Terraform

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Introduction

Your Name

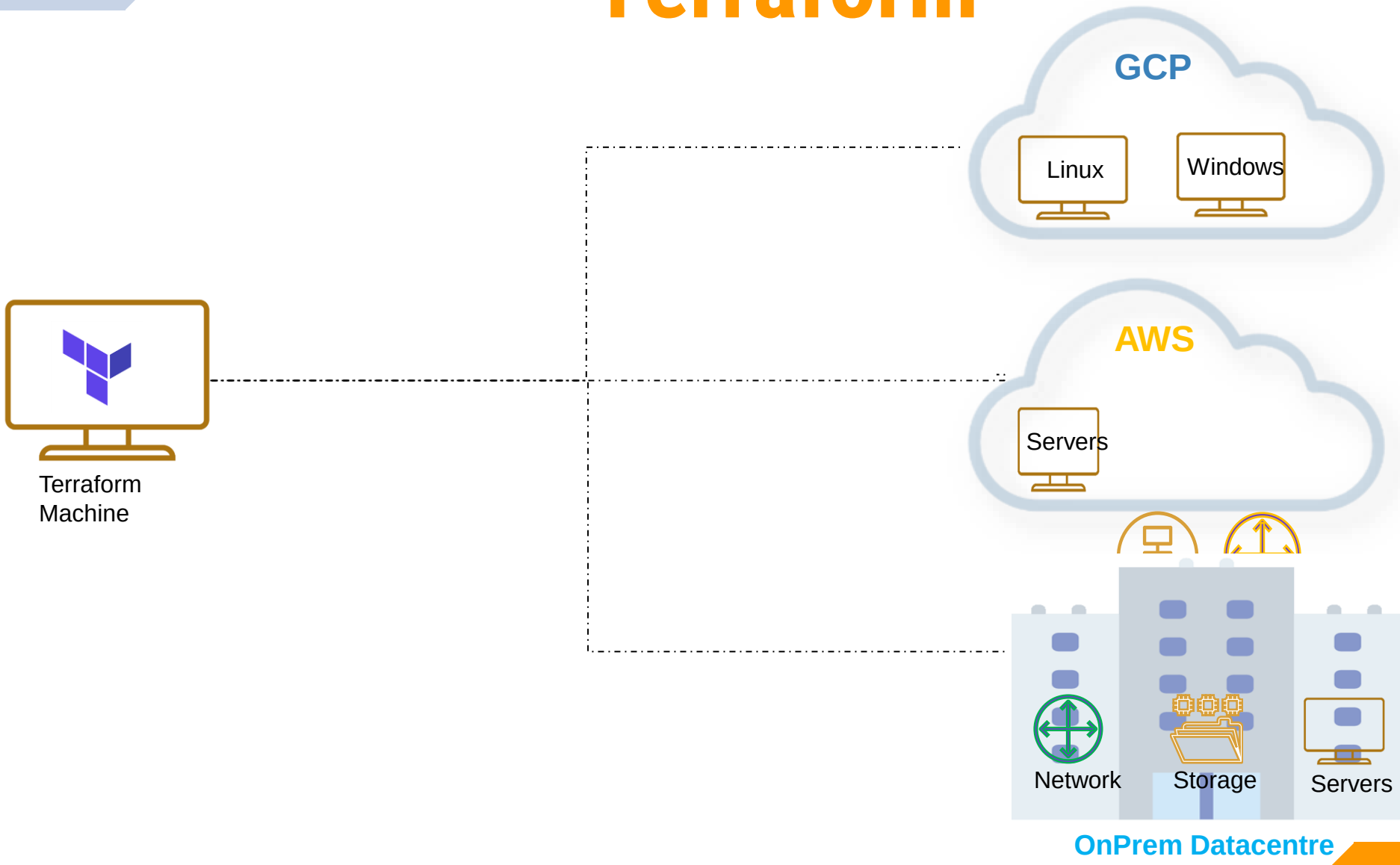
Total experience

Background – Development / Infrastructure / Database / Network

Experience on AWS Cloud and Terraform

What is Orchestration?

Terraform


GCP
Linux
Windows
AWS
Servers
Terraform
Machine
Network
Storage
Servers
OnPrem Datacentre

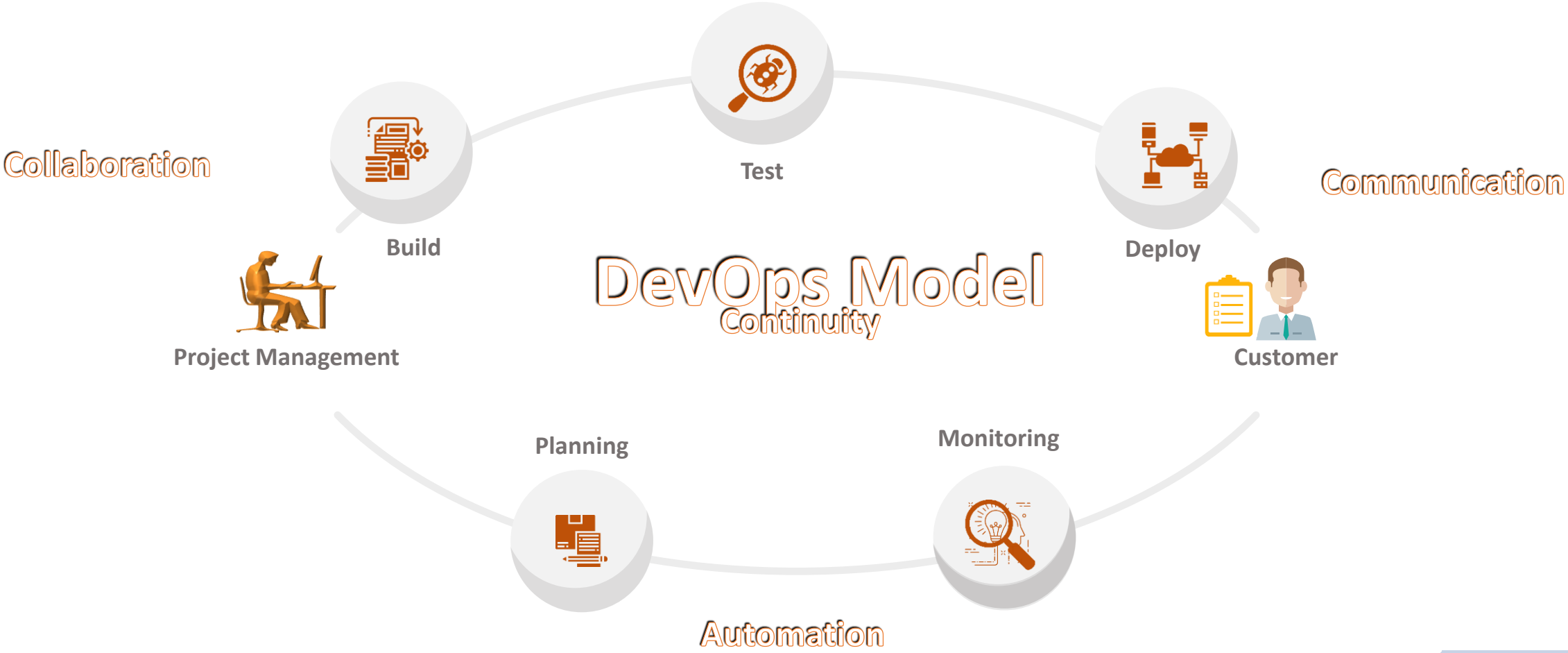
GUI vs CLI vs IAC

- **GUI (Graphical User Interface)**
  - ✓ Best for end user experience
  - ✓ Easy management
  - ✓ Bad for Automation
  - ✓ Not helpful for Administrators

