Terraform

Terraform

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Introduction

Your Name

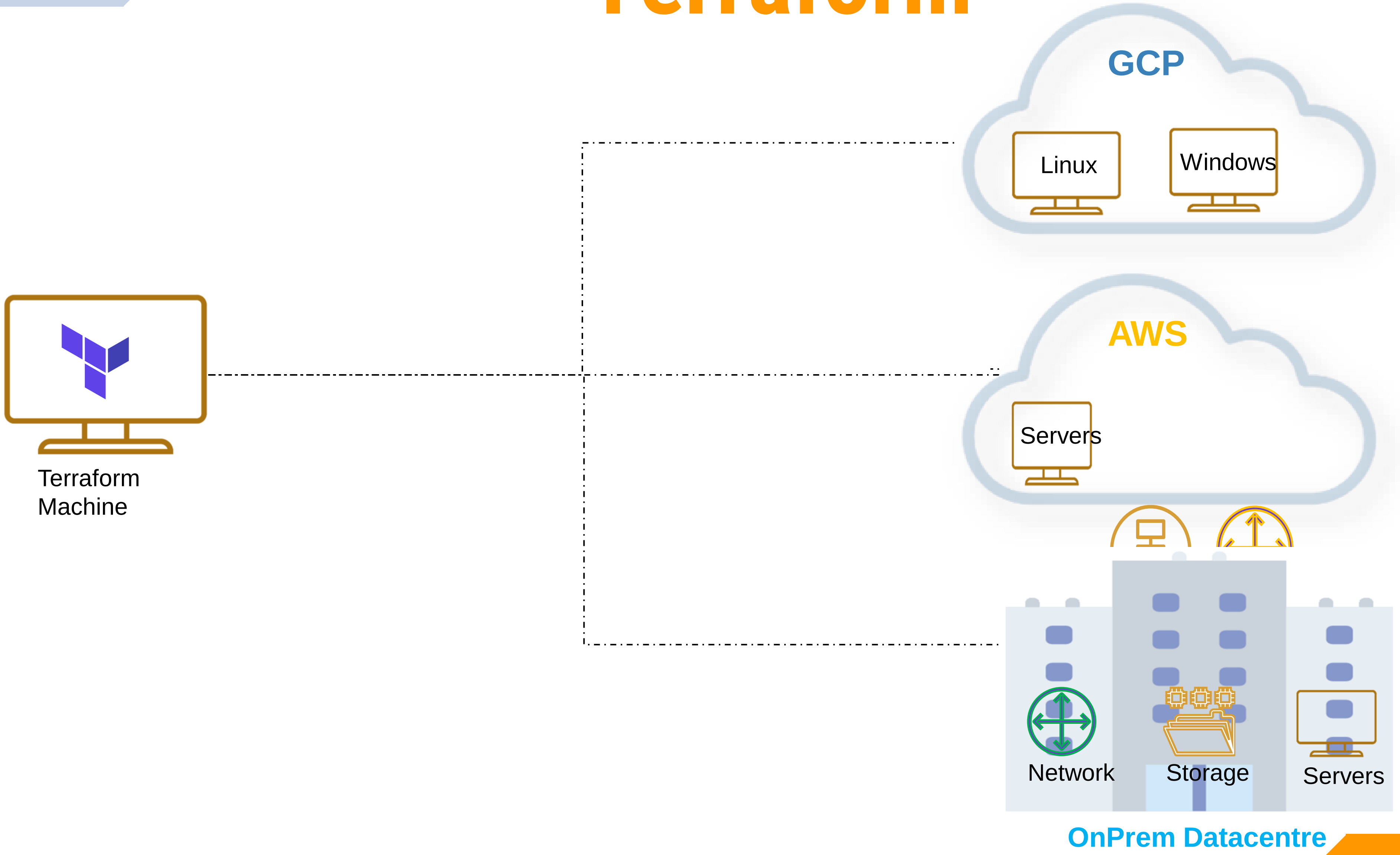
Total experience

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

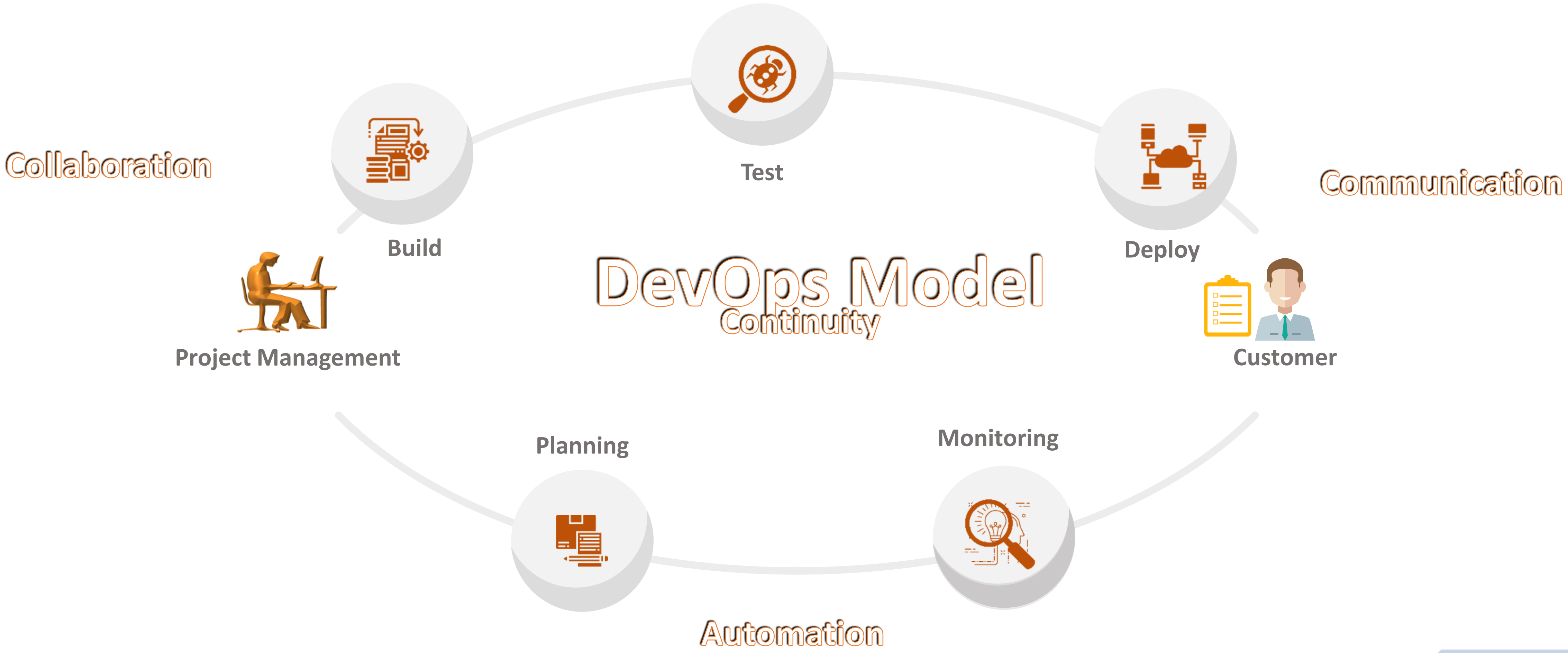
GUI vs CLI vs IAC

- **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

