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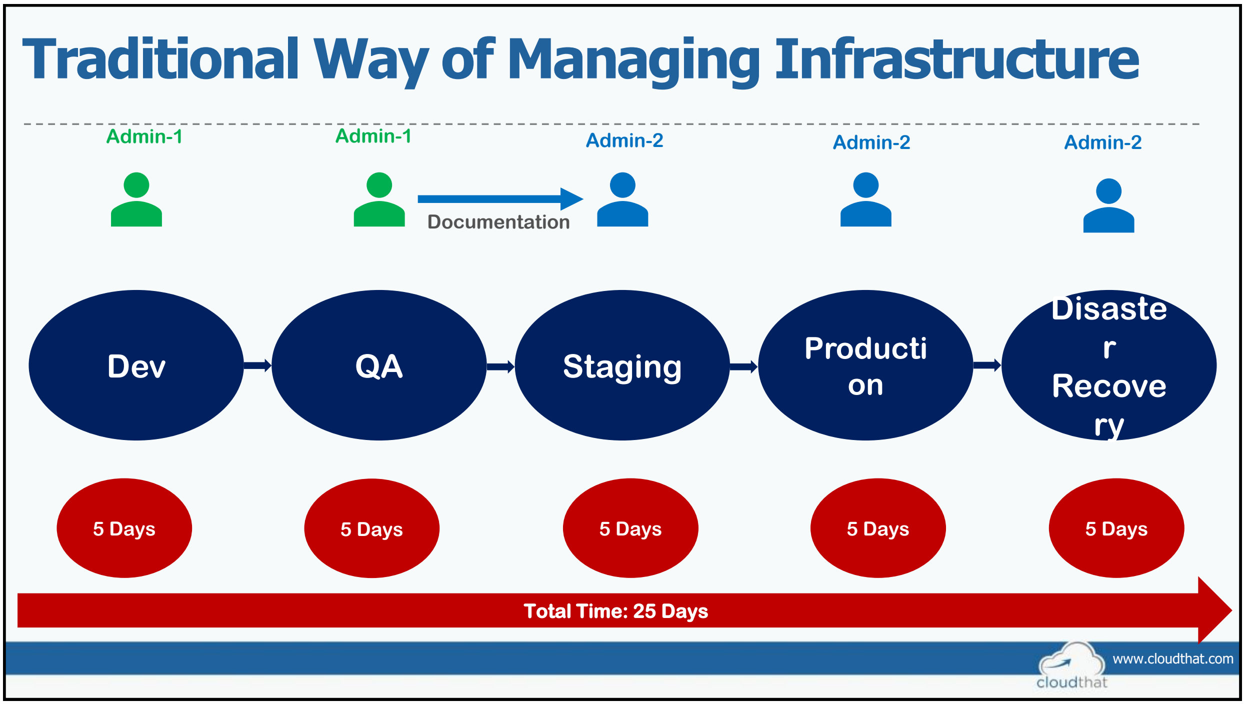
Terraform
Infrastructure as Code

1

What is Infrastructure as Code ?

2



Traditional Way of Managing Infrastructure

Admin-1 — Admin-1 → Documentation → Admin-2 — Admin-2 — Admin-2

Dev → QA → Staging → Production → Disaster Recovery

5 Days — 5 Days — 5 Days — 5 Days — 5 Days

Total Time: 25 Days

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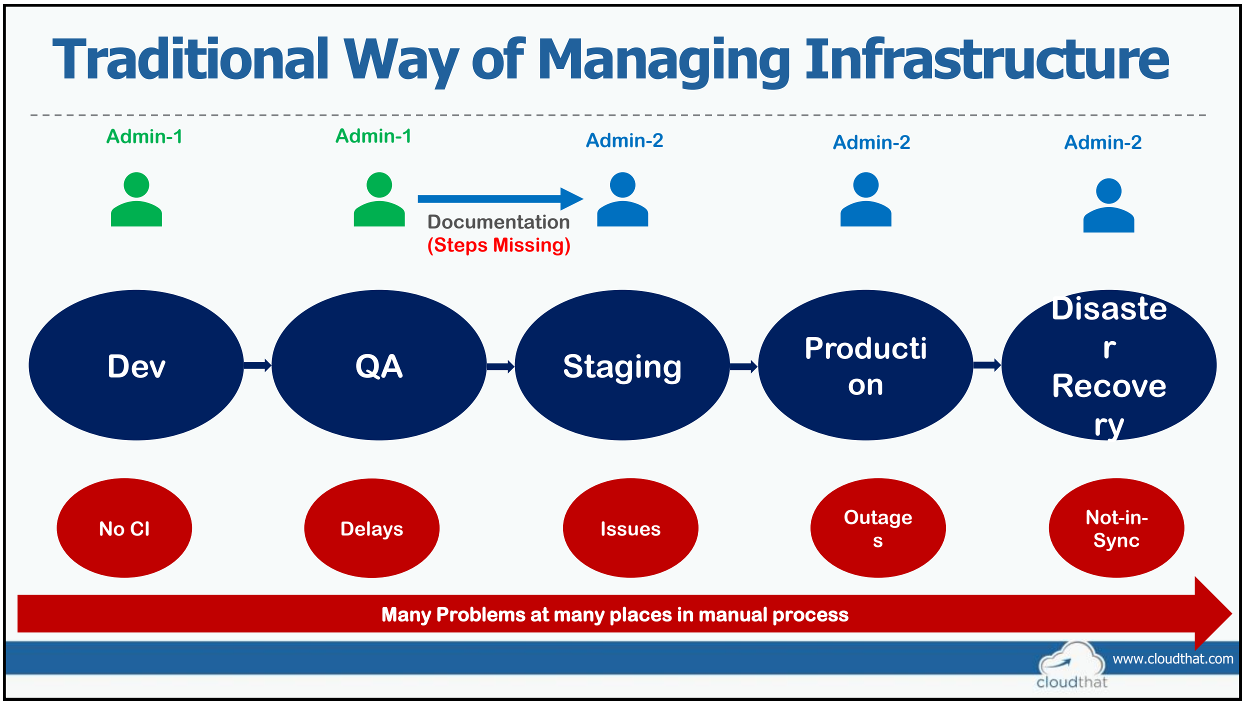

Traditional Way of Managing Infrastructure

Admin-1 — Admin-1 → Documentation (Steps Missing) → Admin-2 — Admin-2 — Admin-2

Dev → QA → Staging → Production → Disaster Recovery

No CI — Delays — Issues — Outages — Not-in-Sync

Many Problems at many places in manual process

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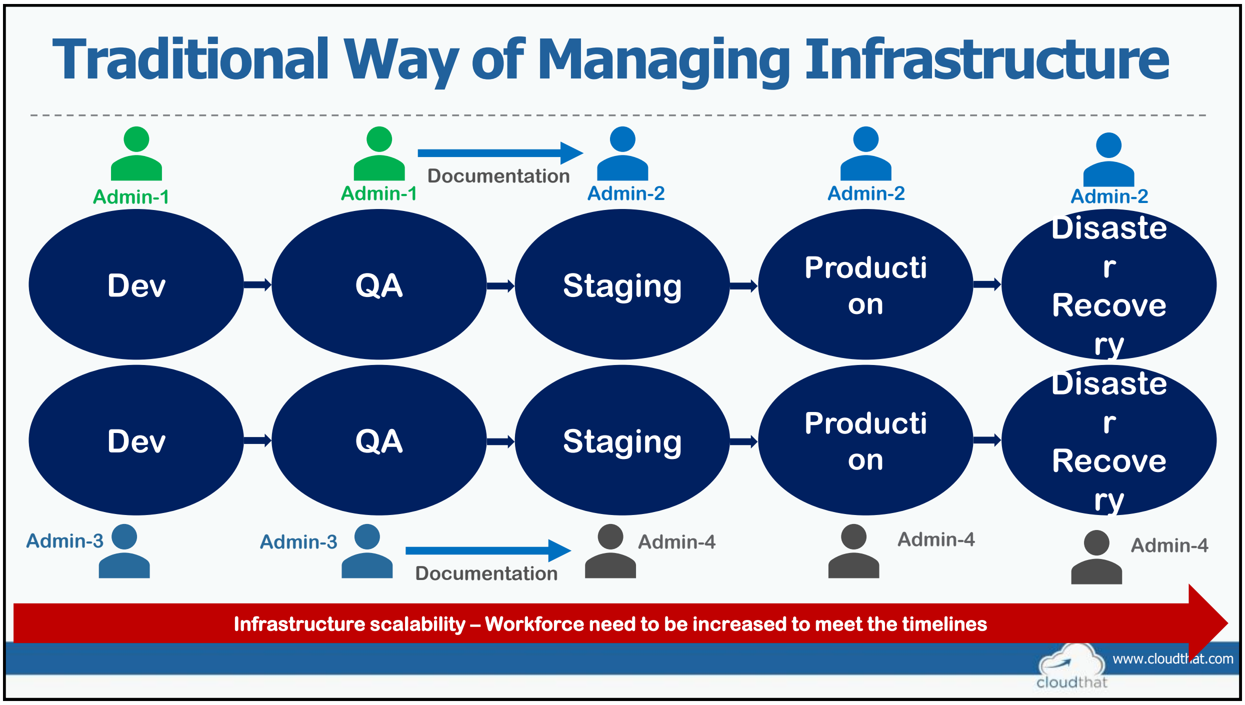

Traditional Way of Managing Infrastructure

Admin-1 Admin-1 Documentation Admin-2 Admin-2 Admin-2

Dev → QA → Staging → Production → Disaster Recovery

Dev → QA → Staging → Production → Disaster Recovery

Admin-3 Admin-3 Documentation Admin-4 Admin-4 Admin-4

Infrastructure scalability – Workforce need to be increased to meet the timelines

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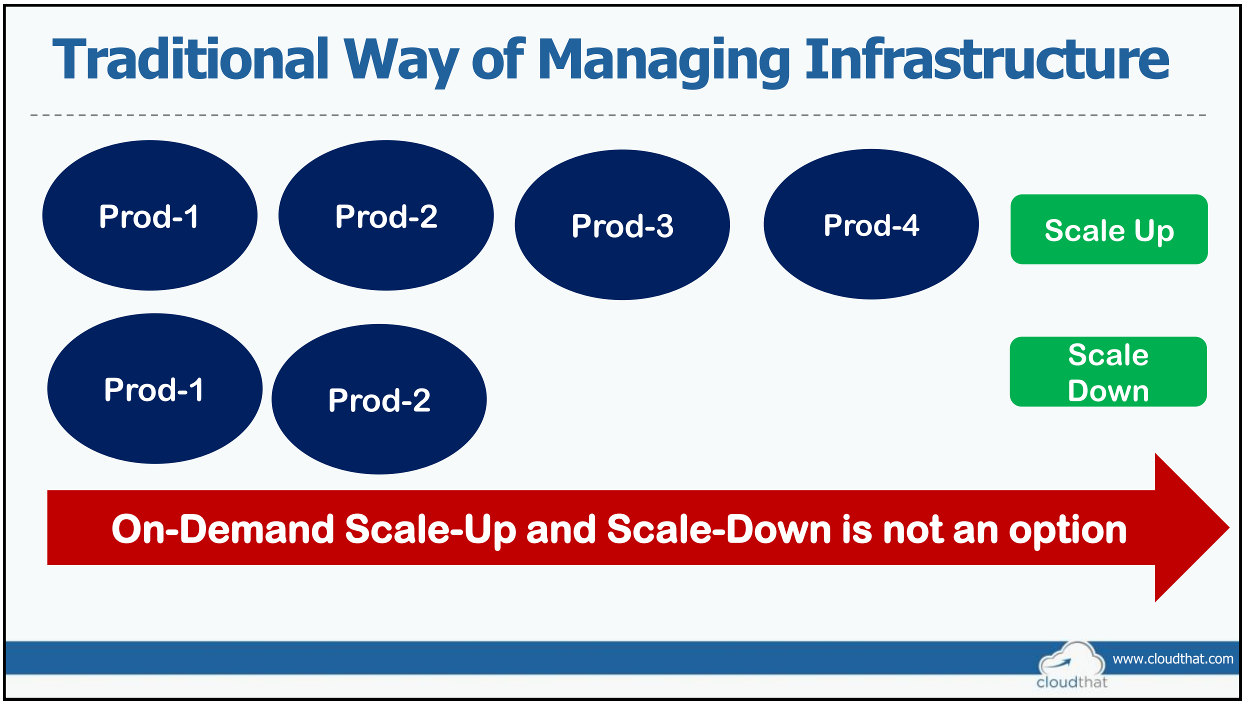

Traditional Way of Managing Infrastructure

Prod-1 Prod-2 Prod-3 Prod-4

Scale Up

Prod-1 Prod-2

Scale Down

On-Demand Scale-Up and Scale-Down is not an option

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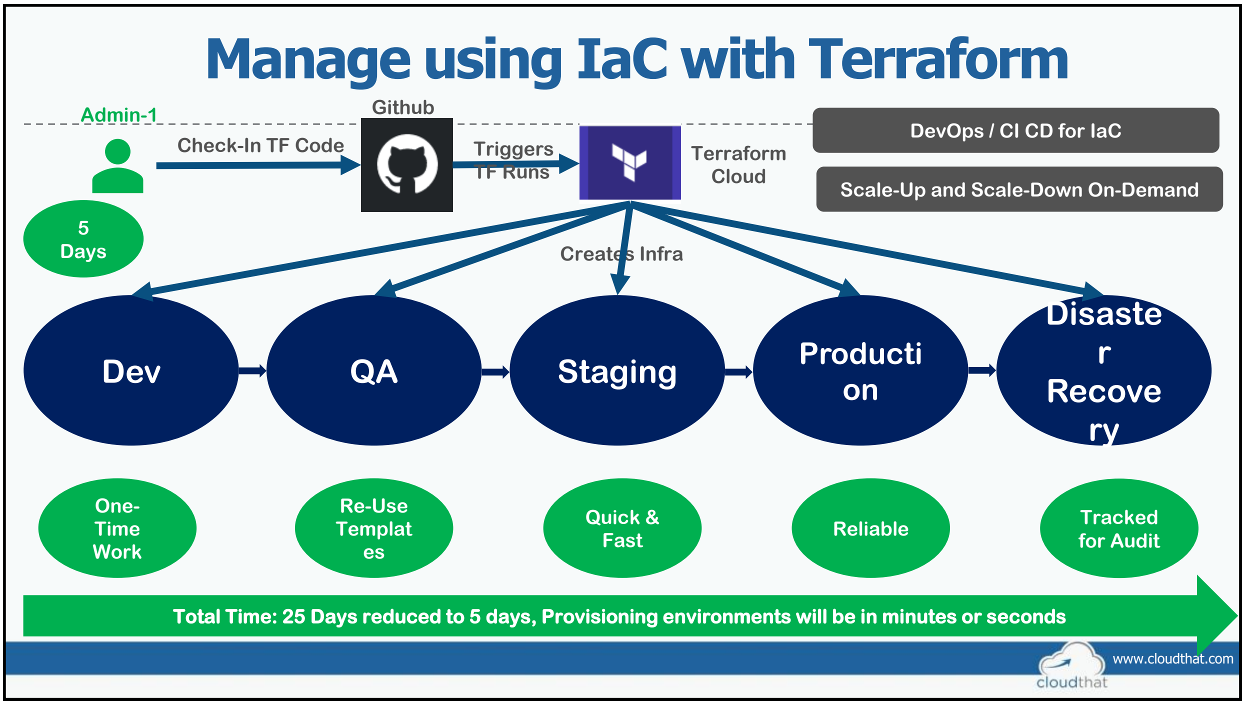

Manage using IaC with Terraform

Admin-1

5 Days

Check-In TF Code

Github

Triggers TF Runs

Terraform Cloud

DevOps / CI CD for IaC

Scale-Up and Scale-Down On-Demand

Creates Infra

Dev

QA

Staging

Production

Disaster Recovery

One-Time Work

Re-Use Templates

Quick & Fast

Reliable

Tracked for Audit

Total Time: 25 Days reduced to 5 days, Provisioning environments will be in minutes or seconds

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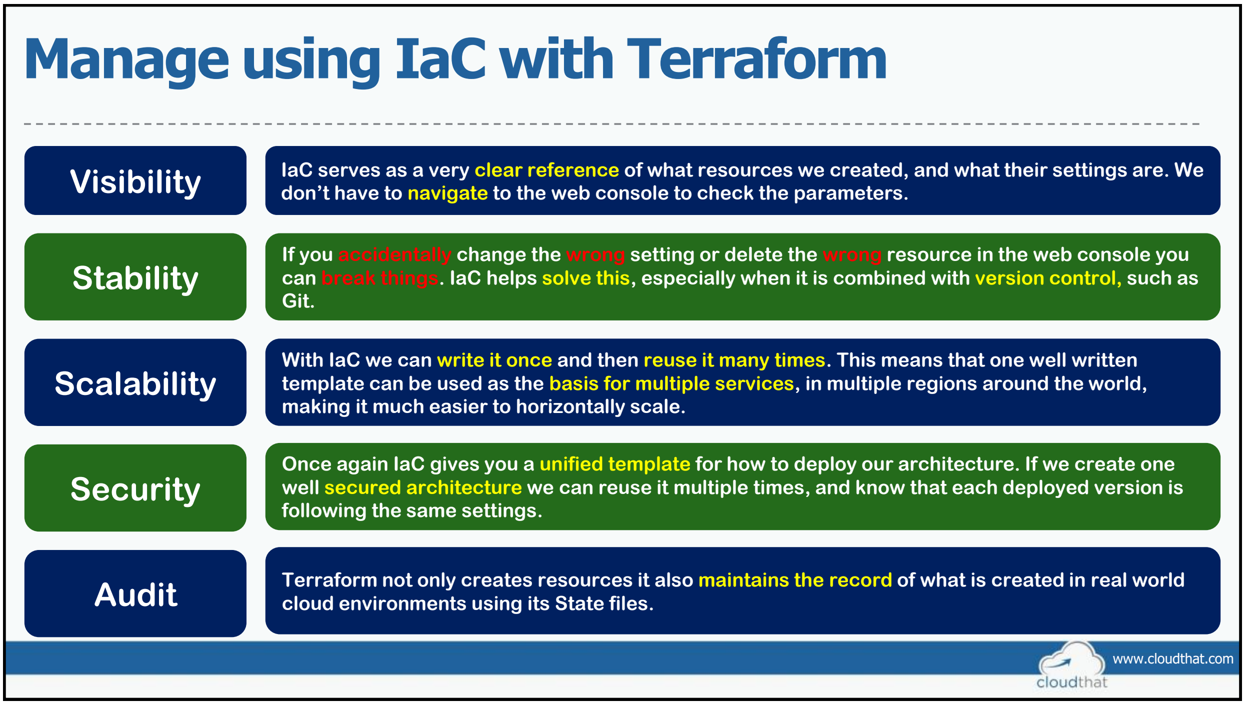

Manage using IaC with Terraform

Visibility — IaC serves as a very clear reference of what resources we created, and what their settings are. We don’t have to navigate to the web console to check the parameters.

Stability — If you accidentally change the wrong setting or delete the wrong resource in the web console you can break things. IaC helps solve this, especially when it is combined with version control, such as Git.

Scalability — With IaC we can write it once and then reuse it many times. This means that one well written template can be used as the basis for multiple services, in multiple regions around the world, making it much easier to horizontally scale.

Security — Once again IaC gives you a unified template for how to deploy our architecture. If we create one well secured architecture we can reuse it multiple times, and know that each deployed version is following the same settings.

Audit — Terraform not only creates resources it also maintains the record of what is created in real world cloud environments using its State files.

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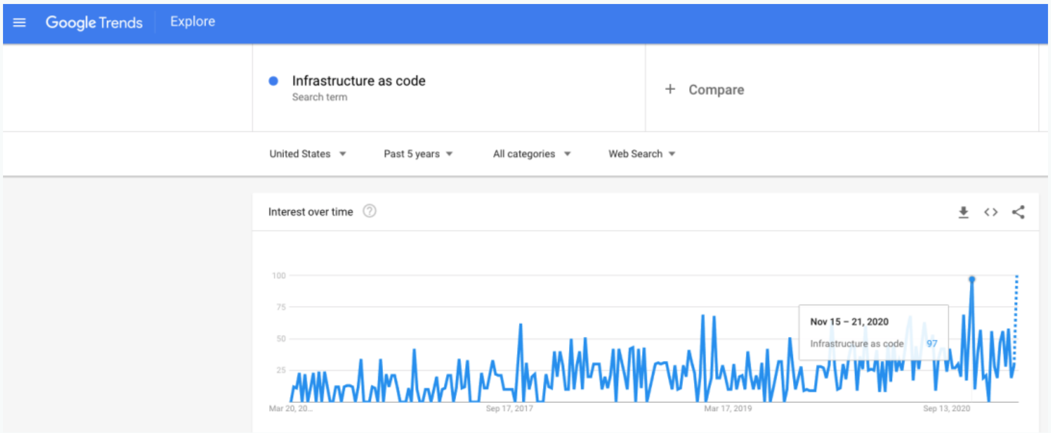
Google Trends – Past 5 Years



Google Trends Explore

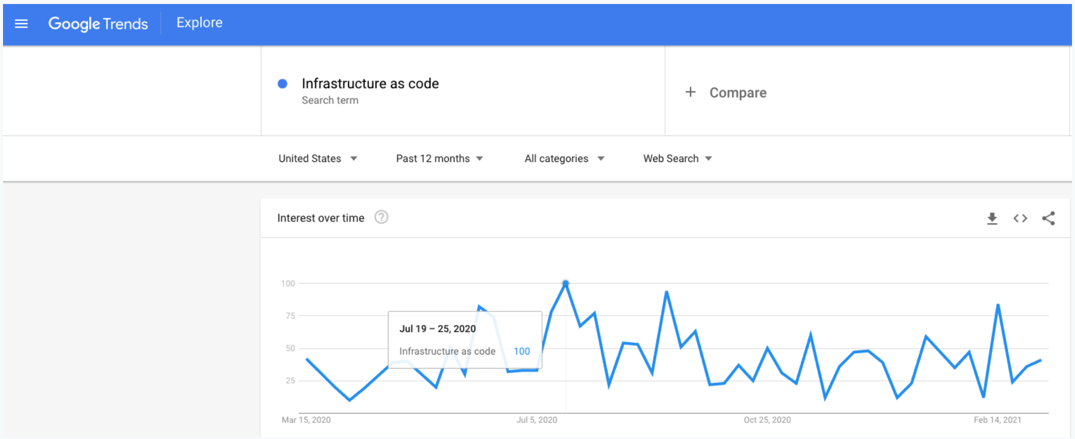
Infrastructure as code
Search term

+ Compare

United States ▾ Past 5 years ▾ All categories ▾ Web Search ▾

Interest over time

Google Trends – Past 1 Year



Google Trends Explore

Infrastructure as code
Search term

+ Compare

United States ▾ Past 12 months ▾ All categories ▾ Web Search ▾

Interest over time

Terraform Installation

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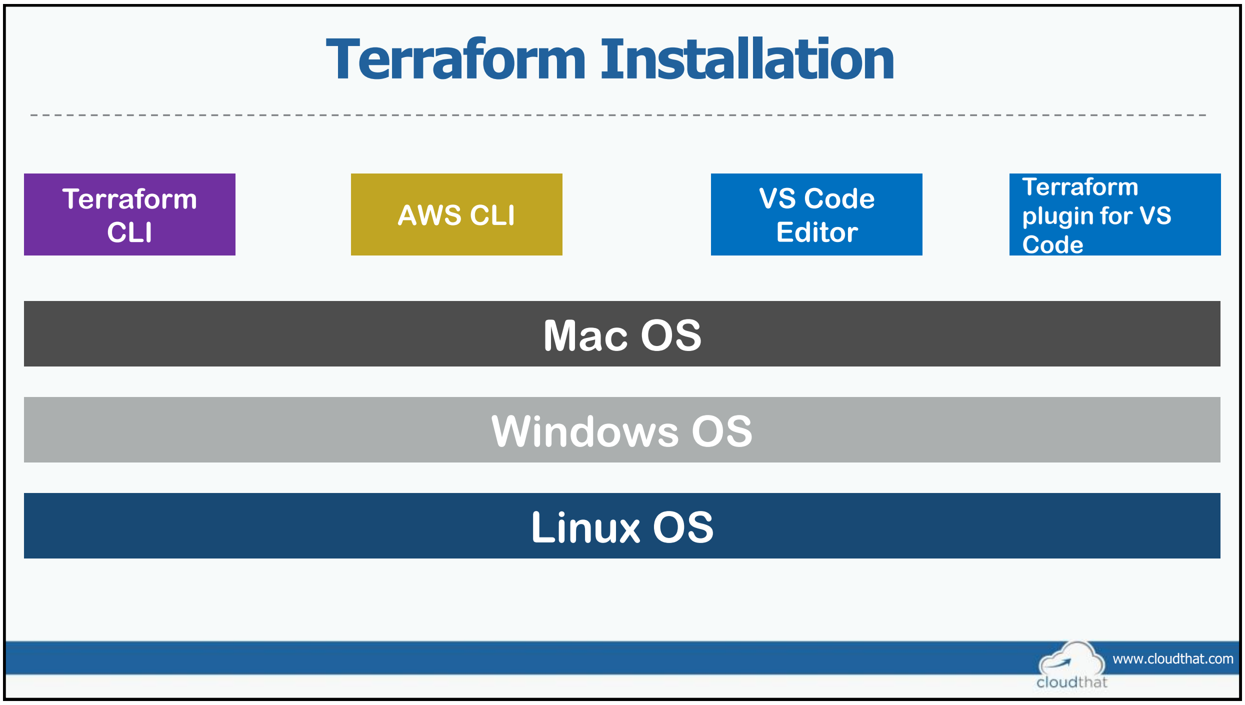

Terraform Installation

Terraform CLI

AWS CLI

VS Code Editor

Terraform plugin for VS Code

Mac OS

Windows OS

Linux OS

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Terraform Command Basics

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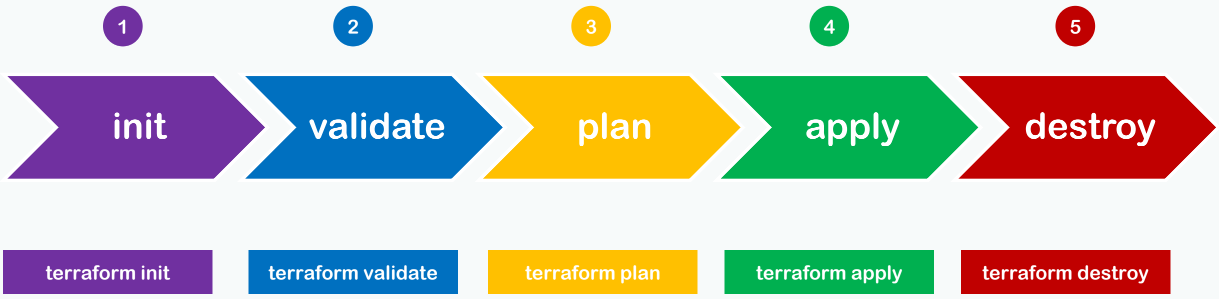
Terraform Workflow



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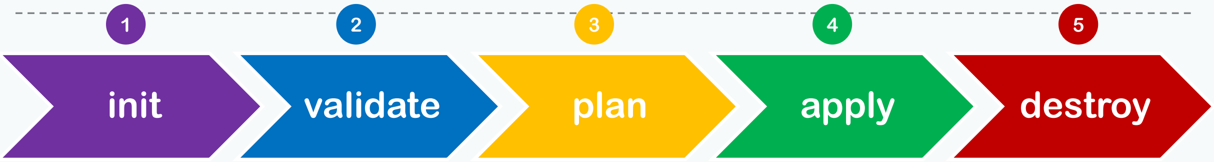
Terraform Workflow



init

- Used to Initialize a working directory containing terraform config files
- This is the first command that should be run after writing a new Terraform configuration
- Downloads Providers

validate

- Validates the terraform configurations files in that respective directory to ensure they are syntactically valid and internally consistent.

plan

- Creates an execution plan
- Terraform performs a refresh and determines what actions are necessary to achieve the desired state specified in configuration files

apply

- Used to apply the changes required to reach the desired state of the configuration.
- By default, apply sc ans the current directory for the configuration and applies the changes appropriately.

destroy

- Used to destroy the Terraform-managed infrastructure
- This will ask for confirmation before destroying.

