

# Introduction to IBM Edge Application Manager - IEAM

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Introduction to IBM Edge Application Manager - Think 2021 Lab #2122 workbook

Successfully deploy models to the edge using IBM Edge Application Manager workload orchestration

## Introduction

Gain hands-on experience with the IBM Edge Application Manager web management console. Install the Horizon agent, then deploy and manage a Horizon edge service on your edge device.

This Code@Think lab session is available for IBM Think 2021 conference attendees (Sign up for Free!)

- Wednesday, May 12, 2021 3:00 PM to 5:00 PM EDT

## Prerequisites

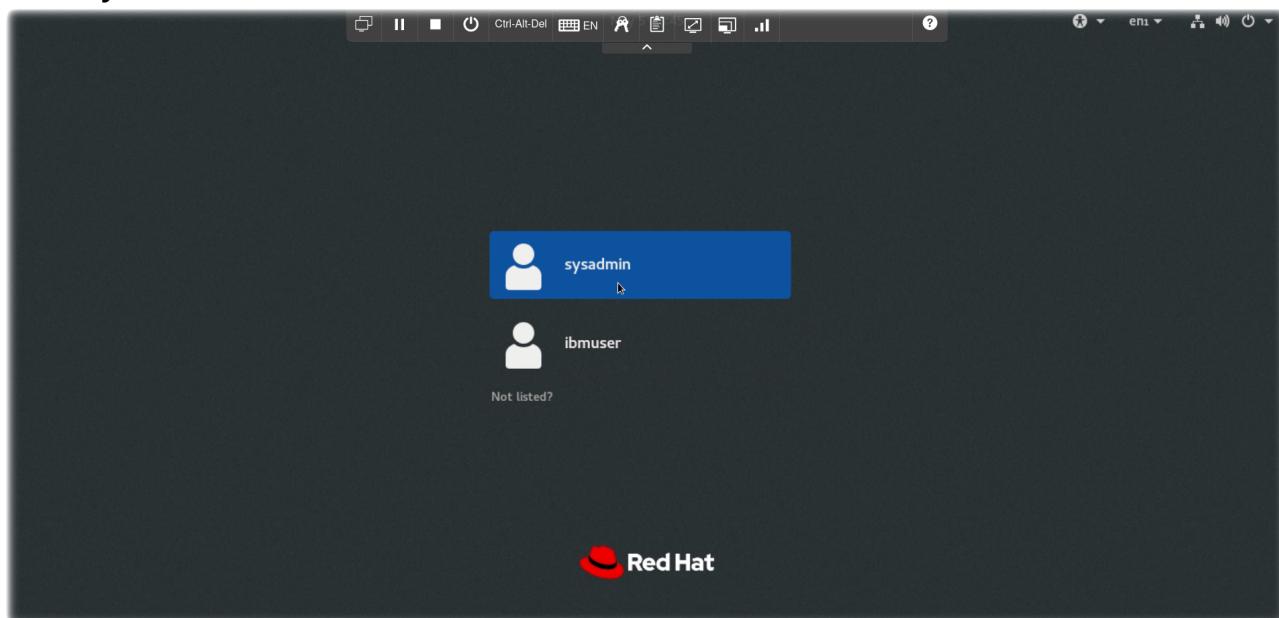
- Create a free [IBM Cloud account](#)
- [Sign up for Think 2021](#)
- Register for the [Introduction to IEAM lab](#)
- Join us on Wednesday, May 12, 2021 3:00 PM to 5:00 PM EDT by logging into the [Think portal](#)

## Lab Objectives

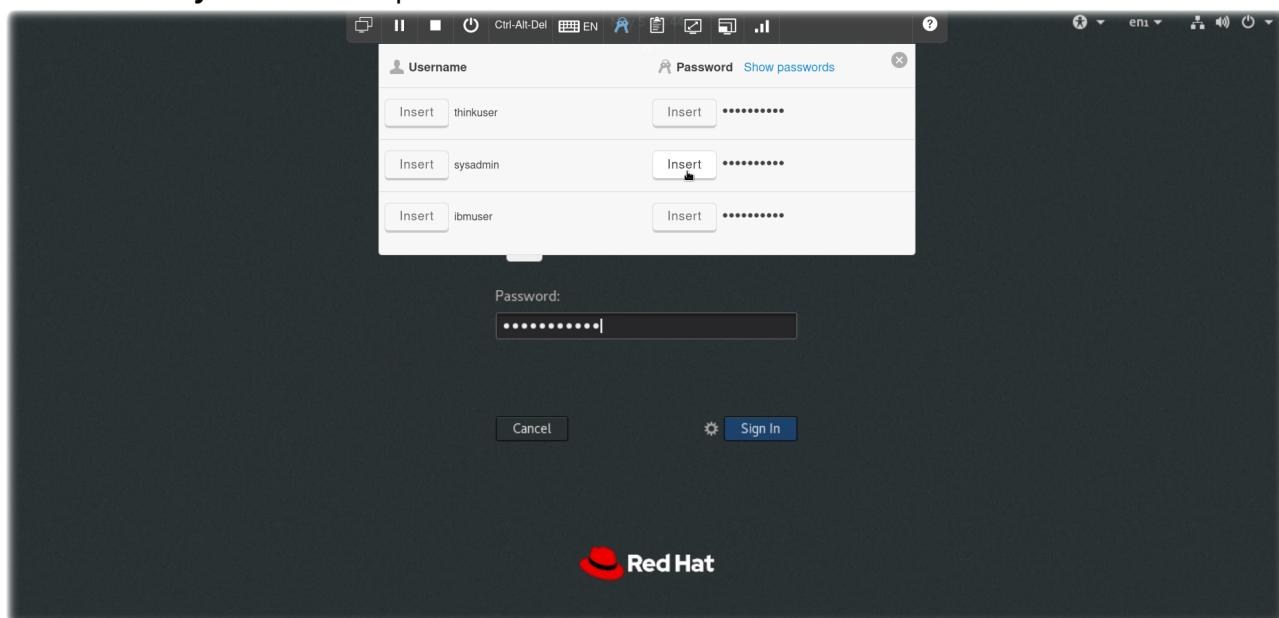
- Access the Think 2021 Lab virtual machine environment
- Learn about IEAM components
- Explore the IEAM web console
- Register an Edge node
- Experiment with the hzn command line interface
- Configure IEAM Services and Policies
- Deploy containerized workloads to your edge device

## Access to the Think 2021 Lab Environment

- Select **sysadmin**



- Login Credentials for the virtual machine are stored in the toolbar
- Click on the **Keys** icon in the top toolbar

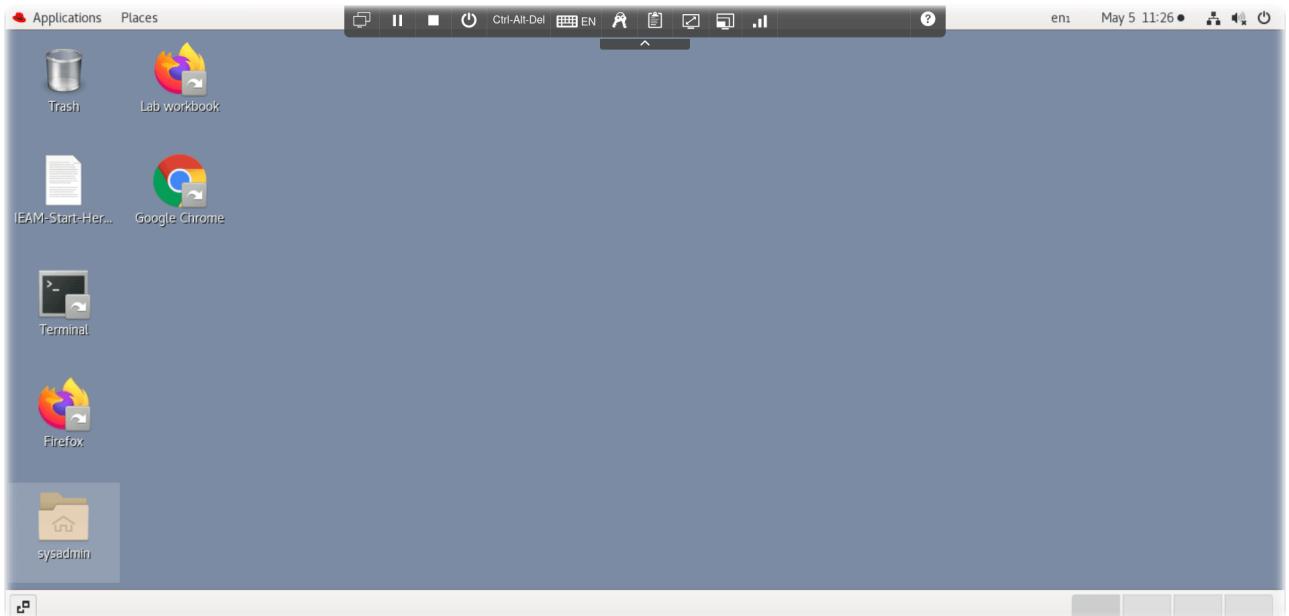


- A drop down dialog will appear with various credentials used in this lab
- Click on the **Insert** button for the sysadmin password
- Click on the **Sign In** button

## Navigating the Virtual Machine

This lab will use several components within the RHEL Gnome desktop environment:

- Review the desktop



- a terminal window to execute `hzn` Horizon edge agent commands
- a browser window with access to the IBM Edge Application Manager web console
- this GitHub repository / PDF which provides exercises to learn about IEAM, the Horizon agent, and containerized edge workloads
- Select the Lab workbook Firefox icon (if you prefer Chrome, select the Chrome icon and then open the 'Lab Workbook' from the bookmark bar)
- The browser will open to the [Introduction to IBM Edge Application Manager - IEAM](#) github repo

## IEAM Component Definitions

Before proceeding to the lab instructions, let's review some IEAM component definitions.

