



## Lab: Terraform State Backend Storage

In order to properly and correctly manage your infrastructure resources, Terraform stores the state of your managed infrastructure. Each Terraform configuration can specify a backend which defines exactly where and how operations are performed. Most backends support security and collaboration features so using a backend is a must-have both from a security and teamwork perspective.

Terraform has a built-in selection of backends, and the configured backend must be available in the version of Terraform you are using. In this lab we will explore the use of some common Terraform standard and enhanced backends.

- Task 1: Standard Backend: S3
- Task 2: Standard Backend: HTTP Backend (Optional)

### Standard Backends

The built in Terraform standard backends store state remotely and perform terraform operations locally via the command line interface. Popular standard backends include:

- AWS S3 Backend (with DynamoDB)
- Google Cloud Storage Backend
- Azure Storage Backend

Consult Terraform documentaion for a full list of Terraform standard backends

Most backends also support collaboration features so using a backend is a must-have both from a security and teamwork perspective. Not all of these features need to be configured and enabled, but we will walk you some of the most beneficial items including versioning, encryption and state locking.

### Task 1: Standard Backend: S3

#### Step 1.1 - Create S3 Bucket and validate Terraform Configuration

In the previous lab we created an S3 bucket to centralize our terraform state to a remote S3 bucket. If you have not performed these steps please step through them as outlined in the previous lab. If you have already performed these steps you can move to the next step of the lab.





### Step 1.2 - Validate State on S3 Backend

We will want to validate that we can authenticate to our terraform backend and list the information in the state file. Let's validate that our configuration is pointing to the correct bucket and path.

terraform.tf

```
terraform {  
  backend "s3" {  
    bucket = "myterraformstate"  
    key    = "path/to/my/key"  
    region = "us-east-1"  
  }  
}
```

```
terraform state list
```

### Step 1.3 - Enable Versioning on S3 Bucket

Enabling versioning on our terraform backend is important as it allows us to restore the previous version of state should we need to. The `s3` backend supports versioning, so every revision of your state file is stored.





Amazon S3 > my-terraform-state-ghm > Edit Bucket Versioning

## Edit Bucket Versioning [Info](#)

### Bucket Versioning

Versioning is a means of keeping multiple variants of an object in the same bucket. You can use versioning to preserve, retrieve, and restore every version of every object stored in your Amazon S3 bucket. With versioning, you can easily recover from both unintended user actions and application failures. [Learn more](#)

#### Bucket Versioning

☐ Suspend

This suspends the creation of object versions for all operations but preserves any existing object versions.

☒ Enable

After enabling Bucket Versioning, you might need to update your lifecycle rules to manage previous versions of objects.

#### Multi-factor authentication (MFA) delete

An additional layer of security that requires multi-factor authentication for changing Bucket Versioning settings and permanently deleting object versions. To modify MFA delete settings, use the AWS CLI, AWS SDK, or the Amazon S3 REST API. [Learn more](#)

Disabled

Cancel

Save changes

**Figure 1:** S3 Versioning

Once versioning is enabled on your bucket let's make a configuration change that will result in a state change and execute that change with a `terraform apply`.

Update the size of your web server from `t2.micro` to a `t2.small` and apply the change.

```
resource "aws_instance" "web_server_2" {
  ami           = data.aws_ami.ubuntu.id
  instance_type = "t2.small"
  subnet_id     = aws_subnet.public_subnets["public_subnet_2"].id
  tags = {
    Name = "Web EC2 Server 2"
  }
}
```

```
terraform apply
```





Now you can see that your state file has been updated and if you check [Show Versions](#) on the bucket you will see the different versions of your state file.

**Objects (3)**

Objects are the fundamental entities stored in Amazon S3. You can use [Amazon S3 Inventory](#) to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. [Learn more](#)

☒ Show versions < 1 >

<input type="checkbox"/>	Name	Type	Version ID	Last modified	Size	Storage class
<input type="checkbox"/>	aws_infra	-	WBZubSfcWeVmusgK.aK_i3XeKoouphJK		47.8 KB	Standard
<input type="checkbox"/>	aws_infra	-	2BeR91EDXoQLGpTLY6ltPHm3r5b3LtQh		47.8 KB	Standard
<input type="checkbox"/>	aws_infra	-	null		813.0 B	Standard

**Figure 2:** Show Versions

### Step 1.4 - Enable Encryption on S3 Bucket

It is also incredibly important to protect terraform state data as it can contain extremely sensitive information. Store Terraform state in a backend that supports encryption. Instead of storing your state in a local terraform.tfstate file. Many backends support encryption, so that instead of your state files being in plain text, they will always be encrypted, both in transit (e.g., via TLS) and on disk (e.g., via AES-256). The [s3](#) backend supports encryption, which reduces worries about storing sensitive data in state files.





