Configure Autoscaling in Red Hat OpenStack Platform

OpenStack Team
rhos-docs@redhat.com
Abstract

Use Red Hat OpenStack Platform telemetry components and heat templates to automatically launch instances for workloads.
Table of Contents

MAKING OPEN SOURCE MORE INCLUSIVE ................................................................. 3

PROVIDING FEEDBACK ON RED HAT DOCUMENTATION ...................................... 4

CHAPTER 1. INTRODUCTION TO AUTOSCALING COMPONENTS ............................. 5
  1.1. DATA COLLECTION SERVICE (CEILOMETER) FOR AUTOSCALING ............... 5
  1.1.1. Publishers ......................................................................................... 5
  1.2. TIME-SERIES DATABASE SERVICE (GNOCCHI) FOR AUTOSCALING .......... 5
  1.3. ALARMING SERVICE (AODH) ............................................................... 6
  1.4. ORCHESTRATION SERVICE (HEAT) FOR AUTOSCALING ...................... 6

CHAPTER 2. CONFIGURING AND DEPLOYING THE OVERCLOUD FOR AUTOSCALING .... 7
  2.1. CONFIGURING THE OVERCLOUD FOR AUTOSCALING ......................... 7
  2.2. DEPLOYING THE OVERCLOUD FOR AUTOSCALING .............................. 8
    2.2.1. Deploying the overcloud for autoscaling by using director .......... ...... 9
  2.3. VERIFYING THE OVERCLOUD DEPLOYMENT FOR AUTOSCALING ......... 9

CHAPTER 3. USING THE HEAT SERVICE FOR AUTOSCALING .............................. 12
  3.1. CREATING THE GENERIC ARCHIVE POLICY FOR AUTOSCALING ........... 12
  3.2. CONFIGURING A HEAT TEMPLATE FOR AUTOMATICALLY SCALING INSTANCES 13
  3.3. CREATING THE STACK DEPLOYMENT FOR AUTOSCALING .................... 16

CHAPTER 4. TESTING AND TROUBLESHOOTING AUTOSCALING .......................... 20
  4.1. TESTING AUTOMATIC SCALING UP OF INSTANCES .............................. 20
  4.2. TESTING AUTOMATIC SCALING DOWN OF INSTANCES ......................... 21
  4.3. TROUBLESHOOTING FOR AUTOSCALING .......................................... 22
  4.4. USING CPU TELEMETRY VALUES FOR AUTOSCALING THRESHOLD WHEN USING RATE:MEAN AGGREGATION ................................................................. 24
    4.4.1. Calculating CPU telemetry values as a percentage ......................... 24
    4.4.2. Displaying instance workload vCPU as a percentage .................... 25
    4.4.3. Retrieving available telemetry for an instance workload ................ 27
Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright’s message.
PROVIDING FEEDBACK ON RED HAT DOCUMENTATION

We appreciate your input on our documentation. Tell us how we can make it better.

Providing documentation feedback in Jira

Use the Create Issue form to provide feedback on the documentation. The Jira issue will be created in the Red Hat OpenStack Platform Jira project, where you can track the progress of your feedback.

1. Ensure that you are logged in to Jira. If you do not have a Jira account, create an account to submit feedback.

2. Click the following link to open a the Create Issue page: Create Issue

3. Complete the Summary and Description fields. In the Description field, include the documentation URL, chapter or section number, and a detailed description of the issue. Do not modify any other fields in the form.

4. Click Create.
CHAPTER 1. INTRODUCTION TO AUTOSCALING COMPONENTS

Use telemetry components to collect data about your Red Hat OpenStack Platform (RHOSP) environment, such as CPU, storage, and memory usage. You can launch and scale instances in response to workload demand and resource availability. You can define the upper and lower bounds of telemetry data that control the scaling of instances in your Orchestration service (heat) templates.

Control automatic instance scaling with the following telemetry components:

- **Data collection**: Telemetry uses the data collection service (Ceilometer) to gather metric and event data.
- **Storage**: Telemetry stores metrics data in the time-series database service (gnocchi).
- **Alarm**: Telemetry uses the Alarming service (aodh) to trigger actions based on rules against metrics or event data collected by Ceilometer.

1.1. DATA COLLECTION SERVICE (CEILOMETER) FOR AUTOSCALING

You can use Ceilometer to collect data about metering and event information for Red Hat OpenStack Platform (RHOSP) components.

The Ceilometer service uses three agents to collect data from RHOSP components:

- **A compute agent (ceilometer-agent-compute)**: Runs on each Compute node and polls for resource use statistics.
- **A central agent (ceilometer-agent-central)**: Runs on the Controller nodes to poll for resource use statistics for resources that are not provided by Compute nodes.
- **A notification agent (ceilometer-agent-notification)**: Runs on the Controller nodes and consumes messages from the message queues to build event and metering data.

The Ceilometer agents use publishers to send data to the corresponding end points, for example the time-series database service (gnocchi).

Additional resources

- **Ceilometer** in the *Managing overcloud observability* guide.

1.1.1. Publishers

In Red Hat OpenStack Platform (RHOSP), you can use several transport methods to transfer the collected data into storage or external systems, such as Service Telemetry Framework (STF).

When you enable the gnocchi publisher, the measurement and resource information is stored as time-series data.

1.2. TIME-SERIES DATABASE SERVICE (GNOCCHI) FOR AUTOSCALING

Gnocchi is a time-series database that you can use for storing metrics in SQL. The Alarming service (aodh) and Orchestration service (heat) use the data stored in gnocchi for autoscaling.
Additional resources

- Storage with gnocchi.

1.3. ALARMING SERVICE (AODH)

You can configure the Alarming service (aodh) to trigger actions based on rules against metrics data collected by Ceilometer and stored in gnocchi. Alarms can be in one of the following states:

- **Ok**: The metric or event is in an acceptable state.
- **Firing**: The metric or event is outside of the defined **Ok** state.
- **insufficient data**: The alarm state is unknown, for example, if there is no data for the requested granularity, or the check has not been executed yet, and so on.