- *IEAM Management Hub* - The web UI used by IEAM administrators to view and manage the other components of IBM Edge Application Manager.
- *Node* - Typically, **edge devices** have a prescriptive purpose, provide (often limited) compute capabilities, and are located near or at the data source. Currently [supported IEAM edge device OS and architectures](#):
  - `x86_64`
    - Linux x86\_64 devices or virtual machines that run Ubuntu 20.x (focal), Ubuntu 18.x (bionic), Debian 10 (buster), Debian 9 (stretch)
    - Red Hat Enterprise Linux® 8.2
    - Fedora Workstation 32
    - CentOS 8.2
    - SuSE 15 SP2
  - `ppc64le` (support starting Horizon version 2.28)

- Red Hat Enterprise Linux® 7.9
  - ARM (32-bit)
    - Linux on ARM (32-bit), for example Raspberry Pi, running Raspberry Pi OS buster or stretch
  - ARM (64-bit)
    - Linux on ARM (64-bit), for example NVIDIA Jetson Nano, TX1, or TX2, running Ubuntu 18.x (bionic)
  - Mac
    - macOS
- *Containerized Workload* - Any Docker/OCI containerized service, microservice, or piece of software that does meaningful work when it runs on an edge node.
  - *Service* - A service that is designed specifically to be deployed on an edge cluster, edge gateway, or edge device. Visual recognition, acoustic insights, and speech recognition are all examples of potential edge services.
  - *properties* - name/value pairs, often used to describe attributes of nodes (like model, serial number, role, capabilities, attached hardware. etc.) or attributes of a service or deployment (see “policy”).
  - *constraints* - logical expressions in terms of “properties”. Constraints are used to control and manage software deployment to edge nodes.
  - *policy* - a collection of zero or more properties and zero or more constraints, sometimes with additional data fields (see “node policy”, “service policy”, and “deployment policy”)
  - *node policy* - a set of properties and constraints related to an edge node (either a stand-alone Linux edge node or a Kubernetes cluster node)
  - *service policy* - a set of properties and constraints related to a specific deployable service
  - *business policy* - (deprecated) the former name for “deployment policy”
  - *deployment policy* - a set of properties and constraints related to the deployment of a specific service together with an identifier for the service version to deploy, and other information such as how rollbacks should be handled when failures occur.
  - *pattern* - another name for “deployment pattern”
  - *deployment pattern* - a list of specific deployable services. Patterns are a simplification of the more general, and more capable, “policy” mechanism. Edge nodes can register with a deployment pattern to cause the pattern’s set of services to be deployed.
  - *IEAM Edge Cluster* - IBM Edge Application Manager (IEAM) [edge cluster capability](#) helps you manage and deploy workloads from a management hub cluster to remote instances of OpenShift® Container Platform or other Kubernetes-based clusters. Edge clusters are IEAM edge nodes that are Kubernetes clusters. An edge cluster enables use cases at the edge, which require colocation of compute with business operations, or that require more scalability, availability, and compute capability than what can be supported by an edge device. IEAM edge cluster configuration is outside the scope of this introduction lab.

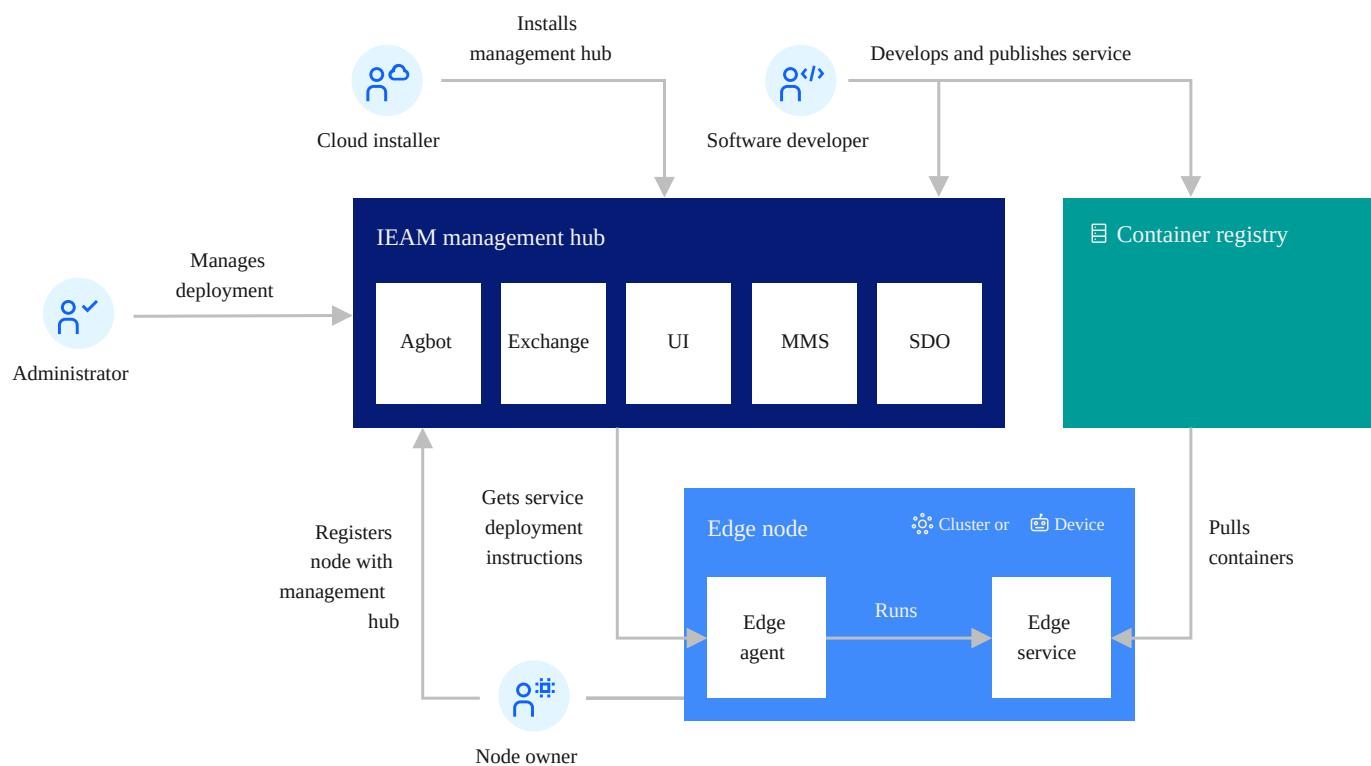
## Architecture

The goal of edge computing is to harness the disciplines that have been created for hybrid cloud computing to support remote operations of edge computing facilities. IEAM is designed for that purpose.

The deployment of IEAM includes the management hub that runs in an instance of OpenShift Container Platform installed in your data center. The management hub is where the management of all of your remote edge nodes (edge devices and edge clusters) occurs.

These edge nodes can be installed in remote on-premises locations to make your application workloads local to where your critical business operations physically occur, such as at your factories, warehouses, retail outlets, distribution centers, and more.

The following diagram depicts the high-level topology for a typical edge computing setup:

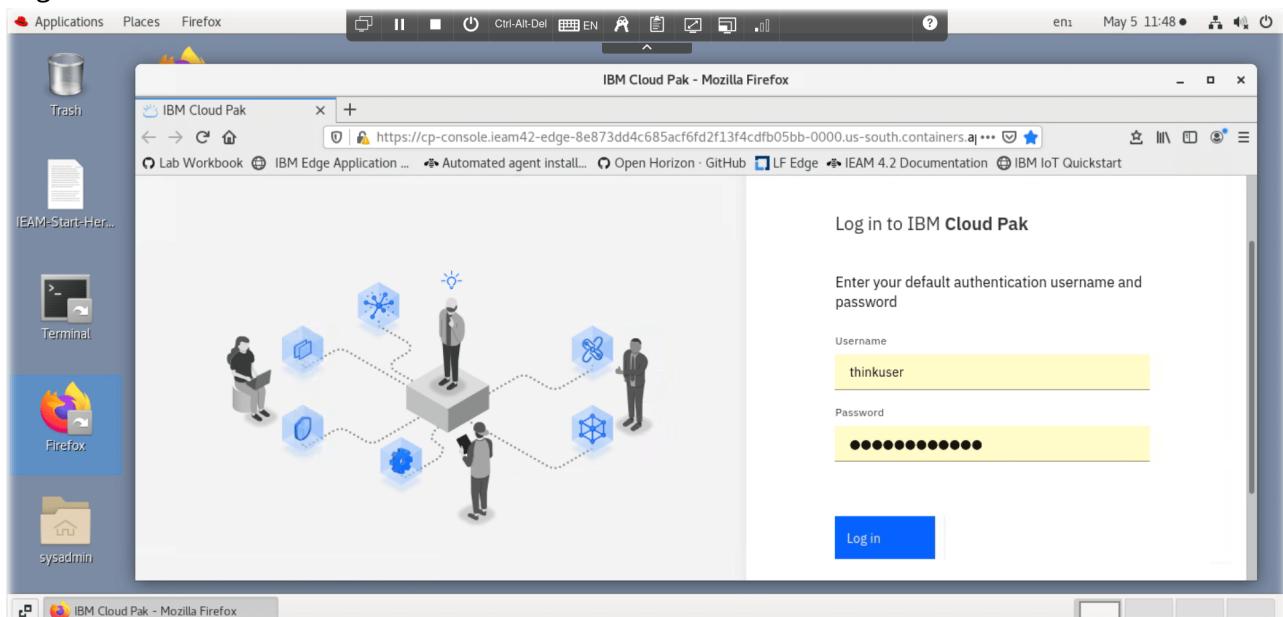


# Let's Get Started

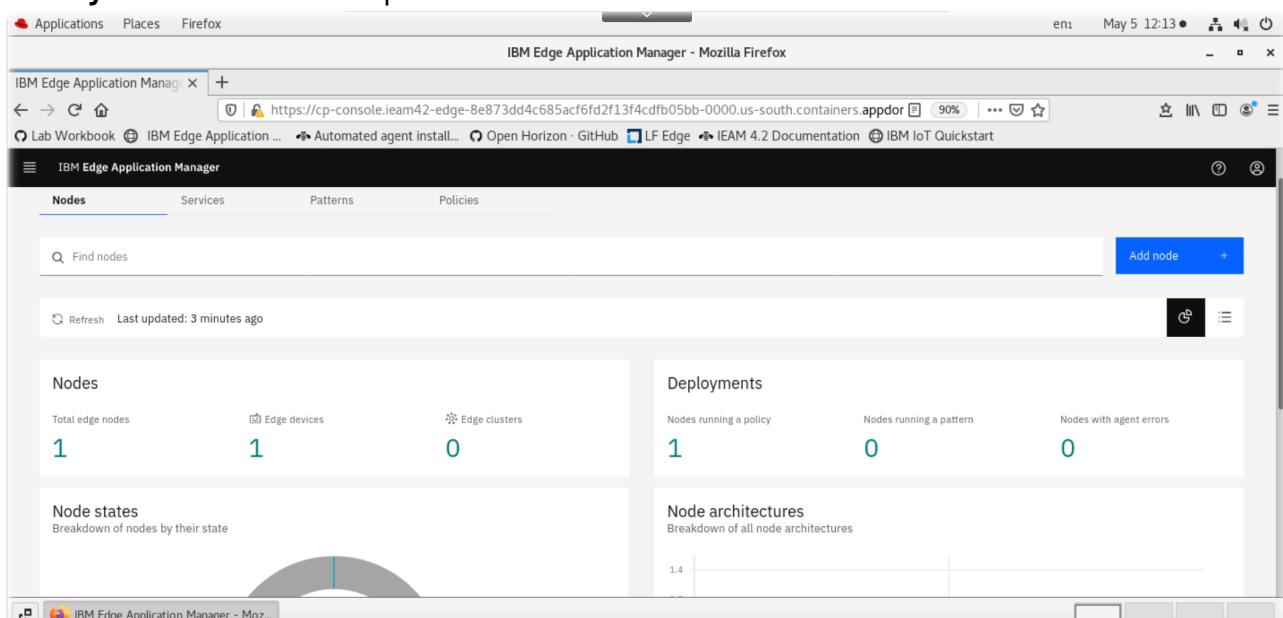
## Explore the IEAM web console

In this section, explore the IEAM mgmt web console.