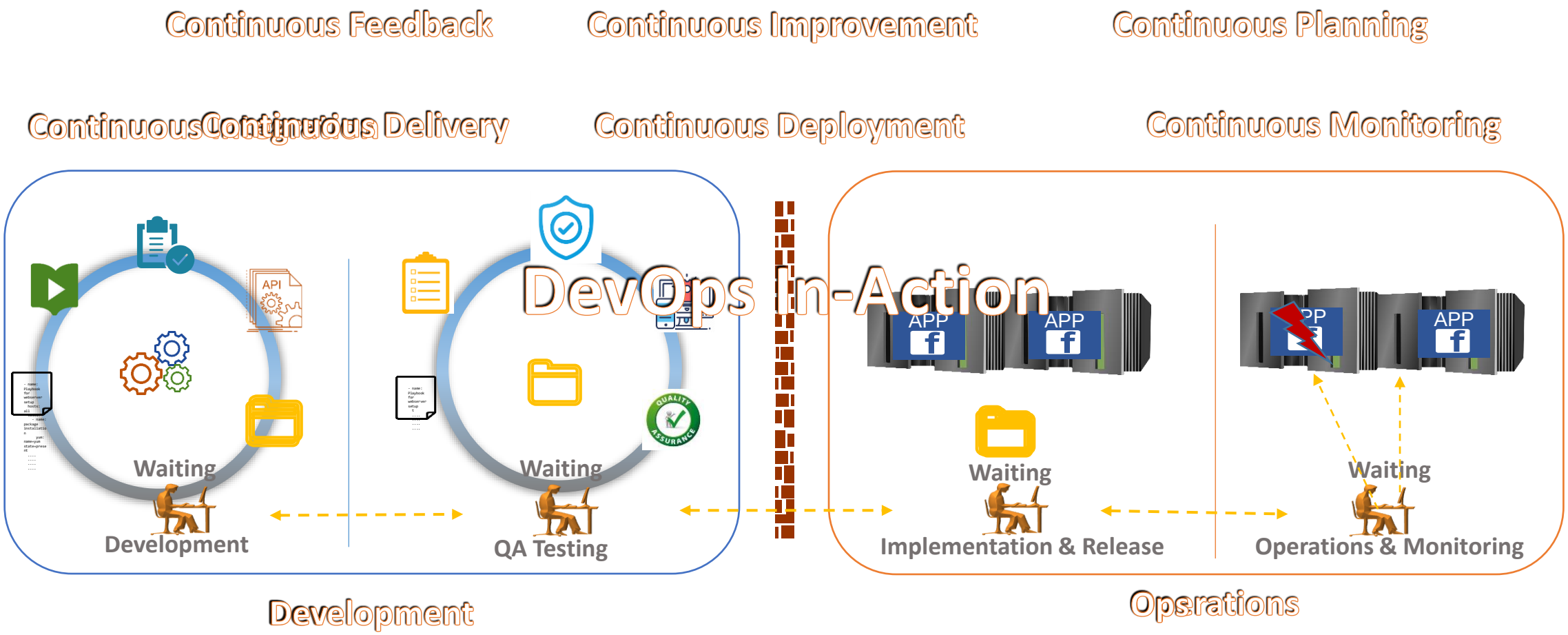
- **CLI (Command Line Interface)**
  - Best for Admin Experience
  - Easy management for Admin level tasks
  - Bad for end user experience
  - Bad for maintaining desired state and consistency

- **IaC (Infrastructure as Code)**
  - Best for Admin Experience
  - Easy management for Admin tasks
  - Easy to understand for end users too
  - Can easily maintain consistency and desired state
  - Infrastructure is written in files, so can be versioned

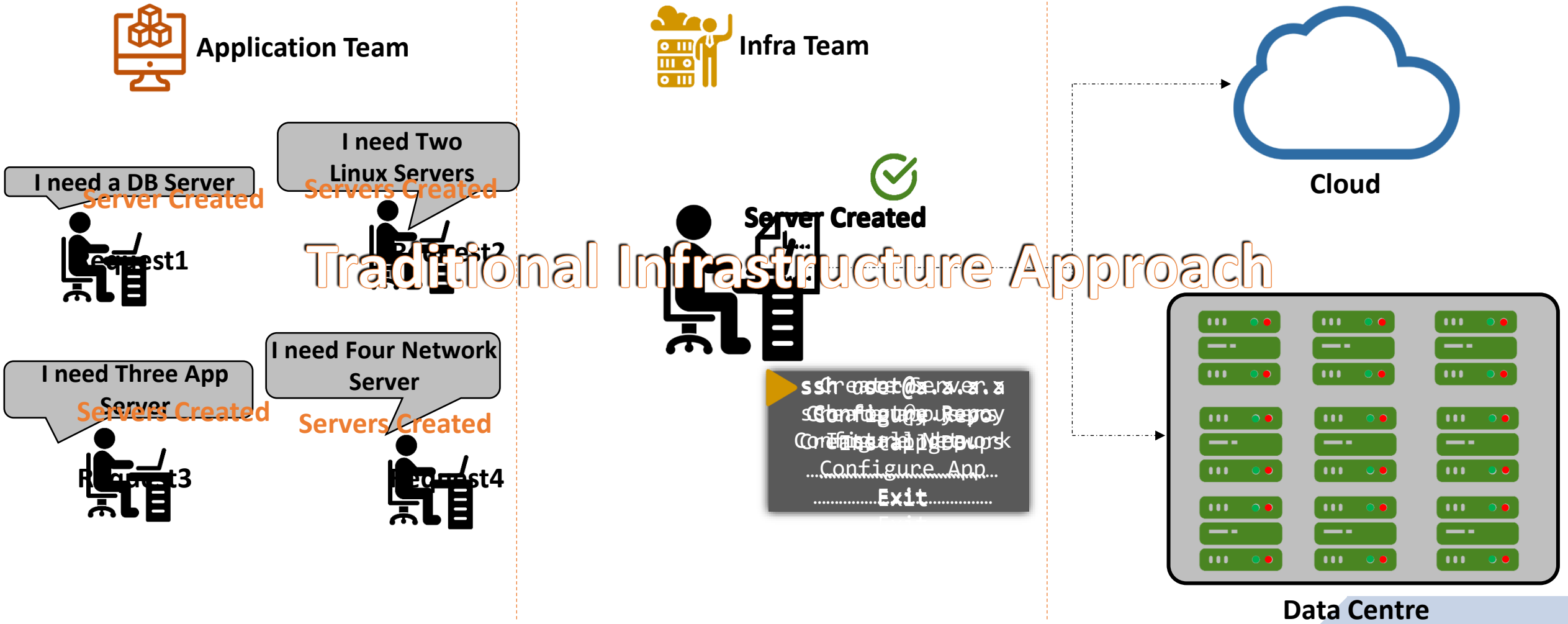
DevOps


Collaboration
Build
Test
Deploy
Communication
Project Management
DevOps Model
Continuity
Customer
Planning
Monitoring
Automation

DevOps in Action



Why DevOps IaC



Traditional Infrastructure Approach

IAC (Infrastructure as Code)