**Edit default encryption** [Info](#)

**Default encryption**  
Automatically encrypt new objects stored in this bucket. [Learn more](#)

**Server-side encryption**

☐ Disable

☒ Enable

**Encryption key type**  
To upload an object with a customer-provided encryption key (SSE-C), use the AWS CLI, AWS SDK, or Amazon S3 REST API.

☒ **Amazon S3 key (SSE-S3)**  
An encryption key that Amazon S3 creates, manages, and uses for you. [Learn more](#)

☐ **AWS Key Management Service key (SSE-KMS)**  
An encryption key protected by AWS Key Management Service (AWS KMS). [Learn more](#)

[Cancel](#) [Save changes](#)

**Figure 3:** Enable S3 Encryption

Anyone on your team who has access to that S3 bucket will be able to see the state files in an unencrypted form, so this is still a partial solution, but at least the data will be encrypted at rest (S3 supports server-side encryption using AES-256) and in transit (Terraform uses SSL to read and write data in S3).

#### Step 1.4 - Enable Locking for S3 Backend

The `s3` backend stores Terraform state as a given key in a given bucket on Amazon S3 to allow everyone working with a given collection of infrastructure the ability to access the same state data. In order to prevent concurrent modifications which could cause corruption, we need to implement locking on the backend. The `s3` backend supports state locking and consistency checking via Dynamo DB.

State locking for the `s3` backend can be enabled by setting the `dynamodb_table` field to an existing DynamoDB table name. A single DynamoDB table can be used to lock multiple remote state files.

Create a DynamoDB table





Database

# Amazon DynamoDB

A fast and flexible NoSQL database service for any scale

DynamoDB is a fully managed, key-value, and document database that delivers single-digit-millisecond performance at any scale.

**Get started**

Create a new table to start exploring DynamoDB.

[Create table](#)

**Pricing**

**Figure 4:** Create DynamoDB





## Create table

### Table details [Info](#)

DynamoDB is a schemaless database that requires only a table name and a primary key when you create the table.

#### Table name

This will be used to identify your table.

terraform-locks

Between 3 and 255 characters, containing only letters, numbers, underscores (`_`), hyphens (`-`), and periods (`.`).

#### Partition key

The partition key is part of the table's primary key. It is a hash value that is used to retrieve items from your table and allocate data across hosts for scalability and availability.

LockID

String

1 to 255 characters and case sensitive.

#### Sort key - optional

You can use a sort key as the second part of a table's primary key. The sort key allows you to sort or search among all items sharing the same partition key.

Enter the sort key name

String

1 to 255 characters and case sensitive.

## Settings

### ☒ Default settings

The fastest way to create your table. You can modify these settings now or after your table has been created.

### ☐ Customize settings

Use these advanced features to make DynamoDB work better for your needs.

Figure 5: Config DynamoDB

Tables (1) [Info](#)

Find tables by table name

Any table tag

Actions

Delete

Create table

< 1 >

<input type="checkbox"/>	Name	Status	Partition key	Sort key	Indexes	Read capacity mode	Write capacity mode	Encryption
<input type="checkbox"/>	terraform-locks	Active	LockID (String)	-	0	Provisioned with auto scaling (5)	Provisioned with auto scaling (5)	Default

Figure 6: DynamoDB Complete

Update the `s3` backend to use the new DynamoDB Table and reconfigure your backend.





```
terraform {  
  backend "s3" {  
    # Replace this with your bucket name!  
    bucket = "myterraformstate"  
    key    = "path/to/my/key"  
    region = "us-east-1"  
  
    # Replace this with your DynamoDB table name!  
    dynamodb_table = "terraform-locks"  
    encrypt         = true  
  }  
}
```

```
terraform init -reconfigure
```

Initializing the backend...

Successfully configured the backend "s3"! Terraform will automatically use **this** backend unless the backend configuration changes.

Update the size of your web server from `t2.small` to a `t2.micro` and apply the change.

```
resource "aws_instance" "web_server_2" {  
  ami           = data.aws_ami.ubuntu.id  
  instance_type = "t2.micro"  
  subnet_id     = aws_subnet.public_subnets["public_subnet_2"].id  
  tags = {  
    Name = "Web EC2 Server 2"  
  }  
}
```

```
terraform apply
```

Now you can see that your state file is locked by selecting the DynamoDB table and looking at [View Items](#) to see the lock.