- Click either the Firefox or Chrome browser icon on your desktop
  - Note** if you select Chrome, launch IBM Edge Application Manager from the browser toolbar.  
You will also need to click on the Advanced button and proceed to the self-signed certificate.  
Choose Default Authentication.
- Login into the IEAM console



- The **thinkuser** userid / password are already saved in your browser keystore but if you need to, use the **Keys** toolbar to insert the password.



- Note:** If you receive a **403** error, modify the browser URL in the address bar, remove the **common-nav/403** and replace it with **edge**
- Nodes
  - Manage the node properties and constraints

- Note there are only a few edge nodes registered. In a subsequent section of the lab, your edge node will appear here.

Name	Owner	Architecture	Last updated	Node Type	Heartbeat	Errors
think-edge-walicki	thinkuser	amd64	5 minutes ago		green	

- Services

Devices	Architecture	Version	Nodes
root	Multiple	1.4.3	0

Devices	Architecture	Version	Nodes
root	Multiple	1.1.0	0

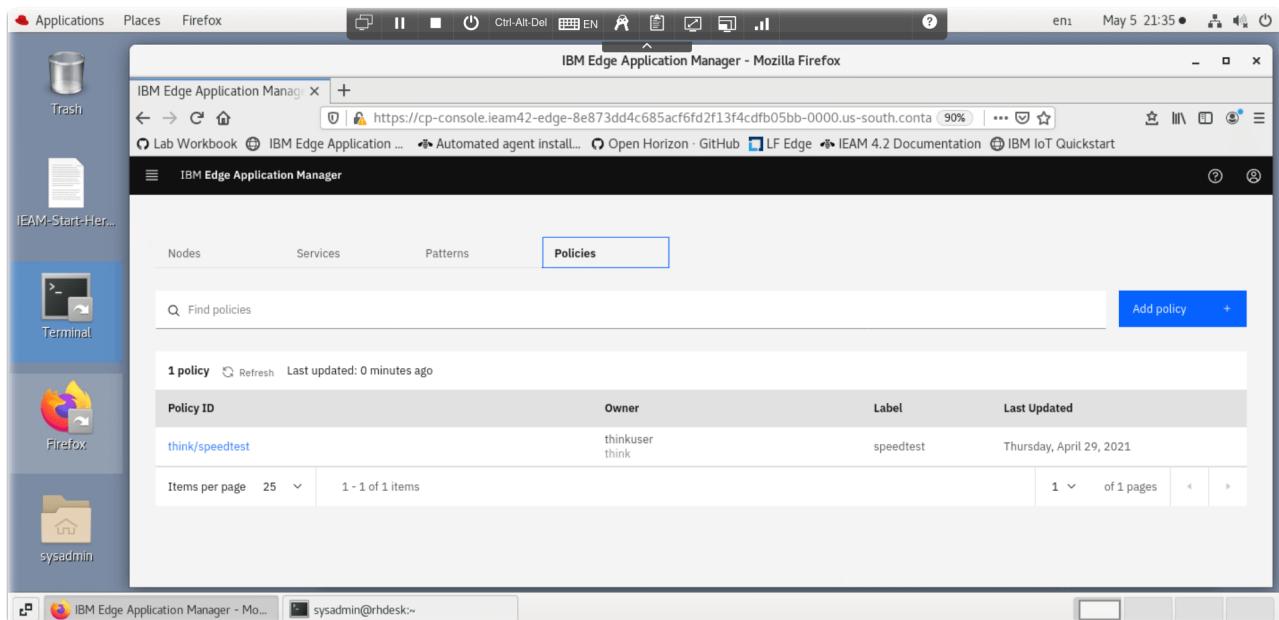
Devices	Architecture	Version	Nodes
root	Multiple	1.0.0	1

Devices	Architecture	Version	Nodes
root	Multiple	2.1.2	0

- Patterns

Pattern ID	Owner	Public	Last updated
pattern-ibm.hello-mms-arm	root	true	Wednesday, November 11, 2020
pattern-ibm.hello-mms	root	true	Wednesday, November 11, 2020
pattern-ibm.helloworld	root	true	Wednesday, November 11, 2020
pattern-ibm.operator-amd64	root	true	Wednesday, November 11, 2020
pattern-ibm.hello-mms-amd64	root	true	Wednesday, November 11, 2020

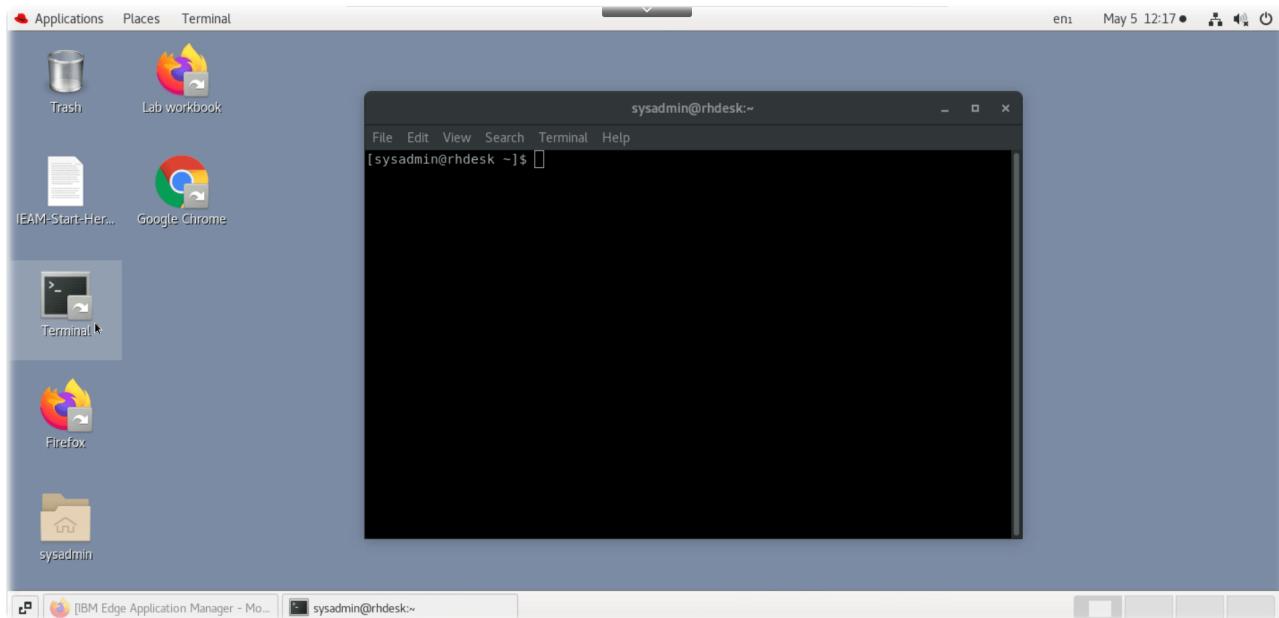
- Policies



## Explore the "Edge" Device

The virtual machine lab environment provided during the Think 2021 lab will be your "edge device" today. Normally, your edge device might be an industrial computer, small board computer, etc.

- Click on the **Terminal** icon and launch a console window.



- To simplify the edge lab setup, the HZN environment variables have been pre-configured in the `~/.bashrc` profile

- Inspect the HZN environment variables by entering this shell pipeline

```
export | grep HZN
```

**Note:** (the urls and iamapikey have been blurred in the public screenshots)

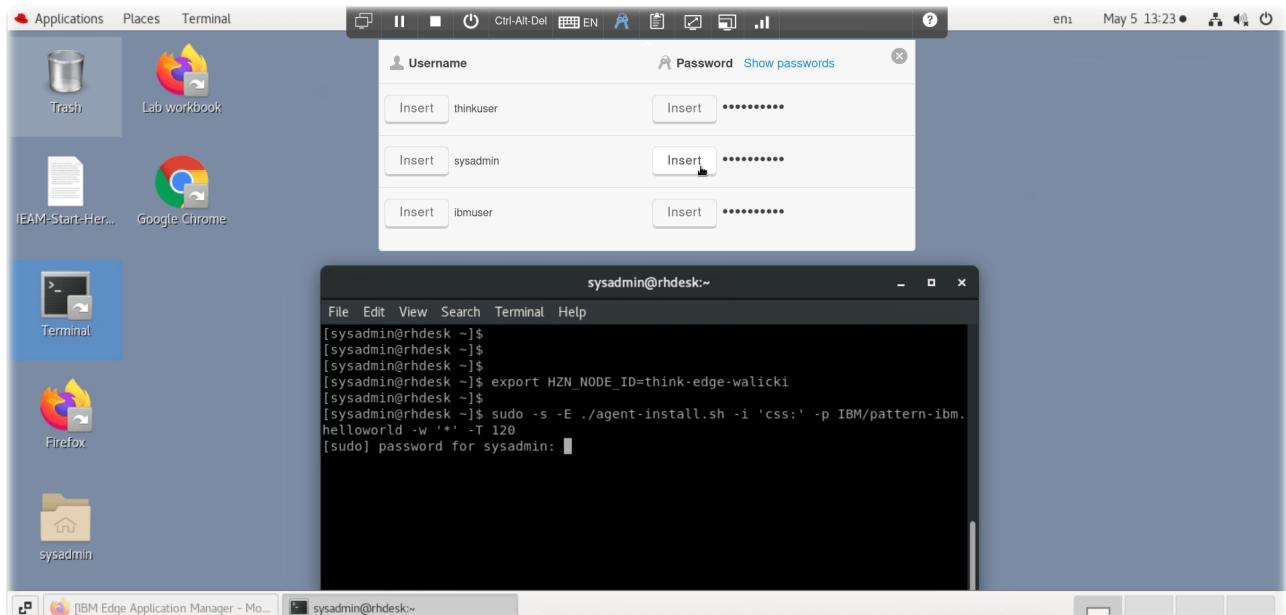
- Set your HZN\_NODE\_ID environment variable to something unique which will allow you to find your "edge" device in the IEAM management console. eg `think-edge-<yourname>`

```
export HZN_NODE_ID=think-edge-<yourname>
```

- **Stop :** Did you `export HZN_NODE_ID=think-edge-<yourname>` as required in the above step?  
You won't be able to find your device in the IEAM mgmt console if you don't set a node name.

