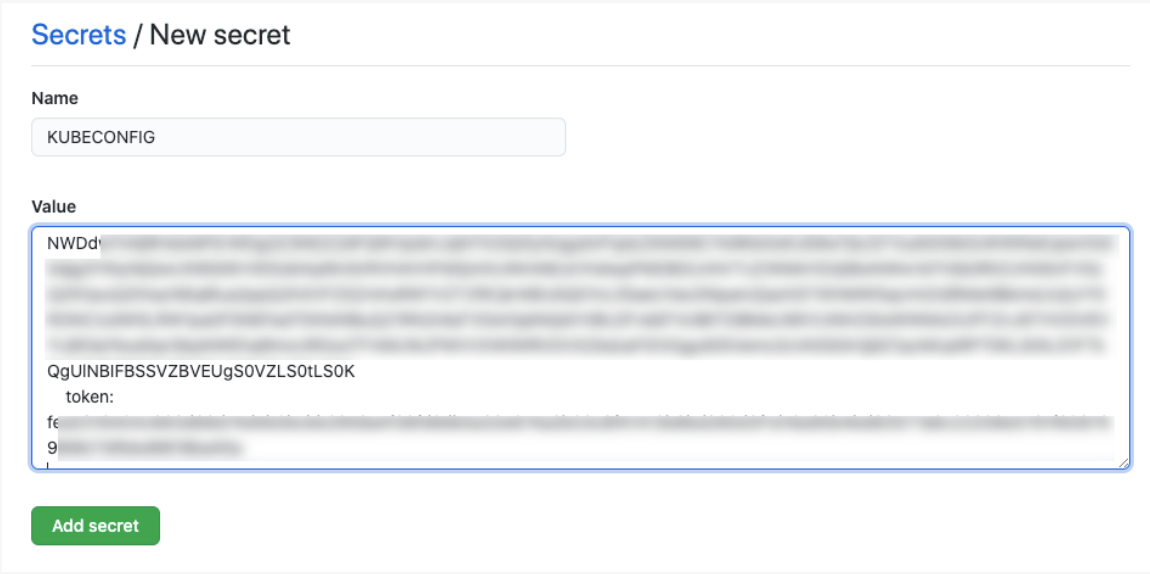
3. Save the file.

4. In the Azure Cloud Shell, use the following command to output the `/.kube/config` file that contains the credentials fo

```
cat ~/.kube/config
```

5. In GitHub, return to the **Fabmedical** repository screen, select the **Settings** tab, select **Secrets** from the left menu,

6. Create a new GitHub Secret with the Name of `KUBECONFIG` and paste in the contents of the `~/.kube/config` file that was pr



7. Now return to edit the `content-web.yml` workflow and paste the following at the end of the file.

> **Note**: Be careful to check your indenting when pasting. The `aks-deployment` node should be indented with 2 spaces a

```
  aks-deployment:
    name: AKS Deployment
    runs-on: ubuntu-latest
    needs: [build-and-publish-docker-image,build-and-push-helm-chart]
    steps:
    # Checkout the repo
    - uses: actions/checkout@master
```

```
      - name: Helm Install
        uses: azure/setup-helm@v1

      - name: kubeconfig
        run: echo "${{ secrets.KUBECONFIG }}" &gt;&gt; kubeconfig

      - name: Helm Repo Add
        run: |
          helm repo add ${{ env.containerRegistry }} https://${{ env.containerRegistry }}/helm/v1/repo --username ${{ secrets.ACR_USERNAME }} --pass
          helm repo update
        env:
          HELM_EXPERIMENTAL_OCI: 1

      - name: Helm Upgrade
        run: |
          helm registry login ${{ env.containerRegistry }} --username ${{ secrets.ACR_USERNAME }} --password ${{ secrets.ACR_PASSWORD }}
          helm chart pull ${{ env.containerRegistry }}/helm/content-web:v${{ env.tag }}
          helm chart export ${{ env.containerRegistry }}/helm/content-web:v${{ env.tag }} --destination ./upgrade
          helm upgrade web ./upgrade/web
        env:
          KUBECONFIG: './kubeconfig'
          HELM_EXPERIMENTAL_OCI: 1</code></pre></li>
```

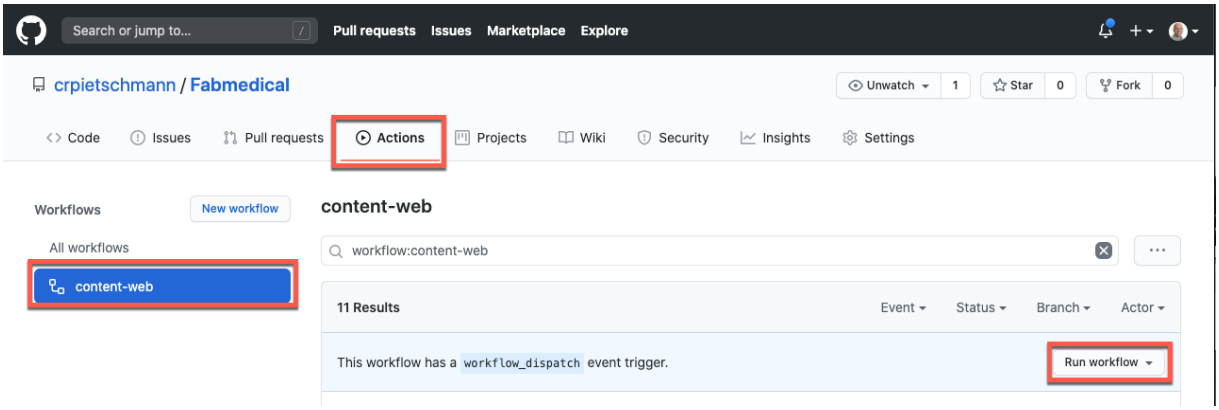
8. Save the file.

9. Commit your changes

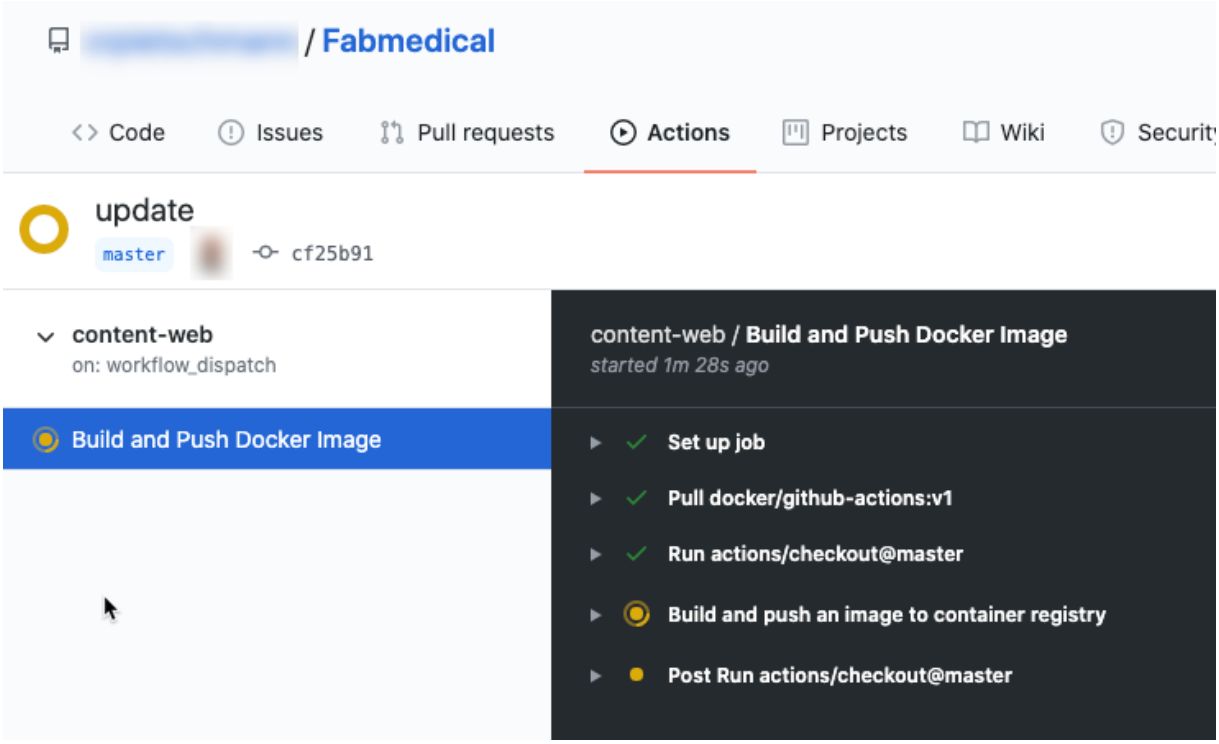
```
cd ..
git pull
git add --all
git commit -m "Deployment update."
git push
```

10. Switch back to GitHub

11. On the **content-web** workflow, select **Run workflow** and manually trigger the workflow to execute.



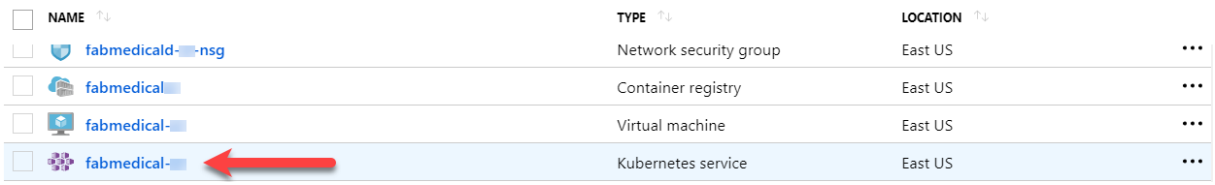
12. Selecting the currently running workflow will display its status.



Task 8: Review Azure Monitor for Containers

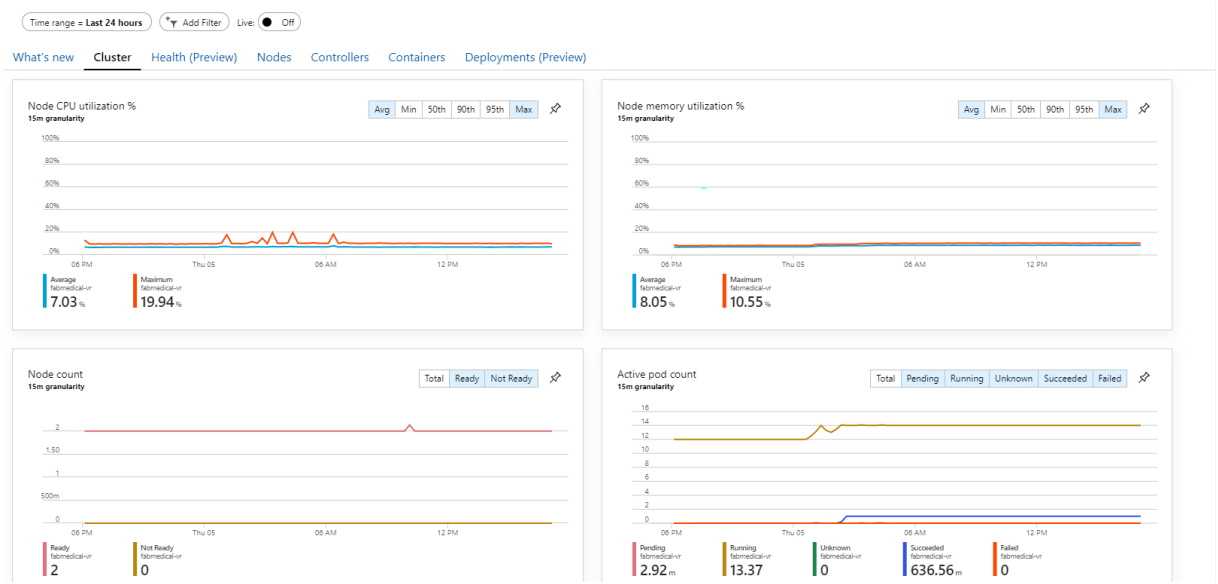
In this task, you will access and review the various logs and dashboards made available by Azure Monitor for Containers.

1. From the Azure Portal, select the resource group you created named `fabmedical-SUFFIX`, and then select your `Kubernetes Service` Azure resource.

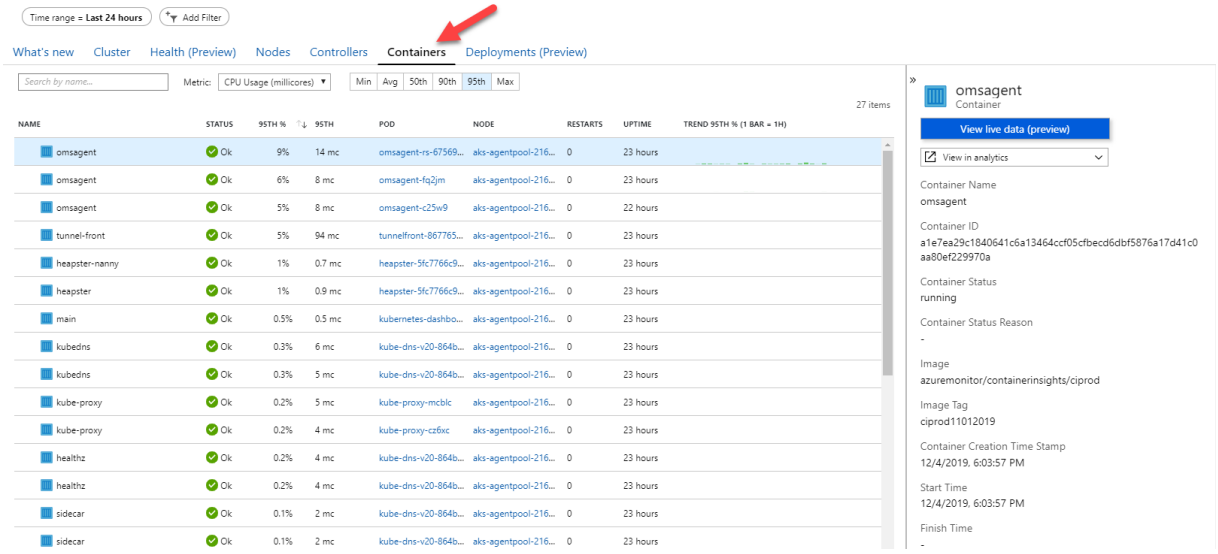


2. From the Monitoring blade, select **Insights**.

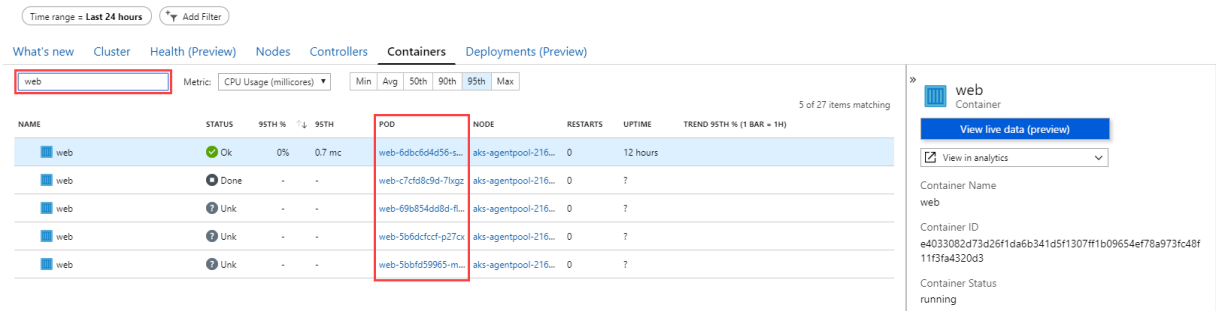
3. Review the various available dashboards and a deeper look at the various metrics and logs available on the Cluster, Nodes, Controllers, and deployed Containers.