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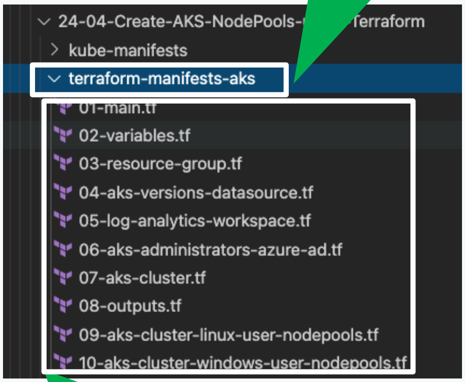
Terraform Language Basics

Terraform Language Basics – Files

- Code in the Terraform language is stored in plain text files with the .tf file extension.
- There is also a JSON-based variant of the language that is named with the .tf.json file extension.
- We can call the files containing terraform code as Terraform Configuration Files or Terraform Manifests

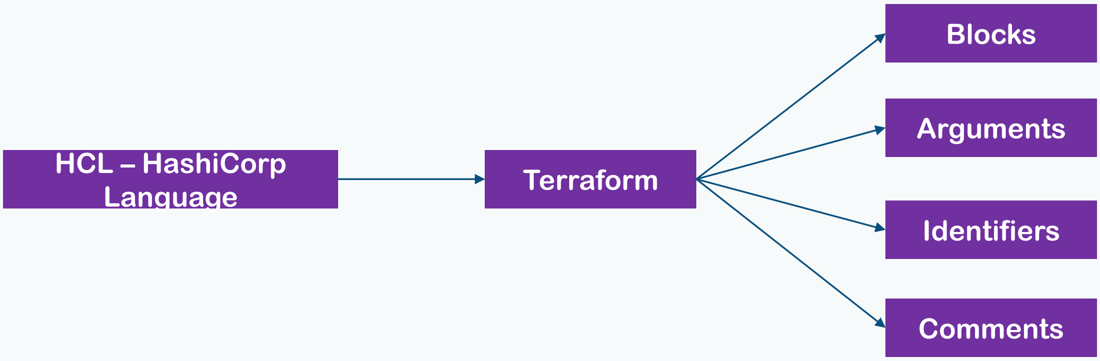
Terraform Working Directory



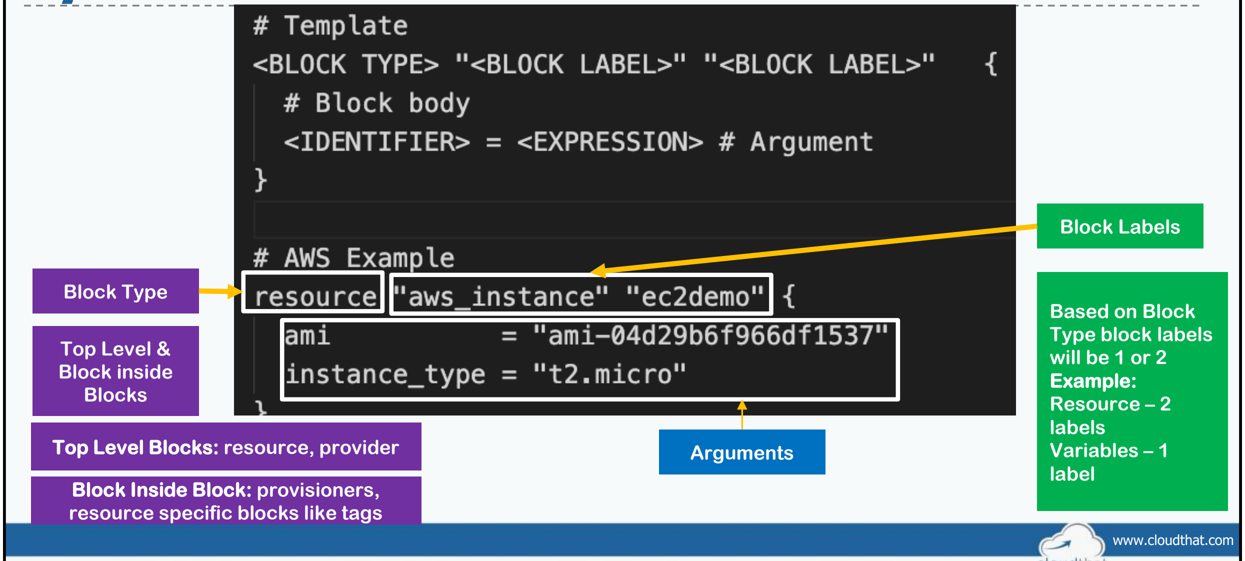
```
24-04-Create-AKS-NodePools-     Terraform
  kube-manifests
  terraform-manifests-aks
    01-main.tf
    02-variables.tf
    03-resource-group.tf
    04-aks-versions-datasource.tf
    05-log-analytics-workspace.tf
    06-aks-administrators-azure-ad.tf
    07-aks-cluster.tf
    08-outputs.tf
    09-aks-cluster-linux-user-nodepools.tf
    10-aks-cluster-windows-user-nodepools.tf
```

Terraform Configuration Files ending with .tf as extension

Terraform Language Basics – Configuration Syntax



Terraform Language Basics – Configuration Syntax



```
# Template
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>"   {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}

# AWS Example
resource "aws_instance" "ec2demo" {
  ami           = "ami-04d29b6f966df1537"
  instance_type = "t2.micro"
}
```

Block Type

Top Level & Block inside Blocks

Top Level Blocks: resource, provider

Block Inside Block: provisioners, resource specific blocks like tags

Arguments

Block Labels

Based on Block Type block labels will be 1 or 2
Example:
Resource – 2 labels
Variables – 1 label

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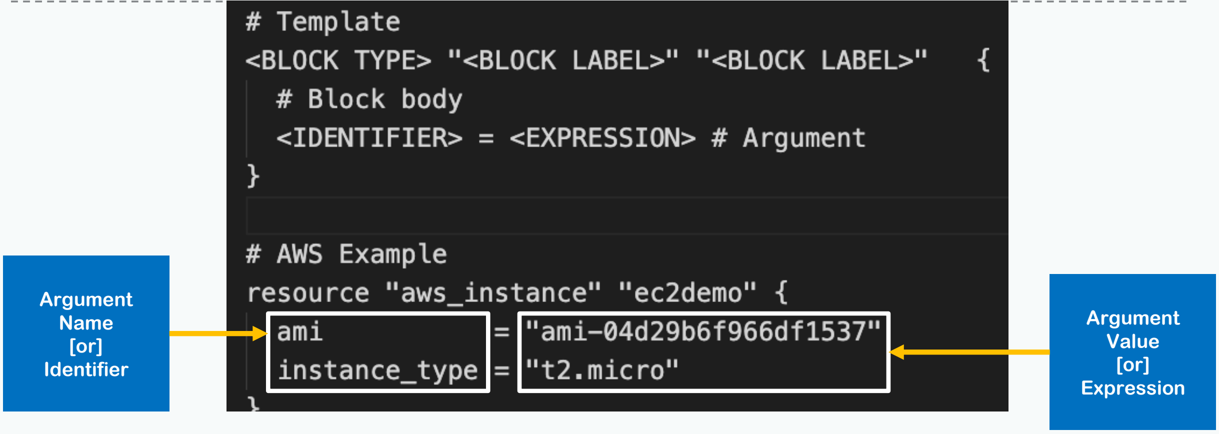
Terraform Language Basics – Configuration Syntax



```
# Template
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>"   {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}

# AWS Example
resource "aws_instance" "ec2demo" {
  ami           = "ami-04d29b6f966df1537"
  instance_type = "t2.micro"
}
```

Argument Name [or] Identifier

Argument Value [or] Expression

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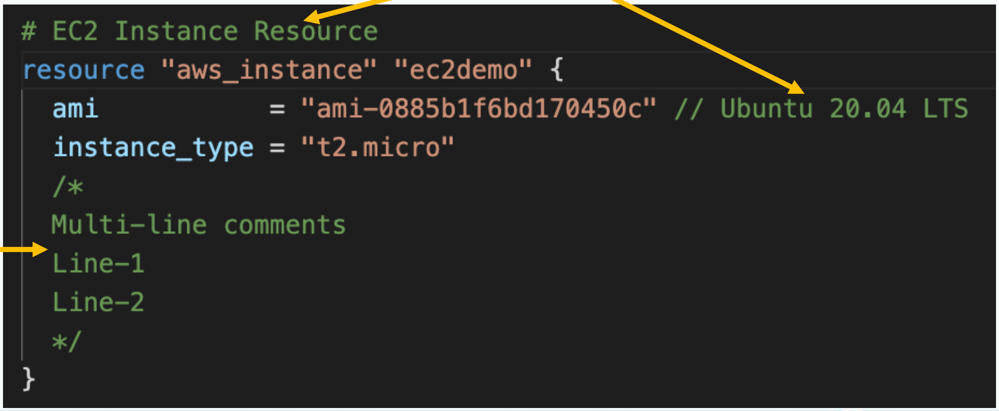
Terraform Language Basics – Configuration Syntax

Single Line Comments with # or //

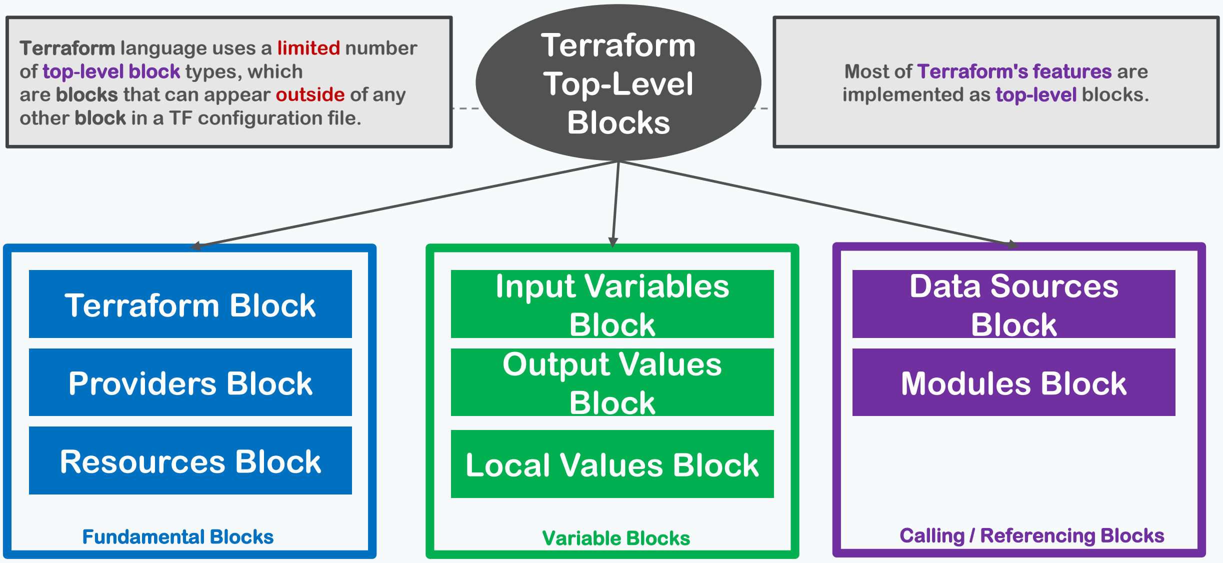
Multi-line comment



```
# EC2 Instance Resource
resource "aws_instance" "ec2demo" {
  ami           = "ami-0885b1f6bd170450c" // Ubuntu 20.04 LTS
  instance_type = "t2.micro"
  /*
  Multi-line comments
  Line-1
  Line-2
  */
}
```

Terraform language uses a **limited** number of **top-level block** types, which are **blocks** that can appear **outside** of any other **block** in a TF configuration file.

Most of **Terraform's features** are implemented as **top-level** blocks.



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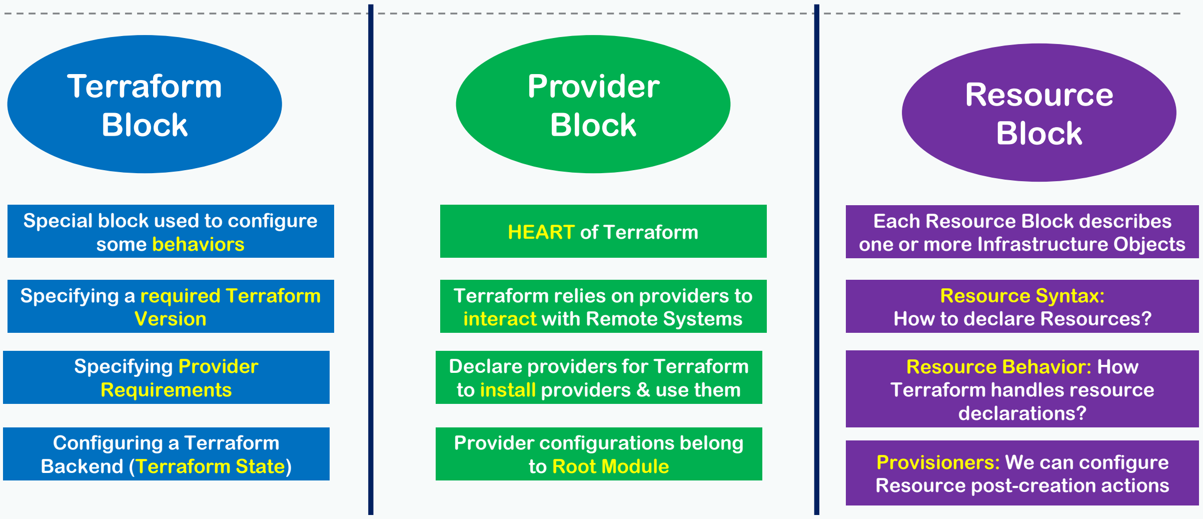
Terraform Fundamental Blocks

Terraform Basic Blocks



Terraform Block

- Special block used to configure some behaviors
- Specifying a required Terraform Version
- Specifying Provider Requirements
- Configuring a Terraform Backend (Terraform State)

Provider Block

- HEART of Terraform
- Terraform relies on providers to interact with Remote Systems
- Declare providers for Terraform to install providers & use them
- Provider configurations belong to Root Module

Resource Block

- Each Resource Block describes one or more Infrastructure Objects
- Resource Syntax: How to declare Resources?
- Resource Behavior: How Terraform handles resource declarations?
- Provisioners: We can configure Resource post-creation actions

Terraform Block

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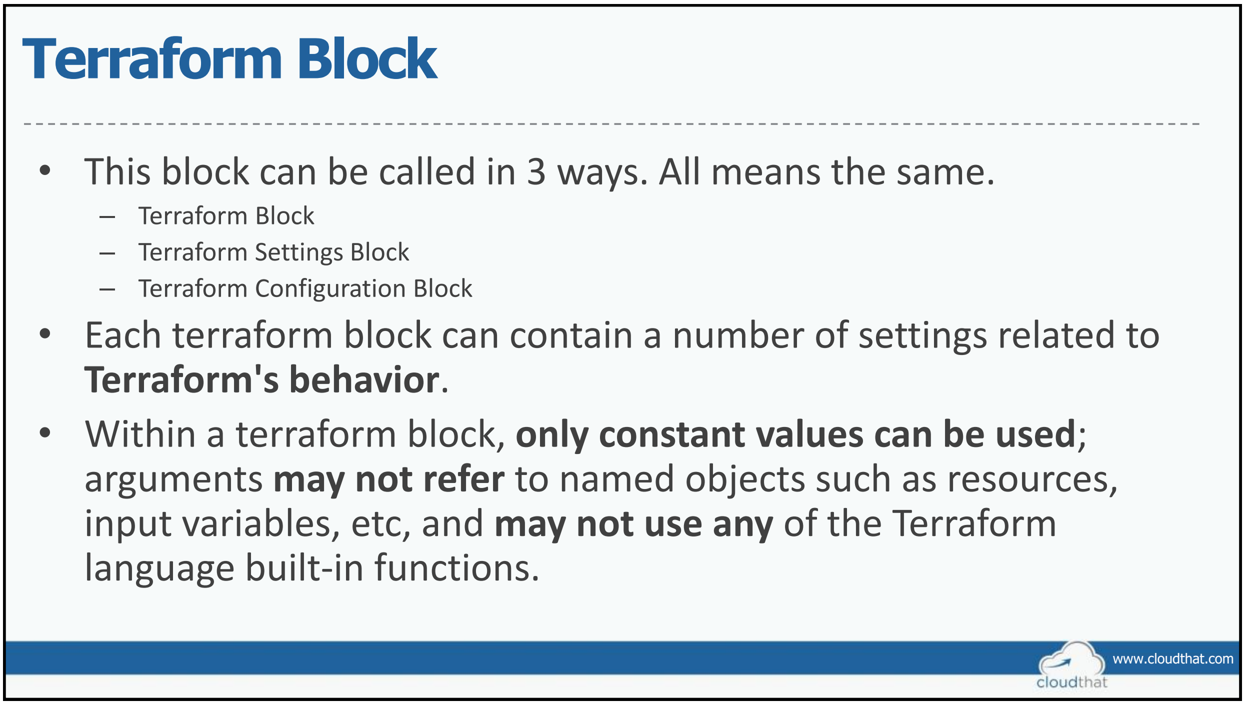

Terraform Block

- This block can be called in 3 ways. All means the same.
  - Terraform Block
  - Terraform Settings Block
  - Terraform Configuration Block
- Each terraform block can contain a number of settings related to **Terraform's behavior**.
- Within a terraform block, **only constant values can be used**; arguments **may not refer** to named objects such as resources, input variables, etc, and **may not use any** of the Terraform language built-in functions.

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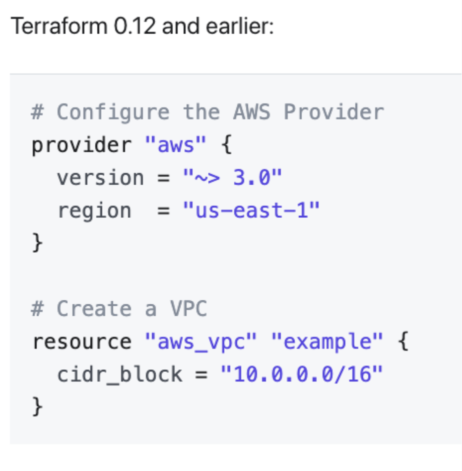
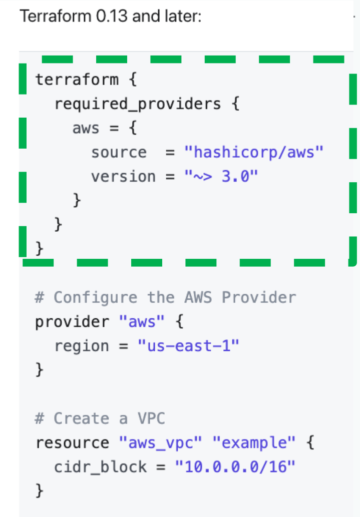
Terraform Block from 0.13 onwards



Terraform 0.12 and earlier:

```
# Configure the AWS Provider
provider "aws" {
  version = "~> 3.0"
  region  = "us-east-1"
}

# Create a VPC
resource "aws_vpc" "example" {
  cidr_block = "10.0.0.0/16"
}
```



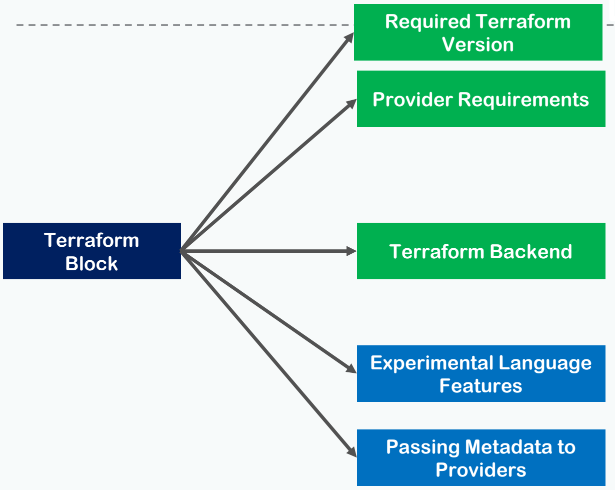
Terraform 0.13 and later:

```
terraform {
  required_providers {
    aws = {
      source  = "hashicorp/aws"
      version = "~> 3.0"
    }
  }
}

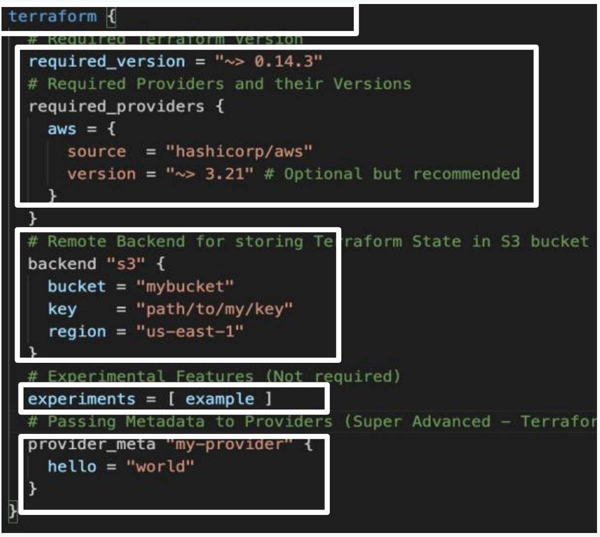
# Configure the AWS Provider
provider "aws" {
  region = "us-east-1"
}

# Create a VPC
resource "aws_vpc" "example" {
  cidr_block = "10.0.0.0/16"
}
```

Terraform Block



Terraform Block
Required Terraform Version
Provider Requirements
Terraform Backend
Experimental Language Features
Passing Metadata to Providers



```
terraform {
  # Required Terraform Version
  required_version = "~> 0.14.3"
  # Required Providers and their Versions
  required_providers {
    aws = {
      source  = "hashicorp/aws"
      version = "~> 3.21" # Optional but recommended
    }
  }
  # Remote Backend for storing Terraform State in S3 bucket
  backend "s3" {
    bucket = "mybucket"
    key    = "path/to/my/key"
    region = "us-east-1"
  }
  # Experimental Features (Not required)
  experiments = [ example ]
  # Passing Metadata to Providers (Super Advanced - Terrafor
  provider_meta "my-provider" {
    hello = "world"
  }
}
```

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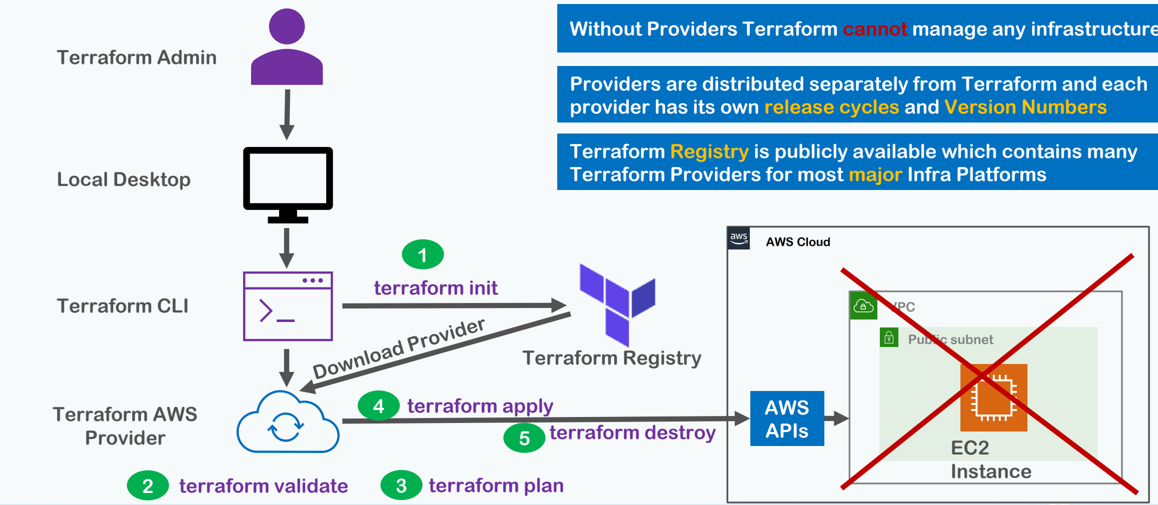
Terraform Providers

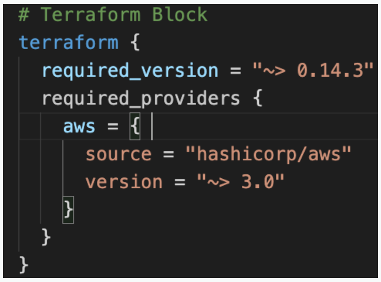
Terraform Providers

- Providers are HEART of Terraform
- Every Resource Type (example: EC2 Instance), is implemented by a Provider
- Without Providers Terraform cannot manage any infrastructure.
- Providers are distributed separately from Terraform and each provider has its own release cycles and Version Numbers
- Terraform Registry is publicly available which contains many Terraform Providers for most major Infra Platforms



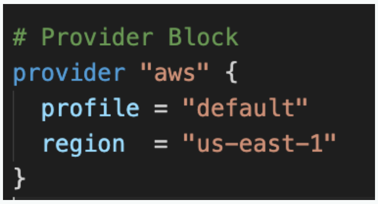
Terraform Providers

Provider Requirements



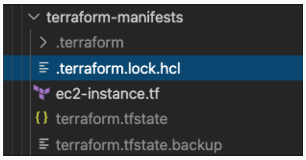
```
# Terraform Block
terraform {
  required_version = "~> 0.14.3"
  required_providers {
    aws = {
      source = "hashicorp/aws"
      version = "~> 3.0"
    }
  }
}
```