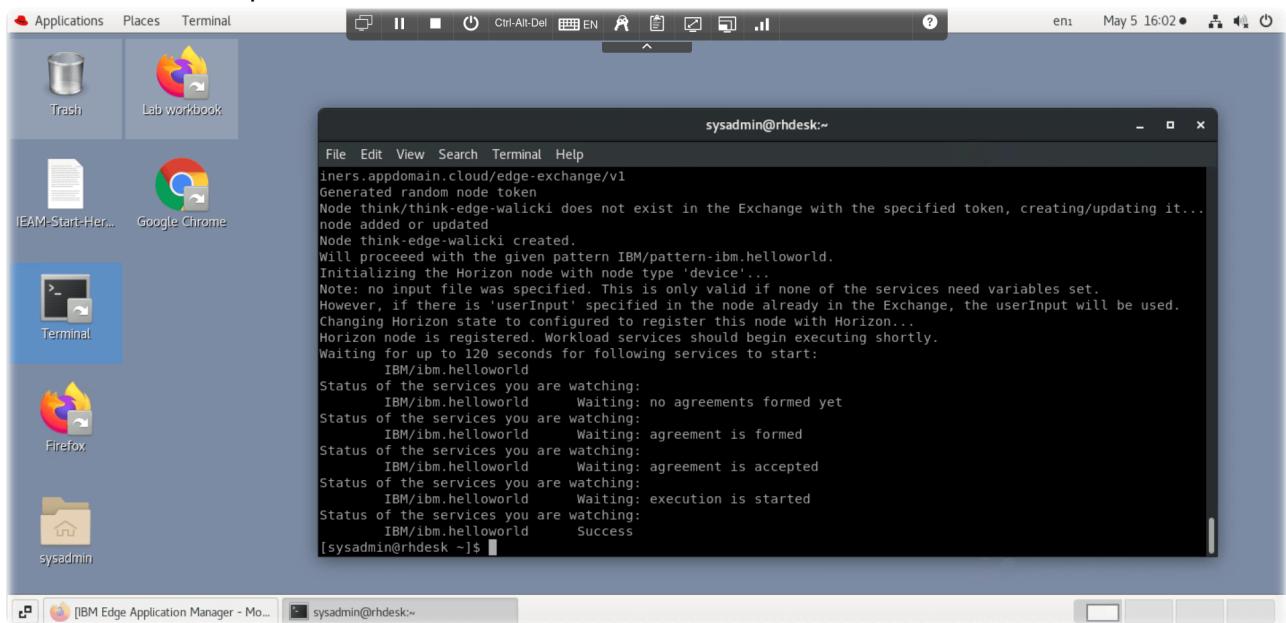
- Install / Register your edge node

```
sudo -s -E ./agent-install.sh -i 'css:' -p IBM/pattern-ibm.helloworld
-w '*' -T 120
```



Use the **Keys** toolbar to insert the **sysadmin** password at the **sudo** prompt

- When the node registration completes, it will have also configured an **IBM/pattern-ibm.helloworld** pattern to execute on this node.



- Query the version that was installed

```
hzn version
Horizon CLI version: 2.28.0-338
Horizon Agent version: 2.28.0-338
```

- Return to the IEAM web console. Refresh, Find your device

The screenshot shows the 'IBM Edge Application Manager - Mozilla Firefox' window. The URL is <https://cp-console.ieam42-edge-8e873dd4c685acf6fd2f13f4cdfb05bb-0000.us-south.cloud.ibm.com/>. The page displays a table of nodes with one entry:

Name	Owner	Architecture	Last updated	Node Type	Heartbeat	Errors
think-edge-walicki	thinkuser think	amd64	5 minutes ago		.	

Items per page: 25 | 1 - 1 of 1 items

- If you don't see your node, or you skipped the step which sets the name of your edge node, **export HZN\_NODE\_ID=think-edge-<yourname>**, you can unregister the node and try again.

```
sudo hzn unregister -vrfD
export HZN_NODE_ID=think_edge_<yourname>
sudo -s -E ./agent-install.sh -i 'css:' -p IBM/pattern-ibm.helloworld
-w '*' -T 120
```

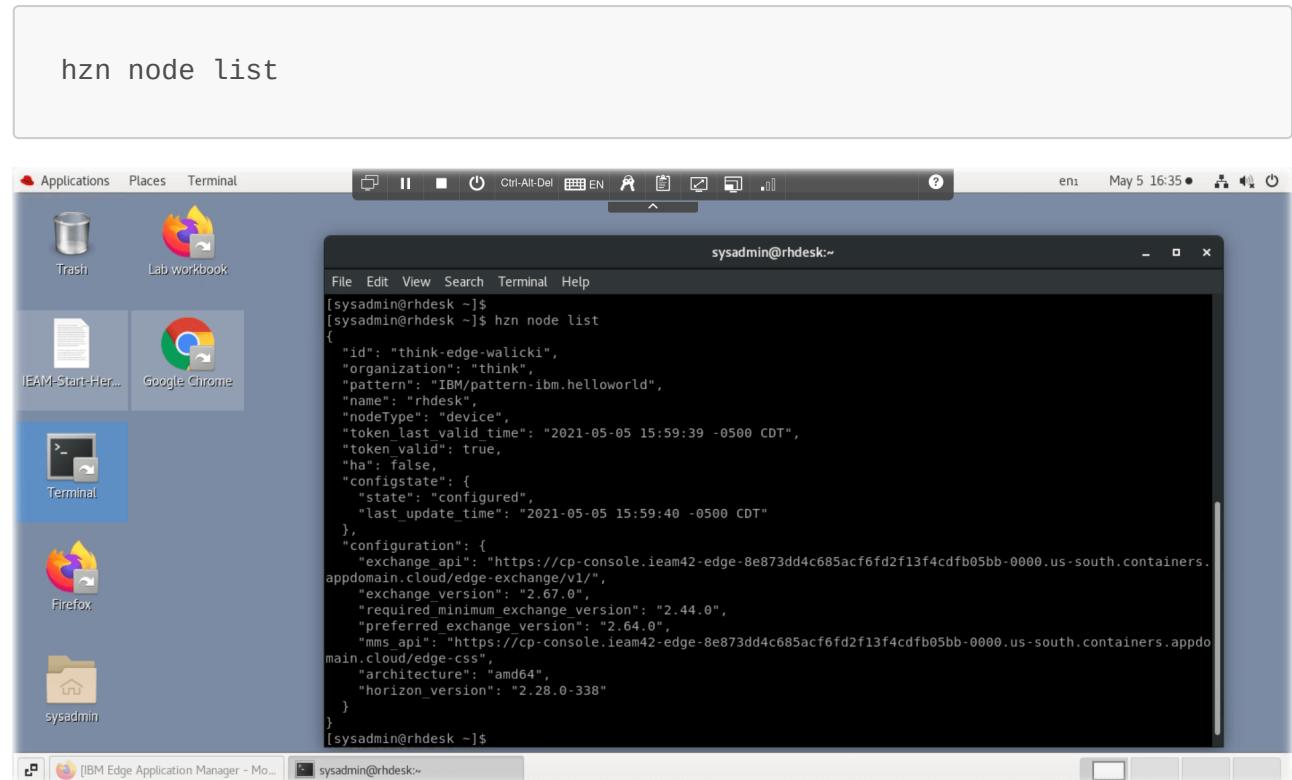
- Return to the Terminal window. See what agreements are running.

```
watch hzn agreement list
```

The terminal window shows the following command and its output:

```
[sysadmin@rhdesk ~]$ hzn agreement list
[
  {
    "name": "pattern-ibm.helloworld_ibm.helloworld_IBM_amd64 merged with pattern-ibm.helloworld_ibm.helloworld_IBM_amd64",
    "current_agreement_id": "3f2cf8582f8afa19be8f802e850aba192807e362c4c12871b5d7ca0427a91f1f",
    "consumer_id": "IBM/agbot",
    "agreement_creation_time": "2021-05-05 16:00:01 -0500 CDT",
    "agreement_accepted_time": "2021-05-05 16:00:11 -0500 CDT",
    "agreement_finalized_time": "2021-05-05 16:00:11 -0500 CDT",
    "agreement_execution_start_time": "2021-05-05 16:00:13 -0500 CDT",
    "agreement_data_received_time": "",
    "agreement_protocol": "Basic",
    "workload_to_run": {
      "url": "ibm.helloworld",
      "org": "IBM",
      "version": "1.0.0",
      "arch": "amd64"
    }
  }
]
```