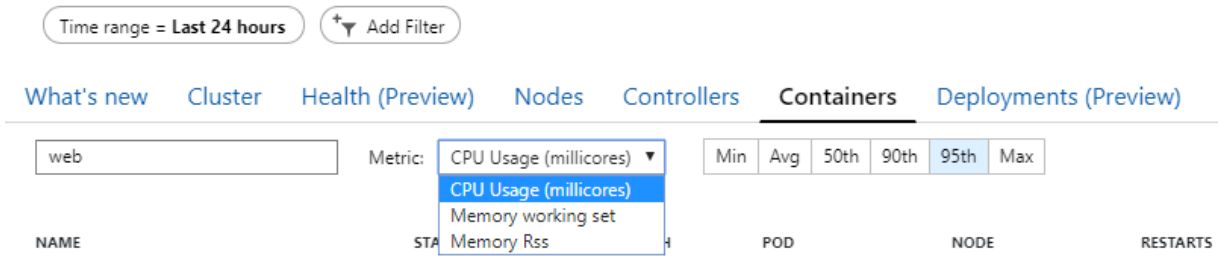
4. To review the Containers dashboards and see more detailed information about each container, select the **Containers** tab.



5. Now filter by container name and search for the **web** containers, you will see all the containers created in the Kubernetes cluster with the pod names. You can compare the names with those in the kubernetes dashboard.



6. By default, the CPU Usage metric will be selected displaying all cpu information for the selected container, to switch to another metric open the metric dropdown list and select a different metric.



7. Upon selecting any pod, all the information related to the selected metric will be displayed on the right panel, and that would be the case when selecting any other metric, the details will be displayed on the right panel for the selected pod.

»

web

Container

View live data (preview)

View in analytics

Container Name

web

Container ID

e4033082d73d26f1da6b341d5f1307ff1b09654ef78a973fc48f11f3fa4320d3

Container Status

running

Container Status Reason

-

Image

content-web

Image Tag

latest

Container Creation Time Stamp

12/5/2019, 4:18:30 AM

Start Time

12/5/2019, 4:18:30 AM

Finish Time

-

CPU Limit

1900 mc

CPU Request

1000 mc

Memory Limit

4.45 GB

Memory Request

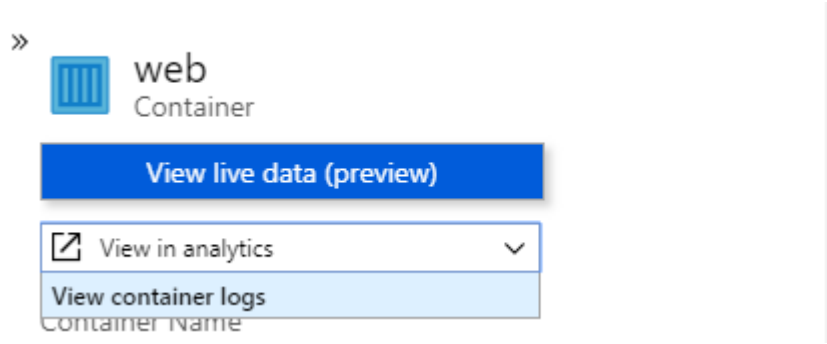
128 MB

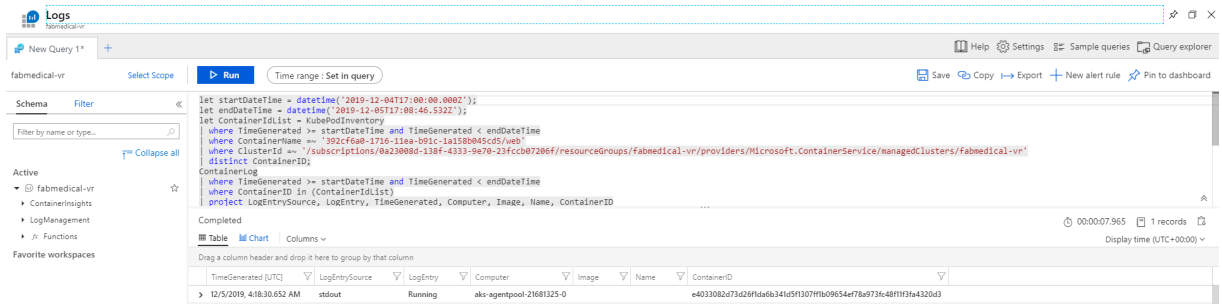
Last reported

16 secs ago

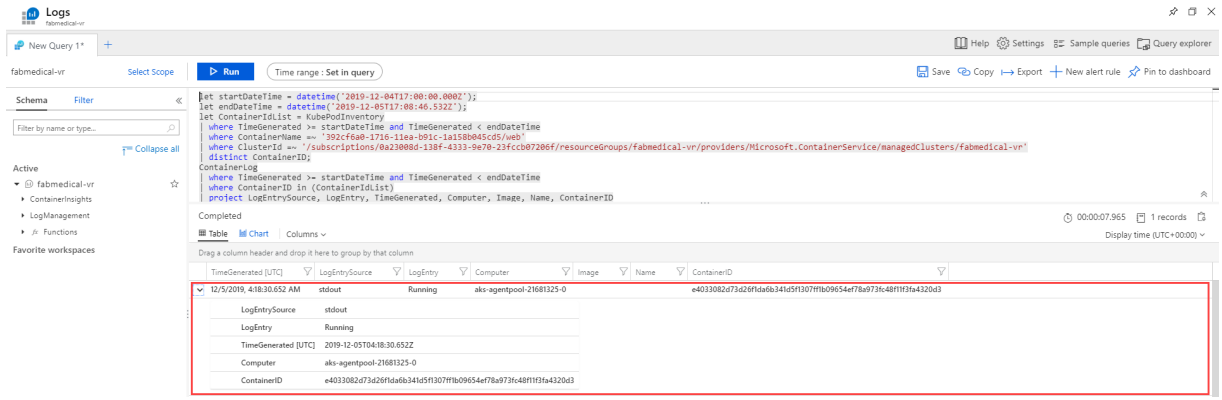
▷ Environment Variables

8. To display the logs for any container simply select it and view the right panel and you will find "View container logs" option which will list all logs for this specific container.





9. For each log entry you can display more information by expanding the log entry to view the below details.



Exercise 3: Scale the application and test HA

Duration: 20 minutes

At this point, you have deployed a single instance of the web and API service containers. In this exercise, you will increase the number of container instances for the web service and scale the front-end on the existing cluster.

Task 1: Increase service instances from the Kubernetes dashboard

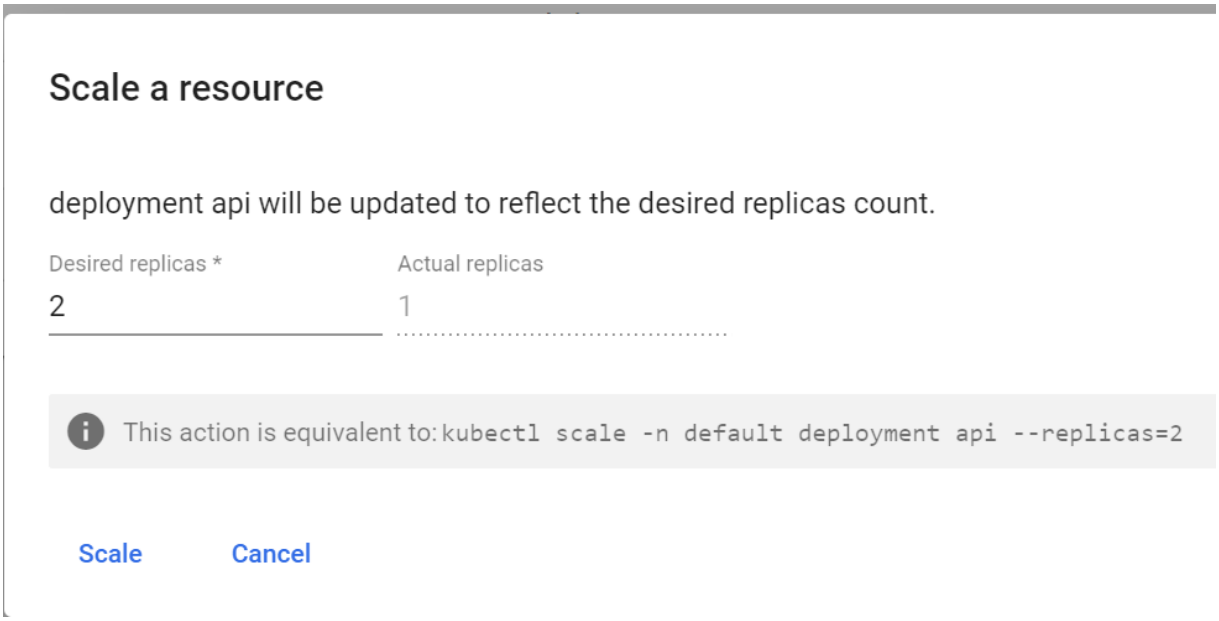
In this task, you will increase the number of instances for the API deployment in the Kubernetes management dashboard. While it is deploying, you will observe the changing status.

1. Switch to the Kubernetes Dashboard

2. From the navigation menu, select **Workloads** -> **Deployments**, and then select the **API** deployment.

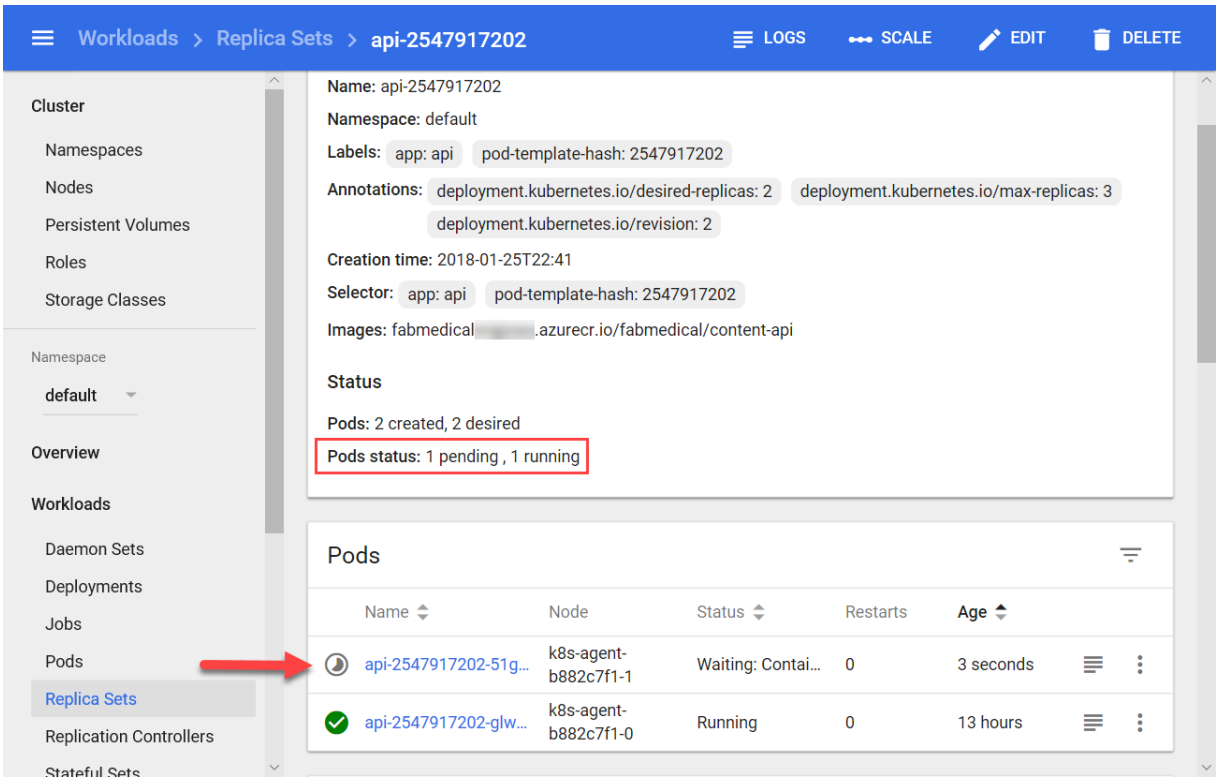
3. Select the vertical ellipses, then select **SCALE**.