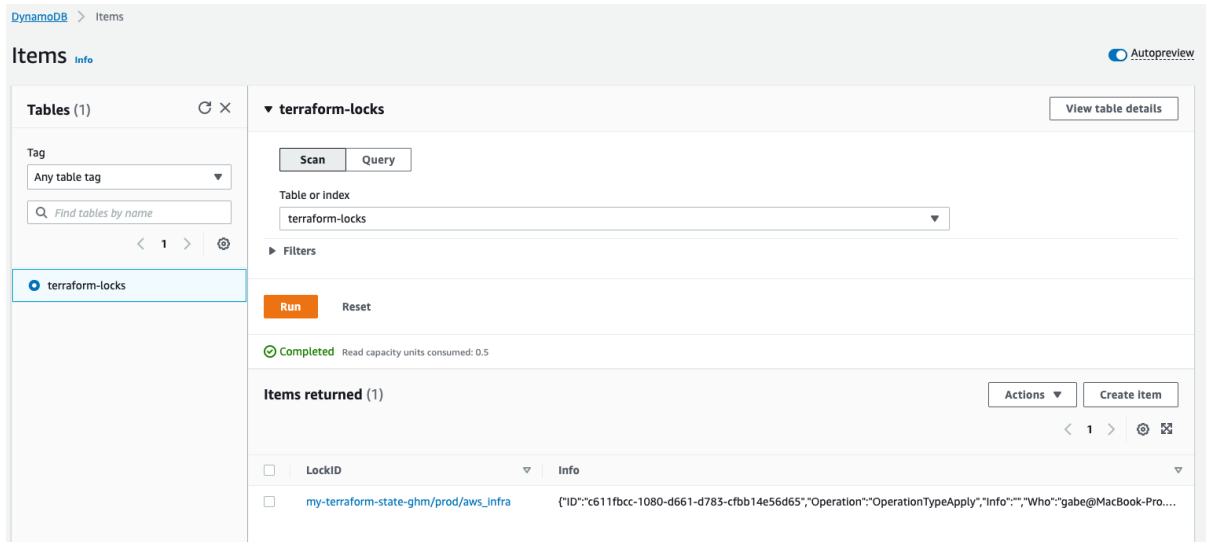


Figure 7: View Lock

### Step 1.4 - Remove existing resources with terraform destroy

Before exploring other types of state backends we will issue a cleanup of our infrastructure using a `terraform destroy` before changing our our backend in the next steps. This is not a requirement as Terraform supports the migration of state data between backends, which will be covered in a future lab.

```
terraform destroy
```

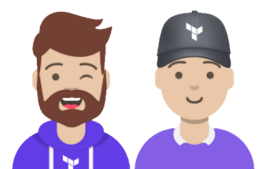
```
Plan: 0 to add, 0 to change, 27 to destroy.
```

```
Do you really want to destroy all resources?
```

```
Terraform will destroy all your managed infrastructure, as shown above.  
There is no undo. Only 'yes' will be accepted to confirm.
```

```
Enter a value: yes
```

Note: You delete any instances of the `terraform.tfstate` or `terraform.tfstate.backup` items locally as your state is now being managed remotely. Although not required with standard backends it is helpful to keep your working directory clean.





## Task 2: Standard Backend: HTTP Backend (Optional)

Let's take a look at a different standard Terraform backend type - [http](#). A configuration can only provide one backend block, so let's update our configuration to utilize the [http](#) backend instead of [s3](#).

To use this backend we will first need to provide an simple HTTP Server for which Terraform can store it's state. This lab is optional because not all students will be able to launch or have access to a HTTP server. This lab will use a simple Simple HTTP server that is being executed via python. The source code of this HTTP server is available for use.