1.4. ORCHESTRATION SERVICE (HEAT) FOR AUTOSCALING

Director uses Orchestration service (heat) templates as the template format for the overcloud deployment. Heat templates are usually expressed in YAML format. The purpose of a template is to define and create a stack, which is a collection of resources that heat creates, and the configuration of the resources. Resources are objects in Red Hat OpenStack Platform (RHOSP) and can include compute resources, network configuration, security groups, scaling rules, and custom resources.

Additional resources

- Understanding heat templates.
CHAPTER 2. CONFIGURING AND DEPLOYING THE OVERCLOUD FOR AUTOSCALING

You must configure the templates for the services on your overcloud that enable autoscaling.

Procedure

1. Create environment templates and a resource registry for autoscaling services before you deploy the overcloud for autoscaling. For more information, see Section 2.1, “Configuring the overcloud for autoscaling”

2. Deploy the overcloud. For more information, see Section 2.2, “Deploying the overcloud for autoscaling”

2.1. CONFIGURING THE OVERCLOUD FOR AUTOSCALING

Create the environment templates and resource registry that you need to deploy the services that provide autoscaling.

Procedure

1. Log in to the undercloud host with your overcloud administrator credentials, for example overcloudrc.

2. Create a directory for the autoscaling configuration files:

   ```
   $ mkdir -p $HOME/templates/autoscaling/
   ```

3. Create the resource registry file for the definitions that the services require for autoscaling:

   ```
   $ cat <<EOF > $HOME/templates/autoscaling/resources-autoscaling.yaml
   resource_registry:
   OS::TripleO::Services::AodhApi: /usr/share/openstack-tripleo-heat-templates/deployment/aodh/aodh-api-container-puppet.yaml
   OS::TripleO::Services::AodhEvaluator: /usr/share/openstack-tripleo-heat-templates/deployment/aodh/aodh-evaluator-container-puppet.yaml
   OS::TripleO::Services::AodhListener: /usr/share/openstack-tripleo-heat-templates/deployment/aodh/aodh-listener-container-puppet.yaml
   OS::TripleO::Services::AodhNotifier: /usr/share/openstack-tripleo-heat-templates/deployment/aodh/aodh-notifier-container-puppet.yaml
   OS::TripleO::Services::CeilometerAgentCentral: /usr/share/openstack-tripleo-heat-templates/deployment/ceilometer/ceilometer-agent-central-container-puppet.yaml
   OS::TripleO::Services::CeilometerAgentNotification: /usr/share/openstack-tripleo-heat-templates/deployment/ceilometer/ceilometer-agent-notification-container-puppet.yaml
   OS::TripleO::Services::ComputeCeilometerAgent: /usr/share/openstack-tripleo-heat-templates/deployment/ceilometer/ceilometer-agent-compute-container-puppet.yaml
   OS::TripleO::Services::GnocchiApi: /usr/share/openstack-tripleo-heat-templates/deployment/gnocchi/gnocchi-api-container-puppet.yaml
   OS::TripleO::Services::GnocchiMetricd: /usr/share/openstack-tripleo-heat-templates/deployment/gnocchi/gnocchi-metricd-container-puppet.yaml
   OS::TripleO::Services::GnocchiStatsd: /usr/share/openstack-tripleo-heat-templates/deployment/gnocchi/gnocchi-statsd-container-puppet.yaml
   OS::TripleO::Services::HeatApi: /usr/share/openstack-tripleo-heat-templates/deployment/heat/heat-api-container-puppet.yaml
   EOF
   ```
4. Create an environment template to configure the services required for autoscaling:

```yaml
parameter_defaults:
    NotificationDriver: 'messagingv2'
    GocnchiDebug: false
    CeilometerEnableGnocchi: true
    ManagePipeline: true
    ManageEventPipeline: true

    EventPipelinePublishers:
        - gnocchi://?archive_policy=generic
    PipelinePublishers:
        - gnocchi://?archive_policy=generic

    ManagePolling: true
    ExtraConfig:
        ceilometer::agent::polling::polling_interval: 60
EOF
```

If you use Red Hat Ceph Storage as the data storage back end for the time-series database service, add the following parameters to your `parameters-autoscaling.yaml` file:

```yaml
parameter_defaults:
    GocnchiRbdPoolName: 'metrics'
    GocnchiBackend: 'rbd'
```

You must create the defined archive policy **generic** before you can store metrics. You define this archive policy after the deployment. For more information, see Section 3.1, “Creating the generic archive policy for autoscaling”.

5. Set the `polling_interval` parameter, for example, 60 seconds. The value of the `polling_interval` parameter must match the gnocchi granularity value that you defined when you created the archive policy. For more information, see Section 3.1, “Creating the generic archive policy for autoscaling”.

6. Deploy the overcloud. For more information, see Section 2.2, “Deploying the overcloud for autoscaling”

## 2.2. DEPLOYING THE OVERCLOUD FOR AUTOSCALING

You can deploy the overcloud for autoscaling by using director.

**Prerequisites**

- You have created the environment templates for deploying the services that provide autoscaling capabilities. For more information, see Section 2.1, “Configuring the overcloud for autoscaling”.

2.2.1. Deploying the overcloud for autoscaling by using director

Use director to deploy the overcloud.

**Prerequisites**

- A deployed undercloud. For more information, see Installing director on the undercloud.