Provider Configuration

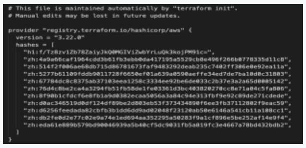


```
# Provider Block
provider "aws" {
  profile = "default"
  region  = "us-east-1"
}
```

Dependency Lock File



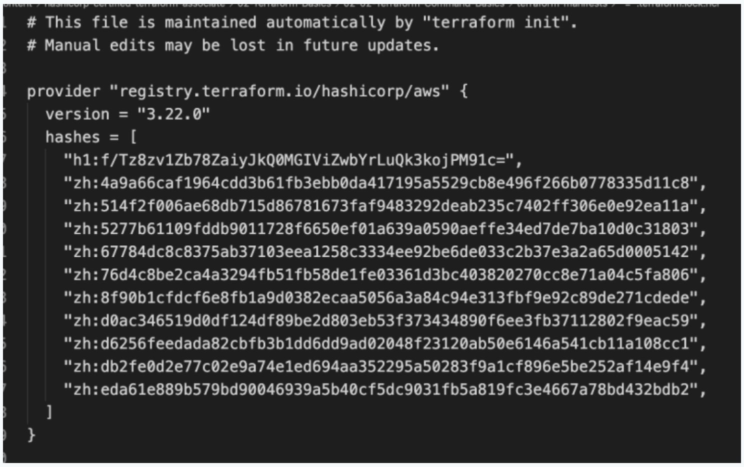
```
terraform-manifests
  .terraform
  .terraform.lock.hcl
  ec2-instance.tf
  terraform.tfstate
  terraform.tfstate.backup
```



```
# This file is maintained automatically by "terraform init".
# Manual edits may be lost in future updates.

provider "registry.terraform.io/hashicorp/aws" {
  version = "3.22.0"
  hashes = [
    "h1:f/Tz8zv1Zb78ZaiyJkQ0MGIViZwbYrLuQk3kojPM91c=",
    "zh:4a9a66caf1964cdd3b61fb3ebb0da417195a5529cb8e496f266b0778335d11c8",
    "zh:514f2f006ae68db715d86781673faf9483292deab235c7402ff306e0e92ea11a",
    "zh:5277b61109fddb9011728f6650ef01a639a0590aeffe34ed7de7ba10d0c31803",
    "zh:67784dc8c8375ab37103eea1258c3334ee92be6de033c2b37e3a2a65d0005142",
    "zh:76d4c8be2ca4a3294fb51fb58de1fe03361d3bc403820270cc8e71a04c5fa806",
    "zh:8f90b1cfdcf6e8fb1a9d0382ecaa5056a3a84c94e313fbf9e92c89de271cdede",
    "zh:d0ac346519d0df124df89be2d803eb53f373434890f6ee3fb37112802f9eac59",
    "zh:d6256feedada82cbfb3b1dd6dd9ad02048f23120ab50e6146a541cb11a108cc1",
    "zh:db2fe0d2e77c02e9a74e1ed694aa352295a50283f9a1cf896e5be252af14e9f4",
    "zh:eda61e889b579bd90046939a5b40cf5dc9031fb5a819fc3e4667a78bd432bdb2",
  ]
}
```

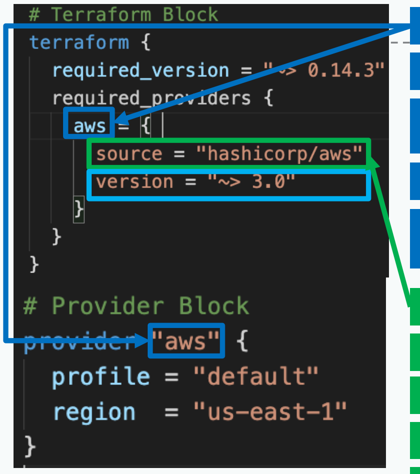
Dependency Lock File



```
# This file is maintained automatically by "terraform init".
# Manual edits may be lost in future updates.

provider "registry.terraform.io/hashicorp/aws" {
  version = "3.22.0"
  hashes = [
    "h1:f/Tz8zv1Zb78ZaiyJkQ0MGIViZwbYrLuQk3kojPM91c=",
    "zh:4a9a66caf1964cdd3b61fb3ebb0da417195a5529cb8e496f266b0778335d11c8",
    "zh:514f2f006ae68db715d86781673faf9483292deab235c7402ff306e0e92ea11a",
    "zh:5277b61109fddb9011728f6650ef01a639a0590aeffe34ed7de7ba10d0c31803",
    "zh:67784dc8c8375ab37103eea1258c3334ee92be6de033c2b37e3a2a65d0005142",
    "zh:76d4c8be2ca4a3294fb51fb58de1fe03361d3bc403820270cc8e71a04c5fa806",
    "zh:8f90b1cfdcf6e8fb1a9d0382ecaa5056a3a84c94e313fbf9e92c89de271cdede",
    "zh:d0ac346519d0df124df89be2d803eb53f373434890f6ee3fb37112802f9eac59",
    "zh:d6256feedada82cbfb3b1dd6dd9ad02048f23120ab50e6146a541cb11a108cc1",
    "zh:db2fe0d2e77c02e9a74e1ed694aa352295a50283f9a1cf896e5be252af14e9f4",
    "zh:eda61e889b579bd90046939a5b40cf5dc9031fb5a819fc3e4667a78bd432bdb2",
  ]
}
```

Required Providers



```
# Terraform Block
terraform {
  required_version = "~> 0.14.3"
  required_providers {
    aws = {
      source = "hashicorp/aws"
      version = "~> 3.0"
    }
  }
}

# Provider Block
provider "aws" {
  profile = "default"
  region  = "us-east-1"
}
```

Local Names

Local Names are Module specific and should be unique per-module

Terraform configurations always refer to local name of provider outside required_provider block

Users of a provider can choose any local name for it (myaws, aws1, aws2).

Recommended way of choosing local name is to use preferred local name of that provider (For AWS Provider: hashicorp/aws, preferred local name is aws)

Source

It is the primary location where we can download the Terraform Provider

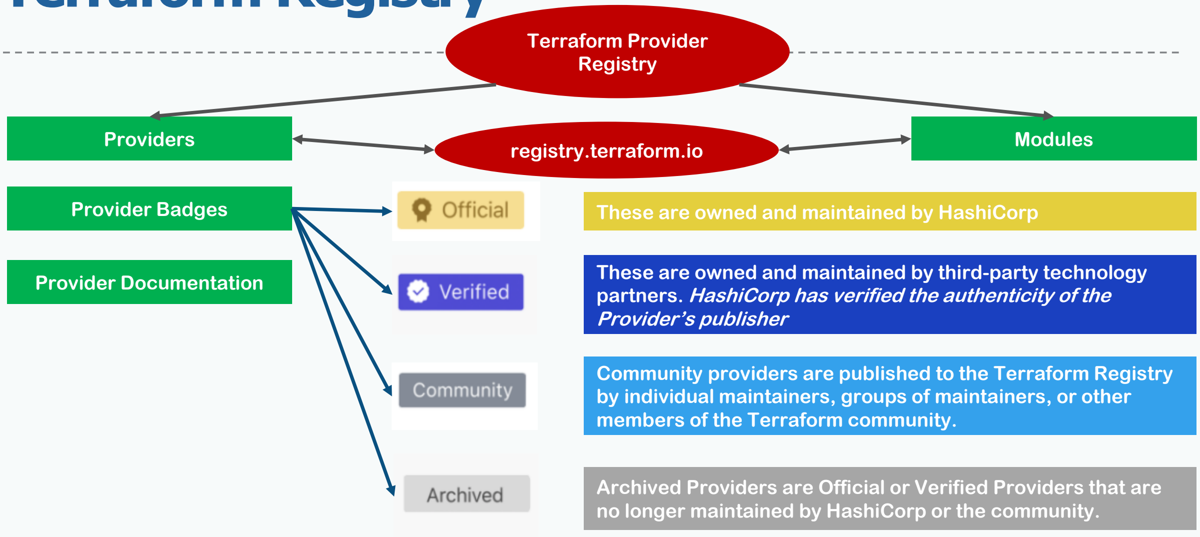
Source addresses consist of three parts delimited by slashes (/)

[<HOSTNAME>/]<NAMESPACE>/<TYPE>

registry.terraform.io/hashicorp/aws

Registry Name is optional as default is going to be Terraform Public Registry

Terraform Registry



Terraform Provider Registry

Providers

registry.terraform.io

Modules

Provider Badges

Provider Documentation

Official — These are owned and maintained by HashiCorp

Verified — These are owned and maintained by third-party technology partners. *HashiCorp has verified the authenticity of the Provider's publisher*

Community — Community providers are published to the Terraform Registry by individual maintainers, groups of maintainers, or other members of the Terraform community.

Archived — Archived Providers are Official or Verified Providers that are no longer maintained by HashiCorp or the community.

Terraform Multiple Providers

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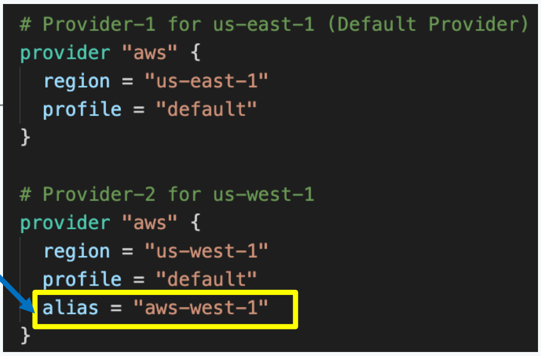
Multiple Providers

We can define **multiple** configurations for the **same provider**, and select which one to use on a **per-resource** or **per-module** basis.

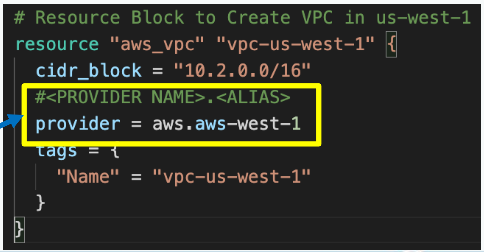
The primary reason for this is to **support multiple regions** for a **cloud** platform

We can **use** the alternate provider in a resource, data or module by referencing it as **<PROVIDER NAME>.<ALIAS>**



```
# Provider-1 for us-east-1 (Default Provider)
provider "aws" {
  region = "us-east-1"
  profile = "default"
}

# Provider-2 for us-west-1
provider "aws" {
  region = "us-west-1"
  profile = "default"
  alias = "aws-west-1"
}
```



```
# Resource Block to Create VPC in us-west-1
resource "aws_vpc" "vpc-us-west-1" {
  cidr_block = "10.2.0.0/16"
  #<PROVIDER NAME>.<ALIAS>
  provider = aws.aws-west-1
  tags = {
    "Name" = "vpc-us-west-1"
  }
}
```

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Terraform Dependency Lock File

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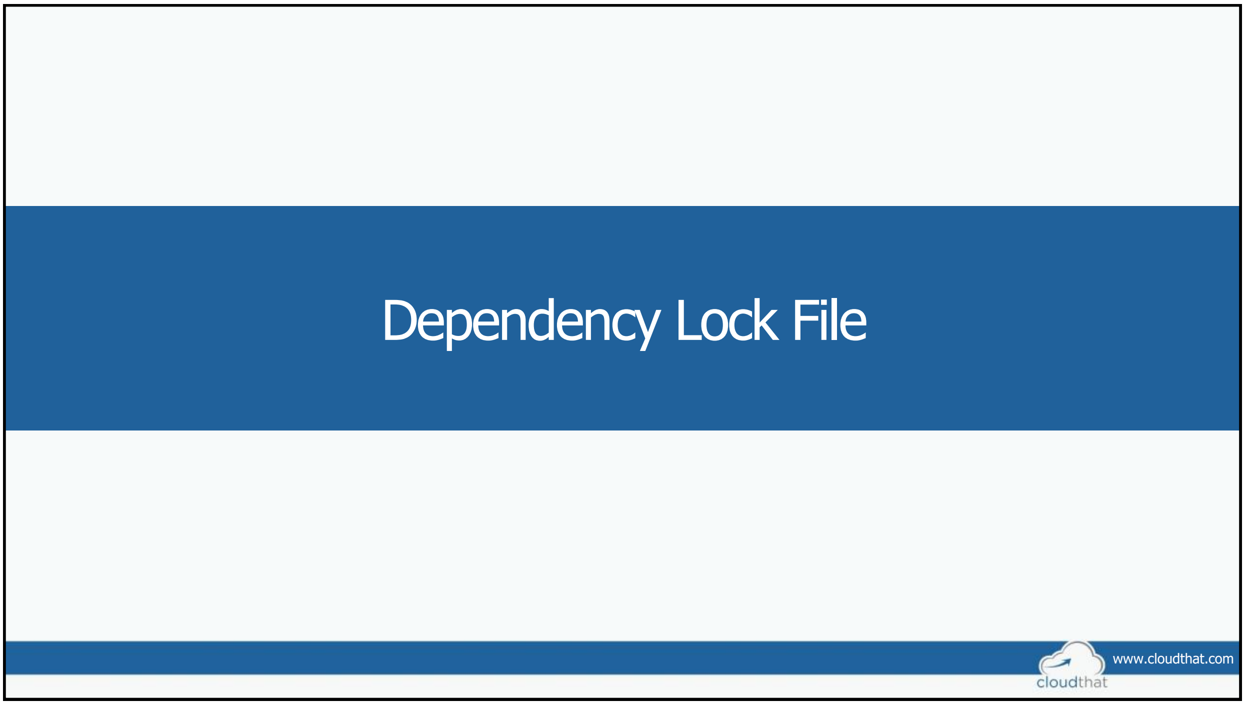

Dependency Lock File

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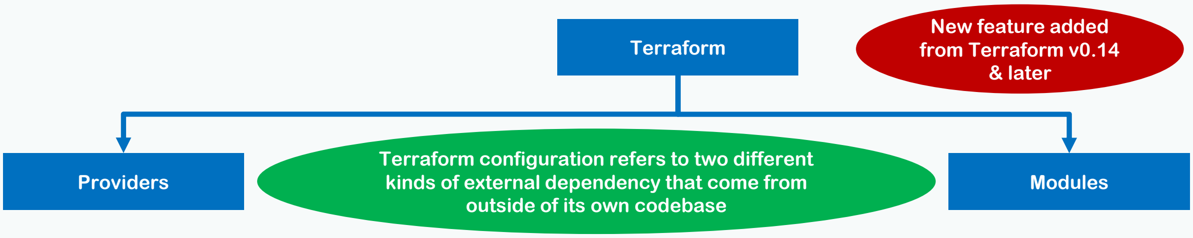


Terraform

New feature added from Terraform v0.14 & later

Providers

Terraform configuration refers to two different kinds of external dependency that come from outside of its own codebase

Modules

Version Constraints within the configuration itself determine which versions of dependencies are *potentially* compatible

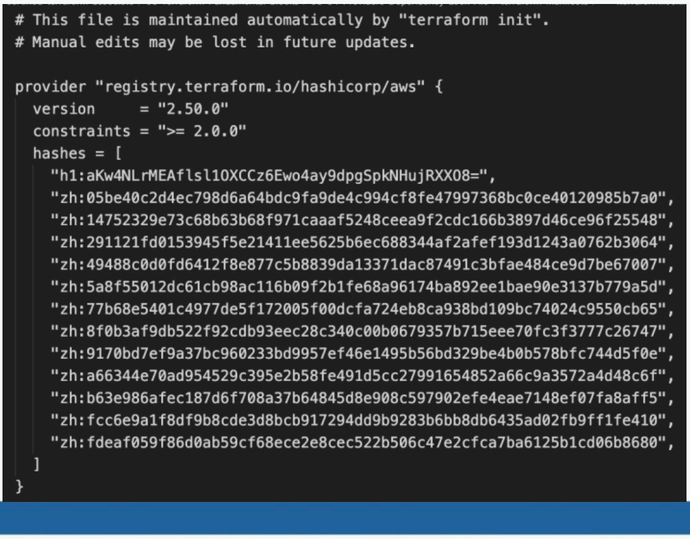
Dependency Lock File: After selecting a specific version of each dependency using Version Constraints Terraform remembers the decisions it made in a dependency lock file so that it can (by default) make the same decisions again in future.

Location of Lock File: Current Working Directory

Very Important: Lock File currently tracks only Provider Dependencies. For modules continue to use exact version constraint to ensure that Terraform will always select the same module version.

Checksum Verification: Terraform will also verify that each package it installs matches at least one of the checksums it previously recorded in the lock file, if any, returning an error if none of the checksums match

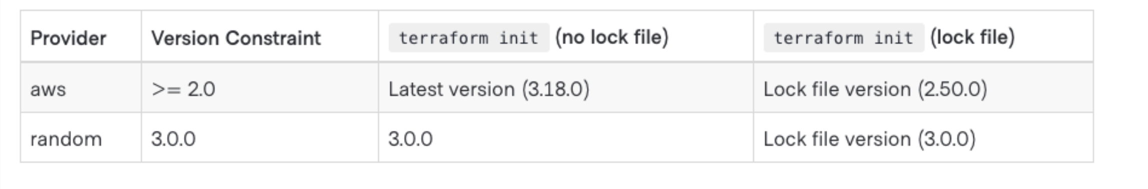
Dependency Lock File



```
# This file is maintained automatically by "terraform init".
# Manual edits may be lost in future updates.

provider "registry.terraform.io/hashicorp/aws" {
  version     = "2.50.0"
  constraints = ">= 2.0.0"
  hashes = [
    "h1:aKw4NLrMEAflsl1OXCCz6Ewo4ay9dpgSpkNHujRXXO8=",
    "zh:05be40c2d4ec798d6a64bdc9fa9de4c994cf8fe47997368bc0ce40120985b7a0",
    "zh:14752329e73c68b63b68f971caaaf5248ceea9f2cdc166b3897d46ce96f25548",
    "zh:291121fd0153945f5e21411ee5625b6ec688344af2afef193d1243a0762b3064",
    "zh:49488c0d0fd6412f8e877c5b8839da13371dac87491c3bfae484ce9d7be67007",
    "zh:5a8f55012dc61cb98ac116b09f2b1fe68a96174ba892ee1bae90e3137b779a5d",
    "zh:77b68e5401c4977de5f172005f00dcfa724eb8ca938bd109bc74024c9550cb65",
    "zh:8f0b3af9db522f92cdb93eec28c340c00b0679357b715eee70fc3f3777c26747",
    "zh:9170bd7ef9a37bc960233bd9957ef46e1495b56bd329be4b0b578bfc744d5f0e",
    "zh:a66344e70ad954529c395e2b58fe491d5cc27991654852a66c9a3572a4d48c6f",
    "zh:b63e986afec187d6f708a37b64845d8e908c597902efe4eae7148ef07fa8aff5",
    "zh:fcc6e9a1f8df9b8cde3d8bcb917294dd9b9283b6bb8db6435ad02fb9ff1fe410",
    "zh:fdeaf059f86d0ab59cf68ece2e8cec522b506c47e2cfca7ba6125b1cd06b8680",
  ]
}
```

Importance of Dependency Lock File



Provider	Version Constraint	`terraform init` (no lock file)	`terraform init` (lock file)
aws	>= 2.0	Latest version (3.18.0)	Lock file version (2.50.0)
random	3.0.0	3.0.0	Lock file version (3.0.0)

If Terraform did not find a lock file, it would download the latest versions of the providers that fulfill the version constraints you defined in the required_providers block inside Terraform Settings Block.

If we have lock file, the lock file causes Terraform to always install the same provider version, ensuring that runs across your team or remote sessions will be consistent.

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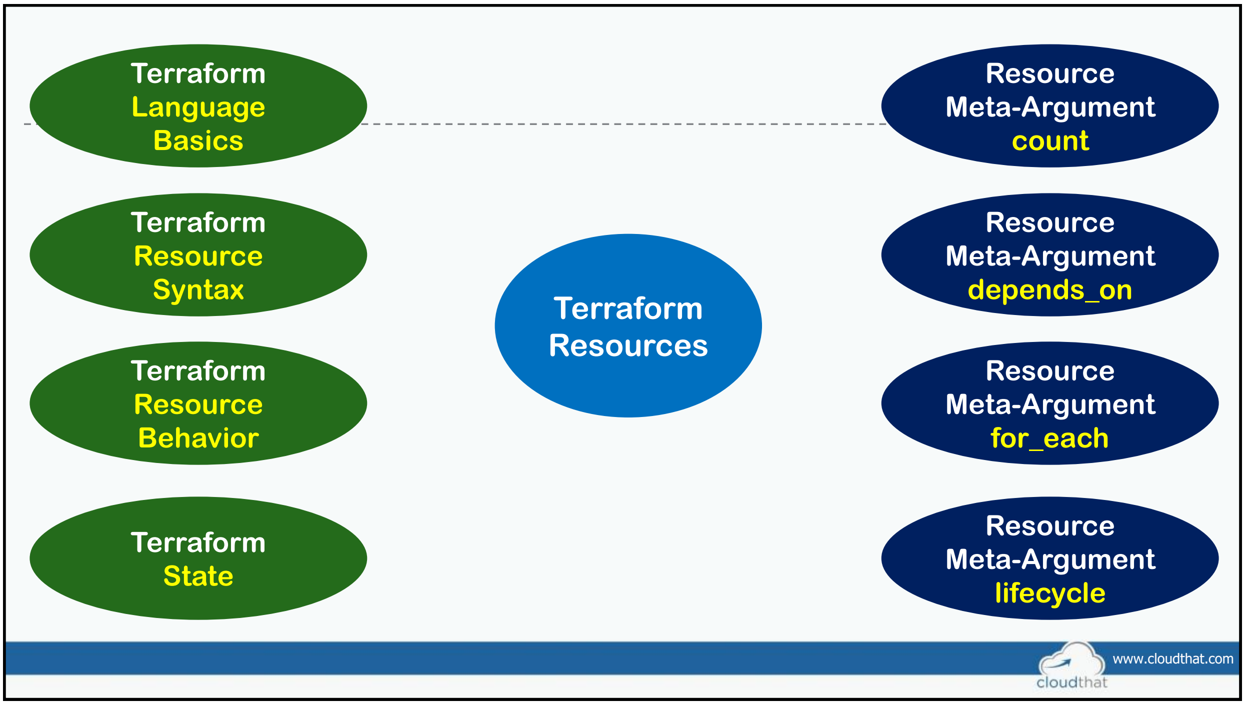
Terraform Resources Introduction



Terraform Resources

Terraform Language Basics

Terraform Resource Syntax

Terraform Resource Behavior

Terraform State

Resource Meta-Argument count

Resource Meta-Argument depends_on

Resource Meta-Argument for_each

Resource Meta-Argument lifecycle

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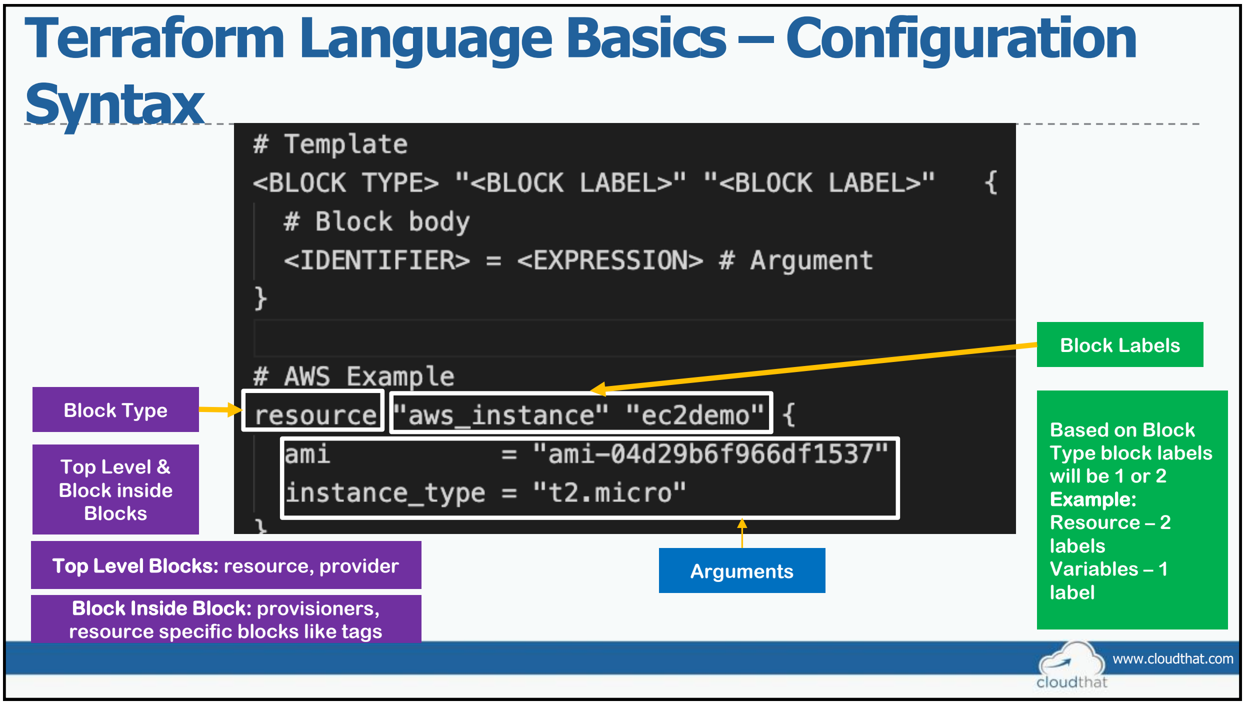

Terraform Language Basics – Configuration Syntax

```
# Template
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>"   {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}

# AWS Example
resource "aws_instance" "ec2demo" {
  ami           = "ami-04d29b6f966df1537"
  instance_type = "t2.micro"
}
```

Block Type

Block Labels

Arguments

Top Level & Block inside Blocks

Top Level Blocks: resource, provider

Block Inside Block: provisioners, resource specific blocks like tags

Based on Block Type block labels will be 1 or 2
Example:
Resource – 2 labels
Variables – 1 label

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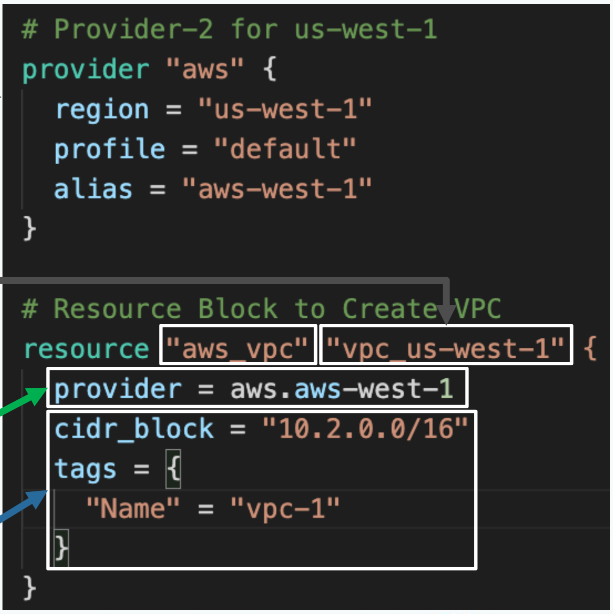
Resource Syntax

Resource Type: It determines the kind of infrastructure object it manages and what arguments and other attributes the resource supports.