- Query details about your node



## Using the Horizon HZN command line

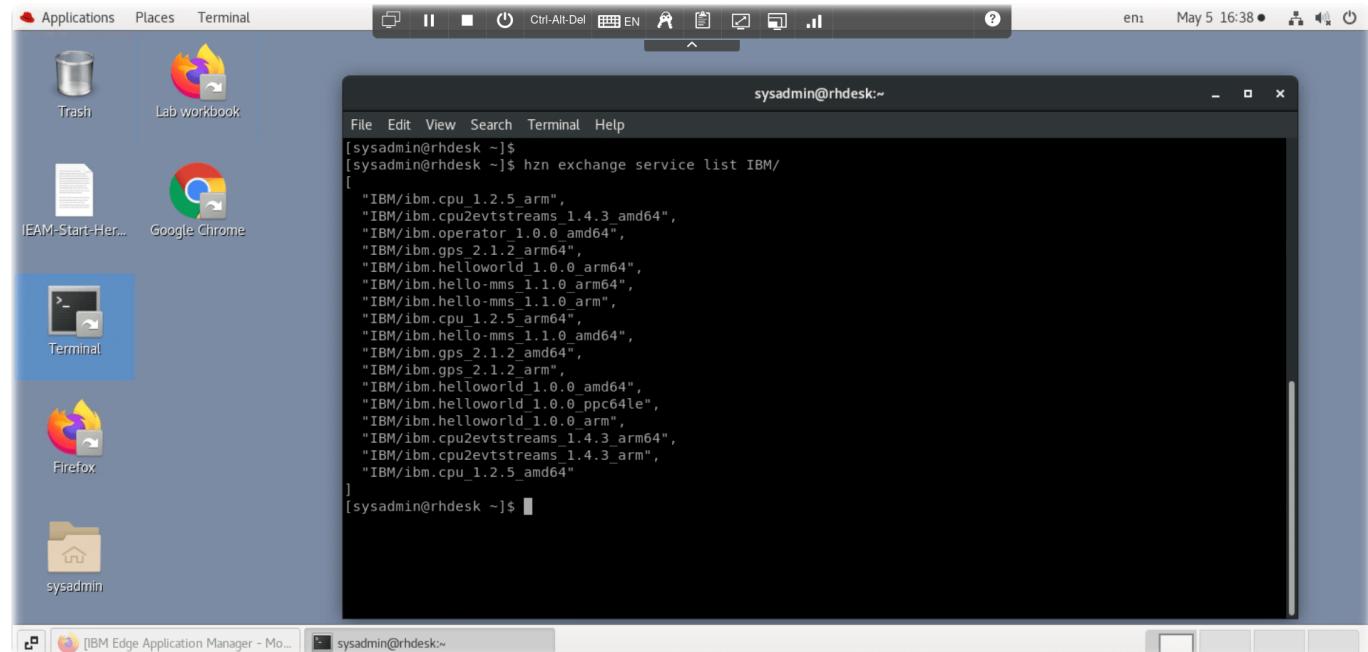
There are many horizon command line interface parameters. This section will explore some of them.

```
hzn help
```

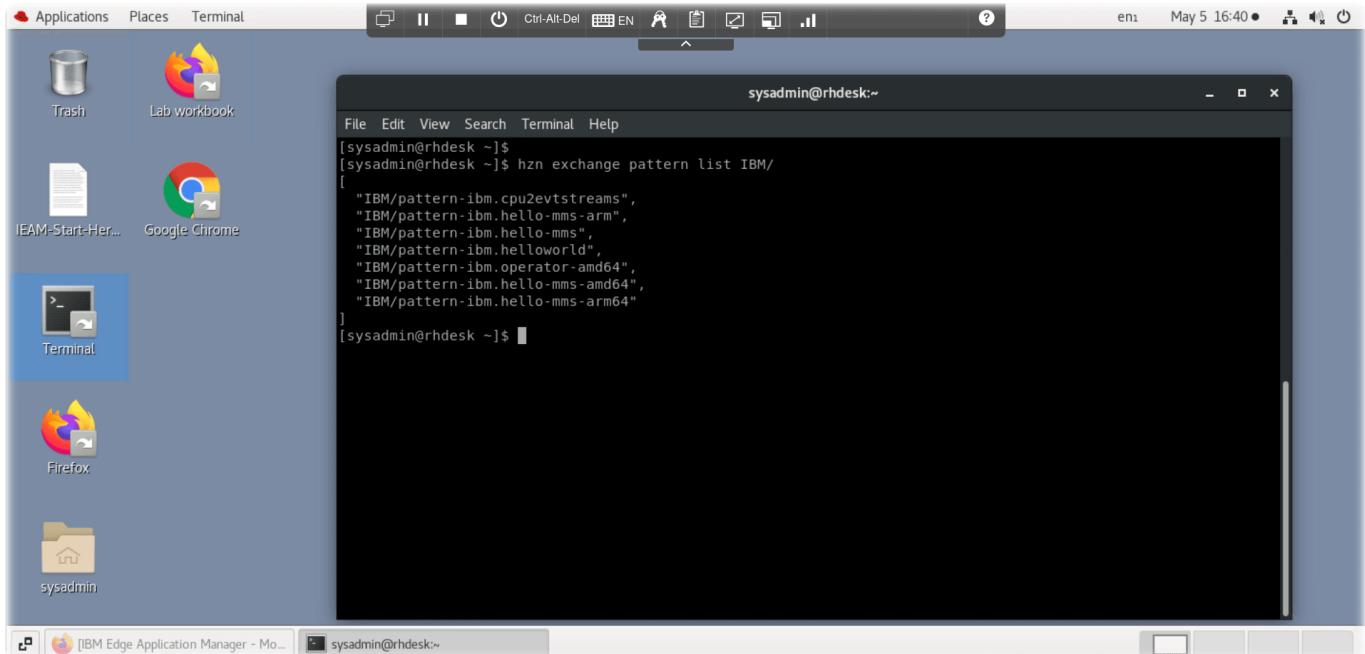
The IEAM management hub installation includes several services which have been published into the exchange automatically. The following commands will list the services, patterns, and deployment policies available in your exchange:

**Note:** The following commands assume you have the Horizon environment variables `HZN_ORG_ID` and `HZN_EXCHANGE_USER_AUTH` set

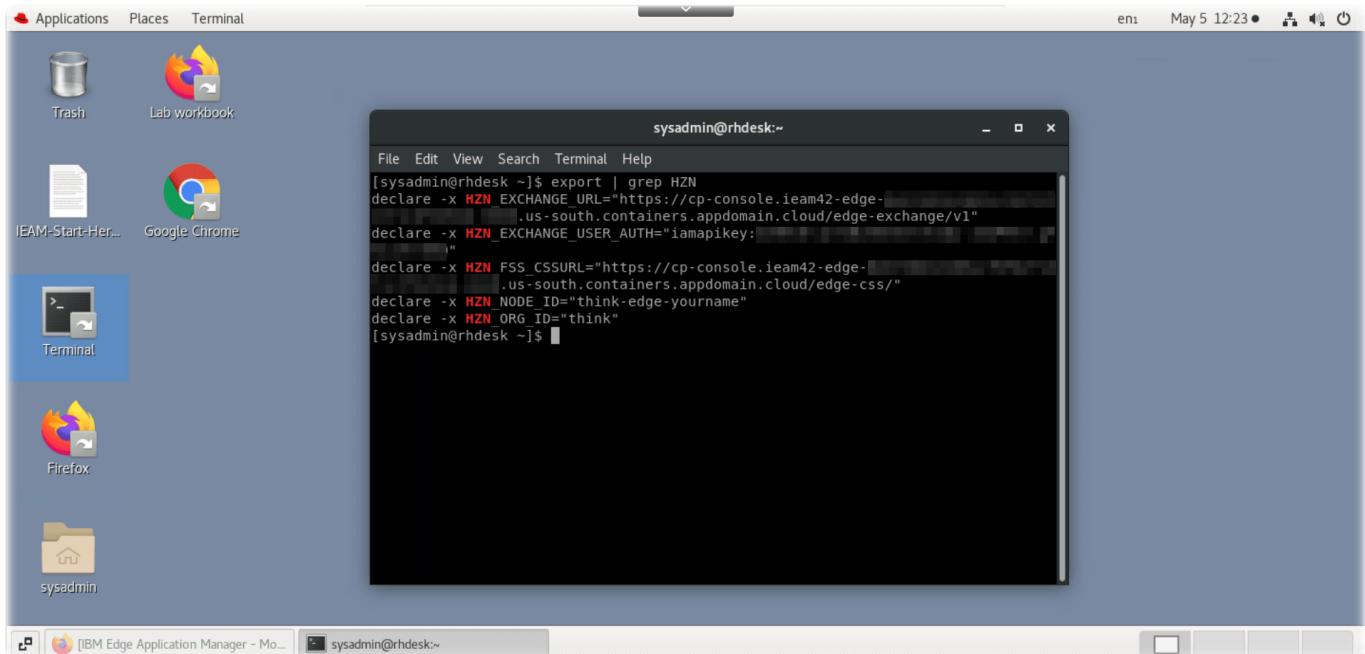
```
hzn exchange service list IBM/
```



```
hzn exchange pattern list IBM/
```

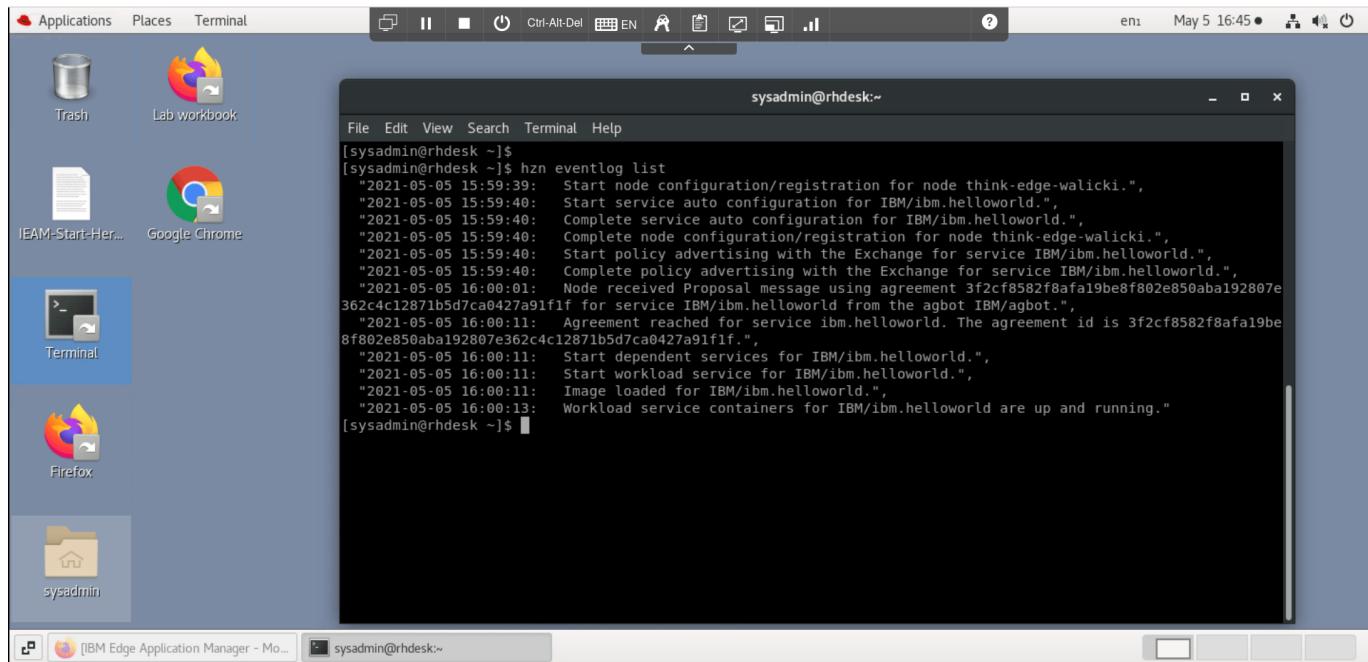


```
hzn exchange deployment listpolicy
```