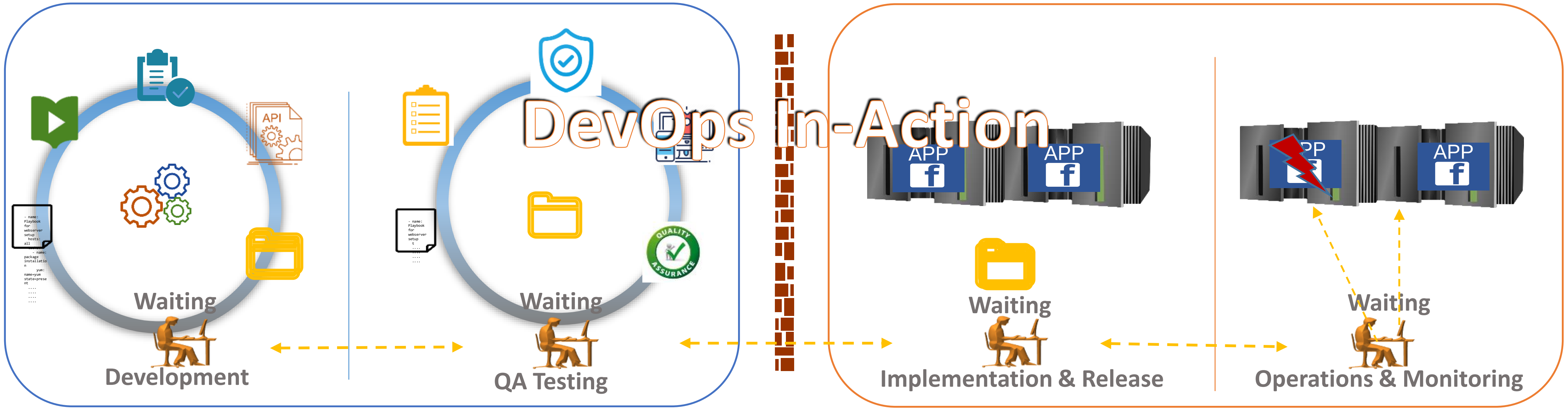
DevOps


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

DevOps in Action

Continuous Feedback Continuous Improvement Continuous Planning

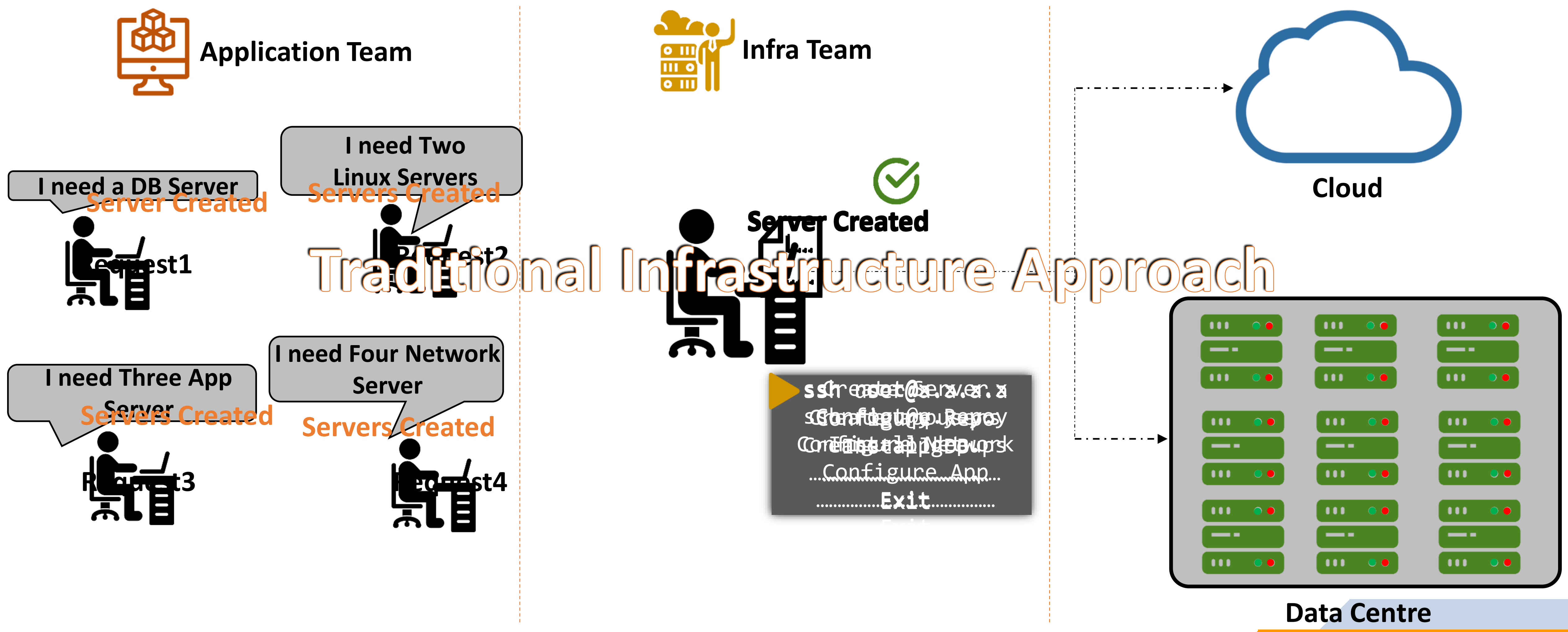
Continuous Integration Continuous Delivery Continuous Deployment Continuous Monitoring