**Procedure**

1. Log in to the undercloud as the **stack** user.
2. Source the **stackrc** undercloud credentials file:

   ```bash
   [stack@director ~]$ source ~/stackrc
   ```
3. Add the autoscaling environment files to the stack with your other environment files and deploy the overcloud:

   ```bash
   (undercloud)$ openstack overcloud deploy --templates \
   -e [your environment files] \
   -e $HOME/templates/autoscaling/parameters-autoscaling.yaml \
   -e $HOME/templates/autoscaling/resources-autoscaling.yaml
   ```

2.3. VERIFYING THE OVERCLOUD DEPLOYMENT FOR AUTOSCALING

Verify that the autoscaling services are deployed and enabled. The verification output examples might be different from your use case.

**Prerequisites**

- You have deployed the autoscaling services in an existing overcloud using director. For more information, see Section 2.2, "Deploying the overcloud for autoscaling".

**Procedure**

1. Log in to your environment as the **stack** user.
2. For director environments, source the **stackrc** undercloud credentials file:

   ```bash
   [stack@undercloud ~]$ source ~/stackrc
   ```

**Verification**

1. Verify that the deployment was successful and ensure that the service API endpoints for autoscaling are available:

   ```bash
   $ openstack endpoint list --service metric
   +----------------------------------+-----------+--------------+--------------+---------+-----------+---------+
   ```
Use the overcloud credentials to check the heat service:

```
$ openstack endpoint list --service alarming
```

Use the overcloud credentials to check the heat service:

```
$ openstack endpoint list --service orchestration
```

2. Verify that the services are running on the overcloud:

```
$ sudo podman ps --filter=name='heat|gnocchi|ceilometer|aodh'
```
3. Verify that the time-series database service is available:

```bash
$ openstack metric status --fit-width
```

```text
+-----------------------------------------------------+---------------------------------------------------------
| Field                                               | Value                                                  |
+-----------------------------------------------------+---------------------------------------------------------
| metricd/processors                                  | ['host-80.general.local.0.a94fbf77-1ac0-49ed-bfe2-a89f014fde01',
|                                                     | 'host-80.general.local.3.28ca78d7-a80e-4515-8060-233360b410eb',
|                                                     | 'host-80.general.local.1.7e8b5a5b-2ca1-49be-bc22-25f51d67c00a',
|                                                     | 'host-80.general.local.2.3c4fe59e-23cd-4742-833d-42ff0a4cb692'] |
| storage/number of metric having measures to process | 0                                                      |
| storage/total number of measures to process         | 0                                                      |
+-----------------------------------------------------+---------------------------------------------------------
```
CHAPTER 3. USING THE HEAT SERVICE FOR AUTOSCALING

After you deploy the services required to provide autoscaling in the overcloud, you must configure the overcloud environment so that the Orchestration service (heat) can manage instances for autoscaling.

Prerequisites

- A deployed overcloud. For more information, see Section 2.2, “Deploying the overcloud for autoscaling”.

Procedure

- Section 3.1, “Creating the generic archive policy for autoscaling”
- Section 3.2, “Configuring a heat template for automatically scaling instances”
- Section 3.3, “Creating the stack deployment for autoscaling”

3.1. CREATING THE GENERIC ARCHIVE POLICY FOR AUTOSCALING

After you deploy the services for autoscaling in the overcloud, you must configure the overcloud environment so that the Orchestration service (heat) can manage the instances for autoscaling.

Prerequisites

- You have deployed an overcloud that has autoscaling services. For more information, see Section 2.1, “Configuring the overcloud for autoscaling”.

Procedure

1. Log in to your environment as the stack user.

2. For director environments source the stackrc file:

   [stack@undercloud ~]$ source ~/stackrc

3. Create the archive policy defined in $HOME/templates/autoscaling/parameters-autoscaling.yaml:

   $ openstack metric archive-policy create generic \
   --back-window 0 \
   --definition timespan:'4:00:00',granularity:'0:01:00',points:240 \
   --aggregation-method 'rate:mean' \
   --aggregation-method 'mean'

Verification

- Verify that the archive policy was created:

   $ openstack metric archive-policy show generic

   +---------------------+--------------------------------------------------------+
   | Field               | Value                                                  |
   +---------------------+--------------------------------------------------------+
You can configure an Orchestration service (heat) template to create the instances, and configure alarms that create and scale instances when triggered.

**NOTE**

This procedure uses example values that you must change to suit your environment.

### Prerequisites

- You have deployed the overcloud with the autoscaling services. For more information, see Section 2.2, “Deploying the overcloud for autoscaling”.

- You have configured the overcloud with an archive policy for autoscaling telemetry storage. For more information, see Section 3.1, “Creating the generic archive policy for autoscaling”.

### Procedure

1. Log in to your environment as the stack user.

   ```bash
   $ source ~/stackrc
   ```

2. Create a directory to hold the instance configuration for the autoscaling group:

   ```bash
   $ mkdir -p $HOME/templates/autoscaling/vnf/
   ```

3. Create an instance configuration template, for example, `$HOME/templates/autoscaling/vnf/instance.yaml`.

4. Add the following configuration to your `instance.yaml` file:

   ```yaml
   cat <<EOF > $HOME/templates/autoscaling/vnf/instance.yaml
   heat_template_version: wallaby
   description: Template to control scaling of VNF instance
   parameters:
   metadata:
     type: json
   image:
     type: string
     description: image used to create instance
     default: fedora36
   flavor:
     type: string
     description: instance flavor to be used
   ```
The parameters parameter defines the custom parameters for this new resource.

The vnf sub-parameter of the resources parameter defines the name of the custom sub-resource referred to in the OS::Heat::AutoScalingGroup, for example, OS::Nova::Server::VNF.