- Review the event log for this node.

```
hzn eventlog list
```



The screenshot shows a Linux desktop environment with a terminal window open. The terminal window title is "sysadmin@rhdesk:~". The terminal displays the command "hzn eventlog list" followed by its output, which is a log of events from May 5, 2021, at 15:59:39. The log entries include various system and service configurations and start-ups. The desktop background is a blue gradient, and the taskbar at the bottom shows icons for the terminal, file manager, and browser.

```
[sysadmin@rhdesk ~]$ hzn eventlog list
"2021-05-05 15:59:39: Start node configuration/registration for node think-edge-walicki.",
"2021-05-05 15:59:40: Start service auto configuration for IBM/ibm.helloworld.",
"2021-05-05 15:59:40: Complete service auto configuration for IBM/ibm.helloworld.",
"2021-05-05 15:59:40: Complete node configuration/registration for node think-edge-walicki.",
"2021-05-05 15:59:40: Start policy advertising with the Exchange for service IBM/ibm.helloworld.",
"2021-05-05 15:59:40: Complete policy advertising with the Exchange for service IBM/ibm.helloworld.",
"2021-05-05 16:00:01: Node received Proposal message using agreement 3f2cf8582f8afa19be8f802e850aba192807e362c4c12871b5d7ca0427a91f1f for service IBM/ibm.helloworld from the agbot IBM/agbot.",
"2021-05-05 16:00:11: Agreement reached for service ibm.helloworld. The agreement id is 3f2cf8582f8afa19be8f802e850aba192807e362c4c12871b5d7ca0427a91f1f.",
"2021-05-05 16:00:11: Start dependent services for IBM/ibm.helloworld.",
"2021-05-05 16:00:11: Start workload service for IBM/ibm.helloworld.",
"2021-05-05 16:00:11: Image loaded for IBM/ibm.helloworld.",
"2021-05-05 16:00:13: Workload service containers for IBM/ibm.helloworld are up and running."
[sysadmin@rhdesk ~]$
```

## Web Hello containerized workload

In this exercise, we will create a Web Hello service that runs a containerized HTTP server workload on your edge device. The [web-hello-python](#) example is an extremely simple HTTP server (written in Python) that responds on port 8000 with a hello message.

The core principle of IBM Edge Application Manager is to orchestrate containerized workloads, at scale, on edge devices. Edge developers should be familiar with creating Docker containers optimized for (CPU/Memory/Power) constrained devices. This example builds a small container, pushes it to your Docker Hub registry and creates a service and pattern in the IEAM exchange hub.

The source / instructions to build the container are posted in the [web-hello-python](#) github repository, but are copied here for the lab exercise.

- Open a Terminal window in your virtual machine
- Clone the github repository:

```
cd  
git clone https://github.com/TheMosquito/web-hello-python  
cd web-hello-python
```

- Log into your Docker Hub account so the container can be hosted for edge deployment

```
docker login
```

- Edit the variables at the top of the Makefile as desired. If you plan to push it to a Docker registry, make sure you give your docker ID. You may also want to create unique names for your service and pattern (necessary for this lab in the multi-tenant IEAM instance that is shared with other lab participants and you are all publishing this service).
  - gedit / vi / nano editors are available
  - Change the following **Makefile** lines:

```
DOCKERHUB_ID:=<your docker registry account>  
SERVICE_NAME:="web-hello-python-<yourname>"  
SERVICE_VERSION:="1.0.0"  
PATTERN_NAME:="pattern-web-hello-python-<yourname>"
```

- Create a hzn cryptographic signing keys. All edge services and deployment patterns must be cryptographically signed. If you do not already have an appropriate asymmetric cryptographic signing key pair, you must create a key pair that you can use for signing. If you need to create a new key pair, run the following command:

```
hzn key create **yourcompany** **youremail**
```

This command creates the following two files:

```
~/.hzn/keys/service.private.key  
~/.hzn/keys/service.public.pem
```

- Build the container, push the container to the Docker registry, publish the service and publish the pattern

```
make build  
make push  
make publish-service  
make publish-pattern
```

- Before we can register this containerized workload to run on your specific Horizon edge node, you will need to unregister the prior IEAM pattern. Remember, only one deployment pattern can be registered on an edge node.

```
hzn unregister -v  
make register-pattern  
watch hzn agreement list  
...  
make test
```

- Test your containerized workload by opening a browser session to <http://localhost:8000>
- Test the container on the command line

```
curl -sS http://localhost:8000  
  
<!DOCTYPE html>  
  
<html>  
<head>  
  
<meta charset="utf-8">  
  
<title>WebHello</title>  
  
</head>  
<body>  
Hello, "172.17.0.1".
```

```
</body>
</html>
```

## SpeedTest to MQTT containerized workload

In this exercise, we will create a Docker containerized workload that can be deployed to an edge node running the Open Horizon agent. The workload can be configured as a managed service and pattern in IBM Edge Application Manager. It runs Speedtest periodically and sends the download bandwidth results over MQTT to Watson IoT Platform Quickstart and plots the results in a chart. This example builds a small container, pushes it to your Docker Hub registry and creates a service and pattern in the IEAM exchange hub.

The source / instructions to build the container are posted in the [ieam-speedtest-mqtt](#) github repository, but are copied here for the lab exercise.

- Open a Terminal window in your virtual machine
- Clone the github repository:

```
cd  
git clone https://github.com/johnwalicki/ieam-speedtest-mqtt  
cd ieam-speedtest-mqtt
```

- Log into your Docker Hub account so the container can be hosted for edge deployment

```
docker login
```

- Edit the variables at the top of the Makefile as desired. If you plan to push it to a Docker registry, make sure you give your docker ID. You may also want to create unique names for your service and pattern (necessary for this lab in the multi-tenant IEAM instance that is shared with other lab participants and you are all publishing this service).

- gedit / vi / nano editors are available
- Change the following **Makefile** lines:

```
DOCKERHUB_ID:=<your docker registry account>  
SERVICE_NAME:="speedtest-mqtt-example-<yourname>"  
SERVICE_VERSION:="1.0.0"  
PATTERN_NAME:="pattern-speedtest-mqtt-example-<yourname>"
```

- The prior section created hzn cryptographic signing keys. If you need to create a new key pair, run the following command:

```
hzn key create **yourcompany** **youremail**
```

This command creates the following two files:

```
~/hzn/keys/service.private.key  
~/hzn/keys/service.public.pem
```

- Build the container, push the container to the Docker registry, publish the service and publish the pattern

```
make build  
make push
```

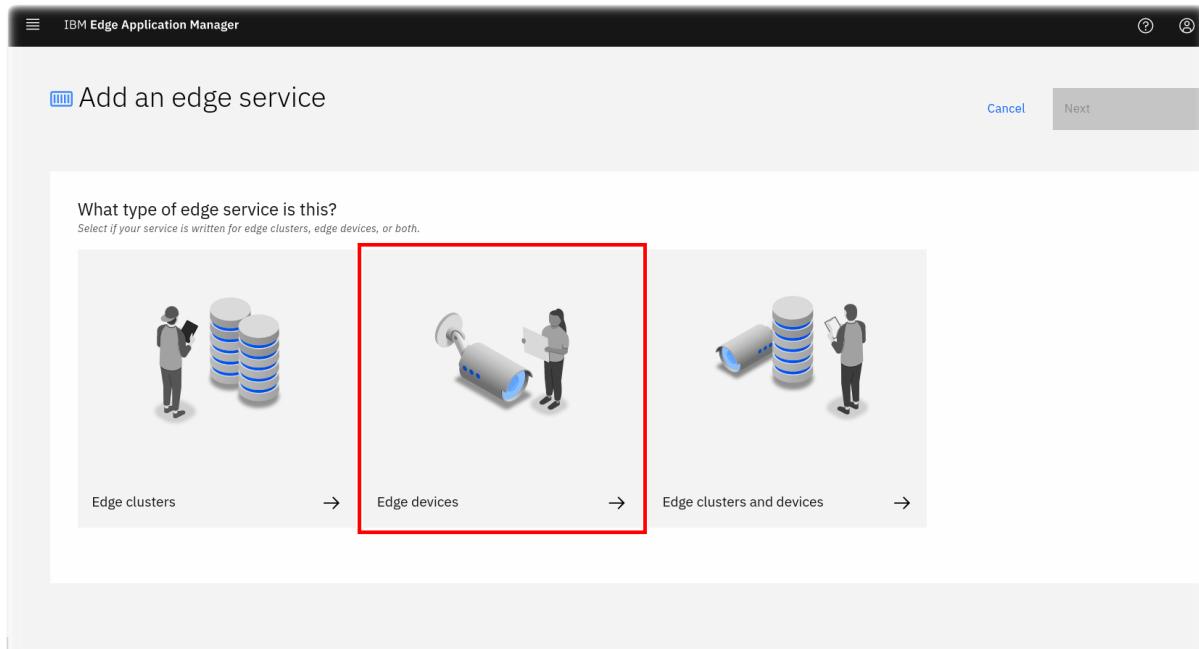
- Instead of publishing the service and pattern from the `hzn` command line interface using `make publish-service` and `make publish-pattern`, in this exercise, open the IEAM web console browser page again from the bookmark bar.

- Select the **Services** tab and click on the **Add service** button.