Development

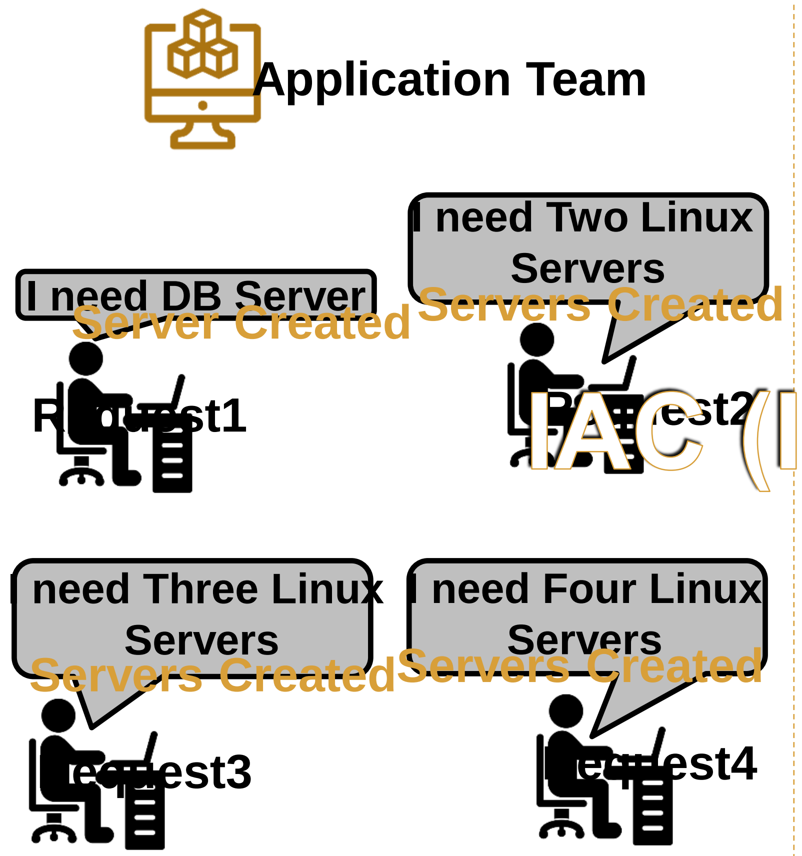
Operations

Why DevOps IaC



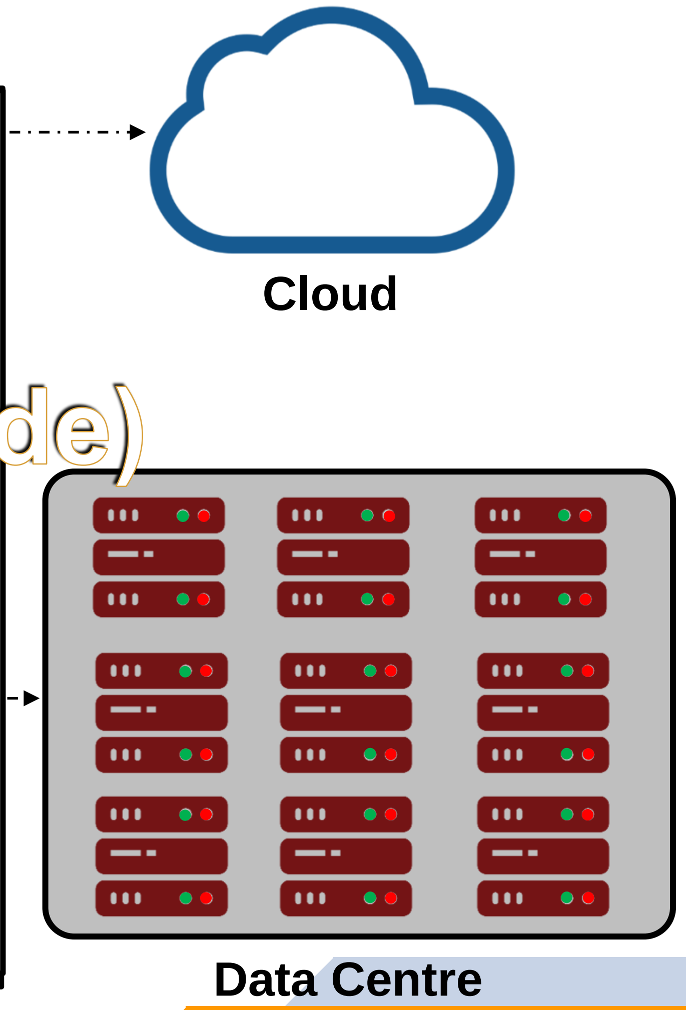
```
ssh user@x.x.x.x
Create Server
Configure Repo
Setup Repos
Configure Network
Install app
Create groups
Configure App
Exit
```

IAC (Infrastructure as Code)



Infra Team

```
File is: main.tf
provider "aws" {
  region = "us-east-1"
}
resource "aws_instance" “requestfour" {
  count = "4"
  ami = "ami-0c3[illegible]8b5"
  instance_type = "t2.micro"
  tags = {
    Name = "DevOpsInAction"
  }
}
output "myawsserver" {
  value =
"${aws_instance.myawsserver.public_ip}"
}
```



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

What is Terraform?

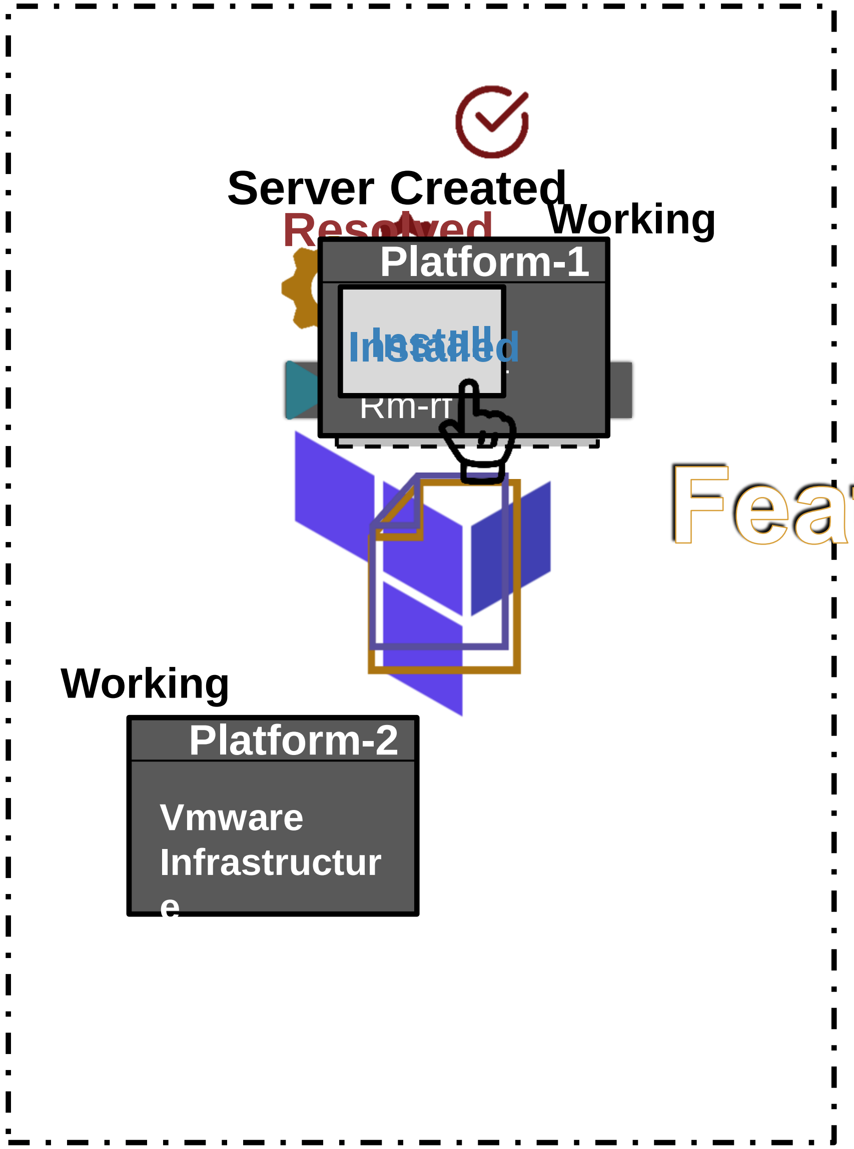
Infrastructure as code (IAC)

