



{KODE}{CLOUD}

Objectives

Introduction
to IaC

Types of
IaC Tools

Why
Terraform?

HCL
Basics

Provision,
Update and
Destory

Providers

Input
Variables

Output
Variables

Resource
Attributes

Resource
Dependencies

Objectives

Terraform
State

Commands

Mutable vs
Immutable

LifeCycle
Rules

Datasources

Meta-
Arguments

count

for-each

Version
Constraints

AWS Basics

Objectives

Programmatic Access

IAM Basics

IAM with Terraform

Introduction to S3

S3 with Terraform

Introduction to
DynamoDB

DynamoDB
with
Terraform

Objectives

Remote
State

State Locking

Remote
Backend with
S3

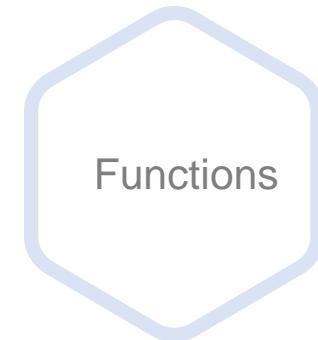
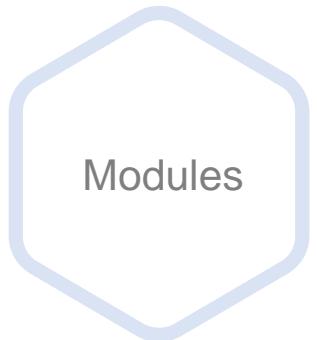
State
Commands

Introduction
to EC2

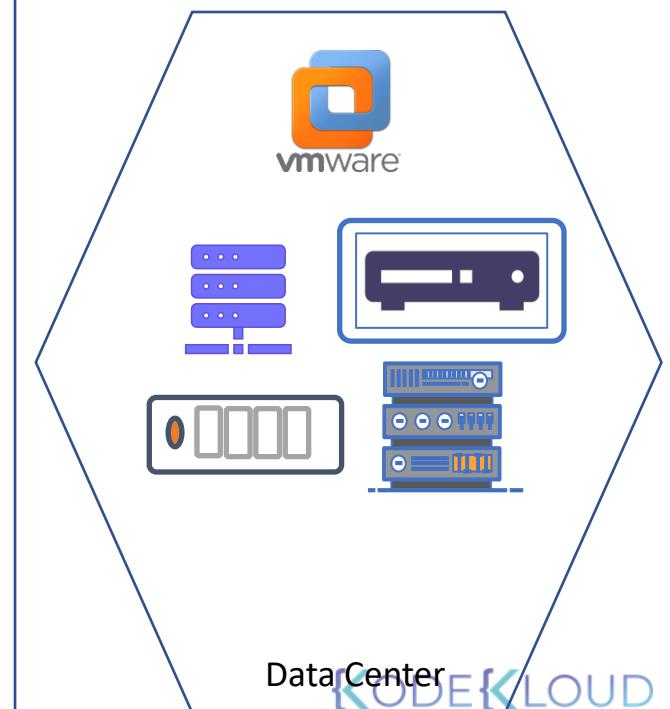
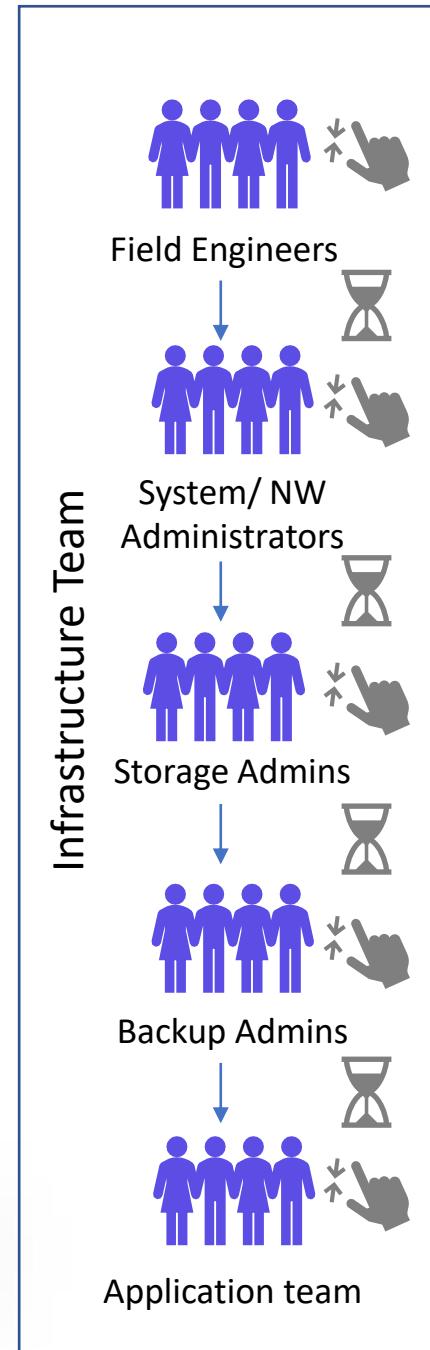
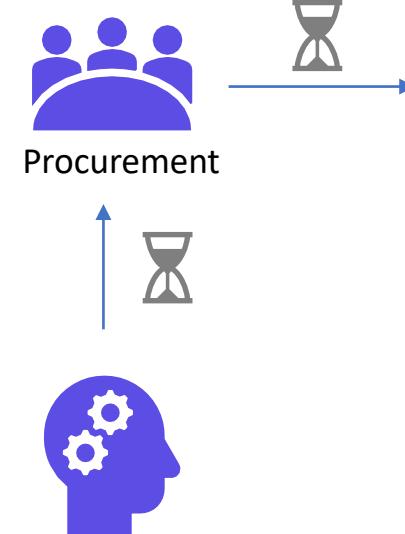
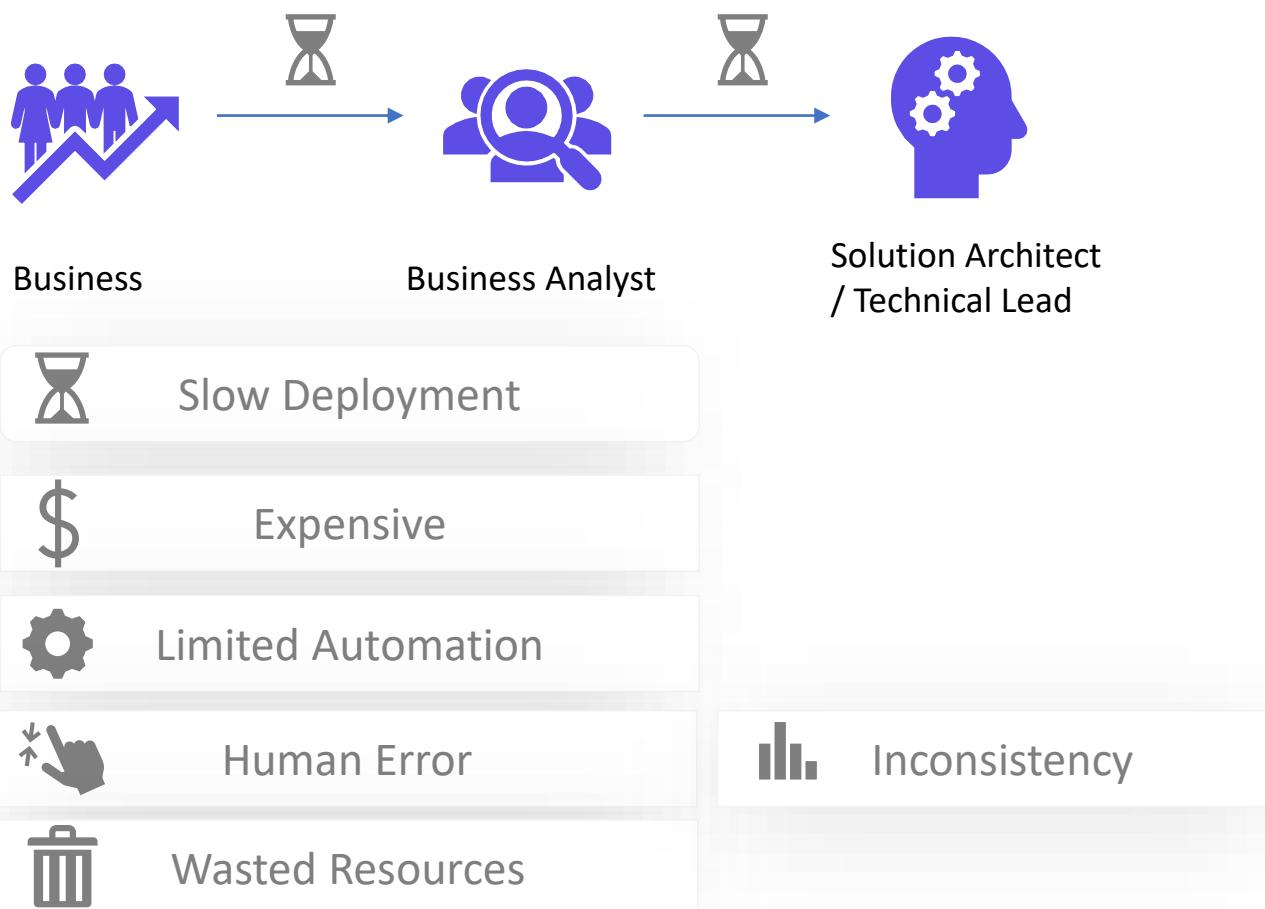
AWS EC2
With
Terraform

Provisioners

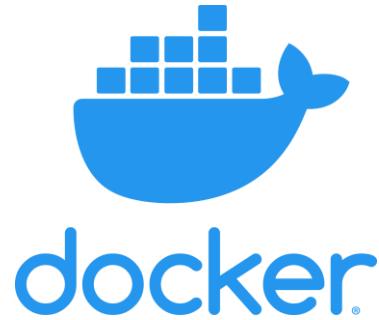
Objectives



Traditional IT & Challenges



Types of IAC Tools



SALTSTACK

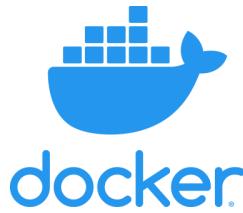


Types of IAC Tools

Configuration Management



Server Templating



Provisioning Tools



Types of IAC Tools

Configuration Management



ANSIBLE



Designed to Install and Manage Software

Maintains Standard Structure

Version Control

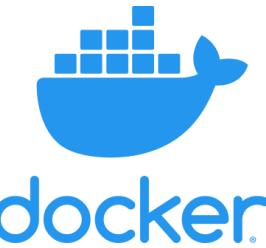
Idempotent

Server Templating Tools

Pre Installed Software and Dependencies

Virtual Machine or Docker Images

Immutable Infrastructure



Provisioning Tools

Deploy Immutable Infrastructure resources

Servers, Databases, Network Components etc.

Multiple Providers

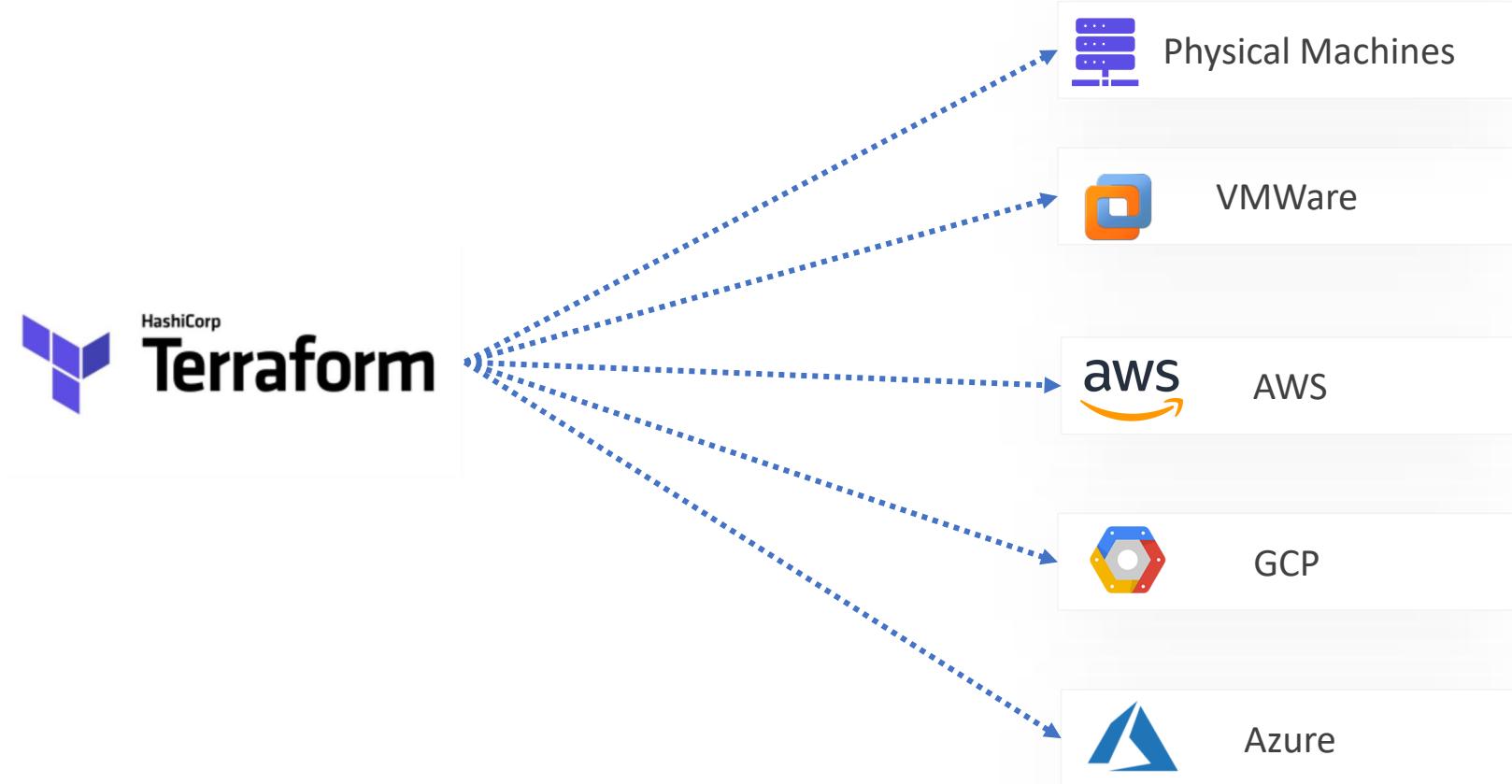




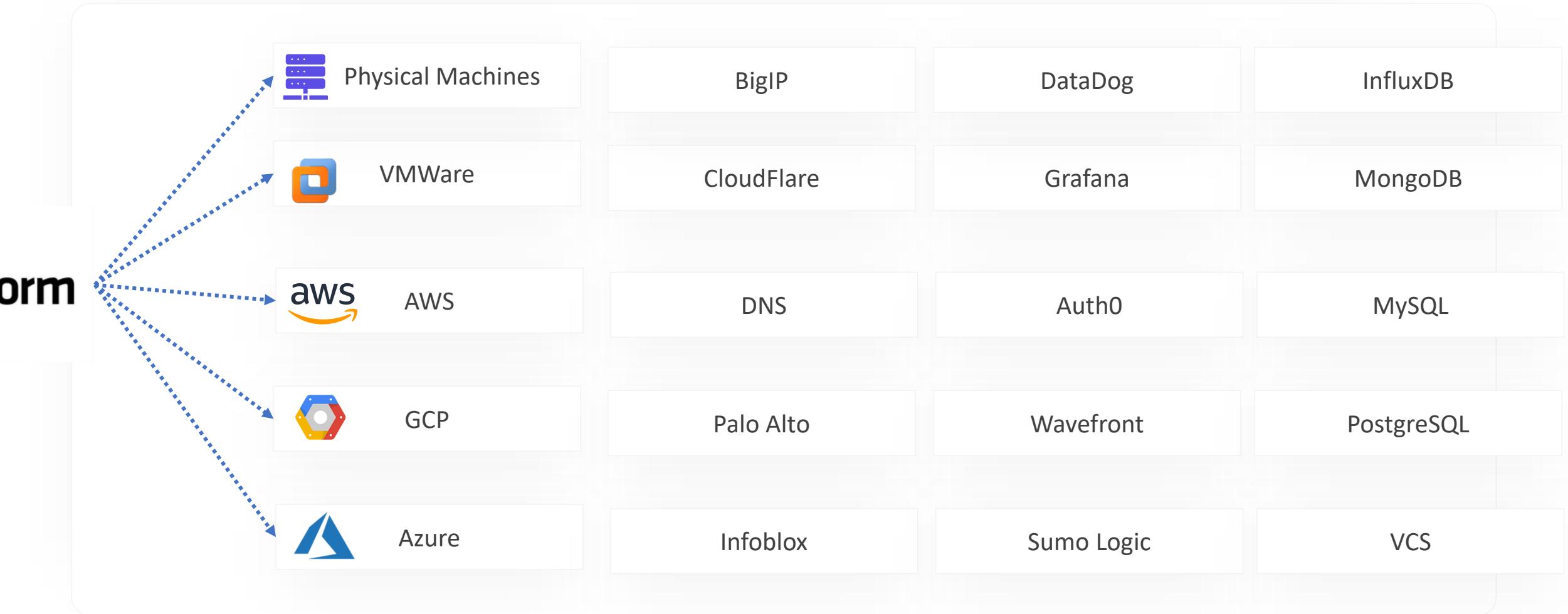
{KODE}{CLOUD}

Terraform

Why Terraform?



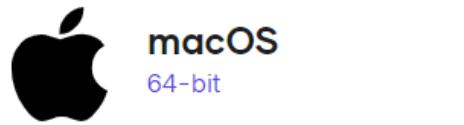
Providers



Installing Terraform

>_

```
$ wget https://releases.hashicorp.com/terraform/0.13.0/terraform_0.13.0_linux_amd64.zip  
$ unzip terraform_0.13.0_linux_amd64.zip  
$ mv terraform /usr/local/bin  
$ terraform version  
Terraform v0.13.0
```



macOS

64-bit



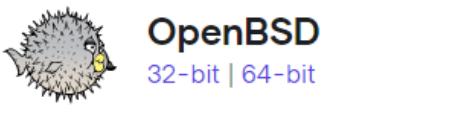
FreeBSD

32-bit | 64-bit | Arm



Linux

32-bit | 64-bit | Arm



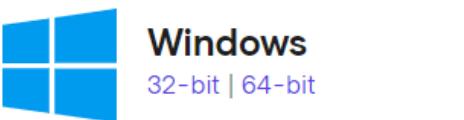
OpenBSD

32-bit | 64-bit



Solaris

64-bit



Windows

32-bit | 64-bit

HCL – Declarative Language

```
aws.tf
```

```
resource "aws_instance" "webserver" {
    ami = "ami-0c2f25c1f66a1ff4d"
    instance_type = "t2.micro"
}
```

HCL Basics

```
>_
```

```
$ mkdir /root/terraform-local-file  
$ cd /root/terraform-local-file
```

```
local.tf
```

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
}
```





aws-ec2.tf

```
resource "aws_instance" "webserver" {
    ami = "ami-0c2f25c1f66a1ff4d"
    instance_type = "t2.micro"
}
```



aws-s3.tf

```
resource "aws_s3_bucket" "data" {
    bucket = "webserver-bucket-org-2207"
    acl    = "private"
}
```



local.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
}
```



local.tf

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content = "We love pets!"
}
```



```
>_
```

```
$ terraform init
```

```
Initializing the backend...
```

```
Initializing provider plugins...
```

```
..- Finding latest version of hashicorp/local...-----
```

```
- Installing hashicorp/local v1.4.0...
```

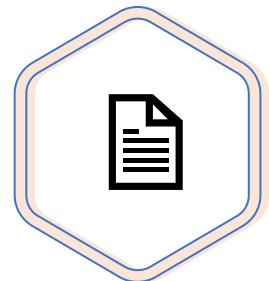
```
- Installed hashicorp/local v1.4.0 (signed by HashiCorp)
```

```
The following providers do not have any version constraints in configuration,
so the latest version was installed.
```

```
To prevent automatic upgrades to new major versions that may contain breaking
changes, we recommend adding version constraints in a required_providers block
in your configuration, with the constraint strings suggested below.
```

```
* hashicorp/local: version = "~> 1.4.0"
```

```
Terraform has been successfully initialized!
```



```
>_
```

```
$ terraform plan
```

```
Refreshing Terraform state in-memory prior to plan...
The refreshed state will be used to calculate this plan, but will not be
persisted to local or remote state storage.
```

```
-----
```

```
An execution plan has been generated and is shown below.
```

```
Resource actions are indicated with the following symbols:
```

```
[+ create]
```

```
Terraform will perform the following actions:
```

```
# local_file.pet will be created
+ resource "local_file" "pet" {
    + content          = "We love pets!"
    + directory_permission = "0777"
    + file_permission      = "0777"
    + filename           = "/root/pets.txt"
    + id                 = (known after apply)
}
```

```
Plan: 1 to add, 0 to change, 0 to destroy.
```

```
-----
```

```
Note: You didn't specify an "-out" parameter to save this plan, so
Terraform
can't guarantee that exactly these actions will be performed if
"terraform apply" is subsequently run.
```



```
>_
```

```
$ terraform apply
```

An execution plan has been generated and is shown below.

Resource actions are indicated with the following symbols:

+ create

Terraform will perform the following actions:

```
[... # local_file.pet will be created]
+ resource "local_file" "pet" {
    + content          = "We love pets!"
    + directory_permission = "0777"
    + file_permission   = "0777"
    + filename         = "/root/pets.txt"
    + id               = (known after apply)
}
```

Plan: 1 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 ...]
local_file.new_file: Creating...
local_file.new_file: Creation complete after 0s
[id=521c5c732c78cb42cc9513ecc7c0638c4a115b55]
[Apply complete! Resources: 1 added, 0 changed, 0 destroyed.]
```

```
$ cat /root/pets.txt
```

We love pets!

>_

```
$ terraform show  
# local_file.pet:  
resource "local_file" "pet" {  
    content          = "We love pets!"  
    directory_permission = "0777"  
    file_permission      = "0777"  
    filename           = "/root/pets.txt"  
    id                 = "cba595b7d9f94ba1107a46f3f731912d95fb3d2c"  
}
```





A screenshot of a terminal window titled "local.tf". The code inside defines a local file resource named "pet" with a filename of "/root/pets.txt" and content "We love pets!".

```
resource("local_file") "pet" {
  filename = "/root/pets.txt"
  content = "We love pets!"
}
```



provider



resource_type



Arguments

Argument-1

Argument-1

Argument-1

Argument-2

Argument-2

Argument-2

Argument-X

Argument-X

Argument-X



Argument-1

Argument-1

Argument-1

Argument-2

Argument-2

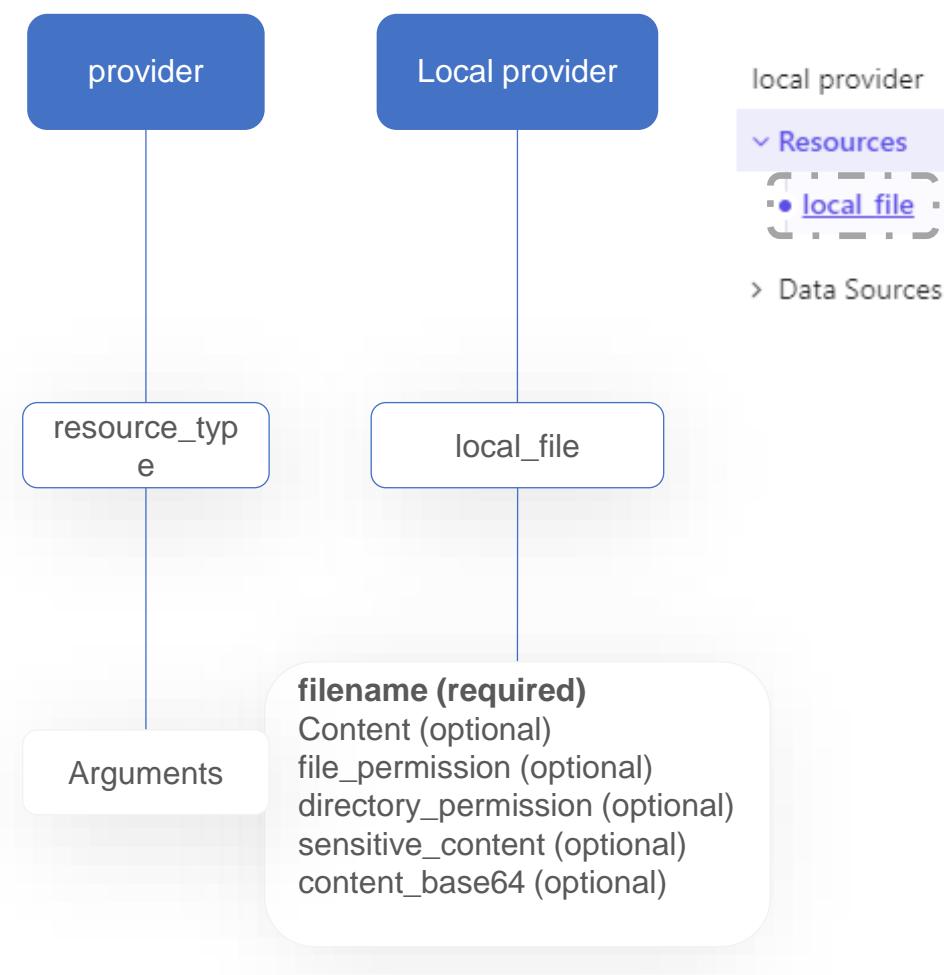
Argument-2

Argument-X

Argument-X

Argument-X





Argument Reference

The following arguments are supported:

- `content` - (Optional) The content of file to create. Conflicts with `sensitive_content` .
- `sensitive_content` - (Optional) The content of file to create. Will not be encoded. Conflicts with `content` and `content_base64` .
- `content_base64` - (Optional) The base64 encoded content of the file to create when dealing with binary data. Conflicts with `content` and `sensitive_content` .
-  `filename` - (Required) The path of the file to create.
- `file_permission` - (Optional) The permission to set for the created file. Expects a string. The default value is `"0777"` .
- `directory_permission` - (Optional) The permission to set for any directories in the path. Expects a string. The default value is `"0777"` .

Update and Destroy Infrastructure

local.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
    file_permission = "0700"  
}
```



```
$ terraform plan
```

```
local_file.pet: Refreshing state...  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]
```

```
-----  
An execution plan has been generated and is shown below.  
Resource actions are indicated with the following symbols:  
-/+ destroy and then create replacement
```

```
Terraform will perform the following actions:
```

```
  # local_file.pet must be replaced  
-/+ resource "local_file" "pet" {  
    content          = "We love pets!"  
    directory_permission = "0777"  
    file_permission   = "0777" -> "0700" # forces replacement  
    filename         = "/root/pet.txt"  
    ~ id             =  
"5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf" -> (known after apply)  
}  
-----  
Plan: 1 to add, 0 to change, 1 to destroy.  
-----
```

```
Note: You didn't specify an "-out" parameter to save this plan, so  
Terraform  
can't guarantee that exactly these actions will be performed if  
"terraform apply" is subsequently run.
```

>_

```
$ ls -ltr /root/pets.txt  
-rwx----- 1 root root 30 Aug 17 23:20 pet.txt
```



>_

```
$ terraform apply
```

```
# local_file.pet must be replaced  
-/+ resource "local_file" "pet" {  
    content          = "We love pets!"  
    directory_permission = "0777"  
    ~ file_permission     = "0777" -> "0700" # forces replacement  
    filename         = "/root/pet.txt"  
    ~ id              =  
    "5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf" -> (known after apply)  
}
```

```
Plan: 1 to add, 0 to change, 1 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

```
local_file.pet: Destroying...  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]  
local_file.pet: Destruction complete after 0s  
local_file.pet: Creating...  
local_file.pet: Creation complete after 0s  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]
```

```
Apply complete! Resources: 1 added, 0 changed, 1 destroyed.
```

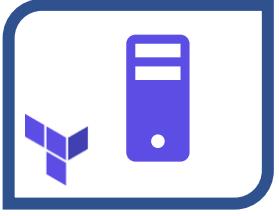
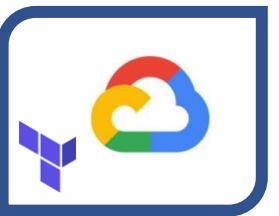


```
> _  
$ terraform destroy  
local_file.pet: Refreshing state...  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]  
  
An execution plan has been generated and is shown below.  
Resource actions are indicated with the following symbols:  
- destroy  
  
Terraform will perform the following actions:  
  
  # local_file.pet will be destroyed  
- resource "local_file" "pet" {  
    content          = "My favorite pet is a gold fish" -> null  
    directory_permission = "0777" -> null  
    file_permission     = "0700" -> null  
    filename           = "/root/pet.txt" -> null  
    id                = "5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf" -> null  
}  
  
Plan: 0 to add, 0 to change, 1 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  
  
local_file.pet: Destroying... [id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]  
local_file.pet: Destruction complete after 0s  
-----  
Destroy complete! Resources: 1 destroyed.  
!
```

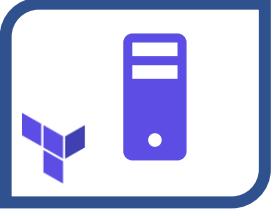
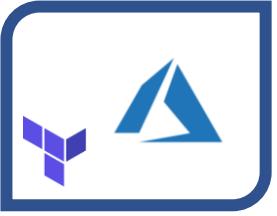
Using Terraform Providers

```
>_
```

```
$ terraform init
```



Official



Verified



bigip

by: F5Networks



heroku

by: heroku



[digitalocean](#)

by: [digitalocean](#)

Community



activedirectory



ucloud



netapp-gcp

```
>_
```

```
$ terraform init
```

```
Initializing the backend...
```

```
Initializing provider plugins...
```

```
- Finding latest version of hashicorp/local...
```

```
[ - Installing hashicorp/local v2.0.0...
```

```
[ - Installed hashicorp/local v2.0.0 (signed by HashiCorp)
```

```
The following providers do not have any version constraints in  
configuration,  
so the latest version was installed.
```

```
To prevent automatic upgrades to new major versions that may  
contain breaking  
changes, we recommend adding version constraints in a  
required_providers block  
in your configuration, with the constraint strings suggested  
below.
```

```
* hashicorp/local: version = "~> 2.0.0"
```

```
Terraform has been successfully initialized!
```

```
>_
```

```
$ ls /root/terraform-local-file/.terraform  
plugins
```

To prevent automatic upgrades to new major versions from containing breaking changes, we recommend adding version constraints to your required_providers block in your configuration, with the constraint below.

```
* [hashicorp/local]: version = "~> 2.0.0"
```

Organizational
Namespace

Type

Terraform has been successfully initialized!

To prevent automatic upgrades to new major versions from containing breaking changes, we recommend adding version constraints to your required_providers block in your configuration, with the constraints shown below.

```
* provider "aws" {  
    version = "2.7.0"  
}
```

Hostname

Organizational Namespace

Type

Terraform has been successfully initialized!

Initializing provider plugins...

- Finding latest version of hashicorp/local...
 - **Installing hashicorp/local v2.0.0...**
 - **Installed hashicorp/local v2.0.0 (signed by HashiCorp)**
-

The following providers do not have any version configuration,
so the latest version was installed.

To prevent automatic upgrades to new major versions
contain breaking
changes, we recommend adding version constraint
required_providers block

Configuration Directory

```
>_
```

```
[terraform-local-file]$ ls /root/terraform-local-file  
local.tf
```

local.tf

```
resource "local_file" "pet" {  
  filename = "/root/pets.txt"  
  content = "We love pets!"  
}
```

cat.tf

```
resource "local_file" "cat" {  
  filename = "/root/cat.txt"  
  content = "My favorite pet is Mr. Whiskers"  
}
```

local.tf

cat.tf

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
}  
  
resource "local_file" "cat" {  
    filename = "/root/cat.txt"  
    content = "My favorite pet is Mr. Whiskers"  
}
```

File Name	Purpose
main.tf	Main configuration file containing resource definition
variables.tf	Contains variable declarations
outputs.tf	Contains outputs from resources
provider.tf	Contains Provider definition

Multiple Providers

main.tf

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content = "We love pets!"
}
```



```
main.tf
```

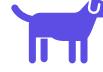
```
resource "local_file" "pet" {
    filename = "/root/pets.txt"
    content = "We love pets!"
}

resource "random_pet" "my-pet" {
    prefix = "Mrs"
    separator = "."
    length = "1"
}
```



random provider

Resources

- random_id
- random_integer
- random_password
- random_pet
- random_shuffle
- random_string
- random_uuid 

Argument Reference

The following arguments are supported:

- `keepers` - (Optional) Arbitrary map of values that, when provided, will be used to generate random values. See [the main provider documentation](#) for more information.
- `length` - (Optional) The length (in words) of the pet's name.
- `prefix` - (Optional) A string to prefix the name with.
- `separator` - (Optional) The character to separate words in the generated name.

>_

```
$ terraform plan
```

```
Refreshing Terraform state in-memory prior to plan...
```

```
The refreshed state will be used to calculate this plan, but  
will not be  
persisted to local or remote state storage.
```

```
local_file.pet: Refreshing state...
```

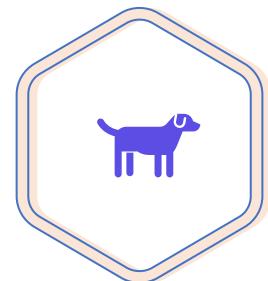
```
[id=d1a31467f206d6ea8ab1cad382bc106bf46df69e]
```

```
.
```

```
.
```

```
# random_pet.my-pet will be created  
+ resource "random_pet" "my-pet" {  
    + id      = (known after apply)  
    + length   = 1  
    + prefix    = "Mrs"  
    + separator = "."  
}
```

```
Plan: 1 to add, 0 to change, 0 to destroy.
```



>_

```
$ terraform init
```

Initializing the backend...

Initializing provider plugins...

- Using previously-installed hashicorp/local v2.0.0
- Finding latest version of hashicorp/random...
- Installing hashicorp/random v2.3.0...
 -
- Installed hashicorp/random v2.3.0 (signed by HashiCorp)

The following providers do not have any version constraints in configuration,
so the latest version was installed.

To prevent automatic upgrades to new major versions that may contain breaking changes, we recommend adding version constraints in a required_providers block in your configuration, with the constraint strings suggested below.

- * hashicorp/local: version = "~> 2.0.0"
- * hashicorp/random: version = "~> 2.3.0"

Terraform has been successfully initialized!



>_

```
$ terraform apply
```

```
local_file.new_file: Refreshing state...
[id=d1a31467f206d6ea8ab1cad382bc106bf46df69e]
```

An execution plan has been generated and is shown below.
Resource actions are indicated with the following symbols:
+ create

Terraform will perform the following actions:

```
# random_pet.my-pet will be created
+ resource "random_pet" "my-pet" {
    + id      = (known after apply)
    + length  = 1
    + prefix   = "Mrs"
    + separator = "."
}
```

Plan: 1 to add, 0 to change, 0 to destroy.

```
random_pet.my-pet: Creating...
random_pet.my-pet: Creation complete after 0s [id=Mrs.hen]
```

Apply complete! Resources: 1 added, 0 changed, 0 destroyed.



Mrs.hen

Define Input Variables

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
}  
  
resource "random_pet" "my-pet" {  
    prefix = "Mrs"  
    separator = ":"  
    length = "1"  
}
```

Argument	Value
filename	"/root/pets.txt"
content	"We love pets!"
prefix	"Mrs"
separator	:
length	"1"

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
}  
  
resource "random_pet" "my-pet" {  
    prefix = "Mrs"  
    separator = "."  
    length = "1"  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "We love pets!"  
}  
variable "prefix" {  
    default = "Mrs"  
}  
variable "separator" {  
    default = "."  
}  
variable "length" {  
    default = "1"  
}
```

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content = var.content  
}  
  
resource "random_pet" "my-pet" {  
    prefix = var.prefix  
    separator = var.separator  
    length = var.length  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "We love pets!"  
}  
variable "prefix" {  
    default = "Mrs"  
}  
variable "separator" {  
    default = "."  
}  
variable "length" {  
    default = "1"  
}
```

>_

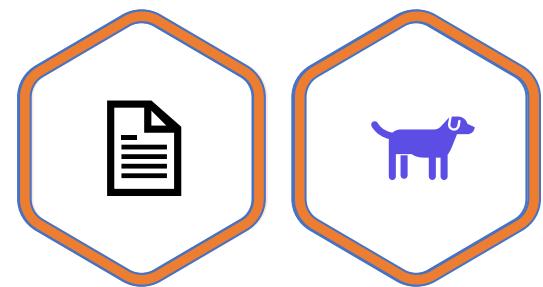
```
$ terraform apply

# local_file.pet will be created
+ resource "local_file" "pet" {
    + content          = "We love pets!"
    + directory_permission = "0777"
    + file_permission   = "0777"
    + filename         = "/root/pet.txt"
    + id               = (known after apply)
}

# random_pet.my-pet will be created
+ resource "random_pet" "my-pet" {
    + id           = (known after apply)
    + length       = 1
    + prefix       = "Mrs"
    + separator    = "."
}

Plan: 2 to add, 0 to change, 0 to destroy.

.
.
random_pet.my-pet: Creating...
random_pet.my-pet: Creation complete after 0s [id=Mrs.ram]
local_file.pet: Creating...
local_file.pet: Creation complete after 0s
[id=f392b4bcf5db76684f719bf72061627a9a177de1]
```



main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content = var.content  
}  
  
resource "random_pet" "my-pet" {  
    prefix = var.prefix  
    separator = var.separator  
    length = var.length  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "My favorite pet is Mrs. Whiskers"  
}  
variable "prefix" {  
    default = "Mrs"  
}  
variable "separator" {  
    default = "."  
}  
variable "length" {  
    default = "2"  
}
```

```
>_
```

```
$ terraform apply
```

```
Terraform will perform the following actions:
```

```
-/+ resource "local_file" "pet" {
  ~ content          = "We love pets!" -> "My favorite pet is Mrs. Whiskers!" #
  forces replacement
  directory_permission = "0777"
  file_permission      = "0777"
  filename              = "/root/pet.txt"
  ~ id                 = "bc9cabef1d8b0071d3c4ae9959a9c328f35fe697" -> (known after
apply)
}

# random_pet.my-pet must be replaced
-/+ resource "random_pet" "my-pet" {
  ~ id           = "Mrs.Hen" -> (known after apply)
  ~ length       = 1 -> 2 # forces replacement
  prefix         = "Mrs"
  separator      = "."
}
```

```
Plan: 2 to add, 0 to change, 2 to destroy.
```

```
random_pet.my-pet: Destroying... [id=Mrs.hen]
```

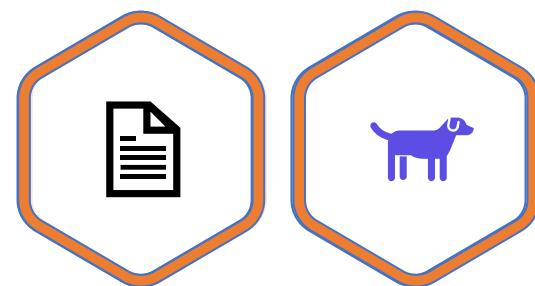
```
random_pet.my-pet: Destruction complete after 0s
```

```
local_file.pet: Destroying... [id=bc9cabef1d8b0071d3c4ae9959a9c328f35fe697]
```

```
local_file.pet: Destruction complete after 0s
```

```
random_pet.my-pet: Creating...
```

```
local_file.pet: Creating...
```



main.tf

```
resource "aws_instance" "webserver" {  
    ami          = var.ami  
    instance_type = var.instance_type  
}
```

variables.tf

```
variable "ami" {  
    default = "ami-0edab43b6fa892279"  
}  
variable "instance_type" {  
    default = "t2.micro"  
}
```

Understanding the Variable Block

variables.tf

```
variable "filename" {
    default = "/root/pets.txt"
}
variable "content" {
    default = "I love pets!"
}
variable "prefix" {
    default = "Mrs"
}
variable "separator" {
    default = "."
}
variable "length" {
    default = "1"
}
```

variables.tf

```
variable "filename" {
    default = "/root/pets.txt"
    type = string
    description = "the path of local file"

}
variable "content" {
    default = "I love pets!"
    type = string
    description = "the content of the file"

}
variable "prefix" {
    default = "Mrs"
    type = string
    description = "the prefix to be set"

}
variable "separator" {
    default = "."
    type = string
    description = "the separator to be used"
```

variables.tf

```
variable "filename" {
  default = "/root/pets.txt"
  type = string
  description = "the path of local file"
}

variable "content" {
  default = "I love pets!"
  type = string
  description = "the content of the file"
}

variable "prefix" {
  default = "Mrs"
  type = string
  description = "the prefix to be set"
}

variable "separator" {
  default = "."
}
```

Type	Example
string	"/root/pets.txt"
number	1
bool	true/false
any	Default Value

variables.tf

```
variable "length" {
  default = "2"
  type = number
  description = "length of the pet name"
}

variable "password_change" {
  default = "true"
  type = bool
}
```

Type	Example
string	"/root/pets.txt"
number	1
bool	true/false
any	Default Value
list	["cat", "dog"]
map	pet1 = cat pet2 = dog
object	Complex Data Structure
tuple	Complex Data Structure

List

variables.tf

```
variable "prefix" {  
  default = ["Mr", "Mrs", "Sir"]  
  type = list  0      1      2  
}
```

maint.tf

```
resource "random_pet" "my-pet" {  
  prefix      = var.prefix[0]  
}
```

Index	Value
0	Mr
1	Mrs
2	Sir

Map

variables.tf

```
variable file-content {  
    type      = map  
    default   = {  
        "statement1" = "We love pets!"  
        "statement2" = "We love animals!"  
    }  
}
```

maint.tf

```
resource local_file my-pet {  
    filename  = "/root/pets.txt"  
    content   = var.file-content["statement2"]  
}
```

Key	Value
statement1	We love pets!
statement2	We love animals!