5. Create the resource to reference in the heat template:

```bash
$ cat <<EOF > $HOME/templates/autoscaling/vnf/resources.yaml
resource_registry:
  "OS::Nova::Server::VNF": $HOME/templates/autoscaling/vnf/instance.yaml
EOF
```
6. Create the deployment template for heat to control instance scaling:

```
$ cat <<-EOF > $HOME/templates/autoscaling/vnf/template.yaml
heat_template_version: wallaby
description: Example auto scale group, policy and alarm
resources:
scaleup_group:
type: OS::Heat::AutoScalingGroup
properties:
  max_size: 3
  min_size: 1
  #desired_capacity: 1
resource:
type: OS::Nova::Server::VNF
properties:
  metadata: {"metering.server_group": {get_param: "OS::stack_id"}}

scaleup_policy:
type: OS::Heat::ScalingPolicy
properties:
  adjustment_type: change_in_capacity
  auto_scaling_group_id: { get_resource: scaleup_group }
  cooldown: 60
  scaling_adjustment: 1

scaledown_policy:
type: OS::Heat::ScalingPolicy
properties:
  adjustment_type: change_in_capacity
  auto_scaling_group_id: { get_resource: scaleup_group }
  cooldown: 60
  scaling_adjustment: -1

cpu_alarm_high:
type: OS::Aodh::GnocchiAggregationByResourcesAlarm
properties:
  description: Scale up instance if CPU > 50%
  metric: cpu
  aggregation_method: rate:mean
  granularity: 60
  evaluation_periods: 3
  threshold: 60000000000.0
  resource_type: instance
  comparison_operator: gt
  alarm_actions:
    - str_replace:
      template: trust+url
      params:
        url: {get_attr: [scaleup_policy, signal_url]}
    query:
      list_join:
        ": "
    - '{=": {server_group: {get_param: "OS::stack_id"}}}'}

cpu_alarm_low:
type: OS::Aodh::GnocchiAggregationByResourcesAlarm
```
3.3. CREATING THE STACK DEPLOYMENT FOR AUTOSCALING

Create the stack deployment for the worked VNF autoscaling example.

Prerequisites

- Section 3.2, “Configuring a heat template for automatically scaling instances”

Procedure

1. Log in to the undercloud host with your overcloud administrator credentials, for example `overcloudrc`:

   ```
   (undercloud)$ source ~/overcloudrc
   ```

2. Create the stack:

   ```
   $ openstack stack create \
   -t $HOME/templates/autoscaling/vnf/template.yaml \
   -e $HOME/templates/autoscaling/vnf/resources.yaml \
   -v nfn
   ```
Verification

1. Verify that the stack was created successfully:

   ```
   $ openstack stack show vnf -c id -c stack_status
   +--------------+--------------------------------------+
   | Field        | Value                                |
   +--------------+--------------------------------------+
   | id           | cb082cbd-535e-4779-84b0-98925e103f5e  |
   | stack_status | CREATE_COMPLETE                      |
   +--------------+--------------------------------------+
   ```

2. Verify that the stack resources were created, including alarms, scaling policies, and the autoscaling group:

   ```
   $ export STACK_ID=$(openstack stack show vnf -c id -f value)
   $ openstack stack resource list $STACK_ID
   +------------------+--------------------------------------+----------------------------------------------+-----
   | resource_name    | physical_resource_id                 | resource_type               |     |
   | resource_status | updated_time         |                               |     |
   +------------------+--------------------------------------+----------------------------------------------+-----+
   | cpu_alarm_high   | d72d2e0d-1888-4f89-b888-02174c48e463  | OS::Aodh::GnocchiAggregationByResourcesAlarm |     |
   |                   | OS::Heat::ScalingPolicy              | CREATE_COMPLETE | 2022-10-06T23:08:37Z |     |
   | cpu_alarm_low    | b9c04ef4-8b57-4730-af03-1a71c3885914  | OS::Aodh::GnocchiAggregationByResourcesAlarm |     |
   |                   | OS::Heat::ScalingPolicy              | CREATE_COMPLETE | 2022-10-06T23:08:37Z |     |
   | scaleup_policy   | 1c4446b7242e479090bef4b8075df9d4     | OS::Heat::ScalingPolicy      |     |
   |                   | OS::Heat::AutoScalingGroup           | CREATE_COMPLETE | 2022-10-06T23:08:37Z |     |
   +------------------+--------------------------------------+----------------------------------------------+-----+
   $ openstack server list --long | grep $STACK_ID
   | 62e1b27c-8d9d-44a5-a010-80e7e6d437c7 | vn-dvaxcqb-6bqh2qd2fpif-hicmkm5dzjg-vnf-ywryd5wqjc | ACTIVE | None | Running | private=192.168.100.61, 192.168.25.99 | fedora36 | a6aa7b11-1b99-4c62-a43b-d0b7c774b72 | m1.small | 5cd46fec-50c2-43d5-89e8-ed3fa7660852 | nova | host-80.localdomain | metering.server_group='cb082cbd-535e-4779-84b0-98925e103f5e'
   ```

3. Verify that an instance was launched by the stack creation:

   ```
   $ openstack server list --long | grep $STACK_ID
   ```

4. Verify that the alarms were created for the stack:
   a. List the alarm IDs. The state of the alarms might reside in the **insufficient data** state for a period of time. The minimal period of time is the polling interval of the data collection and data storage granularity setting:
b. List the resources for the stack and note the physical_resource_id values for the cpu_alarm_high and cpu_alarm_low resources.

```
$ openstack stack resource list $STACK_ID
```

```
<table>
<thead>
<tr>
<th>resource_name</th>
<th>physical_resource_id</th>
<th>resource_type</th>
<th>resource_status</th>
<th>updated_time</th>
</tr>
</thead>
<tbody>
<tr>
<td>cpu_alarm_high</td>
<td>d72d2e0d-1888-4f89-b888-02174c48e463</td>
<td>OS::Aodh::GnocchiAggregationByResourcesAlarm</td>
<td>CREATE_COMPLETE</td>
<td>2022-10-06T23:08:37Z</td>
</tr>
<tr>
<td>scaleup_policy</td>
<td>1c4446b7242e479090bef4b8075df9d4</td>
<td>OS::Heat::ScalingPolicy</td>
<td>CREATE_COMPLETE</td>
<td>2022-10-06T23:08:37Z</td>
</tr>
<tr>
<td>cpu_alarm_low</td>
<td>b9c04ef4-8b57-4730-af03-1a71c3885914</td>
<td>OS::Aodh::GnocchiAggregationByResourcesAlarm</td>
<td>CREATE_COMPLETE</td>
<td>2022-10-06T23:08:37Z</td>
</tr>
<tr>
<td>scaledown_policy</td>
<td>a5af7af5a1344849c3425cb2c5f18db</td>
<td>OS::Heat::ScalingPolicy</td>
<td>CREATE_COMPLETE</td>
<td>2022-10-06T23:08:37Z</td>
</tr>
<tr>
<td>scaleup_group</td>
<td>9609f208-6d50-4b8f-836e-b0222dc1e0b1</td>
<td>OS::Heat::AutoScalingGroup</td>
<td>CREATE_COMPLETE</td>
<td>2022-10-06T23:08:37Z</td>
</tr>
</tbody>
</table>
```