4. Change the number of replicas to **2**, and then select **Scale**.

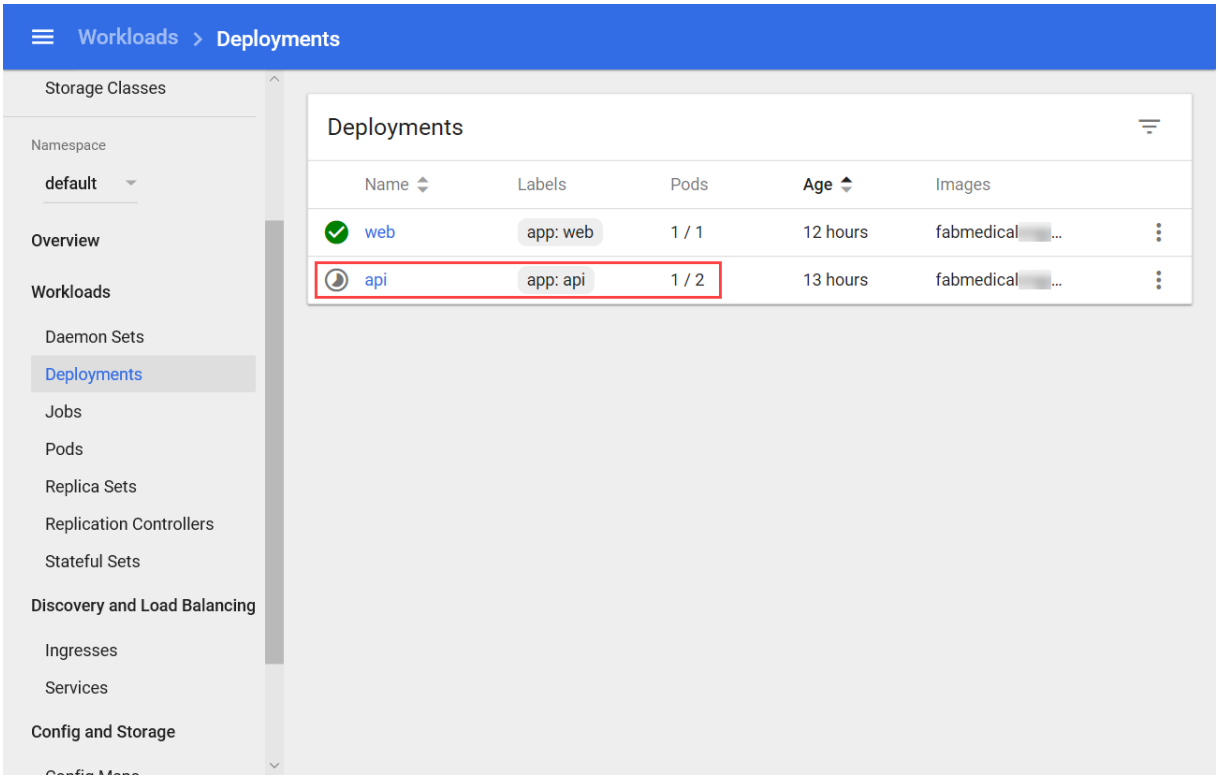


> **Note**: If the deployment completes quickly, you may not see the deployment Waiting states in the dashboard, as described in the following steps.

5. From the Replica Set view for the API, you will see it is now deploying and that there is one healthy instance and one pending instance.



6. From the navigation menu, select Deployments from the list. Note that the api service has a pending status indicated by the grey timer icon, and it shows a pod count 1 of 2 instances (shown as "1/2").



7. From the Navigation menu, select Workloads. From this view, note that the health overview in the right panel of this view. You will see the following:

    - One deployment and one replica set are each healthy for the api service.
    - One replica set is healthy for the web service.
    - Three pods are healthy.

8. Navigate to the web application from the browser again. The application should still work without errors as you navigate to Speakers and Sessions pages.

    - Navigate to the /stats page. You will see information about the environment including:
        - **webTaskId:** The task identifier for the web service instance.
        - **taskId:** The task identifier for the API service instance.
        - **hostName:** The hostname identifier for the API service instance.
        - **pid:** The process id for the API service instance.
        - **mem:** Some memory indicators returned from the API service instance.
        - **counters:** Counters for the service itself, as returned by the API service instance.
        - **uptime:** The up time for the API service.
    - Refresh the page in the browser, and you can see the hostName change between the two API service instances. The letters after "api-{number}-" in the hostname will change.

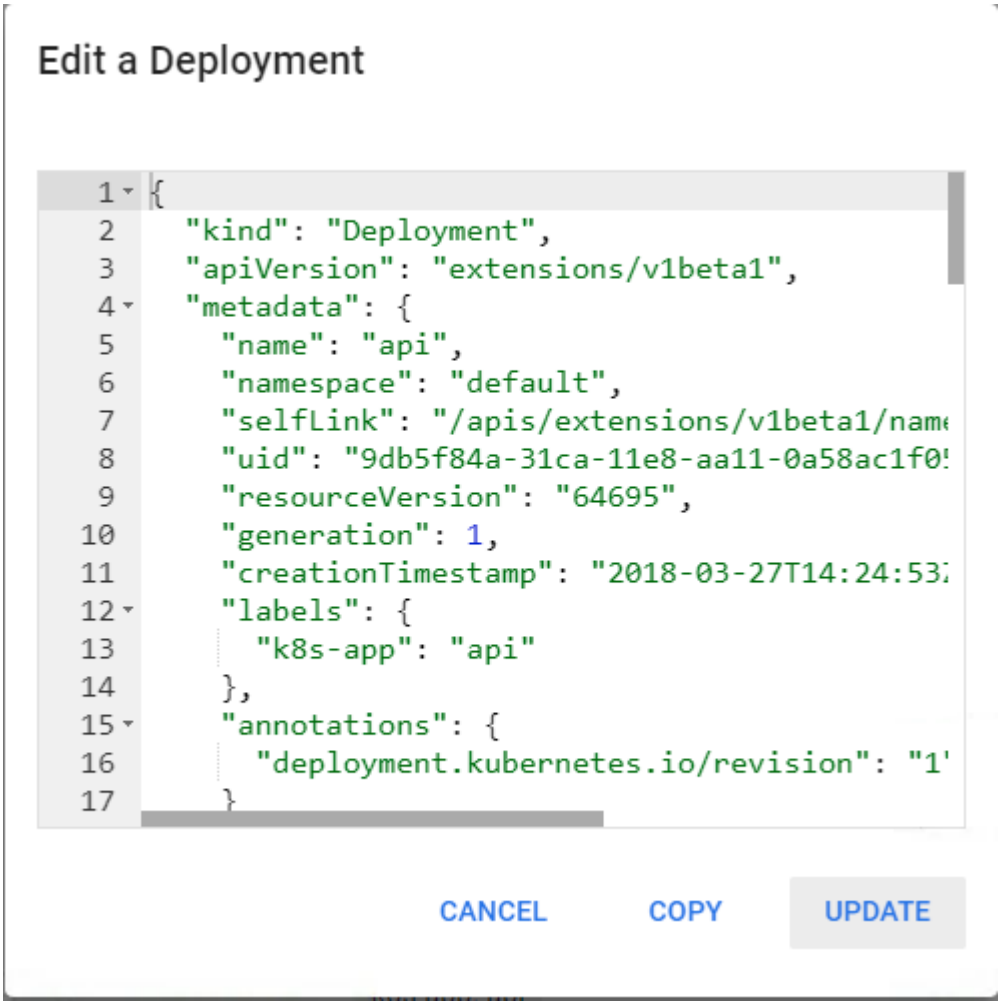
Task 2: Increase service instances beyond available resources

In this task, you will try to increase the number of instances for the API service container beyond available resources in the cluster. You will observe how Kubernetes handles this condition and correct the problem.

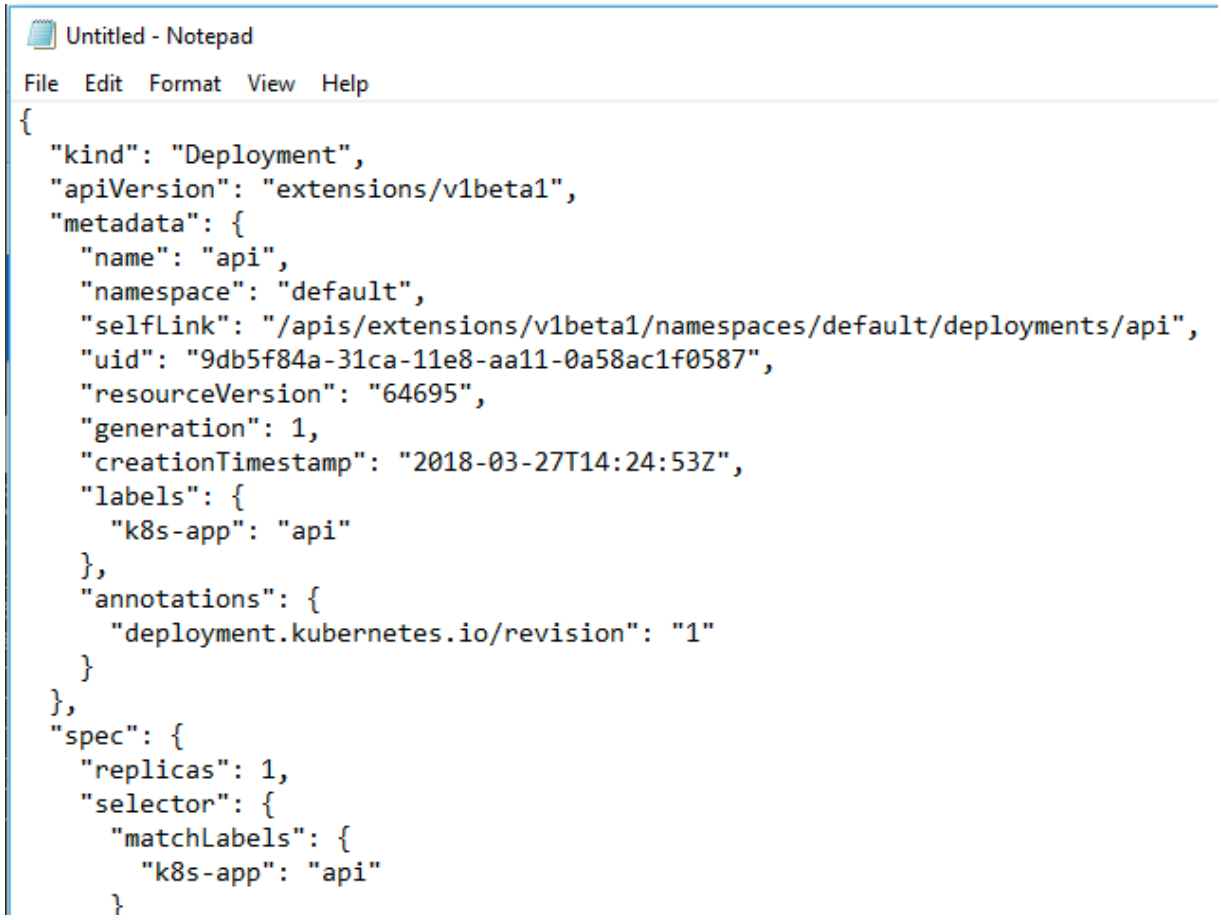
1. From the navigation menu, select **Deployments**. From this view, select the **api** deployment.

2. Configure the deployment to use a fixed host port for initial testing. Select the vertical ellipses and then select **Edit**.

3. In the Edit a Deployment dialog, select the JSON tab. You will see a list of settings shown in JSON format. Use the copy button to copy the text to your clipboard.



4. Paste the contents into the text editor of your choice (notepad is shown here, macOS users can use TextEdit).



5. Scroll down about halfway to find the node `$.spec.template.spec.containers[0]`, as shown in the screenshot below.

   !Screenshot of the deployment code, with the $.spec.template.spec.containers[0] section highlighted.

6. The containers spec has a single entry for the API container at the moment. You will see that the name of the container is `api` - this is how you know you are looking at the correct container spec.

   - Add the following snippet below the `name` property in the container spec:

```
ports:
      containerPort: 3001
      hostPort: 3001
```

- Your container spec should now look like this:

  !Screenshot of the deployment JSON code, with the $.spec.template.spec.containers[0] section highlighted, showing the updated values for containerPort and hostPort, both set to port 3001.

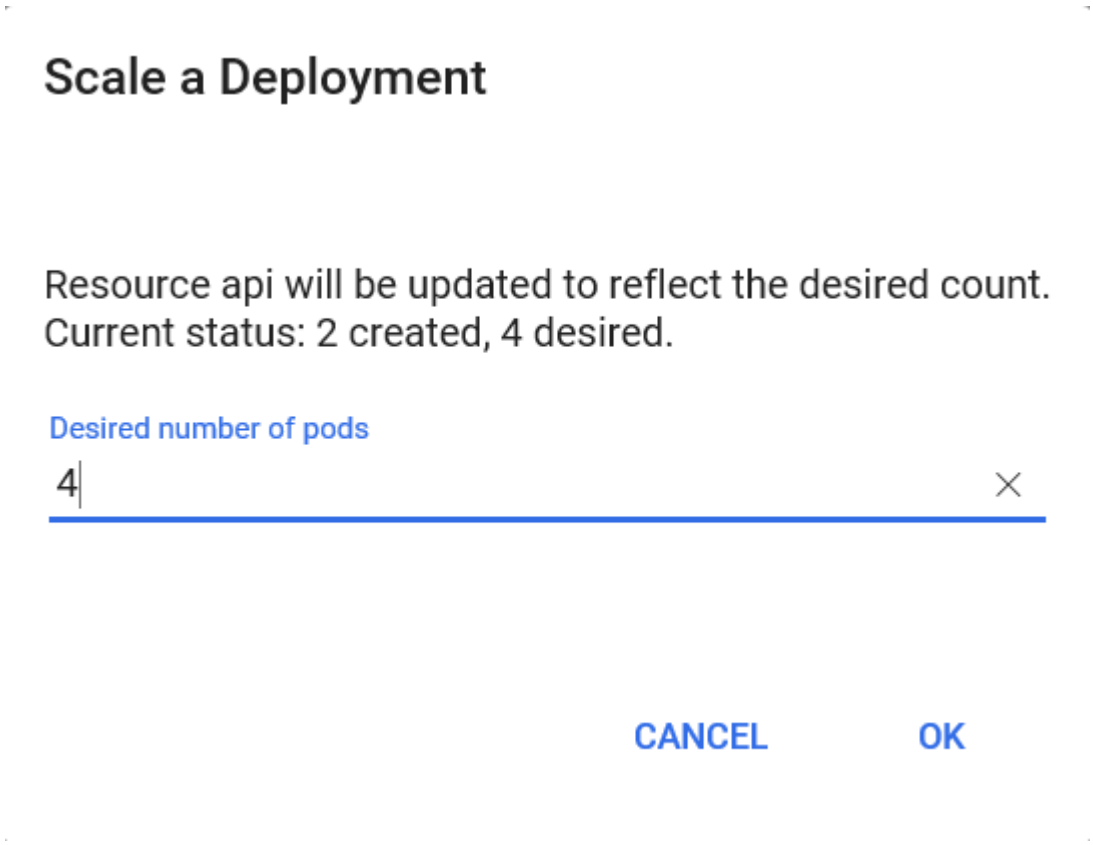
1. Copy the updated document from notepad into the clipboard. Return to the Kubernetes dashboard, which should still be viewing the **api** deployment.

