HashiCorp Nomad on the AWS Cloud

Quick Start Reference Deployment

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This Quick Start deployment guide was created by Amazon Web Services (AWS) in partnership with HashiCorp, Inc.
Overview

This Quick Start reference deployment guide provides step-by-step instructions for deploying HashiCorp Nomad on the Amazon Web Services (AWS) Cloud. Quick Starts are automated reference deployments that use AWS CloudFormation templates to launch, configure, and run the AWS compute, network, storage, and other services required to deploy a specific workload on AWS.

Nomad is a distributed, highly available, data center-aware cluster manager and scheduler that helps deploy applications on any infrastructure, at any scale, on premises or in the cloud.

Nomad provides a common workflow to deploy applications across an infrastructure. Developers use a declarative job specification to define how an application should be deployed and the resources it requires (CPU, memory, disk). Nomad accepts these jobs and finds available resources to run them. The scheduling algorithm ensures that all constraints are satisfied, and packs as many applications on a host as possible to optimize resource utilization. Additionally, Nomad supports virtualized, containerized, or standalone applications running on all major operating systems, which gives it the flexibility to support a broad range of workloads.

This Quick Start is for users who are looking to deploy their jobs efficiently by leveraging a scheduler on the AWS Cloud.

Costs and Licenses

You are responsible for the cost of the AWS services used while running this Quick Start reference deployment. There is no additional cost for using the Quick Start.

The AWS CloudFormation template for this Quick Start includes configuration parameters that you can customize. Some of these settings, such as instance type, will affect the cost of deployment. For cost estimates, see the pricing pages for each AWS service you will be using. Prices are subject to change.

HashiCorp Nomad is an open-source tool that you can download for free from the Nomad website. If you would like to deploy Nomad in production in your enterprise environment, see the details about Nomad Enterprise on the HashiCorp website.
Architecture

Deploying this Quick Start for a new virtual private cloud (VPC) with default parameters builds the following HashiCorp Nomad environment in the AWS Cloud.

Nomad requires an existing HashiCorp Consul environment, which the Quick Start automatically sets up. This QuickStart deploys the following components:

- A scalable VPC configured with public and private subnets across three Availability Zones. (For more information about this VPC infrastructure, see the Amazon VPC Quick Start.)*
- An internet gateway to allow access to the internet. The bastion hosts use this gateway to send and receive traffic.*
In the public subnets, NAT gateways to provide outbound Internet connectivity for resources in the private subnets.*

In the public subnets, Linux bastion hosts in an Auto Scaling group to allow inbound Secure Shell (SSH) access. One bastion host is deployed by default, but this number is configurable. (For more information about the bastion hosts, see the Linux bastion host Quick Start.)*

An AWS Identity and Access Management (IAM) instance role with fine-grained permissions for access to AWS services necessary for the deployment process.

Security groups to enable communication within the VPC and to restrict access to only necessary protocols and ports.

In the private subnets, a user-configurable number of HashiCorp Consul server and client instances within separate Auto Scaling groups. If the number of client nodes is set to 0 (which is the default), the Quick Start won’t create the Consul client Auto Scaling group, and Consul client instances will be co-located on Nomad client and server instances instead.

In the private subnets, a user-configurable number of HashiCorp Nomad client and server instances within separate Auto Scaling groups.

* You can choose to launch the Quick Start for a new VPC or use your existing VPC. The template that deploys the Quick Start into an existing VPC skips the creation of components marked by asterisks and prompts you for your existing configuration.

Prerequisites

Specialized Knowledge

Before you deploy this Quick Start, we recommend that you become familiar with the following AWS services. (If you are new to AWS, see Getting Started with AWS.)

- Amazon VPC
- Amazon EC2
- Amazon EBS

Deployment Options

This Quick Start provides two deployment options:

- **Deploy HashiCorp Nomad into a new VPC** (end-to-end deployment). This option builds a new AWS environment consisting of the VPC, subnets, NAT gateways,
security groups, bastion hosts, and other infrastructure components, and then deploys HashiCorp Consul and HashiCorp Nomad into this new VPC.