Application Team

I need DB Server

Server Created

Request1

I need Two Linux Servers

Servers Created

Request2

need Three Linux Servers

Servers Created

Request3

I need Four Linux Servers

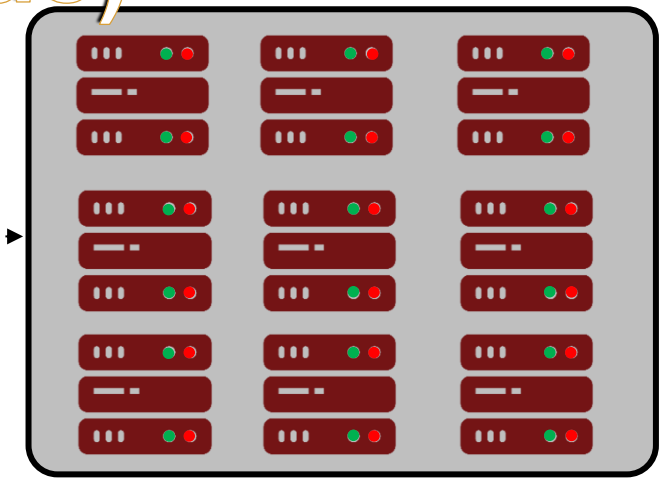
Servers Created

Request4

Infra Team

```
File is: main.tf
provider "aws" {
  region = "us-east-1"
}
resource "aws_instance" “requestfour" {
  count = "4"
  ami = "ami-03d5c68bab01f3496"
  instance_type = "t2.micro"
  tags = {
    Name = "DevOpsInAction"
  }
}
output "myawsserver" {
  value =
"${aws_instance.myawsserver.public_ip}"
}
```

Cloud



Data Centre

IaC is Managing Infrastructure in files rather than manually configuring resources in a user interface

Terraform

Terraform is an easy-to-use IT Orchestration & Automation Software for System Administrators & DevOps Engineers.

- It is the infrastructure as code offering from Hashicorp.
- It is a tool for building, changing, and managing infrastructure in a safe, repeatable way.
- Configuration language called the HashiCorp Configuration Language (HCL) is used to configure the Infrastructure.
- Compatible with almost all major public and private Cloud service provider

Terraform

Infrastructure as code (IAC)

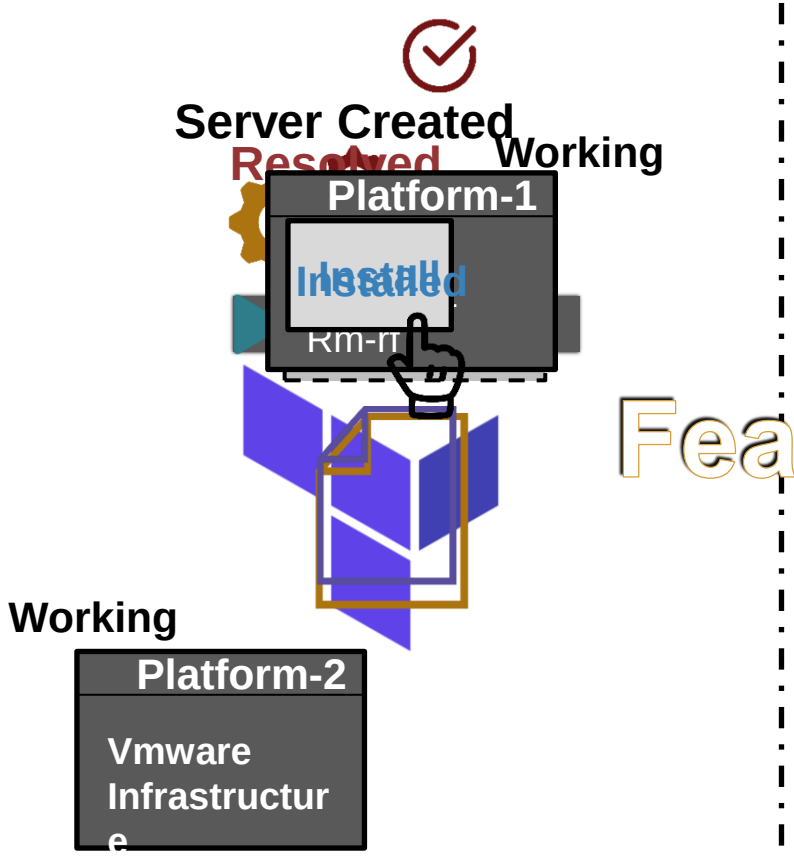
July 2014, HashiCorp

What is Terraform?

Opensource / Enterprise

HCL (Hashicorp Configuration Language)

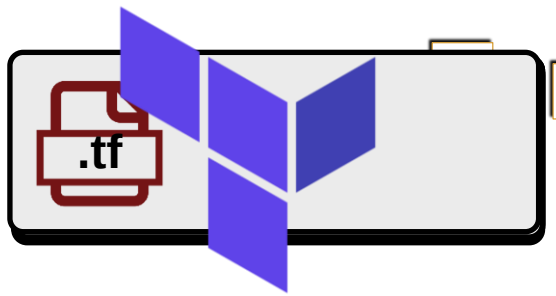
Terraform



Feature & Advantages

- Easy Installation
- Declarative in Nature
- Idempotent
- Intelligent Dependency Resolver
- Platform Agnostic
- Simple and easy to use

Terraform



Terraform Terminologies

Providers

Variables

Resources

Provisioners

DataSources

Outputs

Modules

File extension
.tf

Terraform

main.tf

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

Provider Block

```
resource "aws_instance" "myserver" {
  ami = "ami-030ff268bd7b4e8b5"
  instance_type = "t2.micro"
  tags = {
    Name = "DevOpsInAction"
  }
}
```

Resource Block

```
output "myserveroutputs" {
  description = "Display Servers Public IP"
  value = "${aws_instance.myserver.public_ip}"
}
```

Output Block

Terraform File (Sample Code)

Why Terraform?

- Infrastructure as Code – Write stuff in files, Version it, share it and collaborate with team on same.
- Declarative in Nature
- Automated provisioning
- Clearly mapped Resource Dependencies
- Can plan before you apply
- Consistent
- Compatible with multiple providers and infra can be combined on multiple providers
- 50+ list of official and verified providers
- Approx. 2500+ Modules readily available to work with
- Both Community and Enterprise versions available
- A best fit in DevOps IaC model

Why Terraform?

- **Platform Agnostic** – Manage Heterogeneous Environment
- **Perfect State Management** – Maintains the state and Refreshes the state before each apply action.

  Terraform state is the source of truth. If a change is made or a resource is appended to a configuration, Terraform compares those changes with the state file to determine what changes result in a new resource or resource modifications.
- **Confidence**: Due to easily repeatable operations and a planning phase to allow users to ensure the actions taken by Terraform will not cause disruption in their environment.

Terraform and its Peers

- Chef
- Puppet
- SaltStack
- Ansible
- CloudFormation
- Terraform
- Kubernetes

Terraform and its Peers

Many tools available in Market. Few things to consider, before selecting any tool:

- Configuration Management vs Orchestration
- Mutable Infrastructure vs Immutable Infrastructure
- Procedural vs Declarative

Terraform and its Peers

	Chef	Puppet	Ansible	SaltStack	CloudFormation	Terraform
Code	Open source	Open source	Open source	Open source	Closed source	Open source
Cloud	All	All	All	All	AWS only	All
Type	Config Mgmt	Config Mgmt	Config Mgmt	Config Mgmt	Orchestration	Orchestration
Infrastructure	Mutable	Mutable	Mutable	Mutable	Immutable	Immutable
Language	Procedural	Declarative	Declarative	Declarative	Declarative	Declarative
Architecture	Client/Server	Client/Server	Client-Only	Client/Server	Client-Only	Client-Only

Knowledge Checks

- What is Configuration Management?
- What is Orchestration?
- List a few available configuration Management tools.
- What are the Advantages of Terraform?

Summary: Terraform

Terraform is an easy-to-use IT Orchestration & Automation, Software for System Administrators & DevOps Engineers.

- Terraform is a tool for building, changing, and versioning infrastructure safely and efficiently.
- Terraform can manage existing and popular service providers as well as custom in-house solutions.
- Maintain Desired State
- Highly scalable and can create a complete datacenters in minutes
- Agentless solution
- Declaration in nature than Procedural
- Uses Providers API to provision the Infrastructure
- Terraform creates a dependency graph to determine the correct order of operations.

Installation of Terraform on AWS Env.