   - Paste the updated document.

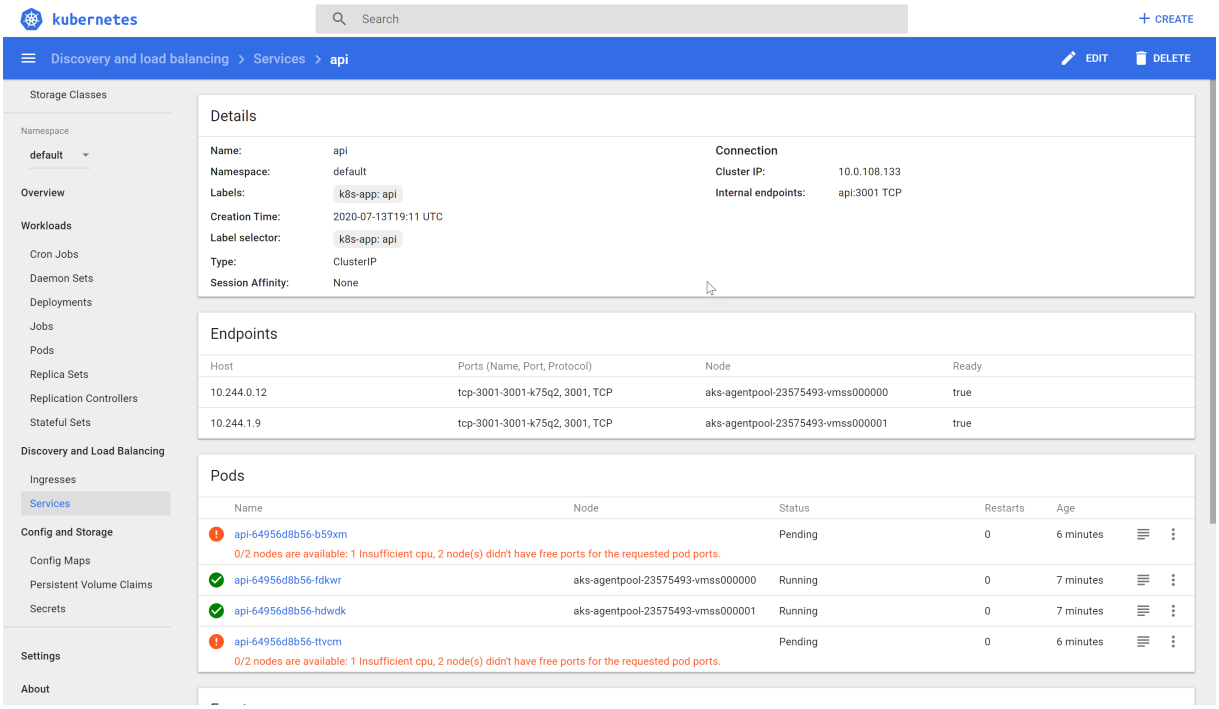
   - Select Update.

2. From the API deployment view, select **Scale**.

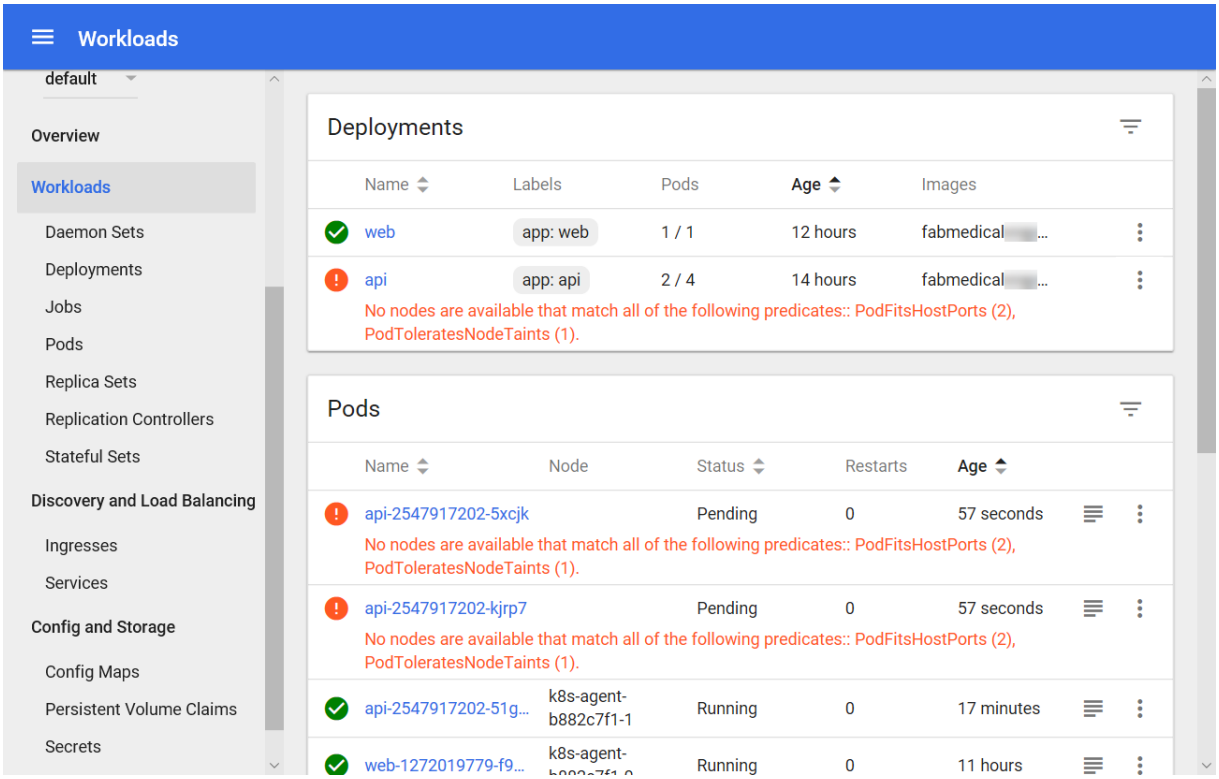
3. Change the number of replicas to 4 and select **Scale**.



4. From the navigation menu, select **Services** view under **Discovery and Load Balancing**. Select the **api** service from the **Services** list. From the api service view, you will see it has two healthy instances and two unhealthy (or possibly pending depending on timing) instances.



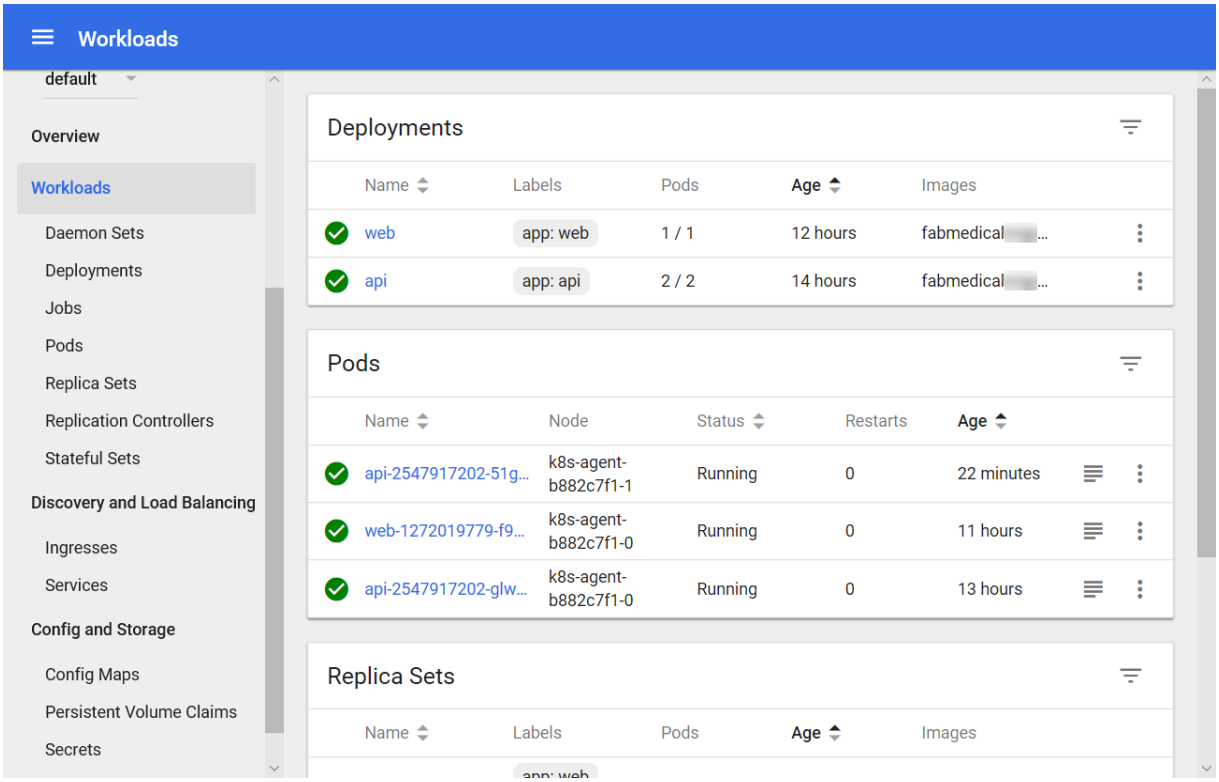
5. After a few minutes, select **Workloads** from the navigation menu. From this view, you should see an alert reported for the api deployment.



> **Note**: This message indicates that there were not enough available resources to match the requirements for a new pod instance. In this case, this is because the instance requires port `3001`, and since there are only 2 nodes available in the cluster, only two api instances can be scheduled. The third and fourth pod instances will wait for a new node to be available that can run another instance using that port.

6. Reduce the number of requested pods to `2` using the **Scale** button.

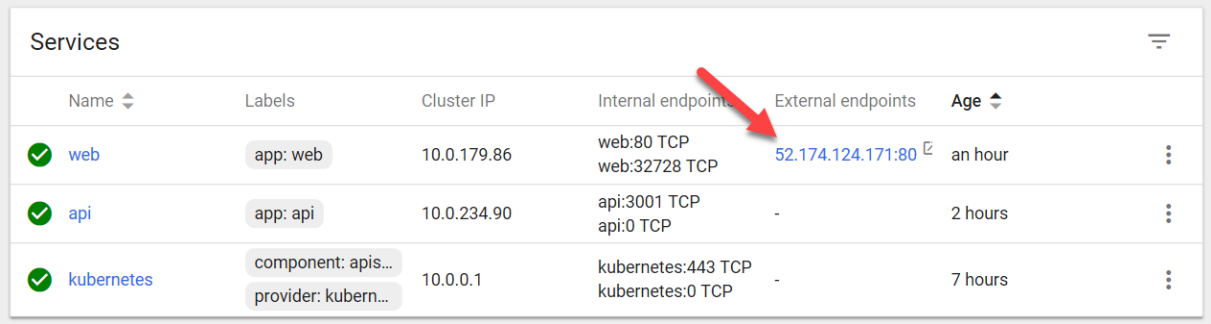
7. Almost immediately, the warning message from the Workloads dashboard should disappear, and the API deployment will show 2/2 pods are running.

