Red Hat OpenShift Pipelines 1.15

Managing performance and resource use

Managing resource consumption in OpenShift Pipelines

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Abstract

This document provides information about managing resource consumption in OpenShift Pipelines.

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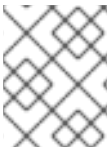
CHAPTER 1. MANAGING OPENSHIFT PIPELINES PERFORMANCE

If your OpenShift Pipelines installation runs a large number of tasks at the same time, its performance might degrade. You might experience slowdowns and failed pipeline runs.

For reference, in Red Hat tests, on a three-node OpenShift Container Platform cluster running on Amazon Web Services (AWS) **m6a.2xlarge** nodes, up to 60 simple test pipelines ran concurrently without significant failures or delays. If more pipelines ran concurrently, the number of failed pipeline runs, the average duration of a pipeline run, the pod creation latency, the work queue depth, and the number of pending pods increased. This testing was performed on Red Hat OpenShift Pipelines version 1.13; no statistically significant difference was observed from version 1.12.



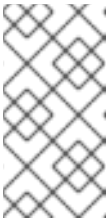
NOTE

These results depend on the test configuration. Performance results with your configuration can be different.

1.1. IMPROVING OPENSHIFT PIPELINES PERFORMANCE

If you experience slowness or recurrent failures of pipeline runs, you can take any of the following steps to improve the performance of OpenShift Pipelines.

- Monitor the resource usage of the nodes in the OpenShift Container Platform cluster on which OpenShift Pipelines runs. If the resource usage is high, increase the number of nodes.
- Enable high-availability mode. This mode affects the controller that creates and starts pods for task runs and pipeline runs. In Red Hat testing, high-availability mode significantly reduced pipeline execution times as well as the delay from creating a **TaskRun** resource CR to the start of the pod executing the task run. To enable high-availability mode, make the following changes in the **TektonConfig** custom resource (CR):
  - Set the **pipeline.performance.disable-ha** spec to **false**.
  - Set the **pipeline.performance.buckets** spec to a number between **5** and **10**.
  - Set the **pipeline.performance.replicas** spec to a number higher than **2** and lower than or equal to the **pipeline.performance.buckets** setting.



NOTE

You can try different numbers for buckets and replicas to observe the effect on performance. In general, higher numbers are beneficial. Monitor for exhausting the resources of the nodes, including CPU and memory utilization.

1.2. ADDITIONAL RESOURCES

- Performance tuning using the TektonConfig CR

CHAPTER 2. REDUCING RESOURCE CONSUMPTION OF OPENSHIFT PIPELINES

If you use clusters in multi-tenant environments you must control the consumption of CPU, memory, and storage resources for each project and Kubernetes object. This helps prevent any one application from consuming too many resources and affecting other applications.

To define the final resource limits that are set on the resulting pods, Red Hat OpenShift Pipelines use resource quota limits and limit ranges of the project in which they are executed.

To restrict resource consumption in your project, you can:

- Set and manage resource quotas to limit the aggregate resource consumption.
- Use limit ranges to restrict resource consumption for specific objects, such as pods, images, image streams, and persistent volume claims.

2.1. UNDERSTANDING RESOURCE CONSUMPTION IN PIPELINES

Each task consists of a number of required steps to be executed in a particular order defined in the **steps** field of the **Task** resource. Every task runs as a pod, and each step runs as a container within that pod.

Steps are executed one at a time. The pod that executes the task only requests enough resources to run a single container image (step) in the task at a time, and thus does not store resources for all the steps in the task.

The **Resources** field in the **steps** spec specifies the limits for resource consumption. By default, the resource requests for the CPU, memory, and ephemeral storage are set to **BestEffort** (zero) values or to the minimums set through limit ranges in that project.

Example configuration of resource requests and limits for a step

```
spec:
  steps:
  - name: <step_name>
    resources:
      requests:
        memory: 2Gi
        cpu: 600m
      limits:
        memory: 4Gi
        cpu: 900m
```

When the **LimitRange** parameter and the minimum values for container resource requests are specified in the project in which the pipeline and task runs are executed, Red Hat OpenShift Pipelines looks at all the **LimitRange** values in the project and uses the minimum values instead of zero.

Example configuration of limit range parameters at a project level

```
apiVersion: v1
kind: LimitRange
metadata:
  name: <limit_container_resource>
```

```
spec:
  limits:
  - max:
      cpu: "600m"
      memory: "2Gi"
    min:
      cpu: "200m"
      memory: "100Mi"
    default:
      cpu: "500m"
      memory: "800Mi"
    defaultRequest:
      cpu: "100m"
      memory: "100Mi"
    type: Container
...
```

2.2. MITIGATING EXTRA RESOURCE CONSUMPTION IN PIPELINES

When you have resource limits set on the containers in your pod, OpenShift Container Platform sums up the resource limits requested as all containers run simultaneously.