Terraform Fundamentals

Providers

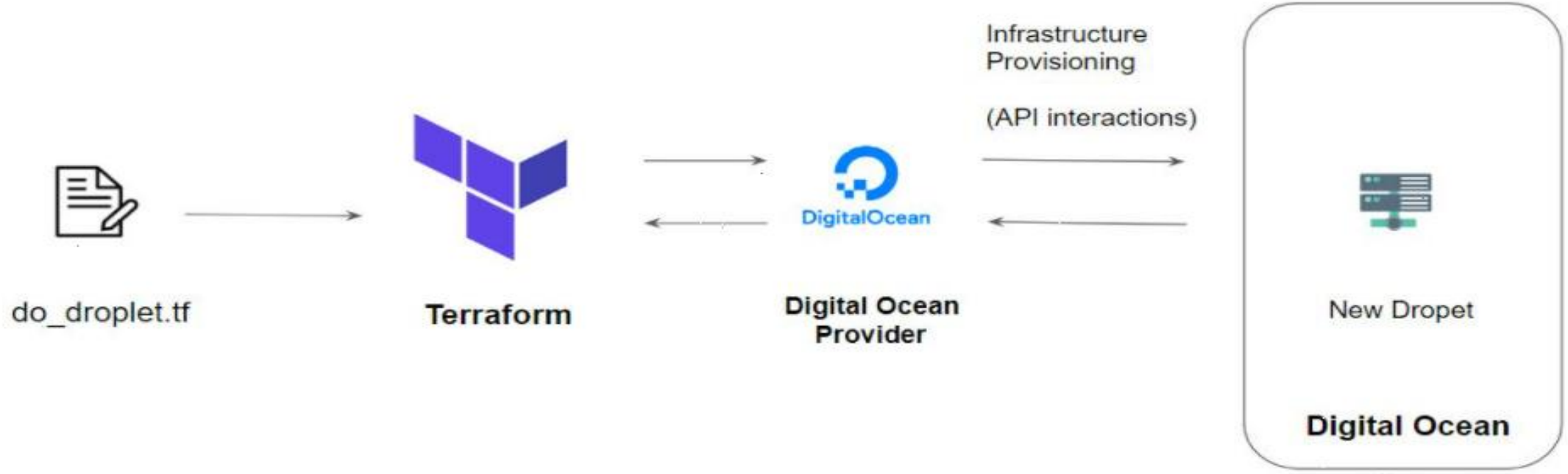
A provider is responsible for understanding API interactions and exposing resources over to a particular cloud service provider. Most providers configure a specific infrastructure platform (either cloud or self-hosted).

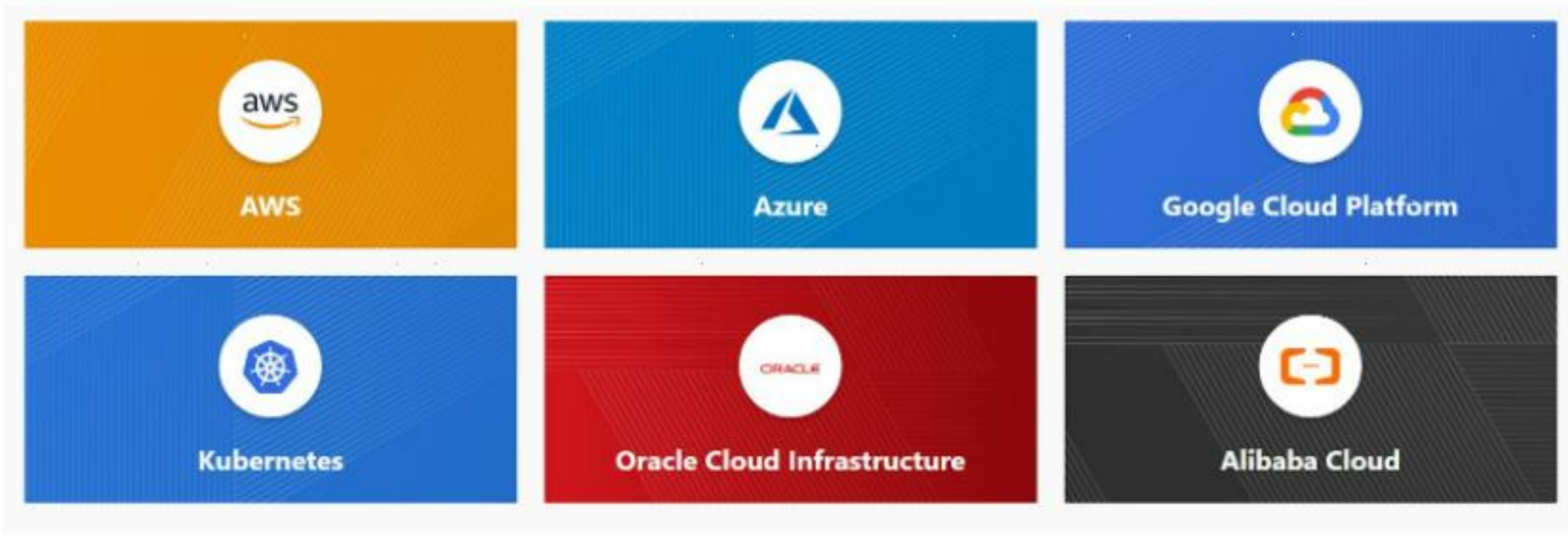
```
provider "aws" {
  region     = "us-east-2"
  access_key = "PUT-YOUR-ACCESS-KEY-HERE"
  secret_key = "PUT-YOUR-SECRET-KEY-HERE"
}
```

A provider is responsible for creating and managing resources.

https://registry.terraform.io/browse/providers

Overview of Provider Architecture :




aws
AWS
Azure
Google Cloud Platform
Kubernetes
ORACLE
Oracle Cloud Infrastructure
Alibaba Cloud

Resources

- Resources are the most important element in the Terraform language. Each resource block describes one or more infrastructure objects, such as virtual networks, compute instances, etc
- ```
  resource "aws_instance" "web" {
    ami           = "ami-a1b2c3d4"
    instance_type = "t2.micro"
  }
  ```

A resource block declares a resource of a given type ("aws_instance") with a given local name ("web"). The name is used to refer to this resource from elsewhere in the same Terraform module but has no significance outside that module's scope.

The resource type and name together serve as an identifier for a given resource and so must be unique within a module.

Resource names must start with a letter or underscore, and may contain only letters, digits, underscores, and dashes.
  ```

LAB 3: Creating first ec2 instance

..

- https://registry.terraform.io/providers/hashicorp/aws/latest/docs/resources/instance

Configuration files

- Whatever you want to achieve(deploy) using terraform will be achieved with configuration files.
- Configuration files ends with .tf extension (tf.json for json version).
- Terraform uses its own configuration language, designed to allow concise descriptions of infrastructure.
- The Terraform language is declarative, describing an intended goal rather than the steps to reach that goal.
- A group of resources can be gathered into a module, which creates a larger unit of configuration.
- As Terraform's configuration language is declarative, the ordering of blocks is generally not significant. Terraform automatically processes resources in the correct order based on relationships defined between them in configuration

Example

- You can write up the terraform code in hashicorp Language – HCL.
- Your configuration file will always endup with .tf extension

```
provider "aws" {
  region     = "us-east-2"
  access_key = "PUT-YOUR-ACCESS-KEY-HERE"
  secret_key = "PUT-YOUR-SECRET-KEY-HERE"
}

resource "aws_instance" "myec2" {
   ami = "ami-082b5a644766e0e6f"
   instance_type = "t2.micro"
}
  tags = {
    Name = "Techlanders-aws-ec2-instance"
  }
}
```

Terraform Workflow

Few Steps to work with terraform:

1) Set the Scope - Confirm what resources need to be created for a given project.
2) Author - Create the configuration file in HCL based on the scoped parameters
3) Run terraform init to initialize the plugins and modules
4) Run terraform validate to validate the template
5) Do terraform plan
6) Run terraform apply to apply the changes

Terraform validate

- Terraform validate will validate the terraform configuration file

- It'll through error for syntax issues:

```
[root@TechLanders aws]# terraform validate
Success! The configuration is valid.