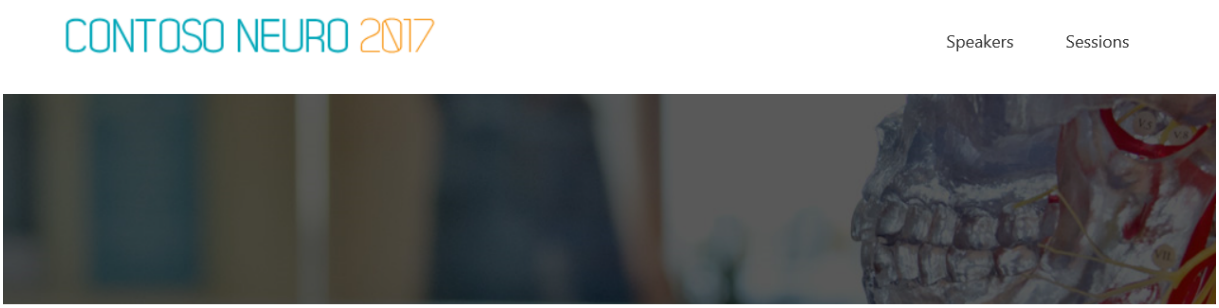


Task 3: Restart containers and test HA

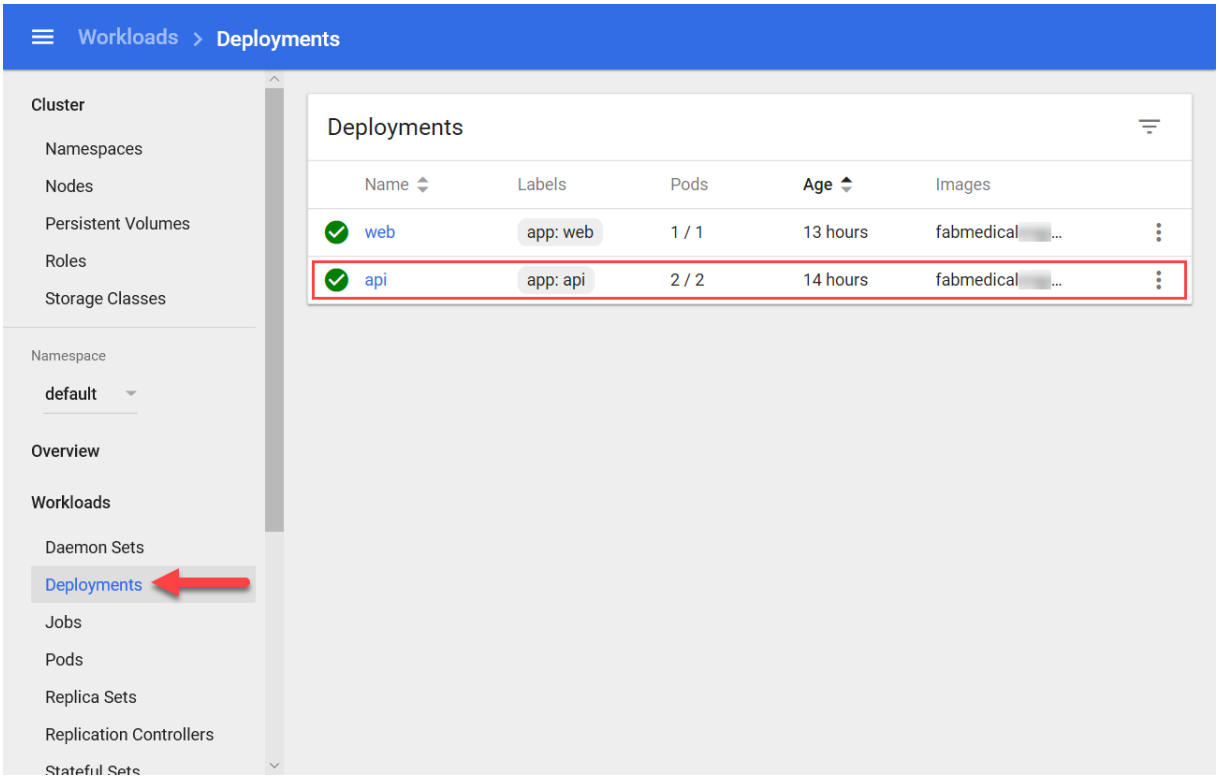
In this task, you will restart containers and validate that the restart does not impact the running service.

1. From the navigation menu on the left, select Services view under Discovery and Load Balancing. From the Services list, select the external endpoint hyperlink for the web service, and visit the stats page by adding /stats to the URL. Keep this open and handy to be refreshed as you complete the steps that follow.



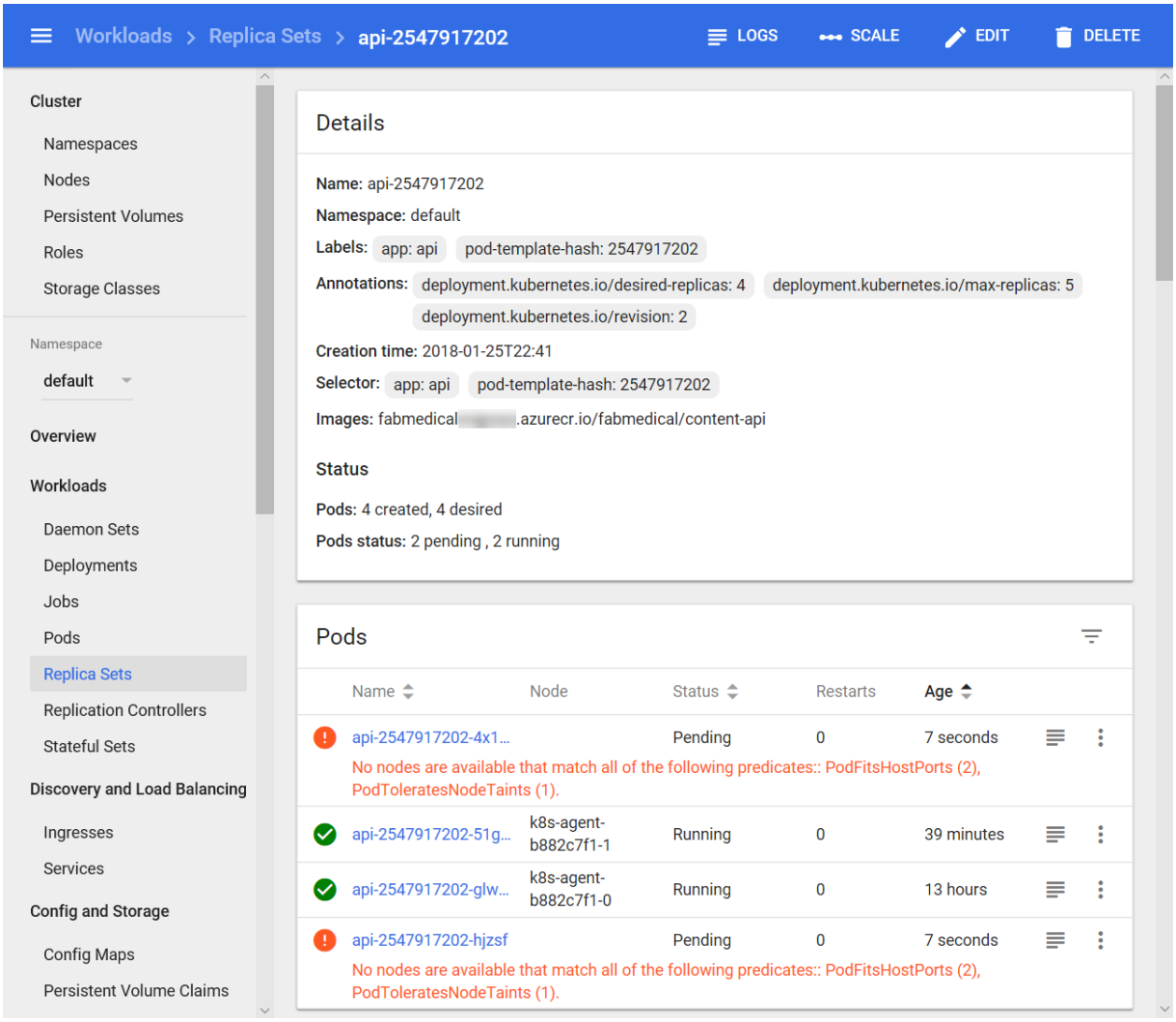


2. From the navigation menu, select Workloads>Deployments. From Deployments list, select the API deployment.

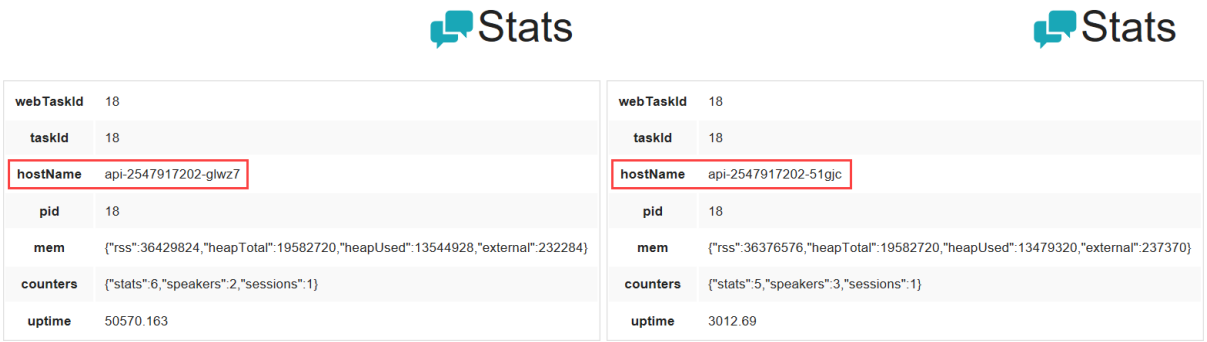


3. From the API deployment view, select **Scale** and from the dialog presented, and enter 4 for the desired number of pods. Select **OK**.

4. From the navigation menu, select **Workloads** -> **Replica Sets**. Select the api replica set, and from the **Replica Set** view, you will see that two pods cannot deploy.

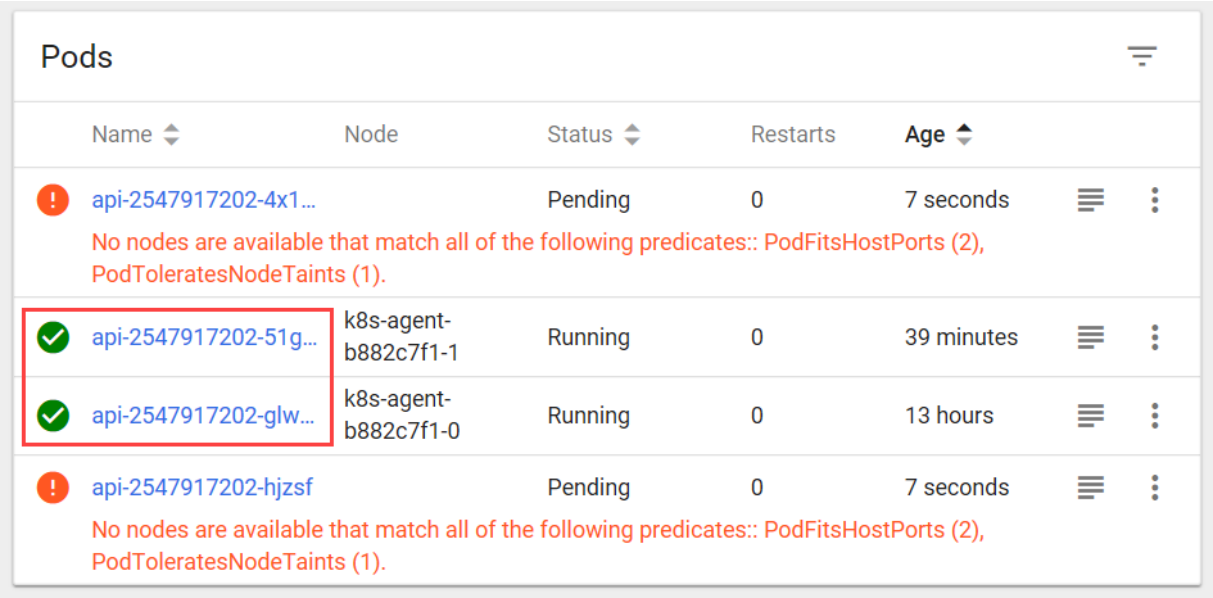


5. Return to the browser tab with the web application stats page loaded. Refresh the page over and over. You will not see any errors, but you will see the api host name change between the two api pod instances periodically. The task id and pid might also change between the two api pod instances.

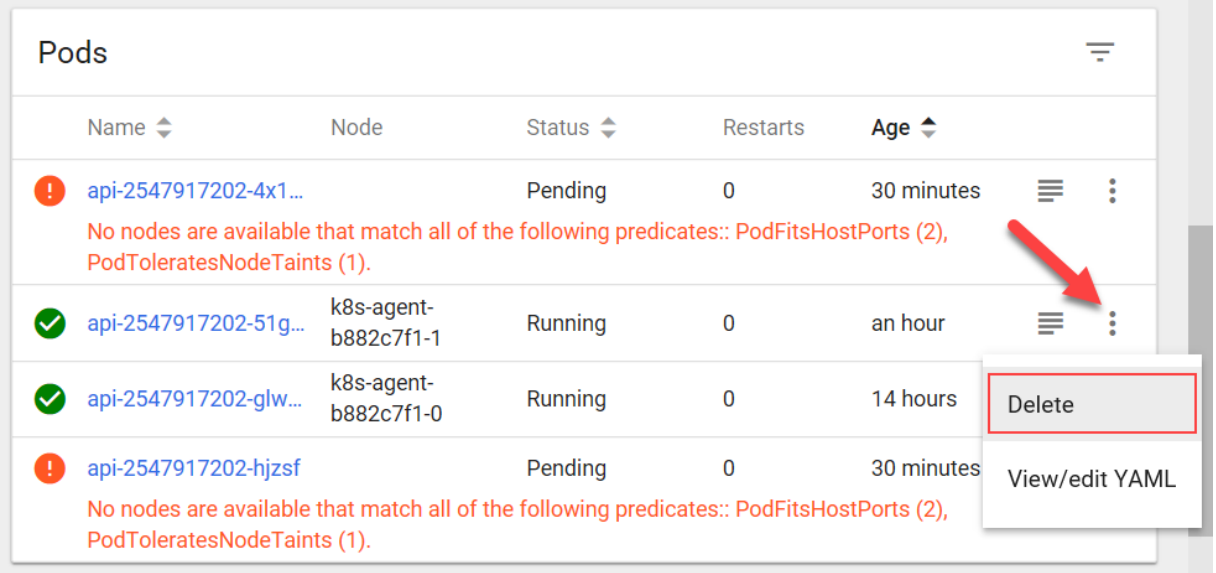


6. After refreshing enough times to see that the hostName value is changing, and the service remains healthy, return to the Replica Sets view for the API. From the navigation menu, select Replica Sets under Workloads and select the API replica set.