Resource Local Name: It is used to refer to this resource from elsewhere in the same Terraform module, but has no significance outside that module's scope.
The resource type and name together serve as an identifier for a given resource and so must be unique within a module

Meta-Arguments: Can be used with any resource to change the behavior of resources

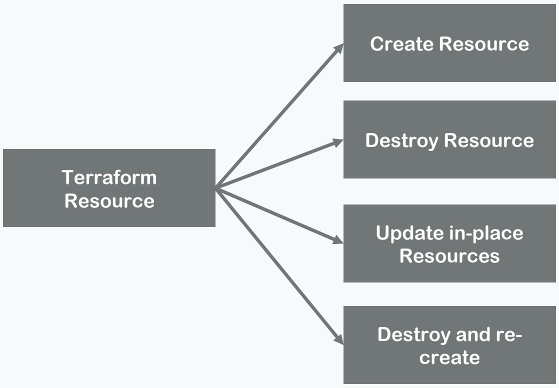
Resource Arguments: Will be specific to resource type. Argument Values can make use of Expressions or other Terraform Dynamic Language Features



```
# Provider-2 for us-west-1
provider "aws" {
  region = "us-west-1"
  profile = "default"
  alias = "aws-west-1"
}

# Resource Block to Create VPC
resource "aws_vpc" "vpc_us-west-1" {
  provider = aws.aws-west-1
  cidr_block = "10.2.0.0/16"
  tags = {
    "Name" = "vpc-1"
  }
}
```

Resource Behavior



Create resources that exist in the configuration but are not associated with a real infrastructure object in the state.

Destroy resources that exist in the state but no longer exist in the configuration.

Update in-place resources whose arguments have changed.

Destroy and re-create resources whose arguments have changed but which cannot be updated in-place due to remote API limitations.

Terraform State

Terraform State

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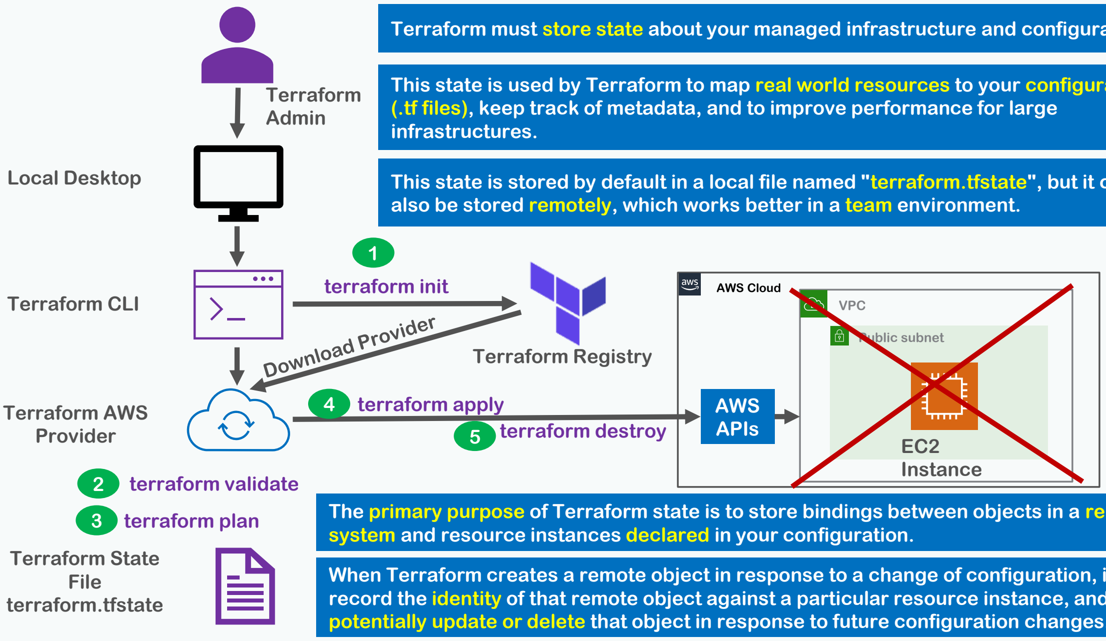
Terraform must store state about your managed infrastructure and configuration

This state is used by Terraform to map real world resources to your configuration (.tf files), keep track of metadata, and to improve performance for large infrastructures.

This state is stored by default in a local file named "terraform.tfstate", but it can also be stored remotely, which works better in a team environment.



The primary purpose of Terraform state is to store bindings between objects in a remote system and resource instances declared in your configuration.

When Terraform creates a remote object in response to a change of configuration, it will record the identity of that remote object against a particular resource instance, and then potentially update or delete that object in response to future configuration changes.

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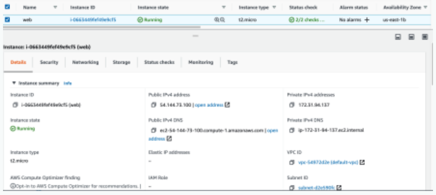
Desired & Current Terraform States

Terraform Configuration Files

Real World Resource – EC2 Instance

c1-versions.tf
c2-ec2-instance.tf

terraform.tfstate



☑	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone
☑	web	i-0663449fef49e9cf5	Running	t2.micro	2/2 checks ...	No alarms +	us-east-1b

Instance: i-0663449fef49e9cf5 (web)

▼ Instance summary Info

Instance ID
i-0663449fef49e9cf5 (web)

Public IPv4 address
54.144.73.100 | open address

Private IPv4 addresses
172.31.94.137

Instance state
Running

Public IPv4 DNS
ec2-54-144-73-100.compute-1.amazonaws.com | open address

Private IPv4 DNS
ip-172-31-94-137.ec2.internal

Instance type
t2.micro

Elastic IP addresses
–

VPC ID
vpc-54972d2e (default-vpc)

AWS Compute Optimizer finding
Opt-in to AWS Compute Optimizer for recommendations. |

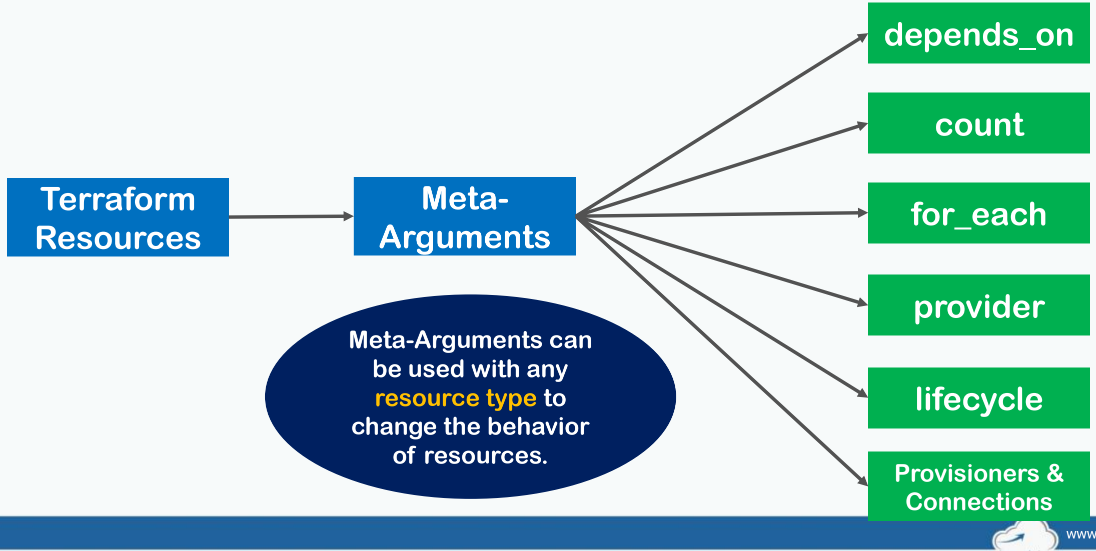
IAM Role
–

Subnet ID
subnet-d2e590fc

Desired State

Current State

Resource Meta-Arguments



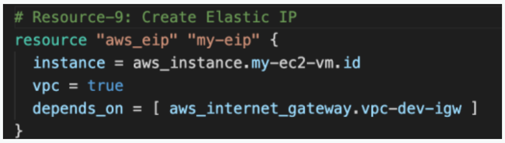
Meta-Arguments can be used with any **resource type** to change the behavior of resources.

Use case: What are we going implement?

- # Resource-2: Create Subnets
- # Resource-3: Internet Gateway
- # Resource-4: Create Route Table
- # Resource-5: Create Route in Route Table for Internet Access
- # Resource-6: Associate the Route Table with the Subnet
- # Resource-7: Create Security Group
- # Resource-8: Create EC2 Instance with Sample App

EIP may require IGW to exist prior to association. Use depends_on to set an explicit dependency on the IGW.

Resource-9: Create Elastic IP
depends_on



```
# Resource-9: Create Elastic IP
resource "aws_eip" "my-eip" {
  instance = aws_instance.my-ec2-vm.id
  vpc = true
  depends_on = [ aws_internet_gateway.vpc-dev-igw ]
}
```

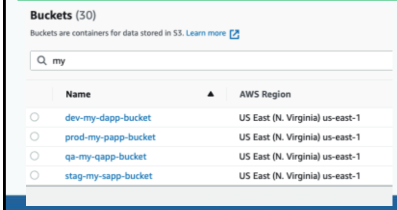
Usecase-1: for_each Maps

# Resource-1: Use Meta-Argument for_each with Maps to create multiple S3 buckets using single Resource

Define for_each with Map with Key Value pairs

Use each.key and each.value for the S3 Bucket name

Use each.key and each.value for S3 Bucket tags

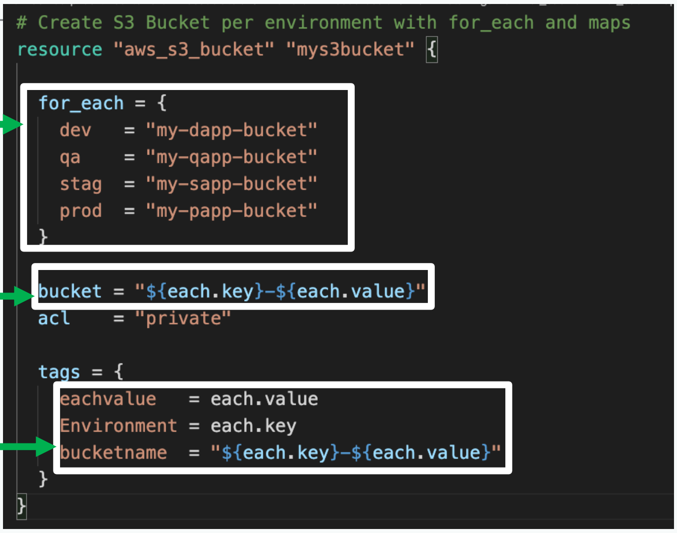


Buckets (30)

Buckets are containers for data stored in S3. Learn more

my

	Name	AWS Region
○	dev-my-dapp-bucket	US East (N. Virginia) us-east-1
○	prod-my-papp-bucket	US East (N. Virginia) us-east-1
○	qa-my-qapp-bucket	US East (N. Virginia) us-east-1
○	stag-my-sapp-bucket	US East (N. Virginia) us-east-1



```
# Create S3 Bucket per environment with for_each and maps
resource "aws_s3_bucket" "mys3bucket" {

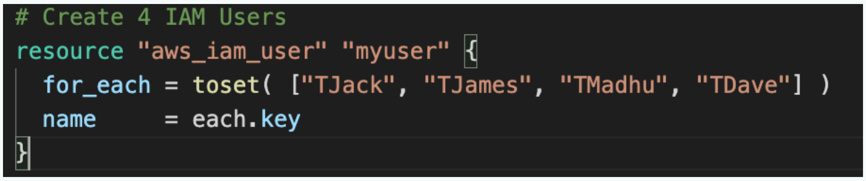
  for_each = {
    dev    = "my-dapp-bucket"
    qa     = "my-qapp-bucket"
    stag   = "my-sapp-bucket"
    prod   = "my-papp-bucket"
  }

  bucket = "${each.key}-${each.value}"
  acl    = "private"

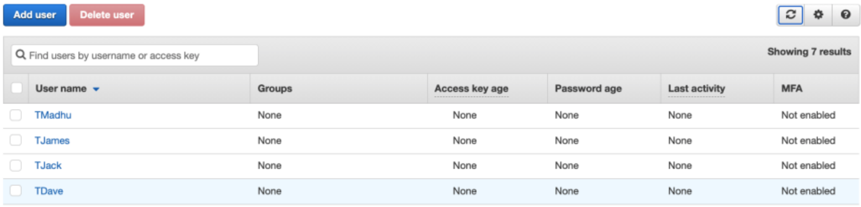
  tags = {
    eachvalue   = each.value
    Environment = each.key
    bucketname  = "${each.key}-${each.value}"
  }
}
```

Usecase-2: for_each Set of Strings (toset)

# Resource-1: Use Meta-Argument for_each with Set of Strings to create multiple IAM Users using single Resource



```
# Create 4 IAM Users
resource "aws_iam_user" "myuser" {
  for_each = toset( ["TJack", "TJames", "TMadhu", "TDave"] )
  name     = each.key
}
```



□	User name	Groups	Access key age	Password age	Last activity	MFA
□	TMadhu	None	None	None	None	Not enabled
□	TJames	None	None	None	None	Not enabled
□	TJack	None	None	None	None	Not enabled
□	TDave	None	None	None	None	Not enabled

lifecycle is a nested block that can appear within a resource block

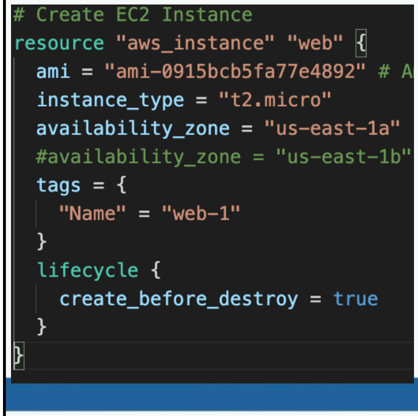
Resource Meta-Argument lifecycle

The lifecycle block and its contents are meta-arguments, available for all resource blocks regardless of type.

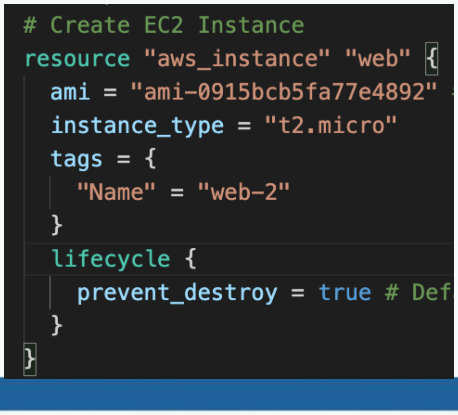
create_before_destroy

prevent_destroy

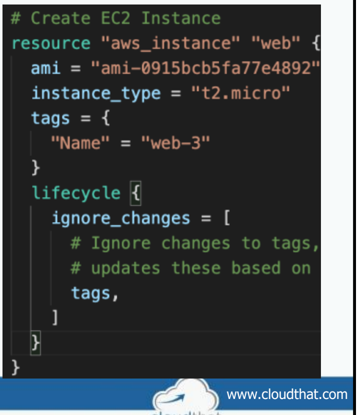
ignore_changes



```
# Create EC2 Instance
resource "aws_instance" "web" {
  ami = "ami-0915bcb5fa77e4892" # A
  instance_type = "t2.micro"
  availability_zone = "us-east-1a"
  #availability_zone = "us-east-1b"
  tags = {
    "Name" = "web-1"
  }
  lifecycle {
    create_before_destroy = true
  }
}
```



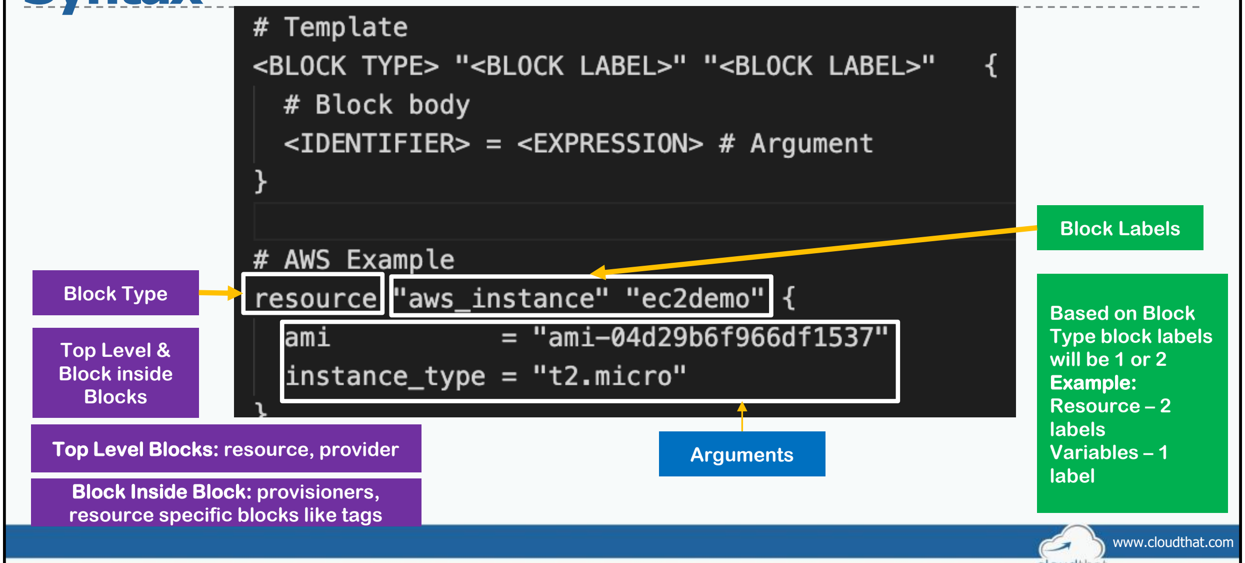
```
# Create EC2 Instance
resource "aws_instance" "web" {
  ami = "ami-0915bcb5fa77e4892"
  instance_type = "t2.micro"
  tags = {
    "Name" = "web-2"
  }
  lifecycle {
    prevent_destroy = true # Def
  }
}
```



```
# Create EC2 Instance
resource "aws_instance" "web" {
  ami = "ami-0915bcb5fa77e4892"
  instance_type = "t2.micro"
  tags = {
    "Name" = "web-3"
  }
  lifecycle {
    ignore_changes = [
      # Ignore changes to tags,
      # updates these based on
      tags,
    ]
  }
}
```

Terraform Resource Syntax

Terraform Language Basics – Configuration Syntax



```
# Template
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>"   {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}

# AWS Example
resource "aws_instance" "ec2demo" {
  ami           = "ami-04d29b6f966df1537"
  instance_type = "t2.micro"
}
```

Block Type

Top Level & Block inside Blocks

Top Level Blocks: resource, provider

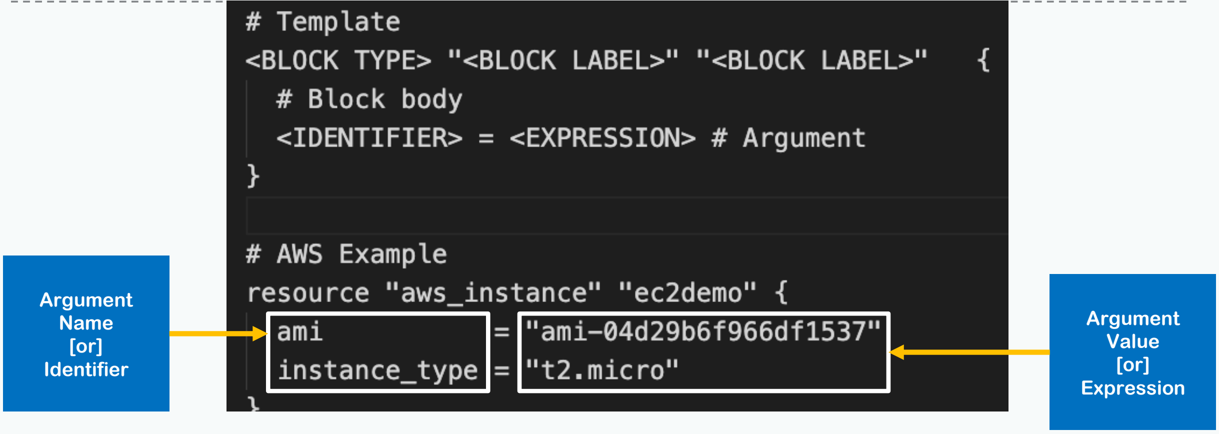
Block Inside Block: provisioners, resource specific blocks like tags

Arguments

Block Labels

Based on Block Type block labels will be 1 or 2
Example:
Resource – 2 labels
Variables – 1 label

Terraform Language Basics – Configuration Syntax



```
# Template
<BLOCK TYPE> "<BLOCK LABEL>" "<BLOCK LABEL>"   {
  # Block body
  <IDENTIFIER> = <EXPRESSION> # Argument
}

# AWS Example
resource "aws_instance" "ec2demo" {
  ami           = "ami-04d29b6f966df1537"
  instance_type = "t2.micro"
}
```

Argument Name [or] Identifier

Argument Value [or] Expression

Resource Syntax

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Resource Local Name: It is used to refer to this resource from elsewhere in the same Terraform module, but has no significance outside that module's scope.
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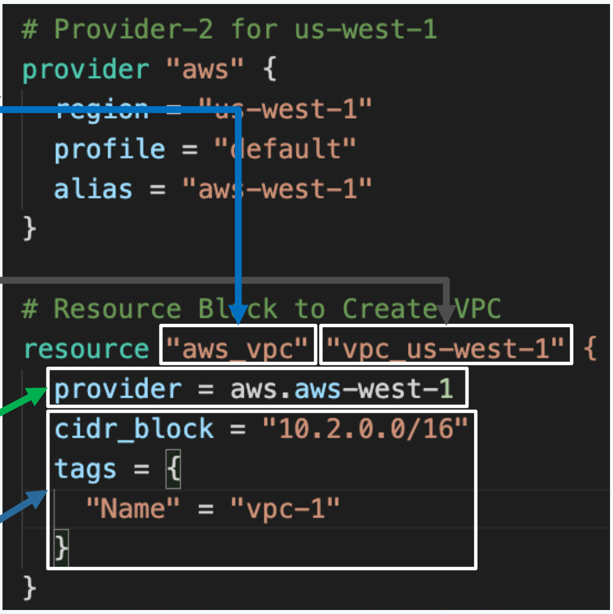

```
# Provider-2 for us-west-1
provider "aws" {
  region = "us-west-1"
  profile = "default"
  alias = "aws-west-1"
}

# Resource Block to Create VPC
resource "aws_vpc" "vpc_us-west-1" {
  provider = aws.aws-west-1
  cidr_block = "10.2.0.0/16"
  tags = {
    "Name" = "vpc-1"
  }
}
```

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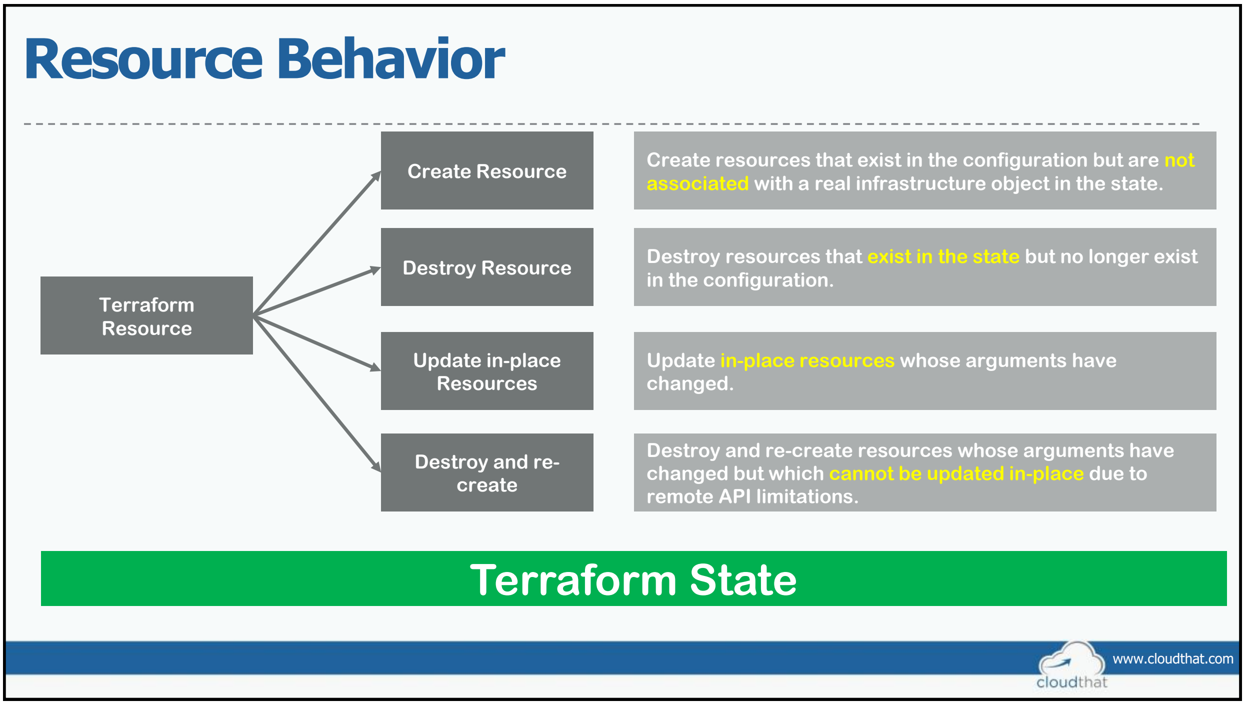
Terraform Resource Behaviour



Resource Behavior

Terraform Resource

Create Resource — Create resources that exist in the configuration but are not associated with a real infrastructure object in the state.

Destroy Resource — Destroy resources that exist in the state but no longer exist in the configuration.

Update in-place Resources — Update in-place resources whose arguments have changed.

Destroy and re-create — Destroy and re-create resources whose arguments have changed but which cannot be updated in-place due to remote API limitations.