[root@TechLanders aws]#
```

Terraform init

- Terraform init will initialize the modules and plugins.
- If you ever set or change modules or backend configuration for Terraform, rerun this command to reinitialize your working directory.
- If you forget running init, terraform plan/apply will remind you about initialization.
- Terraform init will download the connection plugins from Repository “registry.terraform.io” under your current working directory/.terraform:

```
[root@TechLanders plugins]# pwd
/root/aws/.terraform/plugins
[root@TechLanders plugins]# ls -l
total 4
drwxr-xr-x. 3 root root  23 Aug 15 07:06 registry.terraform.io
-rw-r--r--. 1 root root 136 Aug 15 07:06 selections.json
[root@TechLanders plugins]#
```

- Important concept:
  - Always make a best practice to initialize the terraform modules with versions. i.e.
    hashicorp/aws: version = "~> 3.2.0"

Example

- Perform Terraform Init:

```
[root@TechLanders aws]# terraform init

Initializing the backend...

Initializing provider plugins...
- Finding latest version of hashicorp/aws...
- Installing hashicorp/aws v3.2.0...
- Installed hashicorp/aws v3.2.0 (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 = "~> 3.2.0"

Terraform has been successfully initialized!

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.
[root@TechLanders aws]#
```

Terraform plan

- terraform plan will create an execution plan and will update you what changes it going to make.
- It'll update you upfront what its gonna add, change or destroy.
- Terraform will automatically resolve the dependency between components- which to be created first and which in last.

```
[root@TechLanders aws]# 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:
  # aws_instance.myserver will be created
  + resource "aws_instance" "myserver" {
      + ami                          = "ami-06b35f67f1340a795"
      + arn                          = (known after apply)
Plan: 1 to add, 0 to change, 0 to destroy.
```

Terraform apply

- Terraform apply will apply the changes.
- Before it applies changes, it'll showcase changes again and will ask to confirm to move ahead:

```
[root@TechLanders aws]# terraform apply
An execution plan has been generated and is shown below. Resource actions are indicated with the following symbols:
  + create
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.myserver: Creating...
aws_instance.myserver: Still creating... [10s elapsed]
aws_instance.myserver: Still creating... [20s elapsed]
aws_instance.myserver: Creation complete after 21s [id=i-0a63756c96d338801]
Apply complete! Resources: 1 added, 0 changed, 0 destroyed.
[root@TechLanders aws]#
```

Terraform apply

- Terraform apply will create **tfstate** file to maintain the desired state:

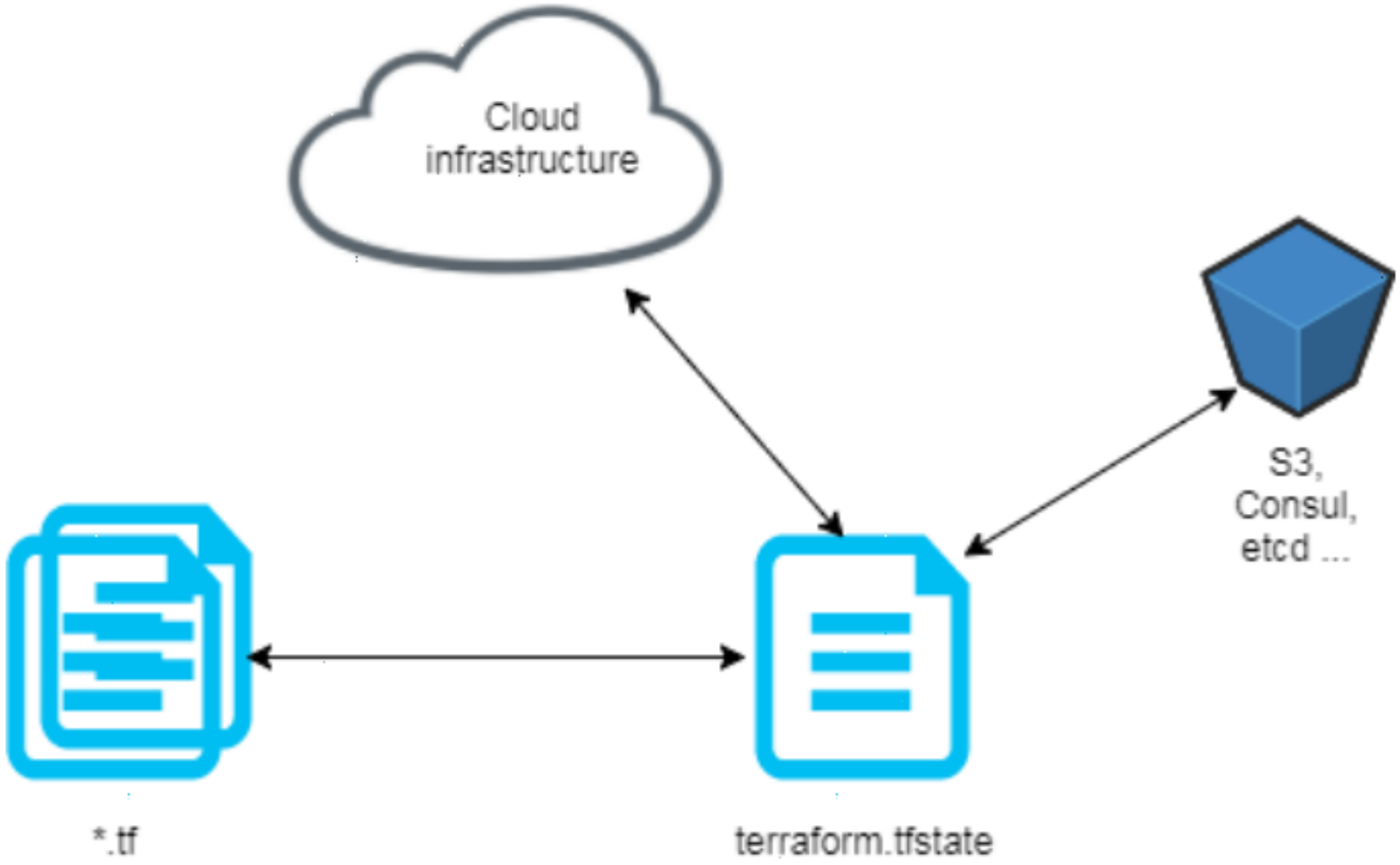
```
[root@TechLanders aws]# ls -l
total 8
-rw-r--r--. 1 root root  234 Aug 15 07:06 myinfra.tf
-rw-r--r--. 1 root root 3209 Aug 15 08:02 terraform.tfstate
[root@TechLanders aws]# cat terraform.tfstate
{
 "version": 4,
 "terraform_version": "0.13.0",
 "serial": 1,
 "lineage": "7f7e0e15-95ef-d8fa-b1cd-12024aed5fa6",
 "outputs": {},
 "resources": [
  "provider": "provider[\"registry.terraform.io/hashicorp/aws\"]",
    "instances": [
     {
       "schema_version": 1,
       "attributes": {
         "ami": "ami-06b35f67f1340a795",
         "arn": "arn:aws:ec2:us-east-2:677729060277:instance/i-0a63756c96d338801",
```

- Note: -auto-approve option can be given alongwith terraform apply to avoid the human intervention.

Terraform show

- Terraform show will show the current state of the environment been created by your config file:

```
[root@ip-172-31-6-233 aws]# terraform show
# aws_instance.myserver:
resource "aws_instance" "myserver" {
    ami                          = "ami-06b35f67f1340a795"
    arn                          = "arn:aws:ec2:us-east-2:677729060277:instance/i-0a63756c96d338801"
    associate_public_ip_address  = true
    availability_zone            = "us-east-2a"
    cpu_core_count               = 1
    cpu_threads_per_core         = 1
----
----
```


Cloud
infrastructure
S3,
Consul,
etcd ...
*.tf
terraform.tfstate

Desired State Maintenance (DSC)

- Delete the newly created server and then check for the terraform plan

```
[root@TechLanders aws]# 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.myserver: Refreshing state... [id=i-0a63756c96d338801]
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:
  # aws_instance.myserver will be created
  + resource "aws_instance" "myserver" {
```

- Run terraform apply command again and witness the provisioning of new server on console.