List of a Type

variables.tf

```
variable "prefix" {  
  default = ["Mr", "Mrs", "Sir"]  
  type = list(string)  
}
```

variables.tf

```
variable "prefix" {  
  default = ["Mr", "Mrs", "Sir"]  
  type = list(number)  
}
```

variables.tf

```
variable "prefix" {  
  default = ["1", "2", "3"]  
  type = list(number)  
}
```

>_

```
$ terraform plan  
Error: Invalid default value for variable  
on variables.tf line 3, in variable "prefix":  
  3:   default      = ["Mr", "Mrs", "Sir"]  
  
This default value is not compatible with the  
variable's type constraint: a number is required.
```

Map of a Type

variables.tf

```
variable "cats" {  
  default = {  
    "color" = "brown"  
    "name" = "bella"  
  }  
  type = map(string)  
}
```

variables.tf

```
variable "pet_count" {  
  default = {  
    "dogs" = "3"  
    "cats" = "1"  
    "goldfish" = "2"  
  }  
  type = map(number)  
}
```

Set

variables.tf

```
variable "prefix" {  
  default = ["Mr", "Mrs", "Sir"]  
  type = set(string)  
}
```

variables.tf

```
variable "prefix" {  
  default = ["Mr", "Mrs", "Sir", "Sir"]  
  type = set(string)  
}
```

variables.tf

```
variable "fruit" {  
  default = ["apple", "banana"]  
  type = set(string)  
}
```

variables.tf

```
variable "fruit" {  
  default = ["apple", "banana", "banana"]  
  type = set(string)  
}
```

variables.tf

```
variable "age" {  
  default = ["10", "12", "15"]  
  type = set(number)  
}
```

variables.tf

```
variable "age" {  
  default = ["10", "12", "15", "10"]  
  type = set(number)  
}
```

Objects

Key	Example	Type
name	bella	string
color	brown	string
age	7	number
food	["fish", "chicken", "turkey"]	list
favorite_pet	true	bool

```
variables.tf

variable "bella" {
  type = object({
    name = string
    color = string
    age = number
    food = list(string)
    favorite_pet = bool
  })

  default = {
    name = "bella"
    color = "brown"
    age = 7
    food = ["fish", "chicken", "turkey"]
    favorite_pet = true
  }
}
```

Tuples

variables.tf

```
variable kitty {  
    type      = tuple([string, number, bool])  
    default   = ["cat", 7, true]  
}
```

variables.tf

```
variable kitty {  
    type      = tuple([string, number, bool])  
    default   = ["cat", 7, true, "dog"]  
}
```

>_

\$ terraform plan

```
Error: Invalid default value for variable  
on variables.tf line 3, in variable "kitty":  
  3:   default      = ["cat", 7, true, "dog"]
```

This default value is not compatible with the
variable's type constraint:
tuple required.

Using Variables in Terraform

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content = var.content  
}  
  
resource "random_pet" "my-pet" {  
    prefix = var.prefix  
    separator = var.separator  
    length = var.length  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "We love pets!"  
}  
variable "prefix" {  
    default = "Mrs"  
}  
variable "separator" {  
    default = "."  
}  
variable "length" {  
    default = 2  
}
```

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content = var.content  
}  
  
resource "random_pet" "my-pet" {  
    prefix = var.prefix  
    separator = var.separator  
    length = var.length  
}
```

variables.tf

```
variable "filename" {  
}  
variable "content" {  
}  
variable "prefix" {  
}  
variable "separator" {  
}  
variable "length" {  
}
```

Interactive Mode

```
>_
$ terraform apply
var.content
  Enter a value: We love Pets!

var.filename
  Enter a value: /root/pets.txt

var.length
  Enter a value: 2

var.prefix
  Enter a value: Mrs.

var.separator
  Enter a value: .
```

Command Line Flags

```
>_
```

```
$ terraform apply -var "filename=/root/pets.txt" -var "content=We love  
Pets!" -var "prefix=Mrs" -var "separator=." -var "length=2"
```

Environment Variables

```
>_  
  
$ export TF_VAR_filename="/root/pets.txt"  
$ export TF_VAR_content="We love pets!"  
$ export TF_VAR_prefix="Mrs"  
$ export TF_VAR_separator=". "  
$ export TF_VAR_length="2"  
$ terraform apply
```

Variable Definition Files

```
terraform.tfvars
```

```
filename = "/root/pets.txt"
content = "We love pets!"
prefix = "Mrs"
separator = "."
length = "2"
```

```
>_
```

```
$ terraform apply -var-file variables.tfvars
```

terraform.tfvars

terraform.tfvars.json

*.auto.tfvars

*.auto.tfvars.json

Automatically Loaded

Variable Definition Precedence

main.tf

```
resource local_file pet {  
    filename = var.filename  
}
```

variables.tf

```
variable filename {  
    type    = string  
}
```

>_

```
$ export TF_VAR_filename="/root/cats.txt" ?
```

terraform.tfvars

```
filename = "/root/pets.txt" ?
```

variable.auto.tfvars

```
filename = "/root/mypet.txt" ?
```

>_

```
$ terraform apply -var "filename=/root/best-pet.txt" ?
```

Variable Definition Precedence

Order	Option
1	Environment Variables
2	terraform.tfvars
3	*.auto.tfvars (alphabetical order)
4	-var or --var-file (command-line flags)



```
>_
$ export TF_VAR_filename="/root/cats.txt" 1
```

```
●      terraform.tfvars
filename = "/root/pets.txt" 2
```

```
●      variable.auto.tfvars
filename = "/root/mypet.txt" 3
```

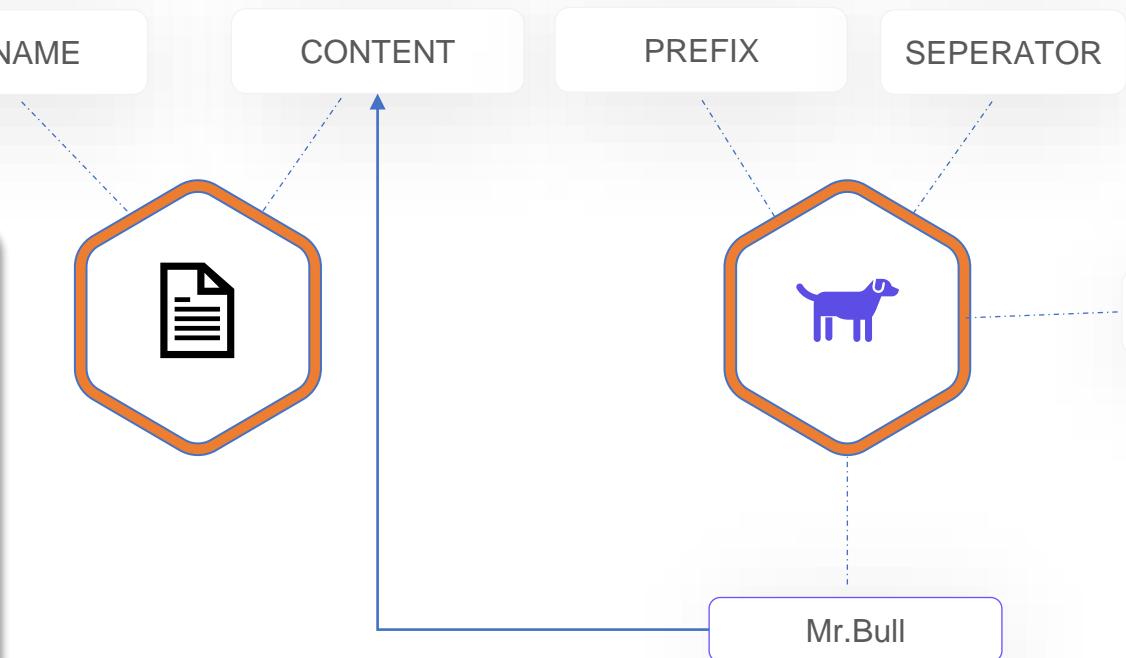
```
>_
$ terraform apply -var "filename=/root/best-pet.txt" 4
```

Resource Attribute Reference

```
main.tf

resource "local_file" "pet" {
  filename = var.filename
  content = "My favorite pet is ${random_pet.my-pet.id}"
}

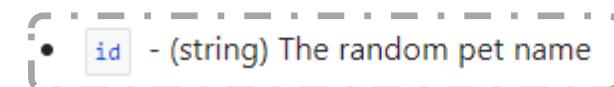
resource "random_pet" "my-pet" {
  prefix = var.prefix
  separator = var.separator
  length = var.length
}
```



```
>_  
random_pet.my-pet: Creating...  
local_file.pet: Creating...  
random_pet.my-pet: Creation complete after 0s [id=Mr.bull]  
local_file.pet: Creation complete after 0s  
[id=059090e865809f9b6debfd7aebf48fdce2220a6]  
  
Apply complete! Resources: 2 added, 0 changed, 0 destroyed.
```

Attribute Reference

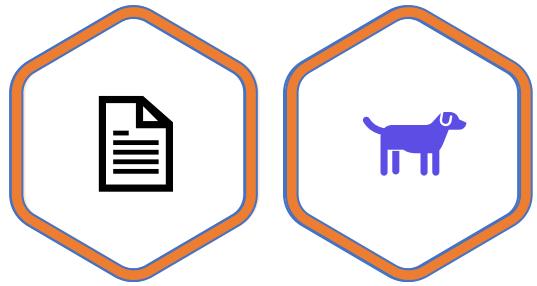
The following attributes are supported:



```
_file" "pet" {  
var.filename
```

My favorite pet is Mr.Bull"

```
om_pet" "my-pet" {  
.prefix  
var.separator  
.length
```



```
>_ $ terraform apply

.

.

.

# local_file.pet must be replaced
-/+ resource "local_file" "pet" {
  ~ content          = "My favorite pet is Mrs.Cat!" ->
  "My favorite pet is Mr.bull" # forces replacement
  . . . . . . . . . . . . . . .
  directory_permission = "0777"
  file_permission      = "0777"
  filename              = "/roots/pets.txt"
  ~ id                  =
  "98af5244e23508cffd4a0c3c46546821c4ccb0" -> (known after
apply)
}
.

.

local_file.pet: Destroying...
[id=98af5244e23508cffd4a0c3c46546821c4ccb0]
local_file.pet: Destruction complete after 0s
local_file.pet: Creating...
local_file.pet: Creation complete after 0s
[id=e56101d304de7cf1b1001102923c6bdeaa60c523]

Apply complete! Resources: 1 added, 0 changed, 1 destroyed.
```

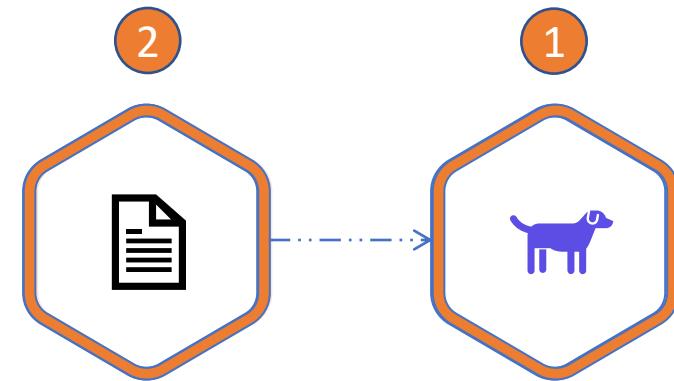
Resource Dependencies

Implicit Dependency

main.tf

```
resource "local_file" "pet" {
  filename = var.filename
  content = "My favorite pet is ${random_pet.my-pet.id}"
}

resource "random_pet" "my-pet" {
  prefix = var.prefix
  separator = var.separator
  length = var.length
}
```

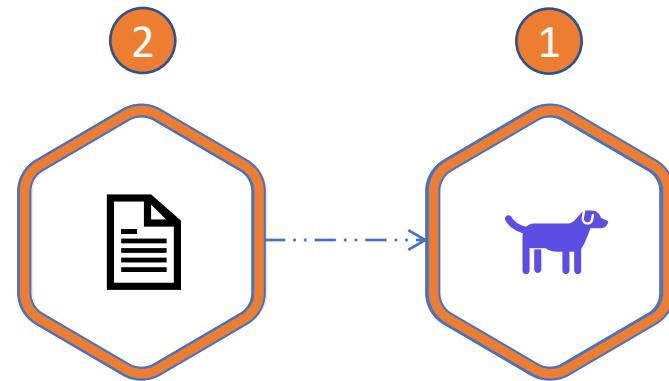


Explicit Dependency

```
main.tf
```

```
resource "local_file" "pet" {
  filename = var.filename
  content = "My favorite pet is Mr.Cat"
  depends_on = [
    random_pet.my-pet
  ]
}

resource "random_pet" "my-pet" {
  prefix = var.prefix
  separator = var.separator
  length = var.length
}
```



Output Variables

main.tf

```
resource "local_file" "pet" {
  filename = var.filename
  content = "My favorite pet is ${random_pet.my-pet.id}"
}

resource "random_pet" "my-pet" {
  prefix = var.prefix
  separator = var.separator
  length = var.length
}

output pet-name {
  value      = random_pet.my-pet.id
  description = "Record the value of pet ID generated by the
random_pet resource"
}
```

variables.tf

```
variable "filename" {
  default = "/root/pets.txt"
}
variable "content" {
  default = "I love pets!"
}
variable "prefix" {
  default = "Mrs"
}
variable "separator" {
  default = "."
}
variable "length" {
  default = "1"
}
```

```
output "<variable_name>" {
  value = "<variable_value>"
  <arguments>
}
```



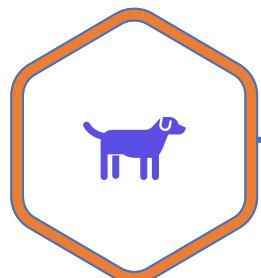
```
>_
$ terraform apply
:
:
Outputs:
:
pet-name = Mrs.gibbon
```

```
>_
```

```
$ terraform output  
pet-name = Mrs.gibbon
```

```
>_
```

```
$ terraform output pet-name  
Mrs.gibbon
```



Output Variable



ANSIBLE



SHELL SCRIPTS

Introduction to Terraform State

```
>_
```

```
$ ls terraform-local-file  
main.tf variables.tf
```



main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content  = var.content  
}
```



variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "I love pets!"  
}
```



```
>_
```

```
$ cd terraform-local-file  
[terraform-local-file]$ terraform init
```

Initializing the backend...

Initializing provider plugins...

- Finding latest version of hashicorp/local...
- Installing hashicorp/local v1.4.0...
- Installed hashicorp/local v1.4.0 (signed by HashiCorp)

The following providers do not have any version constraints in configuration,
so the latest version was installed.

To prevent automatic upgrades to new major versions that may contain breaking changes, we recommend adding version constraints in a required_providers block in your configuration, with the constraint strings suggested below.

* hashicorp/local: version = "~> 1.4.0"

Terraform has been successfully initialized!

```
>_
```

```
$ ls terraform-local-file
```

```
main.tf variables.tf
```

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content  = var.content  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "I love pets!"  
}
```



```
>_
```

```
[terraform-local-file]$ terraform plan
```

Refreshing Terraform state in-memory prior to plan...
The refreshed state will be used to calculate this plan,
persisted to local or remote state storage.

An execution plan has been generated and is shown below.
Resource actions are indicated with the following symbols:
+ create

Terraform will perform the following actions:

```
# local_file.pet will be created  
+ resource "local_file" "pet" {  
    + content          = "I love pets!"  
    + directory_permission = "0777"  
    + file_permission   = "0777"  
    + filename         = "/root/pets.txt"  
    + id               = (known after apply)  
}
```

Plan: 1 to add, 0 to change, 0 to destroy.

Note: You didn't specify an "-out" parameter to save this

```
>_
```

```
$ ls terraform-local-file  
main.tf variables.tf
```

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content  = var.content  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "I love pets!"  
}
```



```
>_
```

```
[terraform-local-file]$ terraform apply
```

An execution plan has been generated and is shown below.
Resource actions are indicated with the following symbols:
+ create

Terraform will perform the following actions:

```
# local_file.pet will be created  
+ resource "local_file" "pet" {  
    + content          = "I love pets!"  
    + directory_permission = "0777"  
    + file_permission   = "0777"  
    + filename         = "/root/pets.txt"  
    + id               = (known after apply)  
}
```

Plan: 1 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

```
local_file.pet: Creating...  
local_file.pet: Creation complete after 0s . . .  
[id=7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68] . . .
```

>_

```
[terraform-local-file]$ cat /root/pets  
I love pets!
```

>_

```
[terraform-local-file]$ terraform apply  
local_file.pet: Refreshing state...  
[id=7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68]
```

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



```
>_
```

```
[terraform-local-file]$ ls  
main.tf variables.tf terraform.tfstate
```



```
>_
```

```
[terraform-local-file]$ cat terraform.tfstate
```

```
{  
    "version": 4,  
    "terraform_version": "0.13.0",  
    "serial": 1,  
    "lineage": "e35dde72-a943-de50-3c8b-1df8986e5a31",  
    "outputs": {},  
    "resources": [  
        {  
            "mode": "managed",  
            "type": "local_file",  
            "name": "pet",  
            "provider":  
                "provider": \"registry.terraform.io/hashicorp/local\",  
            "instances": [  
                {  
                    "schema_version": 0,  
                    "attributes": {  
                        "content": "I love pets!",  
                        "content_base64": null,  
                        "directory_permission": "0777",  
                        "file_permission": "0777",  
                        "filename": "/root/pets.txt",  
                        "id":  
                            "7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68",  
                        "sensitive_content": null  
                    },  
                    "private": "bnVsbA=="  
                },  
                {  
                    "schema_version": 0,  
                    "attributes": {  
                        "content": "I love pets!",  
                        "content_base64": null,  
                        "directory_permission": "0777",  
                        "file_permission": "0777",  
                        "filename": "/root/pets.txt",  
                        "id":  
                            "7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68",  
                        "sensitive_content": null  
                    },  
                    "private": "bnVsbA=="  
                }  
            ]  
        }  
    ]  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "We love pets!"  
}
```

```
>_  
$ terraform plan  
Refreshing Terraform state in-memory  
prior to plan...  
The refreshed state will be used to  
calculate this plan, but will not be  
persisted to local or remote state  
storage.
```

```
local_file.pet: Refreshing state...  
[id=7e4db4fbfdbb108bdd04692602bae3e9bd1e  
1b68]
```



>_

```
[terraform-local-file]$ cat terraform.tfstate  
{  
    "version": 4,  
    "terraform_version": "0.13.0",  
    "serial": 1,  
    "lineage": "e35dde72-a943-de50-3c8b-1df8986e5a31",  
    "outputs": {},  
    "resources": [  
        {  
            "mode": "managed",  
            "type": "local_file",  
            "name": "pet",  
            "provider":  
                "provider": "registry.terraform.io/hashicorp/local",  
            "instances": [  
                {  
                    "schema_version": 0,  
                    "attributes": {  
                        "content": "I love pets!",  
                        "content_base64": null,  
                        "directory_permission": "0777",  
                        "file_permission": "0777",  
                        "filename": "/root/pets.txt",  
                        "id": "7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68",  
                        "sensitive_content": null  
                    },  
                    "private": "bnVsbA=="  
                },  
            ]  
        }  
    ]  
}
```

variables.tf

```
variable "filename" {
  default = "/root/pets.txt"
}
variable "content" {
  default = "We love pets!"
}
```

>_

```
$ terraform apply
```

```
local_file.pet: Refreshing state...
[ id=7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68 ]
```

```
Terraform will perform the following actions:
```

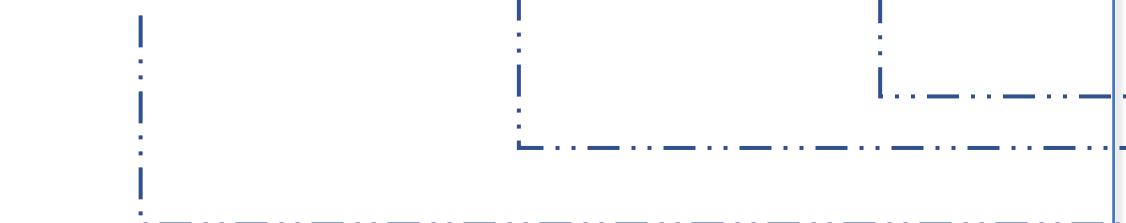
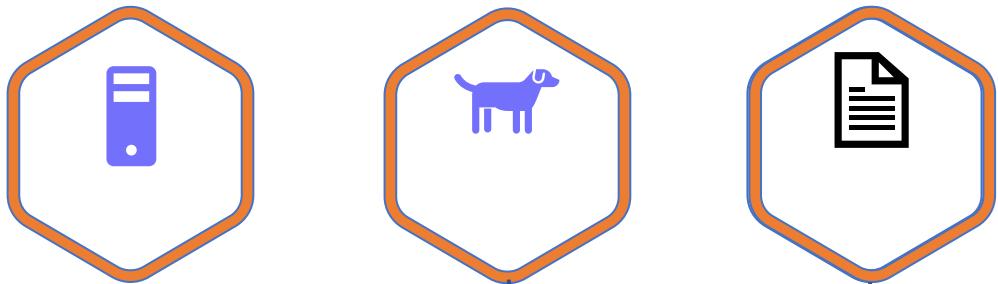
```
# local_file.pet must be replaced
-/+ resource "local_file" "pet" {
    ~ content          = "I love pets!" -
> "We love pets!" # forces replacement
    directory_permission = "0777"
    file_permission      = "0777"
    filename             = "/root/pets.txt"
    ~ id                 =
"7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68" ->
(known after apply)
}
```



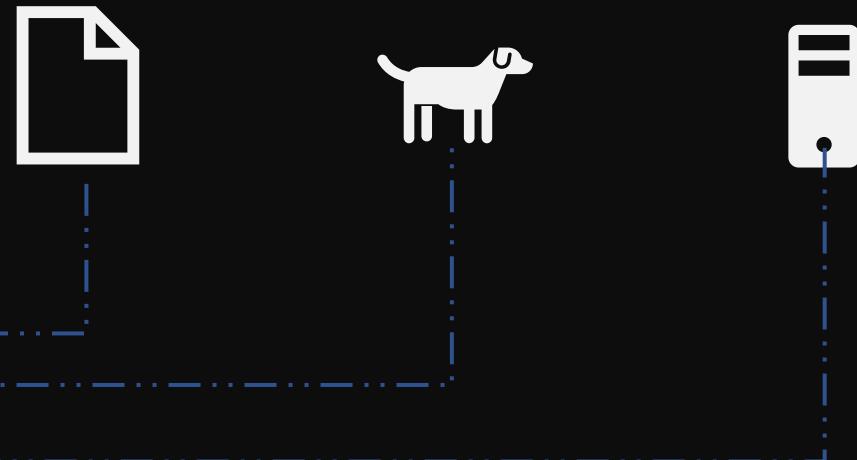
>_

```
[terraform-local-file]$ cat terraform.tfstate
{
  "version": 4,
  "terraform_version": "0.13.0",
  "serial": 1,
  "lineage": "e35dde72-a943-de50-3c8b-1df8986e5a31",
  "outputs": {},
  "resources": [
    {
      "mode": "managed",
      "type": "local_file",
      "name": "pet",
      "provider": "provider[\\"registry.terraform.io/hashicorp/local\\"]",
      "instances": [
        {
          "schema_version": 0,
          "attributes": {
            "content": "We love pets!",
            "content_base64": null,
            "directory_permission": "0777",
            "file_permission": "0777",
            "filename": "/root/pets.txt",
            "id": "7e4db4fbfdbb108bdd04692602bae3e9bc4d1c14",
            "sensitive_content": null
          },
          "private": "bnVsbA=="
        }
      ]
    }
  ]
}
```

Real World Infrastructure

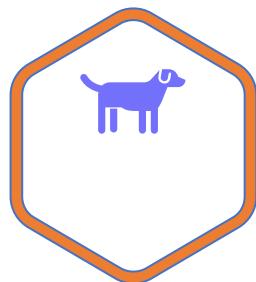


terraform.tfstate

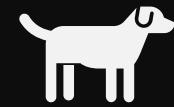


Purpose of State

Real World Infrastructure



terraform.tfstate



id=aabbcc

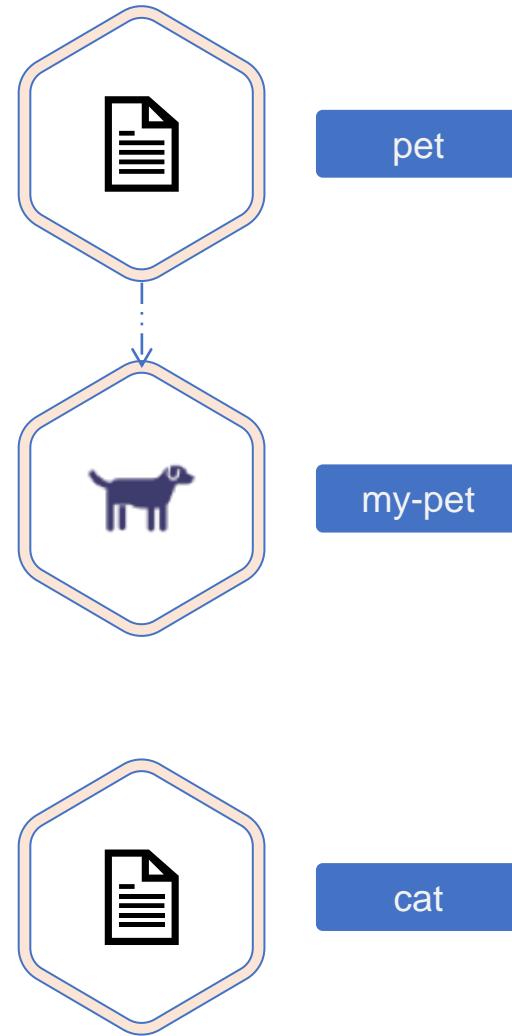
id=eeddff

id=gghhhi

Tracking Metadata

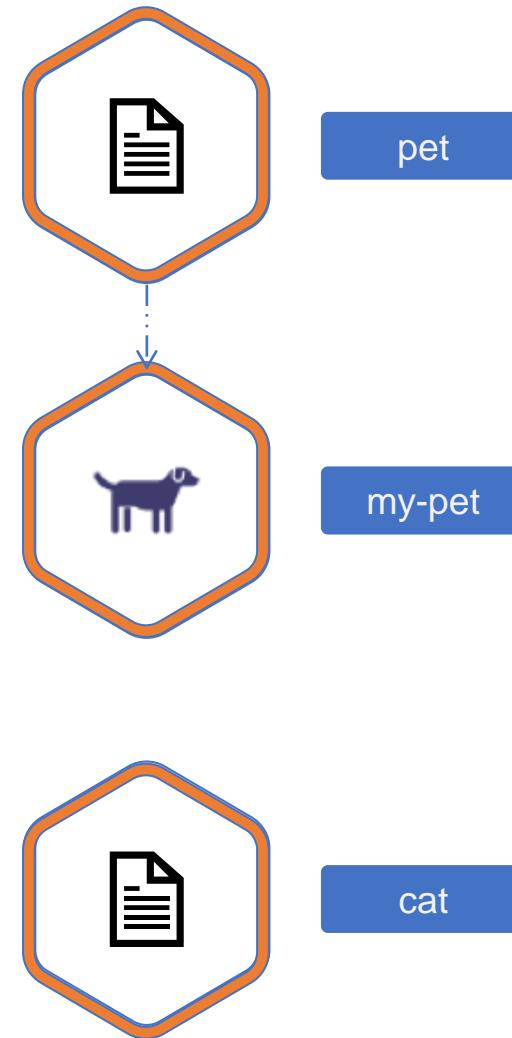
```
main.tf
```

```
resource "local_file" "pet" {
  filename = "/root/pet.txt"
  content  = "My favorite pet is ${random_pet.my-pet.id}!"
}
resource "random_pet" "my-pet" {
  length = 1
}
resource "local_file" "cat" {
  filename = "/root/cat.txt"
  content  = "I like cats too!"
}
```



Tracking Metadata

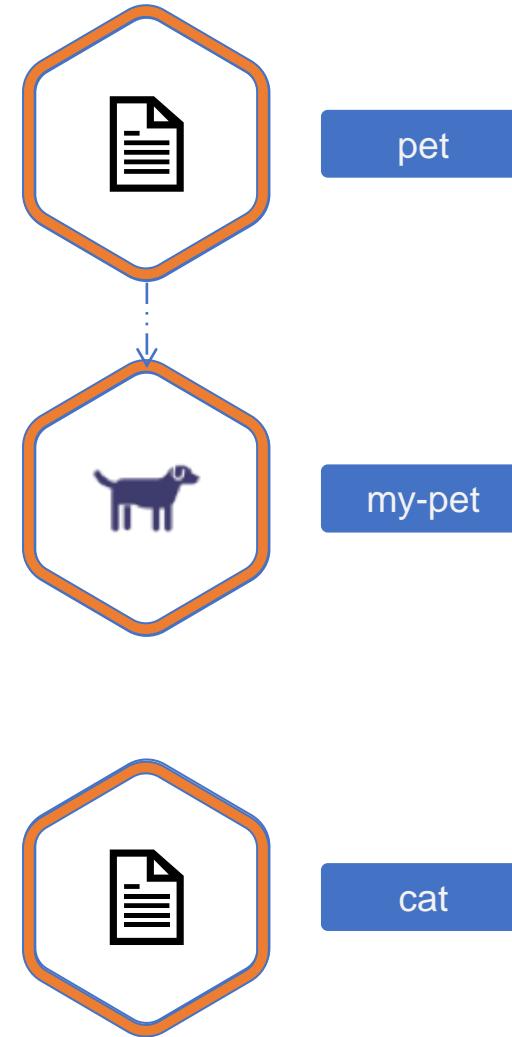
```
>_  
$ terraform apply  
. . .  
Plan: 3 to add, 0 to change, 0 to destroy.  
  
Do you want to perform these actions?  
Terraform will perform the actions described above.  
Only 'yes' will be accepted to approve.  
  
Enter a value: yes  
local_file.cat: Creating...  
random_pet.my-pet: Creating...  
local_file.cat: Creation complete after 0s  
[id=fe44888891fc40342313bc44a1f1a8986520c89]  
random_pet.my-pet: Creation complete after 0s [id=yak]  
  
local_file.pet: Creating...  
local_file.pet: Creation complete after 0s  
[id=28b373c6c1fa3fce132a518eadd0175c98f37f20]  
  
Apply complete! Resources: 3 added, 0 changed, 0 destroyed.
```



Tracking Metadata

```
main.tf
```

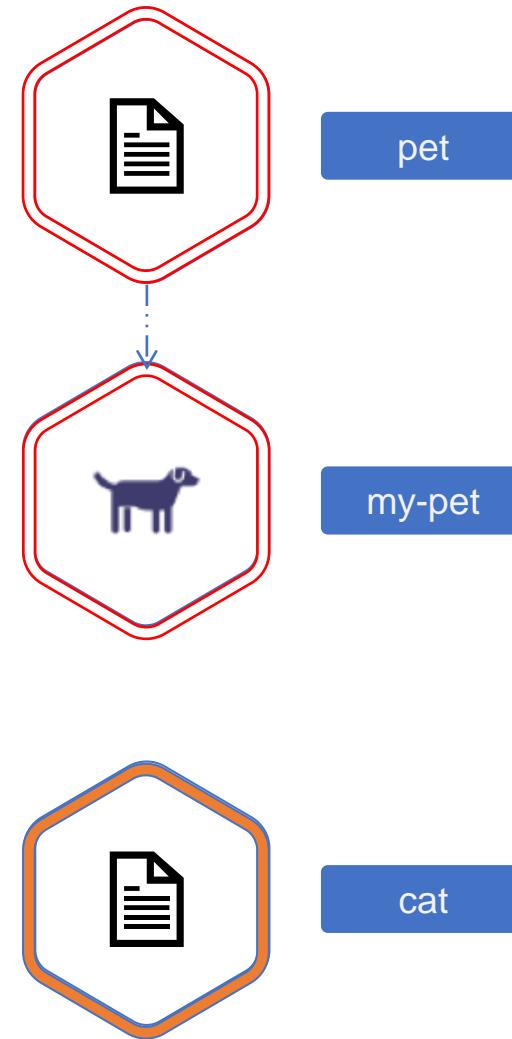
```
resource "local_file" "pet" {
  filename = "/root/pet.txt"
  content  = "My favorite pet is ${random_pet.my-pet.id}!"
}
resource "random_pet" "my-pet" {
  length = 1
}
resource "local_file" "cat" {
  filename = "/root/cat.txt"
  content  = "I like cats too!"
}
```



Tracking Metadata

```
main.tf
```

```
resource "local_file" "cat" {
  filename = "/root/cat.txt"
  content  = "I like cats too!"
}
```



Tracking Metadata

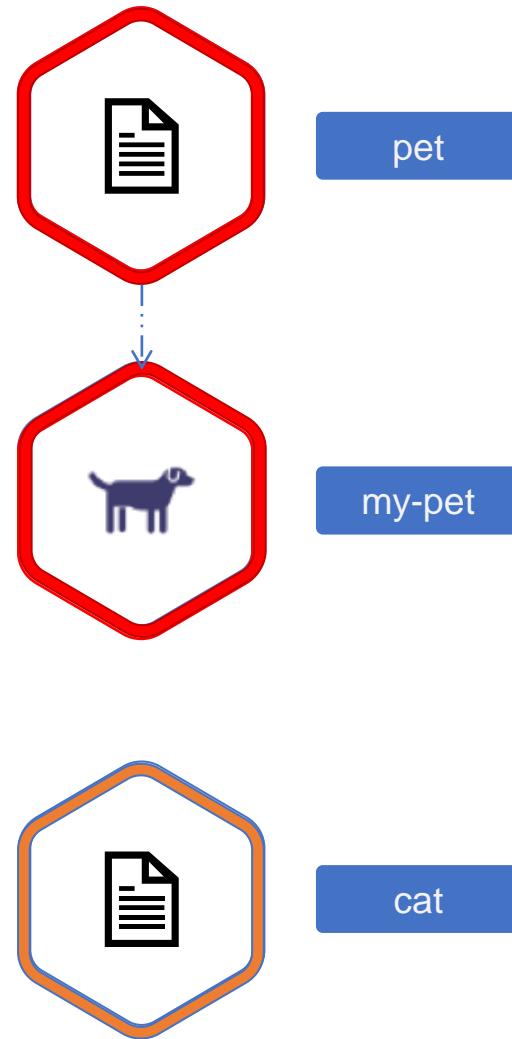
```
main.tf
```

```
resource "local_file" "cat" {
  filename = "/root/cat.txt"
  content  = "I like cats too!"
}
```

```
>_
```

```
$ cat terraform.tfstate
```

```
{
  "mode": "managed",
  "type": "local_file",
  "name": "pet",
  "instances": [
    {
      "schema_version": 0,
      "attributes": {
        "content": "My favorite pet is yak!",
      },
      "private": "bnVsbA==",
      "dependencies": [
        "random_pet.my-pet"
      ]
    }
  ]
}
```



Tracking Metadata

```
main.tf
```

```
resource "local_file" "cat" {
  filename = "/root/cat.txt"
  content  = "I like cats too!"
}
```

```
>_
```

```
$ terraform apply
```

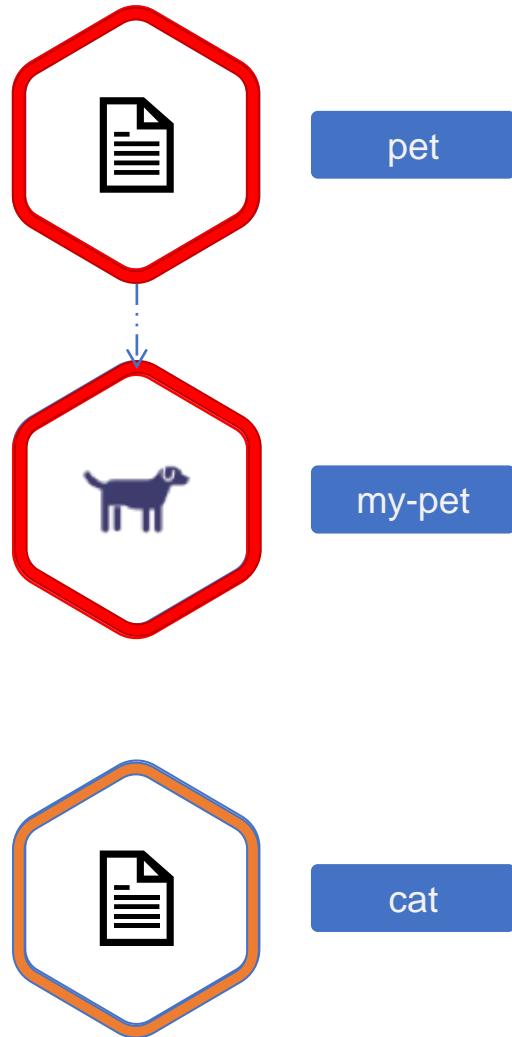
```
Plan: 0 to add, 0 to change, 2 to destroy.
```

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

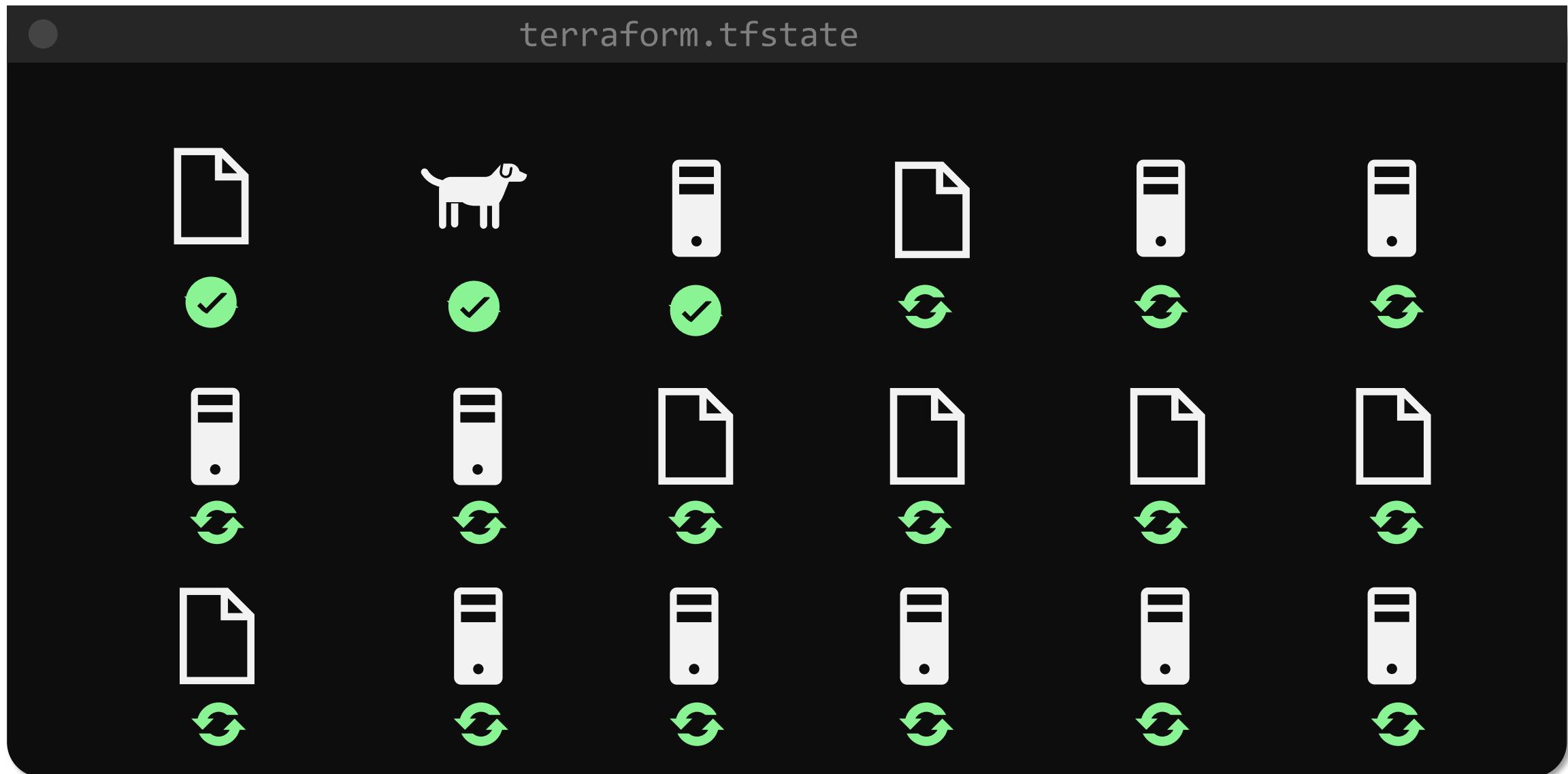
```
Enter a value: yes
```

```
local_file.pet: Destroying...
[id=28b373c6c1fa3fce132a518eadd0175c98f37f20]
local_file.pet: Destruction complete after 0s
```

```
random_pet.my-pet: Destroying... [id=yak]
random_pet.my-pet: Destruction complete after 0s
```



Performance



Performance

terraform.tfstate

```
{  
  "version": 4,  
  "terraform_version": "0.13.0",  
  "serial": 4,  
  "lineage": "e35dde72-a943-de50-3c8b-1df8986e5a31",  
  "outputs": {},  
  "resources": [  
    {  
      "mode": "managed",  
      "type": "local_file",  
      "name": "pet",  
      "instances": [  
        {  
          "schema_version": 0,  
          "attributes": {  
            "content": "We love pets!",  
            "content_base64": null,  
            "directory_permission": "0777",  
            ...  
          }  
        }  
      ]  
    }  
  ]  
}
```

>_

```
$ terraform plan --refresh=false  
An execution plan has been generated and is shown below.  
Resource actions are indicated with the following symbols:  
-/+ destroy and then create replacement  
  
Terraform will perform the following actions:  
  
# local_file.cat must be replaced  
-/+ resource "local_file" "pet" {  
  ~ content = "I like cats too!" ->  
  "Dogs are awesome!" # forces replacement  
  directory_permission = "0777"  
  file_permission = "0777"  
  filename = "/root/pets.txt"  
  ~ id =  
  "cba595b7d9f94ba1107a46f3f731912d95fb3d2c" -> (known  
after apply)  
}  
  
Plan: 1 to add, 0 to change, 1 to destroy.
```

Collaboration

```
terraform.tfstate

{
  "version": 4,
  "terraform_version": "0.13.0",
  "serial": 4,
  "lineage": "e35dde72-a943-de50-3c8b-1df8986e5a31",
  "outputs": {},
  "resources": [
    {
      "mode": "managed",
      "type": "local_file",
      "name": "pet",
      "instances": [
        {
          "schema_version": 0,
          "attributes": {
            "content": "We love pets!",
            "content_base64": null,
            "directory_permission": "0777",
            ...
          }
        }
      ]
    }
  ]
}
```

```
>_
$ ls
main.tf variables.tf terraform.tfstate
```



AWS S3

HashiCorp Consul

Google Cloud Storage

Terraform Cloud

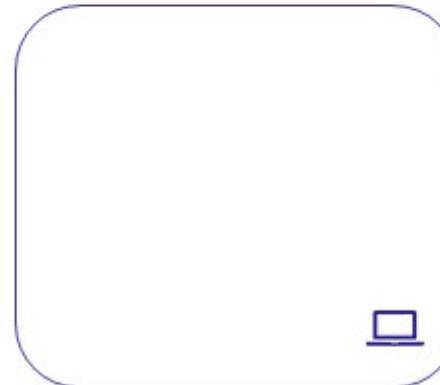
Collaboration

terraform.tfstate

```
{  
  "version": 4,  
  "terraform_version": "0.13.0",  
  "serial": 4,  
  "lineage": "e35dde72-a943-de50-3c8b-1df8986e5a31",  
  "outputs": {},  
  "resources": [  
    {  
      "mode": "managed",  
      "type": "local_file",  
      "name": "pet",  
      "instances": [  
        {  
          "schema_version": 0,  
          "attributes": {  
            "content": "We love pets!",  
            "content_base64": null,  
            "directory_permission": "0777",  
            ...  
          }  
        }  
      ]  
    }  
  ]  
}
```



terraform.tfstate



Terraform State Considerations

Sensitive Data

terraform.tfstate

```
{  
    "mode": "managed",  
    "type": "aws_instance",  
    "name": "dev-ec2",  
    "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",  
    "instances": [  
        {  
            "schema_version": 1,  
            "attributes": {  
                "ami": "ami-0a634ae95e11c6f91",  
                ".":  
                ".":  
                ".":  
                "primary_network_interface_id": "eni-0ccd57b1597e633e0",  
                "private_dns": "ip-172-31-7-21.us-west-2.compute.internal",  
                "private_ip": "172.31.7.21",  
                "public_dns": "ec2-54-71-34-19.us-west-2.compute.amazonaws.com",  
                "public_ip": "54.71.34.19",  
                "root_block_device": [  
                    {  
                        "delete_on_termination": true,  
                        "device_name": "/dev/sda1",  
                        "encrypted": false,  
                        "iops": 100,  
                        "kms_key_id": ""  
                    }  
                ]  
            }  
        }  
    ]  
}
```

Terraform State Considerations

Remote State Backends



terraform.tfstate

```
{  
  "mode": "managed",  
  "type": "aws_instance",  
  "name": "dev-ec2",  
  "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",  
  "instances": [  
    {  
      "schema_version": 1,  
      "attributes": {  
        "ami": "ami-0a634ae95e11c6f91",  
        ·  
        ·  
        "primary_network_interface_id": "eni-0ccd57b1597e633e0",  
        "private_dns": "ip-172-31-7-21.us-west-2.compute.internal",  
        "private_ip": "172.31.7.21",  
        "public_dns": "ec2-54-71-34-19.us-west-2.compute.amazonaws.com",  
        "public_ip": "54.71.34.19",  
        "root_block_device": [  
          {  
            "delete_on_termination": true,  
            "device_name": "/dev/sda1",  
            "encrypted": false,  
            "iops": 100,  
            "kms_key_id": "",  
            "volume_id": "vol-070720a3636979c22",  
            "volume_size": 8  
          }  
        ]  
      }  
    }  
  ]  
}
```

Version Control



main.tf

```
resource "local_file" "pet" {  
  filename = "/root/pet.txt"  
  content  = "My favorite pet is Mr.Whiskers!"  
}  
resource "random_pet" "my-pet" {  
  length = 1  
}  
resource "local_file" "cat" {  
  filename = "/root/cat.txt"  
  content  = "I like cats too!"  
}
```

No Manual Edits

terraform.tfstate

```
{  
    "mode": "managed",  
    "type": "aws_instance",  
    "name": "dev-ec2",  
    "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",  
    "instances": [  
        {  
            "schema_version": 1,  
            "attributes": {  
                "ami": "ami-0a634ae95e11c6f91",  
                ".":  
                ".":  
                ".":  
                "primary_network_interface_id": "eni-0ccd57b1597e633e0",  
                "private_dns": "ip-172-31-7-21.us-west-2.compute.internal",  
                "private_ip": "172.31.7.21",  
                "public_dns": "ec2-54-71-34-19.us-west-2.compute.amazonaws.com",  
                "public_ip": "54.71.34.19",  
                "root_block_device": [  
                    {  
                        "delete_on_termination": true,  
                        "device_name": "/dev/sda1",  
                        "encrypted": false,  
                        "iops": 100,  
                        "kms_key_id": ""  
                    }  
                ]  
            }  
        }  
    ]  
}
```

Terraform Commands

terraform validate

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
    file_permissions = "0700"  
}
```

>_

```
$ terraform validate  
Success! The configuration is valid.  
  