Terraform State

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Terraform State

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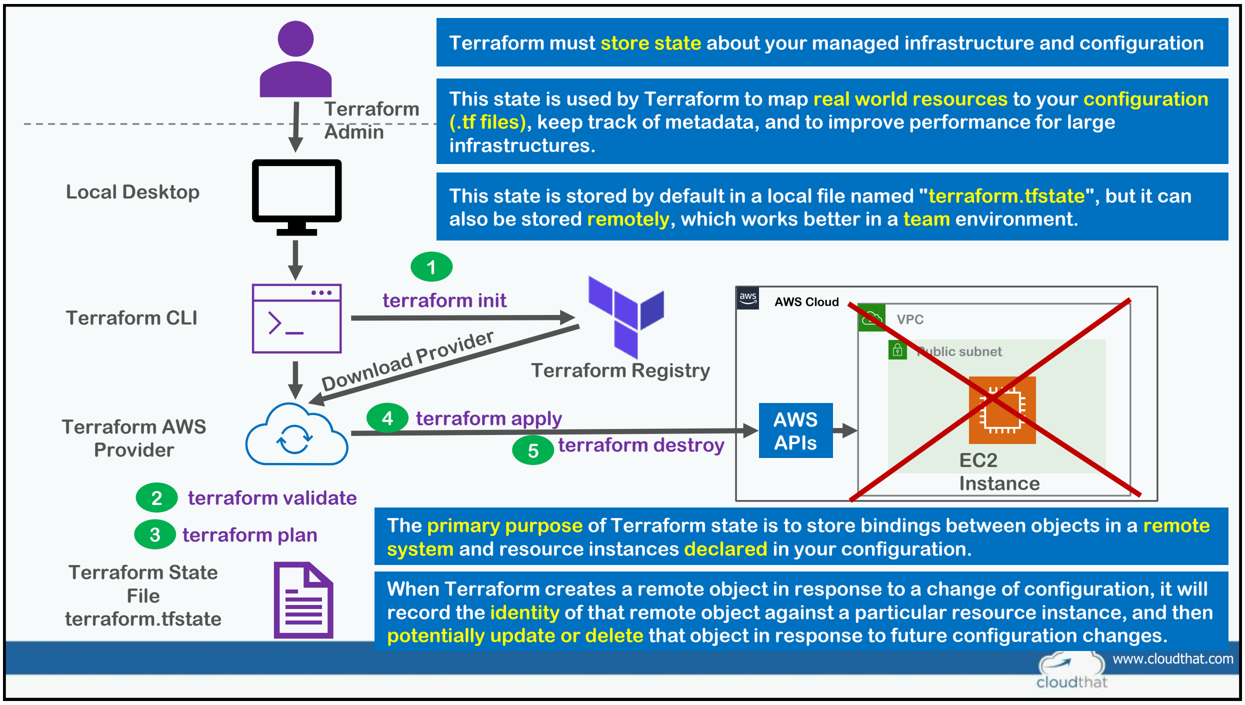

Terraform must store state about your managed infrastructure and configuration

This state is used by Terraform to map real world resources to your configuration (.tf files), keep track of metadata, and to improve performance for large infrastructures.

This state is stored by default in a local file named "terraform.tfstate", but it can also be stored remotely, which works better in a team environment.

The primary purpose of Terraform state is to store bindings between objects in a remote system and resource instances declared in your configuration.

When Terraform creates a remote object in response to a change of configuration, it will record the identity of that remote object against a particular resource instance, and then potentially update or delete that object in response to future configuration changes.

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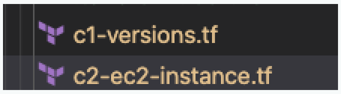
Terrfaform State - Desired & Current

Desired & Current Terraform States

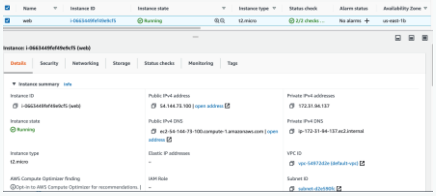
Terraform Configuration Files

Real World Resource – EC2 Instance



```
c1-versions.tf
c2-ec2-instance.tf
```

terraform.tfstate



☑	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone
☑	web	i-0663449fef49e9cf5	Running	t2.micro	2/2 checks ...	No alarms +	us-east-1b

Instance: i-0663449fef49e9cf5 (web)

▼ Instance summary Info

Instance ID: i-0663449fef49e9cf5 (web)

Public IPv4 address: 54.144.73.100 | open address

Private IPv4 addresses: 172.31.94.137

Instance state: Running

Public IPv4 DNS: ec2-54-144-73-100.compute-1.amazonaws.com | open address

Private IPv4 DNS: ip-172-31-94-137.ec2.internal

Instance type: t2.micro

Elastic IP addresses: –

VPC ID: vpc-54972d2e (default-vpc)

AWS Compute Optimizer finding: Opt-in to AWS Compute Optimizer for recommendations. |

IAM Role: –

Subnet ID: subnet-d2e5908c

Desired State

Current State

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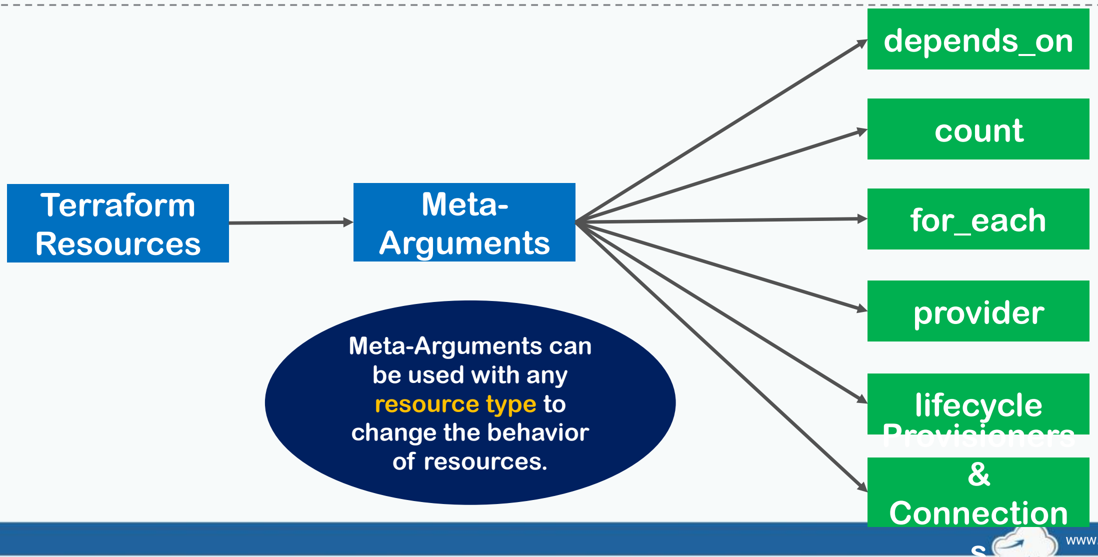
Terraform Resource Meta-Arguments

Resource Meta-Arguments



Meta-Arguments can be used with any **resource type** to change the behavior of resources.

Resource Meta-Arguments

- **depends_on** — To handle hidden resource or module dependencies that Terraform can't automatically infer.
- **count** — For creating multiple resource instances according to a count
- **for_each** — To create multiple instances according to a map, or set of strings
- **provider** — For selecting a non-default provider configuration
- **lifecycle** — Standard Resource behavior can be altered using special nested lifecycle block within a resource block body
- **Provisioners & Connections** — For taking extra actions after resource creation (Example: install some app on server or do something on local desktop after resource is created at remote destination)

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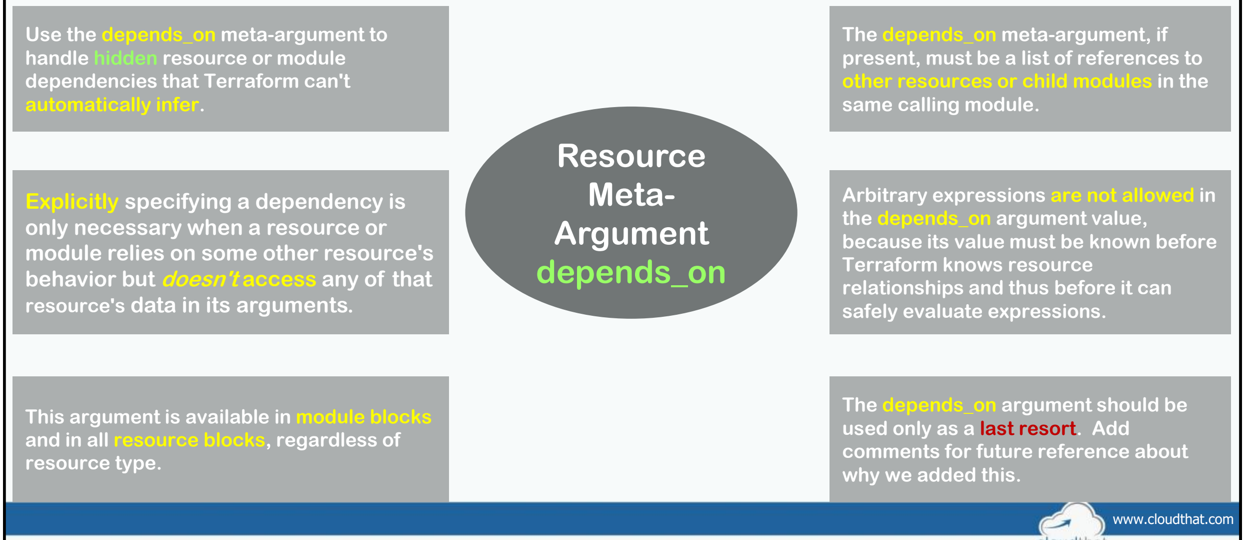
Terraform Resource Meta-Argument – depends on

Resource Meta-Arguments – depends_on



Use the depends_on meta-argument to handle hidden resource or module dependencies that Terraform can't automatically infer.

Explicitly specifying a dependency is only necessary when a resource or module relies on some other resource's behavior but *doesn't* access any of that resource's data in its arguments.

This argument is available in module blocks and in all resource blocks, regardless of resource type.

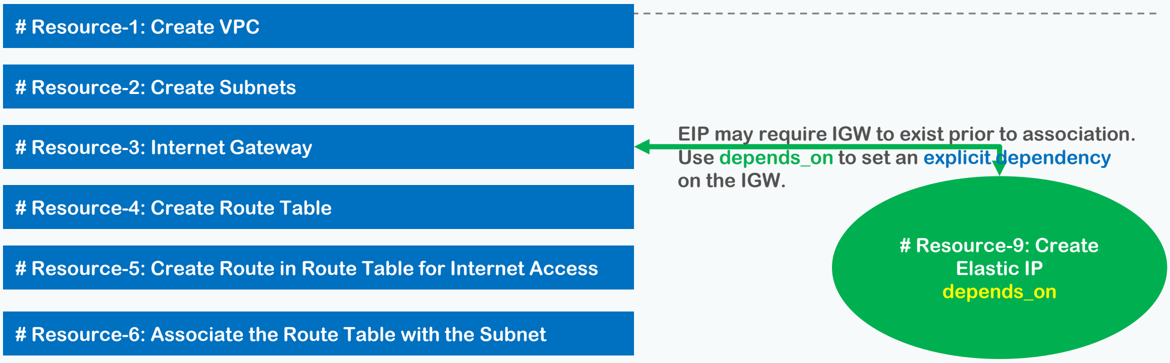
Resource Meta-Argument depends_on

The depends_on meta-argument, if present, must be a list of references to other resources or child modules in the same calling module.

Arbitrary expressions are not allowed in the depends_on argument value, because its value must be known before Terraform knows resource relationships and thus before it can safely evaluate expressions.

The depends_on argument should be used only as a last resort. Add comments for future reference about why we added this.

Use case: What are we going implement?



# Resource-1: Create VPC

# Resource-2: Create Subnets

# Resource-3: Internet Gateway

# Resource-4: Create Route Table

# Resource-5: Create Route in Route Table for Internet Access

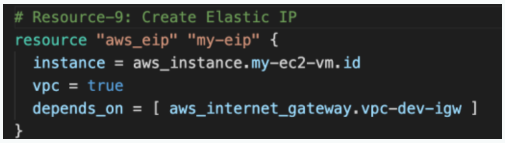
# Resource-6: Associate the Route Table with the Subnet

# Resource-7: Create Security Group

# Resource-8: Create EC2 Instance with Sample App

EIP may require IGW to exist prior to association. Use depends_on to set an explicit dependency on the IGW.

Resource-9: Create Elastic IP depends_on



```
# Resource-9: Create Elastic IP
resource "aws_eip" "my-eip" {
  instance = aws_instance.my-ec2-vm.id
  vpc = true
  depends_on = [ aws_internet_gateway.vpc-dev-igw ]
}
```

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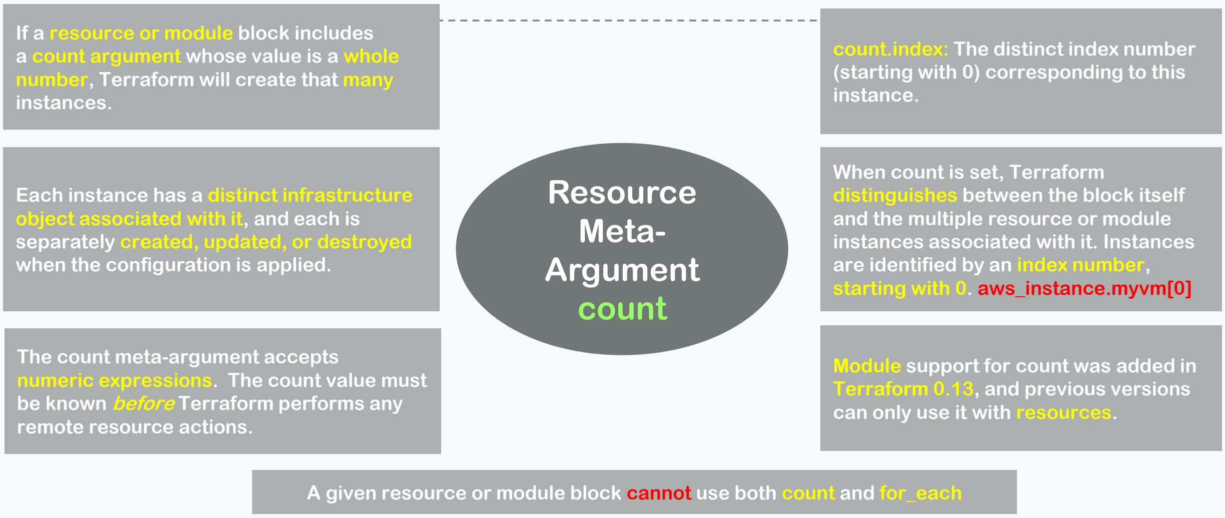
Terraform Resource Meta-Argument - count

Resource Meta-Arguments – count



If a resource or module block includes a count argument whose value is a whole number, Terraform will create that many instances.

Each instance has a distinct infrastructure object associated with it, and each is separately created, updated, or destroyed when the configuration is applied.

The count meta-argument accepts numeric expressions. The count value must be known *before* Terraform performs any remote resource actions.

Resource Meta-Argument count

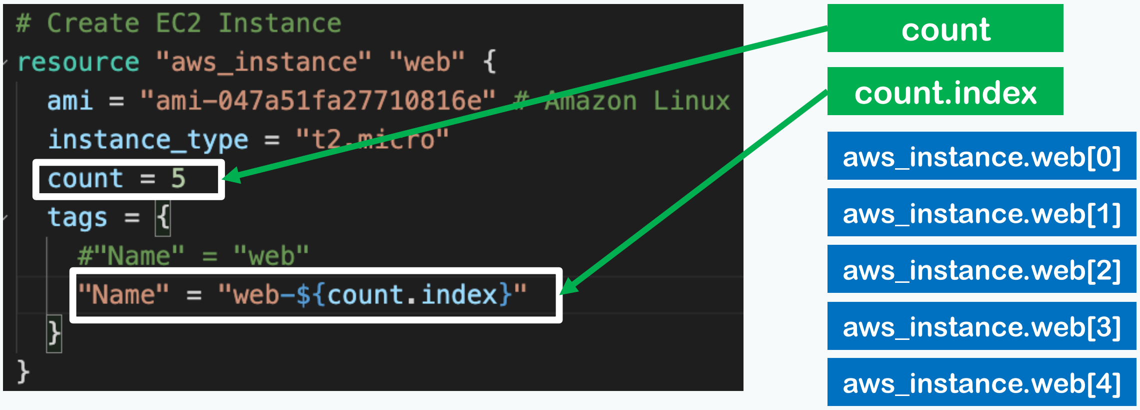
count.index: The distinct index number (starting with 0) corresponding to this instance.

When count is set, Terraform distinguishes between the block itself and the multiple resource or module instances associated with it. Instances are identified by an index number, starting with 0. aws_instance.myvm[0]

Module support for count was added in Terraform 0.13, and previous versions can only use it with resources.

A given resource or module block cannot use both count and for_each

Use case: What are we going implement?



```
# Create EC2 Instance
resource "aws_instance" "web" {
  ami = "ami-047a51fa27710816e" # Amazon Linux
  instance_type = "t2.micro"
  count = 5
  tags = {
    #"Name" = "web"
    "Name" = "web-${count.index}"
  }
}
```

Terraform Resource Meta-Argument – for_each

Resource Meta-Arguments – for_each

If a resource or module block includes a for_each argument whose value is a map or a set of strings, Terraform will create one instance for each member of that map or set.

A given resource or module block cannot use both count and for_each

For set of Strings, each.key = each.value
for_each = toset(["Jack", "James"])
each.key = Jack
each.key = James

Each instance has a distinct infrastructure object associated with it, and each is separately created, updated, or destroyed when the configuration is applied.

Resource Meta-Argument for_each

For Maps, we use each.key & each.value
for_each = {
dev = "my-dapp-bucket"
}
each.key = dev
each.value = my-dapp-bucket

In blocks where for_each is set, an additional each object is available in expressions, so you can modify the configuration of each instance.
each.key — The map key (or set member) corresponding to this instance.
each.value — The map value corresponding to this instance. (If a set was provided, this is the same as each.key.)

Module support for for_each was added in Terraform 0.13, and previous versions can only use it with resources.

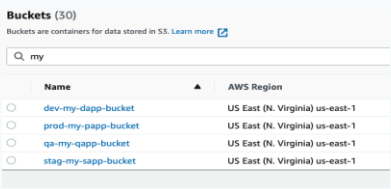
Usecase-1: for_each Maps

# Resource-1: Use Meta-Argument for_each with Maps to create multiple S3 buckets using single Resource

Define for_each with Map with Key Value pairs

Use each.key and each.value for the S3 Bucket name

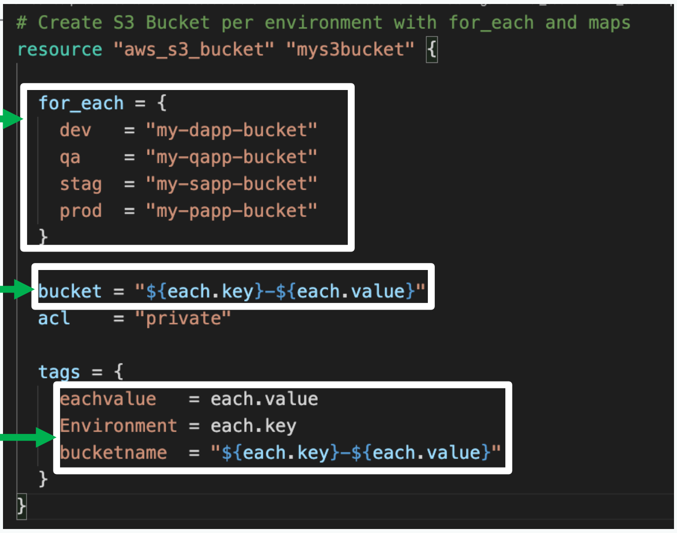
Use each.key and each.value for S3 Bucket tags



Buckets (30)
Buckets are containers for data stored in S3. Learn more

my

	Name	AWS Region
○	dev-my-dapp-bucket	US East (N. Virginia) us-east-1
○	prod-my-papp-bucket	US East (N. Virginia) us-east-1
○	qa-my-qapp-bucket	US East (N. Virginia) us-east-1
○	stag-my-sapp-bucket	US East (N. Virginia) us-east-1



```
# Create S3 Bucket per environment with for_each and maps
resource "aws_s3_bucket" "mys3bucket" {

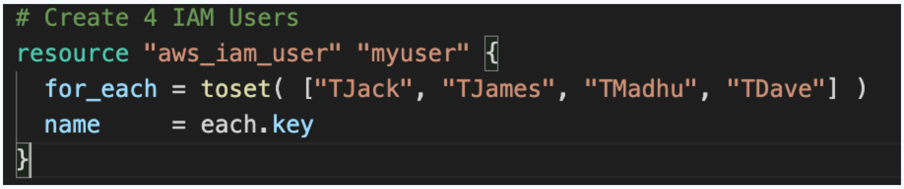
  for_each = {
    dev    = "my-dapp-bucket"
    qa     = "my-qapp-bucket"
    stag   = "my-sapp-bucket"
    prod   = "my-papp-bucket"
  }

  bucket = "${each.key}-${each.value}"
  acl    = "private"

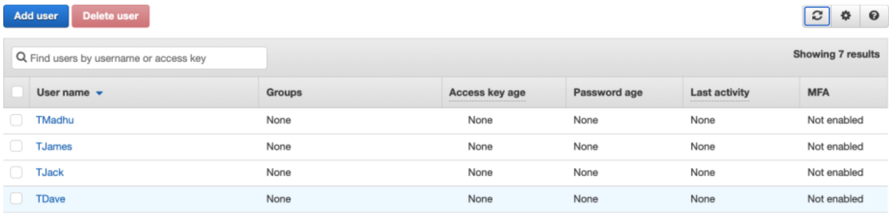
  tags = {
    eachvalue   = each.value
    Environment = each.key
    bucketname  = "${each.key}-${each.value}"
  }
}
```

Usecase-2: for_each Set of Strings (toset)

# Resource-1: Use Meta-Argument for_each with Set of Strings to create multiple IAM Users using single Resource



```
# Create 4 IAM Users
resource "aws_iam_user" "myuser" {
  for_each = toset( ["TJack", "TJames", "TMadhu", "TDave"] )
  name     = each.key
}
```



Showing 7 results

□	User name ▾	Groups	Access key age	Password age	Last activity	MFA
□	TMadhu	None	None	None	None	Not enabled
□	TJames	None	None	None	None	Not enabled
□	TJack	None	None	None	None	Not enabled
□	TDave	None	None	None	None	Not enabled

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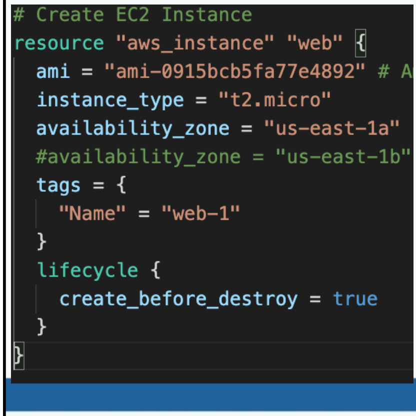
Terraform Resource Meta-Argument - lifecycle

lifecycle is a nested block that can appear within a resource block

Resource Meta-Argument lifecycle

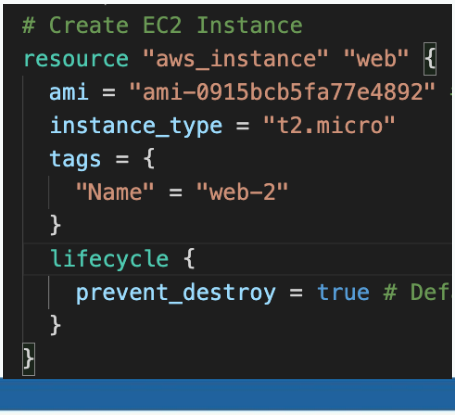
The lifecycle block and its contents are meta-arguments, available for all resource blocks regardless of type.

create_before_destroy



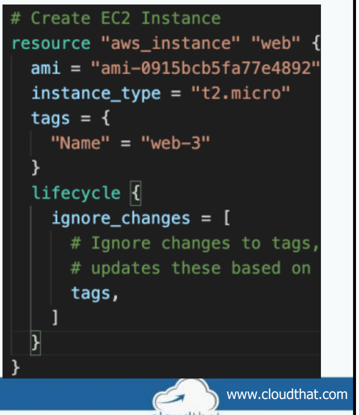
```
# Create EC2 Instance
resource "aws_instance" "web" {
  ami = "ami-0915bcb5fa77e4892" # A
  instance_type = "t2.micro"
  availability_zone = "us-east-1a"
  #availability_zone = "us-east-1b"
  tags = {
    "Name" = "web-1"
  }
  lifecycle {
    create_before_destroy = true
  }
}
```

prevent_destroy



```
# Create EC2 Instance
resource "aws_instance" "web" {
  ami = "ami-0915bcb5fa77e4892"
  instance_type = "t2.micro"
  tags = {
    "Name" = "web-2"
  }
  lifecycle {
    prevent_destroy = true # Def
  }
}
```

ignore_changes



```
# Create EC2 Instance
resource "aws_instance" "web" {
  ami = "ami-0915bcb5fa77e4892"
  instance_type = "t2.micro"
  tags = {
    "Name" = "web-3"
  }
  lifecycle {
    ignore_changes = [
      # Ignore changes to tags,
      # updates these based on
      tags,
    ]
  }
}
```

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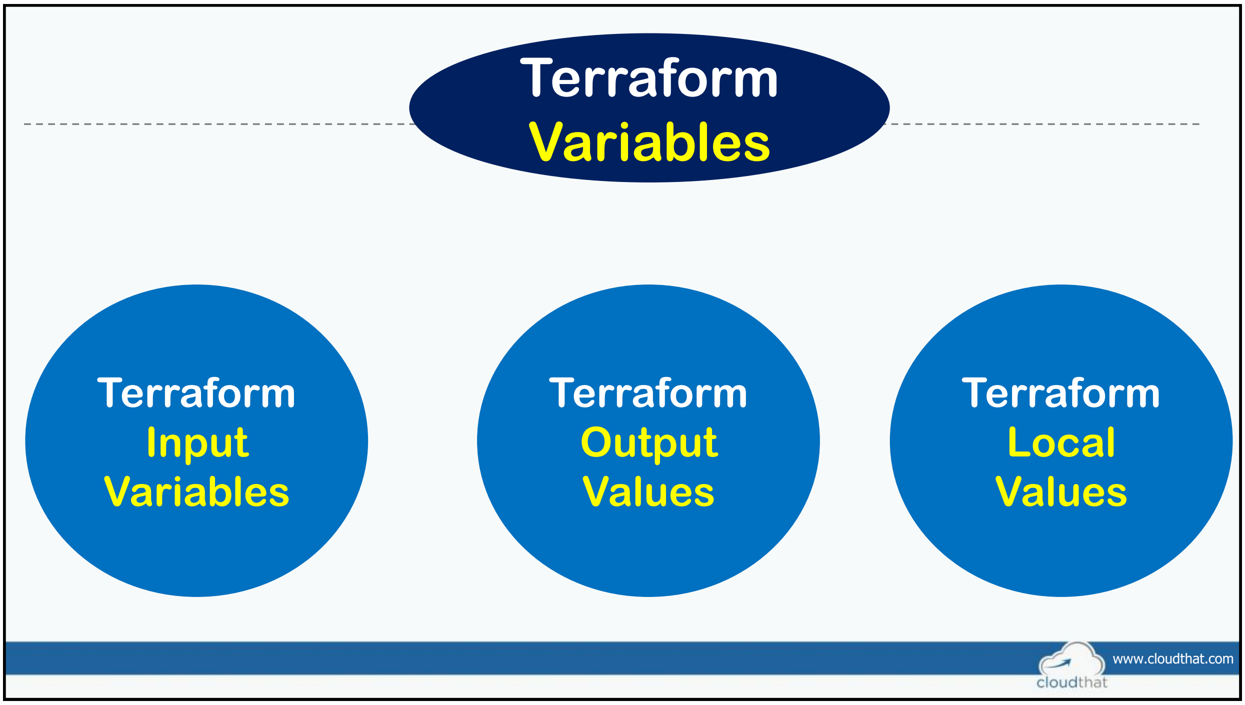
Terraform Variables Introduction