The value of the physical_resource_id must match the alarm_id in the output of the openstack alarm list command.

5. Verify that metric resources exist for the stack. Set the value of the server_group query to the stack ID:

```
$ openstack metric resource search --sort-column launched_at -c id -c display_name -c launched_at -c deleted_at --type instance server_group="$STACK_ID"
```

```
| id             | display_name | launched_at | deleted_at |
```

Red Hat OpenStack Platform 17.1 Auto-scaling for instances
6. Verify that measurements exist for the instance resources created through the stack:

```
$ openstack metric aggregates --resource-type instance --sort-column timestamp '(metric cpu rate:mean)' server_group="$STACK_ID"
```

CHAPTER 4. TESTING AND TROUBLESHOOTING AUTOSCALING

Use the Orchestration service (heat) to automatically scale instances up and down based on threshold definitions. To troubleshoot your environment, you can look for errors in the log files and history records.

4.1. TESTING AUTOMATIC SCALING UP OF INSTANCES

You can use the Orchestration service (heat) to scale instances automatically based on the `cpu_alarm_high` threshold definition. When the CPU use reaches a value defined in the `threshold` parameter, another instance starts up to balance the load. The `threshold` value in the `template.yaml` file is set to 80%.

Procedure

1. Log in to the host environment as the `stack` user.
2. For director environments source the `stackrc` file:
   ```bash
   [stack@undercloud ~]$ source ~/stackrc
   ```
3. Log in to the instance:
   ```bash
   $ ssh -i ~/mykey.pem cirros@192.168.122.8
   ```
4. Run multiple `dd` commands to generate the load:
   ```bash
   [instance ~]$ sudo dd if=/dev/zero of=/dev/null &
   [instance ~]$ sudo dd if=/dev/zero of=/dev/null &
   [instance ~]$ sudo dd if=/dev/zero of=/dev/null &
   ```
5. Exit from the running instance and return to the host.
6. After you run the `dd` commands, you can expect to have 100% CPU use in the instance. Verify that the alarm has been triggered:
   ```bash
   $ openstack alarm list
   +--------------------------------------+--------------------------------------------+--------------------------
   | alarm_id                             |
   | type                                | state                       |
   | name                                | severity | enabled |
   +--------------------------------------+--------------------------------------------+--------------------------
   | 022f707d-46cc-4d39-a0b2-af46a7f86d   | gnocchi_aggregation_by_resources_threshold |
   | example-cpu_alarm_high-oj77qblq7d   | alarm     | low      | True    |
   | example-cpu_alarm_low-m37jv3nn56x2t | ok        | low      | True    |
   +--------------------------------------+--------------------------------------------+--------------------------
   ```
7. After approximately 60 seconds, Orchestration starts another instance and adds it to the group. To verify that an instance has been created, enter the following command:
After another short period of time, observe that the Orchestration service has autoscaled to three instances. The configuration is set to a maximum of three instances. Verify there are three instances:

```
$ openstack server list
```

4.2. TESTING AUTOMATIC SCALING DOWN OF INSTANCES

You can use the Orchestration service (heat) to automatically scale down instances based on the cpu_alarm_low threshold. In this example, the instances are scaled down when CPU use is below 5%.

**Procedure**

1. From within the workload instance, terminate the running `dd` processes and observe Orchestration begin to scale the instances back down.

```
$ killall dd
```

2. Log in to the host environment as the stack user.

3. For director environments source the stackrc file:

```
[stack@undercloud ~]$ source ~/stackrc
```

8. After another short period of time, observe that the Orchestration service has autoscaled to three instances. The configuration is set to a maximum of three instances. Verify there are three instances:

```
$ openstack server list
```

8. After another short period of time, observe that the Orchestration service has autoscaled to three instances. The configuration is set to a maximum of three instances. Verify there are three instances:
4. When you stop the dd processes, this triggers the **cpu_alarm_low event** alarm. As a result, Orchestration begins to automatically scale down and remove the instances. Verify that the corresponding alarm has triggered:

```bash
$ openstack alarm list
```

+--------------------------------------+--------------------------------------------+--------------------------+-------+----------+---------+
| alarm_id                             | type                                       | name                                | state | severity | enabled |
|--------------------------------------|--------------------------------------------|--------------------------------------|-------+----------+---------|
+--------------------------------------|--------------------------------------------+--------------------------------------+-------+----------+---------|
| 022f707d-46cc-4d39-a0b2-afdf27ab86a   | gnocchi_aggregation_by_resources_threshold | example-cpu_alarm_high-odj7q7pbld7   | ok    | low      | True    |
| 46ed2c50-e05a-44d8-b6f6-f1ebd3a913    | gnocchi_aggregation_by_resources_threshold | example-cpu_alarm_low-m37jvnm56x2t   | alarm | low      | True    |
+--------------------------------------|--------------------------------------------+--------------------------------------+-------+----------+---------+
| 022f707d-46cc-4d39-a0b2-afdf27ab86a   | gnocchi_aggregation_by_resources_threshold | example-cpu_alarm_high-odj7q7pbld7   | ok    | low      | True    |
| 46ed2c50-e05a-44d8-b6f6-f1ebd3a913    | gnocchi_aggregation_by_resources_threshold | example-cpu_alarm_low-m37jvnm56x2t   | alarm | low      | True    |
+--------------------------------------|--------------------------------------------+--------------------------------------+-------+----------+---------+

After a few minutes, Orchestration continually reduce the number of instances to the minimum value defined in the **min_size** parameter of the **scaleup_group** definition. In this scenario, the **min_size** parameter is set to **1**.