$ terraform validate  
  
Error: Unsupported argument  
  
on main.tf line 4, in resource "local_file" "pet":  
  4:     file_permissions = "0777"  
  
An argument named "file_permissions" is not expected  
here. Did you mean "file_permission"?
```

terraform fmt

main.tf

```
resource "local_file" "pet" {  
    filename      = "/root/pets.txt"  
    content       = "We love pets!"  
    file_permission = "0700"  
}
```

>_

```
$ terraform fmt  
main.tf
```

terraform show

>_

```
$ terraform show

# local_file.pet:
resource "local_file" "pet" {
    content          = "We love pets!"
    directory_permission = "0777"
    file_permission      = "0777"
    filename           = "/root/pets.txt"
    id                =
"cba595b7d9f94ba1107a46f3f731912d95fb3d2c"
}
```

>_

```
$ terraform show -json

{"format_version": "0.1", "terraform_version": "0.13.0", "values": {"root_module": {"resources": [{"address": "local_file.pet", "mode": "managed", "type": "local_file", "name": "pet", "provider_name": "registry.terraform.io/hashicorp/local", "schema_version": 0, "values": {"content": "We love pets!", "content_base64": null, "directory_permission": "0777", "file_permission": "0777", "filename": "/root/pets.txt", "id": "cba595b7d9f94ba1107a46f3f731912d95fb3d2c", "sensitive_content": null}}}]}}
```

terraform providers

main.tf

```
resource "local_file" "pet" {  
    filename      = "/root/pets.txt"  
    content       = "We love pets!"  
    file_permission = "0700"  
}
```

>_

```
$ terraform providers
```

```
Providers required by configuration:
```

```
.  
└ provider[registry.terraform.io/hashicorp/local]
```

```
Providers required by state:
```

```
provider[registry.terraform.io/hashicorp/local]
```

```
$ terraform providers mirror /root/terraform/new_local_file
```

- Mirroring hashicorp/local...
 - Selected v1.4.0 with no constraints
 - Downloading package for windows_amd64...
 - Package authenticated: signed by HashiCorp

terraform output

main.tf

```
resource "local_file" "pet" {  
    filename      = "/root/pets.txt"  
    content       = "We love pets!"  
    file_permission = "0777"  
}  
resource "random_pet" "cat" {  
    length      = "2"  
    separator   = "-"  
}  
output content {  
    value      = local_file.pet.content  
    sensitive  = false  
    description = "Print the content of the file"  
}  
output pet-name {  
    value      = random_pet.cat.id  
    sensitive  = false  
    description = "Print the name of the pet"  
}
```

>_

```
$ terraform output  
content = We love pets!  
pet-name = huge-owl
```

```
$ terraform output pet-name  
pet-name = huge-owl
```

terraform refresh

main.tf

```
resource "local_file" "pet" {  
    filename      = "/root/pets.txt"  
    content       = "We love pets!"  
    file_permission = "0777"  
}  
resource "random_pet" "cat" {  
    length      = "2"  
    separator   = "-"  
}
```

> _

\$ terraform refresh

```
random_pet.cat: Refreshing state... [id=huge-owl]  
local_file.pet: Refreshing state...  
[id=cba595b7d9f94ba1107a46f3f731912d95fb3d2c]
```

\$ terraform plan

```
Refreshing Terraform state in-memory prior to plan...  
The refreshed state will be used to calculate this  
plan, but will not be  
persisted to local or remote state storage.
```

```
random_pet.cat: Refreshing state... [id=huge-owl]  
local_file.pet: Refreshing state...  
[id=cba595b7d9f94ba1107a46f3f731912d95fb3d2c]
```

No changes. Infrastructure is up-to-date.

terraform graph

main.tf

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content  = "My favorite pet is ${random_pet.my-pet.id}"
}
resource "random_pet" "my-pet" {
  prefix = "Mr"
  separator = "."
  length = "1"
}
```

> _

```
$ terraform graph
digraph {
    compound = "true"
    newrank = "true"
    subgraph "root" {
        "[root] local_file.pet (expand)" [label =
"local_file.pet", shape = "box"]
        "[root]
provider[\"registry.terraform.io/hashicorp/local\"]" [label =
"provider[\"registry.terraform.io/hashicorp/local\"]", shape =
"diamond"]
        "[root]
provider[\"registry.terraform.io/hashicorp/random\"]" [label =
"provider[\"registry.terraform.io/hashicorp/random\"]", shape =
"diamond"]
        "[root] random_pet.my-pet (expand)" [label =
"random_pet.my-pet", shape = "box"]
        "[root] local_file.pet (expand)" -> "[root]
provider[\"registry.terraform.io/hashicorp/local\"]"
        "[root] local_file.pet (expand)" -> "[root]
random_pet.my-pet (expand)"
        "[root] meta.count-boundary (EachMode fixup)" -
> "[root] local_file.pet (expand)"
        "[root]
provider[\"registry.terraform.io/hashicorp/local\"] (close)" ->
"[root] local_file.pet (expand)"]
```

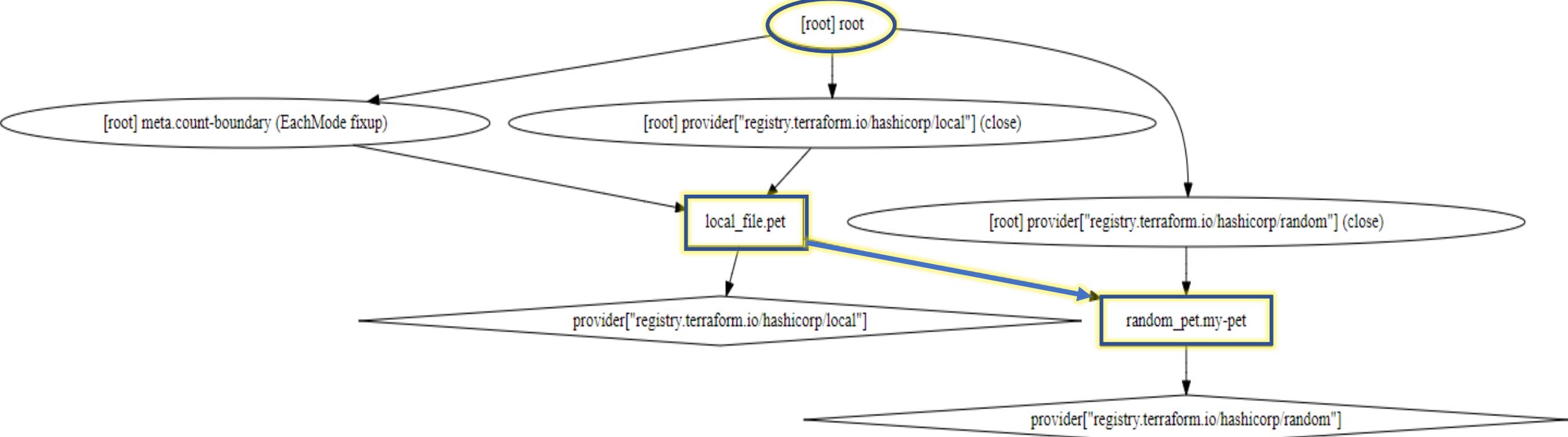
terraform graph

main.tf

```
resource "local_file" "pet" {  
  filename = "/root/pets.txt"  
  content  = "My favorite pet is ${random_pet.my-pet.id}"  
}
```

>_

```
$ apt update  
$ apt install graphviz -y  
$ terraform graph | dot -Tsvg > graph.svg
```



Mutable vs Immutable Infrastructure

terraform validate

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
    file_permission = "0700"  
}
```



>_

```
$ terraform apply  
  
# local_file.pet must be replaced  
-/+ resource "local_file" "pet" {  
    content          = "We love pets!"  
    directory_permission = "0777"  
    ~ file_permission      = "0777" -> "0700" # forces  
replacement  
    filename          = "/root/pet.txt"  
    ~ id              =  
"5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf" -> (known after  
apply)  
}
```

Plan: 1 to add, 0 to change, 1 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

```
local_file.pet: Destroying...  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]  
local_file.pet: Destruction complete after 0s  
local_file.pet: Creating...
```



upgrade-nginx.sh

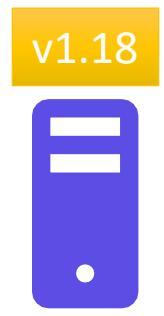
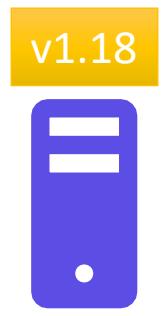


ANSIBLE

Configuration Drift







Immutable Infrastructure



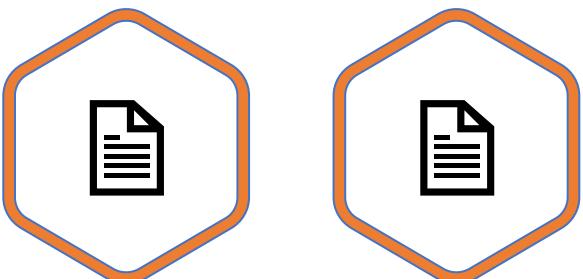
Immutable Infrastructure



Immutable Infrastructure

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
    file_permission = "0700"  
}
```



>_

```
$ terraform apply  
  
# local_file.pet must be replaced  
-/+ resource "local_file" "pet" {  
    content              = "We love pets!"  
    directory_permission = "0777"  
    ~ file_permission     = "0777" -> "0700" # forces  
replacement  
    filename             = "/root/pet.txt"  
    ~ id                 =  
"5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf" -> (known after  
apply)  
    }  
  
Plan: 1 to add, 0 to change, 1 to destroy.  
  
local_file.pet: Destroying...  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]  
local_file.pet: Destruction complete after 0s  
local_file.pet: Creating...  
local_file.pet: Creation complete after 0s  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]
```

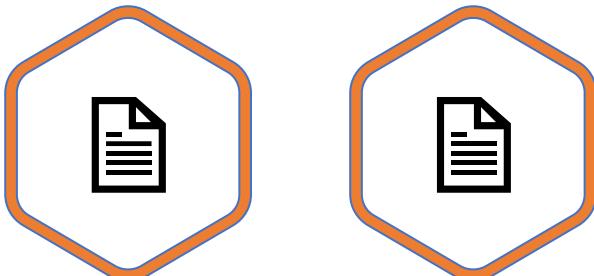
Apply complete! Resources: 1 added, 0 changed, 1 destroyed.

Lifecycle Rules

create_before_destroy

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
    file_permission = "0700"  
  
    lifecycle {  
        create_before_destroy = true  
    }  
}  
}
```



>_

```
$ terraform apply  
  
# local_file.pet must be replaced  
-/+ resource "local_file" "pet" {  
    content          = "We love pets!"  
    directory_permission = "0777"  
    ~ file_permission     = "0777" -> "0755" # forces repl  
    filename         = "/root/pet.txt"  
    ~ id              =  
"5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf" -> (known after ap  
    }
```

Plan: 1 to add, 0 to change, 1 to destroy.

...

```
local_file.pet: Creating...  
local_file.pet: Creation complete after 0s  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]
```

```
local_file.pet: Destroying...  
[id=5f8fb950ac60f7f23ef968097cda0a1fd3c11bdf]  
local_file.pet: Destruction complete after 0s
```

Apply complete! Resources: 1 added, 0 changed, 1 destroyed.

prevent_destroy

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
    file_permission = "0700"  
  
    lifecycle {  
        prevent_destroy = true  
    }  
}
```



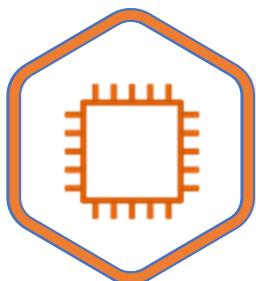
>_

```
$ terraform apply  
local_file.my-pet: Refreshing state...  
[id=cba595b7d9f94ba1107a46f3f731912d95fb3d2c]  
  
Error: Instance cannot be destroyed  
  
on main.tf line 1:  
  1: resource "local_file" "my-pet" {  
  
Resource local_file.my-pet has  
lifecycle.prevent_destroy set, but the plan calls  
for this resource to be destroyed. To avoid this error  
and continue with the plan, either disable  
lifecycle.prevent_destroy or reduce the scope of the  
plan using the -target flag.
```

ignore_changes

main.tf

```
resource "aws_instance" "webserver" {  
    ami           = "ami-0edab43b6fa892279"  
    instance_type = "t2.micro"  
    tags = {  
        Name = "ProjectA-Webserver"  
    }  
}
```



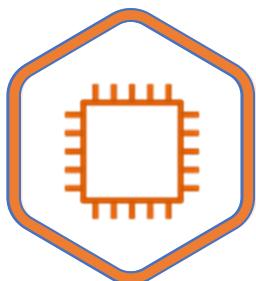
>_

```
$ terraform apply  
...  
Terraform will perform the following actions:  
  
# aws_instance.webserver will be created  
+ resource "aws_instance" "webserver" {  
    + ami           = "ami-0edab43b6fa892279"  
    + get_password_data = false  
    + host_id       = (known after apply)  
    + id            = (known after apply)  
    + instance_state = (known after apply)  
    + instance_type  = "t2.micro"  
    + tags          = {  
        + "Name"      = "ProjectA-WebServer"  
    }  
.  
aws_instance.webserver: Creation complete after 33s [id=i-05cd83b221911acd5]  
  
Apply complete! Resources: 1 added, 0 changed, 0 destroyed.
```

ignore_changes

main.tf

```
resource "aws_instance" "webserver" {  
    ami           = "ami-0edab43b6fa892279"  
    instance_type = "t2.micro"  
    tags = {  
        Name = "ProjectA-Webserver"  
    }  
}
```



>_

```
$ terraform apply  
aws_instance.webserver: Refreshing state... [id=i-05cd83b221911acd5]
```

An execution plan has been generated and is shown below.
Resource actions are indicated with the following symbols:
~ update in-place

Terraform will perform the following actions:

```
# aws_instance.webserver will be updated in-place  
~ resource "aws_instance" "webserver" {  
    .  
    .  
    ~ tags = {  
        ~ "Name" = "ProjectB-WebServer" -> "ProjectA-WebServer"  
    }  
    .  
    .  
Apply complete! Resources: 0 added, 1 changed, 0 destroyed.
```



ProjectB-WebServer

i-05cd83b221911acd5



Running



QQ

t2.micro



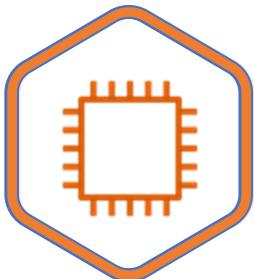
2/2 checks ...

EKLoud

ignore_changes

main.tf

```
resource "aws_instance" "webserver" {  
    ami           = "ami-0edab43b6fa892279"  
    instance_type = "t2.micro"  
    tags = {  
        Name = "ProjectA-Webserver"  
    }  
    lifecycle {  
        ignore_changes = [  
            tags  
        ]  
    }  
}
```



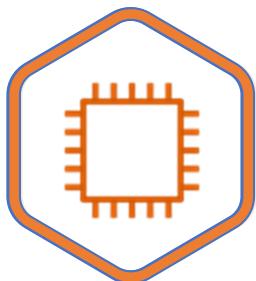
>_

```
$ terraform apply  
aws_instance.webserver: Refreshing state... [id=i-  
05cd83b221911acd5]  
  
Apply complete! Resources: 0 added, 0 changed, 0 destroyed.
```

ignore_changes

main.tf

```
resource "aws_instance" "webserver" {  
    ami           = "ami-0edab43b6fa892279"  
    instance_type = "t2.micro"  
    tags = {  
        Name = "ProjectA-Webserver"  
    }  
    lifecycle {  
        ignore_changes = all  
  
    }  
}
```



>_

```
$ terraform apply  
aws_instance.webserver: Refreshing state... [id=i-  
05cd83b221911acd5]  
  
Apply complete! Resources: 0 added, 0 changed, 0 destroyed.
```

Order	Option	
1	create_before_destroy	Create the resource first and then destroy older
2	prevent_destroy	Prevents destroy of a resource
3	ignore_changes	Ignore Changes to Resource Attributes (specific/all)

Data Sources



puppet

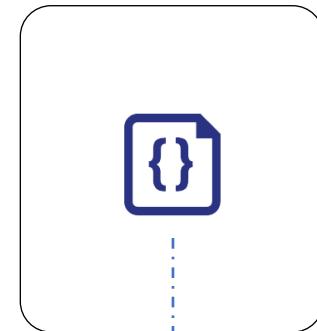


Real World Infrastructure



terraform.tfstate





```
>_
$ cat /root/dog.txt
Dogs are awesome!
```

Real World Infrastructure



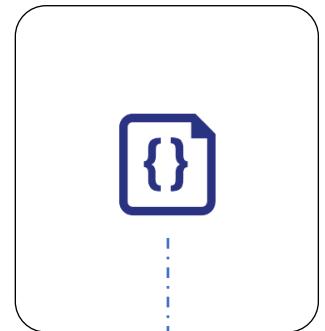
```
main.tf
```

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content = "We love pets!"
}
```

terraform.tfstate

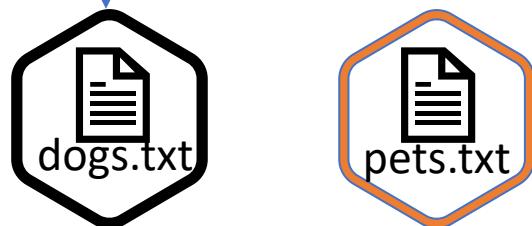


Data Sources



```
>_
$ cat /root/dog.txt
Dogs are awesome!
```

Real World Infrastructure

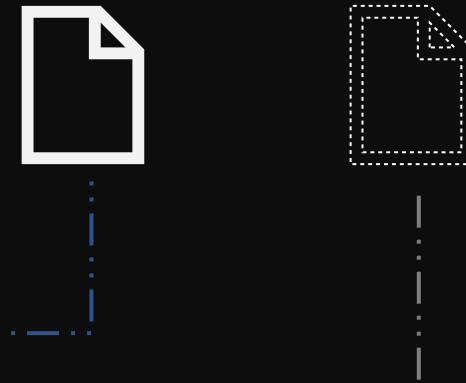


main.tf

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content = data.local_file.dog.content
}

data "local_file" "dog" {
  filename = "/root/dog.txt"
}
```

terraform.tfstate



LOCAL DOCUMENTATION

Filter

- local provider
- ▼ Resources
 - local_file
- ▼ Data Sources
 - local_file

Argument Reference

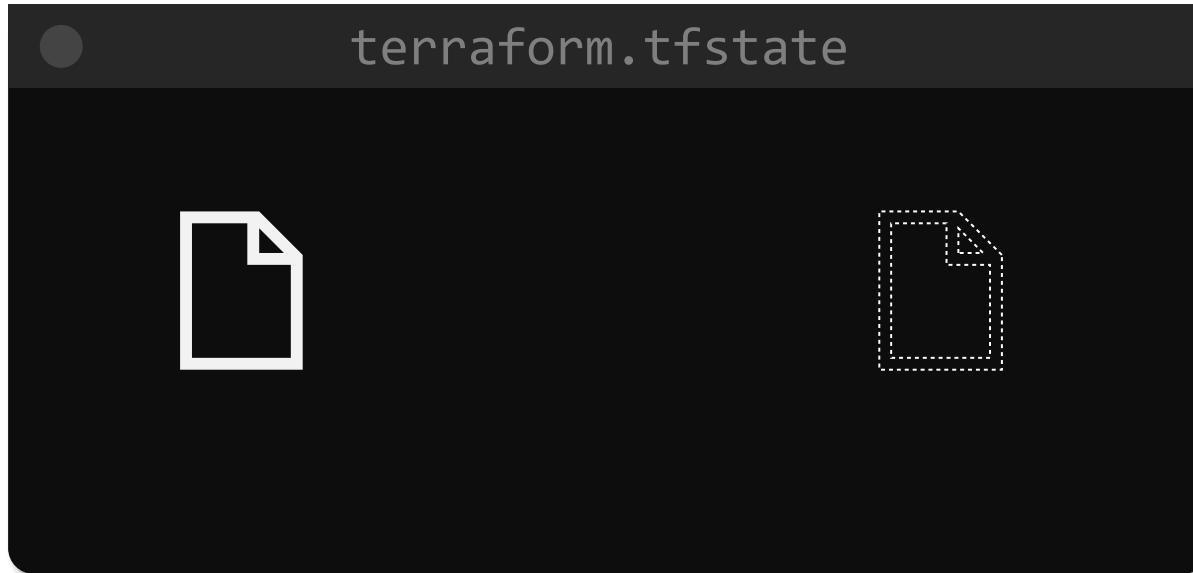
The following argument is required:

- `filename` - (Required) The path to the file that will be read. The data source will return an error if the file does not exist.

Attributes Exported

The following attribute is exported:

- `content` - The raw content of the file that was read.
- `content_base64` - The base64 encoded version of the file content (use this when dealing with binary data).



Resource	Data Source
Keyword: resource	Keyword: data
Creates, Updates, Destroys Infrastructure	Only Reads Infrastructure
Also called Managed Resources	Also called Data Resources

Meta Arguments

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    content = var.content  
}
```

variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}  
variable "content" {  
    default = "I love pets!"  
}
```



Shell Scripts

```
create_files.sh
```

```
#!/bin/bash

for i in {1..3}
do
    touch /root/pet${i}
done
```

```
>_
```

```
$ ls -ltr /root/
-rw-r--r-- 1 root root 0 Sep 9 02:04 pet2
-rw-r--r-- 1 root root 0 Sep 9 02:04 pet1
-rw-r--r-- 1 root root 0 Sep 9 02:04 pet3
```

Iteration	filename
1	/root/pet1
2	/root/pet2
3	/root/pet3

Meta Arguments

depends_on

```
main.tf
```

```
resource "local_file" "pet" {
  filename = var.filename
  content  = var.content
  depends_on = [
    random_pet.my-pet
  ]
}
resource "random_pet" "my-pet" {
  prefix   = var.prefix
  separator = var.separator
  length    = var.length
}
```

lifecycle

```
main.tf
```

```
resource "local_file" "pet" {
  filename = "/root/pets.txt"
  content = "We love pets!"
  file_permission = "0700
  lifecycle {
    create_before_destroy = true
  }
}
```

Count

count

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    count   = 3  
}
```



variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}
```

>_

```
$ terraform plan  
[Output Truncated]  
Terraform will perform the following actions:  
...  
# local_file.pet[2] will be created  
+ resource "local_file" "pet" {  
    + directory_permission = "0777"  
    + file_permission     = "0777"  
    + filename            = "/root/pets.txt"  
    + id                  = (known after apply)  
}
```

Plan: 3 to add, 0 to change, 0 to destroy.

count

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    count    = 3  
}
```

pet[0]



pet[1]



pet[2]



variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}
```

>_

```
$ terraform apply  
[Output Truncated]  
.
```

```
local_file.pet[2]: Creating...  
local_file.pet[0]: Creating...  
local_file.pet[1]: Creating...  
local_file.pet[0]: Creation complete after 0s  
[id=7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68]  
local_file.pet[2]: Creation complete after 0s  
[id=7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68]  
local_file.pet[1]: Creation complete after 0s  
[id=7e4db4fbfdbb108bdd04692602bae3e9bd1e1b68]
```

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

count

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename  
    count   = 3  
}
```

pet[0]



pet[1]



pet[2]



variables.tf

```
variable "filename" {  
    default = "/root/pets.txt"  
}
```

>_

```
$ ls /root  
pet.txt
```

count

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename[count.index]  
    count   = 3  
}
```

pet[0]



pet[1]



pet[2]



variables.tf

```
variable "filename" {  
    default = [  
        "/root/pets.txt",  
        "/root/dogs.txt",  
        "/root/cats.txt"  
    ]  
}
```

>_

```
$ ls /root  
pets.txt  
dogs.txt  
cats.txt
```

Length Function

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename[count.index]  
    count   = length(var.filename)  
}
```

pet[0]



pet[1]



pet[2]



variables.tf

```
variable "filename" {  
    default = [  
        "/root/pets.txt",  
        "/root/dogs.txt",  
        "/root/cats.txt",  
        "/root/cows.txt",  
        "/root/ducks.txt"  
    ]  
}
```

```
>_  
$ ls /root  
pets.txt  
dogs.txt  
cats.txt
```

Length Function

variable	function	value
<code>fruits = ["apple", "banana", "orange"]</code>	<code>length(fruits)</code>	3
<code>cars = ["honda", "bmw", "nissan", "kia"]</code>	<code>length(cars)</code>	4
<code>colors = ["red", "purple"]</code>	<code>length(colors)</code>	2

LengthFunction

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename[count.index]  
    count   = length(var.filename)  
}
```

pet[0]



pet[1]



pet[2]



variables.tf

```
variable "filename" {  
    default = [  
        "/root/pets.txt",  
        "/root/dogs.txt",  
        "/root/cats.txt",  
        "/root/cows.txt",  
        "/root/ducks.txt"  
    ]  
}
```

```
>_  
$ ls /root  
pets.txt  
dogs.txt  
cats.txt
```

```
>_
$ terraform apply
.
.
Terraform will perform the following actions:

# local_file.pet[0] will be created
+ resource "local_file" "pet" {
    + directory_permission = "0777"
    + file_permission      = "0777"
    + filename              = "/root/pets.txt"
    + id                    = (known after apply)
}

# local_file.pet[1] will be created
+ resource "local_file" "pet" {
    + directory_permission = "0777"
    + file_permission      = "0777"
    + filename              = "/root/dogs.txt"
    + id                    = (known after apply)
}

# local_file.pet[2] will be created
+ resource "local_file" "pet" {
    + directory_permission = "0777"
    + file_permission      = "0777"
    + filename              = "/root/cats.txt"
    + id                    = (known after apply)
}
```

```
>_
$ ls /root
pet.txt
dogs.txt
cats.txt
```

main.tf

```
resource "local_file" "pet" {  
    filename = var.filename[count.index]  
  
    count   = length(var.filename)  
}
```

variables.tf

```
variable "filename" {  
    default = [  
  
        "/root/dogs.txt",  
        "/root/cats.txt"  
    ]  
}
```

pet[0]



pet[1]



pet[2]



main.tf

```
resource "local_file" "pet" {
    filename = var.filename[count.index]
    count    = length(var.filename)
}
```

pet[0]



Replace

pet[1]



Replace

pet[2]



Destroy

variables.tf

```
variable "filename" {
    default = [
        "/root/dogs.txt",
        "/root/cats.txt"
    ]
}
```

>_

```
$ terraform plan
```

```
...
# local_file.pet[0] must be replaced
-/+ resource "local_file" "pet" {
    directory_permission = "0777"
    file_permission      = "0777"
    ~ filename            = "/root/pets.txt" -> "/root/dogs.txt" #
forces replacement
}
# local_file.pet[1] must be replaced
-/+ resource "local_file" "pet" {
    directory_permission = "0777"
    file_permission      = "0777"
    ~ filename            = "/root/dogs.txt" -> "/root/cats.txt" #
forces replacement
}
# local_file.pet[2] will be destroyed
- resource "local_file" "pet" {
    - directory_permission = "0777" -> null
    - file_permission      = "0777" -> null
}
```

main.tf

```
resource "local_file" "pet" {
  filename = var.filename[count.index]
  count    = length(var.filename)
}

output "pets" {
  value = local_file.pet
}
```

pet[0]



pet[1]



pet[2]

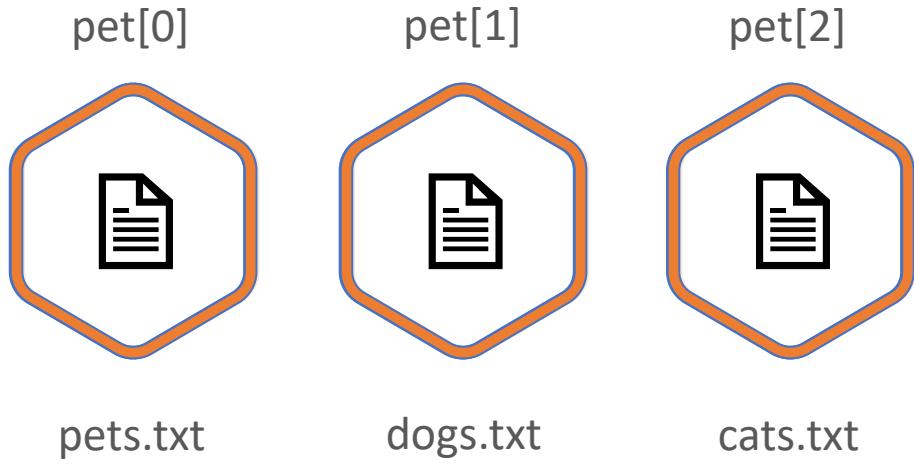


>_

```
$ terraform output
```

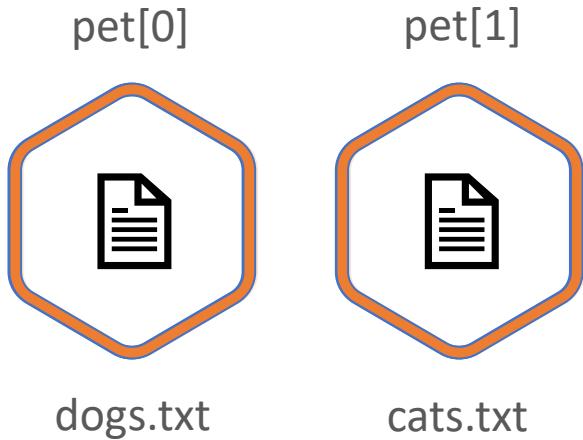
Outputs:

```
pets = [
  {
    "directory_permission" = "0777"
    "file_permission" = "0777"
    "filename" = "/root/pets.txt"
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"
  },
  {
    "directory_permission" = "0777"
    "file_permission" = "0777"
    "filename" = "/root/dogs.txt"
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"
  },
  {
    "directory_permission" = "0777"
    "file_permission" = "0777"
    "filename" = "/root/cats.txt"
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"
  },
]
```



```
variables.tf
```

```
variable "filename" {  
  default = [  
    "/root/dogs.txt",  
    "/root/cats.txt"  
  ]  
}
```



```
variables.tf
variable "filename" {
  default = [
    "/root/dogs.txt",
    "/root/cats.txt"
  ]
}
```

Resource	Resource Updates	Action
<code>pet[0]</code>	<code>/root/pets.txt" -> "/root/dogs.txt"</code>	Destroy and Replace
<code>pet[1]</code>	<code>" /root/dogs.txt" -> "/root/cats.txt"</code>	Destroy and Replace
<code>pet[2]</code>	Does not Exist	Destroy

for_each

for_each

main.tf

```
resource "local_file" "pet" {  
    filename = each.value  
    for_each = var.filename  
}
```

variables.tf

```
variable "filename" {  
    type=set(string)  
    default = [  
        "/root/pets.txt",  
        "/root/dogs.txt",  
        "/root/cats.txt"  
    ]  
}
```

pet[0]



pet[1]



pet[2]



>_

\$ terraform plan

```
Terraform will perform the following actions:  
# local_file.pet["/root/cats.txt"] will be created  
+ resource "local_file" "pet" {  
    + directory_permission = "0777"  
    + file_permission     = "0777"  
    + filename            = "/root/cats.txt"  
}  
... <output trimmed>  
Plan: 3 to add, 0 to change, 0 to destroy.
```

for_each

main.tf

```
resource "local_file" "pet" {
    filename = each.value
    [for_each = toset(var.filename)]
}
```

variables.tf

```
variable "filename" {
    type=set(string)
    default = [
        "/root/pets.txt",
        "/root/dogs.txt",
        "/root/cats.txt"
    ]
}
```

pet[0]



pet[1]



pet[2]



>_

\$ terraform plan

```
Terraform will perform the following actions:
# local_file.pet["/root/cats.txt"] will be created
+ resource "local_file" "pet" {
    + directory_permission = "0777"
    + file_permission      = "0777"
    + filename              = "/root/cats.txt"
}
... <output trimmed>
Plan: 3 to add, 0 to change, 0 to destroy.
```

for_each

main.tf

```
resource "local_file" "pet" {
    filename = each.value
    for_each = toset(var.filename)
}

output "pets" {
    value = local_file.pet
}
```

pet[0]



pet[1]



pet[2]



variables.tf

```
variable "filename" {
    type=list(string)
    default = [
        "/root/dogs.txt",
        "/root/cats.txt"
    ]
}
```

>_

\$ terraform plan

Terraform will perform the following actions:

```
# local_file.pet["/root/pets.txt"] will be destroyed
+ resource "local_file" "pet" {
    + directory_permission = "0777"
    + file_permission      = "0777"
    + filename              = "/root/pets.txt"
}
... <output trimmed>
Plan: 0 to add, 0 to change, 1 to destroy.
```

for_each

main.tf

```
resource "local_file" "pet" {  
    filename = each.value  
    for_each = toset(var.filename)  
}  
  
output "pets" {  
    value = local_file.pet  
}
```

pet[0]



pet[1]



pet[2]



>_

```
$ terraform output  
pets = {  
    "/root/cats.txt" = {  
        "directory_permission" = "0777"  
        "file_permission" = "0777"  
        "filename" = "/root/cats.txt"  
        "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"  
    }  
  
    "/root/dogs.txt" = {  
        "directory_permission" = "0777"  
        "file_permission" = "0777"  
        "filename" = "/root/dogs.txt"  
        "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"  
    }  
}
```

count

```
>_  
$ terraform output  
  
pets = [  
  {  
    "directory_permission" = "0777"  
    "file_permission" = "0777"  
    "filename" = "/root/pets.txt"  
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"  
  },  
  {  
    "directory_permission" = "0777"  
    "file_permission" = "0777"  
    "filename" = "/root/dogs.txt"  
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"  
  },  
  {  
    "directory_permission" = "0777"  
    "file_permission" = "0777"  
    "filename" = "/root/cats.txt"  
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"  
  },  
]
```

for_each

```
>_  
$ terraform output  
  
pets = {  
  "/root/cats.txt" = {  
    "directory_permission" = "0777"  
    "file_permission" = "0777"  
    "filename" = "/root/cats.txt"  
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"  
  }  
  
  "/root/dogs.txt" = {  
    "directory_permission" = "0777"  
    "file_permission" = "0777"  
    "filename" = "/root/dogs.txt"  
    "id" = "da39a3ee5e6b4b0d3255bfef95601890afd80709"  
  }  
}
```

Version Constraints

main.tf

```
resource "local_file" "pet" {  
    filename      = "/root/pet.txt"  
    content      = "We love pets!"  
}
```

>_

```
$ terraform init
```

Initializing the backend...

Initializing provider plugins...

- Finding latest version of hashicorp/local...
- Installing hashicorp/local v1.4.0...
- Installed hashicorp/local v1.4.0 (signed by HashiCorp)

The following providers do not have any version constraints
in configuration, so the latest version was installed.

To prevent automatic upgrades to new major versions that may
contain breaking
changes, we recommend adding version constraints in a
required_providers block
in your configuration, with the constraint strings suggested
below.

```
* hashicorp/local: version = "~> 1.4.0"
```

Terraform has been successfully initialized!

main.tf

```
resource "local_file" "pet" {  
    filename      = "/root/pet.txt"  
    content      = "We love pets!"  
}
```

Terraform Registry

Search Providers and Modules

Providers / hashicorp / local / Version 2.0.0 / Latest Version

local

 **local**

Official by: HashiCorp

Utility

Used to manage local resources, such as creating files

VERSION	PUBLISHED	INSTALLS	SOURCE CODE
2.0.0	9 days ago	15.8M	hashicorp/terraform-provider-local

main.tf

```
resource "local_file" "pet" {  
    filename      = "/root/pet.txt"  
    content      = "We love pets!"  
}
```

The screenshot shows the HashiCorp Terraform Registry interface. The top navigation bar includes the Terraform logo and the word "Registry". A search bar is located at the top right. Below the navigation, a breadcrumb trail shows the path: Providers / hashicorp / local / Version 2.0.0 / Latest Version. A dropdown menu for "Latest Version" is open, showing "Version 2.0.0" as the selected option, which is published 9 days ago. To the left, the "local" provider is listed with its logo, status as "Official" by HashiCorp, and category "Utility". A tooltip for "Used to manage" is visible below the provider name.