July 2014, HashiCorp

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

rraform Terminologies

Providers

Variables

Resources

Provisioners

DataSources

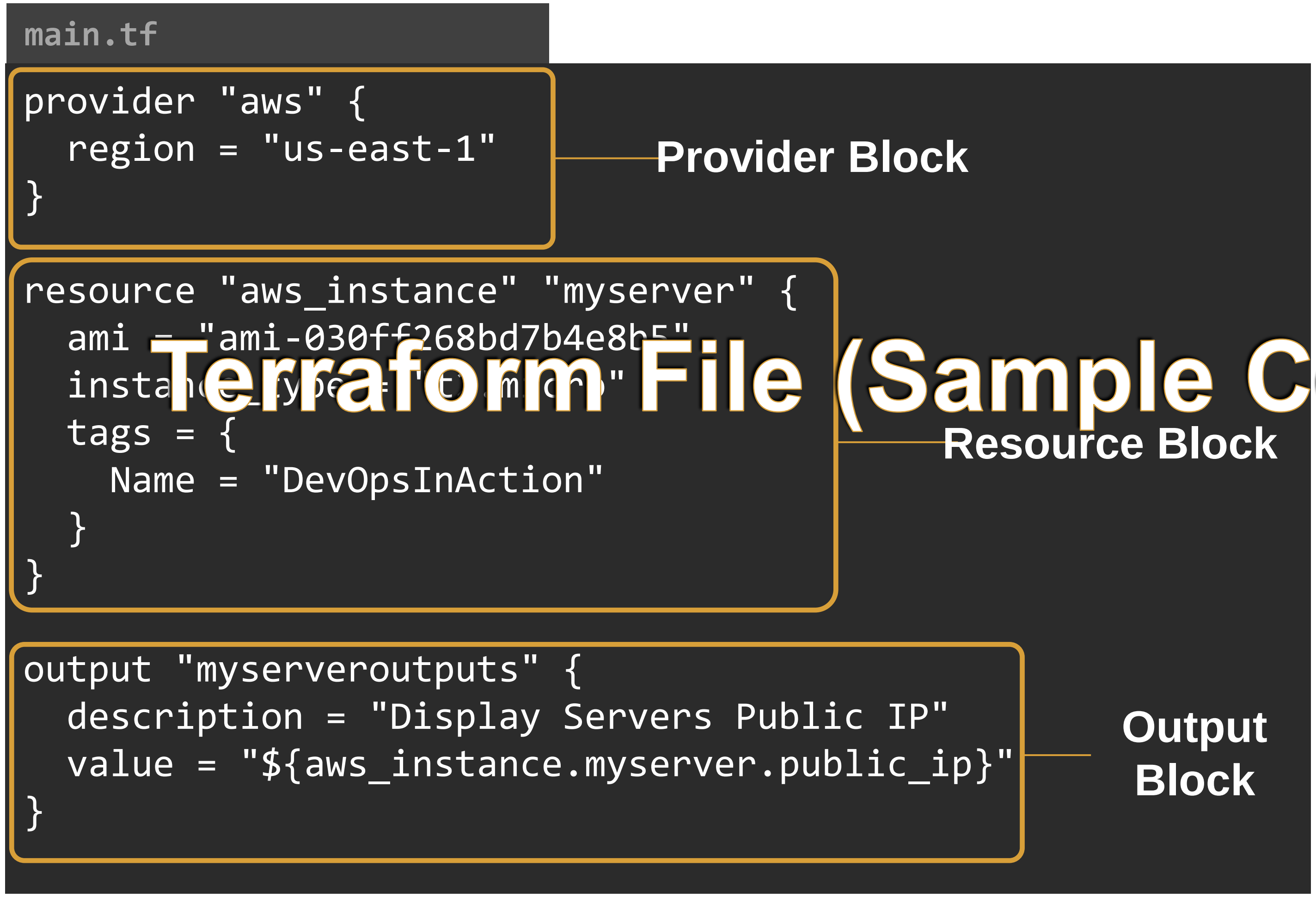
Outputs

Modules

File extension
.tf

Terraform

Terraform File (Sample Code)


main.tf

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

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

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

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

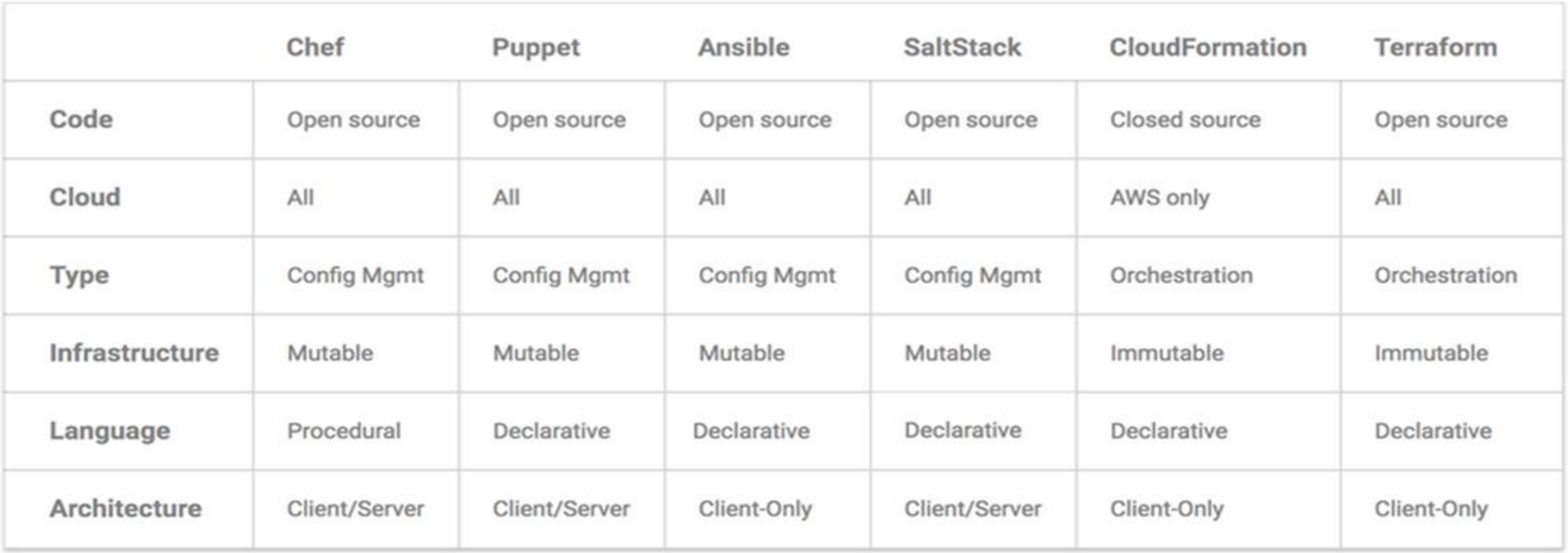
- Chef
- Puppet
- SaltStack
- Ansible
- CloudFormation
- Terraform
- Kubernetes

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.