```
[root@TechLanders aws]# terraform apply
aws_instance.myserver: Refreshing state... [id=i-0a63756c96d338801]
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:
  # aws_instance.myserver will be created
```

Infrastructure as Code

- Modify your template file to change the instance size from t2.micro to t2.small and plan/apply the changes:

```
[root@TechLanders aws]# cat myinfra.tf
resource "aws_instance" "myserver" {
ami = "ami-06b35f67f1340a795"
instance_type = "t2.small"
}
[root@TechLanders aws]#
```

- Run terraform plan and apply again to check the differences

```
[root@TechLanders aws]# terraform apply
aws_instance.myserver: Refreshing state... [id=i-0a1f8a600cb968c7c]
An execution plan has been generated and is shown below.
Resource actions are indicated with the following symbols:
  ~ update in-place
Plan: 0 to add, 1 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_instance.myserver: Modifying... [id=i-0a1f8a600cb968c7c]
```

Refreshing the state

- In case the requirement is to just check for any updates been done in the running environment, we can run terraform refresh command:

```
C:\Users\gagandeep\Desktop\terraform>terraform refresh

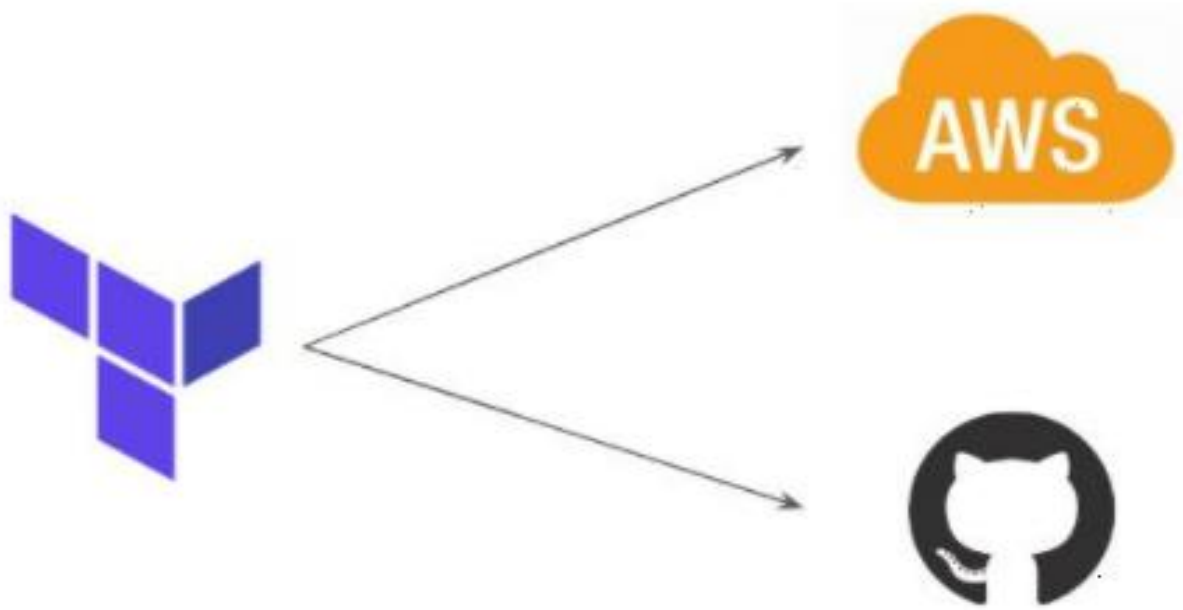
google_compute_network.vpc_network: Refreshing state... [id=projects/accenture-286519/global/networks/terraform-net3]

google_compute_address.vm_static_ip: Refreshing state... [id=projects/accenture-286519/regions/us-central1/addresses/terraform-static-ip1]

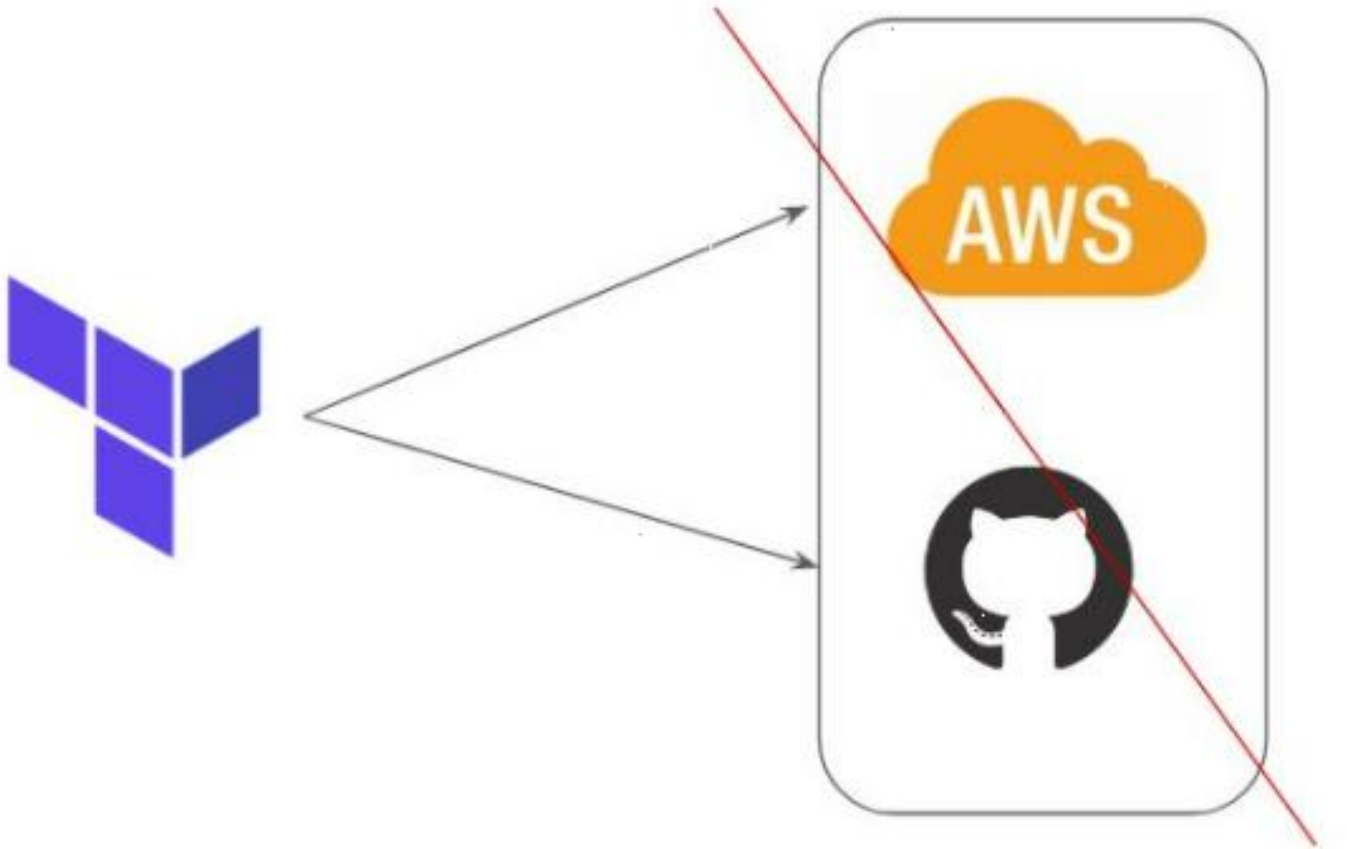
google_compute_instance.vm_instance1: Refreshing state... [id=projects/accenture-286519/zones/us-central1-b/instances/terraform-instance1]