To consume the minimum amount of resources needed to execute one step at a time in the invoked task, Red Hat OpenShift Pipelines requests the maximum CPU, memory, and ephemeral storage as specified in the step that requires the most amount of resources. This ensures that the resource requirements of all the steps are met. Requests other than the maximum values are set to zero.

However, this behavior can lead to higher resource usage than required. If you use resource quotas, this could also lead to unschedulable pods.

For example, consider a task with two steps that uses scripts, and that does not define any resource limits and requests. The resulting pod has two init containers (one for entrypoint copy, the other for writing scripts) and two containers, one for each step.

OpenShift Container Platform uses the limit range set up for the project to compute required resource requests and limits. For this example, set the following limit range in the project:

```
apiVersion: v1
kind: LimitRange
metadata:
  name: mem-min-max-demo-lr
spec:
  limits:
  - max:
      memory: 1Gi
    min:
      memory: 500Mi
    type: Container
```

In this scenario, each init container uses a request memory of 1Gi (the max limit of the limit range), and each container uses a request memory of 500Mi. Thus, the total memory request for the pod is 2Gi.

If the same limit range is used with a task of ten steps, the final memory request is 5Gi, which is higher than what each step actually needs, that is 500Mi (since each step runs after the other).

Thus, to reduce resource consumption of resources, you can:

- Reduce the number of steps in a given task by grouping different steps into one bigger step, using the script feature, and the same image. This reduces the minimum requested resource.
- Distribute steps that are relatively independent of each other and can run on their own to multiple tasks instead of a single task. This lowers the number of steps in each task, making the request for each task smaller, and the scheduler can then run them when the resources are available.

2.3. ADDITIONAL RESOURCES

- Setting compute resource quota for OpenShift Pipelines
- Resource quotas per project
- Restricting resource consumption using limit ranges
- Resource requests and limits in Kubernetes

CHAPTER 3. SETTING COMPUTE RESOURCE QUOTA FOR OPENSHIFT PIPELINES

A **ResourceQuota** object in Red Hat OpenShift Pipelines controls the total resource consumption per namespace. You can use it to limit the quantity of objects created in a namespace, based on the type of the object. In addition, you can specify a compute resource quota to restrict the total amount of compute resources consumed in a namespace.

However, you might want to limit the amount of compute resources consumed by pods resulting from a pipeline run, rather than setting quotas for the entire namespace. Currently, Red Hat OpenShift Pipelines does not enable you to directly specify the compute resource quota for a pipeline.

3.1. ALTERNATIVE APPROACHES FOR LIMITING COMPUTE RESOURCE CONSUMPTION IN OPENSHIFT PIPELINES

To attain some degree of control over the usage of compute resources by a pipeline, consider the following alternative approaches:

- Set resource requests and limits for each step in a task.

  Example: Set resource requests and limits for each step in a task.

  ```
  ...
  spec:
    steps:
      - name: step-with-limts
        resources:
          requests:
            memory: 1Gi
            cpu: 500m
          limits:
            memory: 2Gi
            cpu: 800m
  ...
  ```

- Set resource limits by specifying values for the **LimitRange** object. For more information on **LimitRange**, refer to Restrict resource consumption with limit ranges.

- Reduce pipeline resource consumption.

- Set and manage resource quotas per project.

- Ideally, the compute resource quota for a pipeline should be same as the total amount of compute resources consumed by the concurrently running pods in a pipeline run. However, the pods running the tasks consume compute resources based on the use case. For example, a Maven build task might require different compute resources for different applications that it builds. As a result, you cannot predetermine the compute resource quotas for tasks in a generic pipeline. For greater predictability and control over usage of compute resources, use customized pipelines for different applications.

NOTE

When using Red Hat OpenShift Pipelines in a namespace configured with a **ResourceQuota** object, the pods resulting from task runs and pipeline runs might fail with an error, such as: **failed quota: <quota name> must specify cpu, memory**.

To avoid this error, do any one of the following:

- (Recommended) Specify a limit range for the namespace.
- Explicitly define requests and limits for all containers.

For more information, refer to the issue and the resolution.

If your use case is not addressed by these approaches, you can implement a workaround by using a resource quota for a priority class.

3.2. SPECIFYING PIPELINES RESOURCE QUOTA USING PRIORITY CLASS

A **PriorityClass** object maps priority class names to the integer values that indicates their relative priorities. Higher values increase the priority of a class. After you create a priority class, you can create pods that specify the priority class name in their specifications. In addition, you can control a pod's consumption of system resources based on the pod's priority.

Specifying resource quota for a pipeline is similar to setting a resource quota for the subset of pods created by a pipeline run. The following steps provide an example of the workaround by specifying resource quota based on priority class.