AWS

Amazon Web Services

AWS (Amazon Web Services) is a group of web services (also known as cloud services) being provided by Amazon since 2006.

AWS provides huge list of services starting from basic IT infrastructure like CPU, Storage as a service, to advance services like Database as a service, Serverless applications, IOT, Machine Learning services etc..

Hundreds of instances can be build and use in few minutes as and when required, which saves ample amount of hardware cost for any organizations and make them efficient to focus on their core business areas.

Currently AWS is present and providing cloud services in more than 190 countries.

Well-known for IaaS, but now growing fast in PaaS and SaaS.

Why AWS?

Low Cost: AWS offers, pay as you go pricing. AWS models are usually cheapest among other service providers in the market.

Instant Elasticity: You need 1 server or 1000's of servers, AWS has a massive infrastructure at backend to serve almost any kind of infrastructure demands, with pay for what you use policy.

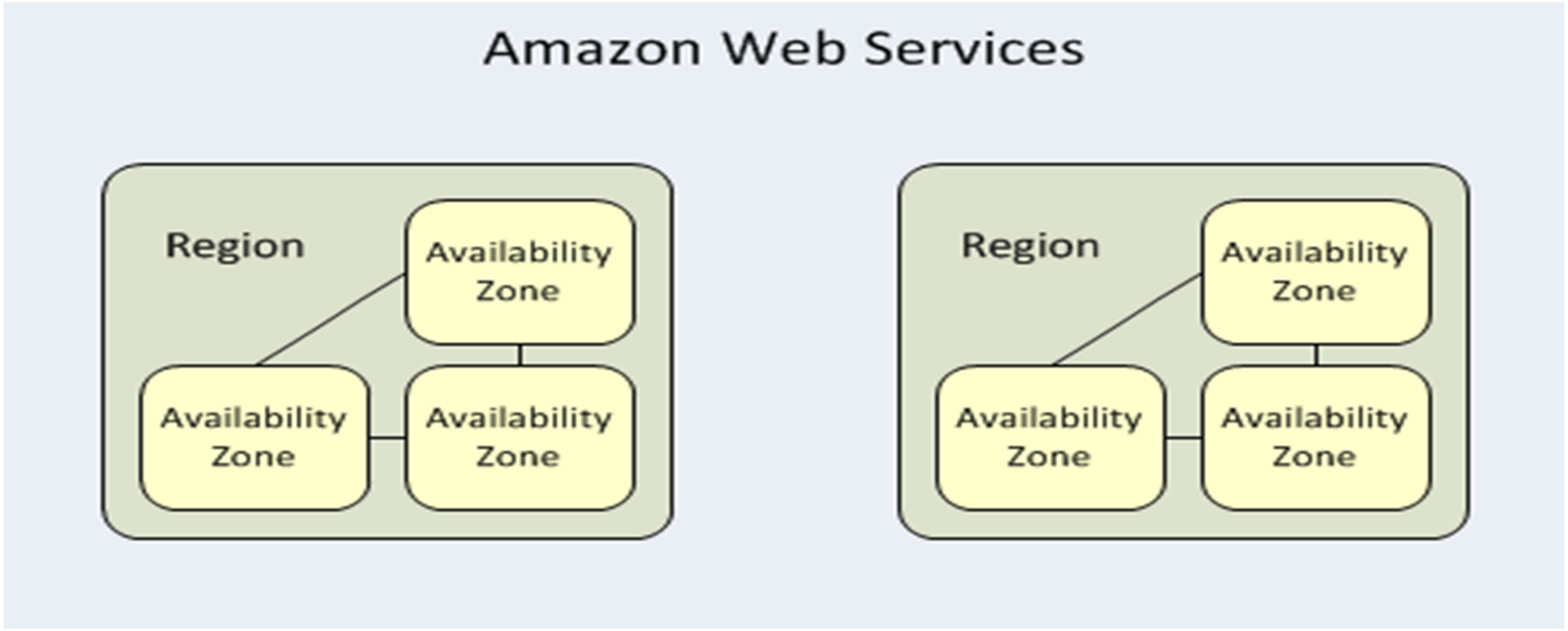
Scalability: Facing some resource issues, no problem within seconds you can scale up the resources and improve your application performance. This cannot be compared with traditional IT datacenters.

Multiple OS's: Choice and use any supported Operating systems.

Multiple Storage Options: Choice of high I/O storage, low cost storage. All is available in AWS, use and pay what you want to use with almost any scalability.

Secure: AWS is PCI DSS Level1, ISO 27001, FISMA Moderate, HIPAA, SAS 70 Type II passed. In-fact systems based on AWS are usually more secure than in-house IT infrastructure systems.

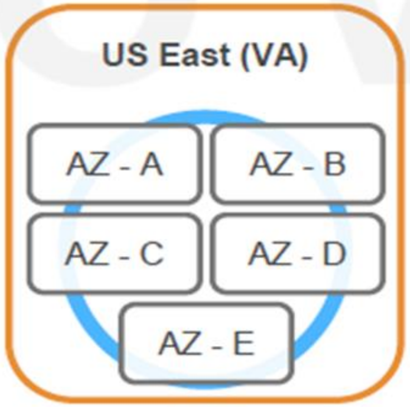
Amazon Web Services

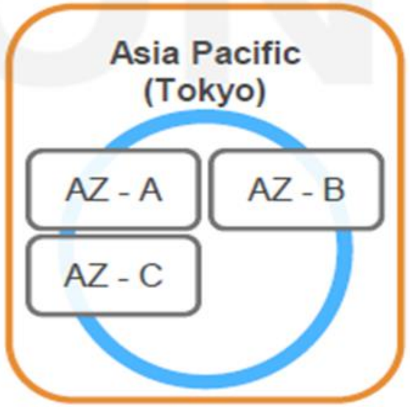


Amazon Web Services

At least 2 AZs per region.

- Examples:
  - US East (N. Virginia)
    - us-east-1a
    - us-east-1b
    - us-east-1c
    - us-east-1d
    - us-east-1e
  - Asia Pacific (Tokyo)
    - ap-northeast-1a
    - ap-northeast-1b
    - ap-northeast-1c





Note: Conceptual drawing only. The number of Availability Zones (AZ) may vary.

Amazon Web Services

AWS Regions:
-Geographic Locations
-Consists of at least two Availability Zones(AZs)
-All of the regions are completely independent of each other with separate Power Sources, Cooling and Internet connectivity.

AWS Availability Zones
-AZ is a distinct location within a region
-Each Availability Zone is isolated, but the Availability Zones in a Region are connected through low-latency links.
-Each Region has minimum two AZ's
-Most of the services/resources are replicated across AZs for HA/DR purpose.

Amazon Web Services

AWS Regions:

-Geographic Locations

-Consists of at least two Availability Zones(AZs)

-All of the regions are completely independent of each other with separate Power Sources, Cooling and Internet connectivity.