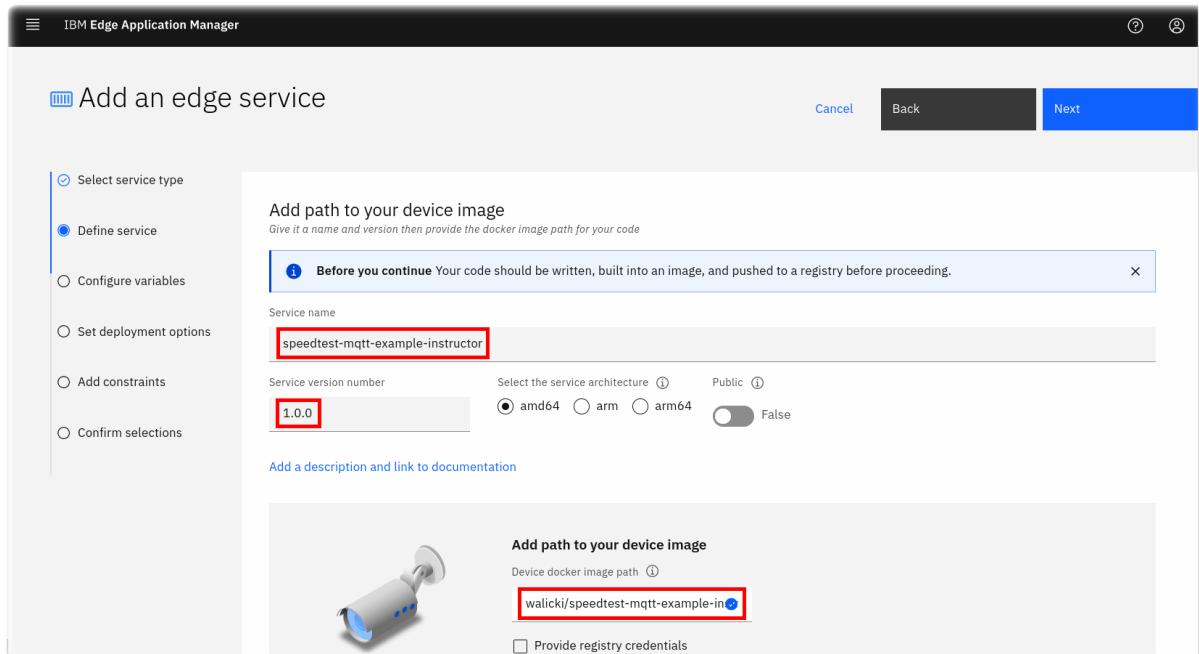
The screenshot shows the IEAM web interface. At the top, there are tabs for 'Nodes', 'Services' (which is highlighted with a red box), 'Patterns', and 'Policies'. Below the tabs is a search bar labeled 'Find services'. To the right of the search bar is a blue button labeled 'Add service' with a '+' sign, also highlighted with a red box. The main area displays a table titled '19 services' with columns: Service ID, Owner, Architecture, Version, and Last Updated. The table lists various services like 'web-hello-python-walicki\_1.0.0\_amd64', 'speedtest2mqtt\_3\_amd64', and several 'ibm.' services. At the bottom of the table, there are pagination controls for 'Items per page' (set to 25), '1 - 8 of 8 items', and '1 of 1 pages'.

Service ID	Owner	Architecture	Version	Last Updated
web-hello-python-walicki_1.0.0_amd64	thinkuser think	amd64	1.0.0	Friday, May 7, 2021
speedtest2mqtt_3_amd64	thinkuser think	amd64	3	Thursday, April 29, 2021
ibm.cpu2evtstreams (3)	root root	Multiple	1.4.3	Multiple
ibm.operator_1.0.0_amd64	root root	amd64	1.0.0	Wednesday, November 11, 2020
ibm.hello-mms (3)	root root	Multiple	1.1.0	Multiple
ibm.helloworld (4)	root root	Multiple	1.0.0	Multiple
ibm.gps (3)	root root	Multiple	2.1.2	Multiple
ibm.cpu (3)	root root	Multiple	1.2.5	Multiple

- Select the **Edge devices** tile.

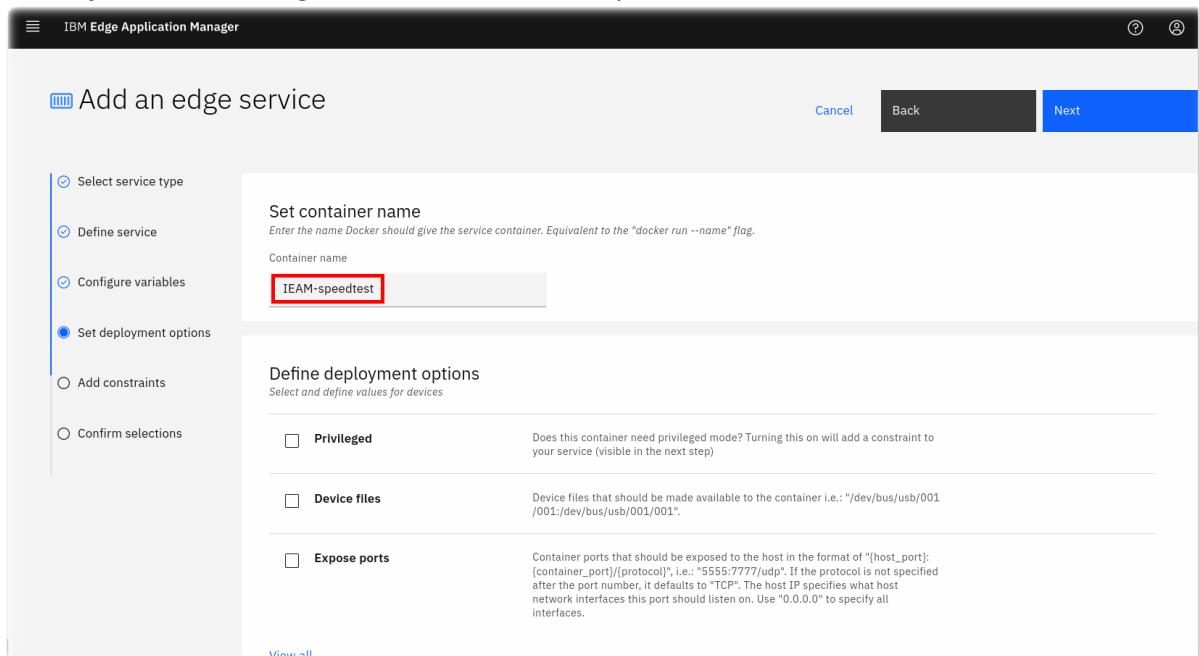


- Give your service a name, eg `speedtest-mqtt-example-<yourname>`, a Service version number, and a path to the Docker container that was pushed, eg `walicki/speedtest-mqtt-example-instructor:1.0.0`

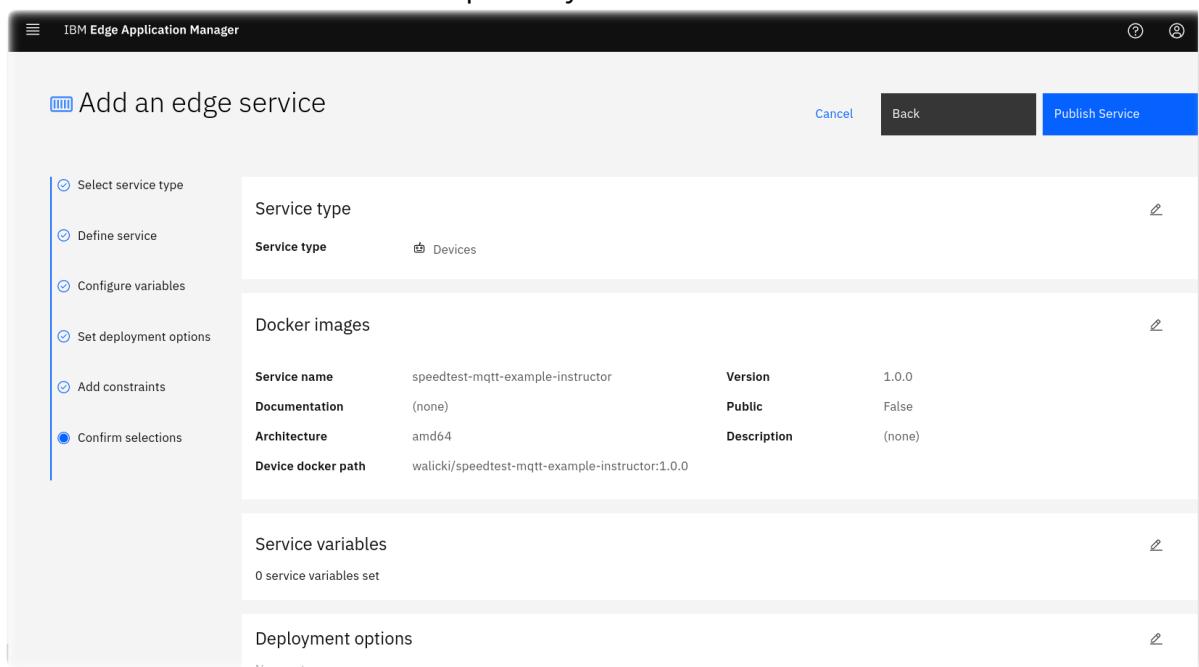


- Press the **Next** button to skip the service variables panel.

- Name your container eg **IEAM-speedtest** and press the **Next** button.



- Press the **Next** button to skip adding constraints to your service.
- Press the **Publish Service** button to publish your service.



Service details

Name	speedtest-.....0.0_amd64	Last updated	a few seconds ago
Owner	think/thinkuser	Version	1.0.0
Public	false	Architecture	amd64
Shareable attributes	Multiple instances		
Description			

Service properties

Properties 0 properties have been set

Facts about your service

Learn more about properties

Service constraints

Deploy this service to nodes with:

Learn more about constraints

- Now that the Service is defined, add a pattern

- Select the **Patterns** tab and click on the **Add pattern** button.