LATEST VERSION

- Version 2.0.0 ✓
Published 9 days ago
- Version 1.4.0
Published a year ago
- Version 1.3.0
Published a year ago
- Version 1.2.2
Published a year ago
- Version 1.2.1

main.tf

```
resource "local_file" "pet" {
  filename      = "/root/pet.txt"
  content      = "We love pets!"
}
```

[Overview](#)[Documentation](#)[USE PROVIDER ▾](#)

How to use this provider

To install this provider, copy and paste this code into your Terraform configuration. Then, run `terraform init`.

Terraform 0.13 [Latest](#)

```
terraform {
  required_providers {
    local = {
      source = "hashicorp/local"
      version = "1.4.0"
    }
  }
}
```

main.tf

```
terraform {  
  required_providers {  
    local = {  
      source = "hashicorp/local"  
      version = "1.4.0"  
    }  
  }  
  
  resource "local_file" "pet" {  
    filename      = "/root/pet.txt"  
    content      = "We love pets!"  
  }  
}
```

[Overview](#)[Documentation](#)[USE PROVIDER ▾](#)

How to use this provider

To install this provider, copy and paste this code into your Terraform configuration. Then, run `terraform init`.

Terraform 0.13 [Latest](#)

```
terraform {  
  required_providers {  
    local = {  
      source = "hashicorp/local"  
      version = "1.4.0"  
    }  
  }  
}
```

main.tf

```
terraform {  
    required_providers {  
        local = {  
            source = "hashicorp/local"  
            version = "1.4.0"  
        }  
    }  
  
    resource "local_file" "pet" {  
        filename      = "/root/pet.txt"  
        content      = "We love pets!"  
    }  
}
```

>_

```
$ terraform init  
Initializing the backend...  
  
Initializing provider plugins...  
- Finding hashicorp/local versions matching "1.4.0"...  
- Installing hashicorp/local v1.4.0...  
- Installed hashicorp/local v1.4.0 (signed by HashiCorp)  
  
Terraform has been successfully initialized!  
  
You may now begin working with Terraform. Try running  
"terraform plan" to see  
any changes that are required for your infrastructure. All  
Terraform commands  
should now work.  
  
If you ever set or change modules or backend configuration for  
Terraform,  
rerun this command to reinitialize your working directory. If  
you forget, other  
commands will detect it and remind you to do so if necessary.
```

main.tf

```
terraform {  
    required_providers {  
        local = {  
            source = "hashicorp/local"  
            version = "> 1.2.0, < 2.0.0, != 1.4.0"  
        }  
    }  
  
    resource "local_file" "pet" {  
        filename      = "/root/pet.txt"  
        content      = "We love pets!"  
    }  
}
```

```
>_  
$ terraform init  
Initializing the backend...  
  
Initializing provider plugins...  
- Finding hashicorp/local versions matching "> 1.2.0, <  
2.0.0, != 1.4.0"...  
- Installing hashicorp/local v1.3.0...  
- Installed hashicorp/local v1.3.0 (signed by  
HashiCorp)  
  
Terraform has been successfully initialized!
```

main.tf

```
terraform {  
    required_providers {  
        local = {  
            source = "hashicorp/local"  
            version = "~> 1.2.0"  
        }  
    }  
  
    resource "local_file" "pet" {  
        filename      = "/root/pet.txt"  
        content      = "We love pets!"  
    }  
}
```

>_

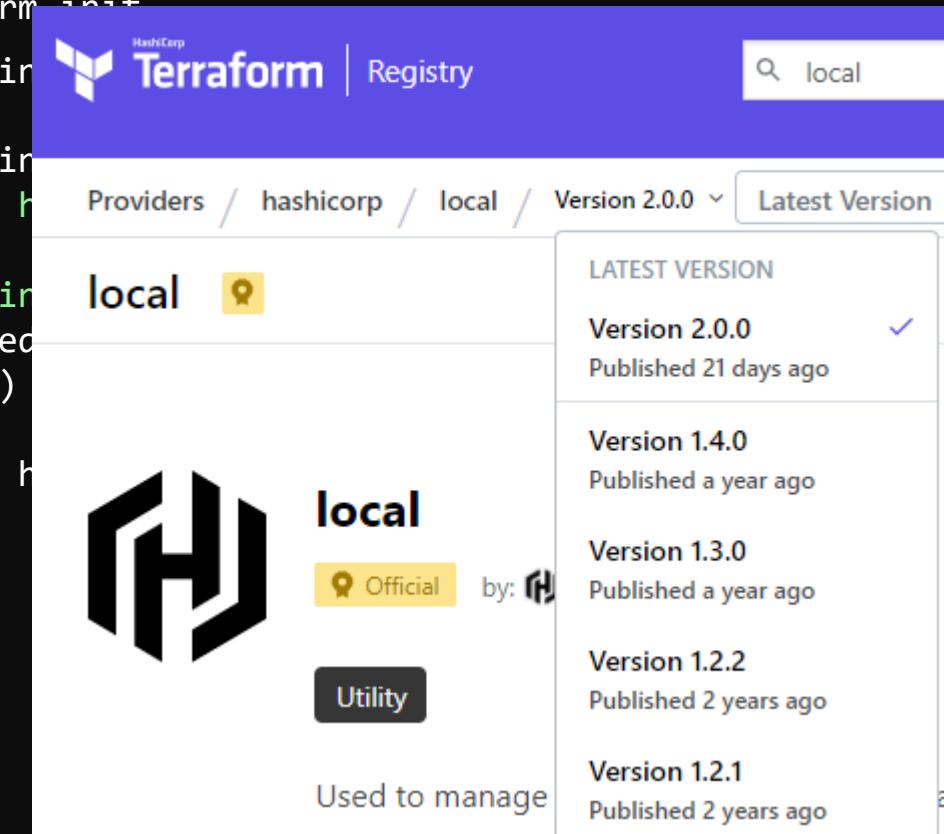
```
$ terraform init
```

```
Initializing provider plugins...
```

```
Initializers:
```

- Finding hashicorp/local v1.2.0...
- Installing hashicorp/local v1.2.0...
- Installed provider hashicorp/local v1.2.0 (from HashiCorp)

```
Terraform has been successfully initialized!
```



The screenshot shows the Terraform Registry interface. At the top, there's a search bar with the text 'local'. Below it, the URL path is visible: Providers / hashicorp / local / Version 2.0.0 / Latest Version. On the left, there's a sidebar with a 'LATEST VERSION' section showing 'Version 2.0.0' (Published 21 days ago). The main content area displays the 'local' provider details. It features the HashiCorp logo, the provider name 'local' in large bold letters, an 'Official' badge with a lock icon, and a 'Utility' tag. A note says 'Used to manage'. To the right, a list of available versions is shown:

Version	Published
Version 2.0.0	Published 21 days ago
Version 1.4.0	Published a year ago
Version 1.3.0	Published a year ago
Version 1.2.2	Published 2 years ago
Version 1.2.1	Published 2 years ago

Getting Started with AWS

Getting Started with AWS

Demo: Setup an AWS Account

Introduction to IAM

Demo: IAM

Programmatic Access

IAM with Terraform



Introduction to AWS S3

S3 with Terraform

Introduction to DynamoDB

Demo DynamoDB

DynamoDB with Terraform

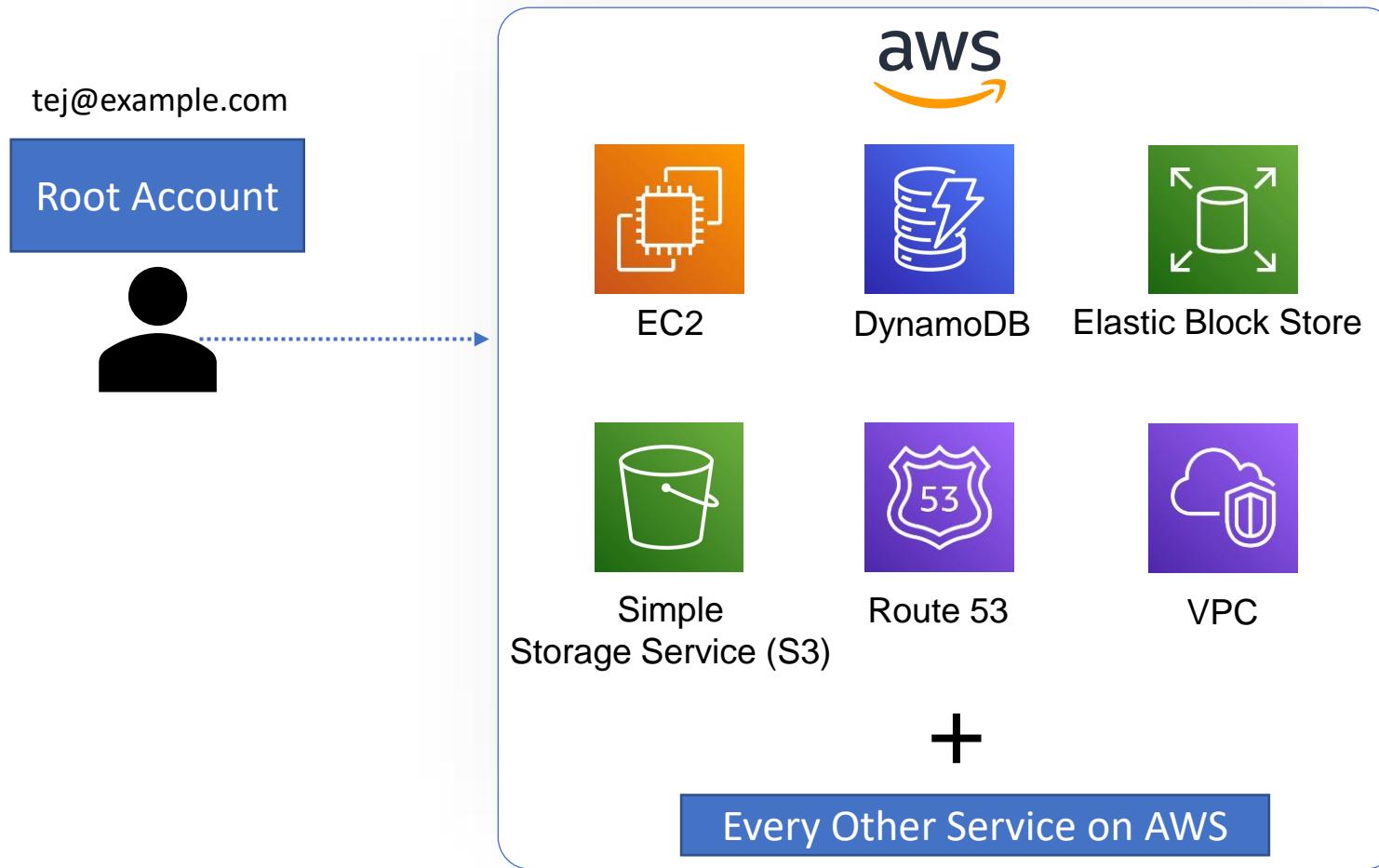


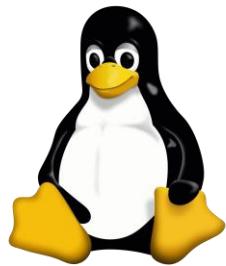


{KODE}{CLOUD}

Introduction to IAM

Identity and Access Management in AWS





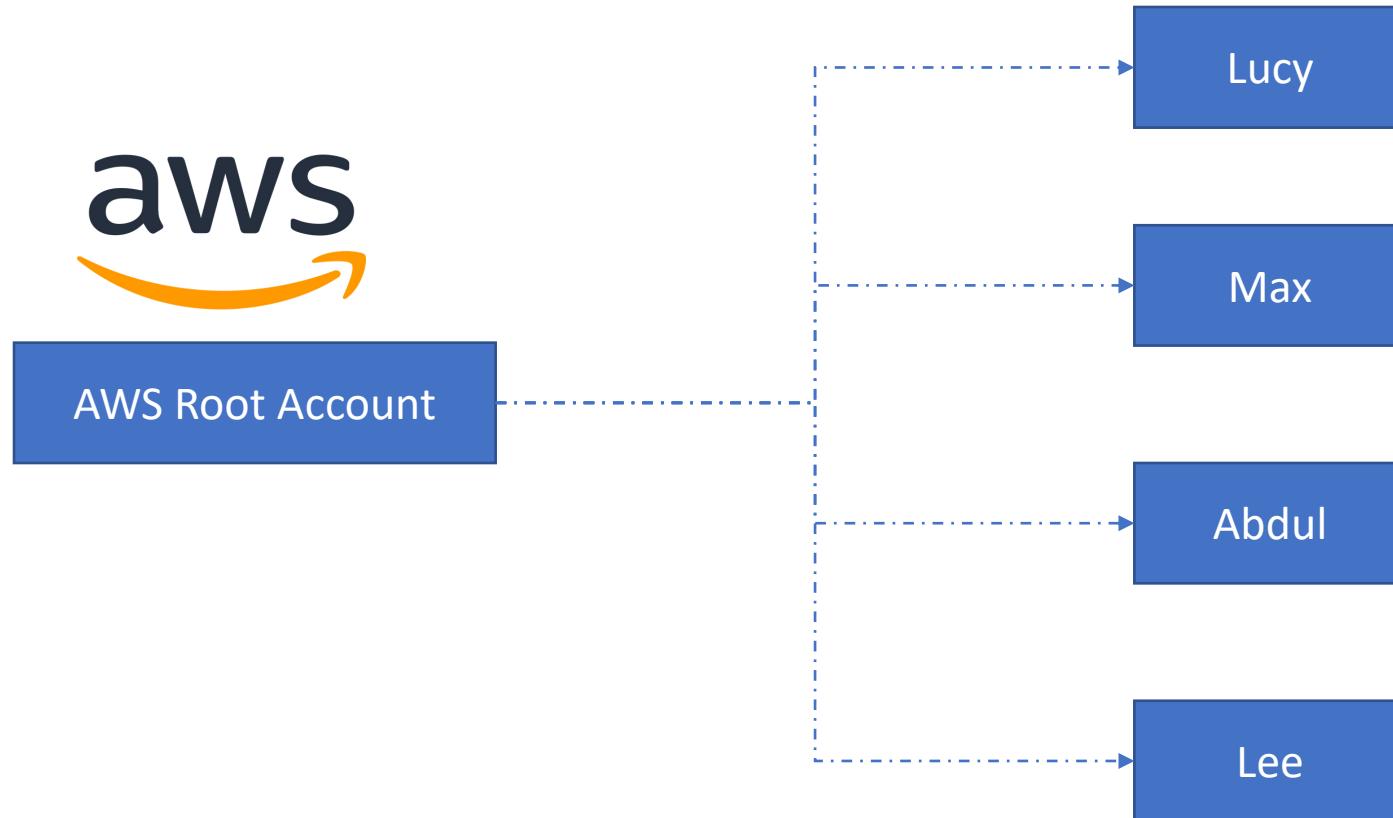
Linux Root User



Windows Admin User



AWS Root Account



The diagram illustrates the AWS CloudFront architecture. On the left, a user profile icon labeled "Lucy" is shown interacting with a "Username" and "Password" input field. A dashed arrow points from this interaction to the AWS CloudFront interface. The interface features a navigation bar with "aws", "Services", "Resource Groups", and a star icon. Below the navigation is a search bar with placeholder text "Find a service by name or feature (for example, EC2, S3 or VM, storage)". The main content area is organized into several categories:

- Compute:** EC2, Lightsail, Lambda, Batch, Elastic Beanstalk, Serverless Application Repository, AWS Outposts, EC2 Image Builder.
- Blockchain:** Amazon Managed Blockchain.
- Analytics:** Athena, EMR, CloudSearch, Elasticsearch Service, Kinesis, QuickSight.
- Business Application:** Alexa for Business, Amazon Chime, WorkMail, Amazon Honeycode.
- End User Computing:** WorkSpaces, AppStream 2.0, WorkDocs, WorkLink.
- Storage:** S3, EFS, FSx, S3 Glacier, Storage Gateway, AWS Backup.
- Quantum Technologies:** Amazon Braket.
- Management & Governance:** AWS Organizations, CloudWatch, AWS Auto Scaling, CloudFormation, CloudTrail, Config.
- Security, Identity, & Compliance:** IAM, Resource Access Manager, Cognito.
- Internet Of Things:** IoT Core, FreeRTOS, IoT 1-Click.

console.aws.com

```
$ aws s3api create-bucket --bucket my-bucket --region us-east-1
```

Access Key ID
Secret Access Key



Lucy



```
{  
  "Version": "2012-10-17",  
  "Statement": [  
    {  
      "Effect": "Allow",  
      "Action": "*",  
      "Resource": "*"  
    }  
  ]  
}
```

AdministratorAccess
Policy



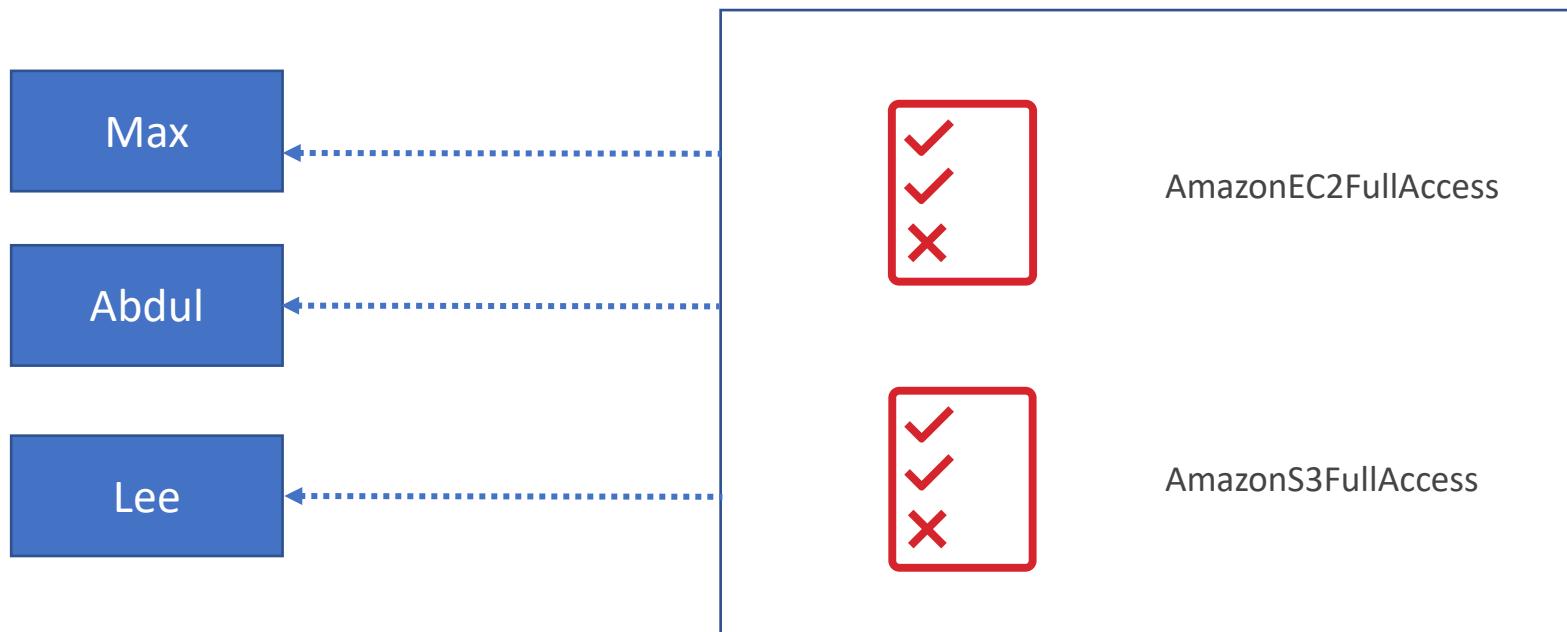
AdministratorAccess

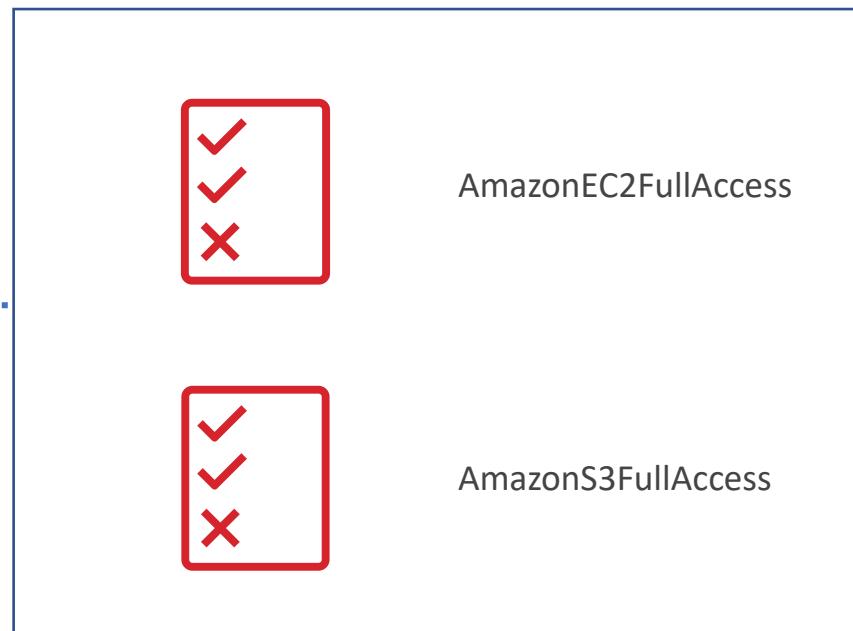
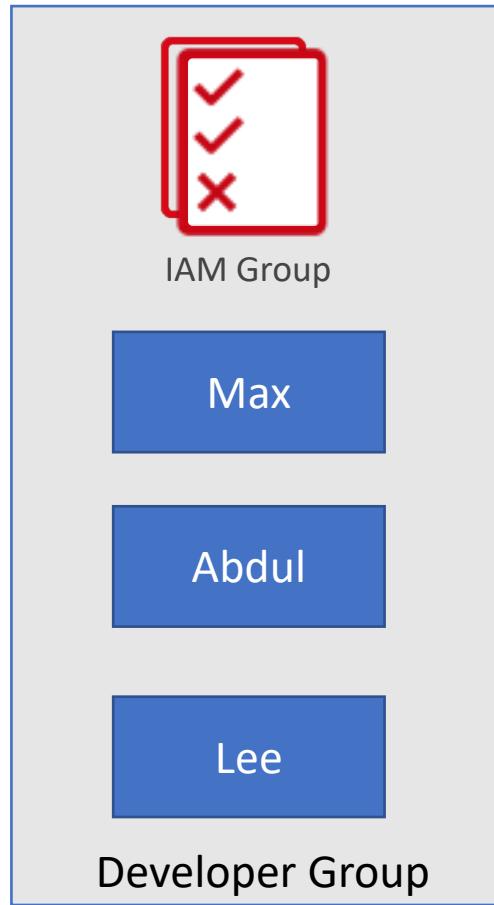


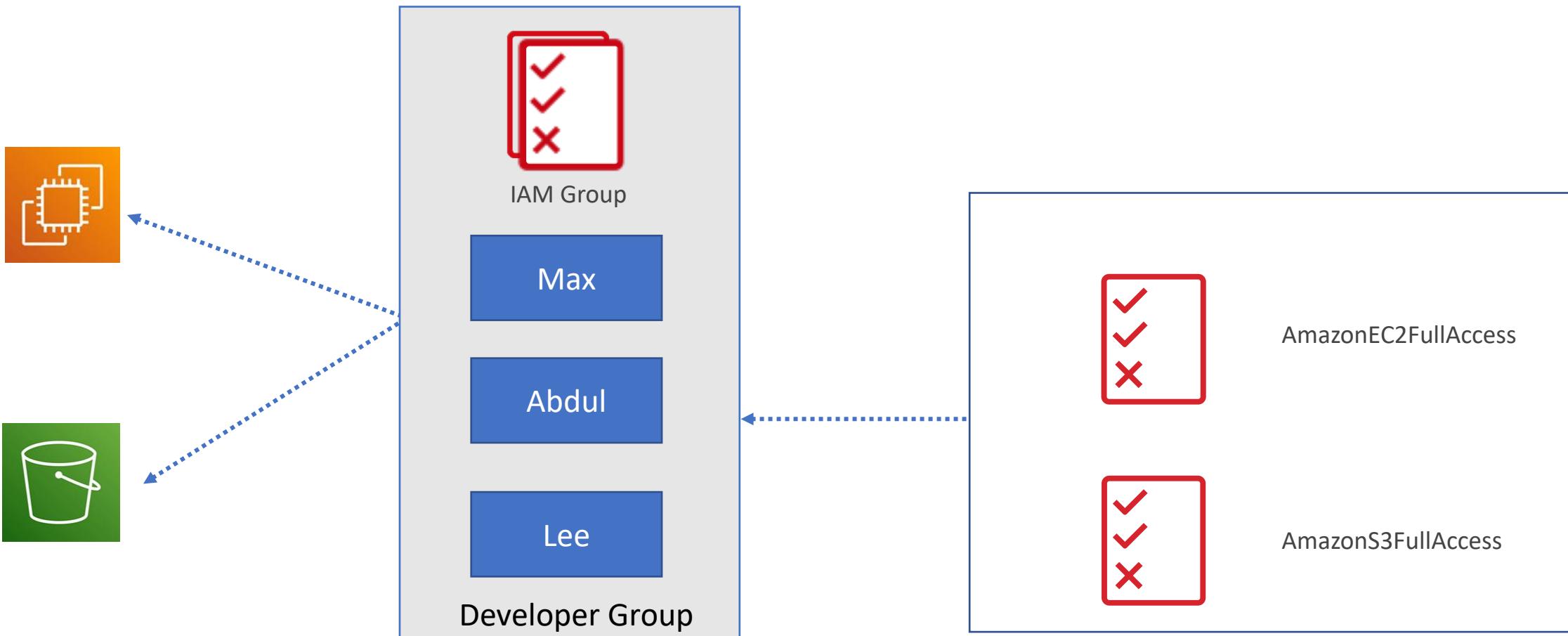
AdministratorAccess

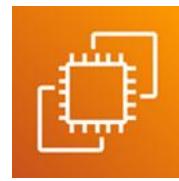
	Policy name ▾	Type	Used as
<input type="checkbox"/>	▶ AdministratorAccess	Job function	Permissions policy (2)
<input type="checkbox"/>	▶ AlexaForBusinessDeviceSetup	AWS managed	None
<input type="checkbox"/>	▶ AlexaForBusinessFullAccess	AWS managed	None
<input type="checkbox"/>	▶ AlexaForBusinessGatewayExecution	AWS managed	None
<input type="checkbox"/>	▶ AlexaForBusinessLifesizeDelegatedAccessPolicy	AWS managed	None
<input type="checkbox"/>	▶ AlexaForBusinessPolyDelegatedAccessPolicy	AWS managed	None
<input type="checkbox"/>	▶ AlexaForBusinessReadOnlyAccess	AWS managed	None
<input type="checkbox"/>	▶ AmazonAPIGatewayAdministrator	AWS managed	None

Job Function	Policy Name
Administrator	AdministratorAccess
Billing	Billing
Database Administrator	DatabaseAdministrator
Network Administrator	NetworkAdministrator
View-Only User	ViewOnlyAccess

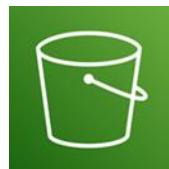


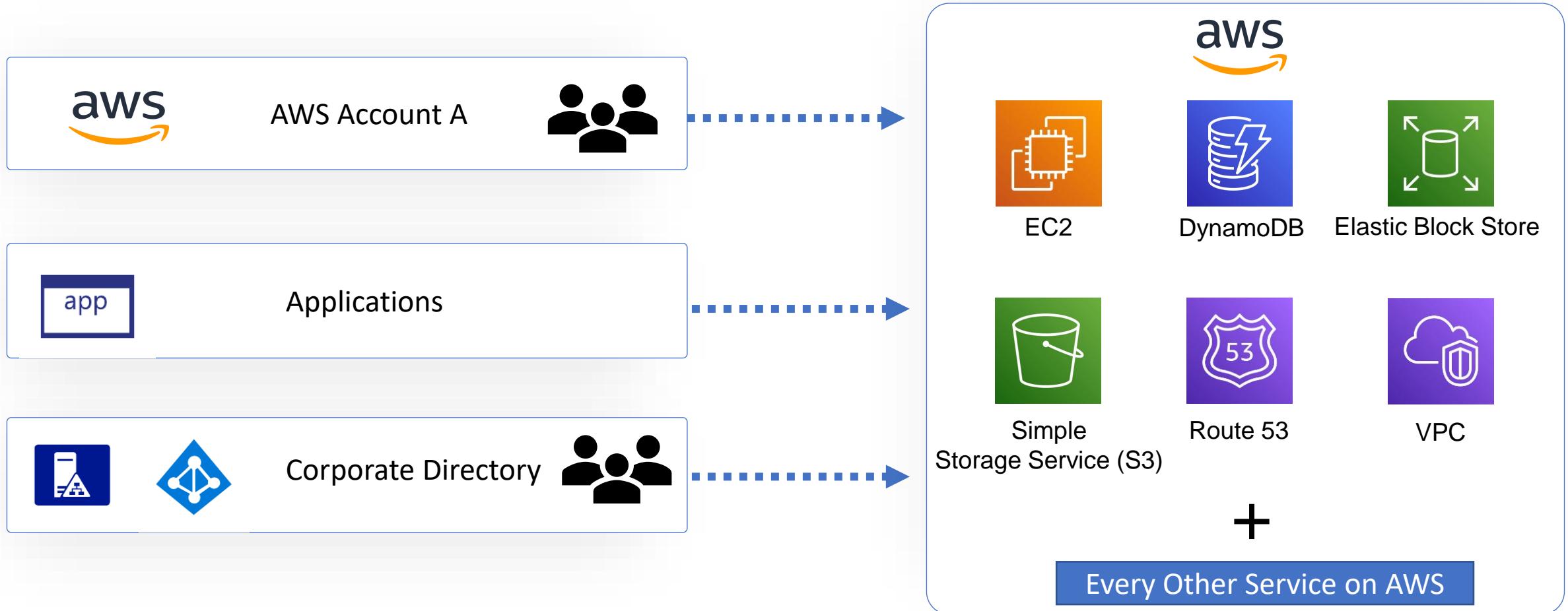






AmazonS3FullAccess







CreateEC2TagsPolicy

```
{  
    "Version": "2012-10-17",  
    "Statement": [  
        {  
            "Effect": "Allow",  
            "Action": [  
                "ec2:DeleteTags",  
                "ec2:CreateTags"  
            ],  
            "Resource": "*"  
        }  
    ]  
}
```

Filter policies	Policy name	Type	Used as	Description
	CreateEC2TagsPolicy	Customer managed	None	Permission to create and delete EC2 Tags



Services ▾

Resource Groups ▾



History

Console Home

VPC

EC2

S3



Compute

- EC2
- Lightsail ↗
- Lambda
- Batch
- Elastic Beanstalk
- Serverless Application Repository
- AWS Outposts
- EC2 Image Builder



Storage

- S3
- EFS
- FSx
- S3 Glacier
- Storage Gateway
- AWS Backup



Blockchain

- Amazon Managed Blockchain



Satellite

- Ground Station



Quantum Technologies

- Amazon Braket



Management & Governance

- AWS Organizations
- CloudWatch
- AWS Auto Scaling
- CloudFormation
- CloudTrail
- Config



Analytics

- Athena
- EMR
- CloudSearch
- Elasticsearch Service
- Kinesis
- QuickSight ↗
- Data Pipeline
- AWS Data Exchange
- AWS Glue
- AWS Lake Formation
- MSK



Security, Identity, & Compliance

- IAM
- Resource Access Manager
- Cognito



Business Applications

- Alexa for Business
- Amazon Chime ↗
- WorkMail
- Amazon Honeycode



End User Computing

- WorkSpaces
- AppStream 2.0
- WorkDocs
- WorkLink



Internet Of Things

- IoT Core
- FreeRTOS
- IoT 1-Click

Identity and Access Management (IAM)

Dashboard

Access management

Groups



Users



Roles

Welcome to Identity and Access Management

IAM users sign-in link:

<https://kodekloud.signin.aws.amazon.com/console> 

IAM Resources

Users: 4

Groups: 2

Customer Managed Policies: 3

Programmatic Access

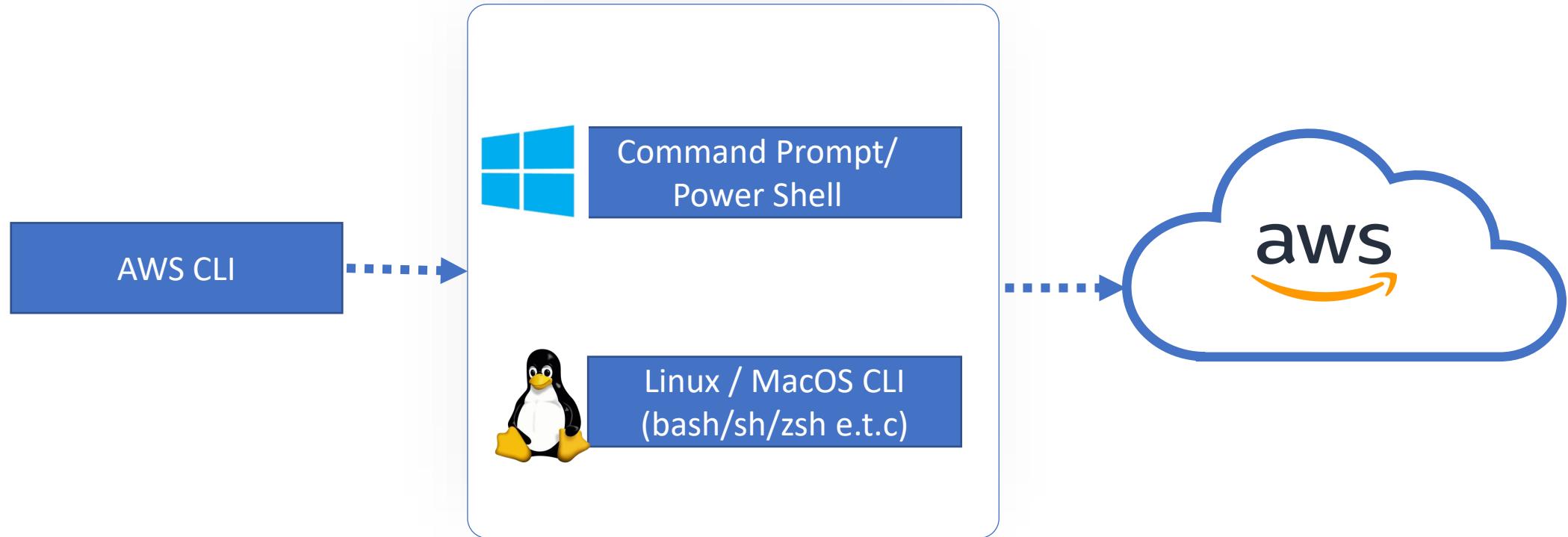
The diagram illustrates the AWS CloudFront architecture. On the left, a user profile icon labeled "Lucy" is shown interacting with a "Username" and "Password" input field. A dashed arrow points from this interaction to the AWS CloudFront interface. The interface features a navigation bar with "aws", "Services", "Resource Groups", and a star icon. Below the navigation is a search bar with placeholder text "Find a service by name or feature (for example, EC2, S3 or VM, storage)". The main content area is organized into several categories:

- Compute:** EC2, Lightsail, Lambda, Batch, Elastic Beanstalk, Serverless Application Repository, AWS Outposts, EC2 Image Builder.
- Blockchain:** Amazon Managed Blockchain.
- Analytics:** Athena, EMR, CloudSearch, Elasticsearch Service, Kinesis, QuickSight.
- Business Application:** Alexa for Business, Amazon Chime, WorkMail, Amazon Honeycode.
- End User Computing:** WorkSpaces, AppStream 2.0, WorkDocs, WorkLink.
- Storage:** S3, EFS, FSx, S3 Glacier, Storage Gateway, AWS Backup.
- Quantum Technologies:** Amazon Braket.
- Management & Governance:** AWS Organizations, CloudWatch, AWS Auto Scaling, CloudFormation, CloudTrail, Config.
- Security, Identity, & Compliance:** IAM, Resource Access Manager, Cognito.
- Internet Of Things:** IoT Core, FreeRTOS, IoT 1-Click.

console.aws.com

```
$ aws s3api create-bucket --bucket my-bucket --region us-east-1
```

Access Key ID
Secret Access Key





```
$ curl "https://awscli.amazonaws.com/awscli-exe-linux-x86_64-2.0.30.zip" -o "awscliv2.zip"  
$ unzip awscliv2.zip  
$ sudo ./aws/install  
  
$ aws --version  
aws-cli/2.0.47 Python/3.7.4 Linux/4.14.133-113.105.amzn2.x86_64 botocore/2.0.0
```



Download and Install <https://awscli.amazonaws.com/AWSCLIV2.msi>

```
C:\> aws --version  
aws-cli/2.0.47 Python/3.7.4 Windows/10 botocore/2.0.0
```



Download and Install
<https://awscli.amazonaws.com/AWSCLIV2.pkg>

```
$ aws --version  
aws-cli/2.0.47 Python/3.7.4 Darwin/18.7.0 botocore/2.0.0
```

```
$ aws configure  
AWS Access Key ID [None]: AKIAI44QH8DHBEXAMPLE  
AWS Secret Access Key [None]: je7MtGbClwBF/2Zp9Utk/h3yCo8nvbEXAMPLEKEY  
Default region name [None]: us-west-2  
Default output format [None]: json
```

```
$ cat .aws/config/config  
[default]  
region = us-west-2  
output = text
```

```
$ cat .aws/config/credentials  
[default]  
aws_access_key_id = AKIAI44QH8DHBEXAMPLE  
aws_secret_access_key = je7MtGbClwBF/2Zp9Utk/h3yCo8nvbEXAMPLEKEY
```

```
$ aws <command> <subcommand> [options and parameters]
```

```
$ aws iam create-user --user-name lucy
{
  "User": {
    "UserName": "lucy",
    "Tags": [],
    "CreateDate": "2020-09-15T23:40:11.168Z",
    "UserId": "h9r2sc5br8ss7uzhs2qm",
    "Path": "/",
    "Arn": "arn:aws:iam::000000000000:user/lucy"
  }
}
```

Command	Value
command	iam
subcommand	create-user
option	--user-name
parameter	lucy

```
$ aws help
AWS()

NAME
    aws - 

DESCRIPTION
    The AWS Command Line Interface is a unified tool to
manage your AWS
    services.

SYNOPSIS
    aws [options] <command> <subcommand> [parameters]

        Use aws command help for information on a specific
command. Use aws
        help topics to view a list of available help topics. The
synopsis for
        each command shows its parameters and their usage.
Optional parameters
        are shown in square brackets.
.

[Output Truncated]
```

```
$ aws iam help
```

```
IAM()
```

```
NAME
```

```
    iam -
```

```
DESCRIPTION
```

```
    AWS Identity and Access Management (IAM) is a web service  
for securely
```

```
    controlling access to AWS services. With IAM, you can  
centrally manage
```

```
    users, security credentials such as access keys, and  
permissions that
```

```
    control which AWS resources users and applications can  
access. For more
```

```
    information about IAM, see AWS Identity and Access  
Management (IAM) and
```

```
    the AWS Identity and Access Management User Guide .
```

```
AVAILABLE COMMANDS
```

```
    o add-client-id-to-open-id-connect-provider
```

```
    o add-role-to-instance-profile
```

```
.
```

```
.
```

```
[Output Truncated]
```

```
$ aws <command> help
```

```
$ aws iam create-user help
```

NAME

create-user -

DESCRIPTION

Creates a new IAM user for your AWS account.

The number and size of IAM resources in an AWS account are limited. For

more information, see IAM and STS Quotas in the IAM User Guide .

See also: AWS API Documentation

See 'aws help' for descriptions of global parameters.