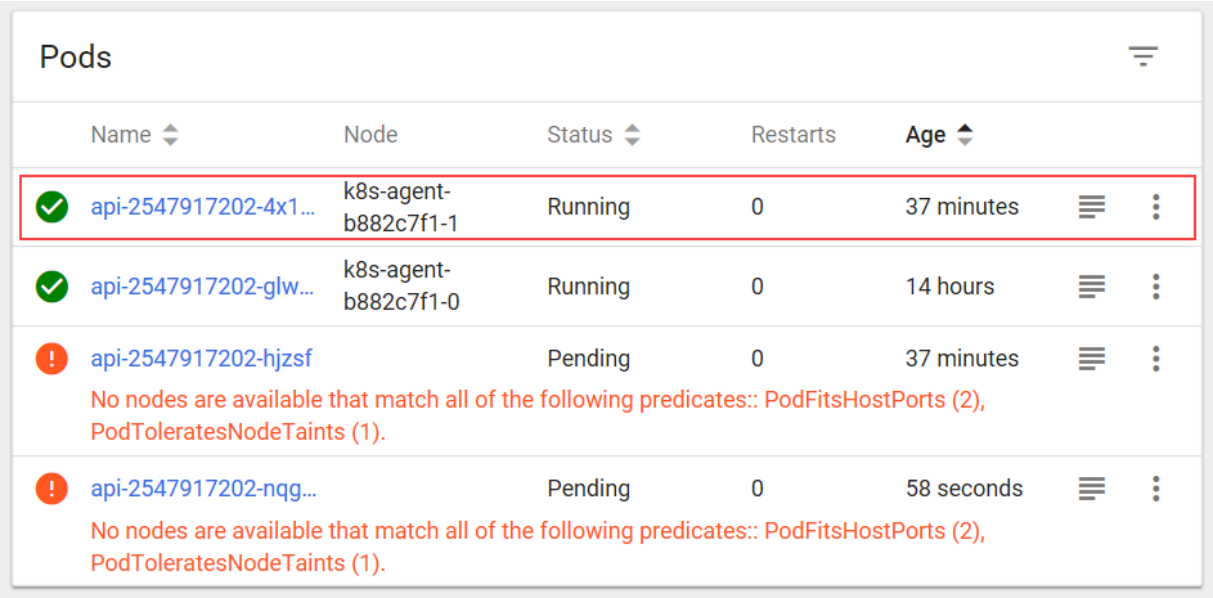
7. From this view, take note that the hostName value shown in the web application stats page matches the pod names for the pods that are running.



8. Note the remaining pods are still pending, since there are not enough port resources available to launch another instance. Make some room by deleting a running instance. Select the context menu and choose Delete for one of the healthy pods.

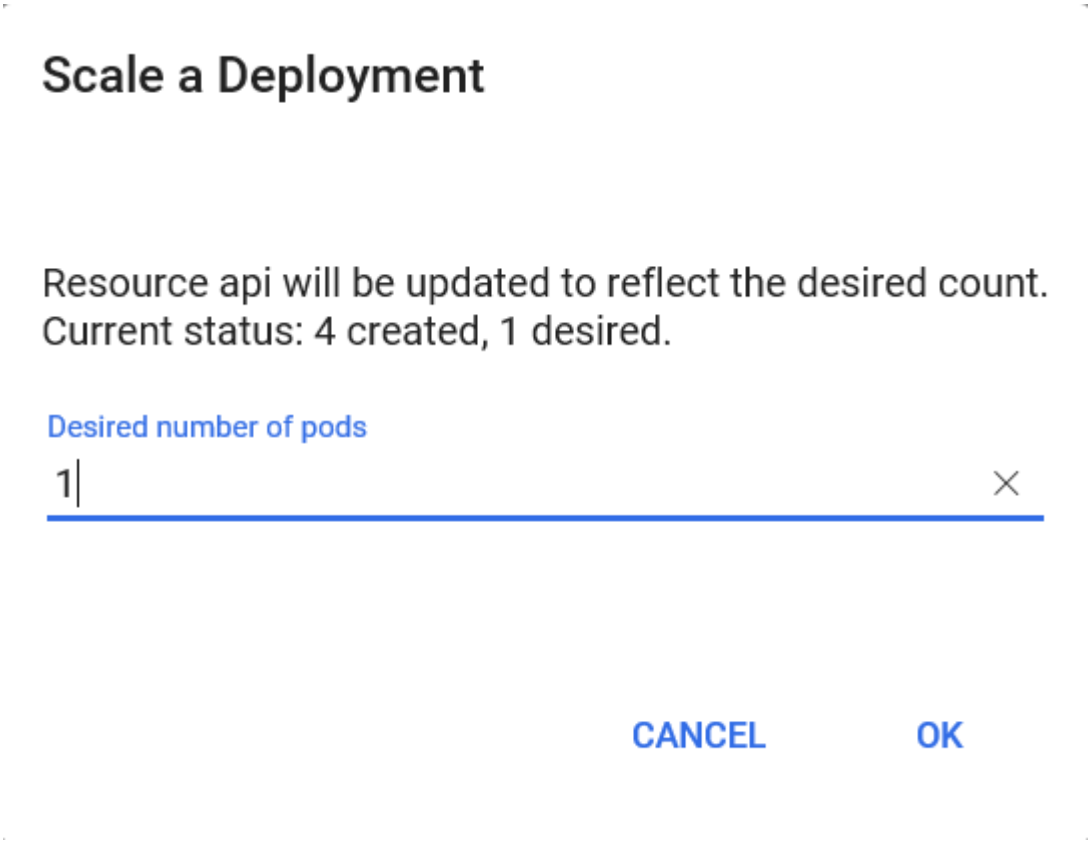


9. Once the running instance is gone, Kubernetes will be able to launch one of the pending instances. However, because you set the desired size of the deploy to 4, Kubernetes will add a new pending instance. Removing a running instance allowed a pending instance to start, but in the end, the number of pending and running instances is unchanged.

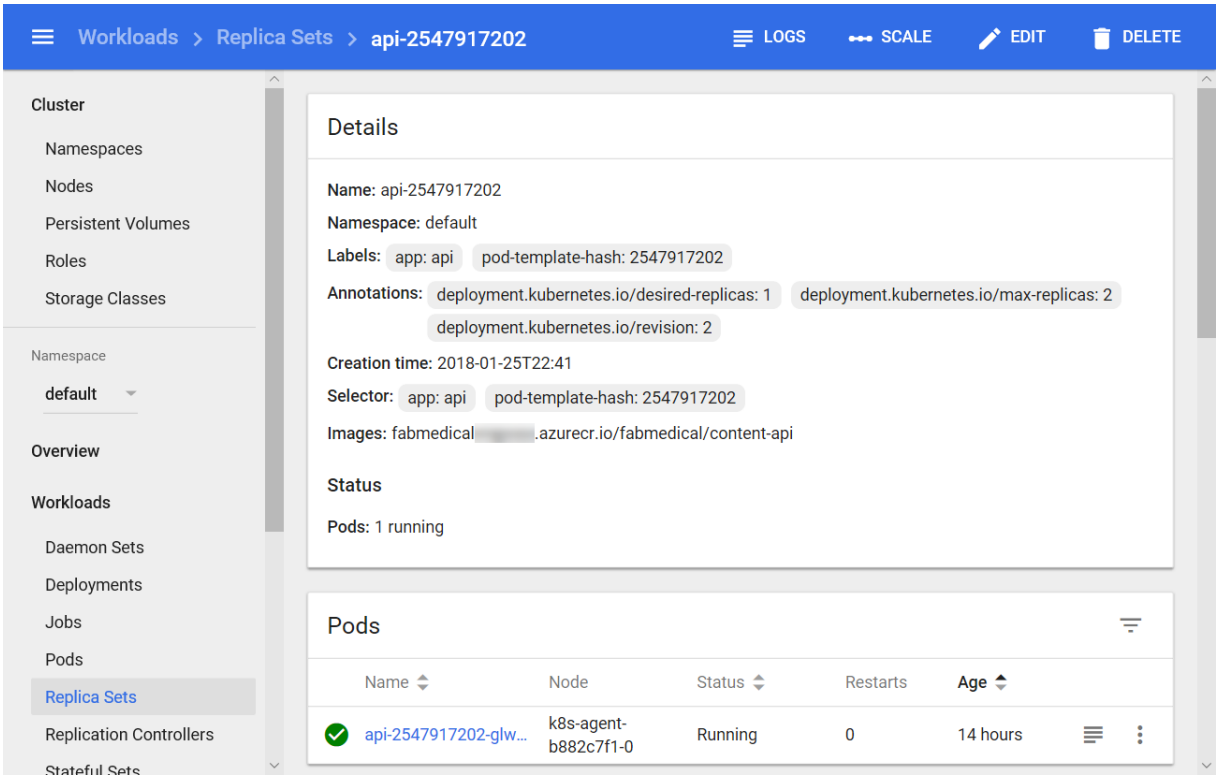


10. From the navigation menu, select **Deployments** under **Workloads**. From the view's Deployments list, select the **API** deployment.

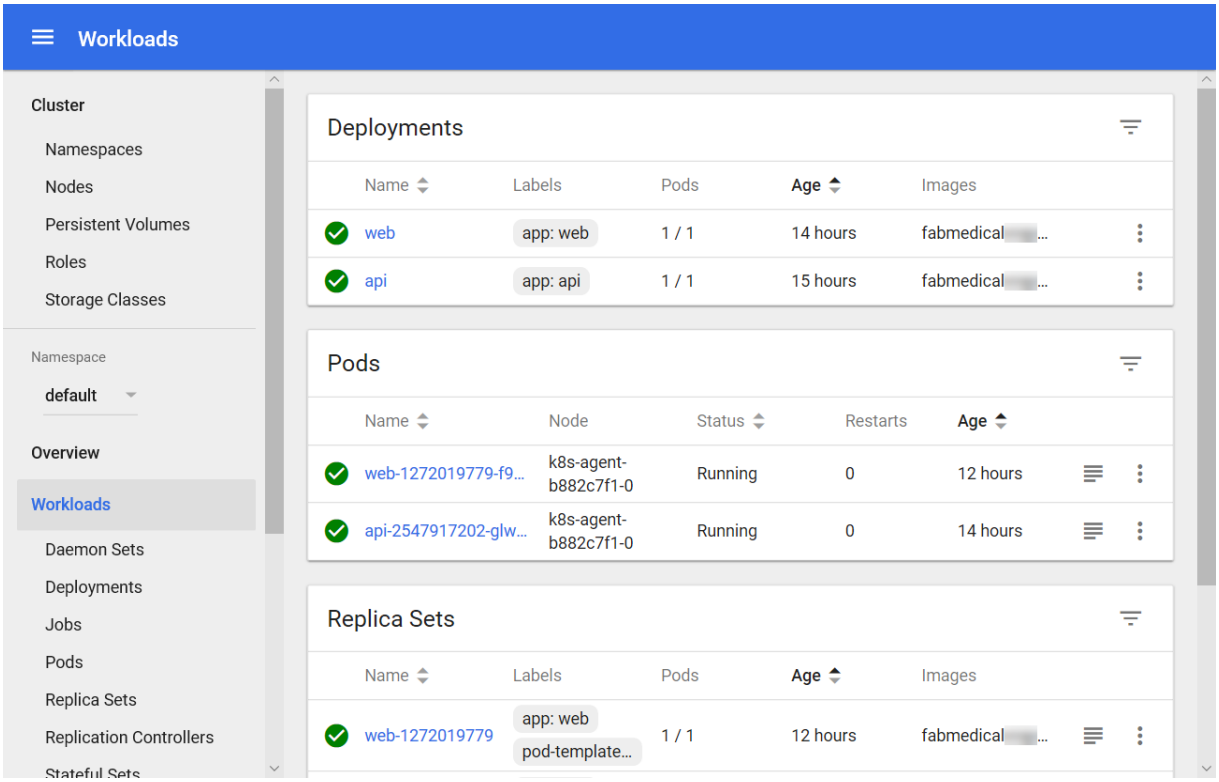
11. From the API Deployment view, select Scale and enter `1` as the desired number of pods. Select **OK**.



12. Return to the web site's stats page in the browser and refresh while this is scaling down. You will notice that only one API host name shows up, even though you may still see several running pods in the API replica set view. Even though several pods are running, Kubernetes will no longer send traffic to the pods it has selected to scale down. In a few moments, only one pod will show in the API replica set view.



13. From the navigation menu, select **Workloads**. From this view, note that there is only one API pod now.



Exercise 4: Working with services and routing application traffic

Duration: 45 minutes

In the previous exercise, we introduced a restriction to the scale properties of the service. In this exercise, you will configure the api deployments to create pods that use dynamic port mappings to eliminate the port resource constraint during scale activities.

Kubernetes services can discover the ports assigned to each pod, allowing you to run multiple instances of the pod on the same agent node --- something that is not possible when you configure a specific static port (such as 3001 for the API service).

Task 1: Scale a service without port constraints

In this task, we will reconfigure the API deployment so that it will produce pods that choose a dynamic hostPort for improved scalability.

1. From the navigation menu select **Deployments** under **Workloads**. From the view's Deployments list, select the API deployment.

2. Select **Edit**.

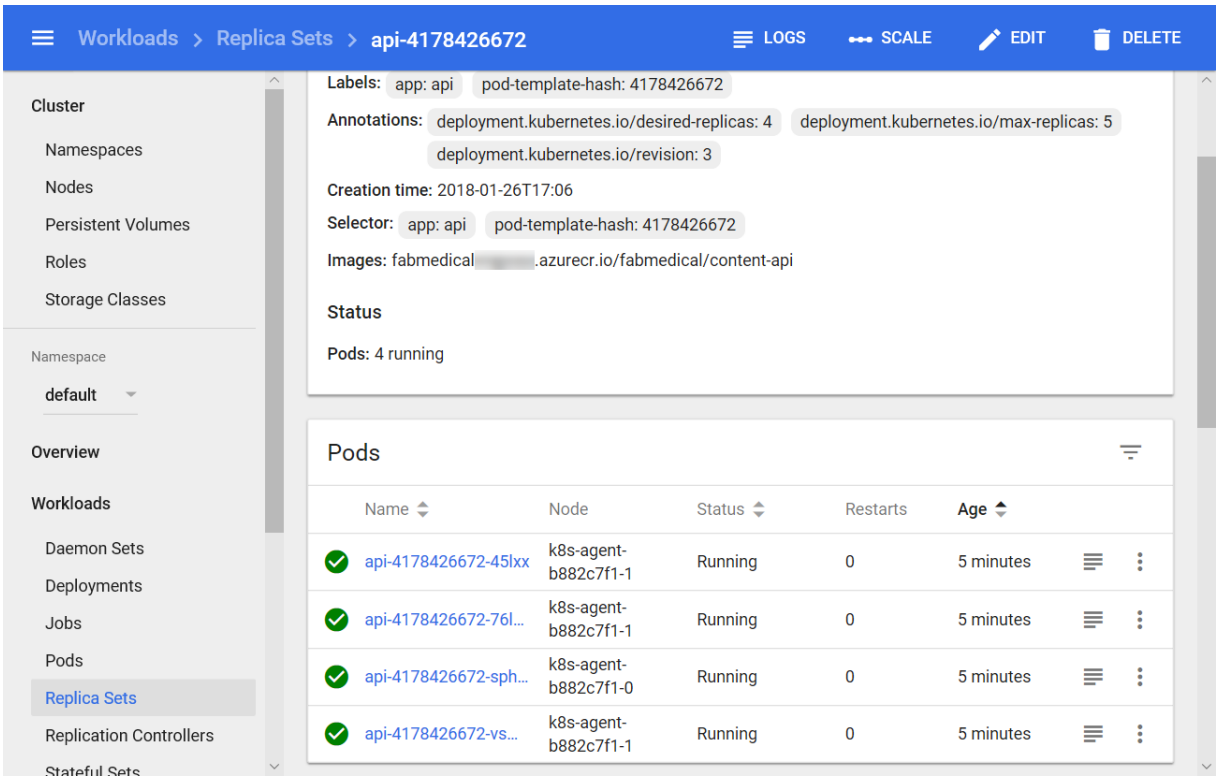
3. From the **Edit a Deployment** dialog, do the following:

    - Scroll to the first spec node that describes replicas as shown in the screenshot. Set the value for replicas to `4`.