### 4.3. TROUBLESHOOTING FOR AUTOSCALING

If your environment is not working properly, you can look for errors in the log files and history records.

**Procedure**

1. Log in to the host environment as the **stack** user.

2. For director environments source the **stackrc** file:

   ```bash
   [stack@undercloud ~]$ source ~/stackrc
   ```

3. To retrieve information on state transitions, list the stack event records:

   ```bash
   $ openstack stack event list example
   2017-03-06 11:12:43Z [example]: CREATE_IN_PROGRESS Stack CREATE started
   2017-03-06 11:12:43Z [example.scaleup_group]: CREATE_IN_PROGRESS state changed
   2017-03-06 11:13:04Z [example.scaleup_group]: CREATE_COMPLETE state changed
   2017-03-06 11:13:04Z [example.scaledown_policy]: CREATE_IN_PROGRESS state changed
   2017-03-06 11:13:05Z [example.scaleup_policy]: CREATE_IN_PROGRESS state changed
   2017-03-06 11:13:05Z [example.scaleup_policy]: CREATE_COMPLETE state changed
   2017-03-06 11:13:05Z [example.scaleup_policy]: CREATE_COMPLETE state changed
   2017-03-06 11:13:05Z [example.cpu_alarm_low]: CREATE_IN_PROGRESS state changed
   2017-03-06 11:13:05Z [example.cpu_alarm_high]: CREATE_IN_PROGRESS state changed
   2017-03-06 11:13:06Z [example.cpu_alarm_low]: CREATE_COMPLETE state changed
   2017-03-06 11:13:07Z [example.cpu_alarm_high]: CREATE_COMPLETE state changed
   2017-03-06 11:13:07Z [example]: CREATE_COMPLETE Stack CREATE completed successfully
   2017-03-06 11:19:34Z [example.scaleup_policy]: SIGNAL_COMPLETE alarm state changed from alarm to alarm
   (Remaining as alarm due to 1 samples outside threshold, most recent: 95.4080102993)
   2017-03-06 11:25:43Z [example.scaleup_policy]: SIGNAL_COMPLETE alarm state
   ```
changed from alarm to alarm (Remaining as alarm due to 1 samples outside threshold, most recent: 95.869217299)
2017-03-06 11:33:25Z [example.scaledown_policy]: SIGNAL_COMPLETE alarm state changed from ok to alarm (Transition to alarm due to 1 samples outside threshold, most recent: 2.73931707966)
2017-03-06 11:39:15Z [example.scaledown_policy]: SIGNAL_COMPLETE alarm state changed from alarm to alarm (Remaining as alarm due to 1 samples outside threshold, most recent: 2.78110858552)

4. Read the alarm history log:

```
$ openstack alarm-history show 022f707d-46cc-4d39-a0b2-afd2fc7ab86a
```

<table>
<thead>
<tr>
<th>timestamp</th>
<th>type</th>
<th>detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017-03-06T11:32:35.510000</td>
<td>state transition</td>
<td>{&quot;transition_reason&quot;: &quot;Transition to ok due to 1 samples inside threshold, most recent: 2.73931707966&quot;, &quot;state&quot;: &quot;ok&quot;}</td>
</tr>
<tr>
<td>2017-03-06T11:17:35.403000</td>
<td>state transition</td>
<td>{&quot;transition_reason&quot;: &quot;Transition to alarm due to 1 samples outside threshold, most recent: 95.0964497325&quot;, &quot;state&quot;: &quot;alarm&quot;}</td>
</tr>
<tr>
<td>2017-03-06T11:15:35.723000</td>
<td>state transition</td>
<td>{&quot;transition_reason&quot;: &quot;Transition to ok due to 1 samples inside threshold, most recent: 3.59330523447&quot;, &quot;state&quot;: &quot;ok&quot;}</td>
</tr>
<tr>
<td>2017-03-06T11:13:06.413000</td>
<td>creation</td>
<td>{&quot;alarm_actions&quot;: [&quot;trust+<a href="http://fca6e27e3d524ed68abdc0fd576aa848:delete@192.168.122.126:8004/v1/fd">http://fca6e27e3d524ed68abdc0fd576aa848:delete@192.168.122.126:8004/v1/fd</a> 224f15c0-b6f1-4690-9a22-0c1d236e65f6&quot;], &quot;user_id&quot;: &quot;a85f83b7f17784025b6acc06f0a8fd8&quot;, &quot;name&quot;: &quot;example-cpu_alarm_high-odj77qpbld7&quot;, &quot;state&quot;: &quot;insufficient data&quot;, &quot;timestamp&quot;: &quot;2017-03-06T11:13:06.413455&quot;, &quot;description&quot;: &quot;Scale up if CPU &gt; 80%, &quot;enabled&quot;: true, &quot;state_timestamp&quot;: &quot;2017-03-06T11:13:06.413455&quot;, &quot;rule&quot;: {&quot;evaluation_periods&quot;: 1, &quot;metric&quot;: &quot;cpu_util&quot;, &quot;aggregation_method&quot;: &quot;mean&quot;, &quot;granularity&quot;: 300, &quot;threshold&quot;: 80.0, &quot;query&quot;: &quot;{&quot;server_group&quot;: &quot;d9ef59ed-b8f8-4e90-bd9b-ae87e73ef6e2&quot;}&quot;}, &quot;comparison_operator&quot;: &quot;gt&quot;, &quot;resource_type&quot;: &quot;instance&quot;, &quot;alarm_id&quot;: &quot;022f707d-46cc-4d39-a0b2-afd2fc7ab86a&quot;, &quot;time_constraints&quot;: [], &quot;insufficient_data_actions&quot;: null, &quot;repeat_actions&quot;: true, &quot;ok_actions&quot;: []}, &quot;project_id&quot;: &quot;fd1c345135be4ee587ef424c241719d&quot;</td>
</tr>
<tr>
<td>2017-03-06T11:32:35.510000</td>
<td>state transition</td>
<td>{&quot;transition_reason&quot;: &quot;Transition to ok due to 1 samples inside threshold, most recent: 2.73931707966&quot;, &quot;state&quot;: &quot;ok&quot;}</td>
</tr>
</tbody>
</table>
```
5. To view the records of scale-out or scale-down operations that heat collects for the existing stack, you can use the `awk` command to parse the `heat-engine.log`:

```
$ awk '/Stack UPDATE started/,/Stack CREATE completed successfully/ {print $0}' /var/log/containers/heat/heat-engine.log
```

6. To view aodh-related information, examine the `aodh-evaluator.log`:

```
$ sudo grep -i alarm /var/log/containers/aodh/aodh-evaluator.log | grep -i transition
```

### 4.4. USING CPU TELEMETRY VALUES FOR AUTOSCALING THRESHOLD WHEN USING RATE:MEAN AGGREGATION

When using the `OS::Heat::Autoscaling` heat orchestration template (HOT) and setting a threshold value for CPU, the value is expressed in nanoseconds of CPU time which is a dynamic value based on the number of virtual CPUs allocated to the instance workload. In this reference guide we'll explore how to calculate and express the CPU nanosecond value as a percentage when using the Gnocchi `rate:mean` aggregation method.

#### 4.4.1. Calculating CPU telemetry values as a percentage

CPU telemetry is stored in Gnocchi (OpenStack time-series data store) as CPU utilization in nanoseconds. When using CPU telemetry to define autoscaling thresholds it is useful to express the values as a percentage of CPU utilization since that is more natural when defining the threshold values. When defining the scaling policies used as part of an autoscaling group, we can take our desired threshold defined as a percentage and calculate the required threshold value in nanoseconds which is used in the policy definitions.

<table>
<thead>
<tr>
<th>Value (ns)</th>
<th>Granularity (s)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>600000000000</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>540000000000</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>480000000000</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>420000000000</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>360000000000</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>300000000000</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>240000000000</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>
4.4.2. Displaying instance workload vCPU as a percentage

You can display the gnocchi-stored CPU telemetry data as a percentage rather than the nanosecond values for instances by using the `openstack metric aggregates` command.

**Prerequisites**

- Create a heat stack using the autoscaling group resource that results in an instance workload.

**Procedure**

1. Login to your OpenStack environment as the cloud administrator.

2. Retrieve the ID of the autoscaling group heat stack:

   ```
   $ openstack stack show vnf -c id -c stack_status
   +--------------+--------------------------------------+
   | Field        | Value                                |
   +--------------+--------------------------------------+
   | id           | e0a15cee-34d1-418a-ac79-74ad07585730 |
   | stack_status | CREATE_COMPLETE                      |
   +--------------+--------------------------------------+
   ``

3. Set the value of the stack ID to an environment variable:

   ```
   $ export STACK_ID=$(openstack stack show vnf -c id -f value)
   ``

4. Return the metrics as an aggregate by resource type instance (server ID) with the value calculated as a percentage. The aggregate is returned as a value of nanoseconds of CPU time. We divide that number by 1000000000 to get the value in seconds. We then divide the value by our granularity, which in this example is 60 seconds. That value is then converted to a percentage by multiplying by 100. Finally, we divide the total value by the number of vCPU provided by the flavor assigned to the instance, in this example a value of 2 vCPU, providing us a value expressed as a percentage of CPU time:

   ```
   $ openstack metric aggregates --resource-type instance --sort-column timestamp --sort-descending `'/ ( (* (/ ((metric cpu rate:mean) 1000000000) 60) 100) 2)' server_group="$STACK_ID"`
   +----------------------------------------------------+---------------------------+-------------+---------------+
<p>| name                                               | timestamp                 | granularity |              value |</p>
<table>
<thead>
<tr>
<th>Server ID</th>
<th>CPU Load (Mean)</th>
<th>Timestamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>3.158333333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>2.633333333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>2.533333333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>2.833333333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>13.450000000000001</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>2.45</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>2.6166666666666667</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>0.595833333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>2.35</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>2.525</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>2.35</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>9.3</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>3.025</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>2.275</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>2.275</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>5.6316666666666667</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>5.950833333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>2.375</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>2.375</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>6.3949999999999999</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>15.558333333333335</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>9.385</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>9.385</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>57.686666666666667</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>57.686666666666667</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>5.7666666666666666</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>5.7666666666666666</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>6.1233333333333334</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>6.1233333333333334</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>7.473333333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>7.473333333333333</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>5.7866666666666667</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>5.7866666666666667</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>199b0cb9-6ed6-4410-9073-0fb2e7842b65</td>
<td>6.4166666666666664</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
<tr>
<td>61bfb555-9efb-46f1-8559-08dec90f94ed</td>
<td>6.4166666666666664</td>
<td>2022-11-07T20:57:00+00:00</td>
</tr>
</tbody>
</table>
4.4.3. Retrieving available telemetry for an instance workload

Retrieve the available telemetry for an instance workload and express the vCPU utilization as a percentage.

Prerequisites

- Create a heat stack using the autoscaling group resource that results in an instance workload.