Nodes Services Patterns Policies

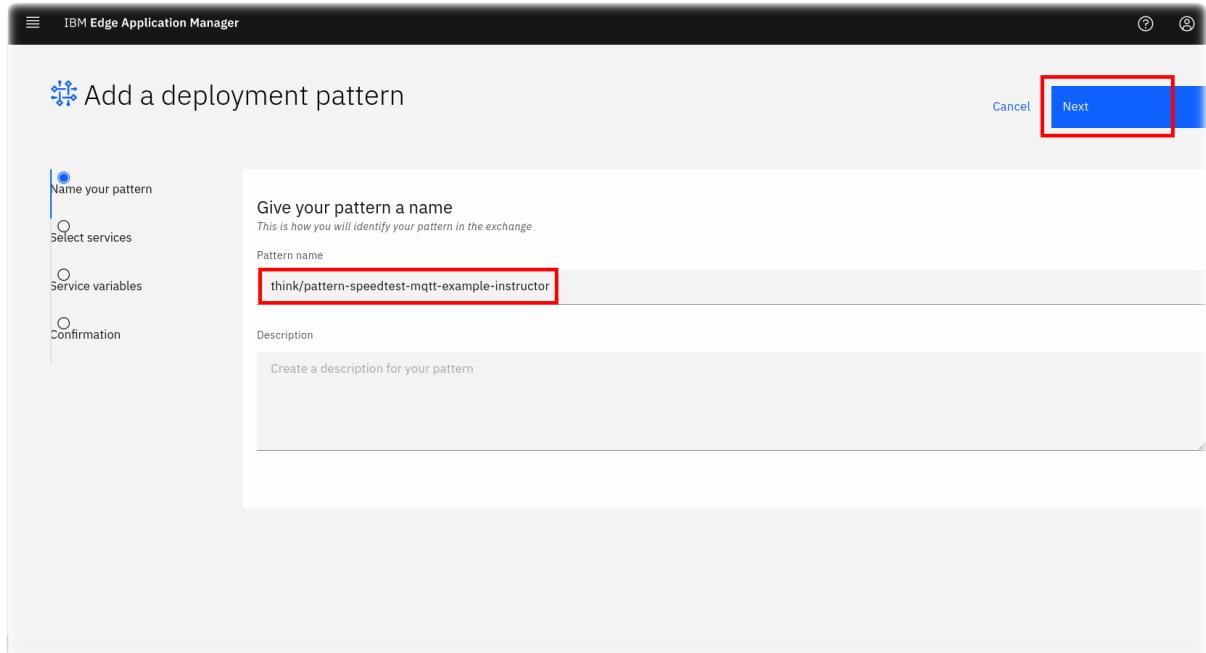
Find patterns

8 patterns Refresh Last updated: 3 minutes ago

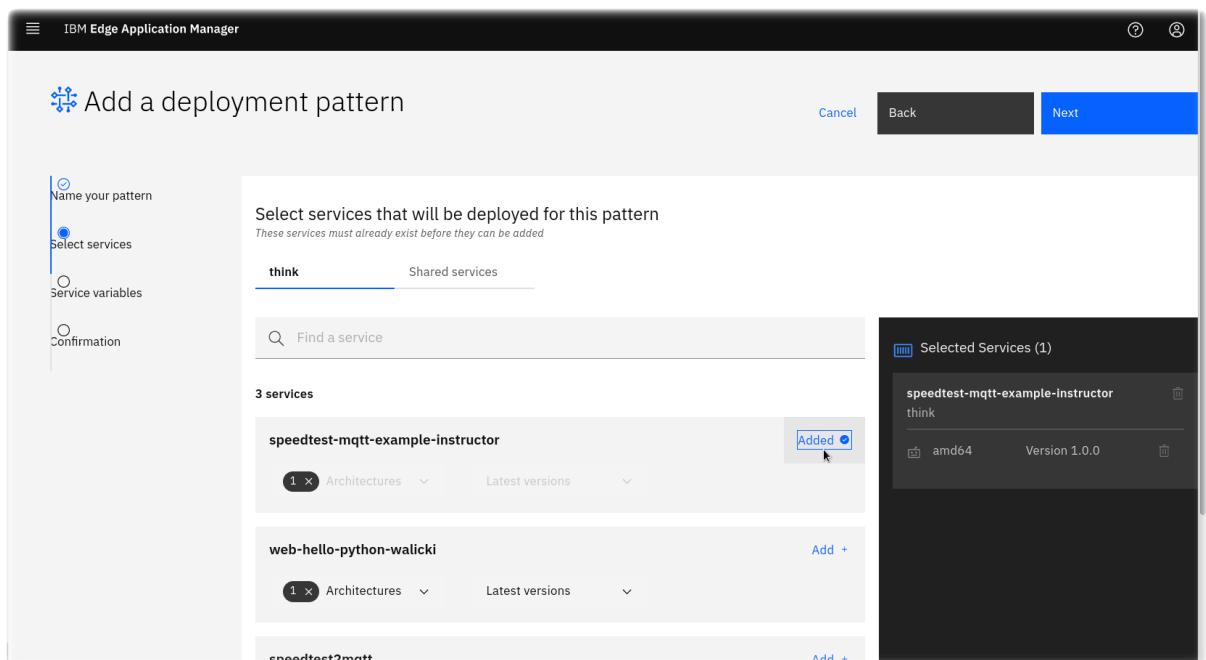
Pattern ID	Owner	Public	Last updated
pattern-web-hello-python-walicki	thinkuser think	false	Friday, May 7, 2021
pattern-ibm.cpu2evtstreams	root root	true	Wednesday, November 11, 2020
pattern-ibm.operator-amd64	root root	true	Wednesday, November 11, 2020
pattern-ibm.hello-mms-arm64	root root	true	Wednesday, November 11, 2020
pattern-ibm.hello-mms-arm	root root	true	Wednesday, November 11, 2020
pattern-ibm.hello-mms-amd64	root root	true	Wednesday, November 11, 2020
pattern-ibm.hello-mms	root root	true	Wednesday, November 11, 2020
pattern-ibm.helloworld	root root	true	Wednesday, November 11, 2020

Items per page 25 ▾ 1 - 8 of 8 items 1 ▾ of 1 pages < >

- Give your pattern a name, eg **think/pattern-speedtest-mqtt-example-instructor** and click the **Next** button.

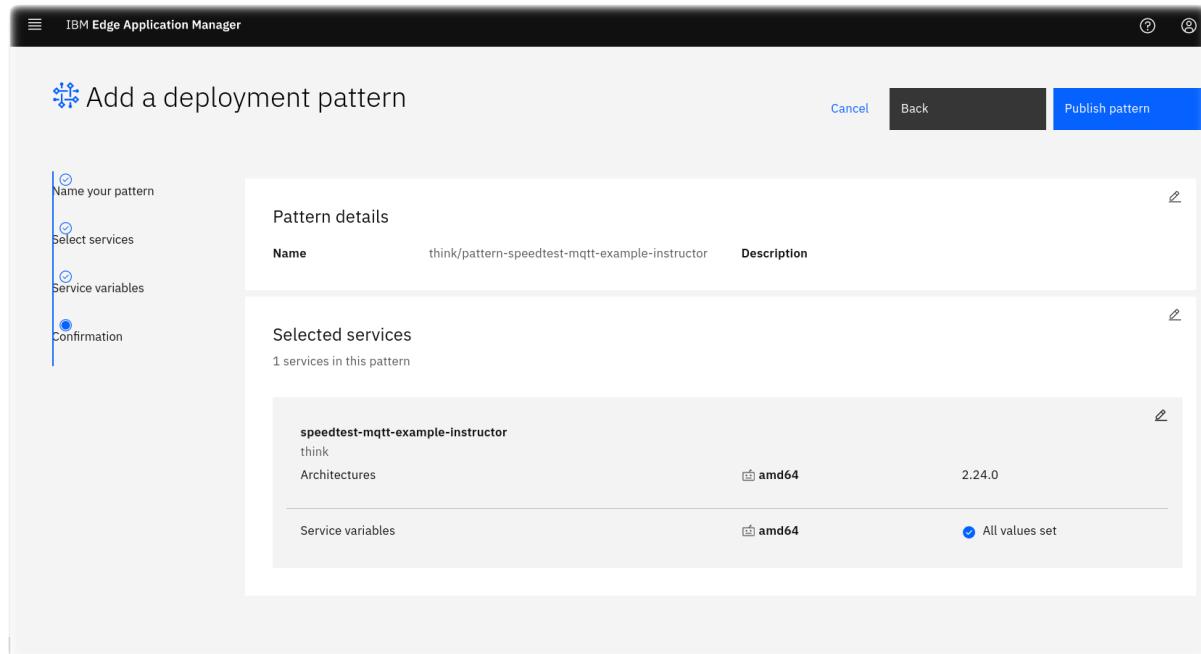


- Search/Find the **speedtest-mqtt-example-<yourname>** service, press the **Add +** button and the **Next** button.



- Press the **Next** button to skip setting service variables for the pattern.

- Press the **Publish pattern** button on the confirmation panel.



- Before we can register this containerized workload to run on your specific Horizon edge node, you will need to unregister the prior IEAM pattern. Remember, only one deployment pattern can be registered on an edge node.

```
hzn unregister -v  
make register-pattern  
watch hzn agreement list  
...  
make test
```

- Observe the Speedtest bandwidth measured by your containerize workload by visiting [Watson IoT Platform Quickstart](#). Enter your unique HZN\_DEVICE\_ID environment variable to something unique which will allow you to observe your "edge" device in the QuickStart chart page eg `think-edge-<yourname>`, then press the **Next** button.

IBM Watson IoT Platform      QUICKSTART      SERVICE ST

! Please be aware this Quickstart page will be sunset on Monday 31st May 2021. For more information on IBM's latest IoT products and solutions please refer to [here](#)

## Quickstart

No sign-up required to see how easy it is to connect your device to Watson IoT Platform and view live sensor data

think-edge-instructor Go Device disconnected at 10:37:49 AM

We have received a message from your device. However it is malformed and therefore we cannot visualize it.  
Last message received at 10:37:49 AM

think-edge-instructor      status.downloadspeed

A line chart showing download speed data over time. The Y-axis represents the value, ranging from 313 to 322. The X-axis represents the time, with a marker at 10:34:10. The data points show a fluctuating trend:

Event	Datapoint	Value	Time Received
1	1	318	10:32:58
2	2	318	10:33:07
3	3	322	10:34:10
4	4	316	
5	5	313	
6	6	314	
7	7	316	
8	8	318	
9	9	315	
10	10	322	
11	11	316	

# Congratulations !

You have completed the **Think 2021 Introduction to IEAM lab**. There are additional resources below. Continue your IEAM / Open Horizon learning journey by watching the [Open Horizon YouTube video playlist](#).

If you enjoyed the session, give the [Introduction to IEAM](#) repository a GitHub star and connect with the [instructors](#).

Clean up your session before exiting the Virtual Machine by deleting your Docker credentials and unregistering your Horizon edge device.

```
rm -rf ~/.docker  
hzn unregister
```

## Additional Resources

- <https://www.lfedge.org/projects/openhorizon/>
- <https://github.com/open-horizon/>
- <https://www.ibm.com/docs/en/edge-computing/4.2>
- <https://www.ibm.com/docs/en/edge-computing/4.2?topic=agent-automated-installation-registration>
- <https://github.com/open-horizon/examples>

## Author

- [John Walicki](#)

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Enjoy! Give me [feedback](#) if you have suggestions on how to improve this lab workbook.

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