- **Deploy HashiCorp Nomad into an existing VPC.** This option provisions HashiCorp Nomad servers and client, each running the Consul client, in your existing AWS infrastructure.

The Quick Start also lets you configure additional settings such as CIDR blocks, instance types, and HashiCorp Nomad and Consul settings, as discussed later in this guide.

**Deployment Steps**

**Step 1. Prepare Your AWS Account**

1. If you don’t already have an AWS account, create one at [https://aws.amazon.com](https://aws.amazon.com) by following the on-screen instructions.

2. Use the region selector in the navigation bar to choose the AWS Region where you want to deploy HashiCorp Nomad on AWS.

3. Create a key pair in your preferred region.

4. If necessary, request a service limit increase for the Amazon EC2 **m4.large** and **t2.medium** instance types. You might need to do this if you already have an existing deployment that uses these instance types, and you think you might exceed the default limits with this reference deployment.

**Step 2. Launch the Quick Start**

**Note** You are responsible for the cost of the AWS services used while running this Quick Start reference deployment. There is no additional cost for using this Quick Start. For full details, see the pricing pages for each AWS service you will be using in this Quick Start. Prices are subject to change.

1. Choose one of the following options to launch the AWS CloudFormation template into your AWS account. For help choosing an option, see deployment options.

   ![Launch Options](option1_option2.png)
Important If you’re deploying HashiCorp Nomad into an existing VPC, make sure that your VPC has three private subnets in different Availability Zones for the Nomad instances. These subnets require NAT gateways or NAT instances in their route tables, to allow the instances to download packages and software without exposing them to the Internet. You’ll also need the domain name option configured in the DHCP options as explained in the Amazon VPC documentation. You’ll be prompted for your VPC settings when you launch the Quick Start.

Each deployment takes about 35 minutes to complete.

2. Check the region that’s displayed in the upper-right corner of the navigation bar, and change it if necessary. This is where the network infrastructure for HashiCorp Nomad will be built. The template is launched in the US West (Oregon) Region by default.

3. On the Select Template page, keep the default setting for the template URL, and then choose Next.

4. On the Specify Details page, change the stack name if needed. Review the parameters for the template. Provide values for the parameters that require input. For all other parameters, review the default settings and customize them as necessary. When you finish reviewing and customizing the parameters, choose Next.

In the following tables, parameters are listed by category and described separately for the two deployment options:

- Parameters for deploying HashiCorp Nomad into a new VPC
- Parameters for deploying HashiCorp Nomad into an existing VPC

• Option 1: Parameters for deploying HashiCorp Nomad into a new VPC

View template

VPC Network Configuration:

<table>
<thead>
<tr>
<th>Parameter label (name)</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability Zones (AvailabilityZones)</td>
<td>Requires input</td>
<td>The list of Availability Zones to use for the subnets in the VPC. The Quick Start uses three Availability Zones and preserves the logical order you specify.</td>
</tr>
<tr>
<td>VPC CIDR (VPCCIDR)</td>
<td>10.0.0.0/16</td>
<td>The CIDR block for the VPC to create.</td>
</tr>
<tr>
<td>Private Subnet 1 CIDR (PrivateSubnet1CIDR)</td>
<td>10.0.0.0/19</td>
<td>The CIDR block for the private subnet located in Availability Zone 1.</td>
</tr>
</tbody>
</table>
### AWS Cloud Setup

<table>
<thead>
<tr>
<th>Parameter label (name)</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Subnet 2 CIDR</td>
<td>10.0.32.0/19</td>
<td>The CIDR block for the private subnet located in Availability Zone 2.</td>
</tr>
<tr>
<td>Private Subnet 3 CIDR</td>
<td>10.0.64.0/19</td>
<td>The CIDR block for the private subnet located in Availability Zone 3.</td>
</tr>
<tr>
<td>Public Subnet 1 CIDR</td>
<td>10.0.128.0/20</td>
<td>The CIDR block for the public (DMZ) subnet located in Availability Zone 1.</td>
</tr>
<tr>
<td>Public Subnet 2 CIDR</td>
<td>10.0.144.0/20</td>
<td>The CIDR block for the public (DMZ) subnet located in Availability Zone 2.</td>
</tr>
<tr>
<td>Public Subnet 3 CIDR</td>
<td>10.0.160.0/20</td>
<td>The CIDR block for the public (DMZ) subnet located in Availability Zone 3.</td>
</tr>
<tr>
<td>Permitted IP range (AccessCIDR)</td>
<td>Requires input</td>
<td>The CIDR IP range that is permitted to access Consul Nomad. We recommend that you set this value to a trusted IP range. For example, you might want to grant only your corporate network access to the software.</td>
</tr>
</tbody>
</table>