Procedure

1. Login to your OpenStack environment as the cloud administrator.

2. Retrieve the ID of the autoscaling group heat stack:

   ```bash
   $ openstack stack show vnf -c id -c stack_status
   +--------------+--------------------------------------+
   | Field        | Value                                |
   +--------------+--------------------------------------+
   | id           | e0a15cee-34d1-418a-ac79-74ad07585730 |
   | stack_status | CREATE_COMPLETE                      |
   +--------------+--------------------------------------+
   ```

3. Set the value of the stack ID to an environment variable:

   ```bash
   $ export STACK_ID=$(openstack stack show vnf -c id -f value)
   ```

4. Retrieve the ID of the workload instance you want to return data for. We are using the server list long form and filtering for instances that are part of our autoscaling group:

   ```bash
   $ openstack server list --long --fit-width | grep "metering.server_group='STACK_ID'"
   | bc1811de-48ed-44c1-ae22-c01f36d6cb02 | vn-xlfb4jb-yhbq6fkk2kec-qsu2fr47zigs-vnf-y27wuo25ce4e | ACTIVE | None       | Running     | private=192.168.100.139, 192.168.25.179 |
   | fedora36   | d21f1aaa-0077-4313-8a46-266c39b705c1 | m1.small    | 692533fe-0912-417e-b706-5d08549db53 | nova              | host.localdomain | metering.server_group='e0a15cee-34d1-418a-ac79-74ad07585730' |
   ```

5. Set the instance ID for one of the returned instance workload names:

   ```bash
   $ INSTANCE_NAME='vn-xlfb4jb-yhbq6fkk2kec-qsu2fr47zigs-vnf-y27wuo25ce4e'; export INSTANCE_ID=$(openstack server list --name $INSTANCE_NAME -c ID -f value)
   ```

6. Verify metrics have been stored for the instance resource ID. If no metrics are available it’s possible not enough time has elapsed since the instance was created. If enough time has elapsed, you can check the logs for the data collection service in `/var/log/containers/ceilometer/` and logs for the time-series database service gnocchi in `/var/log/containers/gnocchi/`:

   ```bash
   $ openstack metric resource show --column metrics $INSTANCE_ID
   +---------+---------------------------------------------------------------------+
   | Field   | Value                                                               |
   +---------+---------------------------------------------------------------------+
   | metrics | compute.instance.booting.time: 57ca241d-764b-4c58-aa32-35760d720b08 |
   |         | cpu: d7767d7f-b10c-4124-8893-679b2e5d2ccd                            |
   ```
7. Verify there are available measures for the resource metric and note the granularity value as we’ll use it when running the `openstack metric aggregates` command:

```bash
disk ephemeral.size: 038b11db-0598-4cfd-9f8d-4ba6b725375b
disk.root.size: 843f8998-e644-41f6-8635-e7c99e28859e
memory.usage: 1e554370-05ac-4107-98d8-9330265db750
memory: fbd50c0e-90fa-4ad9-b0df-f7361ceb4e38
vcpus: 0629743e-6baa-4e22-ae93-512dc16bac85
```

```bash
$ openstack metric measures show --resource-id $INSTANCE_ID --aggregation rate:mean cpu
```

```
+---------------------------+-------------+---------------+
| timestamp                 | granularity | value         |
| 2022-11-08T14:12:00+00:00 | 60.0        | 71920000000.0 |
| 2022-11-08T14:13:00+00:00 | 60.0        | 88920000000.0 |
| 2022-11-08T14:14:00+00:00 | 60.0        | 76130000000.0 |
| 2022-11-08T14:15:00+00:00 | 60.0        | 17640000000.0 |
| 2022-11-08T14:16:00+00:00 | 60.0        | 33300000000.0 |
| 2022-11-08T14:17:00+00:00 | 60.0        | 24500000000.0 |
...
```

8. Retrieve the number of vCPU cores applied to the workload instance by reviewing the configured flavor for the instance workload:

```bash
$ openstack server show $INSTANCE_ID -cflavor -f value
m1.small (692533fe-0912-417e-b706-5d085449db53)
```

```bash
$ openstack flavor show 692533fe-0912-417e-b706-5d085449db53 -c vcpus -f value
2
```

9. Return the metrics as an aggregate by resource type instance (server ID) with the value calculated as a percentage. The aggregate is returned as a value of nanoseconds of CPU time. We divide that number by 1000000000 to get the value in seconds. We then divide the value by our granularity, which in this example is 60 seconds (as previously retrieved with the `openstack metric measures show` command). That value is then converted to a percentage by multiplying by 100. Finally, we divide the total value by the number of vCPU provided by the flavor assigned to the instance, in this example a value of 2 vCPU, providing us a value expressed as a percentage of CPU time:

```bash
$ openstack metric aggregates --resource-type instance --sort-column timestamp --sort-descending '/(* (/ (/ (metric cpu rate:mean) 1000000000) 60) 100) 2)' id=$INSTANCE_ID
```

```
+----------------------------------------------------+---------------------------+-------------+---------------+
| name                                               | timestamp                 | granularity | value         |
| bc1811de-48ed-44c1-ae22-c01f36d6cb02/cpu/rate:mean | 2022-11-08T14:26:00+00:00 | 60.0        | 2.45          |
| bc1811de-48ed-44c1-ae22-c01f36d6cb02/cpu/rate:mean | 2022-11-08T14:25:00+00:00 | 60.0        | 11.075        |
| bc1811de-48ed-44c1-ae22-c01f36d6cb02/cpu/rate:mean | 2022-11-08T14:24:00+00:00 | 60.0        | 61.3          |
| bc1811de-48ed-44c1-ae22-c01f36d6cb02/cpu/rate:mean | 2022-11-08T14:23:00+00:00 | 60.0        |               |
```

Red Hat OpenStack Platform 17.1 Auto-scaling for instances