-This achieves the greatest possible fault tolerance and stability.

-There is a charge for data transfer between Regions.

-When you view your resources, you'll only see the resources tied to the Region you've specified.

-An AWS account provides multiple Regions so that you can launch Amazon EC2 instances in locations that meet your requirements. For example, you might want to launch instances in Europe to be closer to your European customers or to meet legal requirements.

-Resources aren't replicated across regions unless you do so specifically.

Amazon Web Services

AWS Availability Zones

-AZ is a distinct location within a region

-Each Availability Zone is isolated, but the Availability Zones in a Region are connected through low-latency links.

-Each Region has minimum two AZ’s

-Most of the services/resources are replicated across AZs for HA/DR purpose.

-While launching instance you should specify an Availability Zone if your new instances must be close to, or separated from, your running instances.

Amazon Web Services

Current:

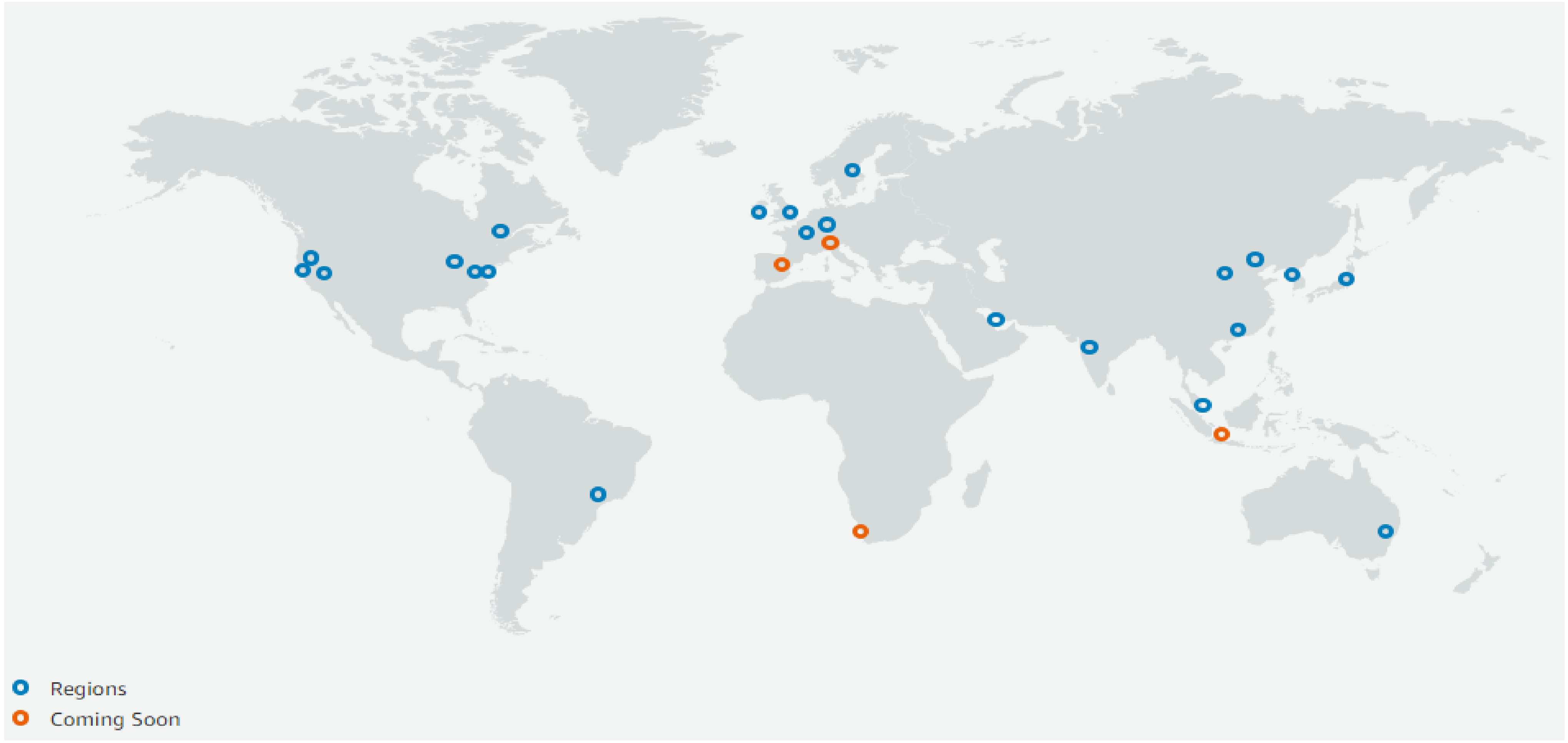
22 AWS Regions

69 AZs

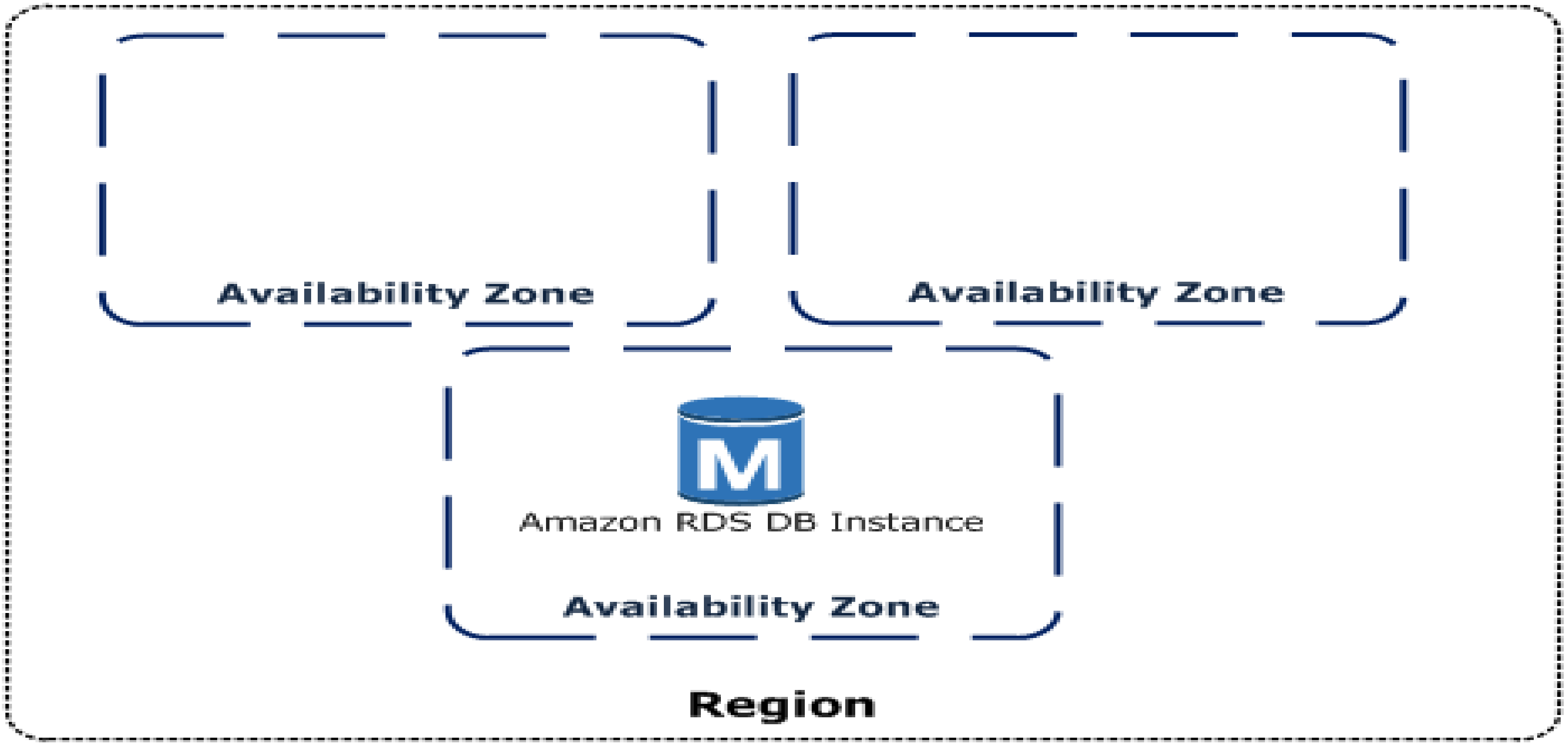
Upcoming:

4 Regions

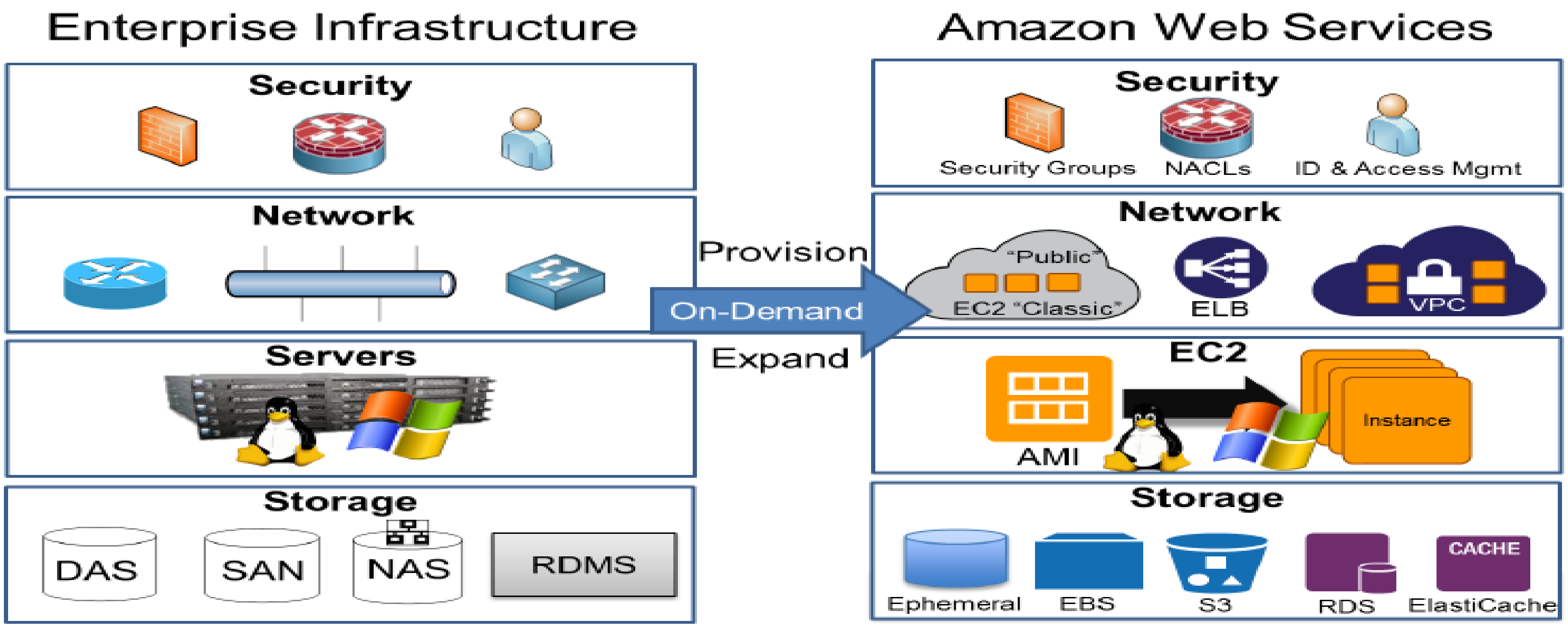
13 AZs



Amazon Web Services



AWS


Enterprise Infrastructure
Security
Network
Servers
Storage
DAS
SAN
NAS
RDMS
Provision
On-Demand
Expand
Amazon Web Services
Security
Security Groups
NACLs
ID & Access Mgmt
Network
"Public"
EC2 "Classic"
ELB
VPC
EC2
AMI
Instance
Storage
Ephemeral
EBS
S3
RDS
CACHE
ElastiCache