Terraform Variables

Terraform Input Variables

Terraform Output Values

Terraform Local Values

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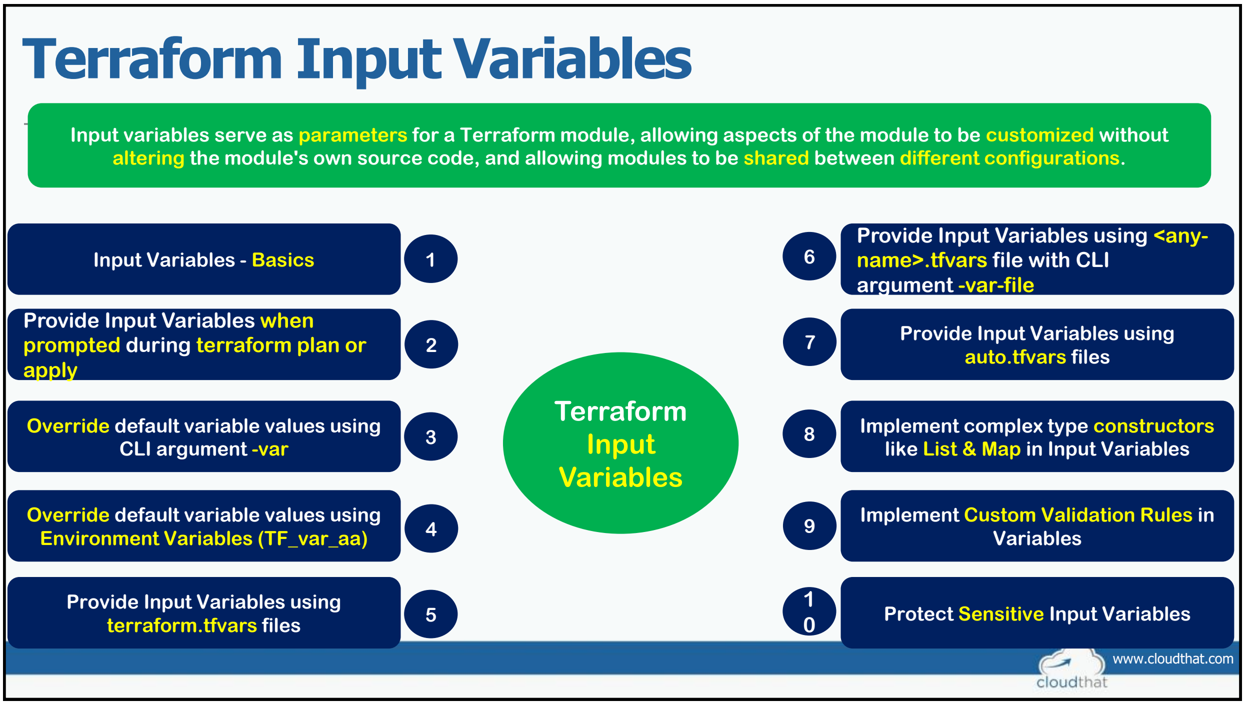

Terraform Input Variables

Input variables serve as parameters for a Terraform module, allowing aspects of the module to be customized without altering the module's own source code, and allowing modules to be shared between different configurations.

Terraform Input Variables

1. Input Variables - Basics
2. Provide Input Variables when prompted during terraform plan or apply
3. Override default variable values using CLI argument -var
4. Override default variable values using Environment Variables (TF_var_aa)
5. Provide Input Variables using terraform.tfvars files
6. Provide Input Variables using <any-name>.tfvars file with CLI argument -var-file
7. Provide Input Variables using auto.tfvars files
8. Implement complex type constructors like List & Map in Input Variables
9. Implement Custom Validation Rules in Variables
10. Protect Sensitive Input Variables

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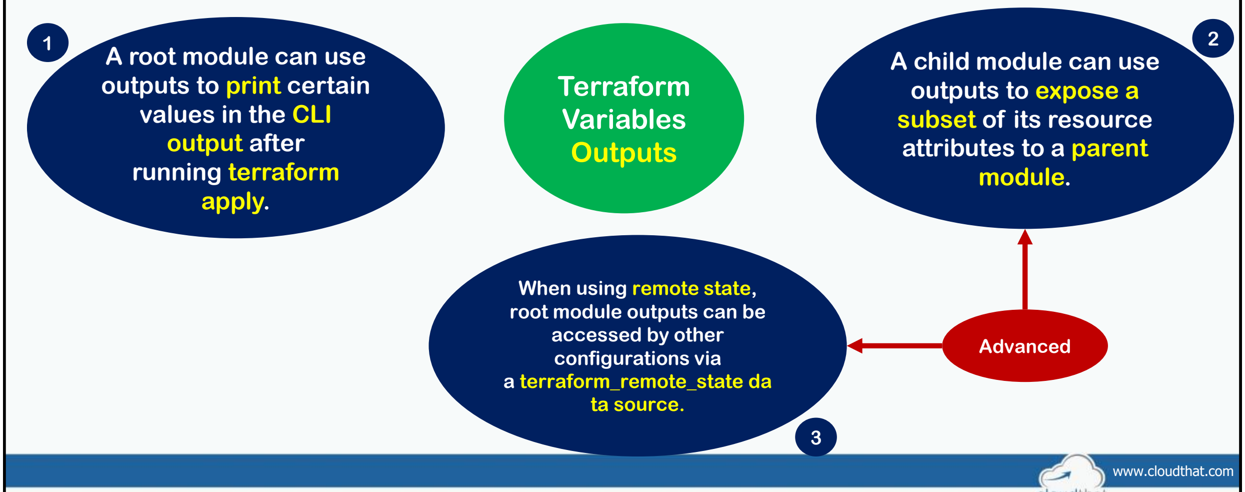
Terraform Variables – Output Values

Output values are like the return values of a Terraform module and have several uses



Terraform Variables Outputs

1 A root module can use outputs to print certain values in the CLI output after running terraform apply.

2 A child module can use outputs to expose a subset of its resource attributes to a parent module.

3 When using remote state, root module outputs can be accessed by other configurations via a terraform_remote_state data source.

Terraform Variables – Local Values

A local value assigns a name to an expression, so you can use that name multiple times within a module without repeating it.

Local values are like a function's temporary local variables.

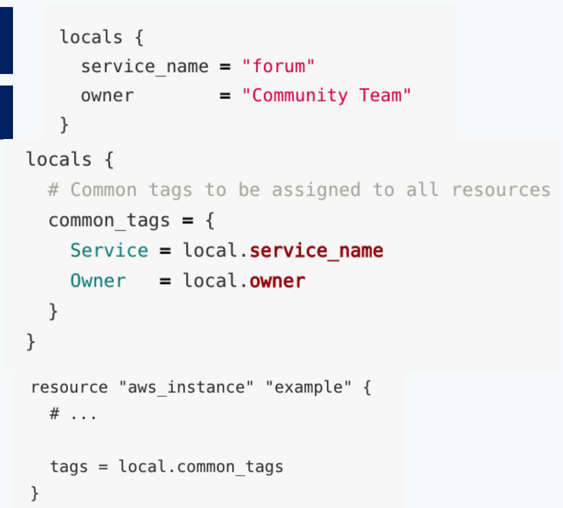
Once a local value is declared, you can reference it in expressions as local.<NAME>.

Local values can be helpful to avoid repeating the same values or expressions multiple times in a configuration

If overused they can also make a configuration hard to read by future maintainers by hiding the actual values used

The ability to easily change the value in a central place is the key advantage of local values.

In short, Use local values only in moderation

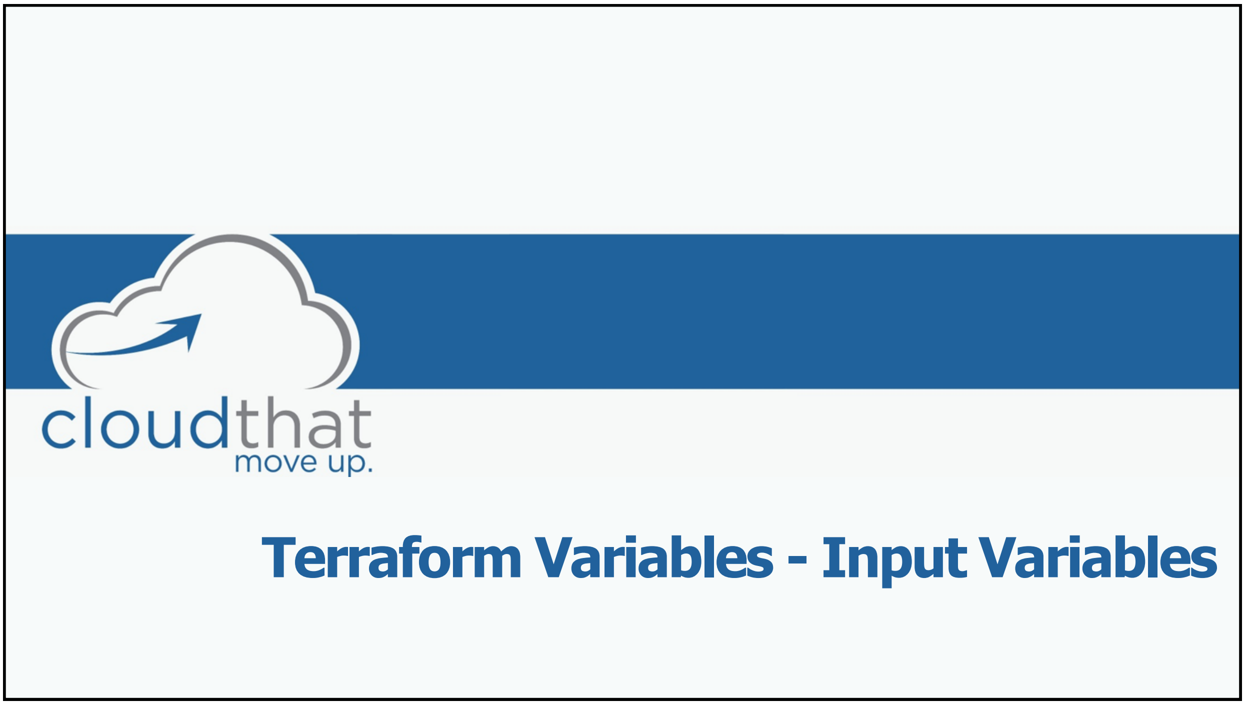


```
locals {
  service_name = "forum"
  owner        = "Community Team"
}
```

```
locals {
  # Common tags to be assigned to all resources
  common_tags = {
    Service = local.service_name
    Owner   = local.owner
  }
}
```

```
resource "aws_instance" "example" {
  # ...

  tags = local.common_tags
}
```



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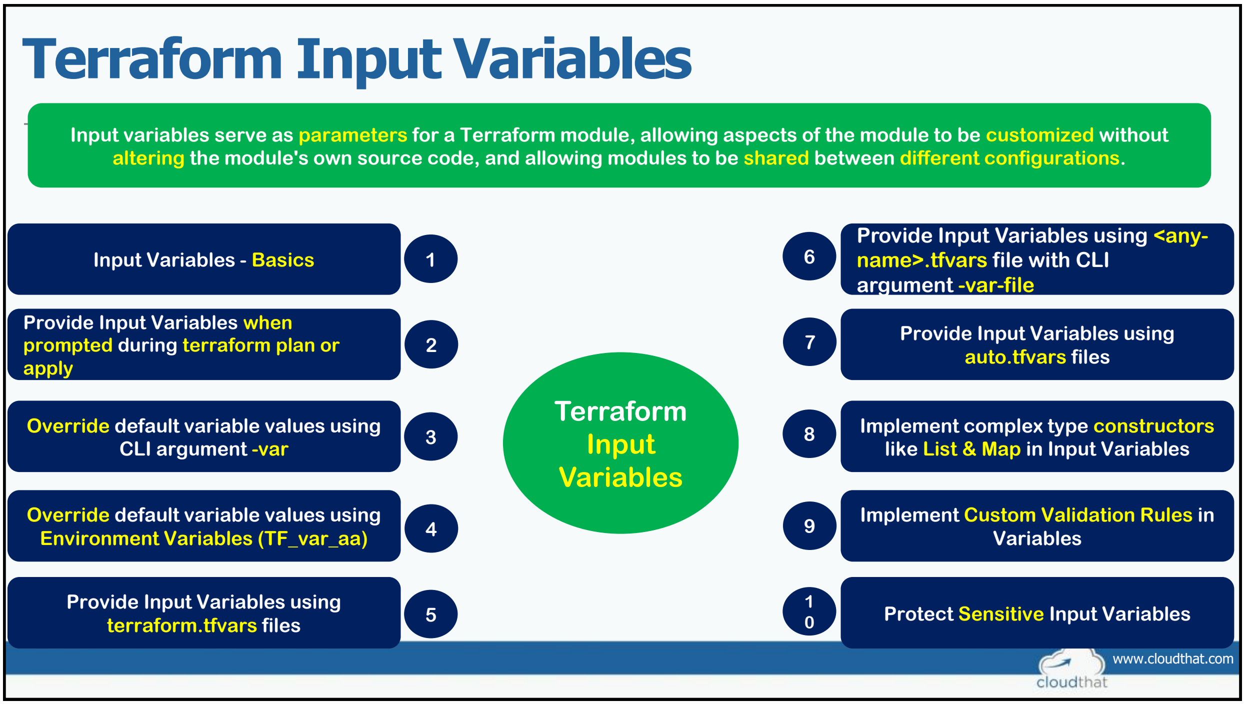
Terraform Variables - Input Variables



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Terraform Variables - Output Values

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Terraform Variables – Output Values

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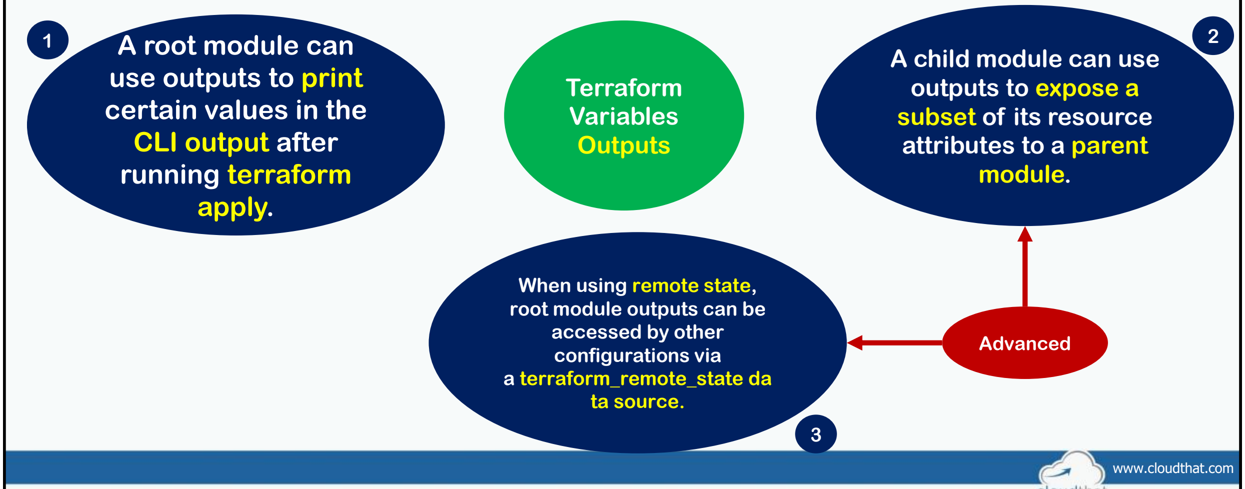

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Advanced

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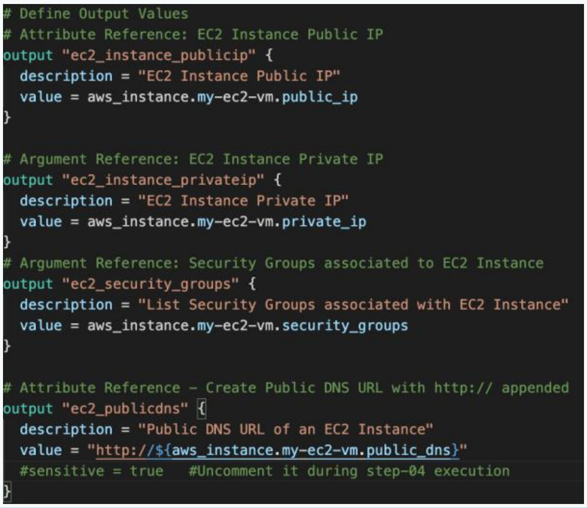
Terraform Variables
Output Values

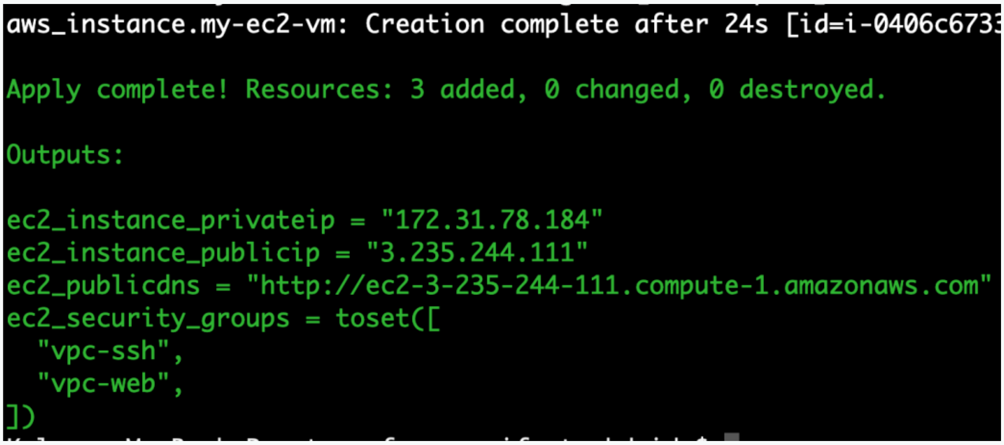


```
# Define Output Values
# Attribute Reference: EC2 Instance Public IP
output "ec2_instance_publicip" {
  description = "EC2 Instance Public IP"
  value = aws_instance.my-ec2-vm.public_ip
}

# Argument Reference: EC2 Instance Private IP
output "ec2_instance_privateip" {
  description = "EC2 Instance Private IP"
  value = aws_instance.my-ec2-vm.private_ip
}
# Argument Reference: Security Groups associated to EC2 Instance
output "ec2_security_groups" {
  description = "List Security Groups associated with EC2 Instance"
  value = aws_instance.my-ec2-vm.security_groups
}

# Attribute Reference - Create Public DNS URL with http:// appended
output "ec2_publicdns" {
  description = "Public DNS URL of an EC2 Instance"
  value = "http://${aws_instance.my-ec2-vm.public_dns}"
  #sensitive = true   #Uncomment it during step-04 execution
}
```

Terraform Variables - Output Values



```
aws_instance.my-ec2-vm: Creation complete after 24s [id=i-0406c673

Apply complete! Resources: 3 added, 0 changed, 0 destroyed.

Outputs:

ec2_instance_privateip = "172.31.78.184"
ec2_instance_publicip = "3.235.244.111"
ec2_publicdns = "http://ec2-3-235-244-111.compute-1.amazonaws.com"
ec2_security_groups = toset([
  "vpc-ssh",
  "vpc-web",
])
```

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Terraform Variables - Local Values

Terraform Variables – Local Values

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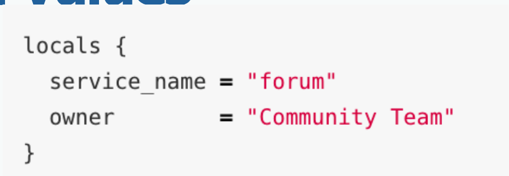

```
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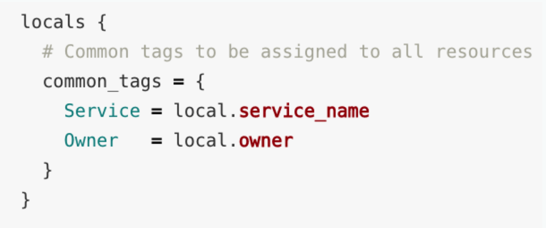
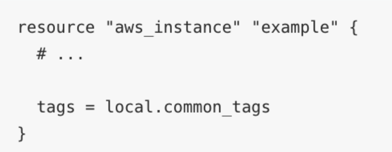
}
```



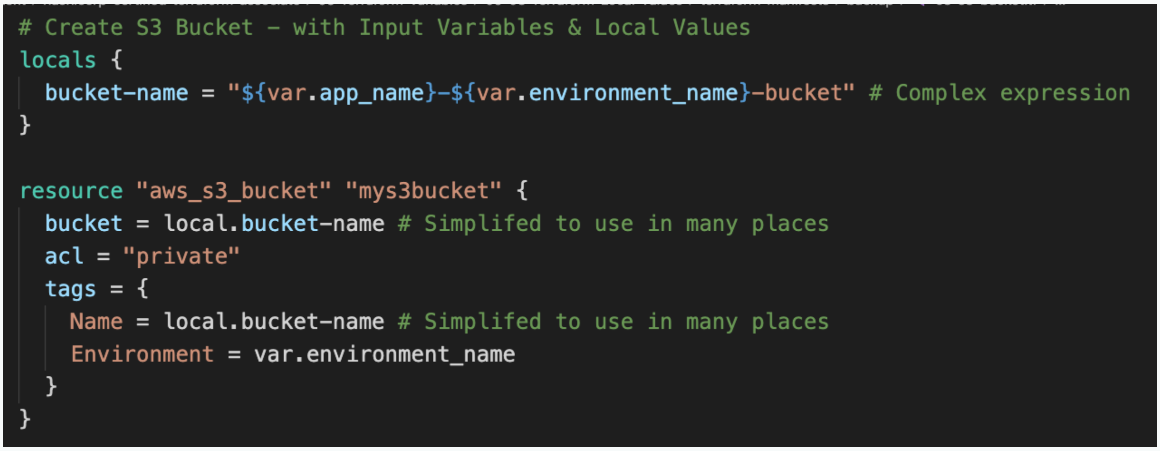
```
locals {
  # Common tags to be assigned to all resources
  common_tags = {
    Service = local.service_name
    Owner   = local.owner
  }
}
```



```
resource "aws_instance" "example" {
  # ...

  tags = local.common_tags
}
```

Terraform Variables – Local Values



```
# Create S3 Bucket - with Input Variables & Local Values
locals {
  bucket-name = "${var.app_name}-${var.environment_name}-bucket" # Complex expression
}

resource "aws_s3_bucket" "mys3bucket" {
  bucket = local.bucket-name # Simplifed to use in many places
  acl = "private"
  tags = {
    Name = local.bucket-name # Simplifed to use in many places
    Environment = var.environment_name
  }
}
```

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Terraform Datasources

Terraform Datasources

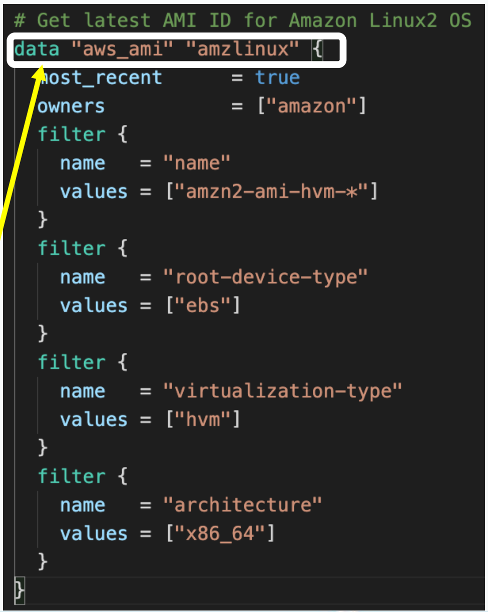
Data sources allow data to be fetched or computed for use elsewhere in Terraform configuration.

Use of data sources allows a Terraform configuration to make use of information defined outside of Terraform, or defined by another separate Terraform configuration.

A data source is accessed via a special kind of resource known as a *data resource*, declared using a data block

Each data resource is associated with a single data source, which determines the kind of object (or objects) it reads and what query constraint arguments are available

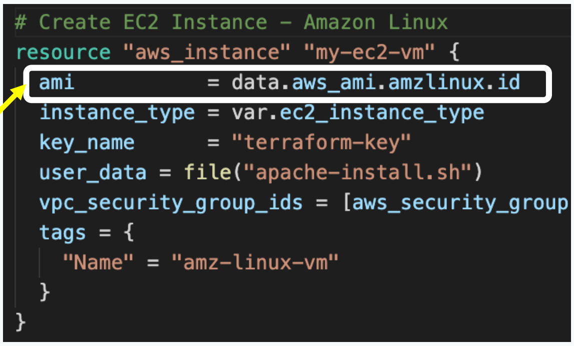
Data resources have the same dependency resolution behavior as defined for managed resources. Setting the depends_on meta-argument within data blocks defers reading of the data source until after all changes to the dependencies have been applied.



```
# Get latest AMI ID for Amazon Linux2 OS
data "aws_ami" "amzlinux" {
  most_recent      = true
  owners           = ["amazon"]
  filter {
    name   = "name"
    values = ["amzn2-ami-hvm-*"]
  }
  filter {
    name   = "root-device-type"
    values = ["ebs"]
  }
  filter {
    name   = "virtualization-type"
    values = ["hvm"]
  }
  filter {
    name   = "architecture"
    values = ["x86_64"]
  }
}
```

Terraform Datasources

We can refer the data resource in a resource as depicted



```
# Create EC2 Instance - Amazon Linux
resource "aws_instance" "my-ec2-vm" {
  ami           = data.aws_ami.amzlinux.id
  instance_type = var.ec2_instance_type
  key_name      = "terraform-key"
  user_data = file("apache-install.sh")
  vpc_security_group_ids = [aws_security_group
  tags = {
    "Name" = "amz-linux-vm"
  }
}
```

Meta-Arguments for Datasources

Data resources support the provider meta-argument as defined for managed resources, with the same syntax and behavior.

