

Debugging pods in a Kubernetes cluster

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Overview

Pods are the smallest deployable units in Kubernetes and critical to application functionality. Debugging pods helps ensure applications run smoothly, scale seamlessly, and use cluster resources effectively.

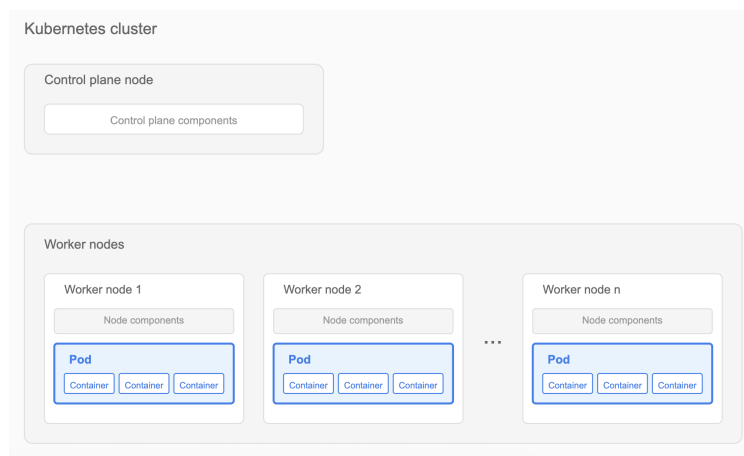


Figure 1: Kubernetes cluster architecture

This article helps Kubernetes cluster administrators and developers diagnose and troubleshoot pod issues. After reading, you will be able to:

- Inspect pod status in a cluster.
- Analyze logs for debugging.
- Execute shell commands within containers.
- Use ephemeral containers for interactive debugging.

Prerequisites

Before starting, verify that you have:

- Access to a Kubernetes cluster with running pods.
- Sufficient permissions to execute `kubectl` commands.

Debug pods in a Kubernetes cluster

The following sections describe common debugging techniques. Use these techniques sequentially or combine them based on your specific scenario.

1. Check pod status

Begin debugging by checking the status of your pods.

To list all pods:

```
$ kubectl get pods
```

To list pods in a specific namespace:

```
$ kubectl get pods --namespace=<namespace-name>
```

Example:

```
$ kubectl get pods --namespace=default
```

Expected output:

| NAME | READY | STATUS | RESTARTS | AGE |
|-----------------------------------|-------|------------------|----------|-----|
| hello-node-7b87cd5f68-2wp4m | 1/1 | Running | 0 | 21m |
| nginx-deployment-66b6c48dd5-8k4h2 | 0/1 | Pending | 0 | 5m |
| redis-master-58db8984f-xp4c8 | 0/1 | ImagePullBackOff | 0 | 2m |

Tip

If a pod is stuck in **Pending** status, check cluster resource availability running the following command:

```
$ kubectl describe node <node-name>
```

For a graphical interface, use the Kubernetes dashboard:

1. Open the Kubernetes dashboard.
2. Navigate to the *Pods* section.
3. Select a pod to view its details.

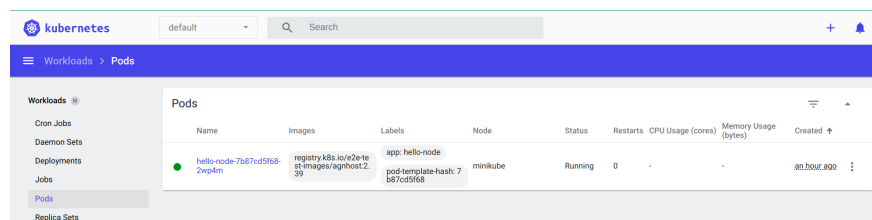


Figure 2: Pods in a Kubernetes dashboard

2. Review pod logs

Logs help identify what a container is doing or why it failed.

To view logs from all containers in a pod:

```
$ kubectl logs <pod-name> --all-containers=true
```

To view logs from a specific container:

```
$ kubectl logs <pod-name> -c <container-name>
```

Note

For pods with a single container, omit the container name.

Example:

```
$ kubectl logs hello-node-7b87cd5f68-2wp4m
```

Expected output:

```
I0715 06:51:04.198447    1 log.go:195] Started HTTP server on port 8080
I0715 06:51:04.198572    1 log.go:195] Started UDP server on port 8081
```

Tip

For pods in `CrashLoopBackOff` status, check logs with the `--previous` flag to see the last container's logs before it crashed:

```
$ kubectl logs <pod-name> --previous
```

3. Execute container commands

Inspect container state by running shell commands directly inside it.

Syntax:

```
$ kubectl exec <pod-name> -c <container-name> -- <command>
```

Note

If not specified, commands run in the first container of the pod.

Examples:

Check container environment variables

```
$ kubectl exec nginx-deployment-66b6c48dd5-8k4h2 -- env
```

Expected output:

```
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
HOSTNAME=nginx-deployment-66b6c48dd5-8k4h2
NGINX_VERSION=1.21.1
NJS_VERSION=0.6.1
PKG_RELEASE=1~buster
HOME=/root
```

Verify network connectivity

```
$ kubectl exec nginx-deployment-66b6c48dd5-8k4h2 -- curl -I localhost:80
```

Expected output:

```
HTTP/1.1 200 OK
Server: nginx/1.21.1
Date: Tue, 14 Jan 2025 10:15:23 GMT
Content-Type: text/html
Content-Length: 612
Connection: keep-alive
```

Check running processes

```
$ kubectl exec nginx-deployment-66b6c48dd5-8k4h2 -- ps aux
```

Expected output:

| USER | PID | %CPU | %MEM | VSZ | RSS | TTY | STAT | START | TIME | COMMAND |
|-------|-----|------|------|-------|------|-----|------|-------|------|-----------------------|
| root | 1 | 0.0 | 0.1 | 10640 | 5548 | ? | Ss | 10:00 | 0:00 | nginx: master process |
| nginx | 31 | 0.0 | 0.1 | 11088 | 5164 | ? | S | 10:00 | 0:00 | nginx: worker process |

Tip

For containers that crash immediately, create a copy of the pod with a sleep command:

```
$ kubectl debug <pod-name> --copy-to=<pod-name>-debug --container=<container-name> -- sleep 1d
```

4. Use ephemeral debug containers

Ephemeral containers let you attach debugging tools to running pods without modifying the original containers.

To create an ephemeral debug container:

```
$ kubectl debug <pod-name> -it --image=<debug-image>
```

Examples:

Debug networking issues using netshoot

```
$ kubectl debug nginx-deployment-66b6c48dd5-8k4h2 -it --image=nicolaka/netshoot
```

Expected output:

```
Defaulting debug container name to debugger-nx8j2.
If you don't see a command prompt, try pressing enter.
~#dig_Kubernetes.default.svc.cluster.local
~#curl_v_telnet://nginx-service:80
~#tcpdump_i_any_port_80
```

Analyze memory usage with tools

```
$ kubectl debug redis-master-58db8984f-xp4c8 -it --image=ubuntu
```

Expected output:

```
Defaulting debug container name to debugger-7xj4d.
If you don't see a command prompt, try pressing enter.
root@redis-master-58db8984f-xp4c8:/#_apt-get_update
root@redis-master-58db8984f-xp4c8:/#_apt-get_install_y_procs
root@redis-master-58db8984f-xp4c8:/#_top
...Memory_usage_details...
```

Tip

For pods with ImagePullBackOff status, verify image name and registry credentials. Check image pull secrets using:

```
$ kubectl get pod <pod-name> -o=jsonpath='{.spec.imagePullSecrets[0].name}'
```