SYNOPSIS

```
  create-user
  [--path <value>]
  --user-name <value>
  [--permissions-boundary <value>]
  [--tags <value>]
  [--cli-input-json <value>]
  [--generate-cli-skeleton <value>]
```

```
$ aws <command> <subcommand> help
```

IAM with Terraform



Filter

> GuardDuty

▼ IAM

▼ Resources

aws_iam_access_key

aws_iam_account_alias

aws_iam_account_password_policy

aws_iam_group

aws_iam_role

aws_iam_role_policy

aws_iam_role_policy_attachment

aws_iam_saml_provider

aws_iam_server_certificate

aws_iam_service_linked_role

• aws_iam_user

aws_iam_user_group_membership

aws_iam_user_login_profile

aws_iam_user_policy

J

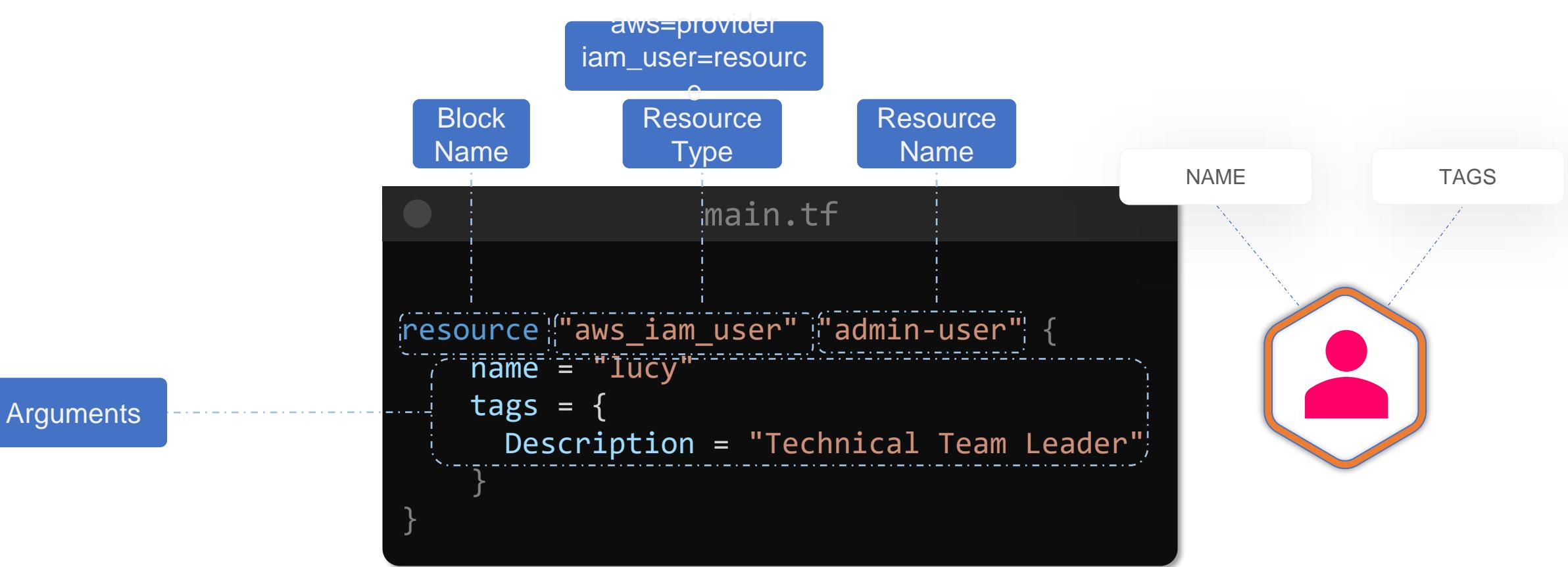
EOF

}

Argument Reference

The following arguments are supported:

- `name` - (Required) The user's name. The name must consist of upper and lowercase alphanumeric characters with no spaces. You can also include any of the following characters: `=,.@-_`. User names are not distinguished by case. For example, you cannot create users named both "TESTUSER" and "testuser".
- `path` - (Optional, default "/") Path in which to create the user.
- `permissions_boundary` - (Optional) The ARN of the policy that is used to set the permissions boundary for the user.
- `force_destroy` - (Optional, default false) When destroying this user, destroy even if it has non-Terraform-managed IAM access keys, login profile or MFA devices. Without `force_destroy` a user with non-Terraform-managed access keys and login profile will fail to be destroyed.
- `tags` - Key-value map of tags for the IAM user



main.tf

```
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}
```



>_

```
$ terraform init
```

Initializing the backend...

Initializing provider plugins...

- Finding latest version of hashicorp/aws...
- Installing hashicorp/aws v3.6.0...
- Installed hashicorp/aws v3.6.0 (signed by HashiCorp)

The following providers do not have any version constraints in configuration, so the latest version was installed.

To prevent automatic upgrades to new major versions that may contain breaking changes, we recommend adding version constraints in a required_providers block in your configuration, with the constraint strings suggested below.

```
* hashicorp/aws: version = "~> 3.6.0"
```

Terraform has been successfully initialized!

You may now begin working with Terraform. Try running "terraform plan" to see any changes that are required for your infrastructure. All Terraform commands should now work.

If you ever set or change modules or backend configuration for

main.tf

```
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}
```



>_

```
$ terraform plan
```

```
provider.aws.region
```

The region where AWS operations will take place. Examples are us-east-1, us-west-2, etc.

Enter a value: `us-west-1`

Refreshing Terraform state in-memory prior to plan...

The refreshed state will be used to calculate this plan, but will not be persisted to local or remote state storage.

Error: error configuring Terraform AWS Provider: no valid credential sources for Terraform AWS Provider found.

Please see

<https://registry.terraform.io/providers/hashicorp/aws> for more information about providing credentials.

Error: NoCredentialProviders: no valid providers in chain.
Deprecated.

For verbose messaging see
`aws.Config.CredentialsChainVerboseErrors`

main.tf

```
provider "aws" {  
    region = "us-west-2"  
    access_key = "AKIAI44QH8DHBEXAMPLE"  
    secret_key = "je7MtGbClwBF/2tk/h3yCo8n..."  
}  
resource "aws_iam_user" "admin-user" {  
    name = "lucy"  
    tags = {  
        Description = "Technical Team Leader"  
    }  
}
```



> _

```
$ terraform plan
```

```
.  
. + create
```

Terraform will perform the following actions:

```
# aws_iam_user.admin-user will be created  
+ resource "aws_iam_user" "admin-user" {  
    + arn          = (known after apply)  
    + force_destroy = false  
    + id           = (known after apply)  
    + name         = "Lucy"  
    + path         = "/"  
    + tags         = {  
        + "Description" = "Technical Team Lead"  
    }  
    + unique_id    = (known after apply)  
}
```

Plan: 1 to add, 0 to change, 0 to destroy.

Note: You didn't specify an "-out" parameter to save this

main.tf

```
provider "aws" {  
    region = "us-west-2"  
    access_key = "AKIAI44QH8DHBEXAMPLE"  
    secret_key = "je7MtGbClwBF/2tk/h3yCo8n..."  
}  
resource "aws_iam_user" "admin-user" {  
    name = "lucy"  
    tags = {  
        Description = "Technical Team Leader"  
    }  
}
```



> _

```
$ terraform apply
```

```
# aws_iam_user.admin-user will be created  
+ resource "aws_iam_user" "admin-user" {  
    + arn          = (known after apply)  
    + force_destroy = false  
    + id           = (known after apply)  
    + name         = "Lucy"  
    + path         = "/"  
    + tags         = {  
        + "Description" = "Technical Team Lead"  
    }  
    + unique_id    = (known after apply)  
}
```

```
Plan: 1 to add, 0 to change, 0 to destroy.
```

```
aws_iam_user.admin-user: Creating...  
aws_iam_user.admin-user: Creation complete after 1s  
[id=Lucy]
```

```
Apply complete! Resources: 1 added, 0 changed, 0 destroyed.
```

main.tf

```
provider "aws" {
  region = "us-west-2"
  access_key = "AKIAI44QH8DHBEXAMPLE"
  secret_key = "je7MtGbClwBF/2tk/h3yCo8n..."
}
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}
```

.aws/config/credentials

```
[default]
aws_access_key_id =
aws_secret_access_key =
```

main.tf

```
provider "aws" {
  region = "us-west-2"

}
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}
```

.aws/config/credentials

```
[default]
aws_access_key_id = AKIAI44QH8DHBEXAMPLE
aws_secret_access_key = je7MtGbClwBF/2tk/h3yCo8n...
```

>_

```
$ export AWS_ACCESS_KEY_ID=
$ export AWS_SECRET_ACCESS_KEY_ID=
```

main.tf

```
provider "aws" {
  region = "us-west-2"

}

resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}
```

.aws/config/credentials

```
[default]
aws_access_key_id =
aws_secret_access_key =
```

>_

```
$ export AWS_ACCESS_KEY_ID=AKIAI44QH8DHBEEXAMPLE
$ export AWS_SECRET_ACCESS_KEY_ID=je7MtGbC1wBF/2tk/h3yCo8n...
$ export AWS_REGION=us-west-2
```



IAM policies with Terraform

main.tf

```
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}
```



```
{  
  "Version": "2012-10-17",  
  "Statement": [  
    {  
      "Effect": "Allow",  
      "Action": "*",  
      "Resource": "*"  
    }  
  ]  
}
```

AdministratorAccess
Policy

Argument Reference

The following arguments are supported:

- `description` - (Optional, Forces new resource) Description of the IAM policy.
- `name` - (Optional, Forces new resource) The name of the policy. If omitted, Terraform will assign a random, unique name.
- `name_prefix` - (Optional, Forces new resource) Creates a unique name beginning with the specified prefix. Conflicts with `name`.
- `path` - (Optional, default "/") Path in which to create the policy. See [IAM Identifiers](#) for more information.
- `policy` - (Required) The policy document. This is a JSON formatted string. For more information about building AWS IAM policy documents with Terraform, see the [AWS IAM Policy Document Guide](#)

main.tf

```
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}

resource "aws_iam_policy" "adminUser" {
  name    = "AdminUsers"
  policy = ?
}
```



IAM Policy

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    }
  ]
}
```

AdministratorAccess
Policy

```
[COMMAND] <>DELIMITER
Line1
Line2
Line3
DELIMITER
```

Heredoc Syntax

main.tf

```
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}

resource "aws_iam_policy" "adminUser" {
  name    = "AdminUsers"
  policy = <<EOF
EOF
}
```



```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    }
  ]
}
```

AdministratorAccess
Policy

```
[COMMAND] <<DELIMITER
Line1
Line2
Line3
DELIMITER
```

Heredoc Syntax

main.tf

```
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}

resource "aws_iam_policy" "adminUser" {
  name = "AdminUsers"
  policy = <<EOF
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    }
  ]
}
EOF

resource "aws_iam_user_policy_attachment" "lucy-admin-access" {
  user = aws_iam_user.admin-user.name
  policy_arn = aws_iam_policy.adminUser.arn
}
```

AdministratorAccess
Policy

[COMMAND] <<DELIMITER
Line1
Line2
Line3
DELIMITER

Heredoc Syntax



??

main.tf

```
resource "aws_iam_user" "admin-user" {
  name    = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}

resource "aws_iam_policy" "adminUser" {
  name    = "AdminUsers"
  policy = <<EOF
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    }
  ]
}
EOF
}

resource "aws_iam_user_policy_attachment" "lucy-admin-access" {
  user = aws_iam_user.admin-user.name
  policy_arn = aws_iam_policy.adminUser.arn
}
```

\$ terraform apply

```
# aws_iam_policy.adminUser will be created
+ resource "aws_iam_policy" "adminUser" {
  + arn      = (known after apply)
  + id       = (known after apply)
  + name     = "AdminUsers"
  + path     = "/"
  + policy   = jsonencode(
    {
      + Statement = [
        + {
          + Action    = "*"
          + Effect   = "Allow"
          + Resource = "*"
        },
        ...
      ],
      + Version   = "2012-10-17"
    }
  )
}

.[Output Truncated]
aws_iam_user.lucy: Creating...
aws_iam_policy.adminUser: Creating...
aws_iam_user.lucy: Creation complete after 0s [id=lucy]
aws_iam_policy.adminUser: Creation complete after 0s
[id=arn:aws:iam::000000000000:policy/AdminUsers]
aws_iam_user_policy_attachment.lucy-admin-access: Creating...
aws_iam_user_policy_attachment.lucy-admin-access: Creation complete
after 0s [id=lucy-2020091903415868610000001]
```

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

main.tf

```
resource "aws_iam_user" "admin-user" {
  name = "lucy"
  tags = {
    Description = "Technical Team Leader"
  }
}

resource "aws_iam_policy" "adminUser" {
  name    = "AdminUsers"
  policy = <<EOF
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    }
  ]
}
EOF
}

resource "aws_iam_user_policy_attachment" "lucy-admin-access" {
  user = aws_iam_user.admin-user.name
  policy_arn = aws_iam_policy.adminUser.arn
}
```

admin-policy.json

main.tf

```
resource "aws_iam_user" "admin-user" {
    name = "lucy"
    tags = {
        Description = "Technical Team Leader"
    }
}

resource "aws_iam_policy" "adminUser" {
    name    = "AdminUsers"
    policy = file("admin-policy.json")
}

EOF

}

resource "aws_iam_user_policy_attachment" "lucy-admin-access" {

    user = aws_iam_user.admin-user.name

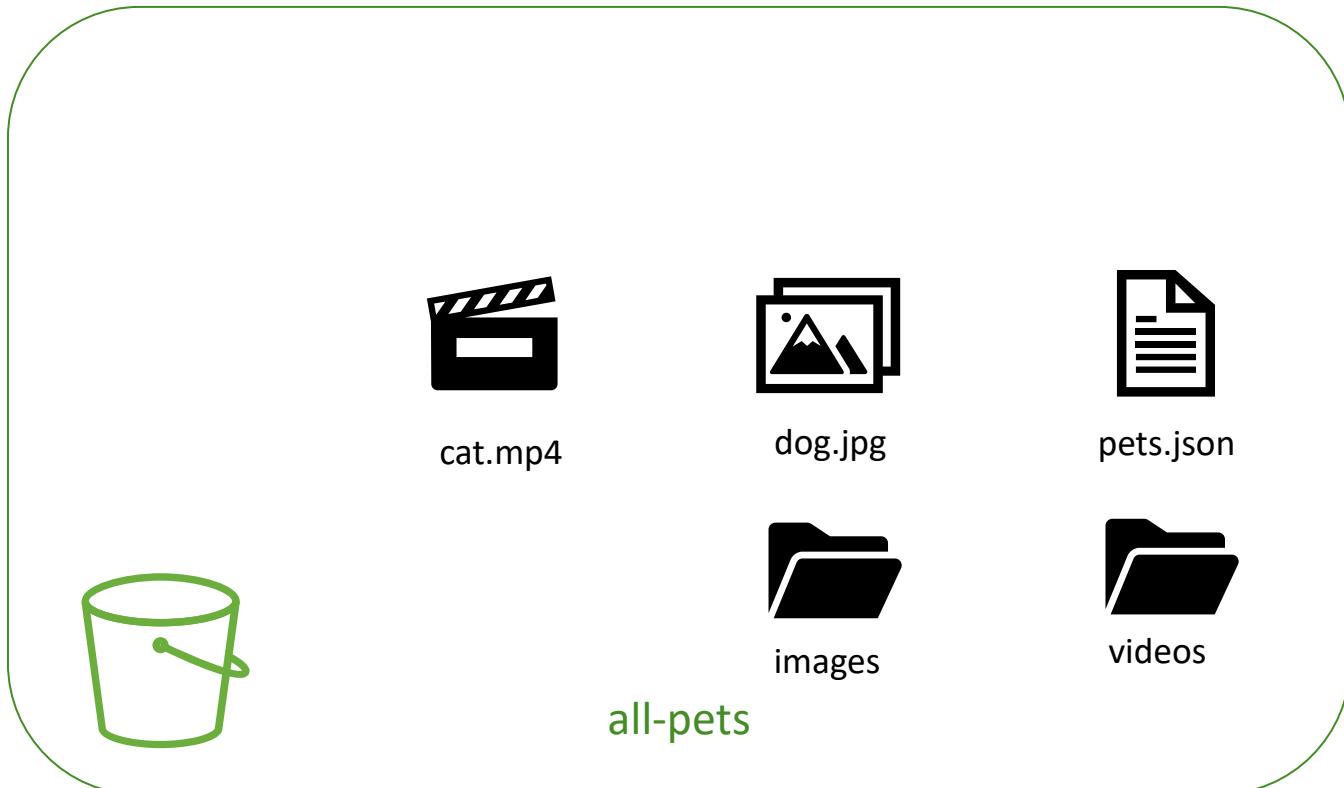
    policy_arn = aws_iam_policy.adminUser.arn
}
```

admin-policy.json

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": "*",
            "Resource": "*"
        }
    ]
}
```

AWS S3





Object #	Name
1	<code>pets.json</code>
2	<code>dog.jpg</code>
3	<code>cat.mp4</code>
4	<code>pictures/cat.jpg</code>
5	<code>videos/dog.mp4</code>

Unique Bucket Name

DNS Compliant Name

Files size between 0 to
5TB

Create bucket

① Name and region ② Configure options ③ Set permissions ④ Review

Name and region

Bucket name ?

Enter DNS-compliant bucket name

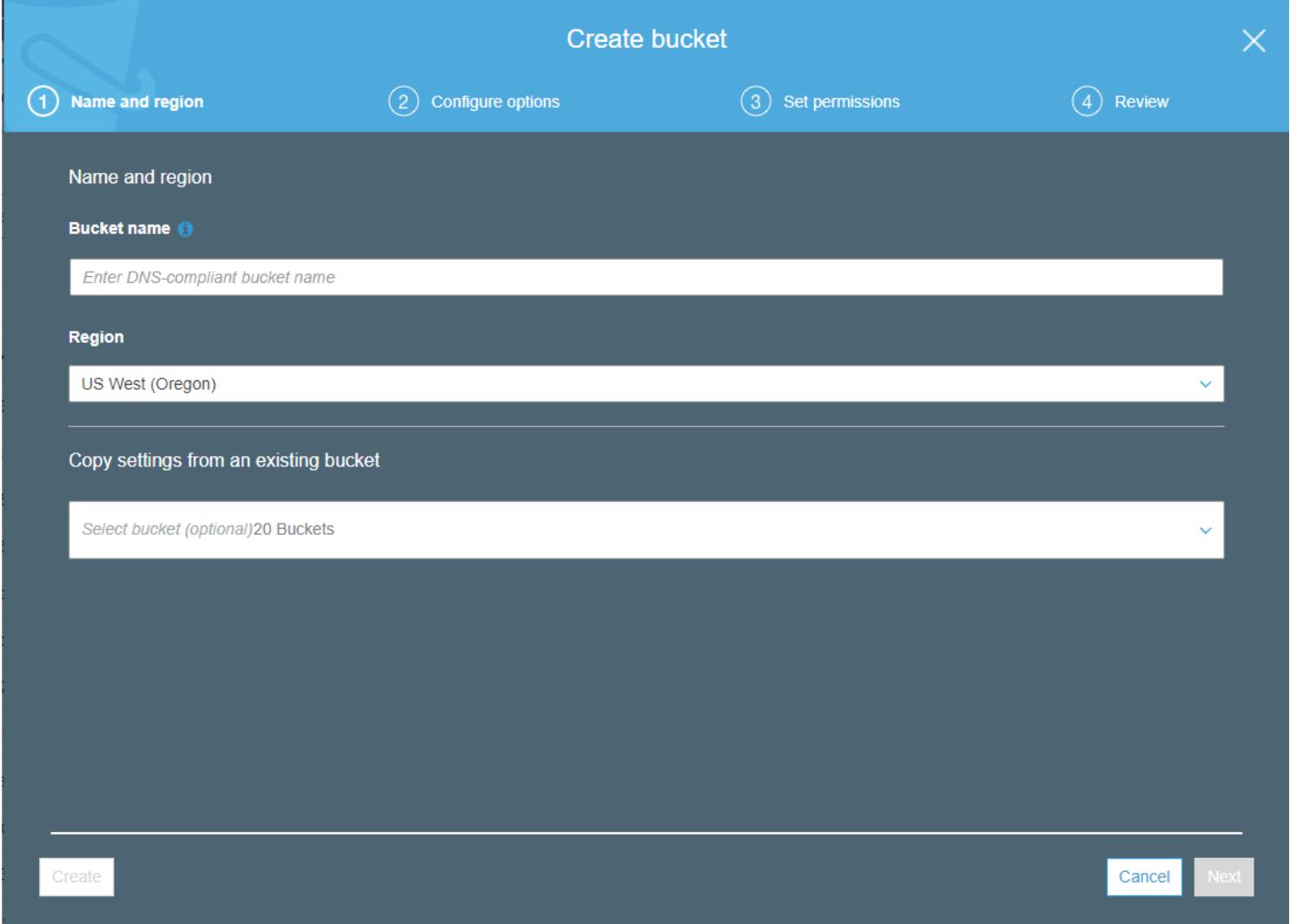
Region

US West (Oregon)

Copy settings from an existing bucket

Select bucket (optional) 20 Buckets

Create Cancel Next



https://<bucket_name>.<region>.amazonaws.com

<https://all-pets.us-west-1.amazonaws.com>

Object #	Name	Address
1	pets.json	https://all-pets.us-west-1.amazonaws.com/pets.json
2	dog.jpg	https://all-pets.us-west-1.amazonaws.com/dog.jpg
3	cat.mp4	https://all-pets.us-west-1.amazonaws.com/cat.mp4
4	pictures/cat.jpg	https://all-pets.us-west-1.amazonaws.com/pictures/cat.jpg
5	videos/dog.mp4	https://all-pets.us-west-1.amazonaws.com/videos/dog.mp4



dog.jpg

Key = dog.jpg

Value = Data

Object data

Owner = Lucy

Size = 5MB

Last Modified = Jan 26, 2020 12:55:21 AM GMT-0500

Metadata

all-pets

Access Control Lists



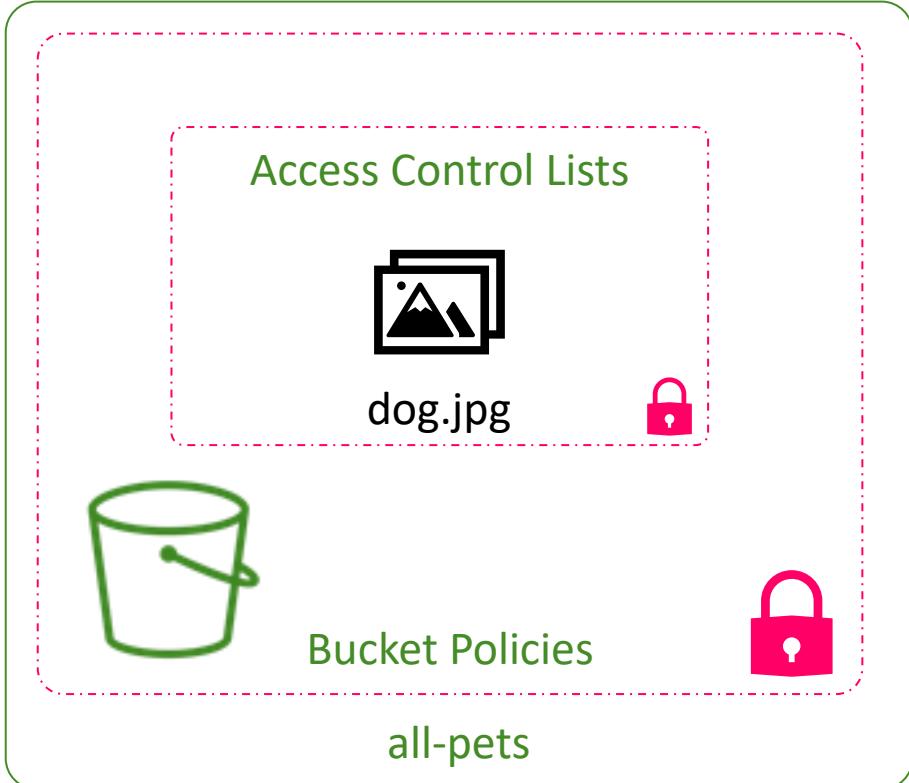
dog.jpg



Bucket Policies

all-pets





A screenshot of a JSON file titled "read-objects.json" showing an AWS IAM policy document. The policy grants Lucy permission to read objects from the "all-pets" bucket.

```
{  
  "Version": "2012-10-17",  
  "Statement": [  
    {  
      "Action": [  
        "s3:GetObject"  
      ],  
      "Effect": "Allow",  
      "Resource": "arn:aws:s3:::all-pets/*",  
      "Principal": {  
        "AWS": [  
          "arn:aws:iam::123456123457:user/Lucy"  
        ]  
      }  
    }  
  ]  
}
```

The file is labeled "read-objects.json" at the bottom.

S3 with Terraform

main.tf

```
resource "aws_s3_bucket" "finance" {
  bucket = "finanace-21092020"
  tags   = {
    Description = "Finance and Payroll"
  }
}
```

>_

```
$ terraform apply
Terraform will perform the following actions:

# aws_s3_bucket.finance will be created
+ resource "aws_s3_bucket" "finance" {
    + acceleration_status  = (known after apply)
    + acl                  = "private"
    + arn                  = (known after apply)
    + bucket               = "finanace-21092020"
    .
    .
}
```

Plan: 1 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

```
aws_s3_bucket.finance: Creating...
aws_s3_bucket.finance: Creation complete after 0s
[id=finanace-21092020]
```

Apply complete! Resources: 1 added, 0 changed, 0 destroyed.

main.tf

```
resource "aws_s3_bucket" "finance" {
    bucket = "finanace-21092020"
    tags   = {
        Description = "Finance and Payroll"
    }
}

resource "aws_s3_bucket_object" "finance-2020" {
    content = "/root/finance/finance-2020.doc"
    key     = "finance-2020.doc"
    bucket  = aws_s3_bucket.finance.id
}
```

>_

```
$ terraform apply
.
.
Terraform will perform the following actions:

# aws_s3_bucket_object.finance-2020 will be created
+ resource "aws_s3_bucket_object" "finance-2020" {
    + acl           = "private"
    + bucket        = "finanace-21092020"
    + content       = "/root/finance/finance-
2020.doc"
    + force_destroy = false
    + id            = (known after apply)
    + key           = "finance/finance-
2020.doc"

Plan: 1 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

```
aws_s3_bucket_object.finance-2020: Creating...
aws_s3_bucket_object.finance-2020: Creation complete
after 0s [id=finance/finance-2020.doc]
```

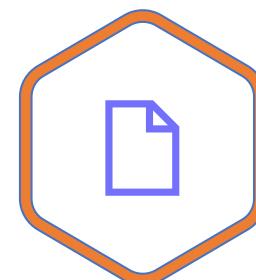
main.tf

```
resource "aws_s3_bucket" "finance" {  
    bucket = "finanace-21092020"  
    tags   = {  
        Description = "Finance and Payroll"  
    }  
  
resource "aws_s3_bucket_object" "finance-2020" {  
    content = "/root/finance/finance-2020.doc"  
    key     = "finance-2020.doc"  
    bucket  = aws_s3_bucket.finance.id  
  
}  
  
data "aws_iam_group" "finance-data" {  
    group_name = "finance-analysts"  
}
```

AWS



finance-21092020

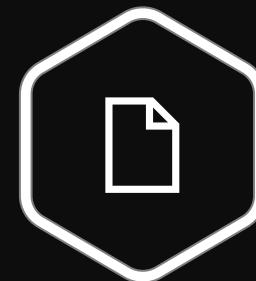


finance-2020.doc



finance-analysts

terraform.tfstate



finance-data

```
content = "/root/finance/finance-2020.doc"
key     = "finance-2020.doc"
bucket = aws_s3_bucket.finance.id
```

```
}
```

```
data "aws_iam_group" "finance-data" {
  group_name = "finance-analysts"
```

```
}
```

```
resource "aws_s3_bucket_policy" "finance-policy" {
  bucket = aws_s3_bucket.finance.id
  policy = <<EOF
```

```
EOF
}
```

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": "*",
      "Effect": "Allow",
      "Resource": "arn:aws:s3:::<>bucket-name>/*",
      "Principal": {
        "AWS": [
          "<<    arn    >>"
        ]
      }
    }
  ]
}
```

read-objects.json

```
content = "/root/finance/finance-2020.doc"
key     = "finance-2020.doc"
bucket = aws_s3_bucket.finance.id
}

data "aws_iam_group" "finance-data" {
    group_name = "finance-analysts"
}

resource "aws_s3_bucket_policy" "finance-policy" {
    bucket = aws_s3_bucket.finance.id
    policy = <<EOF
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Action": "*",
            "Effect": "Allow",
            "Resource": "arn:aws:s3:::${aws_s3_bucket.finance.id}/*",
            "Principal": {
                "AWS": [
                    "${data.aws_iam_group.finance-data.arn}"
                ]
            }
        }
    ]
}
EOF
}
```

```
>_
$ terraform apply
.
.

Terraform will perform the following actions:

# aws_s3_bucket_object.finance-2020 will be created
+ resource "aws_s3_bucket_object" "finance-2020" {
    + acl                  = "private"
    + bucket               = "finanace-21092020"
    + content              = "/root/finance/finance-2020.doc"
+ force_destroy          = false
    + id                  = (known after apply)
    + key                 = "finance/finance-2020.doc"

Plan: 1 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

aws_s3_bucket_object.finance-2020: Creating...
aws_s3_bucket_object.finance-2020: Creation complete after 0s
[id=finance/finance-2020.doc]

Apply complete! Resources: 1 added, 0 changed, 0 destroyed.
```

Introduction to DynamoDB



DynamoDB

Highly Scalable

Fully Managed by AWS

NoSQL Database

Single-Digit Millisecond Latency

Data Replicated across Regions

Manufacturer	Model
Toyota	Corolla
Honda	Civic
Dodge	Journey
Ford	F150

	Manufacturer	Model	Year	VIN
Item 1	Toyota	Corolla	2004	4Y1SL65848Z411439
Item 2	Honda	Civic	2017	DY1SL65848Z411432
Item 3	Dodge	Journey	2014	SD1SL65848Z411443
Item 4	Ford	F150	2020	DH1SL65848Z41100

cars

```
{  
  "Manufacturer": "Toyota",  
  "Make": "Corolla",  
  "Year": 2004,  
  "VIN" : "4Y1SL65848Z411439"  
}
```

```
{  
  "Manufacturer": "Honda",  
  "Make": "Civic",  
  "Year": 2017,  
  "VIN" : "DY1SL65848Z411432"  
}
```

```
{  
  "Manufacturer": "Dodge",  
  "Make": "Journey",  
  "Year": 2014,  
  "VIN" : "SD1SL65848Z411443"  
}
```

```
{  
  "Manufacturer": "Ford",  
  "Make": "F150",  
  "Year": 2020,  
  "VIN" : "DH1SL65848Z41100"  
}
```

Manufacturer	Model	Year	VIN
Toyota	Corolla	2004	4Y1SL65848Z411439
Honda	Civic	2017	DY1SL65848Z411432
Dodge	Journey	2014	SD1SL65848Z411443
Ford	F150	2020	DH1SL65848Z41100

PRIMARY KEY

Manufacturer	Model	Year	VIN
Toyota	Corolla	2004	4Y1SL65848Z411439
Honda	Civic	2017	DY1SL65848Z411432
Dodge	Journey	2014	SD1SL65848Z411443
Ford	F150	2020	DH1SL65848Z41100

```
{"Manufacturer": "Honda",
"Make": "Civic",
"Year": 2017,
"VIN" : "DY1SL65848Z411432"
}
```

```
{ "Manufacturer": "Dodge",
"Make": "Journey",
"Year": 2014,
"VIN" : "SD1SL65848Z411443"
}
```

```
{ "Manufacturer": "Ford",
"Make": "F150",
"Year": 2020,
"VIN" : "DH1SL65848Z41100"
}
```

```
{ "Manufacturer": "Jaguar",
"Make": "",
"Year": "",
"VIN" : "LB1SL65848Z41123"
}
```

DynamoDB with Terraform

main.tf

```
resource "aws_dynamodb_table" "cars" {
  name      = "cars"
  hash_key  = "VIN"
  billing_mode = "PAY_PER_REQUEST"
  attribute {
    name = "VIN"
    type = "S"
  }
}
```

- `billing_mode` - (Optional) Controls how you are charged for read and write throughput and how you manage capacity. The valid values are `PROVISIONED` and `PAY_PER_REQUEST`. Defaults to `PROVISIONED`.
- `write_capacity` - (Optional) The number of write units for this table. If the `billing_mode` is `PROVISIONED`, this field is required.
- `read_capacity` - (Optional) The number of read units for this table. If the `billing_mode` is `PROVISIONED`, this field is required.

main.tf

```
resource "aws_dynamodb_table" "cars" {
  name      = "cars"
  hash_key  = "VIN"
  billing_mode = "PAY_PER_REQUEST"
  attribute {
    name = "VIN"
    type = "S"
  }
}
```

>_

```
$ terraform apply
+ create

Terraform will perform the following actions:

# aws_dynamodb_table.cars will be created
+ resource "aws_dynamodb_table" "cars" {
    + arn          = (known after apply)
    + billing_mode = "PAY_PER_REQUEST"
    + hash_key     = "VIN"
    + id           = (known after apply)
    + name         = "cars"
    + stream_arn   = (known after apply)
    + stream_label = (known after apply)
    + stream_view_type = (known after apply)

    + attribute {
        + name = "VIN"
        + type = "S"
      }

    + point_in_time_recovery {
        + enabled = (known after apply)
      }
    .
    .

aws_dynamodb_table.cars: Creating...
aws_dynamodb_table.cars: Creation complete after 0s [id=cars]
```

main.tf

```
resource "aws_dynamodb_table" "cars" {
  name      = "cars"
  hash_key  = "VIN"
  billing_mode = "PAY_PER_REQUEST"
  attribute {
    name = "VIN"
    type = "S"
  }
}

resource "aws_dynamodb_table_item" "car-items" {
  table_name = aws_dynamodb_table.cars.name
  hash_key   = aws_dynamodb_table.cars.hash_key
  item       = <<EOF
EOF
}
```

cars

```
{
  "Manufacturer": "Toyota",
  "Make": "Corolla",
  "Year": 2004,
  "VIN" : "4Y1SL65848Z411439"
}

{
  "Manufacturer": "Honda",
  "Make": "Civic",
  "Year": 2017,
  "VIN" : "DY1SL65848Z411432"
}

{
  "Manufacturer": "Dodge",
  "Make": "Journey",
  "Year": 2014,
  "VIN" : "SD1SL65848Z411443"
}

{
  "Manufacturer": "Ford",
  "Make": "F150",
  "Year": 2020,
  "VIN" : "DH1SL65848Z41100"
}
```

main.tf

```
resource "aws_dynamodb_table" "cars" {
  name      = "cars"
  hash_key  = "VIN"
  billing_mode = "PAY_PER_REQUEST"
  attribute {
    name = "VIN"
    type = "S"
  }
}

resource "aws_dynamodb_table_item" "car-items" {
  table_name = aws_dynamodb_table.cars.name
  hash_key   = aws_dynamodb_table.cars.hash_key
  item       = <<EOF
{
  "Manufacturer": {"S": "Toyota"},
  "Make": {"S": "Corolla"},
  "Year": {"N": "2004"},
  "VIN" : {"S": "4Y1SL65848Z411439"},
}
EOF
}
```

>_

```
$ terraform apply
```

```
# aws_dynamodb_table_item.car-items will be created
+ resource "aws_dynamodb_table_item" "car-items" {
  + hash_key    = "VIN"
  + id          = (known after apply)
  + item         = jsonencode(
    {
      + Manufacturer = {
        + S = "Toyota"
      }
      + Model        = {
        + S = "Corolla"
      }
      + VIN          = {
        + S = "4Y1SL65848Z411439"
      }
      + Year         = {
        + N = "2004"
      }
    }
  )
  + table_name = "cars"
}
```

```
Plan: 1 to add, 0 to change, 0 to destroy.
```

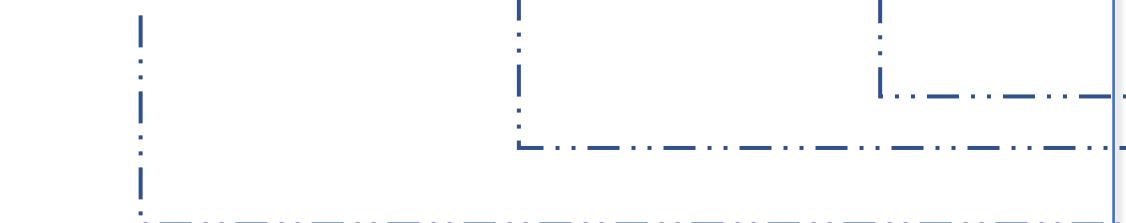
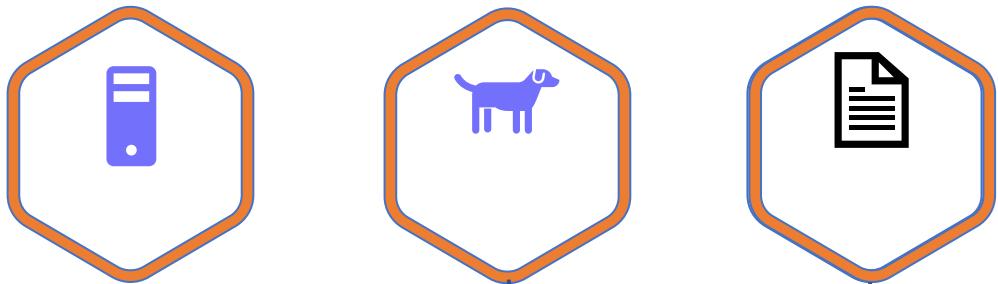
.

.