Procedure

1. Create a priority class for a pipeline.

   Example: Priority class for a pipeline

   ```
   apiVersion: scheduling.k8s.io/v1
   kind: PriorityClass
   metadata:
     name: pipeline1-pc
   value: 1000000
   description: "Priority class for pipeline1"
   ```

2. Create a resource quota for a pipeline.

   Example: Resource quota for a pipeline

   ```
   apiVersion: v1
   kind: ResourceQuota
   metadata:
     name: pipeline1-rq
   spec:
     hard:
       cpu: "1000"
       memory: 200Gi
   ```

```
    pods: "10"
  scopeSelector:
    matchExpressions:
    - operator : In
      scopeName: PriorityClass
      values: ["pipeline1-pc"]
```

3. Verify the resource quota usage for the pipeline.

Example: Verify resource quota usage for the pipeline

```
$ oc describe quota
```

Sample output

```
Name:       pipeline1-rq
Namespace:  default
Resource    Used  Hard
--------    ----  ----
cpu         0     1k
memory      0     200Gi
pods        0     10
```

Because pods are not running, the quota is unused.

4. Create the pipelines and tasks.

Example: YAML for the pipeline

```
apiVersion: tekton.dev/v1
kind: Pipeline
metadata:
  name: maven-build
spec:
  params:
  - name: GIT_URL
  workspaces:
  - name: local-maven-repo
  - name: source
  tasks:
  - name: git-clone
    taskRef:
      resolver: cluster
      params:
      - name: kind
        value: task
      - name: name
        value: git-clone
      - name: namespace
        value: openshift-pipelines
    workspaces:
    - name: output
      workspace: source
    params:
```

```
    - name: URL
      value: $(params.GIT_URL)
  - name: build
    taskRef:
      name: mvn
    runAfter: ["git-clone"]
    params:
    - name: GOALS
      value: ["package"]
    workspaces:
    - name: maven-repo
      workspace: local-maven-repo
    - name: source
      workspace: source
  - name: int-test
    taskRef:
      name: mvn
    runAfter: ["build"]
    params:
    - name: GOALS
      value: ["verify"]
    workspaces:
    - name: maven-repo
      workspace: local-maven-repo
    - name: source
      workspace: source
  - name: gen-report
    taskRef:
      name: mvn
    runAfter: ["build"]
    params:
    - name: GOALS
      value: ["site"]
    workspaces:
    - name: maven-repo
      workspace: local-maven-repo
    - name: source
      workspace: source
```

Example: YAML for a task in the pipeline

```
apiVersion: tekton.dev/v1
kind: Task
metadata:
  name: mvn
spec:
  workspaces:
  - name: maven-repo
  - name: source
  params:
  - name: GOALS
    description: The Maven goals to run
    type: array
    default: ["package"]
  steps:
    - name: mvn
```

```
    image: gcr.io/cloud-builders/mvn
    workingDir: $(workspaces.source.path)
    command: ["/usr/bin/mvn"]
    args:
      - -Dmaven.repo.local=$(workspaces.maven-repo.path)
      - "$(params.GOALS)"
```

5. Create and start the pipeline run.

Example: YAML for a pipeline run

```
apiVersion: tekton.dev/v1
kind: PipelineRun
metadata:
  generateName: petclinic-run-
spec:
  pipelineRef:
    name: maven-build
  params:
  - name: GIT_URL
    value: https://github.com/spring-projects/spring-petclinic
  taskRunTemplate:
    podTemplate:
      priorityClassName: pipeline1-pc
  workspaces:
  - name: local-maven-repo
    emptyDir: {}
  - name: source
    volumeClaimTemplate:
      spec:
        accessModes:
          - ReadWriteOnce
        resources:
          requests:
            storage: 200M
```

NOTE

The pipeline run might fail with an error: **failed quota: <quota name> must specify cpu, memory**.

To avoid this error, set a limit range for the namespace, where the defaults from the **LimitRange** object apply to pods created during the build process.

For more information about setting limit ranges, refer to *Restrict resource consumption with limit ranges* in the *Additional resources* section.

6. After the pods are created, verify the resource quota usage for the pipeline run.

Example: Verify resource quota usage for the pipeline

```
$ oc describe quota
```

Sample output

```
Name:       pipeline1-rq
Namespace:  default
Resource    Used  Hard
--------    ----  ----
cpu         500m  1k
memory      10Gi  200Gi
pods        1     10
```

The output indicates that you can manage the combined resource quota for all concurrent running pods belonging to a priority class, by specifying the resource quota per priority class.

3.3. ADDITIONAL RESOURCES

- Restrict resource consumption with limit ranges
- Resource quotas in Kubernetes
- Limit ranges in Kubernetes
- Resource requests and limits in Kubernetes