    - Within the replicas spec, beneath the template node, find the **api** containers spec. Remove the hostPort entry for the API container's port mapping. The screenshot below shows the desired configuration after editing.

4. Select **Update**. New pods will now choose a dynamic port.

5. The API service can now scale to 4 pods since it is no longer constrained to an instance per node -- a previous limitation while using port `3001`.



6. Return to the browser and refresh the stats page. You should see all 4 pods serve responses as you refresh.

Task 2: Update an external service to support dynamic discovery with a load balancer

In this task, you will update the web service so that it supports dynamic discovery through the Azure load balancer.

1. From the navigation menu, select **Deployments** under **Workloads**. From the view's Deployments list, select the **web** deployment.

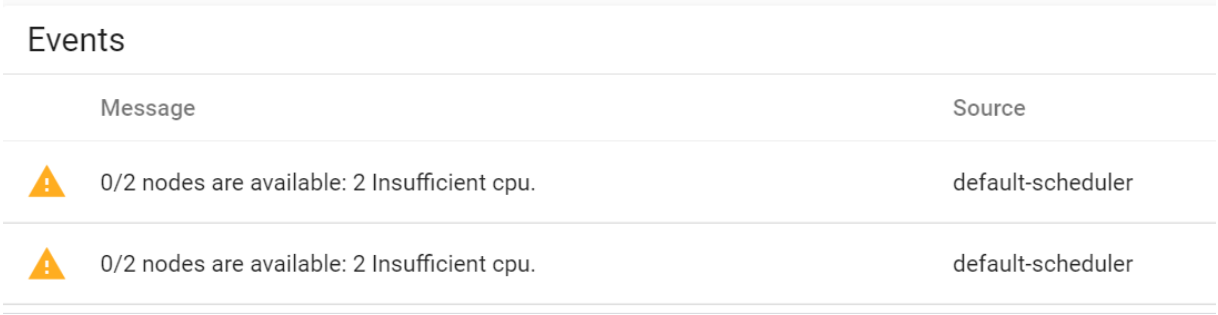
2. Select **Edit**, then select the **JSON** tab

3. From the dialog, scroll to the web containers spec as shown in the screenshot. Remove the hostPort entry for the web container's port mapping.

4. Select **Update**.

5. From the web Deployments view, select **Scale**. From the dialog presented enter 4 as the desired number of pods and select **OK**.

6. Check the status of the scale out by refreshing the web deployment's view. From the navigation menu, select **Pods** from under Workloads. Select the **api** pods. From this view, you should see an error like that shown in the following screenshot.



Like the API deployment, the web deployment used a fixed *hostPort*, and your ability to scale was limited by the number of available agent nodes. However, after resolving this issue for the web service by removing the *hostPort* setting, the web deployment is still unable to scale past two pods due to CPU constraints. The deployment is requesting more CPU than the web application needs, so you will fix this constraint in the next task.

Task 3: Adjust CPU constraints to improve scale

In this task, you will modify the CPU requirements for the web service so that it can scale out to more instances.

1. From the navigation menu, select **Deployments** under **Workloads**. From the view's Deployments list, select the **web** deployment.

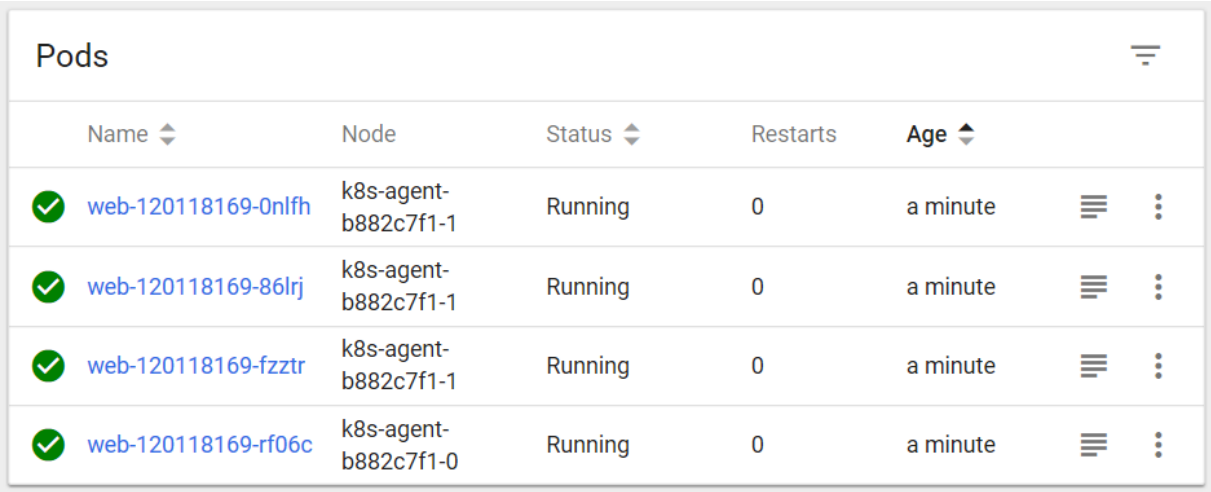
2. Select the vertical ellipses, then select **Edit**.

3. From the Edit a Deployment dialog, select the **JSON** tab, then find the **cpu** resource requirements for the web container. Change this value to `125m`.

4. Select **Update** to save the changes and update the deployment.

5. From the navigation menu, select **Replica Sets** under **Workloads**. From the view's Replica Sets list select the web replica set.

6. When the deployment update completes, four web pods should be shown in running state.



7. Return to the browser tab with the web application loaded. Refresh the stats page at /stats to watch the display update to reflect the different api pods by observing the host name refresh.

Task 4: Perform a rolling update

In this task, you will edit the web application source code to add Application Insights and update the Docker image used by the deployment. Then you will perform a rolling update to demonstrate how to deploy a code change.

1. Execute this command in Azure Cloud Shell to retrieve the instrumentation key for the `content-web` Application Insights resource:

```
az resource show -g fabmedical-[SUFFIX] -n content-web --resource-type "Microsoft.Insights/components" --query prope
```

Copy this value. You will use it later.

2. Update your starter files by pulling the latest changes from the Git repository:

```
cd ~/MCW-Cloud-native-applications/Hands-on\ lab/lab-files/developer/content-web
git pull
```

3. Install support for Application Insights.

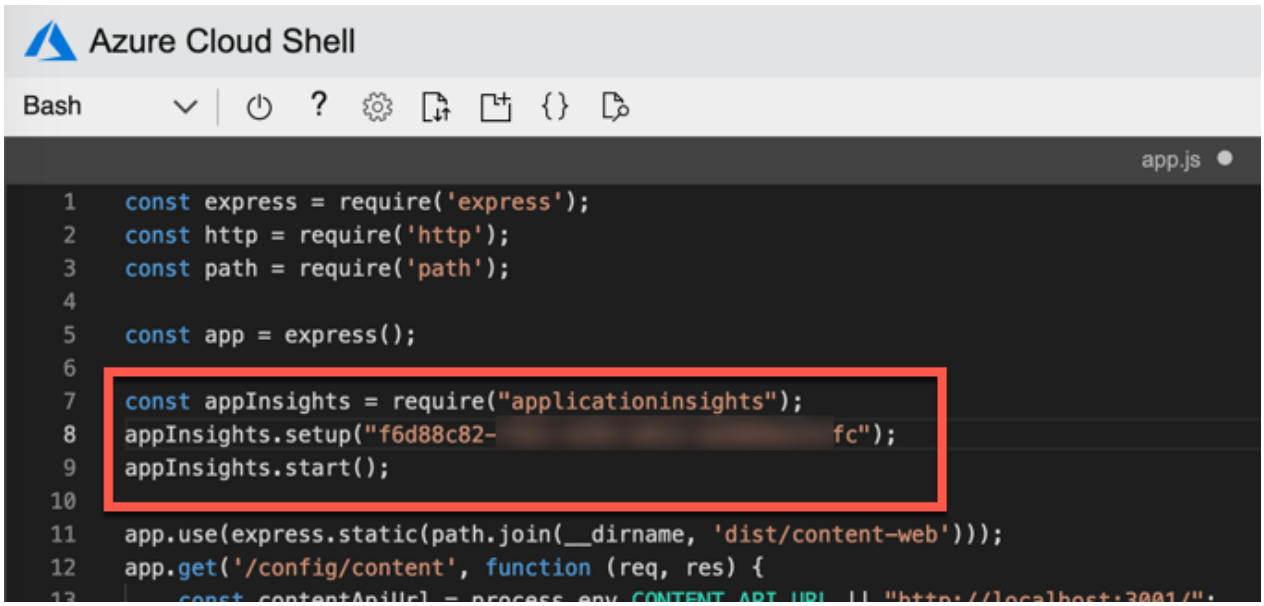
```
npm install applicationinsights --save
```

4. Open the `app.js` file:

```
code app.js
```

5. Add the following lines immediately after `express` is instantiated on line 6:

```
const appInsights = require("applicationinsights");
appInsights.setup("3324847d-625d-47cf-994b-386644d34a9a");
appInsights.start();
```



6. Save changes and close the editor.

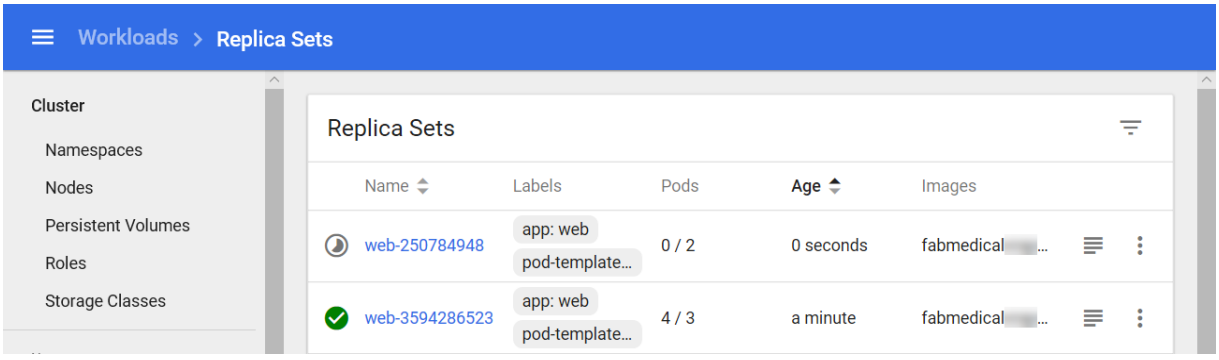
7. Push these changes to your repository so that GitHub Actions CI will build and deploy a new image.

```
git add .
git commit -m "Added Application Insights"
git push
```

8. Visit the `content-web` workflow for your GitHub repository and see the new image being deployed into your Kubernetes cluster.

9. While this update runs, return the Kubernetes management dashboard in the browser.

10. From the navigation menu, select **Replica Sets** under **Workloads**. From this view, you will see a new replica set for the web, which may still be in the process of deploying (as shown below) or already fully deployed.



11. While the deployment is in progress, you can navigate to the web application and visit the stats page at `/stats`. Refresh the page as the rolling update executes. Observe that the service is running normally, and tasks continue to be load balanced.

Stats

webTaskId	web-250784948-g9fk4
taskId	18
hostName	api-4178426672-f0dp8
pid	18
mem	{"rss":37785600,"heapTotal":19582720,"heapUsed":13256432,"external":211680}
counters	{"stats":4,"speakers":0,"sessions":0}
uptime	2559.844

Task 5: Configure Kubernetes Ingress

In this task you will setup a Kubernetes Ingress to take advantage of path-based routing and TLS termination.

1. Update your helm package list.

```
helm repo update
```

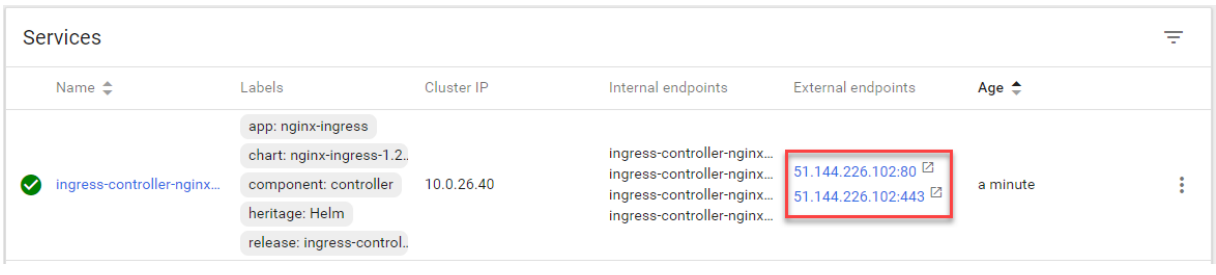
> **Note**: If you get a "no repositories found." error, then run the following command. This will add back the official Helm "stable" repository.
>
> ```
> helm repo add stable https://kubernetes-charts.storage.googleapis.com/
> ```

2. Install the ingress controller resource to handle ingress requests as they come in. The ingress controller will receive a public IP of its own on the Azure Load Balancer and be able to handle requests for multiple services over port 80 and 443.

```
helm install stable/nginx-ingress --namespace kube-system --set controller.replicaCount=2 --generate-name
```

3. From the Kubernetes dashboard, ensure the Namespace filter is set to **All namespaces**

4. Under **Discovery and Load Balancing**, select **Services**, then copy the IP Address for the **External endpoints** for the `nginx-ingress-RANDOM-controller` service.