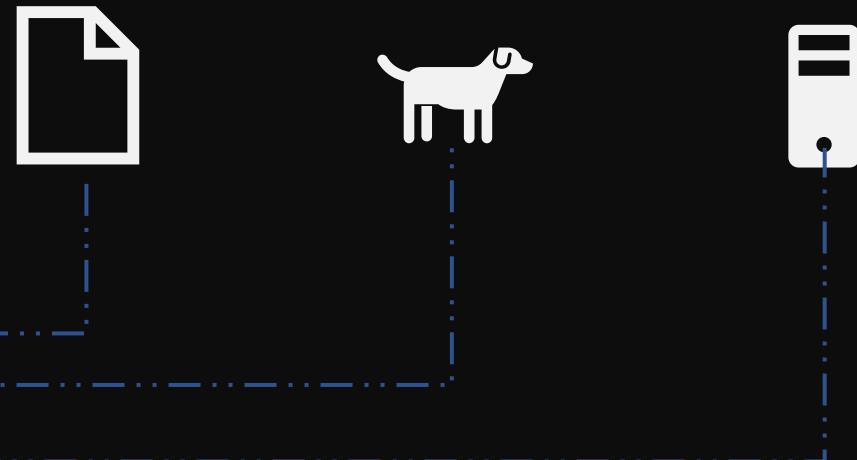
```
aws_dynamodb_table_item.car-items: Creating...
```

Remote State

Real World Infrastructure



terraform.tfstate



Mapping Configuration to Real World

Tracking Metadata

Performance

Collaboration

>_

\$ ls

main.tf variables.tf **terraform.tfstate**

Version Control



main.tf

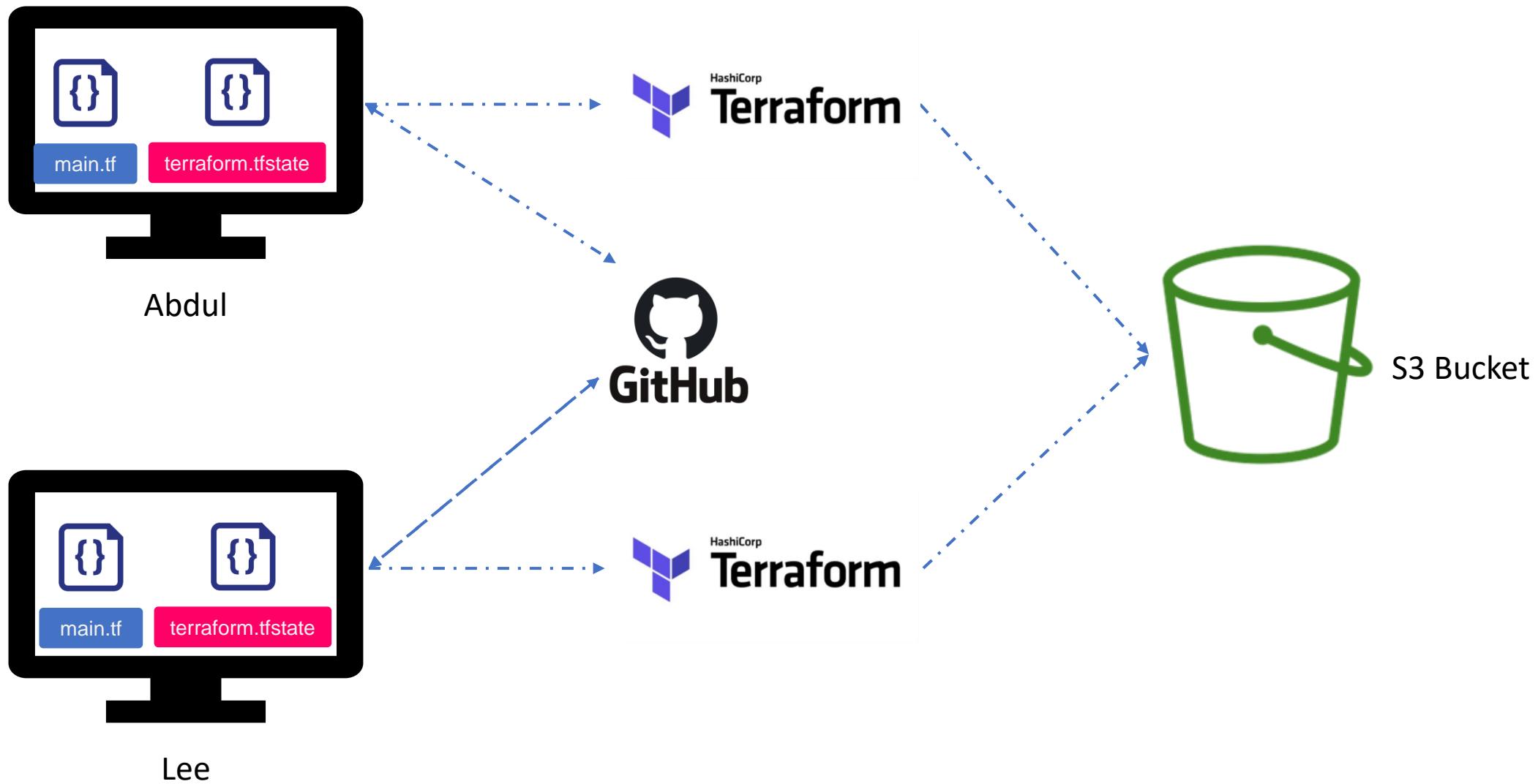
```
resource "local_file" "pet" {
  filename = "/root/pet.txt"
  content  = "My favorite pet is Mr.Whiskers!"
}
resource "random_pet" "my-pet" {
  length = 1
}
resource "local_file" "cat" {
  filename = "/root/cat.txt"
  content  = "I like cats too!"
}
```

Remote State Backends



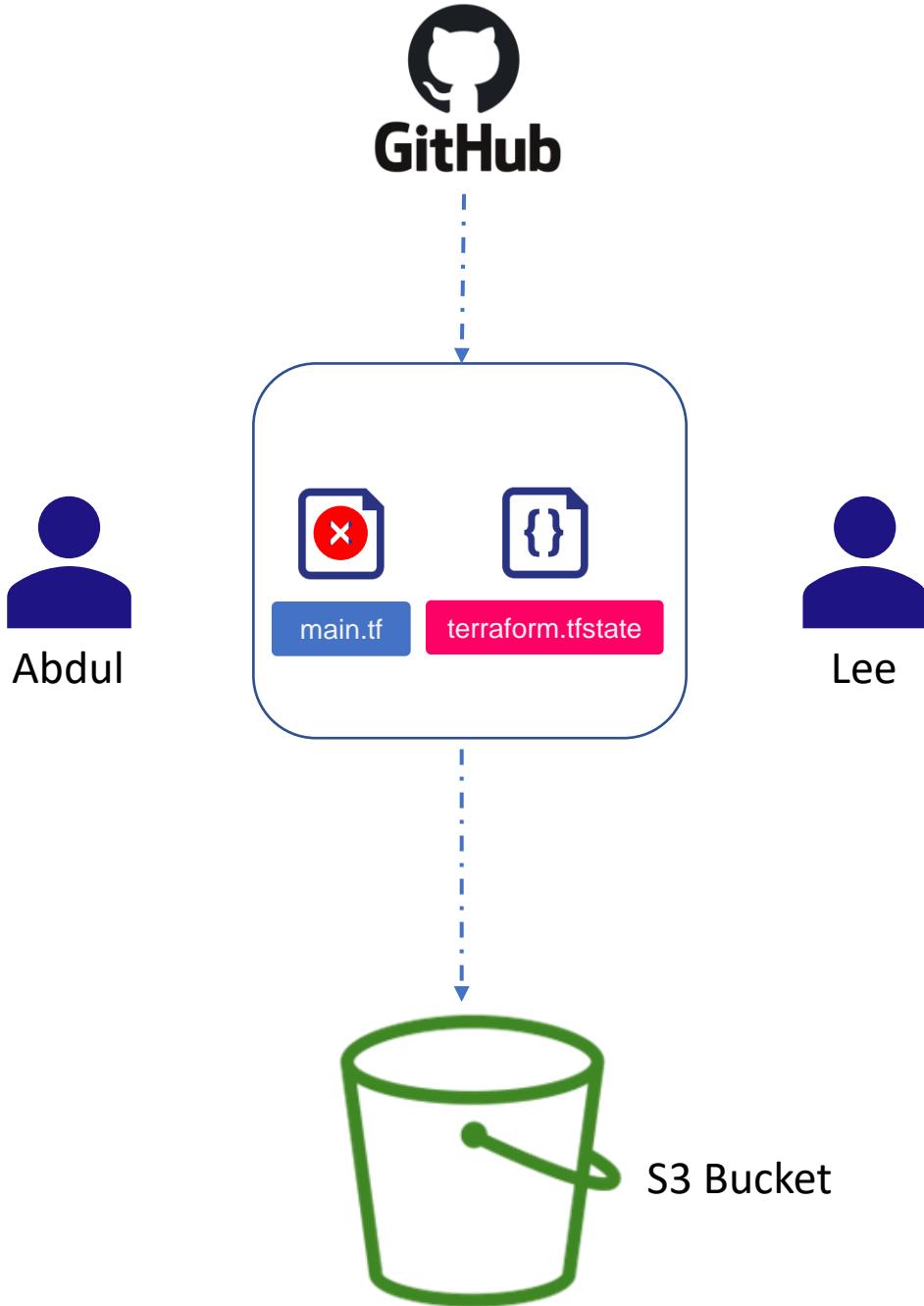
terraform.tfstate

```
{
  "mode": "managed",
  "type": "aws_instance",
  "name": "dev-ec2",
  "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",
  "instances": [
    {
      "schema_version": 1,
      "attributes": {
        "ami": "ami-0a634ae95e11c6f91",
        .
        .
        .
        "primary_network_interface_id": "eni-0ccd57b1597e633e0",
        "private_dns": "ip-172-31-7-21.us-west-2.compute.internal",
        "private_ip": "172.31.7.21",
        "public_dns": "ec2-54-71-34-19.us-west-2.compute.amazonaws.com",
        "public_ip": "54.71.34.19",
        "root_block_device": [
          {
            "delete_on_termination": true,
            "device_name": "/dev/sda1",
            "encrypted": false,
            "iops": 100,
            "kms_key_id": "",
            "volume_id": "vol-070720a3636979c22",
            "volume_size": 8,
            "volume_type": "gp2"
          }
        ]
      }
    }
  ]
}
```



terraform.tfstate

```
{  
    "mode": "managed",  
    "type": "aws_instance",  
    "name": "dev-ec2",  
    "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",  
    "instances": [  
        {  
            "schema_version": 1,  
            "attributes": {  
                "ami": "ami-0a634ae95e11c6f91",  
                ".  
                ".  
                ".  
                "primary_network_interface_id": "eni-0ccd57b1597e633e0",  
                "private_dns": "ip-172-31-7-21.us-west-2.compute.internal",  
                "private_ip": "172.31.7.21",  
                "public_dns": "ec2-54-71-34-19.us-west-2.compute.amazonaws.com",  
                "public_ip": "54.71.34.19",  
                "root_block_device": [  
                    {  
                        "delete_on_termination": true,  
                        "device_name": "/dev/sda1",  
                        "encrypted": false,  
                        "iops": 100,  
                        "kms_key_id": "",  
                        "volume_id": "vol-070720a3636979c22",  
                        "volume_size": 8,  
                        "volume_type": "gp2"  
                    }  
                ],  
            }  
        },  
    ]  
}
```



>_

Terminal 1

```
$ terraform apply  
.  
.."  
    + server_side_encryption = (known after apply)  
    + storage_class          = (known after apply)  
    + version_id              = (known after apply)  
}  
  
Plan: 2 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

```
aws_s3_bucket_object.finance-2020: Creating...  
aws_s3_bucket.finance: Creating...  
aws_s3_bucket_object.finance-2020: Still creating...  
[10s elapsed]  
aws_s3_bucket.finance: Still creating... [10s  
elapsed]  
aws_s3_bucket_object.finance-2020: Still creating...  
[20s elapsed]  
aws_s3_bucket.finance: Still creating... [20s
```

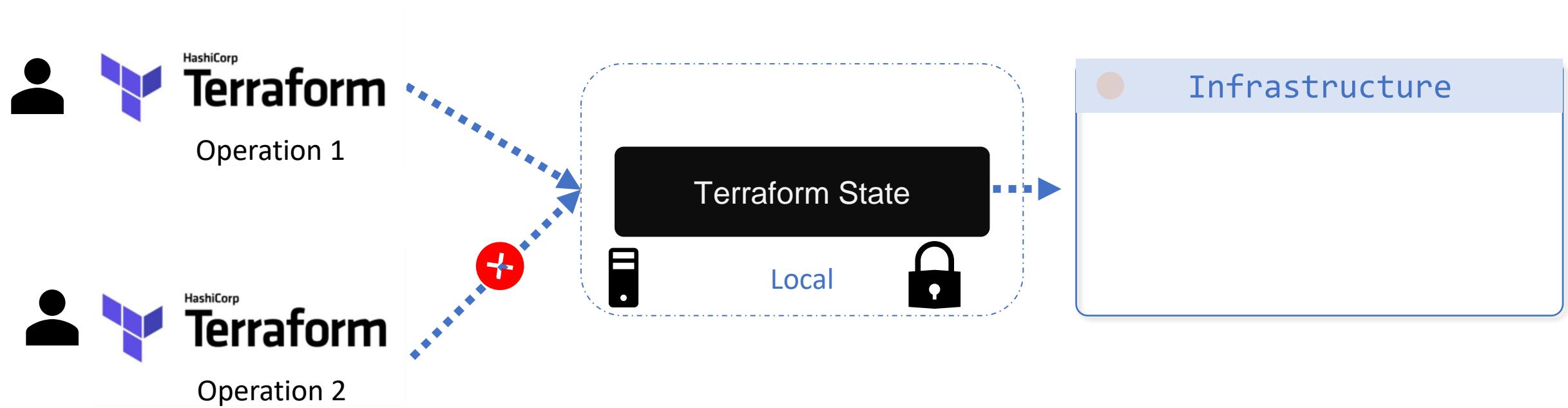
>_

Terminal 2

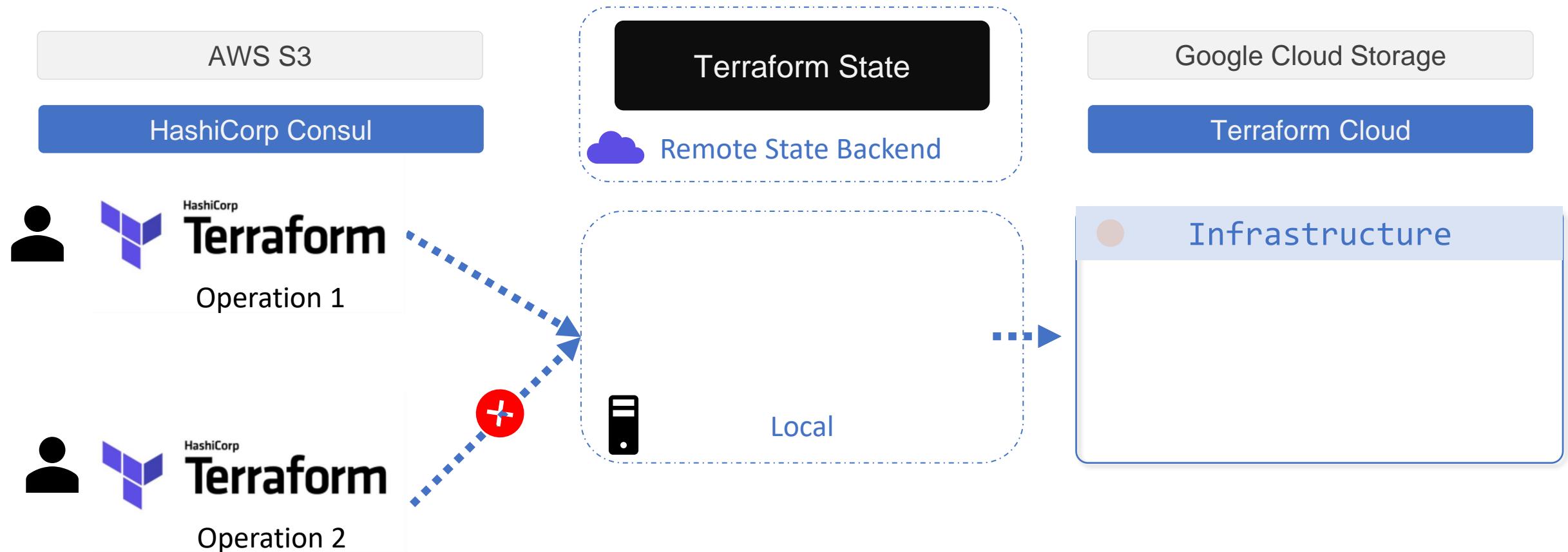
```
$ terraform apply  
Error: Error locking state: Error acquiring the state  
lock: resource temporarily unavailable  
Lock Info:  
    ID:      fefe3806-007c-084b-be61-cef4cdc77dee  
    Path:    terraform.tfstate  
    Operation: OperationTypeApply  
    Who:     root@iac-server  
    Version: 0.13.3  
    Created: 2020-09-22 20:35:27.051330492 +0000 UTC  
    Info:
```

Terraform acquires a state lock to protect the state from being written by multiple users at the same time. Please resolve the issue above and try again. For most commands, you can disable locking with the "-lock=false" flag, but this is not recommended.

State Locking



State Locking



State Locking

AWS S3

HashiCorp Consul

Terraform State



Remote State Backend

Google Cloud Storage

Terraform Cloud

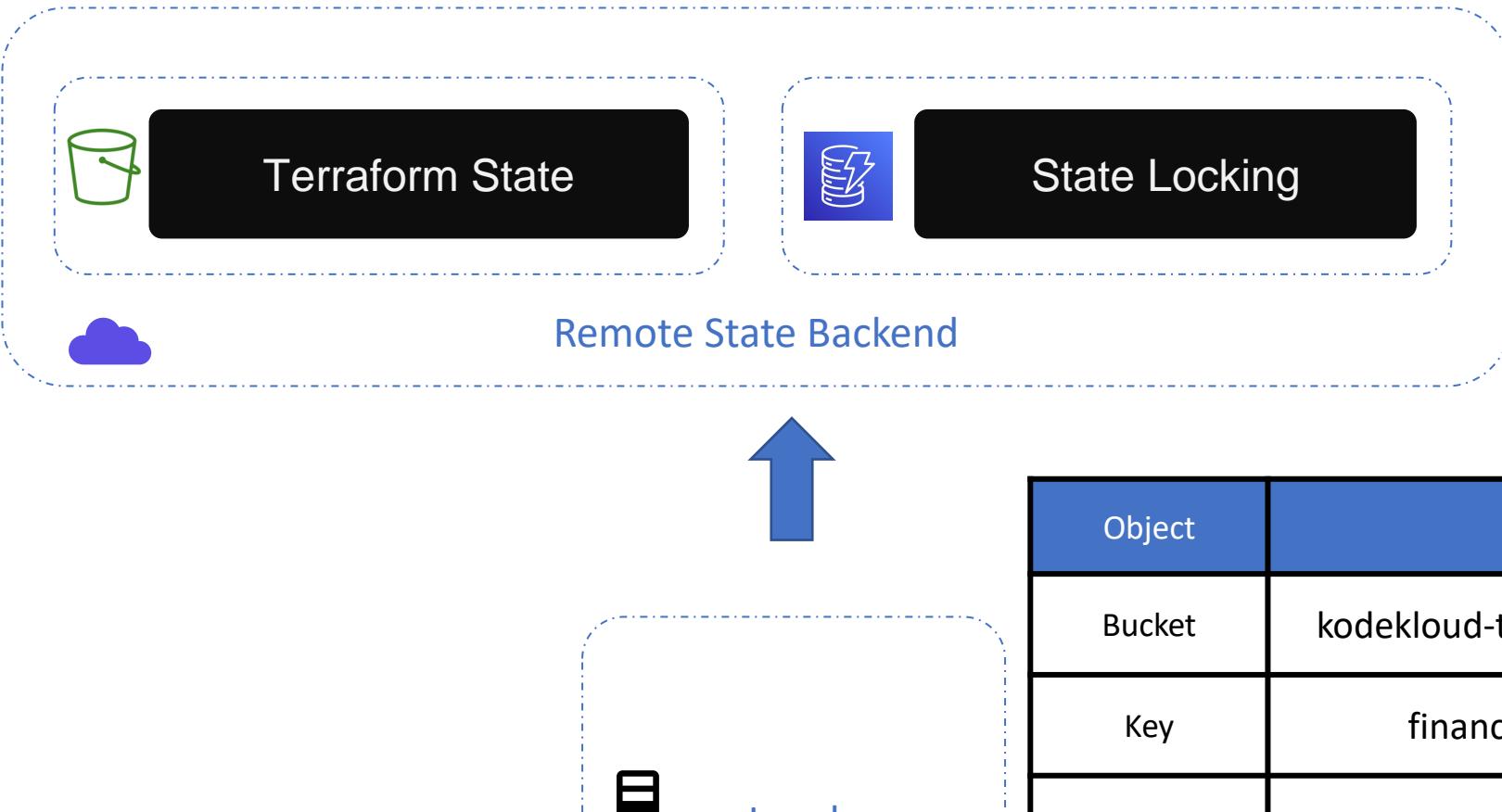
Automatically Load and Upload State File

Many Backends Support State Locking

Security

Remote Backends with S3

Remote Backend



Remote State Backend

Object	Value
Bucket	kodekloud-terraform-state-bucket01
Key	finance/terraform.tfstate
Region	us-west-1
DynamoDB Table	state-locking

main.tf

```
resource "local_file" "pet" {  
    filename = "/root/pets.txt"  
    content = "We love pets!"  
}  
  
terraform {  
    backend "s3" {  
        bucket      = "kodekloud-terraform-state-bucket01"  
        key         = "finance/terraform.tfstate"  
        region      = "us-west-1"  
        dynamodb_table = "state-locking"  
    }  
}
```

>_

```
$ ls  
main.tf  terraform.tfstate
```

Object	Value
Bucket	kodekloud-terraform-state-bucket01
Key	finance/terraform.tfstate
Region	us-west-1
DynamoDB Table	state-locking

main.tf

```
resource "local_file" "pet" {  
  filename = "/root/pets.txt"  
  content = "We love pets!"  
}
```

terraform.tf

```
terraform {  
  backend "s3" {  
    bucket      = "kodekloud-terraform-state-bucket01"  
    key         = "finance/terraform.tfstate"  
    region      = "us-west-1"  
    dynamodb_table = "state-locking"  
  }  
}
```

>_

```
$ terraform apply
```

Backend reinitialization required. Please run "terraform init". Reason: Initial configuration of the requested backend "s3"

The "backend" is the interface that Terraform uses to store state, perform operations, etc. If this message is showing up, it means that the Terraform configuration you're using is using a custom configuration for the Terraform backend.

Changes to backend configurations require reinitialization. This allows Terraform to setup the new configuration, copy existing state, etc. This is only done during "terraform init". Please run that command now then try again.

Error: Initialization required. Please see the error message above.

>_

```
$ terraform init
```

Initializing the backend...

Do you want to copy existing state to the new backend?

Pre-existing state was found while migrating the previous "local" backend to the newly configured "s3" backend. No existing state was found in the newly configured "s3" backend. Do you want to copy this state to the new "s3" backend? Enter "yes" to copy and "no" to start with an empty state.

Enter a value: yes

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

Initializing provider plugins...

- Using previously-installed hashicorp/aws v3.7.0
- .
- .[Output Truncated]

>_

```
$ rm -rf terraform.tfstate
```

>_

```
$ terraform apply
```

```
Acquiring state lock. This may take a few moments...
```

```
aws_s3_bucket.terraform-state: Refreshing state... [id=kodekloud-terraform-state-bucket01]
```

```
aws_dynamodb_table.state-locking: Refreshing state... [id=state-locking]
```

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

```
Releasing state lock. This may take a few moments.
```

Terraform State Commands

```
>_
```

```
$ vi terraform.tfstate  
$ terraform state show aws_s3_bucket.finance  
# terraform state <subcommand> [options] [args]
```



terraform.tfstate

```
{  
  "mode": "managed",  
  "type": "aws_instance",  
  "name": "dev-ec2",  
  "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",  
  "instances": [  
    {  
      "schema_version": 1,  
      "attributes": {  
        "ami": "ami-0a634ae95e11c6f91",  
        .  
        .  
        .  
        "primary_network_interface_id": "eni-0ccd57b1597e633e0",  
        "private_dns": "ip-172-31-7-21.us-west-2.compute.internal",  
        "private_ip": "172.31.7.21",  
        "public_dns": "ec2-54-71-34-19.us-west-2.compute.amazonaws.com",  
        "public_ip": "54.71.34.19",  
        "root_block_device": [  
          {  
            "delete_on_termination": true,  
            "device_name": "/dev/sda1",  
            "encrypted": false,  
            "iops": 100,  
            "kms_key_id": "",  
            "volume_id": "vol-070720a3636979c22",  
            "volume_size": 8,  
            "volume_type": "gp2"  
          }  
        ],  
      }  
    },  
  ]}
```

>_

```
# terraform state list [options] [address]

$ terraform state list
aws_dynamodb_table.cars
aws_s3_bucket.finance-2020922

$ terraform state list aws_s3_bucket.finance-2020922
aws_s3_bucket.finance-2020922
```

>_

```
# terraform state show [options] [address]

$ terraform state show aws_s3_bucket.finance-2020922

resource "aws_s3_bucket" "terraform-state" {
    acl                  = "private"
    arn                 = "arn:aws:s3::: finance-2020922 "
    bucket              = "finance-2020922 "
    bucket_domain_name = "finance-2020922.s3.amazonaws.com"
    bucketRegionalDomainName = " finance-2020922.s3.us-west-1.amazonaws.com"
    force_destroy        = false
    hosted_zone_id      = "Z2F5ABCDE1ACD"
    id                 = "finance-2020922 "
    region             = "us-west-1"
    request_payer       = "BucketOwner"
    tags               = {
        "Description" = "Bucket to store Finance and Payroll Information"
    }

    versioning {
        enabled    = false
        mfa_delete = false
    }
}
```

main.tf

```
resource "aws_dynamodb_table" "state-locking" {
  name = "state-locking-db"
  billing_mode = "PAY_PER_REQUEST"
  hash_key = "LockID"
  attribute {
    name = "LockID"
    type = "S"
  }
}
```

terraform.tfstate

```
"resources": [
  {
    "mode": "managed",
    "type": "aws_dynamodb_table",
    "name": "state-locking-db"
    "provider":
      "provider[\"registry.terraform.io/hashicorp/aws\"]",
    .
    .
  }
```

>_

```
# terraform state mv [options] SOURCE DESTINATION
$ terraform state mv aws_dynamodb_table.state-locking aws_dynamodb_table.state-locking-db
Move "aws_dynamodb_table.state-locking" to "aws_dynamodb_table.state-locking-db"
Successfully moved 1 object(s).

$ terraform apply

aws_dynamodb_table.state-locking-db: Refreshing state... [id=state-locking]

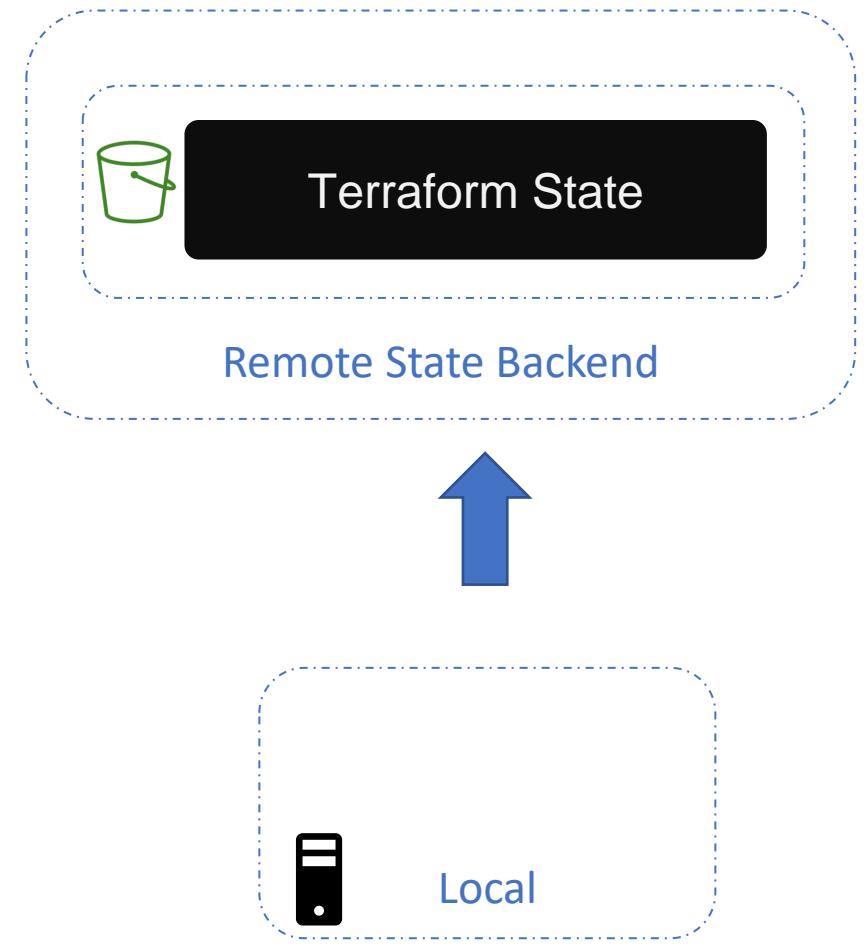
Apply complete! Resources: 0 added, 0 changed, 0 destroyed.
```

```
>_
$ ls
main.tf provider.tf

# terraform state pull [options] SOURCE DESTINATION

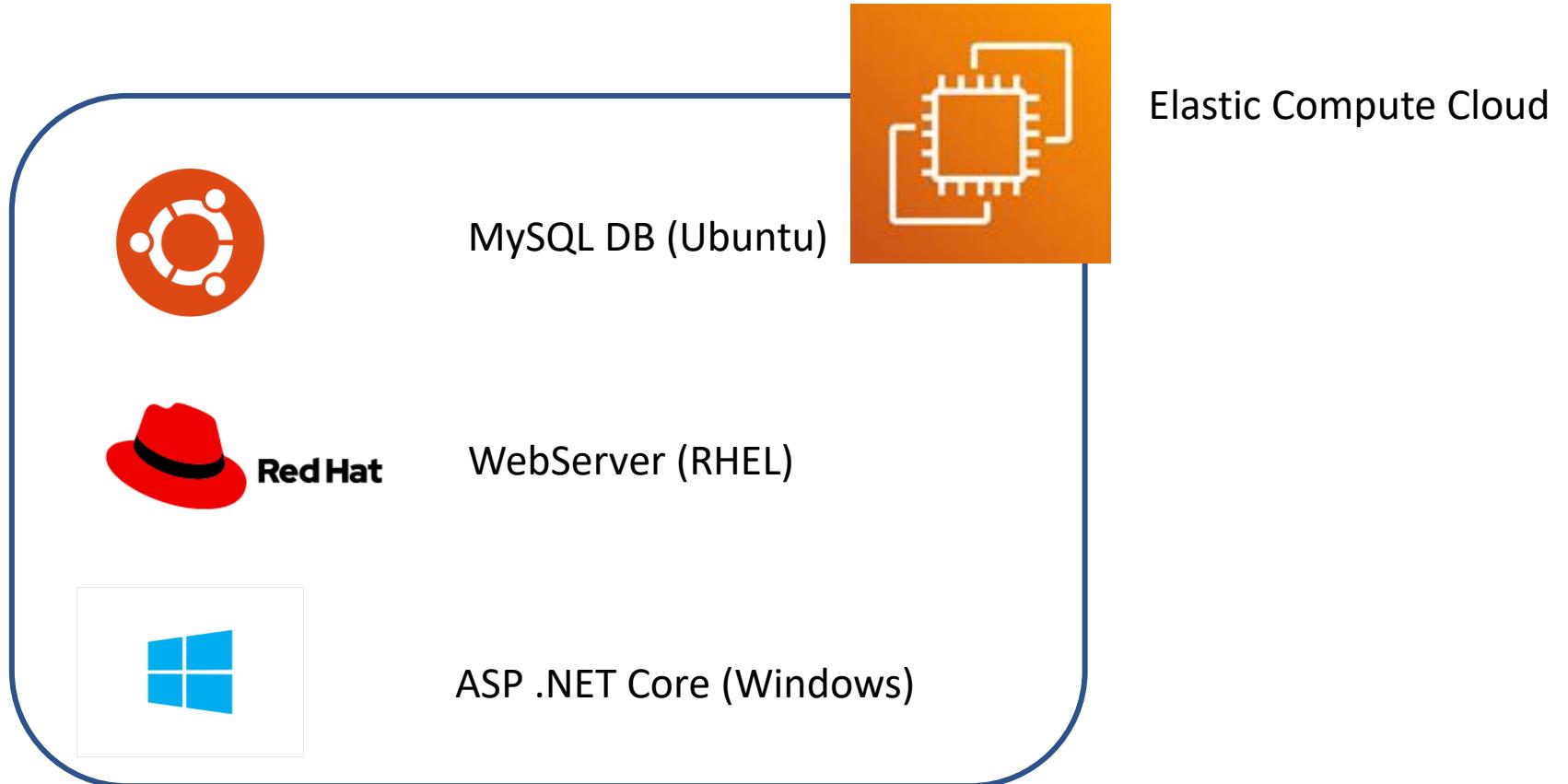
$ terraform state pull

{
  "version": 4,
  "terraform_version": "0.13.0",
  "serial": 0,
  "lineage": "b6e2cf0e-ef8d-3c59-1e11-c6520dcd745c",
  "resources": [
    {
      "mode": "managed",
      "type": "aws_dynamodb_table",
      "name": "state-locking-db",
      "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",
      "instances": [
        {
          "schema_version": 1,
          "attributes": {
            ...
            ...
            $ terraform state pull | jq '.resources[] | select(.name == "state-locking-db")|.instances[].attributes.hash_key'
            "LockID"
          }
        }
      ]
    }
  ]
}
```



```
>_  
# terraform state rm ADDRESS  
$ terraform state rm aws_s3_bucket.finance-2020922  
Acquiring state lock. This may take a few moments...  
Removed aws_s3_bucket.finance-2020922  
Successfully removed 1 resource instance(s).  
Releasing state lock. This may take a few moments...
```

Introduction to AWS EC2



Amazon Machine Image (AMI's)



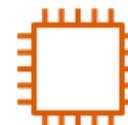
Amazon Linux 2 AMI ami-0c2f25c1f66a1ff4d



Red Hat Enterprise Linux 8 ami-04312317b9c8c4b51



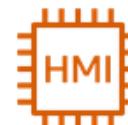
Ubuntu Server 20.04 LTS ami-0edab43b6fa892279



General Purpose



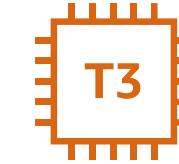
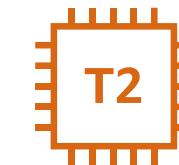
Compute Optimized



Memory Optimized

Instance Types

T2 General Purpose		
Instance Type	vCPU	Memory (GB)
t2.nano	1	0.5
t2.micro	1	1
t2.small	1	2
t2.medium	2	4
t2.large	2	8
t2.xlarge	4	16
t2.2xlarge	8	32

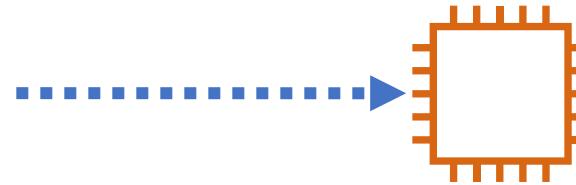
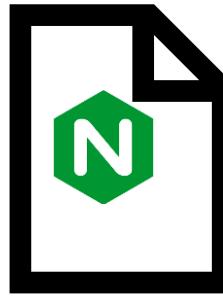




EBS Volume Types		
Name	Type	Description
io1	SSD	For business-critical Apps
io2	SSD	For latency-sensitive transactional workloads
gp2	SSD	General Purpose
st1	HDD	Low Cost HDD frequently accessed, throughput-intensive workloads
sc1	HDD	Lowest cost HDD volume designed for less frequently accessed workloads

User Data

```
#!/bin/bash  
sudo apt update  
sudo apt install nginx  
systemctl enable nginx  
systemctl start nginx
```



Ubuntu Web Server



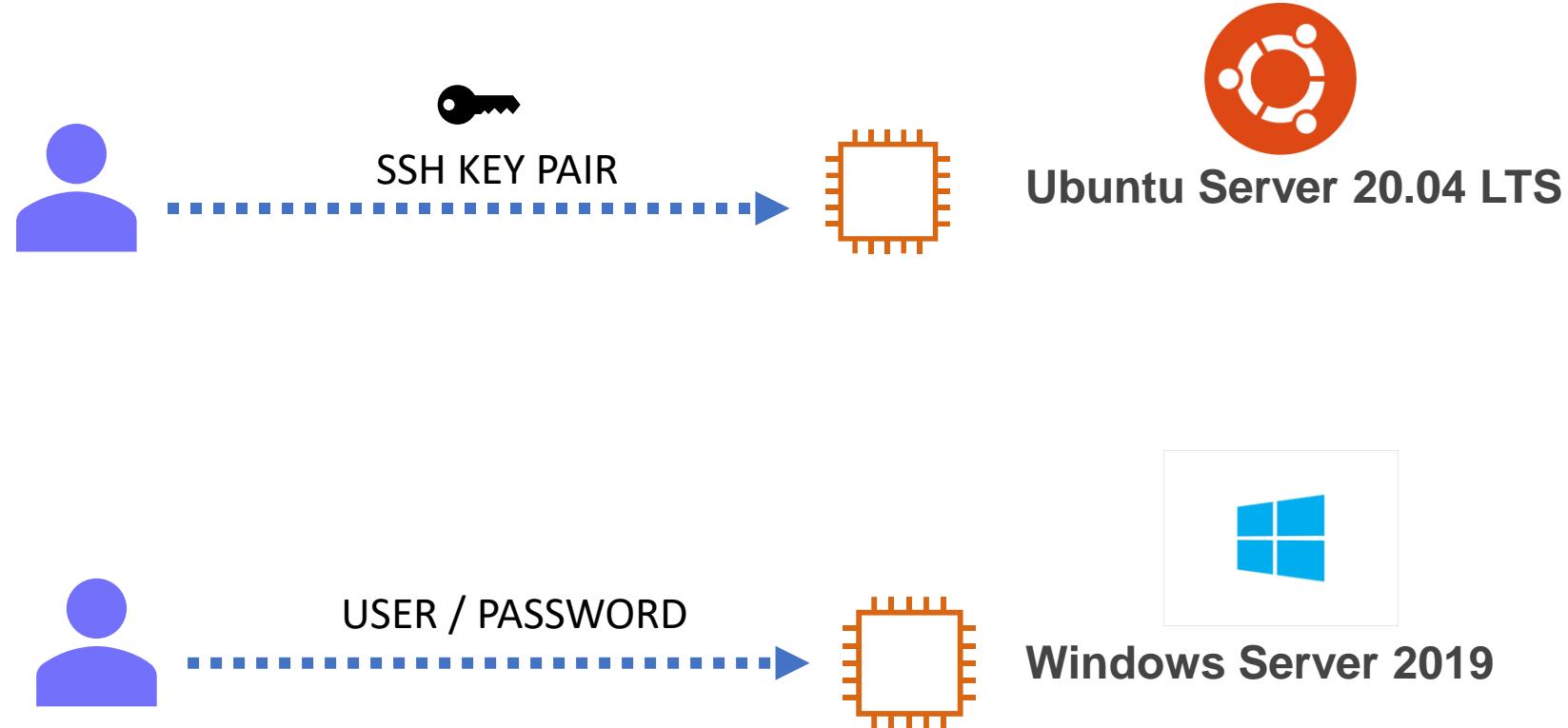
PowerShell PS1



Batch .bat



Windows Instance



AWS EC2 With Terraform

main.tf

```
resource "aws_instance" "webserver" {  
    ami           = "ami-0edab43b6fa892279"  
    instance_type = "t2.micro"  
}
```

Argument Reference

The following arguments are supported:

- `ami` - (Required) The AMI to use for the instance.
- `instance_type` - (Required) The type of instance to start. Updates to this field will trigger a stop/start of the EC2 instance.
- `tags` - (Optional) A map of tags to assign to the resource.

provider.tf

```
provider "aws" {  
    region = "us-west-1"  
}
```

main.tf

```
resource "aws_instance" "webserver" {
  ami           = "ami-0edab43b6fa892279"
  instance_type = "t2.micro"
  tags = {
    Name        = "webserver"
    Description = "An Nginx WebServer on Ubuntu"
  }
}
```

Argument Reference

The following arguments are supported:

- `ami` - (Required) The AMI to use for the instance.
- `instance_type` - (Required) The type of instance to start. Updates to this field will trigger a stop/start of the EC2 instance.
- `tags` - (Optional) A map of tags to assign to the resource.

provider.tf

```
provider "aws" {
  region = "us-west-1"
}
```

main.tf

```
resource "aws_instance" "webserver" {
  ami           = "ami-0edab43b6fa892279"
  instance_type = "t2.micro"
  tags = {
    Name        = "webserver"
    Description = "An Nginx WebServer on Ubuntu"
  }
  user_data = <<<-EOF
    #!/bin/bash
    sudo apt update
    sudo apt install nginx -y
    systemctl enable nginx
    systemctl start nginx
    EOF
}
```

provider.tf

```
provider "aws" {
  region = "us-west-1"
}
```

Argument Reference

The following arguments are supported:

- `ami` - (Required) The AMI to use for the instance.
- `instance_type` - (Required) The type of instance to start. Updates to this field will trigger a stop/start of the EC2 instance.
- `tags` - (Optional) A map of tags to assign to the resource.
- `user_data` - (Optional) The user data to provide when launching the instance. Do not pass gzip-compressed data via this argument; see `user_data_base64` instead.