C:\Users\gagandeep\Desktop\terraform>
```

Lab 4: Working with other providers ..



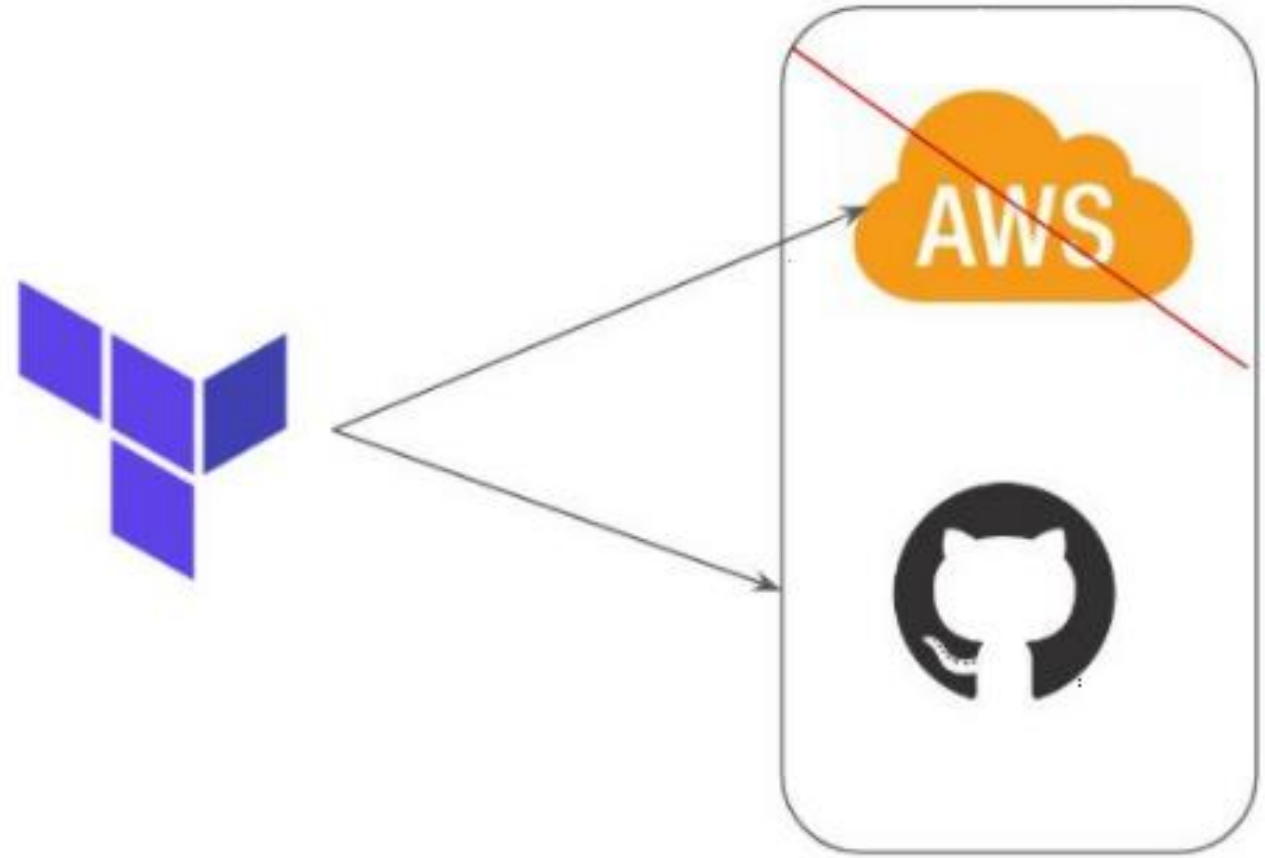
Destroying Infra in one go :



Destroying Infra in one go

- Terraform destroy will destroy the infrastructure in one go by using your tfstate file.