Data resources do not currently have any customization settings available for their lifecycle, but the lifecycle nested block is reserved in case any are added in future versions.

Data resources support count and for_each meta-arguments as defined for managed resources, with the same syntax and behavior.
Each instance will separately read from its data source with its own variant of the constraint arguments, producing an indexed result.

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Terraform State Introduction

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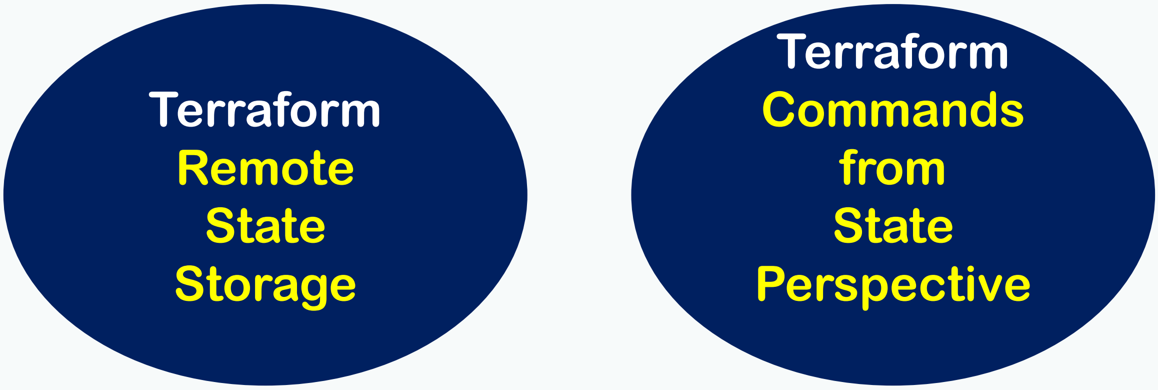
Terraform State



Terraform Remote State Storage

Terraform Commands from State Perspective

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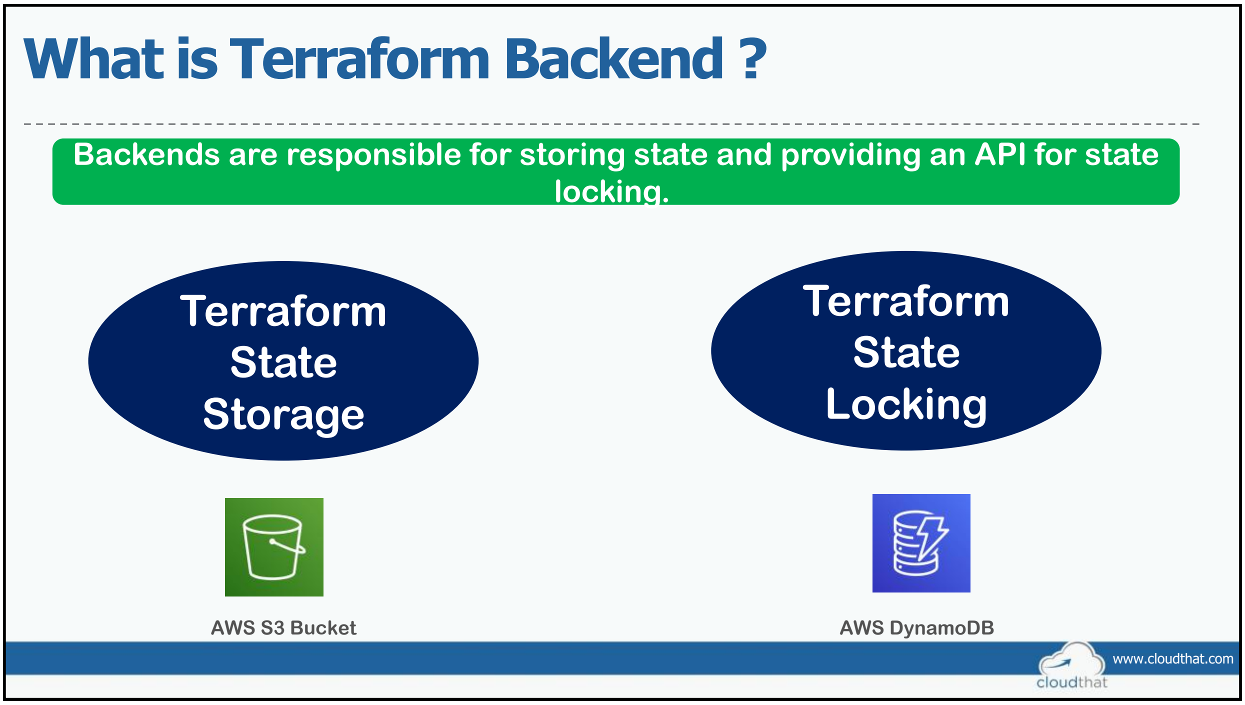


What is Terraform Backend ?

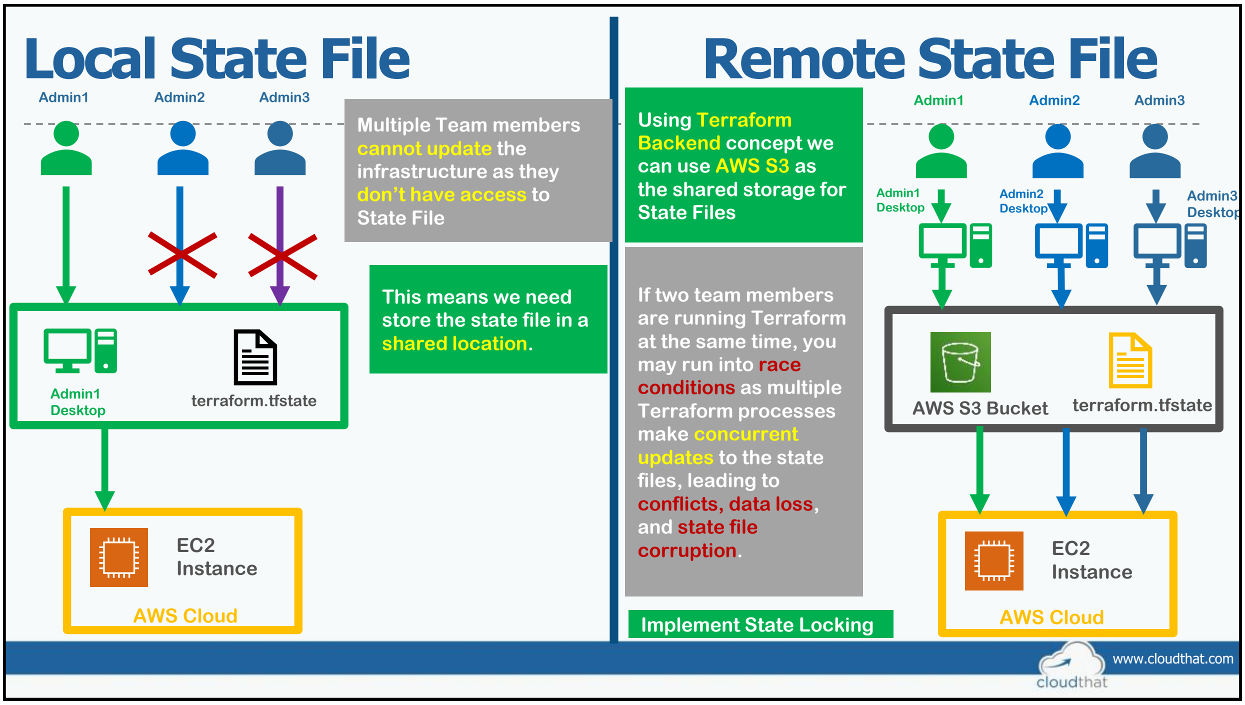
Backends are responsible for storing state and providing an API for state locking.

Terraform State Storage

Terraform State Locking

AWS S3 Bucket

AWS DynamoDB



Local State File

Multiple Team members cannot update the infrastructure as they don't have access to State File

This means we need store the state file in a shared location.

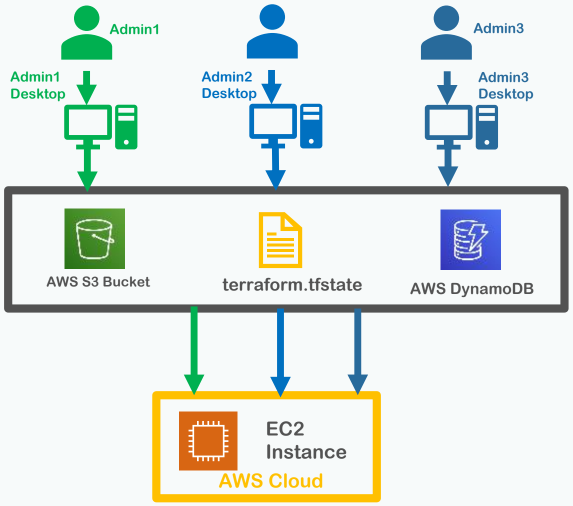
Remote State File

Using Terraform Backend concept we can use AWS S3 as the shared storage for State Files

If two team members are running Terraform at the same time, you may run into race conditions as multiple Terraform processes make concurrent updates to the state files, leading to conflicts, data loss, and state file corruption.

Implement State Locking

Terraform Remote State File with State Locking



Not all backends support State Locking. AWS S3 supports State Locking

State locking happens automatically on all operations that could write state.

If state locking fails, Terraform will not continue.

You can disable state locking for most commands with the -lock flag but it is not recommended.

If acquiring the lock is taking longer than expected, Terraform will output a status message.

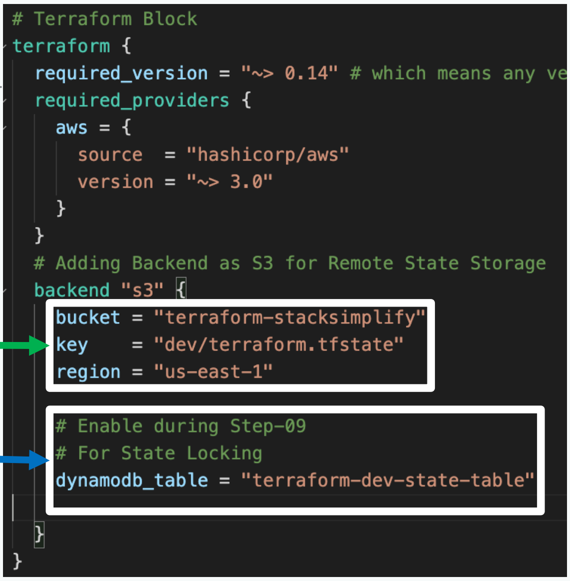
If Terraform doesn't output a message, state locking is still occurring if your backend supports it.

Terraform has a force-unlock command to manually unlock the state if unlocking failed.

Terraform Remote State File with State Locking

Terraform State Storage to Remote Backend

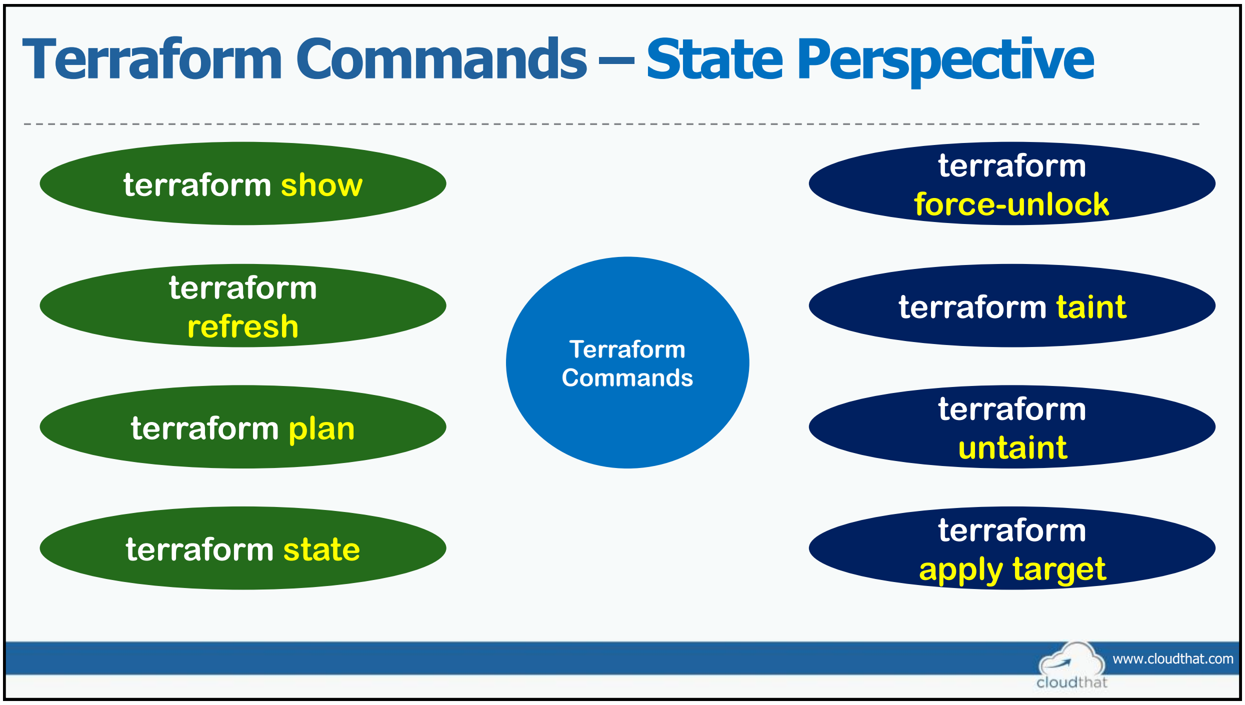
Terraform State Locking



```
# Terraform Block
terraform {
  required_version = "~> 0.14" # which means any ve
  required_providers {
    aws = {
      source  = "hashicorp/aws"
      version = "~> 3.0"
    }
  }
  # Adding Backend as S3 for Remote State Storage
  backend "s3" {
    bucket = "terraform-stacksimplify"
    key    = "dev/terraform.tfstate"
    region = "us-east-1"

    # Enable during Step-09
    # For State Locking
    dynamodb_table = "terraform-dev-state-table"

  }
}
```



Terraform Commands – State Perspective

Terraform Commands

- terraform show
- terraform refresh
- terraform plan
- terraform state
- terraform force-unlock
- terraform taint
- terraform untaint
- terraform apply target

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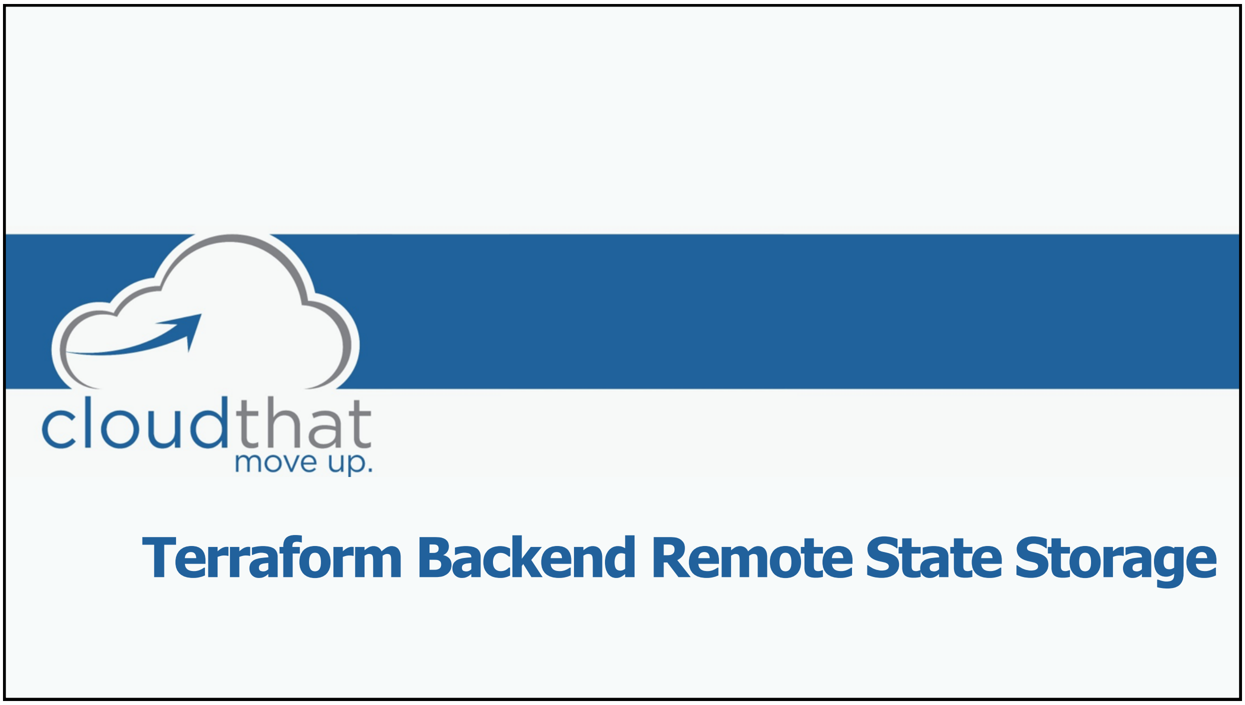

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move up.

Terraform Backend Remote State Storage

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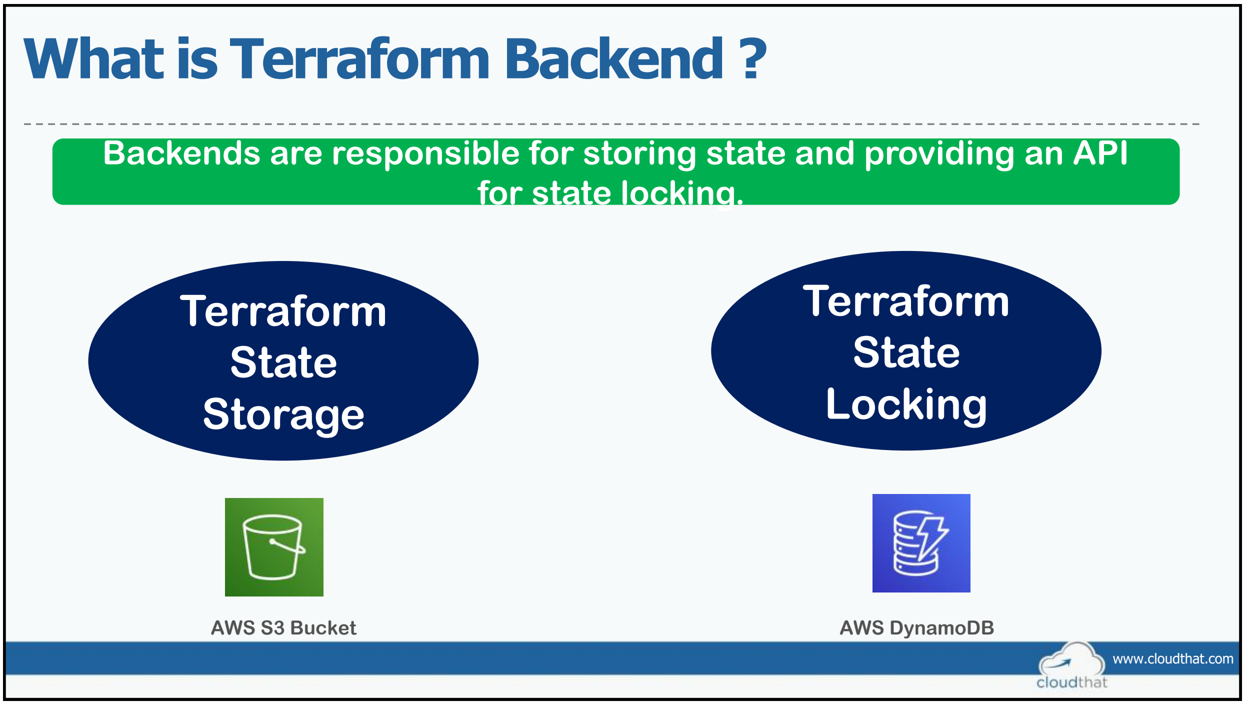

What is Terraform Backend ?

Backends are responsible for storing state and providing an API for state locking.

Terraform State Storage

Terraform State Locking

AWS S3 Bucket

AWS DynamoDB

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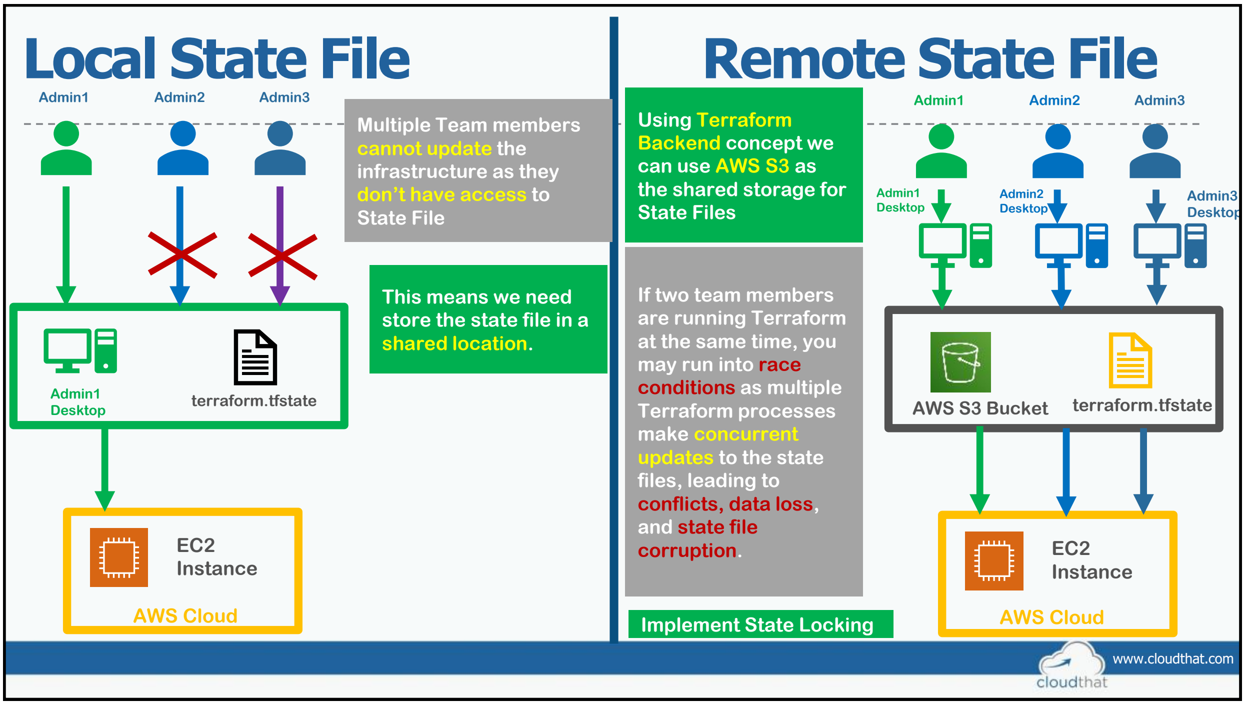

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Implement State Locking

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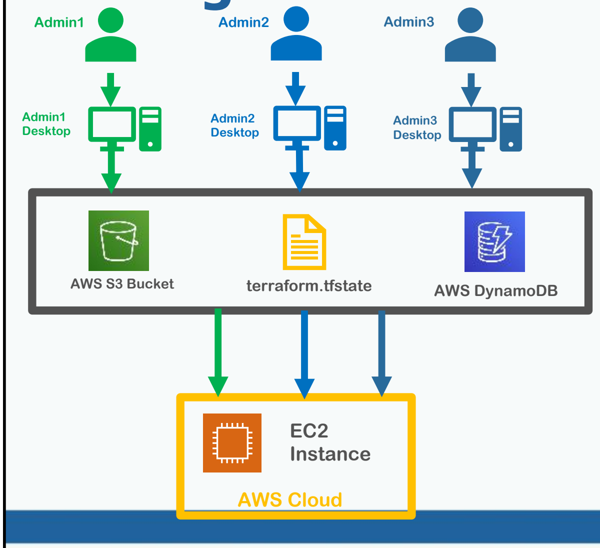
Terraform Remote State File with State Locking



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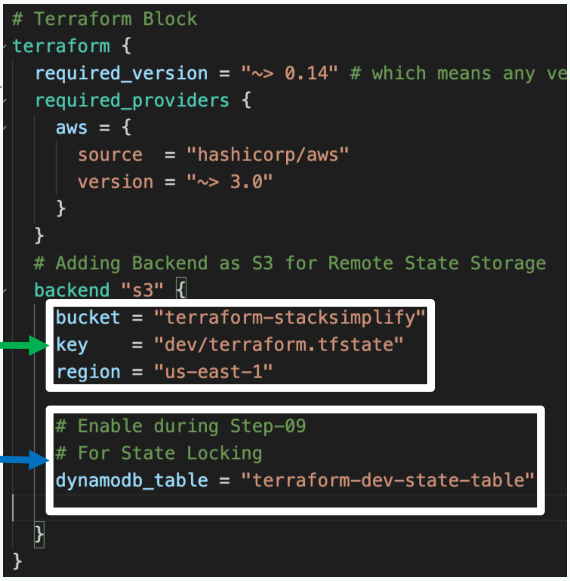
Terraform Remote State File with State Locking