### Nomad Setup:

<table>
<thead>
<tr>
<th>Parameter label (name)</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Name (KeyPairName)</td>
<td>Requires input</td>
<td>Public/private key pair, which allows you to connect securely to your instance after it launches. When you created an AWS account, this is the key pair you created in your preferred region.</td>
</tr>
<tr>
<td>Nomad Instance Type (NomadInstanceType)</td>
<td>m4.large</td>
<td>The EC2 instance type for the HashiCorp Nomad instances.</td>
</tr>
<tr>
<td>Nomad Server Nodes (NomadServerNodes)</td>
<td>3</td>
<td>The number of Nomad server nodes that will be created. You can choose 3, 5, or 7 nodes.</td>
</tr>
<tr>
<td>Private Nomad Client Nodes (PrivateNomadClientNodes)</td>
<td>3</td>
<td>The number of Nomad client nodes that will be created.</td>
</tr>
<tr>
<td>Minimum Private Nomad Client Nodes (MinPrivateNomadClientNodes)</td>
<td>1</td>
<td>The minimum number of Nomad client nodes that will be created.</td>
</tr>
</tbody>
</table>

### Consul Setup:

<table>
<thead>
<tr>
<th>Parameter label (name)</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consul Client Nodes (ConsulClientNodes)</td>
<td>0</td>
<td>The number of Consul client nodes that will be created. When this parameter is set to 0 (default), Consul clients will be co-located on Nomad client and server instances.</td>
</tr>
<tr>
<td>Consul Server Nodes (ConsulServerNodes)</td>
<td>3</td>
<td>The number of Consul server nodes that will be created. You can choose 3, 5, or 7 nodes.</td>
</tr>
</tbody>
</table>
### AWS Quick Start Configuration:

<table>
<thead>
<tr>
<th>Parameter label (name)</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consul Instance Type (ConsulInstanceType)</td>
<td>t2.medium</td>
<td>The EC2 instance type for the HashiCorp Consul instances.</td>
</tr>
<tr>
<td>Quick Start S3 Bucket Name (QSS3BucketName)</td>
<td>aws-quickstart</td>
<td>The S3 bucket where the Quick Start templates and scripts are installed. Use this parameter to specify the S3 bucket name you’ve created for your copy of Quick Start assets, if you decide to customize or extend the Quick Start for your own use. The bucket name can include numbers, lowercase letters, uppercase letters, and hyphens, but should not start or end with a hyphen.</td>
</tr>
<tr>
<td>Quick Start S3 Key Prefix (QSS3KeyPrefix)</td>
<td>quickstart-hashicorp-nomad/</td>
<td>The S3 key name prefix used to simulate a folder for your copy of Quick Start assets, if you decide to customize or extend the Quick Start for your own use. This prefix can include numbers, lowercase letters, uppercase letters, hyphens, and forward slashes.</td>
</tr>
</tbody>
</table>

- **Option 2: Parameters for deploying HashiCorp Nomad into an existing VPC**

  View template

### VPC Network Configuration:

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Private Subnet 1 ID (PrivateSubnet1ID)</td>
<td>Requires input</td>
<td>ID of the private subnet in Availability Zone 1 in your existing VPC (e.g., subnet-a0246dc).</td>
</tr>
<tr>
<td>Private Subnet 2 ID (PrivateSubnet2ID)</td>
<td>Requires input</td>
<td>ID of the private subnet in Availability Zone 2 in your existing VPC.</td>
</tr>
<tr>
<td>Private Subnet 3 ID (PrivateSubnet3ID)</td>
<td>Requires input</td>
<td>ID of the private subnet in Availability Zone 3 in your existing VPC.</td>
</tr>
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<td>Permitted IP range (AccessCIDR)</td>
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<td>Requires input</td>
<td>CIDR block for your existing VPC.</td>
</tr>
<tr>
<td>VPC ID (VPCID)</td>
<td>Requires input</td>
<td>ID of your existing VPC (e.g., vpc-0343606e).</td>
</tr>
</tbody>
</table>
### Consul Client:

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<tr>
<th>Parameter label (name)</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consul EC2 Retry TagKey (ConsulEc2RetryTagKey)</td>
<td>aws:cloudformation: stack-name</td>
<td>The EC2 instance tag key to filter on when joining to other Consul nodes. For information about tagging AWS resources, see the <a href="https://aws.amazon.com/documentation/">AWS documentation</a>.</td>
</tr>
<tr>
<td>Consul EC2 Retry TagValue (ConsulEc2RetryTagValue)</td>
<td>Requires input</td>
<td>The EC2 instance tag value to filter on when joining to other Consul nodes. For information about tagging AWS resources, see the <a href="https://aws.amazon.com/documentation/">AWS documentation</a>.</td>
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<td>quickstart-hashicorp-nomad/</td>
<td>The S3 key name prefix used to simulate a folder for your copy of Quick Start assets, if you decide to customize or extend the Quick Start for your own use. This prefix can include numbers, lowercase letters, uppercase letters, hyphens, and forward slashes.</td>
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</table>
5. On the **Options** page, you can specify tags (key-value pairs) for resources in your stack and set advanced options. When you’re done, choose **Next**.

6. On the **Review** page, review and confirm the template settings. Under **Capabilities**, select the check box to acknowledge that the template will create IAM resources.

7. Choose **Create** to deploy the stack.

8. Monitor the status of the stack. When the status is **CREATE_COMPLETE**, the HashiCorp cluster is ready.

9. Use the URLs displayed in the **Outputs** tab for the stack to view the resources that were created.

**Step 3. Test the Deployment**

To use an SSH agent to access the Nomad environment on macOS or Linux:

1. Use the command:

   ```bash
   ssh-add ~/.ssh/id_rsa
   ```

2. At the prompt, type your passphrase or press **Enter** for no passphrase.

   ```
   Enter passphrase (empty for no passphrase): [Hit Enter Again or Enter passphrase]
   Enter same passphrase again: [Hit Enter Again or Enter passphrase]
   ```

3. Log in to the Linux bastion host:
   a. In the AWS CloudFormation console, select the Linux bastion stack.
   b. Choose the **Outputs** tab.
   c. Note the value of the Elastic IP (EIP1) key. (In the example, it’s **52.206.189.125**.)
Figure 2: Elastic IP key value for the Linux bastion host

4. Log in, and type `yes` when prompted to continue connecting. (Use the `-A` option, which enables agent forwarding.)

```
ssh -A ubuntu@52.206.189.125
```
5. In the Amazon EC2 console, select one of the Nomad server hosts and note its private IP address. (In the example, it’s **10.0.83.250**.)

6. Log in, and type **yes** when prompted to continue connecting.

   ```
   ssh -A ubuntu@10.0.83.250
   ```

7. Verify the integrity of the Consul cluster:

   ```
   consul members
   ```
8. Verify that a Nomad leader was elected:

   `nomad server-members`

9. Verify that the Nomad clients are healthy:

   `nomad node-status`
Step 4: (Optional) Create a Nomad File

To get started using Nomad, you can use the sample Nomad file provided with this Quick Start. This file will start a NGINX web server on port 80.