```
[root@TechLanders aws]# terraform destroy
aws_instance.myserver: Refreshing state... [id=i-0a1f8a600cb968c7c]
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:
  # aws_instance.myserver will be destroyed
  - resource "aws_instance" "myserver" {
      - ami  = "ami-06b35f67f1340a795“
 Enter a value: yes
aws_instance.myserver: Destroying... [id=i-0a1f8a600cb968c7c]
aws_instance.myserver: Still destroying... [id=i-0a1f8a600cb968c7c, 10s elapsed]
aws_instance.myserver: Still destroying... [id=i-0a1f8a600cb968c7c, 20s elapsed]
aws_instance.myserver: Destruction complete after 29s
Destroy complete! Resources: 1 destroyed.
```


AWS

Destroying Infra

- Terraform destroy can also delete selected resources given with –target option and can also be auto-approved with –auto-approve option. But it is always recommended to modify the configuration file instead of –target.

terraform destroy -target github_repository.repo

github_repository.repo: Refreshing state... [id=terraform-repo]

Terraform used the selected providers to generate the following execution plan. Resource actions are indicated with the following symbols:

- destroy

Terraform will perform the following actions:

github_repository.repo will be destroyed

- resource "github_repository" "repo" {

- allow_auto_merge = false -> null

, which means that the result of this plan may not represent all of the changes requested by the current configuration.

The -target option is not for routine use and is provided only for exceptional situations such as recovering from errors or mistakes, or when Terraform specifically suggests to use it as part of an error message.

Note: Multiple –target options are supported as well.

Lab 5 : Desired ,current state and last known configuration ..

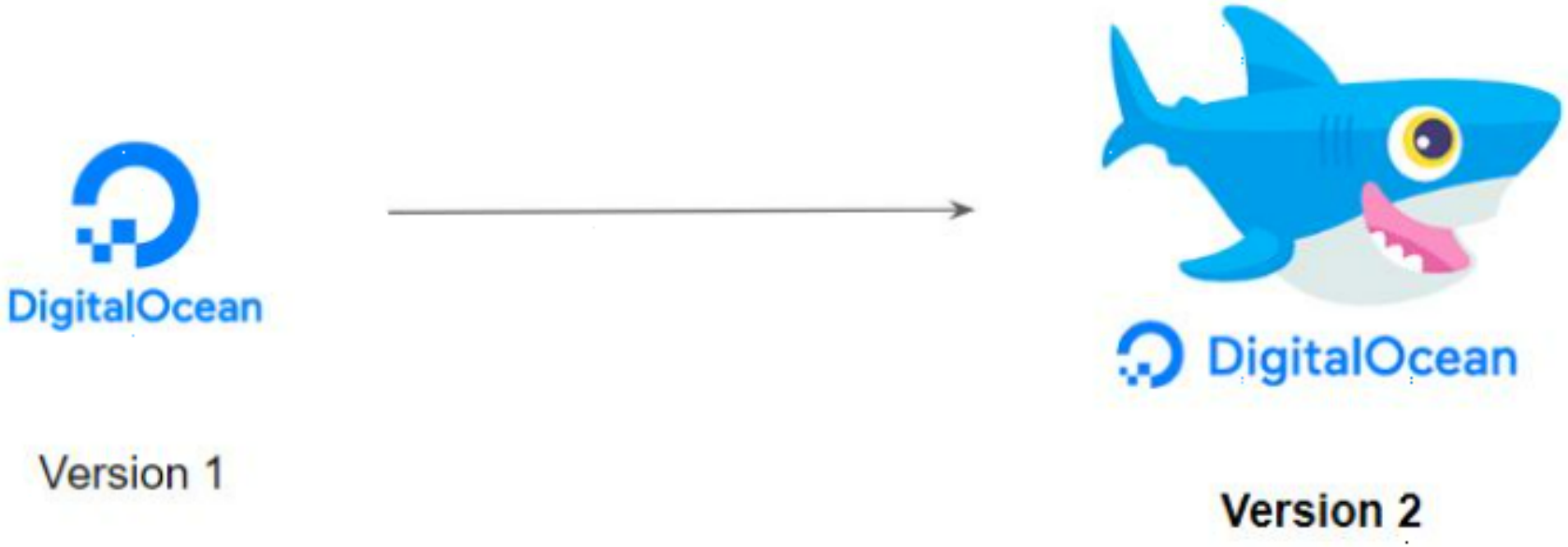
Terraform tries to ensure that the deployed infrastructure is based on the desired state.

If there is a difference between the two, terraform plan presents a description of the changes necessary to achieve the desired state.

LAB 6:CHALLENGE WITH DESIRED AND CURRENT STATE ..

Provider plugins are released separately from Terraform itself.

They have a different set of version numbers.



PROVIDER VERSIONING :

- Different Version Parameters :
- version = "2.7"
- version = ">= 2.8“
- version = “~> 2.x”
- version = "<= 2.8"
- version = ">=2.10,<=2.30"

LAB 7: PROVIDER VERSIONING ..

Output from a run

Terraform provides output for every run and same can be used to list the resources details which are created using help of Terraform:

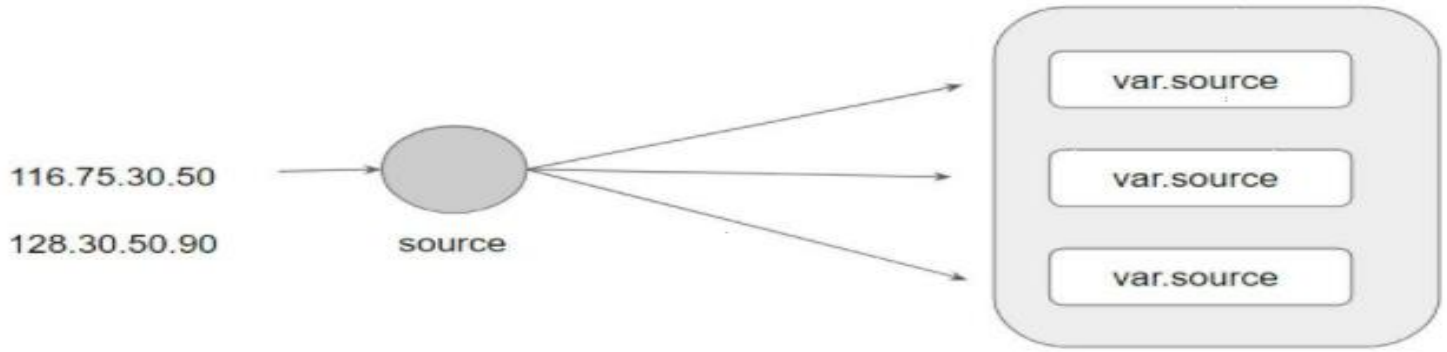
```
output "myawsserver-ip" {
  value = [aws_instance.myawsserver.public_ip]
}
```

LAB 8 : EC2 instance with output value ..

Variables

Repeated static values can create more work in the future.

Terraform Variables allows us to centrally define the values that can be used in multiple terraform configuration blocks.



Lab 9: Variables ..

Variables

- Variables can be of different types, based on terraform versions:
  - Strings

```
variable "project" {
 type = string }
```

  - Numbers

```
variable "web_instance_count" {
 type    = number
 default = 1 }
```

  - Lists

```
variable "cidrs" { default = ["10.0.0.0/16”] }
```

  - Maps

```
variable "machine_types" {
 type    = map
 default = {
  dev  = "f1-micro"
  test = "n1-highcpu-32"
  prod = "n1-highcpu-32"
 }
```

LAB 10: Different Approaches for Variable Assignment ..

Variables

- Variables can be assigned via different ways:
  - Via UI (if no default value is set in variable.tf)

    *Via variable.tf default value

    *Via .tfvars file (terraform.tfvars or custom.tfvars)
  - Via command line flags:

    terraform plan -var="instancetype=t2.small"

    terraform plan -var-file="custom.tfvars“

Variables Definition Precedence

Terraform loads variables in the following order, with later sources taking precedence over earlier ones:

- Environment variables
- The terraform.tfvars file, if present.
- The terraform.tfvars.json file, if present.
- Any *.auto.tfvars or *.auto.tfvars.json files, processed in lexical order of their filenames.
- Any -var and -var-file options on the command line, in the order they are provided. (This includes variables set by a Terraform Cloud workspace.)

Lab 11: Variables

1) Declare AMI as variable and use same in your aws_instance resource

2) Define the value of AMI(with AMIID) inside terraform.tfvars file

3) terraform plan

4) Rename terraform.tfvars with abc.tfvars

5) Run terraform plan again

6) Run terraform plan with -var-file=abc.tfvars and see the outputs

7) Run terraform plan with -var ami="AMI_ID"

Executions

```
[root@main-tf app1]# terraform plan -var-file="abc.tfvars"

Terraform used the selected providers to generate the following execution plan. Resource actions are indicated
with the following symbols:
  + create

Terraform will perform the following actions:

  # aws_instance.myawsserver will be created
  + resource "aws_instance" "myawsserver" {
      + ami                          = "ami-064ff912f78e3e561"
```

LAB 12: Fetching data from map and list in variable ..

Working with change

Changes are of two types:

- Up-date In-place
- Disruptive

So always be careful with what you are adding/modifying

Update in-place

Update in-place will ensure your existing resources intact and modify the existing resources only. Here also based on what configuration is required to be changed, server may or may-not shutdown.

Making an update in your infra so that your resource state does not get affected.

(1 change)

LAB 13 :UPDATE IN PLACE ..

Update - Disruptive

Disruptive updates require a resource to be deleted and recreated.

For example, modifying the image type for an instance will require instance to be deleted and re-created.

Making an update in your infra so that your resource state does not get affected.

(1 change)

update Disruptive:

Making an update in your infra so that old resource gets terminated/destroyed and a new resource gets created/deployed

(1 add, 1 destroy)

LAB 14 :UPDATE DISRUPTIVE ..

LAB 15 : Changes outside of terraform

Changes which occurred outside of terraform are unwanted changes and if anything which is modified outside of terraform is detected, same will be marked in state files and will be corrected at next apply.

- Create a terraform code creating a server (code on next page)
- Run terraform show command to check current required state of infrastructure.
- Modify the tag through management console .
- Run terraform plan to check the behavior of terraform against the changes
- Check the terraform show command to view state file
- Check terraform refresh command to update the state frontend
- Run terraform apply to revert the changes
- Check the terraform refresh/show command as well as console again to validate the reversion of changes.

```
[root@main-tf app1]# cat fetch.tf
provider "aws" {
  region     = "us-east-2"
}

resource "aws_instance" "myec2" {
   ami = "ami-064ff912f78e3e561"
   instance_type = "t2.micro"
tags = {
Name = "raman-server"
}
}
```

COUNT and INDEXING :

Count is a meta-argument defined by the Terraform language. It can be used with modules and with every resource type. The count meta-argument accepts a whole number, and creates that many instances of the resource or module.

LAB 16 : COUNT

..