### Step 2.1 - Initiate HTTP Server

Copy the HTTP Server code to a new directory (for example: [webserver](#)) and after following the instructions start the web server using the following command in a terminal:

```
cd webserver
python -m SimpleHTTPServer 8000
```

```
* Serving Flask app 'stateserver' (lazy loading)
* Environment: production
  WARNING: This is a development server. Do not use it in a production
  deployment.
  Use a production WSGI server instead.
* Debug mode: on
* Running on all addresses.
  WARNING: This is a development server. Do not use it in a production
  deployment.
* Running on http://192.168.1.202:5000/ (Press CTRL+C to quit)
* Restarting with stat
* Debugger is active!
* Debugger PIN: 158-806-515
```

### Step 2.2 - Update Terraform configuration to use HTTP Standard Backend

Update your Terraform configuration block to use the [http](#) backend pointing to the webserver that was just launched.

terraform.tf

```
terraform {
  backend "http" {
```





```
address      = "http://localhost:5000/terraform_state/my_state"
lock_address  = "http://localhost:5000/terraform_lock/my_state"
lock_method   = "PUT"
unlock_address = "http://localhost:5000/terraform_lock/my_state"
unlock_method = "DELETE"
}
```

Note: A Terraform configuration can only specify a single backend. If a backend is already configured be sure to replace it. Copy just the backend block above and not the full terraform block You can validate the syntax is correct by issuing a `terraform validate`

### Step 2.3 - Re-initialize Terraform and Validate HTTP Backend

```
terraform init -reconfigure
```

Initializing the backend...

Successfully configured the backend "http"! Terraform will automatically use **this** backend unless the backend configuration changes.

```
terraform apply
```

Plan: 27 to add, 0 to change, 0 to destroy.

Do you want to perform these actions?  
Terraform will perform the actions described above.  
Only 'yes' will be accepted to approve.

Enter a value: yes

...

Apply complete! Resources: 27 added, 0 changed, 0 destroyed.

View the HTTP Logs in the webserver terminal to showcase the use of the `http` backend

```
127.0.0.1 - - [] "GET /terraform_state/my_state HTTP/1.1" 404 -
[,636] DEBUG in stateserver: PUT for http://localhost:5000/terraform_lock/
my_state...
Header -- Host = localhost:5000
Header -- User-Agent = Go-http-client/1.1
Header -- Content-Length = 199
Header -- Content-Md5 = RLUK/ZscZNV/YNHQw0gyNw==
Header -- Content-Type = application/json
```





```
Header -- Accept-Encoding = gzip
Body -- {"ID":"12cae7fb-5f47-d751-8d8d-00ac15b25a00","Operation":"
        OperationTypeApply","Info":"","Who":"gabe@MacBook-Pro","Version":"
        1.0.10","Created":"06:47.629496Z","Path":""}

127.0.0.1 - - [] "POST /terraform_state/my_state?ID=12cae7fb-5f47-d751-8
        d8d-00ac15b25a00 HTTP/1.1" 200 -
[,998] DEBUG in stateserver: DELETE for http://localhost:5000/
        terraform_lock/my_state...
Header -- Host = localhost:5000
Header -- User-Agent = Go-http-client/1.1
Header -- Content-Length = 199
Header -- Content-Md5 = RlUK/ZscZNV/YNHQw0gyNw==
Header -- Content-Type = application/json
Header -- Accept-Encoding = gzip
Body -- {"ID":"12cae7fb-5f47-d751-8d8d-00ac15b25a00","Operation":"
        OperationTypeApply","Info":"","Who":"gabe@MacBook-Pro","Version":"
        1.0.10","Created":"06:47.629496Z","Path":""}
```

#### Step 2.4 - View the state, log and lock files.

You can view the remote state file in the `http` backend by going into the webserver directory and looking inside the `.stateserver` directory. Both the state file and the log are located in this directory. This backend also supports state locking creating a `my_state.lock` when a lock is applied.

```
webserver
|-- .stateserver
|   |-- my_state
|   |-- my_state.log
|-- requirements.txt
|-- stateserver.py
```

#### Step 2.5 - Remove existing resources with `terraform destroy`

Before exploring other backends we will issue a cleanup of our infrastructure using a `terraform destroy` before changing our our backend in the next steps. This is not a requirement as Terraform supports the migration of state data between backends, which will be covered in a future lab.

```
terraform destroy

Plan: 0 to add, 0 to change, 27 to destroy.
```





Do you really want to destroy all resources?  
Terraform will destroy all your managed infrastructure, as shown above.  
There is no undo. Only 'yes' will be accepted to confirm.

Enter a value: yes

Note: You delete any instances of the `terraform.tfstate` or `terraform.tfstate.backup` items locally as your state is now being managed remotely. Although not required with standard backends it is helpful to keep your working directory clean.

### Step 2.6 - Stop Web Server

Once all the cloud resources have been cleaned up you can stop the HTTP Server in the `webserver` directory.