1. Download the sample Nomad plan file:

   ```
```

2. Update the data center name in the Nomad file:

   ```
NOMAD_DC=$(nomad node-status | tail -1 | awk '{print $2}');
        sed -i "s/__DC__/\$NOMAD_DC/" webjob.nomad
```

3. Use the `nomad plan` command to verify that the scheduler will run successfully:

   ```
nomad plan webjob.nomad
```

   ![Nomad Planner Output]

   **Scheduler dry-run:**
   
   *All tasks successfully allocated.*

   **Job Modify Index:** 0
   
   *To submit the job with version verification run:
   
   `nomad run -check-index 0 webjob.nomad`

   When running the job with the `check-index` flag, the job will only be run if the server side version matches the job modify index returned. If the index has changed, another user has modified the job and the plan's results are potentially invalid.

4. Run the job with the `nomad run` command:

   ```
nomad run -check-index 0 webjob.nomad
```
5. Record the allocation ID from the job output. (In the example, the ID is **718e59a7**.)

6. To inspect this allocation further, use the **nomad fs** command:

   ```bash
   nomad fs [alloc id]
   nomad fs [alloc id] alloc
   nomad fs [alloc id] alloc/logs/frontend.stdout.0
   nomad fs [alloc id] frontend
   nomad fs [alloc id] frontend/executor.out
   ```

7. Use **nomad alloc-status** to determine the web server URL:

   ```bash
   nomad alloc-status 718e59a7
   ```
8. Use `curl` to verify that the web job is running:

```
curl -s 10.0.38.119
```
FAQ

Q. I encountered a CREATE_FAILED error when I launched the Quick Start. What should I do?

A. If AWS CloudFormation fails to create the stack, we recommend that you relaunch the template with **Rollback on failure** set to **No**. (This setting is under **Advanced** in the AWS CloudFormation console, **Options** page.) With this setting, the stack’s state will be retained and the instance will be left running, so you can troubleshoot the issue. (You’ll want to look at the log files in %ProgramFiles%\Amazon\EC2ConfigService and C:\cfn\log.)

**Important** When you set **Rollback on failure** to **No**, you’ll continue to incur AWS charges for this stack. Please make sure to delete the stack when you’ve finished troubleshooting.

For additional information, see [Troubleshooting AWS CloudFormation](https://aws.amazon.com/documentation/cloudformation/troubleshooting/) on the AWS website.

Q. I encountered a size limitation error when I deployed the AWS Cloudformation templates.

A. We recommend that you launch the Quick Start templates from the location we’ve provided or from another S3 bucket. If you deploy the templates from a local copy on your computer or from a non-S3 location, you might encounter template size limitations when you create the stack. For more information about AWS CloudFormation limits, see the [AWS documentation](https://aws.amazon.com/documentation/cloudformation/limits/).
Additional Resources

**AWS services**
- Amazon EC2
- AWS CloudFormation
  [https://aws.amazon.com/documentation/cloudformation/](https://aws.amazon.com/documentation/cloudformation/)
- Amazon VPC
  [https://aws.amazon.com/documentation/vpc/](https://aws.amazon.com/documentation/vpc/)

**HashiCorp Nomad**
- Nomad
  [https://www.nomadproject.io/](https://www.nomadproject.io/)
- Nomad Enterprise
- Nomad million container benchmark
  [https://www.hashicorp.com/c1m/](https://www.hashicorp.com/c1m/)
- Nomad video
  [https://www.youtube.com/watch?v=hllS4Gutams](https://www.youtube.com/watch?v=hllS4Gutams)

**Quick Start reference deployments**
- AWS Quick Start home page
  [https://aws.amazon.com/quickstart/](https://aws.amazon.com/quickstart/)
- HashiCorp Consul Quick Start
- HashiCorp Vault Quick Start
  [https://aws.amazon.com/quickstart/architecture/vault/](https://aws.amazon.com/quickstart/architecture/vault/)
GitHub Repository

You can visit our GitHub repository to download the templates and scripts for this Quick Start, to post your feedback, and to share your customizations with others.

Document Revisions

<table>
<thead>
<tr>
<th>Date</th>
<th>Change</th>
<th>In sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2017</td>
<td>Changed the default number of Consul client nodes to 0. With this default, Consul clients are co-located on Nomad client and server instances.</td>
<td>Architecture diagram, parameter tables</td>
</tr>
<tr>
<td>May 2017</td>
<td>Initial publication</td>
<td>—</td>
</tr>
</tbody>
</table>

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