```
>_  
$ terraform apply  
  
# aws_instance.webserver will be created  
+ resource "aws_instance" "webserver" {  
    + ami                         = "ami-0edab43b6fa892279"  
    .  
    .  
    + instance_type                = "t2.micro"  
    + ipv6_address_count          = (known after apply)  
    + public_ip                    = (known after apply)  
    + source_dest_check           = true  
    + subnet_id                   = (known after apply)  
    + tags {  
        + "Description" = "An NGINX WebServer on Ubuntu"  
        + "Name"       = "webserver"  
    }  
    + tenancy                      = (known after apply)  
    + user_data                    = "527516162d9d8675a26b6ca97664226e6e2bff82"  
    + volume_tags                  = (known after apply)  
    + vpc_security_group_ids      = (known after apply)  
    .  
    .  
aws_instance.webserver: Creating...  
aws_instance.webserver: Still creating... [20s elapsed]  
aws_instance.webserver: Creation complete after 22s [id=i-0085e5d0f442f7c4f]
```

Apply complete! Resources: 1 added, 0 changed, 0 destroyed.

	Name	Instance ID	Instance state	Instance type	Status check	Alarm Status	Availability zone
	webserver	i-0085e5d0f442f7c4f	Running	t2.micro	2/2 checks ...	No alarms +	ca-central-1a

LOUD

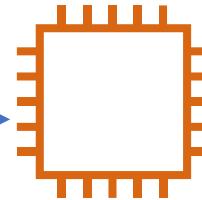


USER ?



SSH KEY PAIR ?

SSH PORT 22 OPEN ?



Ubuntu WebServer

Select an existing key pair or create a new key pair

X

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about [removing existing key pairs from a public AMI](#).

Create a new key pair

▼

Key pair name

webserver

Download Key Pair



You have to download the **private key file** (*.pem file) before you can continue. **Store it in a secure and accessible location.** You will not be able to download the file again after it's created.

Cancel

Launch Instances

main.tf

```
resource "aws_instance" "webserver" {
  ami           = "ami-0edab43b6fa892279"
  instance_type = "t2.micro"
  tags = {
    Name        = "webserver"
    Description = "An Nginx WebServer on Ubuntu"
  }
  user_data = <<<-EOF
    #!/bin/bash
    sudo apt update
    sudo apt install nginx -y
    systemctl enable nginx
    systemctl start nginx
    EOF
}
```

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    tags = {
        Name      = "webserver"
        Description = "An Nginx WebServer on Ubuntu"
    }
    user_data = <<<-EOF
        #!/bin/bash
        sudo apt update
        sudo apt install nginx -y
        systemctl enable nginx
        systemctl start nginx
        EOF
}
resource "aws_key_pair" "web" {
    public_key = file("/root/.ssh/web.pub")
}
```

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    tags = {
        Name      = "webserver"
        Description = "An NGINX WebServer on Ubuntu"
    }
    user_data = <<<-EOF
#!/bin/bash
sudo apt update
sudo apt install nginx -y
systemctl enable nginx
systemctl start nginx
EOF
}
resource "aws_key_pair" "web" {
    public_key = "ssh-
rsa AAAAB3NzaC1yc2EAAAQABAAQDicpU+kT9isaZy7cHYa
+oCTUo1S6Tg6vCEq+ufucIMrA7RLTngi+YfTfvgrY2UiHGxuuJ1lE
yT0x2UrGexVx4G2TzX/am2WFzNbGSg2bCXTkVQY93K0hbW9y851a
+g1wI7T0DC0oxEMFr/CVsrg4bf8p8S896VKBxC1WpSU9GscPP28GV
uDgm2ATBuL78AF root@iac-server"
}
```

main.tf

```
resource "aws_instance" "webserver" {
  ami           = "ami-0edab43b6fa892279"
  instance_type = "t2.micro"
  tags = {
    Name        = "webserver"
    Description = "An Nginx WebServer on Ubuntu"
  }
  user_data = <<<-EOF
    #!/bin/bash
    sudo apt update
    sudo apt install nginx -y
    systemctl enable nginx
    systemctl start nginx
    EOF
  key_name  = aws_key_pair.web.id
}
resource "aws_key_pair" "web" {
  public_key = file("/root/.ssh/web.pub")
}
```

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the low

Number of instances Launch into Auto Scaling Group [i](#)

Purchasing option Request Spot instances

Network [i](#) vpc-7da8d215 (default) [C](#) Create new VPC

Subnet [i](#) No preference (default subnet in any Availability Zone) [Create new subnet](#)

Auto-assign Public IP [i](#) Use subnet setting (Enable)

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet HTTP and HTTPS ports. You can create a new security group or select from an existing one below. [Learn more](#) about Amazon EC2 security groups.

Assign a security group: Create a new security group

Select an existing security group

Security group name:

ssh-access

Description:

SSH Access from the Internet

Type [i](#)

Protocol [i](#)

Port Range [i](#)

Source [i](#)

SSH

TCP

22

Custom

0.0.0.0/0

Add Rule

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    tags = {
        Name      = "webserver"
        Description = "An Nginx WebServer on Ubuntu"
    }
    user_data = <<<-EOF
        #!/bin/bash
        sudo apt update
        sudo apt install nginx -y
        systemctl enable nginx
        systemctl start nginx
        EOF
    key_name  = aws_key_pair.web.id
}
resource "aws_key_pair" "web" {
    public_key = file("/root/.ssh/web.pub")
}
```

```

description = "An Nginx webserver on Ubuntu"
}

user_data = <<<-EOF
#!/bin/bash
sudo apt update
sudo apt install nginx -y
systemctl enable nginx
systemctl start nginx
EOF

key_name  = aws_key_pair.web.id
}

resource "aws_key_pair" "web" {
    public_key = file("/root/.ssh/web.pub")
}

resource "aws_security_group" "ssh-access" {
    name          = "ssh-access"
    description   = "Allow SSH access from the Internet"
    ingress {
        from_port    = 22
        to_port      = 22
        protocol     = "tcp"
        cidr_blocks = ["0.0.0.0/0"]
    }
}

```

The `ingress` block supports:

- `cidr_blocks` - (Optional) List of CIDR blocks.
- `to_port` - (Required) The end range port (or ICMP code if protocol is "icmp" or "icmpv6").
- `from_port` - (Required) The start port (or ICMP type number if protocol is "icmp" or "icmpv6").
- `protocol` - (Required) The protocol. If you select a protocol of "-1" (semantically equivalent to `"all"`, which is not a valid value here), you must specify a "from_port" and "to_port" equal to 0. If not icmp, icmpv6, tcp, udp, or "-1" use the `protocol` block.

```
user_data = <<<-EOF
    #!/bin/bash
    sudo apt update
    sudo apt install nginx -y
    systemctl enable nginx
    systemctl start nginx
EOF

key_name  = aws_key_pair.web.id
vpc_security_group_ids = [aws_security_group.ssh-access.id]
}

resource "aws_key_pair" "web" {
    public_key = file("/root/.ssh/web.pub")
}
resource "aws_security_group" "ssh-access" {
    name          = "ssh-access"
    description   = "AllowSSH access from the Internet"
    ingress {
        from_port    = 22
        to_port      = 22
        protocol     = "tcp"
        cidr_blocks = ["0.0.0.0/0"]
    }
}
```

```
systemctl start nginx
EOF

key_name  = aws_key_pair.web.id
vpc_security_group_ids = [ aws_security_group.ssh-access.id ]

}

resource "aws_key_pair" "web" {
    public_key = file("/root/.ssh/web.pub")
}

resource "aws_security_group" "ssh-access" {
    name          = "ssh-access"
    description   = "AllowSSH access from the Internet"
    ingress {
        from_port    = 22
        to_port      = 22
        protocol     = "tcp"
        cidr_blocks = ["0.0.0.0/0"]
    }
}

output publicip {
    value        = aws_instance.webserver.public_ip
}
```

```
>_
```

```
$ terraform apply
```

```
Plan: 3 to add, 0 to change, 1 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
```

```
aws_instance.webserver: Destroying... [id=i-015b579d0ea84fbb7]
aws_key_pair.web: Creating...
aws_security_group.ssh-access: Creating...
aws_key_pair.web: Creation complete after 1s [id=terraform-2020101403414492620000001]
aws_security_group.ssh-access: Creation complete after 1s [id=sg-0f02f3ea92b14bed8]
aws_instance.webserver: Still destroying... [id=i-015b579d0ea84fbb7, 10s elapsed]
aws_instance.webserver: Still destroying... [id=i-015b579d0ea84fbb7, 20s elapsed]
aws_instance.webserver: Destruction complete after 30s
aws_instance.webserver: Creating...
aws_instance.webserver: Still creating... [10s elapsed]
aws_instance.webserver: Still creating... [20s elapsed]
aws_instance.webserver: Still creating... [30s elapsed]
aws_instance.webserver: Creation complete after 32s [id=i-0fd2c1c5eb0762ff5]
```

```
Apply complete! Resources: 3 added, 0 changed, 1 destroyed.
```

```
Outputs:
```

```
publicip = 3.96.203.171
```

```
>_  
  
$ ssh -i /root/.ssh/web ubuntu@3.96.203.171  
ubuntu@ip-172-31-19-161:~$  
  
[ubuntu@ip-172-31-19-161]$ systemctl status nginx  
nginx.service - A high performance web server and a reverse  
proxy server  
    Loaded: loaded (/lib/systemd/system/nginx.service; enabled;  
            vendor preset: enabled)  
    Active: active (running) since Wed 2020-11-02 22:17:38 UTC;  
            2 min ago  
      Process: 303 ExecStart=/usr/sbin/nginx -g daemon on;  
           master_process on; (code=exited, status=0  
      Process: 264 ExecStartPre=/usr/sbin/nginx -t -q -g daemon  
           on; master_process on; (code=exited,  
           Main PID: 304 (nginx)
```

Terraform Provisioners

Provisioners

```
main.tf

resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    user_data = <<-EOF
        #!/bin/bash
        sudo apt update
        sudo apt install nginx -y
        systemctl enable nginx
        systemctl start nginx
    EOF
    key_name      = aws_key_pair.web.id
    vpc_security_group_ids = [ aws_security_group.ssh-access.id ]
}

resource "aws_key_pair" "web" {
    << code hidden >>
}

resource "aws_security_group" "ssh-access" {
    << code hidden >>
}
```

Advanced Details

Metadata accessible	<input checked="" type="checkbox"/>	Enabled
Metadata version	<input checked="" type="checkbox"/>	V1 and V2 (token optional)
Metadata token response hop limit	<input checked="" type="checkbox"/>	1
User data	<input checked="" type="radio"/>	As text

```
#!/bin/bash
sudo apt update
sudo apt install nginx -y
systemctl enable nginx
systemctl start nginx
```

Remote Exec

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    user_data = <<-EOF
        #!/bin/bash
        sudo apt update
        sudo apt install nginx -y
        systemctl enable nginx
        systemctl start nginx
    EOF
    key_name  = aws_key_pair.web.id
    vpc_security_group_ids = [ aws_security_group.ssh-access.id ]
}

resource "aws_key_pair" "web" {
    << code hidden >>
}

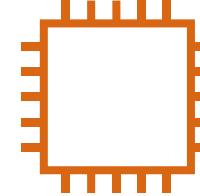
resource "aws_security_group" "ssh-access" {
    << code hidden >>
}
```

```
apt update
apt install nginx -y
systemctl enable nginx
systemctl start nginx
```

Remote Instance (EC2)



SSH



WINRM



Local Machine



- ✓ Network Connectivity (Security Group)
- ✓ Authentication (SSH Key Pair)

Remote Exec

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    provisioner "remote-exec" {
        inline = [ "sudo apt update",
                   "sudo apt install nginx -y",
                   "sudo systemctl enable nginx",
                   "sudo systemctl start nginx",
                 ]
    }
    key_name   = aws_key_pair.web.id
    vpc_security_group_ids = [ aws_security_group.ssh-access.id ]
}

resource "aws_key_pair" "web" {
    << code hidden >>
}

resource "aws_security_group" "ssh-access" {
    << code hidden >>
}
```

Remote Exec

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    provisioner "remote-exec" {
        inline = [ "sudo apt update",
                   "sudo apt install nginx -y",
                   "sudo systemctl enable nginx",
                   "sudo systemctl start nginx",
                ]
    }
    connection {
        type     = "ssh"
        host    = self.public_ip
        user    = "ubuntu"
        private_key = file("/root/.ssh/web")
    }
    key_name  = aws_key_pair.web.id
    vpc_security_group_ids = [ aws_security_group.ssh-access.id ]
}
resource "aws_key_pair" "web" {
    << code hidden >>
}
```

>

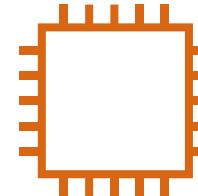
```
$ terraform apply
aws_key_pair.web: Creating...
aws_security_group.ssh-access: Creating...
aws_key_pair.web: Creation complete after 0s [id=terraform-20201015013048509100000001]
aws_security_group.ssh-access: Creation complete after 1s [id=sg-0
aws_instance.webserver: Creating...
aws_instance.webserver: Still creating... [10s elapsed]
aws_instance.webserver: Still creating... [20s elapsed]
aws_instance.webserver: Still creating... [30s elapsed]
aws_instance.webserver: Provisioning with 'remote-exec'...
aws_instance.webserver (remote-exec): Connecting to remote host vi
aws_instance.webserver (remote-exec): Host: 3.96.136.157
aws_instance.webserver (remote-exec): User: ubuntu
aws_instance.webserver (remote-exec): Password: false
aws_instance.webserver (remote-exec): Private key: true
aws_instance.webserver (remote-exec): Certificate: false
aws_instance.webserver (remote-exec): SSH Agent: false
aws_instance.webserver (remote-exec): Checking Host Key: false
aws_instance.webserver: Still creating... [40s elapsed]
aws_instance.webserver (remote-exec): Connecting to remote host vi
aws_instance.webserver (remote-exec): Host: 3.96.136.157
aws_instance.webserver (remote-exec): User: ubuntu
aws_instance.webserver (remote-exec): Password: false
aws_instance.webserver (remote-exec): Private key: true
aws_instance.webserver (remote-exec): Certificate: false
aws_instance.webserver (remote-exec): SSH Agent: false
aws_instance.webserver (remote-exec): Checking Host Key: false
aws_instance.webserver (remote-exec): Connected!
aws_instance.webserver: Still creating... [50s elapsed]
aws_instance.webserver: Creation complete after 50s [id=i-068fad30]
```

Local Exec

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    provisioner "remote-exec" {
        inline = [ "sudo apt update",
                   "sudo apt install nginx -y",
                   "sudo systemctl enable nginx",
                   "sudo systemctl start nginx",
                ]
    }
    connection {
        type      = "ssh"
        host      = self.public_ip
        user      = "ubuntu"
        private_key = file("/root/.ssh/web")
    }
    key_name  = aws_key_pair.web.id
    vpc_security_group_ids = [ aws_security_group.ssh-access.id ]
}
resource "aws_key_pair" "web" {
    << code hidden >>
}
```

Remote Instance (EC2)



Local Machine



```
echo ${aws_instance.webserver.public_ip} >> /tmp/ip.txt
```

KODEKLoud

Local Exec

main.tf

```
resource "aws_instance" "webserver" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"

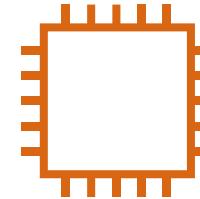
    provisioner "local-exec" {
        command = "echo ${aws_instance.webserver2.public_ip} >> /tmp/ips.txt"
    }
}
```

>_

```
$ cat /tmp/ips.txt
54.214.68.27
```

- **command** - (Required) This is the command to execute. It can be provided as a relative path to the current working directory or as an absolute path. It is evaluated in a shell, and can use environment variables or Terraform variables.

Remote Instance (EC2)



Local Machine



```
echo ${aws_instance.webserver.public_ip} >> /tmp/ip.txt"
```

Provisioner Behavior

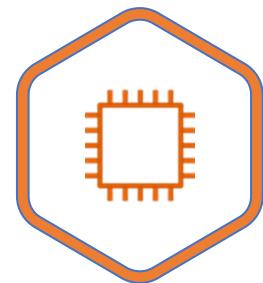
Creation Time Provisioner

main.tf

```
resource "aws_instance" "webserver" {
    ami                  = "ami-0edab43b6fa892279"
    instance_type        = "t2.micro"
    provisioner "local-exec" {
        command = "echo Instance ${aws_instance.webserver.public_ip} Created! > /tmp/instance_state.txt"
    }
}
```

>

```
$ cat /tmp/instance_state.txt
Instance 3.96.136.157 Created!
```



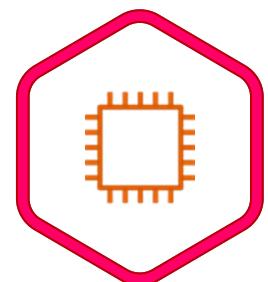
Destroy Time Provisioner

main.tf

```
resource "aws_instance" "webserver" {
    ami                  = "ami-0edab43b6fa892279"
    instance_type        = "t2.micro"
    provisioner "local-exec" {
        command = "echo Instance ${aws_instance.webserver.public_ip} Created! > /tmp/instance_state.txt"
    }
    provisioner "local-exec" {
        when      = destroy
        command = "echo Instance ${aws_instance.webserver.public_ip} Destroyed! > /tmp/instance_state.txt"
    }
}
```

>_

```
$ cat /tmp/instance_state.txt
Instance 3.96.136.157 Deleted!
```



Failure Behavior

main.tf

```
resource "aws_instance" "webserver" {
    ami                  = "ami-0edab43b6fa892279"
    instance_type        = "t2.micro"
    provisioner "local-exec" {
        on_failure = fail
        command = "echo Instance ${aws_instance.webserver.public_ip} Created! > /tmp/instance_state.txt"
    }
    provisioner "local-exec" {
        when      = destroy
        command = "echo Instance ${aws_instance.webserver.public_ip} Destroyed! > /tmp/instance_state.txt"
    }
}
```

>_

```
$ terraform apply
Error: Error running command 'echo 35.183.14.192 > /temp/pub_ip.txt': exit status 1.
Output: The system cannot find the path specified.
```

Failure Behavior

main.tf

```
resource "aws_instance" "webserver" {
    ami                  = "ami-0edab43b6fa892279"
    instance_type        = "t2.micro"
    provisioner "local-exec" {
        on_failure = continue
        command = "echo Instance ${aws_instance.webserver.public_ip} Created! > /tmp/instance_state.txt"
    }
    provisioner "local-exec" {
        when      = destroy
        command = "echo Instance ${aws_instance.webserver.public_ip} Destroyed! > /tmp/instance_state.txt"
    }
}
```

>_

```
$ terraform apply
aws_instance.webserver (local-exec) The system cannot find the path specified.
aws_instance.project: Creation complete after 22s [id=i-01585c2b9dbc445db]

Apply complete! Resources: 1 added, 0 changed, 1 destroyed.
```

Considerations with Provisioners

Local-Exec | Remote-Exec

main.tf

```
resource "aws_instance" "webserver" {
  ami = "ami-0edab43b6fa892279"
  instance_type = "t2.micro"
  tags = {
    Name = "webserver"
    Description = "An NGINX WebServer on Ubuntu"
  }
  provisioner "remote-exec" {
    inline = ["echo $(hostname -i) >> /tmp/ips.txt"]
  }
}
```

No Provisioner Information in Plan

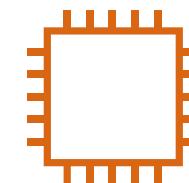
Network Connectivity and Authentication

Local Machine



SSH/ WinRM

EC2 Instance



main.tf

```
resource "aws_instance" "webserver" {
    ami = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    tags = {
        Name = "webserver"
        Description = "An NGINX WebServer on Ubuntu"
    }
    user_data = <<-EOF
        #!/bin/bash
        sudo apt update
        sudo apt install nginx -y
        systemctl enable nginx
        systemctl start nginx
        EOF
}
```

Provider	Resource	Option
AWS	aws_instance	user_data
Azure	azurerm_virtual_machine	custom_data
GCP	google_compute_instance	meta_data
Vmware vSphere	vsphere_virtual_machine	user_data.txt

main.tf

```
resource "aws_instance" "webserver" {
  ami = "ami-XYZ"
  instance_type = "t2.micro"
  tags = {
    Name = "webserver"
    Description = "An NGINX WebServer on Ubuntu"
  }
}
```



Custom AMI with NGINX



nginx-build.json

Terraform Taint

Taint

main.tf

```
resource "aws_instance" "webserver-3" {
  ami                  = "ami-0edab43b6fa892279"
  instance_type        = "t2.micro"
  key_name             = "ws"
  provisioner "local-exec" {
    command = "echo ${aws_instance.webserver-3.public_ip} > /temp/pub_ip.txt"
  }
}
```

>_

```
$ terraform apply
```

```
Plan: 1 to add, 0 to change, 0 to destroy.
```

```
aws_instance.webserver: Creating...
aws_instance.webserver: Still creating... [10s elapsed]
aws_instance.webserver: Still creating... [20s elapsed]
aws_instance.webserver: Still creating... [30s elapsed]
aws_instance.webserver: Provisioning with 'local-exec'...
aws_instance.webserver (local-exec): Executing: ["cmd" "/C" "echo 35.183.14.192 > /temp/pub_ip.txt"]
aws_instance.webserver (local-exec): The system cannot find the path specified.
```

```
Error: Error running command 'echo 35.183.14.192 > /temp/pub_ip.txt': exit status 1. Output: The system
cannot find the path specified.
```

Taint

>_

```
$ terraform plan
```

```
Refreshing Terraform state in-memory prior to plan...
The refreshed state will be used to calculate this plan, but will not
be
persisted to local or remote state storage.
```

```
aws_instance.webserver: Refreshing state... [id=i-0dba2d5dc22a9a904]
```

```
-----  
-
```

```
An execution plan has been generated and is shown below.
Resource actions are indicated with the following symbols:
-/+ destroy and then create replacement
```

```
Terraform will perform the following actions:
```

```
# aws_instance.webserver is tainted, so must be replaced
-/+ resource "aws_instance" "webserver-3" {
```

Taint

>_

```
$ terraform taint aws_instance.webserver  
Resource instance aws_instance.webserver has been marked as tainted.
```

```
$ terraform plan
```

```
Refreshing Terraform state in-memory prior to plan...  
The refreshed state will be used to calculate this plan, but will not be  
persisted to local or remote state storage.
```

```
aws_instance.webserver: Refreshing state... [id=i-0fd3946f5b3ab8af8]
```

```
-----  
An execution plan has been generated and is shown below.  
Resource actions are indicated with the following symbols:  
-/+ destroy and then create replacement
```

```
Terraform will perform the following actions:
```

```
# aws_instance.webserver is tainted, so must be replaced  
-/+ resource "aws_instance" "webserver" {
```

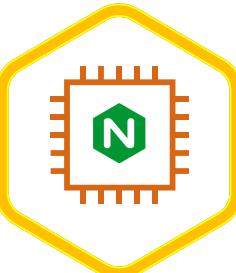
Local Machine



HashiCorp
Terraform
nginx v1.16



EC2 Instance



nginx v1.17

Taint

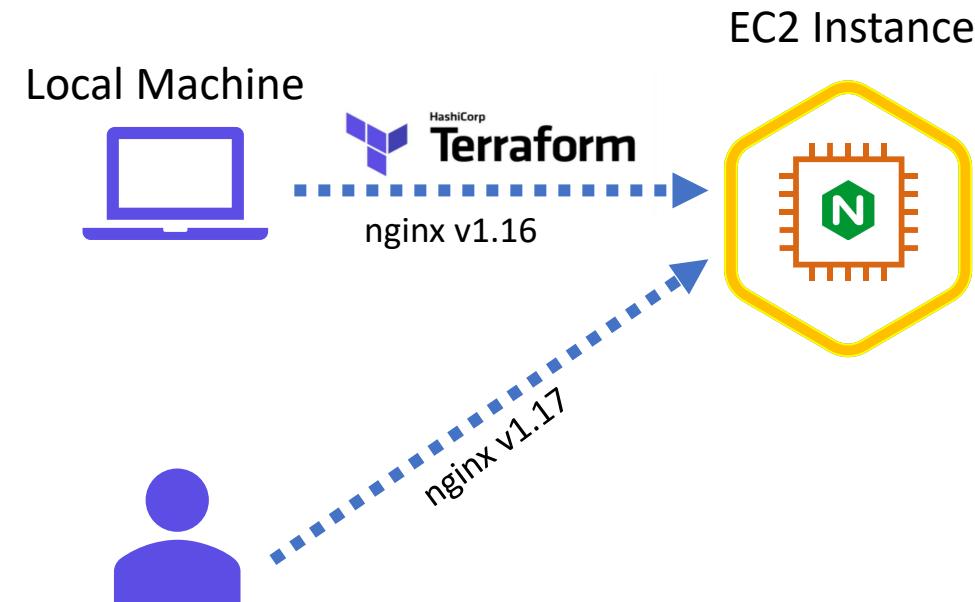
>_

```
$ terraform untaint aws_instance.webserver  
Resource instance aws_instance.webserver has been successfully  
untainted.
```

```
$ terraform plan  
Refreshing Terraform state in-memory prior to plan...  
The refreshed state will be used to calculate this plan, but will not be  
persisted to local or remote state storage.  
  
aws_instance.webserver: Refreshing state... [id=i-0fd3946f5b3ab8af8]
```

```
-----  
No changes. Infrastructure is up-to-date.
```

This means that Terraform did not detect any differences between your configuration and real physical resources that exist. As a result, no actions need to be performed.



Debugging

Log Levels

```
>_  
  
# export TF_LOG=<log_level>  
$ export TF_LOG=TRACE
```

INFO

WARNING

ERROR

DEBUG

TRACE

>_

```
$ terraform plan
```

```
----  
2020/10/18 22:08:30 [INFO] Terraform version: 0.13.0  
2020/10/18 22:08:30 [INFO] Go runtime version: go1.14.2  
2020/10/18 22:08:30 [INFO] CLI args: []string{"C:\\Windows\\system32\\terraform.exe", "plan"}  
2020/10/18 22:08:30 [DEBUG] Attempting to open CLI config file: C:\Users\vpala\AppData\Roaming\terraform.rc  
2020/10/18 22:08:30 [DEBUG] File doesn't exist, but doesn't need to. Ignoring.  
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory terraform.d/plugins  
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory C:\Users\vpala\AppData\Roaming\terraform.d\plugins  
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory  
C:\Users\vpala\AppData\Roaming\HashiCorp\Terraform\plugins  
2020/10/18 22:08:30 [INFO] CLI command args: []string{"plan"}  
2020/10/18 22:08:30 [WARN] Log levels other than TRACE are currently unreliable, and are supported only for backward compatibility.  
Use TF_LOG=TRACE to see Terraform's internal logs.
```

```
----  
2020/10/18 22:08:30 [DEBUG] New state was assigned lineage "f413959c-538a-f9ce-524e-1615073518d4"  
2020/10/18 22:08:30 [DEBUG] checking for provisioner in "."  
2020/10/18 22:08:30 [DEBUG] checking for provisioner in "C:\\Windows\\system32"  
2020/10/18 22:08:30 [INFO] Failed to read plugin lock file .terraform\plugins\windows_amd64\lock.json: open  
.terraform\plugins\windows_amd64\lock.json: The system cannot find the path specified.  
2020/10/18 22:08:30 [INFO] backend/local: starting Plan operation  
2020-10-18T22:08:30.625-0400 [INFO] plugin: configuring client automatic mTLS  
2020-10-18T22:08:30.646-0400 [DEBUG] plugin: starting plugin:  
path=.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe  
args=[.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe]  
2020-10-18T22:08:30.935-0400 [DEBUG] plugin: plugin started:  
path=.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe  
pid=34016  
2020-10-18T22:08:30.935-0400 [DEBUG] plugin: waiting for RPC address:  
path=.terraform/plugins/registry.terraform.io/hashicorp/aws/3.11.0/windows_amd64/terraform-provider-aws_v3.11.0_x5.exe  
2020-10-18T22:08:30.974-0400 [INFO] plugin.terraform-provider-aws_v3.11.0_x5.exe: configuring server automatic mTLS:
```

>_

```
$ export TF_LOG_PATH=/tmp/terraform.log
```

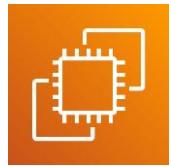
```
$ head -10 /tmp/terraform.logs
```

```
-----
2020/10/18 22:08:30 [INFO] Terraform version: 0.13.0
2020/10/18 22:08:30 [INFO] Go runtime version: go1.14.2
2020/10/18 22:08:30 [INFO] CLI args: []string{"C:\\Windows\\system32\\terraform.exe",
"plan"}
2020/10/18 22:08:30 [DEBUG] Attempting to open CLI config file:
C:\\Users\\vpala\\AppData\\Roaming\\terraform.rc
2020/10/18 22:08:30 [DEBUG] File doesn't exist, but doesn't need to. Ignoring.
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory
terraform.d/plugins
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory
C:\\Users\\vpala\\AppData\\Roaming\\terraform.d\\plugins
2020/10/18 22:08:30 [DEBUG] ignoring non-existing provider search directory
C:\\Users\\vpala\\AppData\\Roaming\\HashiCorp\\Terraform\\plugins
2020/10/18 22:08:30 [INFO] CLI command args: []string{"plan"}
```

```
$ unset TF_LOG_PATH
```

Terraform Import

HashiCorp Terraform



EC2



DynamoDB



Elastic Block Store



S3

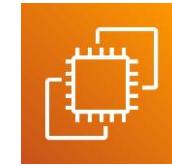


Route 53



VPC

Ansible



EC2



DynamoDB



Route 53

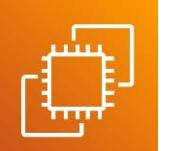
AWS Management Console



S3



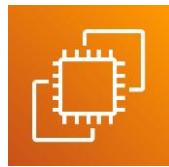
Elastic Block Store



EC2



HashiCorp
Terraform



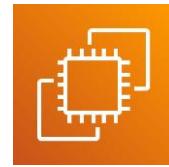
EC2



DynamoDB



Elastic Block Store



EC2



DynamoDB



Route 53



S3



Route 53



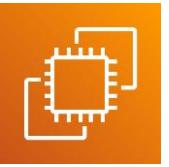
VPC



S3



Elastic Block Store



EC2

Data Source

main.tf

```
.  
. .  
data "aws_instance" "newserver" {  
    instance_id = "i-026e13be10d5326f7"  
}  
output newserver {  
    value      = data.aws_instance.newserver.public_ip  
}
```

>_

```
$ terraform apply  
  
$ data.aws_instance.newserver: Refreshing state... [id=i-026e13be10d5326f7]  
aws_key_pair.web: Refreshing state... [id=terraform-20201015013048509100000001]  
aws_security_group.ssh-access: Refreshing state... [id=sg-0a543f25009e14628]  
aws_instance.webserver: Refreshing state... [id=i-068fad300d9df27ac]
```

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

Outputs:

```
newserver = 15.223.1.176
```

Terraform Import

```
>_
```

```
# terraform import <resource_type>.<resource_name> <attribute>
$ terraform import aws_instance.webserver-2 i-026e13be10d5326f7
```

```
Error: resource address "aws_instance.webserver-2" does not exist
in the configuration.
```

Before importing this resource, please create its configuration in the root module. For example:

```
resource "aws_instance" "webserver-2" {
  # (resource arguments)
}
```

Terraform Import

main.tf

```
resource "aws_instance" "webserver-2" {
  # (resource arguments)
}
```

>_

```
$ terraform import aws_instance.webserver-2 i-026e13be10d5326f7
aws_instance.webserver-2: Importing from ID "i-026e13be10d5326f7"...
aws_instance.webserver-2: Import prepared!
  Prepared aws_instance for import
aws_instance.webserver-2: Refreshing state... [id=i-026e13be10d5326f7]
```

Import successful!

The resources that were imported are shown above. These resources are now in your Terraform state and will henceforth be managed by Terraform.

Instance summary for i-0d7c0088069819ff8 (old-ec2) [Info](#)

Updated less than a minute ago



Connect

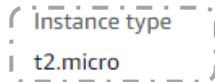
Actions ▾

Instance ID

i-0d7c0088069819ff8 (old-ec2)

Instance state

Running



IAM Role

-

Public IPv4 address

15.223.5.69 | [open address](#)

Public IPv4 DNS

ec2-15-223-5-69.ca-central-1.compute.amazonaws.com | [open address](#)



Elastic IP addresses

-

Subnet ID

subnet-c6c0a8ae

Private IPv4 addresses

172.31.23.147

Private IPv4 DNS

ip-172-31-23-147.ca-central-1.compute.internal

VPC ID

vpc-7da8d215

AWS Compute Optimizer

Opt-in to AWS Compute Optimizer for recommendations.

[Learn more](#)

Details

Security

Networking

Storage

Monitoring

Tags

▼ Instance details [Info](#)

Platform

Ubuntu (Inferred)

AMI ID

ami-0edab43b6fa892279

Monitoring

disabled

terraform.tfstate

```
{  
    "mode": "managed",  
    "type": "aws_instance",  
    "name": "webserver-2",  
    "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",  
    "instances": [  
        {  
            "schema_version": 1,  
            "attributes": {  
                "ami": "ami-0edab43b6fa892279",  
                "instance_state": "running",  
                "instance_type": "t2.micro",  
                "key_name": "ws",  
                ".  
                "tags": {  
                    "Name": "old-ec2"  
                },  
                ".  
                ".  
                "vpc_security_group_ids": [  
                    "sg-8064fdee"  
                ]  
            },  
            ".  
            ".  
        }  
    ],  
},
```

main.tf

```
resource "aws_instance" "webserver-2" {  
    ami                  = "ami-0edab43b6fa892279"  
    instance_type        = "t2.micro"  
    key_name             = "ws"  
    vpc_security_group_ids = ["sg-8064fdee"]  
}
```

```
>_  
$ terraform plan  
Refreshing Terraform state in-memory prior to plan...  
The refreshed state will be used to calculate this plan, but will not be  
persisted to local or remote state storage.  
  
aws_instance.webserver-2: Refreshing state... [id=i-0d7c0088069819ff8]  
  
-----  
  
No changes. Infrastructure is up-to-date.
```

This means that Terraform did not detect any differences between your configuration and real physical resources that exist. As a result, no actions need to be performed.

Terraform Modules

main.tf

```
resource "aws_instance" "weberver" {
  # configuration here
}

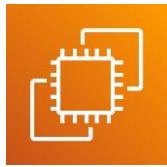
resource "aws_key_pair" "key" {
  # configuration here
}

resource "aws_security_group" "ssh-access" {
  # configuration here
}

resource "aws_s3_bucket" "data-bucket" {
  # configuration here
}

resource "aws_dynamodb_table" "user-data" {
  # configuration here
}

resource "aws_instance" "web-server-2" {
  # configuration here
}
```



aws_instance



aws_key_pair



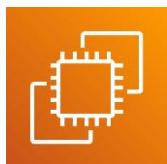
aws_iam_policy



aws_s3_bucket



aws_dynamodb_table



aws_instance

main.tf

```
resource "aws_instance" "webserver" {  
    # configuration here  
}
```

key_pair.tf

```
resource "aws_key_pair" "web" {  
    # configuration here  
}
```

dynamodb_table.tf

```
resource "aws_dynamodb_table" "state-locking" {  
    # configuration here  
}
```

security_group.tf

```
resource "aws_security_group" "ssh-access" {  
    # configuration here  
}
```

ec2_instance.tf

```
resource "aws_instance" "webserver-2" {  
    # configuration here  
}
```

s3_bucket.tf

```
resource "aws_s3_bucket" "terraform-state" {  
    # configuration here  
}
```

```
>_
```

```
$ ls
provider.tf
id_rsa
id_rsa.pub
main.tf
pub_ip.txt
terraform.tfstate.backup
terraform.tfstate
iam_roles.tf
iam_users.tf
security_groups.tf
variables.tf
outputs.tf
s3_buckets.tf
dynamo_db.tf
local.tf
```

Complex Configuration
Files

Duplicate Code

Increased Risk

Limits Reusability

Root Module

>_

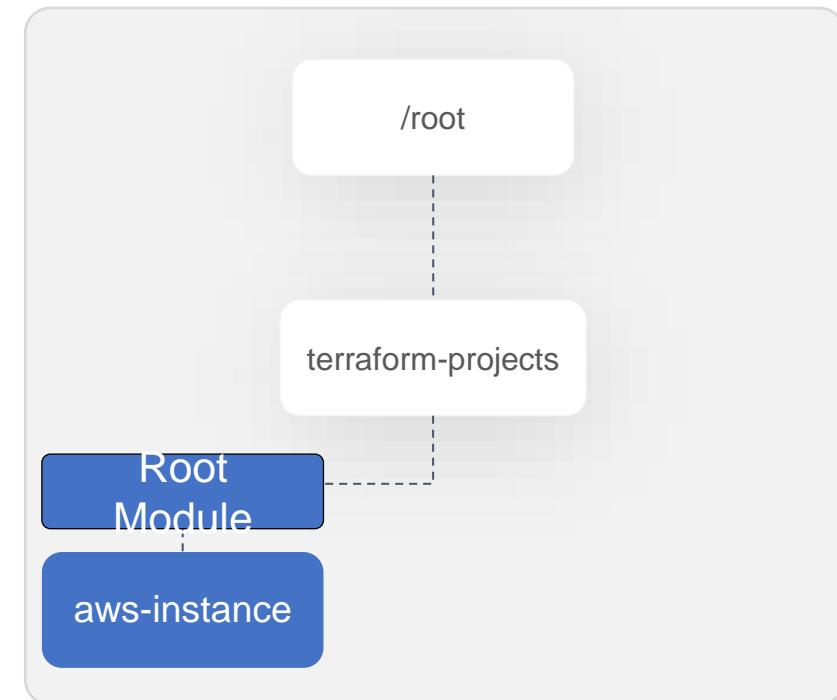
```
$ ls /root/terraform-projects/aws-instance  
main.tf      variables.tf
```

main.tf

```
resource "aws_instance" "webserver" {  
    ami = var.ami  
    instance_type = var.instance_type  
    key_name = var.key  
}
```

variables.tf

```
variable ami {  
    type      = string  
    default   = "ami-0edab43b6fa892279"  
    description = "Ubuntu AMI ID in the ca-  
central-1 region"  
}
```



Root Module

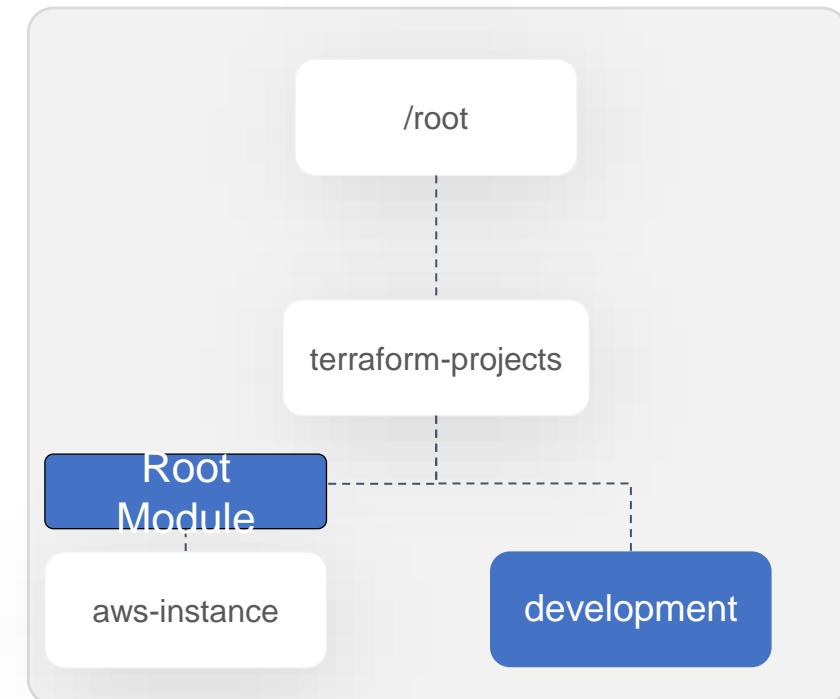
>_

```
$ mkdir /root/terraform-projects/development
```

```
main.tf
```

main.tf

```
module "dev-webserver" {  
    source = "../aws-instance"  
}
```



Root Module

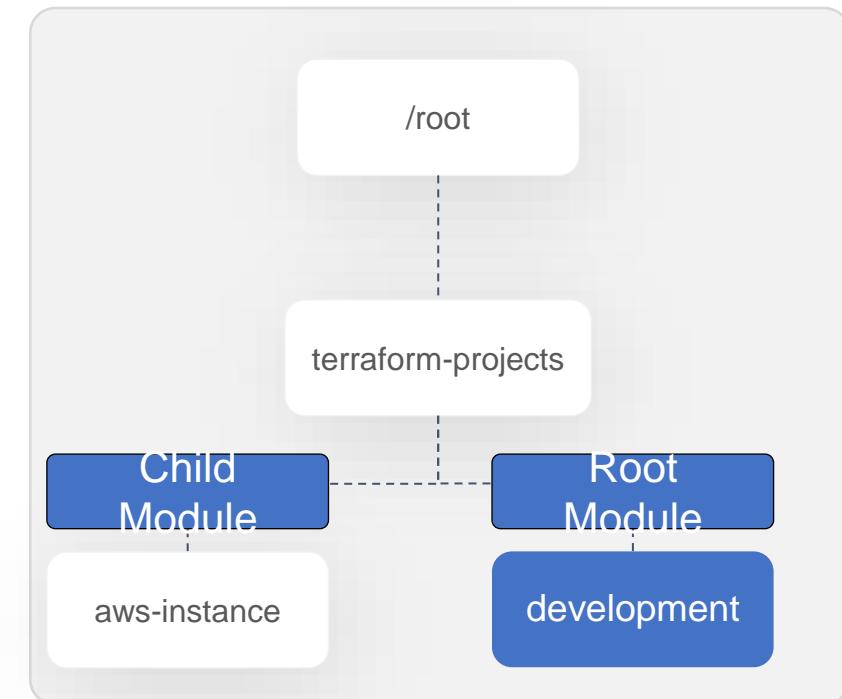
>_

```
$ mkdir /root/terraform-projects/development
```

```
main.tf
```

main.tf

```
module "dev-webserver" {  
    source = "../aws-instance"  
}
```



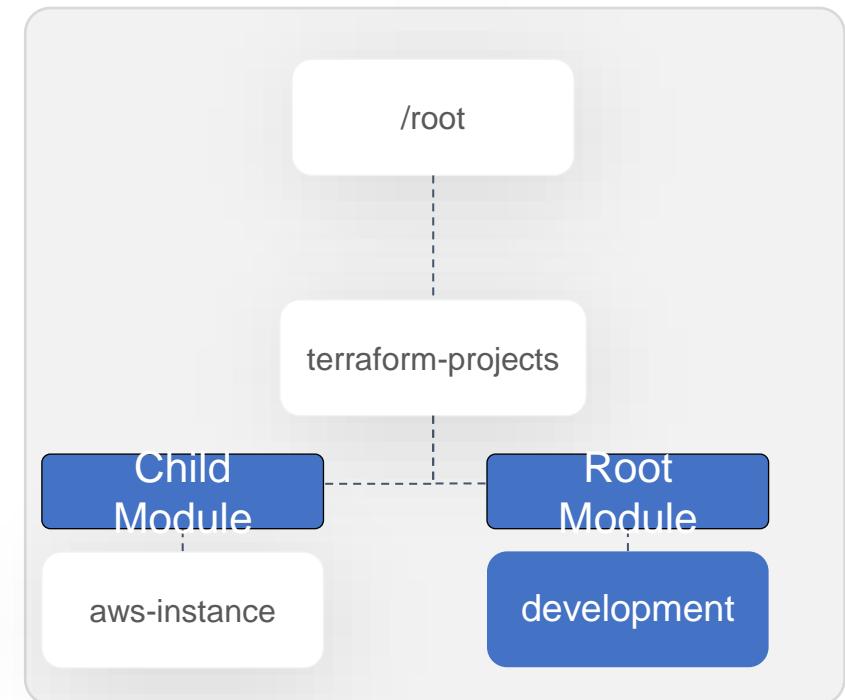
```
>_
```

```
$ mkdir /root/terraform-projects/development
```

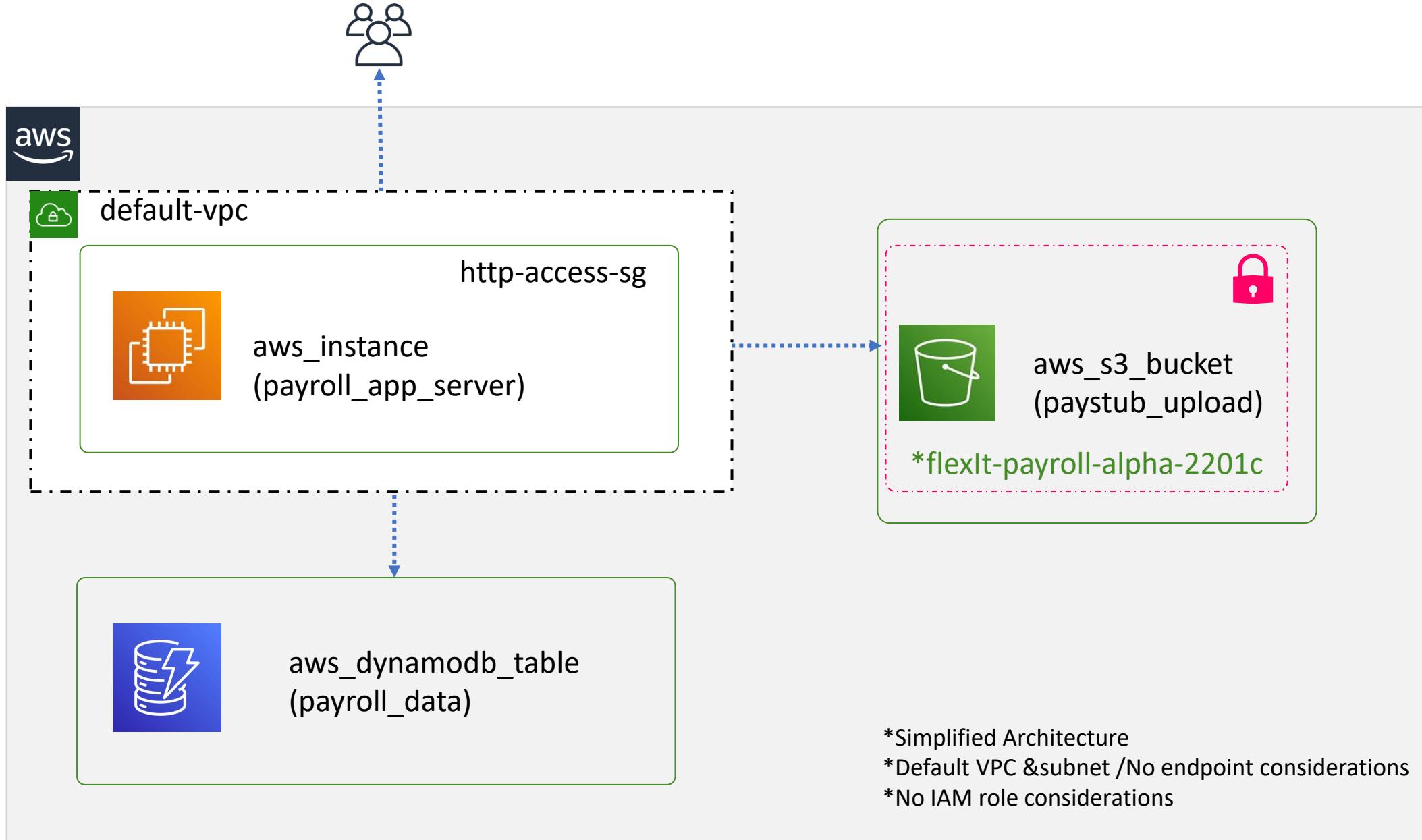
```
main.tf
```

```
main.tf
```

```
[module "dev-webserver" {
  source = "../aws-instance"
}]
```