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  }
}
```

Terraform State Storage to Remote Backend

Terraform State Locking

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Terraform Backends

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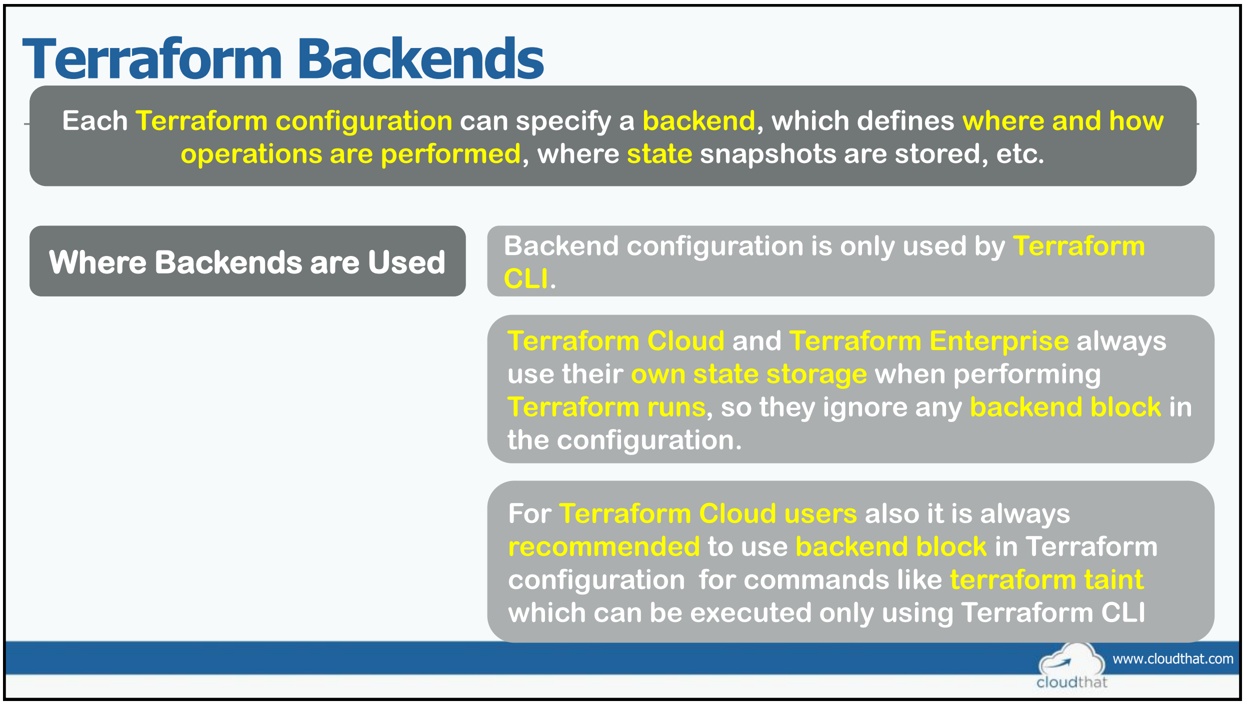

Terraform Backends

Each Terraform configuration can specify a backend, which defines where and how operations are performed, where state snapshots are stored, etc.

Where Backends are Used

Backend configuration is only used by Terraform CLI.

Terraform Cloud and Terraform Enterprise always use their own state storage when performing Terraform runs, so they ignore any backend block in the configuration.

For Terraform Cloud users also it is always recommended to use backend block in Terraform configuration for commands like terraform taint which can be executed only using Terraform CLI

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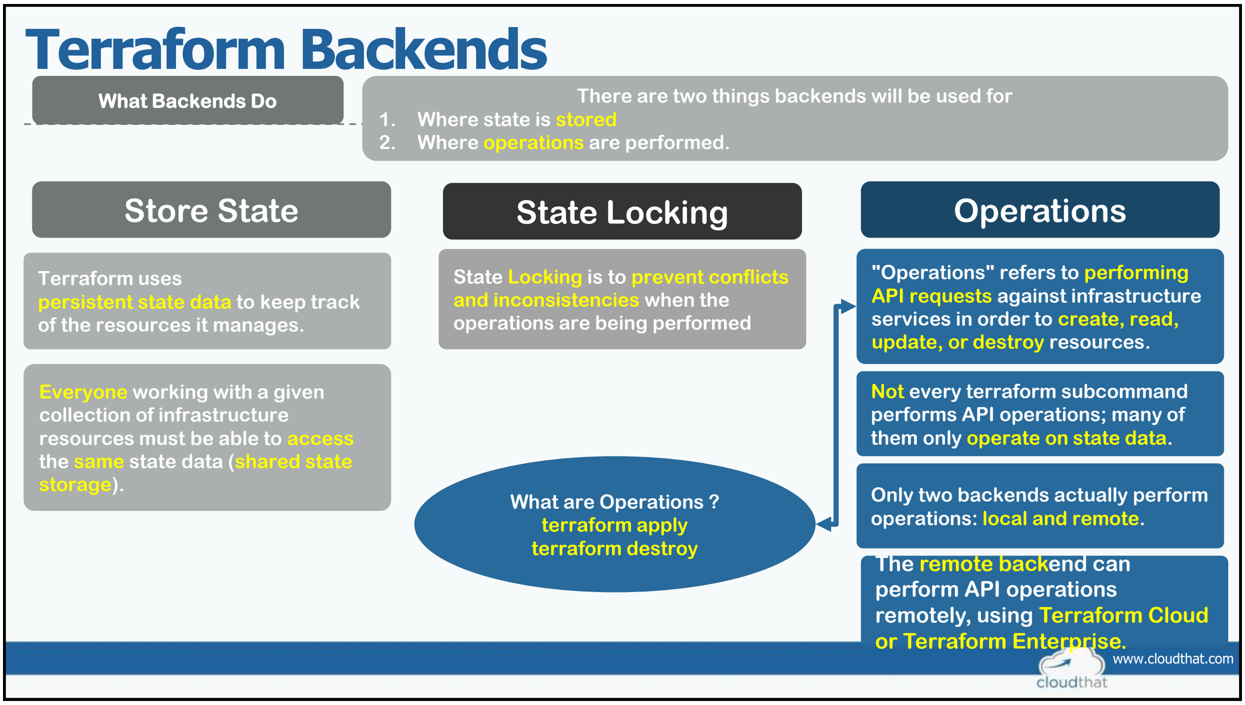

Terraform Backends

What Backends Do

There are two things backends will be used for

1. Where state is stored
2. Where operations are performed.

Store State

Terraform uses persistent state data to keep track of the resources it manages.

Everyone working with a given collection of infrastructure resources must be able to access the same state data (shared state storage).

State Locking

State Locking is to prevent conflicts and inconsistencies when the operations are being performed

What are Operations ?
terraform apply
terraform destroy

Operations

"Operations" refers to performing API requests against infrastructure services in order to create, read, update, or destroy resources.

Not every terraform subcommand performs API operations; many of them only operate on state data.

Only two backends actually perform operations: local and remote.

The remote backend can perform API operations remotely, using Terraform Cloud or Terraform Enterprise.

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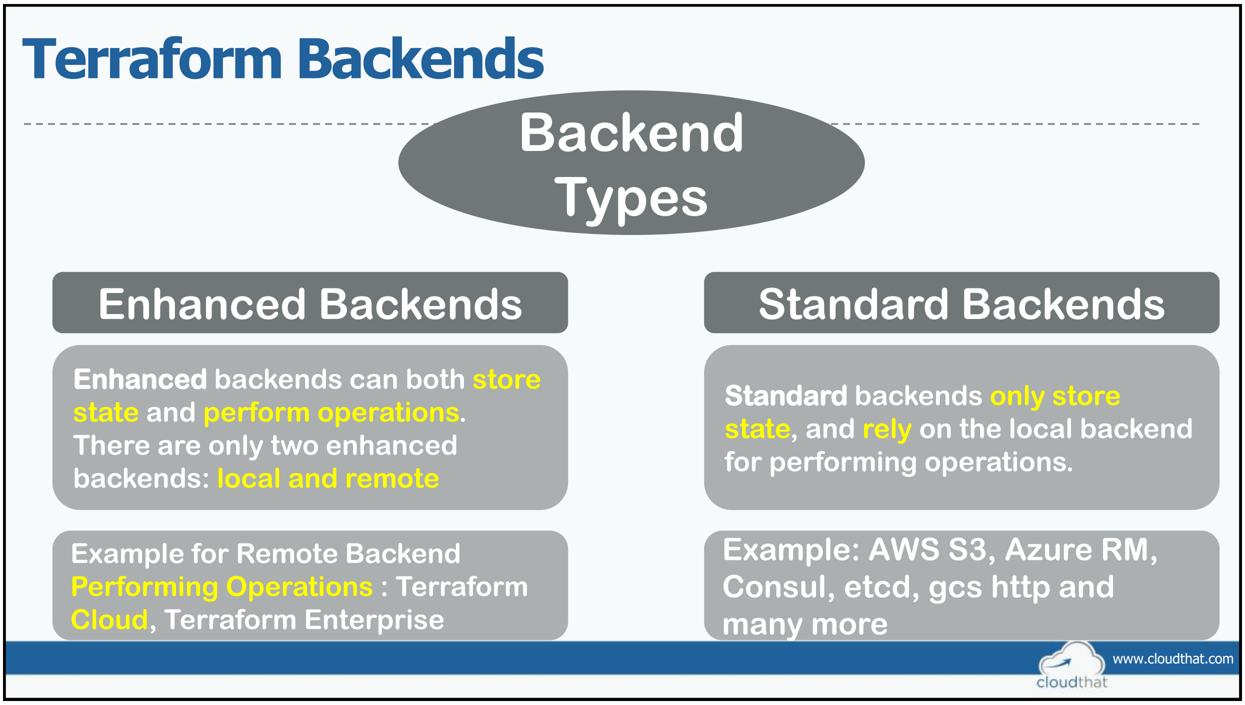

Terraform Backends

Backend Types

Enhanced Backends

Enhanced backends can both store state and perform operations. There are only two enhanced backends: local and remote

Example for Remote Backend Performing Operations : Terraform Cloud, Terraform Enterprise

Standard Backends

Standard backends only store state, and rely on the local backend for performing operations.

Example: AWS S3, Azure RM, Consul, etcd, gcs http and many more

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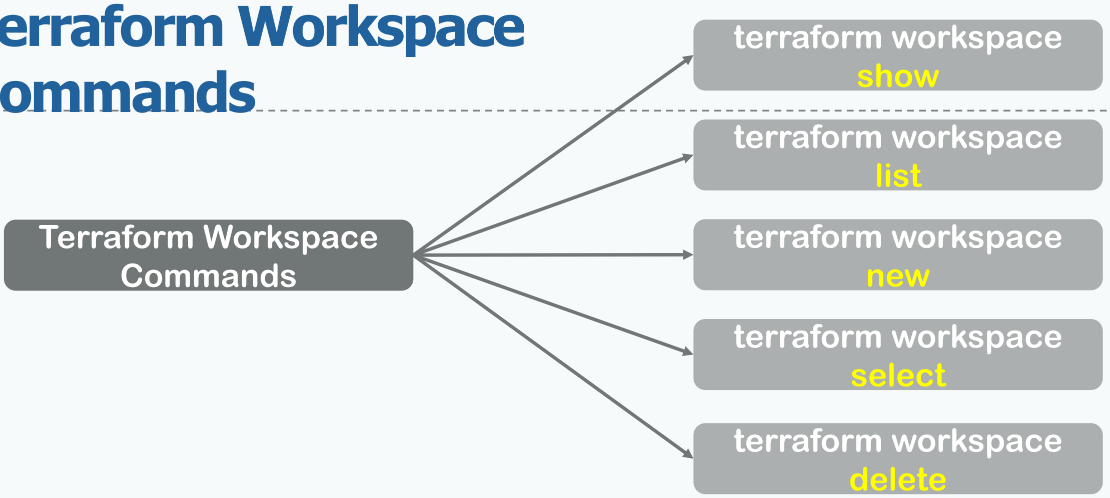
Terraform Workspace Commands


Terraform Workspace Commands
terraform workspace show
terraform workspace list
terraform workspace new
terraform workspace select
terraform workspace delete

Usecase-1: Local Backend

Usecase-2: Remote Backend

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Terraform Provisioners

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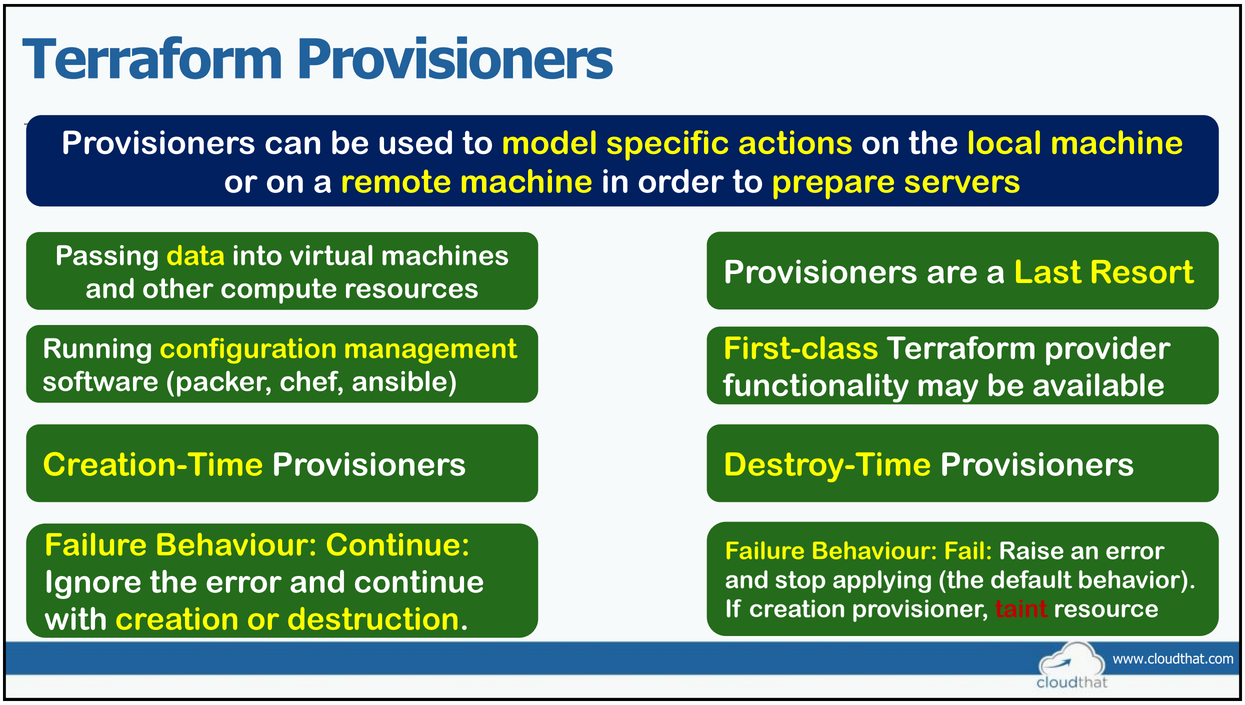

Terraform Provisioners

Provisioners can be used to model specific actions on the local machine or on a remote machine in order to prepare servers

Passing data into virtual machines and other compute resources

Running configuration management software (packer, chef, ansible)

Creation-Time Provisioners

Failure Behaviour: Continue: Ignore the error and continue with creation or destruction.

Provisioners are a Last Resort

First-class Terraform provider functionality may be available

Destroy-Time Provisioners

Failure Behaviour: Fail: Raise an error and stop applying (the default behavior). If creation provisioner, taint resource

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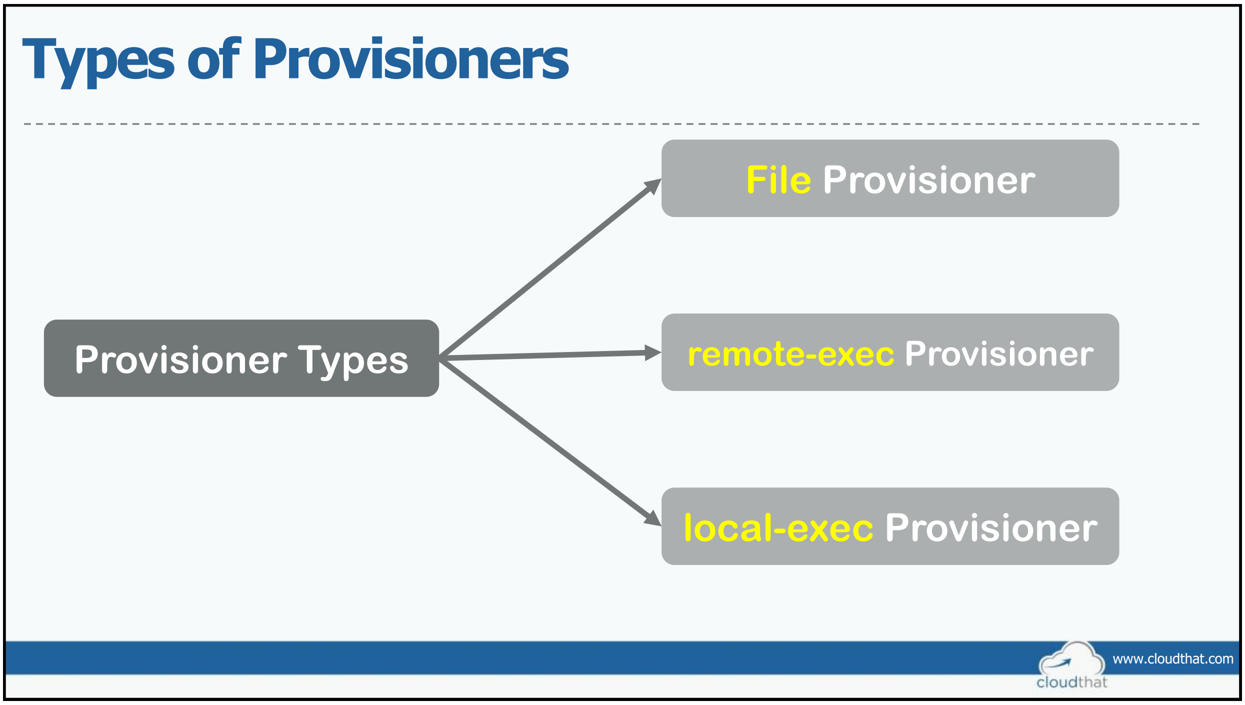

Types of Provisioners

Provisioner Types

File Provisioner

remote-exec Provisioner

local-exec Provisioner

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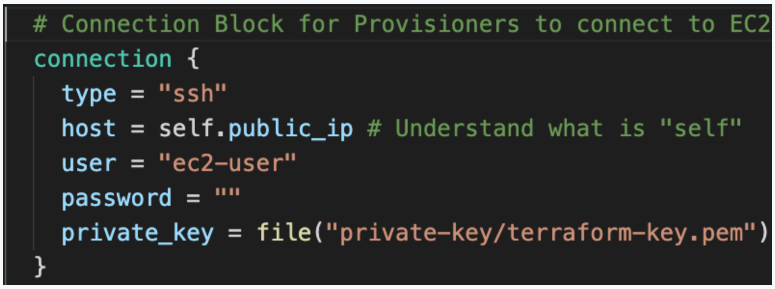
Connection Block

Most provisioners require access to the remote resource via SSH or WinRM, and expect a nested connection block with details about how to connect.

Expressions in connection blocks cannot refer to their parent resource by name. Instead, they can use the special self object.



```
# Connection Block for Provisioners to connect to EC2
connection {
  type = "ssh"
  host = self.public_ip # Understand what is "self"
  user = "ec2-user"
  password = ""
  private_key = file("private-key/terraform-key.pem")
}
```

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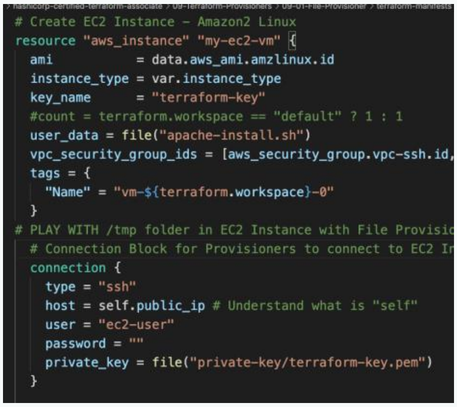
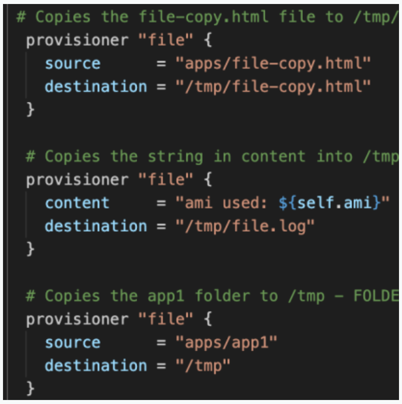
File Provisioner

File Provisioner

- File Provisioner is used to copy files or directories from the machine executing Terraform to the newly created resource.
- The file provisioner supports both ssh and winrm type of connections


› hashicorp-certified-terraform-associate › 09-Terraform-Provisioners › 09-01-File-Provisioner › terraform-manifests

```
# Create EC2 Instance - Amazon2 Linux
resource "aws_instance" "my-ec2-vm" {
  ami           = data.aws_ami.amzlinux.id
  instance_type = var.instance_type
  key_name      = "terraform-key"
  #count = terraform.workspace == "default" ? 1 : 1
  user_data = file("apache-install.sh")
  vpc_security_group_ids = [aws_security_group.vpc-ssh.id,
  tags = {
    "Name" = "vm-${terraform.workspace}-0"
  }
# PLAY WITH /tmp folder in EC2 Instance with File Provisic
  # Connection Block for Provisioners to connect to EC2 Ir
  connection {
    type = "ssh"
    host = self.public_ip # Understand what is "self"
    user = "ec2-user"
    password = ""
    private_key = file("private-key/terraform-key.pem")
  }
```



```
# Copies the file-copy.html file to /tmp/
 provisioner "file" {
   source      = "apps/file-copy.html"
   destination = "/tmp/file-copy.html"
 }

 # Copies the string in content into /tmp
 provisioner "file" {
   content     = "ami used: ${self.ami}"
   destination = "/tmp/file.log"
 }

 # Copies the app1 folder to /tmp - FOLDE
 provisioner "file" {
   source      = "apps/app1"
   destination = "/tmp"
 }
```

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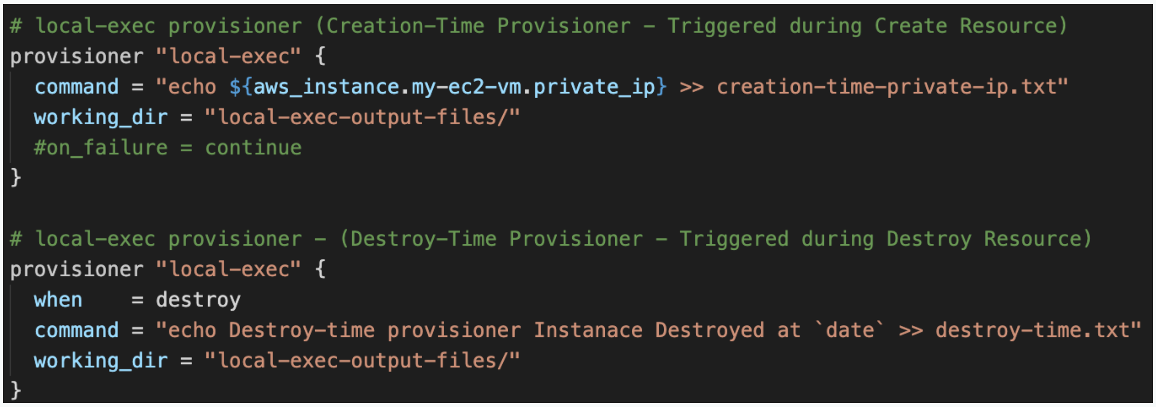
local-exec Provisioner

local-exec Provisioner

- The local-exec provisioner invokes a local executable after a resource is created.
- This invokes a process on the machine running Terraform, not on the resource.



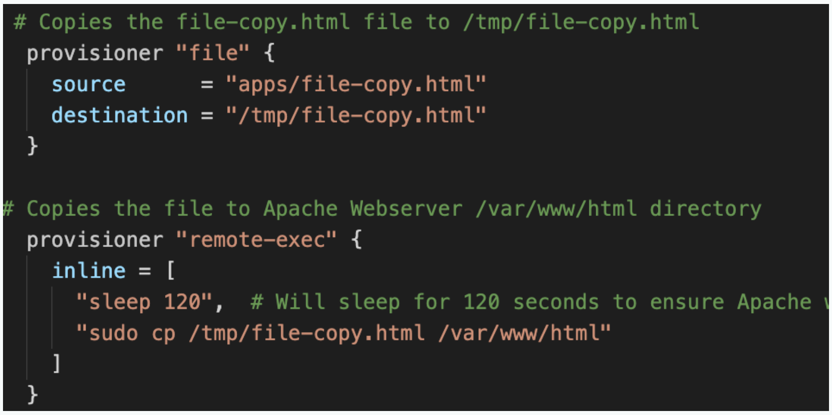
```
# local-exec provisioner (Creation-Time Provisioner - Triggered during Create Resource)
provisioner "local-exec" {
  command = "echo ${aws_instance.my-ec2-vm.private_ip} >> creation-time-private-ip.txt"
  working_dir = "local-exec-output-files/"
  #on_failure = continue
}

# local-exec provisioner - (Destroy-Time Provisioner - Triggered during Destroy Resource)
provisioner "local-exec" {
  when    = destroy
  command = "echo Destroy-time provisioner Instanace Destroyed at `date` >> destroy-time.txt"
  working_dir = "local-exec-output-files/"
}
```

remote-exec Provisioner

remote-exec Provisioner

- The remote-exec provisioner invokes a script on a remote resource after it is created.
- This can be used to run a configuration management tool, bootstrap into a cluster, etc.



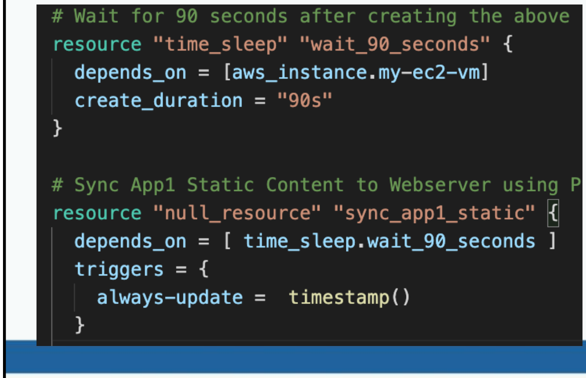
```
# Copies the file-copy.html file to /tmp/file-copy.html
 provisioner "file" {
   source      = "apps/file-copy.html"
   destination = "/tmp/file-copy.html"
 }

# Copies the file to Apache Webserver /var/www/html directory
 provisioner "remote-exec" {
   inline = [
     "sleep 120",  # Will sleep for 120 seconds to ensure Apache
     "sudo cp /tmp/file-copy.html /var/www/html"
   ]
 }
```

Null-Resource & Provisioners

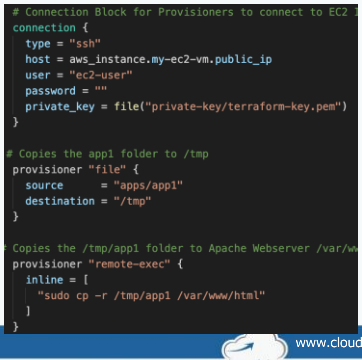
null_resource

- If you need to run provisioners that aren't directly associated with a specific resource, you can associate them with a null_resource.
- Instances of null_resource are treated like normal resources, but they don't do anything.
- Same as other resource, you can configure provisioners and connection details on a null_resource.



```
# Wait for 90 seconds after creating the above
resource "time_sleep" "wait_90_seconds" {
  depends_on = [aws_instance.my-ec2-vm]
  create_duration = "90s"
}

# Sync App1 Static Content to Webserver using P
resource "null_resource" "sync_app1_static" {
  depends_on = [ time_sleep.wait_90_seconds ]
  triggers = {
    always-update =  timestamp()
  }
```



```
# Connection Block for Provisioners to connect to EC2
connection {
  type = "ssh"
  host = aws_instance.my-ec2-vm.public_ip
  user = "ec2-user"
  password = ""
  private_key = file("private-key/terraform-key.pem")
}

# Copies the app1 folder to /tmp
provisioner "file" {
  source      = "apps/app1"
  destination = "/tmp"
}

# Copies the /tmp/app1 folder to Apache Webserver /var/ww
provisioner "remote-exec" {
  inline = [
    "sudo cp -r /tmp/app1 /var/www/html"
  ]
}
```

Thanks