> **Note**: It could take a few minutes to refresh, alternately, you can find the IP using the following command in Azure Cloud Shell.

```
kubectl get svc --namespace kube-system
```

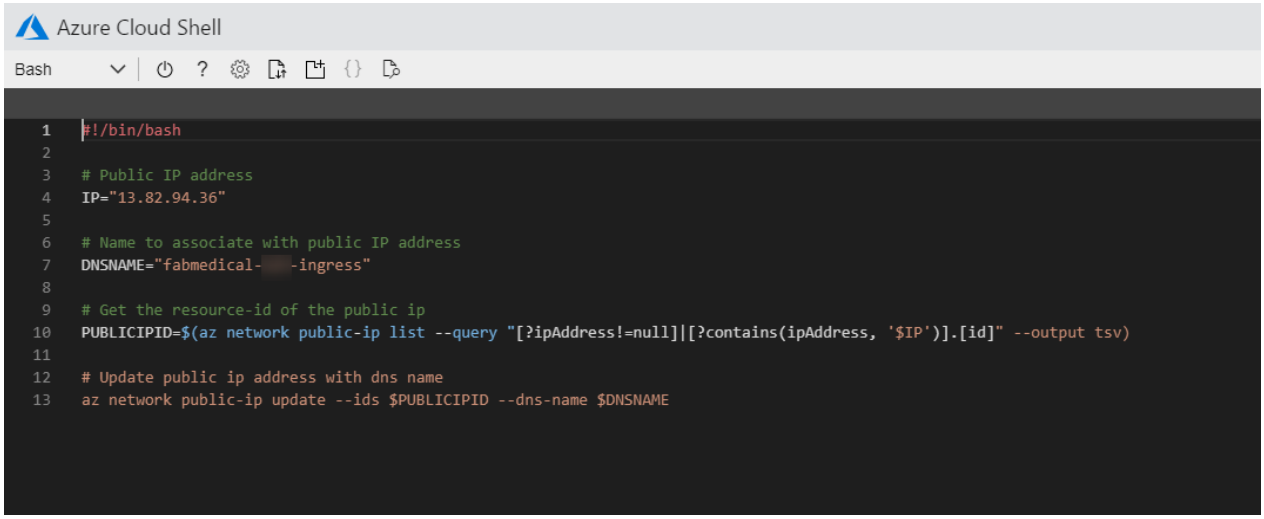
```
@Azure:~$ kubectl get svc --namespace kube-system
NAME                                    TYPE           CLUSTER-IP     EXTERNAL-IP     PORT(S)                      AGE
healthmodel-replicaset-service          ClusterIP      10.0.154.232   <none>          25227/TCP                    12h
ingress-controller-nginx-ingress-controller   LoadBalancer   10.0.26.40     51.144.226.102  80:31716/TCP,443:30115/TCP   8m
ingress-controller-nginx-ingress-default-backend   ClusterIP   10.0.231.84   <none>   80/TCP   8m
kube-dns                                ClusterIP      10.0.0.10      <none>          53/UDP,53/TCP                12h
kubernetes-dashboard                    ClusterIP      10.0.198.13    <none>          80/TCP                       12h
metrics-server                          ClusterIP      10.0.196.10    <none>          443/TCP                      12h
```

5. Create a script to update the public DNS name for the IP.

```
code update-ip.sh
```

Paste the following as the contents and update the IP and SUFFIX values:

```
#!/bin/bash

# Public IP address
IP="[INGRESS PUBLIC IP]"

# Name to associate with public IP address
DNSNAME="fabmedical-[SUFFIX]-ingress"

# Get the resource-id of the public ip
PUBLICIPID=$(az network public-ip list --query "[?ipAddress!=null]|[?contains(ipAddress, '$IP')].[id]" --output tsv)

# Update public ip address with dns name
az network public-ip update --ids $PUBLICIPID --dns-name $DNSNAME
```



Be sure to replace the following placeholders in the script:

- `[INGRESS PUBLIC IP]` : replace this with the IP Address copied previously.
- `[SUFFIX]` : replace this with the same SUFFIX value used previously for this lab

1. Save changes and close the editor.

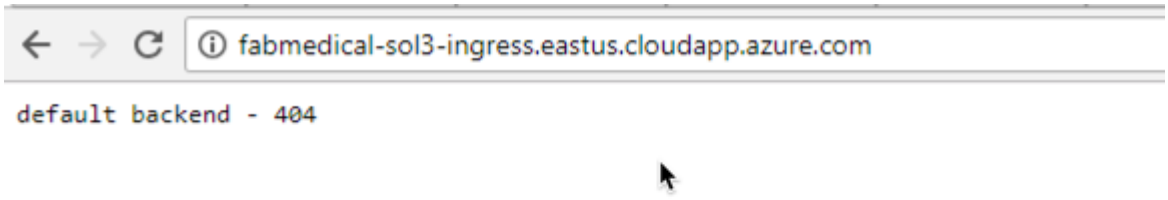
2. Run the update script.

```
bash ./update-ip.sh
```

8. Verify the IP update by visiting the URL in your browser.

> **Note**: It is normal to receive a 404 message at this time.

```
http://fabmedical-[SUFFIX]-ingress.[AZURE-REGION].cloudapp.azure.com/
```



9. Use helm to install `cert-manager`, a tool that can provision SSL certificates automatically from letsencrypt.org.

```
kubectl create namespace cert-manager

kubectl label namespace cert-manager cert-manager.io/disable-validation=true

kubectl apply --validate=false -f https://github.com/jetstack/cert-manager/releases/download/v1.0.1/cert-manager.yam
```

11. Cert manager will need a custom ClusterIssuer resource to handle requesting SSL certificates.

```
code clusterissuer.yml
```

The following resource configuration should work as is:

```
apiVersion: cert-manager.io/v1
kind: ClusterIssuer
metadata:
  name: letsencrypt-prod
spec:
  acme:
    # The ACME server URL
    server: https://acme-v02.api.letsencrypt.org/directory
    # Email address used for ACME registration
    email: user@fabmedical.com
    # Name of a secret used to store the ACME account private key
    privateKeySecretRef:
      name: letsencrypt-prod
    # Enable HTTP01 validations
    solvers:
    - http01:
        ingress:
          class: nginx
```

12. Save changes and close the editor.

13. Create the issuer using `kubectl`.

```
kubectl create --save-config=true -f clusterissuer.yml
```

14. Now you can create a certificate object.

> **Note**:
>
> Cert-manager might have already created a certificate object for you using ingress-shim.
>
> To verify that the certificate was created successfully, use the `kubectl describe certificate tls-secret` command.
>
> If a certificate is already available, skip to step 16.

```
code certificate.yml
```

Use the following as the contents and update the `[SUFFIX]` and `[AZURE-REGION]` to match your ingress DNS name

```
apiVersion: cert-manager.io/v1
kind: Certificate
metadata:
  name: tls-secret
spec:
  secretName: tls-secret
  dnsNames:
    - fabmedical-[SUFFIX]-ingress.[AZURE-REGION].cloudapp.azure.com
  issuerRef:
    name: letsencrypt-prod
    kind: ClusterIssuer
```

15. Save changes and close the editor.

16. Create the certificate using `kubectl`.

```
kubectl create --save-config=true -f certificate.yml
```

> **Note**: To check the status of the certificate issuance, use the `kubectl describe certificate tls-secret` command and look for an *Events* output similar to the following:
>
> ```
> Type    Reason          Age   From          Message
> ----    ------          ----  ----          -------
> Normal  Generated       38s   cert-manager  Generated new private key
> Normal  GenerateSelfSigned  38s   cert-manager  Generated temporary self signed certificate
> Normal  OrderCreated    38s   cert-manager  Created Order resource "tls-secret-3254248695"
> Normal  OrderComplete   12s   cert-manager  Order "tls-secret-3254248695" completed successfully
> Normal  CertIssued      12s   cert-manager  Certificate issued successfully
> ```

It can take between 5 and 30 minutes before the tls-secret becomes available. This is due to the delay involved with provisioning a TLS cert from letsencrypt.

17. Now you can create an ingress resource for the content applications.

```
code content.ingress.yml
```

    Use the following as the contents and update the `[SUFFIX]` and `[AZURE-REGION]` to match your ingress DNS name

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: content-ingress
  annotations:
    kubernetes.io/ingress.class: nginx
    certmanager.k8s.io/cluster-issuer: letsencrypt-prod
    nginx.ingress.kubernetes.io/rewrite-target: /$1
spec:
  tls:
    - hosts:
        - fabmedical-[SUFFIX]-ingress.[AZURE-REGION].cloudapp.azure.com
      secretName: tls-secret
  rules:
    - host: fabmedical-[SUFFIX]-ingress.[AZURE-REGION].cloudapp.azure.com
      http:
        paths:
          - path: /(.*)
            backend:
              serviceName: web
              servicePort: 80
          - path: /content-api/(.*)
            backend:
              serviceName: api
              servicePort: 3001
```

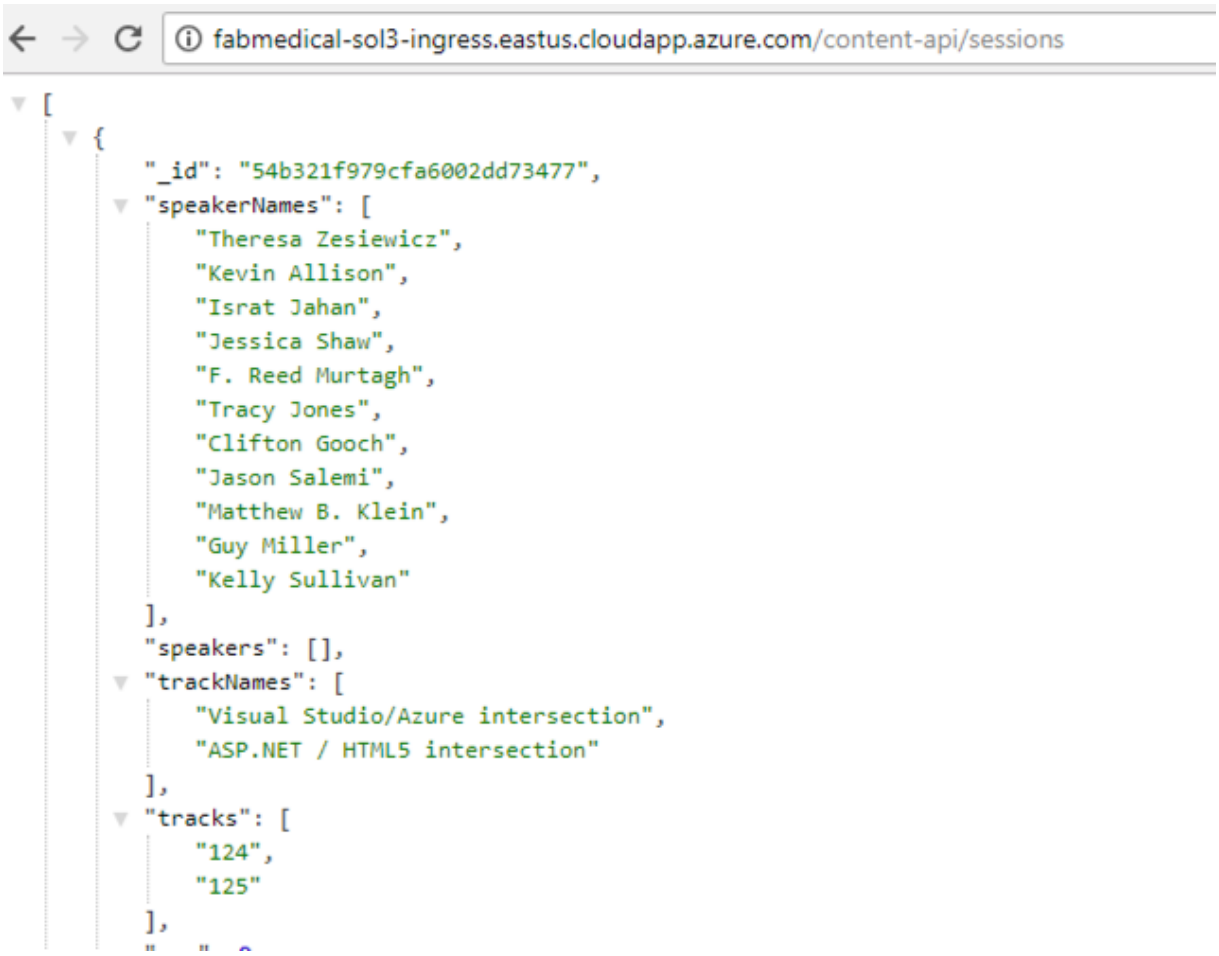
18. Save changes and close the editor.

19. Create the ingress using `kubectl`.

```
kubectl create --save-config=true -f content.ingress.yml
```

20. Refresh the ingress endpoint in your browser. You should be able to visit the speakers and sessions pages and see all the content.

21. Visit the api directly, by navigating to `/content-api/sessions` at the ingress endpoint.



22. Test TLS termination by visiting both services again using `https`.

> It can take between 5 and 30 minutes before the SSL site becomes available. This is due to the delay involved with provisioning a TLS cert from letsencrypt.

After the hands-on lab

Duration: 10 mins

In this exercise, you will de-provision any Azure resources created in support of this lab.

1. Delete the Resource Groups in which you placed all your Azure resources.
    - From the Portal, navigate to the blade of your **Resource Group** and then select **Delete** in the command bar at the top.
    - Confirm the deletion by re-typing the resource group name and selecting Delete.
2. Delete the Service Principal created on Task 3: Create a Service Principal before the hands-on lab.

```
az ad sp delete --id "Fabmedical-sp"
```

You should follow all steps provided *after* attending the Hands-on lab.