Creating and Using a Module



>_

```
$ mkdir /root/terraform-projects/modules/payroll-app  
app_server.tf dynamodb_table.tf s3_bucket.tf variables.tf
```

app_server.tf

```
resource "aws_instance" "app_server" {  
  ami           = var.ami  
  instance_type = "t2.medium"  
  tags = {  
    Name = "${var.app_region}-app-server"  
  }  
  depends_on = [ aws_dynamodb_table.payroll_db,  
                aws_s3_bucket.payroll_data  
  ]  
}
```

s3_bucket.tf

```
resource "aws_s3_bucket" "payroll_data" {  
  bucket = "${var.app_region}-${var.bucket}"  
}
```

/root

terraform-projects

modules

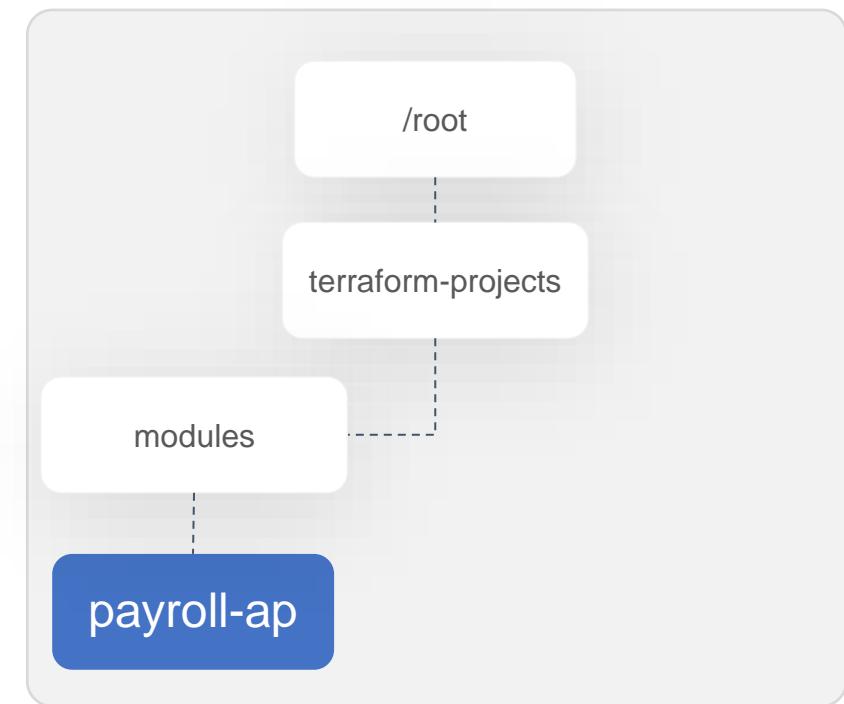
payroll-ap

dynamodb_table.tf

```
resource "aws_dynamodb_table" "payroll_db" {  
  name           = "user_data"  
  billing_mode   = "PAY_PER_REQUEST"  
  hash_key        = "EmployeeID"  
  
  attribute {  
    name = "EmployeeID"  
    type = "N"  
  }  
}
```

variables.tf

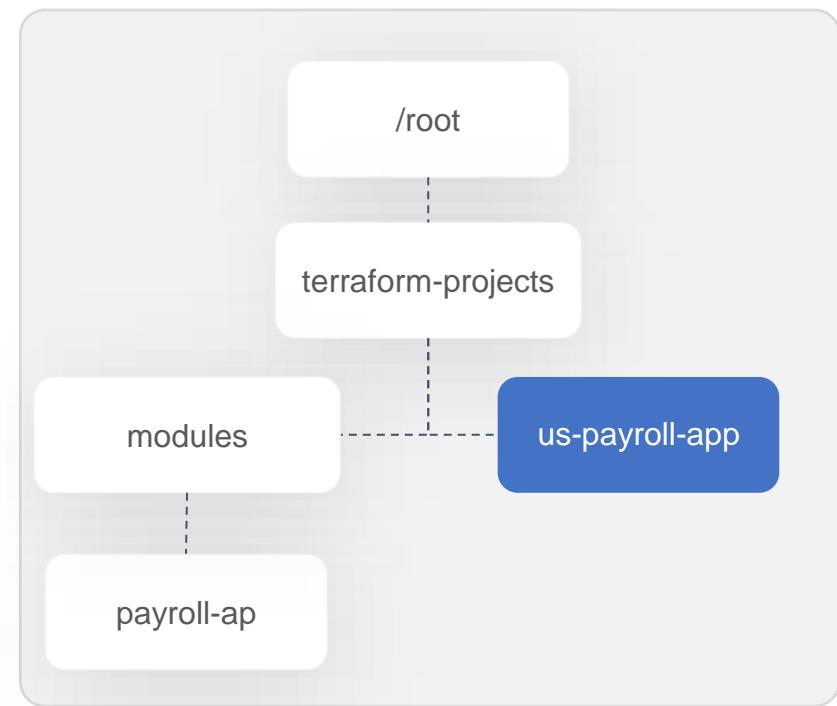
```
variable "app_region" {
    type = string
}
variable "bucket" {
    default = "flexit-payroll-alpha-22001c"
}
variable "ami" {
    type = string
}
```



```
>_
$ mkdir /root/terraform-projects/us-payroll-app
main.tf provider.tf
```

main.tf

```
module "us_payroll" {
  source = "../modules/payroll-app"
  app_region = "us-east-1"
  ami      = "ami-24e140119877avm"
}
```



```
>_
```

```
$ terraform init
```

```
Initializing modules...
```

```
[ - us_payroll in .terraform/modules/us_payroll ]
```

```
Initializing the backend...
```

```
Initializing provider plugins...
```

```
- Finding latest version of hashicorp/aws...
```

```
- Installing hashicorp/aws v3.11.0...
```

```
- Installed hashicorp/aws v3.11.0 (signed by HashiCorp)
```

```
The following providers do not have any version constraints in  
configuration,
```

```
so the latest version was installed.
```

```
To prevent automatic upgrades to new major versions that may contain  
breaking
```

```
changes, we recommend adding version constraints in a required_providers  
block
```

```
in your configuration, with the constraint strings suggested below.
```

```
* hashicorp/aws: version = "~> 3.11.0"
```

```
Terraform has been successfully initialized!
```

>_

```
$ terraform apply
```

.

Terraform will perform the following actions:

```
# module.us_payroll.aws_dynamodb_table.payroll_db will be created
+ resource "aws_dynamodb_table" "payroll_db" {
    + arn          = (known after apply)
    + billing_mode = "PAY_PER_REQUEST"
    + hash_key     = "EmployeeID"
    + name         = "user_data"
}

# module.us_payroll.aws_instance.app_server will be created
+ resource "aws_instance" "app_server" {
    + ami           = "ami-24e140119877avm"
    + instance_type = "t2.medium"
}

+ resource "aws_s3_bucket" "payroll_data" {
    + acceleration_status = (known after apply)
    + acl                 = "private"
    + arn                = (known after apply)
    + bucket              = "us-east-1-flexit-payroll-alpha-22001c"
}
```

Enter a value: yes

```
module.us_payroll.aws_dynamodb_table.payroll_db: Creating...
module.us_payroll.aws_s3_bucket.payroll_data: Creating...
```

LOUD

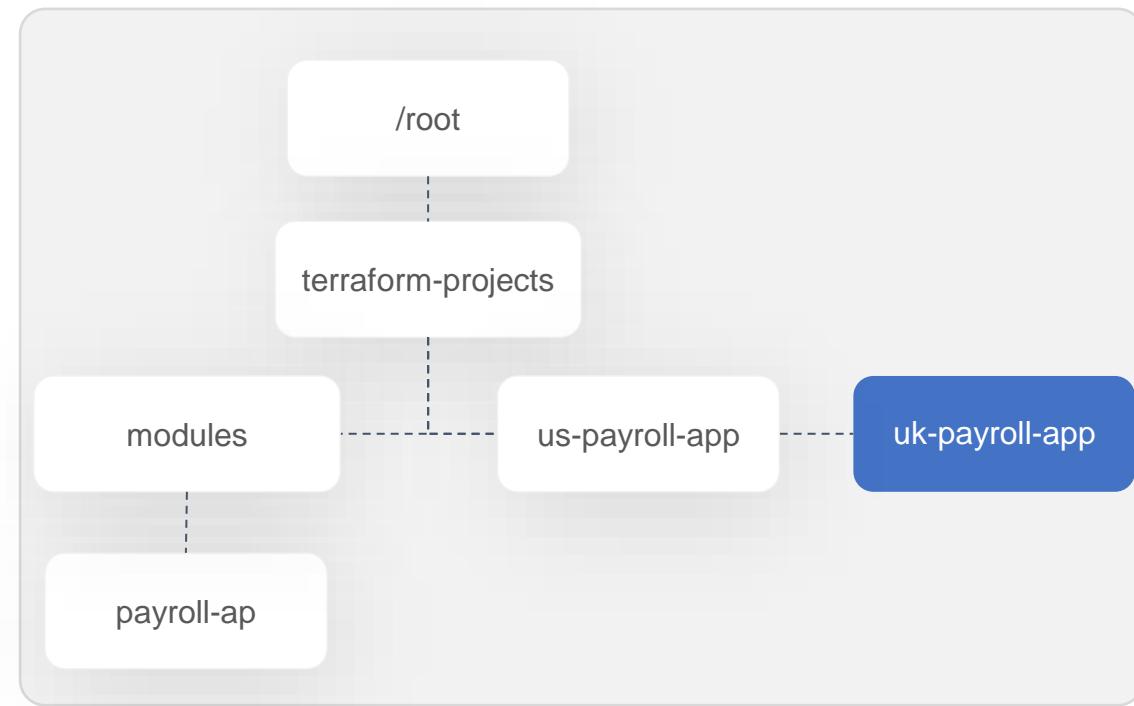
```
>_  
$ mkdir /root/terraform-projects/uk-payroll-app  
main.tf provider.tf
```

main.tf

```
module "uk_payroll" {  
  source = "../modules/payroll-app"  
  app_region = "eu-west-2"  
  ami      = "ami-35e140119877avm"  
}
```

provider.tf

```
provider "aws" {  
  region    = "eu-west-2"  
}
```



>_

```
$ terraform apply
```

.

Terraform will perform the following actions:

```
# module.us_payroll.aws_dynamodb_table.payroll_db will be created
+ resource "aws_dynamodb_table" "payroll_db" {
    + arn          = (known after apply)
    + billing_mode = "PAY_PER_REQUEST"
    + hash_key     = "EmployeeID"
    + name         = "user_data"
.

.

# module.us_payroll.aws_instance.app_server will be created
+ resource "aws_instance" "app_server" {
    + ami           = "ami-35e140119877avm"
    + instance_type = "t2.medium"
.

.

+ resource "aws_s3_bucket" "payroll_data" {
    + acceleration_status      = (known after apply)
    + acl                      = "private"
    + arn...                   = (known after apply)
    + bucket                   = "eu-west-2-flexit-payroll-alpha-22001c"
}
```

Enter a value: yes

```
module.us_payroll.aws_dynamodb_table.payroll_db: Creating...
module.us_payroll.aws_s3_bucket.payroll_data: Creating...
module.us_payroll.aws_dynamodb_table.payroll_db: Creation complete after 1s [id=user_data]
module.us_payroll.aws_s3_bucket.payroll_data: Creation complete after 1s [id=eu-west-2-flexit-payroll-alpha-22001c]
```

LOUD

Terraform will perform the following actions:

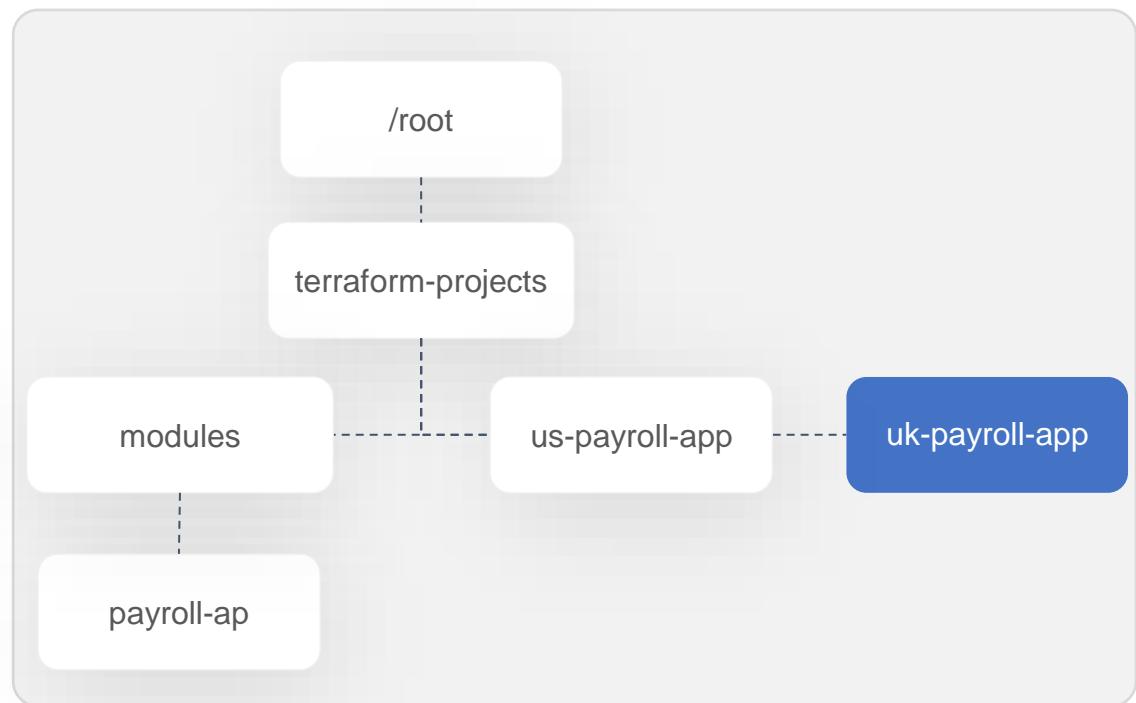
```
# module.us_payroll.aws_dynamodb_table.payroll_db will be created
+ resource "aws_dynamodb_table" "payroll_db" {
    + arn                  = (known after apply)
    + billing_mode         = "PAY_PER_REQUEST"
    + hash_key              = "EmployeeID"
    + name                 = "user_data"
}

# module.us_payroll.aws_instance.app_server will be created
+ resource "aws_instance" "app_server" {
    + ami                  = "ami-35e140119877avm"
    + ami_id               = "ami-35e140119877avm"
    + architecture          = "x86_64"
    + availability_zone     = "us-east-1a"
    + block_device_mappings = []
    + ebs                   = []
    + eni_ids               = []
    + ephemeral_block_device = []
    + instance_type          = "t2.micro"
    + ipv6_address          = "2607:b24::1"
    + key_name               = "tf-key-poc"
    + launch_time            = "2023-09-11T10:45:00Z"
    + monitoring            = false
    + network_interface      = "eni-0000000000000000"
    + private_ip             = "172.31.0.10"
    + public_ip              = "54.175.102.10"
    + root_device_name       = "root"
    + root_device_type       = "Amazon EBS"
    + security_group_ids     = []
    + subnet_id              = "subnet-0000000000000000"
}
```

...

main.tf

```
module "us_payroll" {  
  source = "../modules/payroll-app"  
  app_region = "eu-west-2"  
  ami      = "ami-35e140119877avm"  
}
```



Simpler Configuration Files

Lower Risk

Re-Usability

Standardized Configuration

Using Modules from Registry

Local Module

```
main.tf

module "dev-webserver" {

  source = "../aws-instance/"

  key    = "webserver"
}
```

The screenshot shows the HashiCorp Terraform Registry interface. The top navigation bar has tabs for 'Providers' and 'Modules'. The 'Modules' tab is selected, indicated by a blue underline. Below the tabs is a search bar with the placeholder 'Search Providers and Modules'. On the left, there's a sidebar with 'FILTERS' and a 'Clear Filters' link. Under 'Provider', there's a dropdown menu with options: alicloud, aws, azurerm, google, and oci. The main content area is titled 'Modules' and contains three listed modules:

- terraform-aws-modules / vpc**
Terraform module which creates VPC resources on AWS
Last updated 2 hours ago, 5.5M downloads
- terraform-aws-modules / security-group**
Terraform module which creates EC2-VPC security groups on AWS
Last updated 2 months ago, 5.4M downloads
- terraform-aws-modules / eks**
Terraform module to create an Elastic Kubernetes (EKS) cluster and associated components
Last updated 11 days ago, 2.0M downloads

<https://registry.terraform.io/browse/modules>

Terraform Registry

security-group

x

-  **terraform-aws-modules/security-group**
Terraform module which creates EC2-VPC security groups on AWS
-  **dcos-terraform/security-groups**
Create DC/OS related security groups
-  **Azure/network-security-group**
Terraform module to create a network security group and assign it to the specified subnet
-  **devops-workflow/security-group**
Terraform module which creates EC2-VPC security groups on AWS
-  **claranet/nsg**
Terraform module for Azure Network Security Group

 **security-group** 

AWS

Terraform module which creates EC2-VPC security groups on AWS

Published August 20, 2020 by [terraform-aws-modules](#)

Module managed by [antonbabenko](#)

Total provisions: 5.4M

Source Code: github.com/terraform-aws-modules/terraform-aws-security-group (report an issue)

Terraform Module

 **security-group** 

AWS

Terraform module which creates EC2-VPC security groups on AWS

Published August 20, 2020 by [terraform-aws-modules](#)

Module managed by [antonbabenko](#)

Total provisions: 5.4M

Source Code: github.com/terraform-aws-modules/terraform-aws-security-group ([report an issue](#))

Provision Instructions

Copy and paste into your Terraform configuration, insert the variables, and run `terraform init`:

```
module "security-group" {  
  source  = "terraform-aws-modules/security-group"  
  version = "3.16.0"  
  # insert the 2 required variables here  
}
```

Terraform Module

aws security-group 

AWS

Terraform module which creates EC2-VPC security groups on AWS

Published August 20, 2020 by [terraform-aws-modules](#)

Module managed by [antonbabenko](#)

Total provisions: 5.4M

Source Code: github.com/terraform-aws-modules/terraform-aws-security-group ([report an issue](#))

- activemq
- alertmanager
- carbon-relay-ng
- cassandra
- consul
- docker-swarm
- elasticsearch
- grafana
- graphite-statsd
- http-80
- http-8080
- https-443

Provision Instructions

Copy and paste into your Terraform configuration, insert the variables, and run `terraform init` :

```
module "security-group" {  
  source  = "terraform-aws-modules/security-group/  
  version = "3.16.0"  
  # insert the 2 required variables here  
}
```

KODEKLOUD

main.tf

```
module "security-group_ssh" {  
  source  = "terraform-aws-modules/security-group/aws/modules/ssh"  
  version = "3.16.0"  
  # insert the 2 required variables here  
  vpc_id = "vpc-7d8d215"  
  ingress_cidr_blocks = [ "10.10.0.0/16"]  
  name = "ssh-access"  
  
}
```

Provision Instructions

Copy and paste into your Terraform configuration, insert the variables, and run `terraform init` :

```
module "security-group" {  
  source  = "terraform-aws-modules/security-group/  
  version = "3.16.0"  
  # insert the 2 required variables here  
}  
◀ ▶
```

>_

```
$ terraform get  
Downloading terraform-aws-modules/security-group/aws 3.16.0 for security-group_ssh...  
- security-group_ssh in .terraform\modules\security-group_ssh\modules\ssh
```

Terraform Functions

Functions

main.tf

```
resource "aws_iam_policy" "adminUser" {
    name      = "AdminUsers"
    policy    = file("admin-policy.json")
}

resource "local_file" "pet" {
    filename = var.filename
    count    = length(var.filename)
}
```

main.tf

```
resource "local_file" "pet" {
    filename = var.filename
    for_each = toset(var.region)
}

variable region {
    type      = list
    default   = ["us-east-1",
                "us-east-1",
                "ca-central-1"]
    description = "A list of AWS Regions"
}
```

>_

```
$ terraform console
>file("/root/terraform-projects/main.tf)

resource "aws_instance" "development" {
    ami           = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
}
> length(var.region)
3
> toset(var.region)
[
    "ca-central-1",
    "us-east-1",
]
>
```

OUD

Functions

Numeric Functions

String Functions

Collection Functions

Type Conversion
Functions

Numeric Functions

variables.tf

```
variable "num" {
  type = set(number)
  default = [ 250, 10, 11, 5]
  description = "A set of numbers"
}
```

>_

```
$ terraform console

> max (-1, 2, -10, 200, -250)
200

> min (-1, 2, -10, 200, -250)
-250

> max(var.num...)
250

> ceil(10.1)
11

> ceil(10.9)
11

> floor(10.1)
10

> floor(10.9)
10
```

String Functions

variables.tf

```
variable "ami" {
  type = string
  default = "ami-xyz,AMI-ABC,ami-efg"
  description = "A string containing ami ids"
}
```

> _

```
$ terraform console
> split(", ", "ami-xyz,AMI-ABC,ami-efg")
[ "ami-xyz", "AMI-ABC", "ami-efg" ]

> split(", ", var.ami)
[ "ami-xyz", "AMI-ABC", "ami-efg" ]

> lower(var.ami)
ami-xyz,ami-abc,ami-efg

> upper(var.ami)
AMI-XYZ,AMI-ABC,AMI-EFG

> title(var.ami)
Ami-Xyz,AMI-ABC,A Mi-Efg

> substr(var.ami, 0, 7)
ami-xyz

> substr(var.ami, 8, 7)
AMI-ABC

> substr(var.ami, 16, 7)
ami-efg
```

String Functions

variables.tf

```
variable "ami" {
  type = list
  default = ["ami-xyz", "AMI-ABC", "ami-efg"]
  description = "A list of numbers"
}
```

>_

```
$ terraform console
> join(",", ["ami-xyz", "AMI-ABC", "ami-efg"])
ami-xyz,AMI-ABC,ami-efg

> join(",", var.ami)
ami-xyz,AMI-ABC,ami-efg
```

Collection Functions

variables.tf

```
variable "ami" {
  type = list
  default = ["ami-xyz", "AMI-ABC", "ami-efg"]
  description = "A list of numbers"
}
```

>_

```
$ terraform console
> length(var.ami)
3

> index(var.ami, "AMI-ABC")
1

> element(var.ami,2)
ami-efg

> contains(var.ami, "AMI-ABC")
true

> contains(var.ami, "AMI-XYZ")
false
```

Map Functions

variables.tf

```
variable "ami" {
  type = map
  default = { "us-east-1" = "ami-xyz",
              "ca-central-1" = "ami-efg",
              "ap-south-1" = "ami-ABC"
            }
  description = "A map of AMI ID's for specific regions"
}
```

> _

```
$ terraform console
> keys(var.ami)
[
  "ap-south-1",
  "ca-central-1",
  "us-east-1",
]

> values(var.ami)
[
  "ami-ABC",
  "ami-efg",
  "ami-xyz",
]

> lookup(var.ami, "ca-central-1")
ami-efg
```

Map Functions

variables.tf

```
variable "ami" {
  type = map
  default = { "us-east-1" = "ami-xyz",
              "ca-central-1" = "ami-efg",
              "ap-south-1" = "ami-ABC"
            }
  description = "A map of AMI ID's for specific regions"
}
```

>_

```
$ terraform console
> lookup(var.ami, "us-west-2")
Error: Error in function call
  on <console-input> line 1:
  (source code not available)
  |-----
  | var.ami is map of string with 3 elements

Call to function "lookup" failed: lookup failed
to find 'us-west-2'.

> lookup (var.ami, "us-west-2", "ami-pqr")
ami-pqr
```

Operators & Conditional Expressions

Numeric Operators

```
>_
$ terraform console
> 1 + 2
3

> 5 - 3
2

> 2 * 2
4

> 8 / 2
4
```

Equality Operators

```
>_
$ terraform console

> 8 == 8
true

8 == 7
false

> 8 != "8"
true
```

Comparison Operators

```
>_  
$ terraform console  
  
> 5 > 7  
false  
  
> 5 > 4  
true  
  
> 5 > 5  
False  
  
> 5 >= 5  
true  
  
> 4 < 5  
true  
  
> 3 <= 4  
true
```

Logical Operators

```
>_  
$ terraform console  
  
> 8 > 7 && 8 < 10  
true  
  
> 8 > 10 && 8 < 10  
false  
  
> 8 > 9 || 8 < 10  
True  
  
> var.special  
true  
  
> ! var.special  
false  
  
> ! (var.b > 30)  
true
```

```
variables.tf  
  
variable special {  
  type      = bool  
  default   = true  
  description = "Set to true to  
    use special characters"  
}  
  
variable b {  
  type = number  
  default = 25  
}
```

Logical Operators

```
>_
```

```
$ terraform console
```

```
> var.a > var.b
```

```
true
```

```
> var.a < var.b
```

```
false
```

```
> var.a + var.b
```

```
75
```

```
variables.tf
```

```
variable a {  
    type = number  
    default = 50  
}  
variable b {  
    type = number  
    default = 25  
}
```

main.tf

```
resource "random_password" "password-generator" {
    length = var.length
}

output password {
    value = random_password.password-generator.result
}
```

variables.tf

```
variable length {
    type      = number
    description = "The length of the password"
}
```

>_

```
$ terraform apply -var=length=5 -auto-approve
random_password.password-generator: Creating...
random_password.password-generator: Creation complete after 0s [id=none]
```

Apply complete! Resources: 1 added, 0 changed, 0 destroyed.

Outputs:

```
password = sjsrw]
```

```
$ if [ $length -lt 8 ]
then
    length=8;
    echo $length;
else
    echo $length;
fi
# Generate Password
```

Condition

If True

If False

condition

If True

If False

```
main.tf
```

```
resource "random_password" "password-generator" {
  length = ${var.length < 8 ? 8 : var.length}
}

output password {
  value = random_password.password-generator.result
}
```

condition ? true_val : false_val

```
variables.tf
```

```
variable length {
  type      = number
  description = "The length of the password"
}
```

```
$ if [ $length -lt 8 ]
then
  length=8;
  echo $length;
else
  echo $length;
fi
# Generate Password
```

Condition

If True

If False

```
>_
```

```
$ terraform apply -var=length=5
Terraform will perform the following actions:

# random_password.password-generator will be created
+ resource "random_password" "password-generator" {
    + id          = (known after apply)
    + length      = 8
  .
Apply complete! Resources: 1 added, 0 changed, 0 destroyed.
```

Outputs:

```
password = &(1Beiaq
```

```
$ terraform apply -var=length=12
Terraform will perform the following actions:

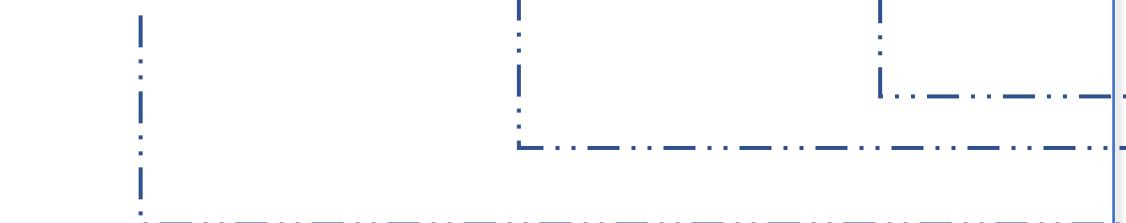
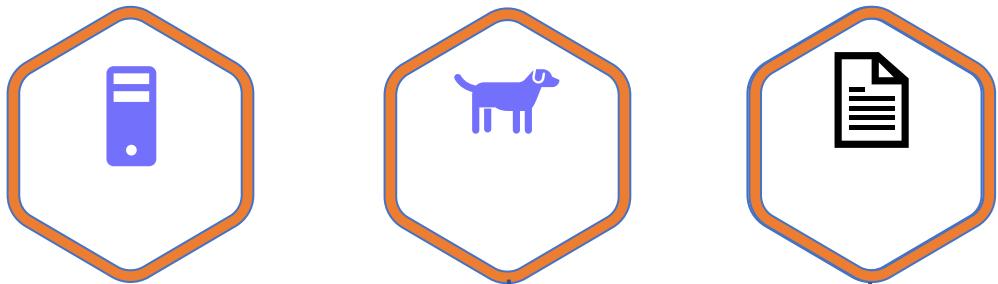
# random_password.password-generator must be replaced
-/+ resource "random_password" "password-generator" {
    ~ id          = "none" -> (known after apply)
    ~ length      = 8 -> 12 # forces replacement.
  .
Apply complete! Resources: 1 added, 0 changed, 0 destroyed.
```

Outputs:

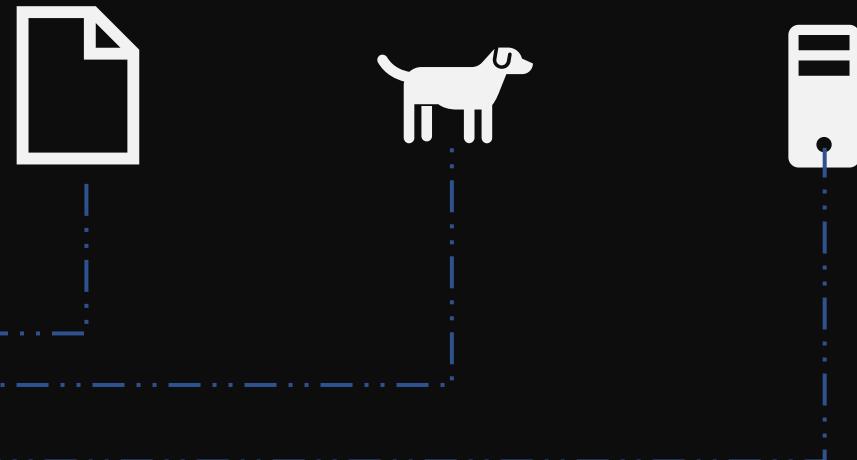
```
password = 8B@o}{cUzrZ7
```

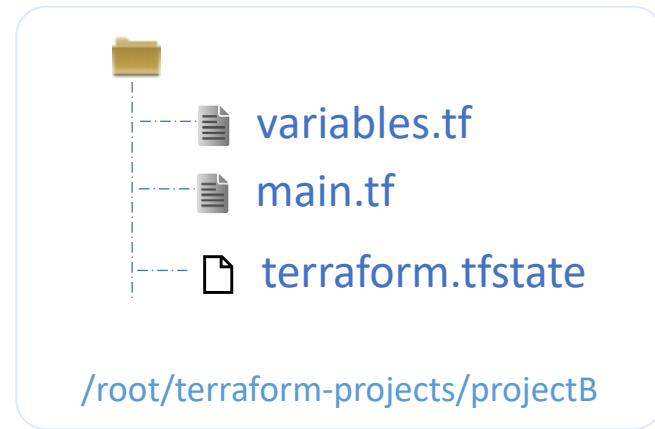
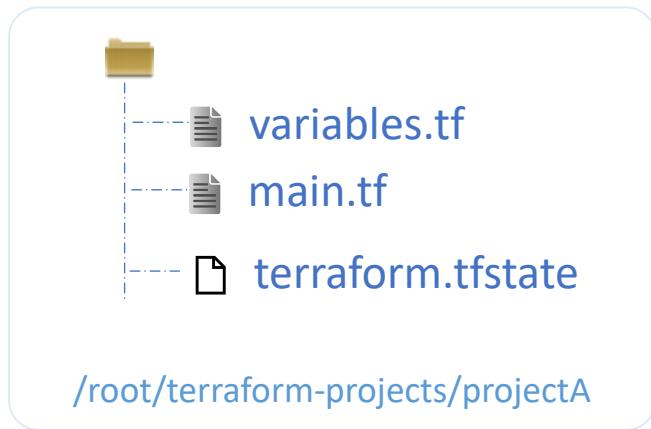
Terraform Workspaces

Real World Infrastructure



terraform.tfstate





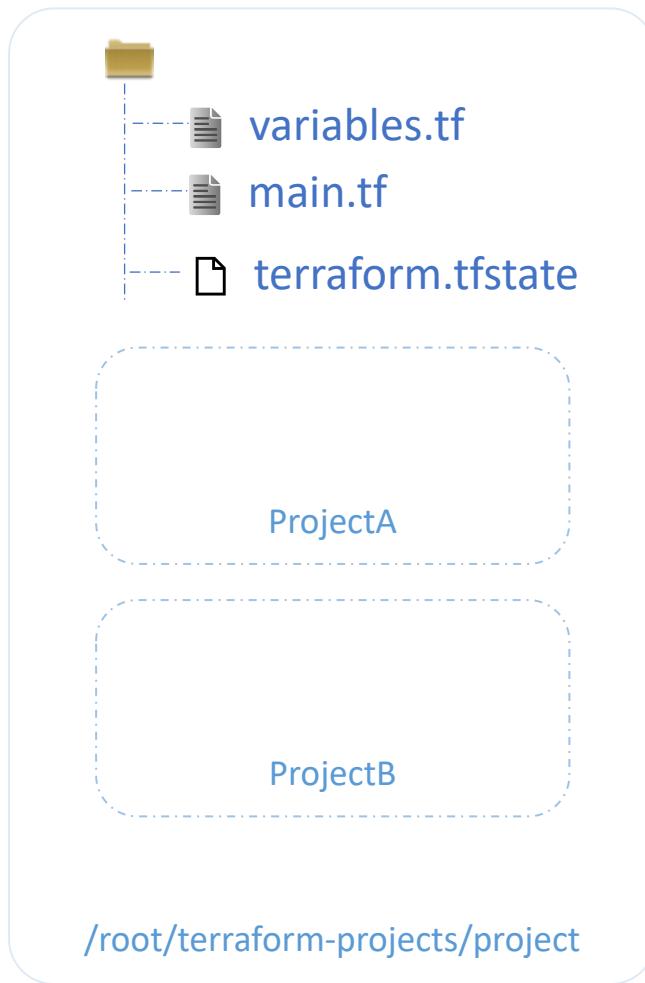
main.tf

```
resource "aws_instance" "projectA" {
  ami = "ami-0edab43b6fa892279"
  instance_type = "t2.micro"
  tags = {
    Name = "ProjectA"
  }
}
```

main.tf

```
resource "aws_instance" "projectB" {
  ami = "ami-0c2f25c1f66a1ff4d"
  instance_type = "t2.micro"
  tags = {
    Name = "ProjectB"
  }
}
```

Workspace

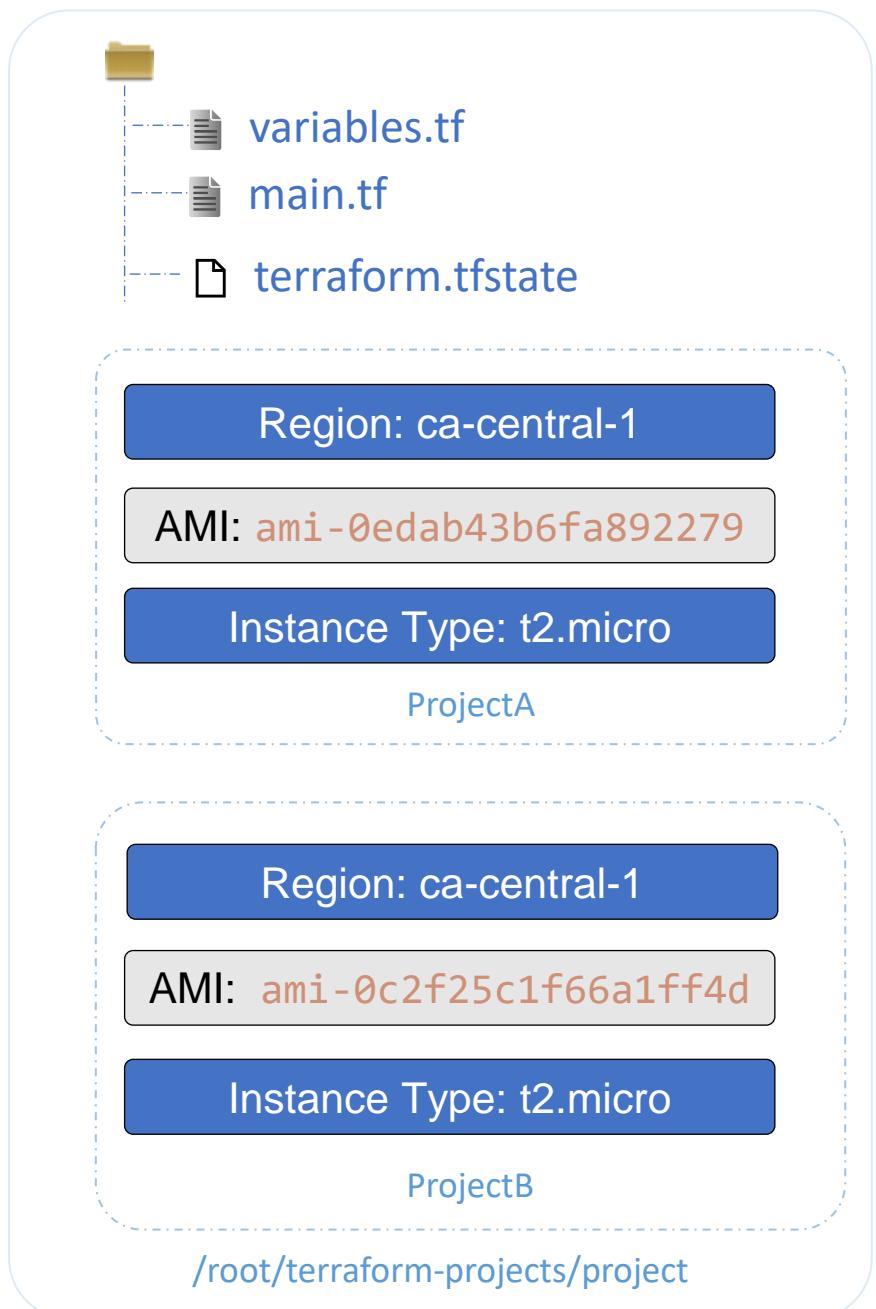


main.tf

```
resource "aws_instance" "projectA" {
    ami = "ami-0edab43b6fa892279"
    instance_type = "t2.micro"
    tags = [
        Name = "ProjectA"
    ]
}
```

Workspace

```
>_  
  
$ terraform workspace new ProjectA  
Created and switched to workspace "ProjectA"!  
  
You're now on a new, empty workspace. Workspaces isolate their state,  
so if you run "terraform plan" Terraform will not see any existing state  
for this configuration.  
  
$ terraform workspace list  
default  
* ProjectA
```



```
variable region {  
    default = "ca-central-1"  
}  
variable instance_type {  
    default = "t2.micro"  
}  
variable ami {  
    type      = map  
    default   = {  
        "ProjectA" = "ami-0edab43b6fa892279",  
        "ProjectB" = "ami-0c2f25c1f66a1ff4d"  
    }  
}
```

```
resource "aws_instance" "projectA" {  
    ami      = "  
    instance_type = "  
    tags     = {  
        Name = "  
    }  
}
```



variables.tf

main.tf

>_

```
$ terraform console  
> terraform.workspace  
ProjectA  
  
> lookup(var.ami, terraform.workspace)  
ami-0edab43b6fa892279
```

Instance Type: t2.micro

ProjectB

/root/terraform-projects/project

variables.tf

```
variable region {  
    default = "ca-central-1"  
}  
variable instance_type {  
    default = "t2.micro"  
}  
variable ami {  
    type      = map  
    default   = {  
        "ProjectA" = "ami-0edab43b6fa892279",  
        "ProjectB" = "ami-0c2f25c1f66a1ff4d"  
    }  
}
```

main.tf

```
resource "aws_instance" "projectA" {  
    ami = lookup(var.ami, terraform.workspace)  
    instance_type = var.instance_type  
    tags = {  
        Name = terraform.workspace  
    }  
}
```

```
>_
```

```
$ terraform plan
```

```
Terraform will perform the following actions:
```

```
# aws_instance.project will be created
+ resource "aws_instance" "project" {
    + ami                      = "ami-0edab43b6fa892279"
    + instance_type             = "t2.micro"
    + tags                     = {
        + "Name" = "ProjectA"
    }
.
.
```

```
$ terraform workspace new ProjectB
```

```
Created and switched to workspace "ProjectB"!
```

You're now on a new, empty workspace. Workspaces isolate their state, so if you run "terraform plan" Terraform will not see any existing state for this configuration.

```
>_  
  
$ terraform plan  
Terraform will perform the following actions:  
  
# aws_instance.project will be created  
+ resource "aws_instance" "project" {  
    + ami                      = "ami-0c2f25c1f66a1ff4d"  
    + instance_type              = "t2.micro"  
    + tags                      = {  
        + "Name" = "ProjectB"  
    }  
.  
.  
. .  
  
$ terraform workspace select ProjectA  
Switched to workspace "ProjectA".
```

```
>_  
  
$ ls  
main.tf provider.tf terraform.tfstate.d variables.tf  
  
$ tree terraform.tfstate.d/  
terramform.tfstate.d/  
| -- ProjectA  
|   '-- terraform.tfstate  
`-- ProjectB  
    '-- terraform.tfstate  
  
2 directories, 2 files
```