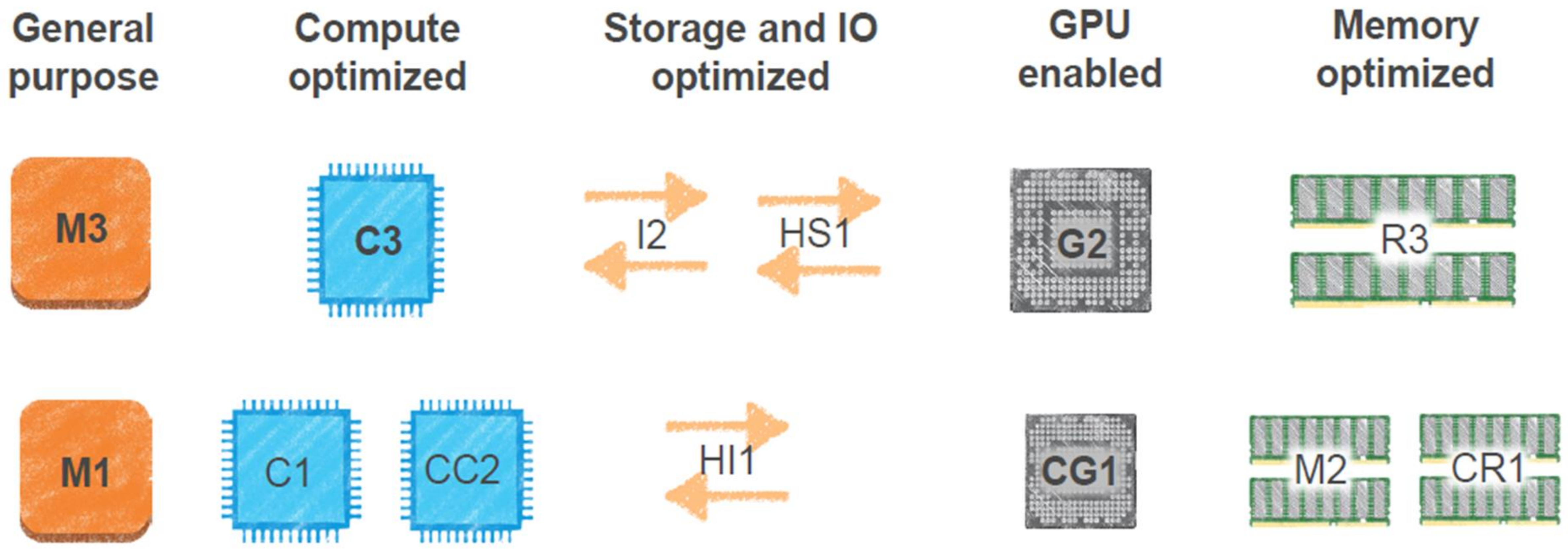
AWS
Compute Services

AWS Elastic Compute Cloud

- Amazon EC2 stands for Elastic Compute Cloud, and is the Primary AWS web service.
- Provides Resizable compute capacity
- Reduces the time required to obtain and boot new server instances to minutes
- There are two key concepts to Launch instances in AWS:
  - Instance Type
  - AMI

- EC2 Facts:
  - Scale capacity as your computing requirements change
  - Pay only for capacity that you actually use
  - Choose Linux or Windows OS as per need. You have to Manage the OS and Security of same.
  - Deploy across AWS Regions and Availability Zones for reliability/HA

AWS EC2


General purpose
Compute optimized
Storage and IO optimized
GPU enabled
Memory optimized
M3
C3
I2
HS1
G2
R3
M1
C1
CC2
HI1
CG1
M2
CR1

EC2 Security Group

Security Group is a Virtual Firewall Protection.

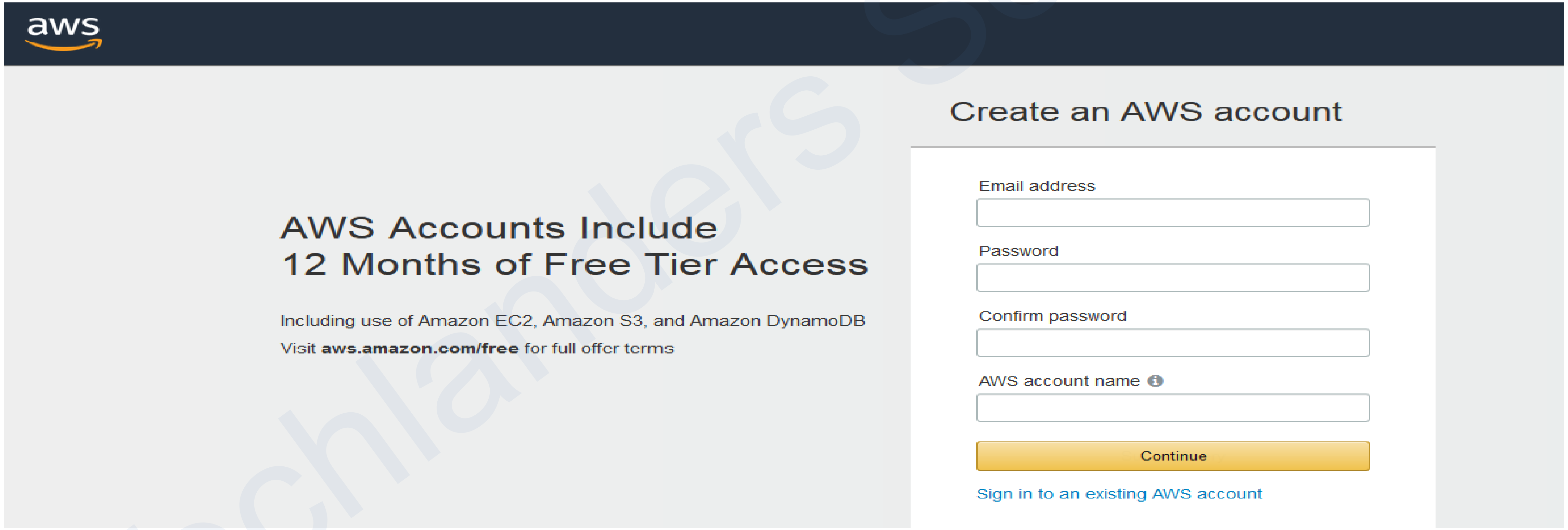
AWS allows you to control traffic in and out of your instances through virtual firewalls called security groups.

Security groups allow you to control traffic based on port, protocol, and source(inbound)/destination(outbound).

Security groups are associated with instances when they are launched. Every instance must have at least one security group. Though they can have more.

A security group is default deny.

LAB 1



Create an AWS account

Email address

Password

Confirm password

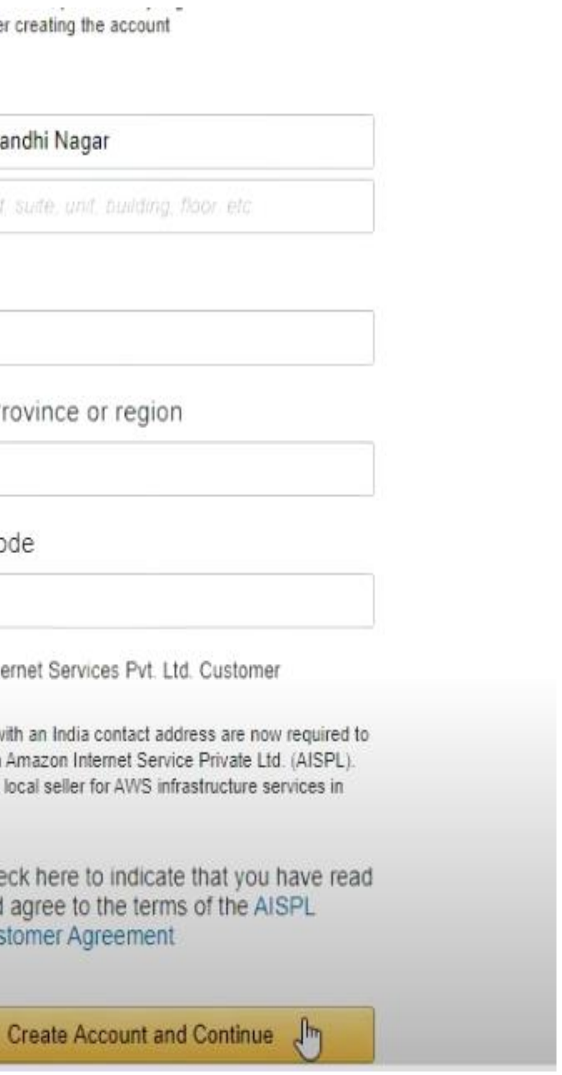
AWS account name

Continue

Sign in to an existing AWS account

AWS Accounts Include
12 Months of Free Tier Access

Including use of Amazon EC2, Amazon S3, and Amazon DynamoDB
Visit **aws.amazon.com/free** for full offer terms



er creating the account

andhi Nagar

t, suite, unit, building, floor, etc

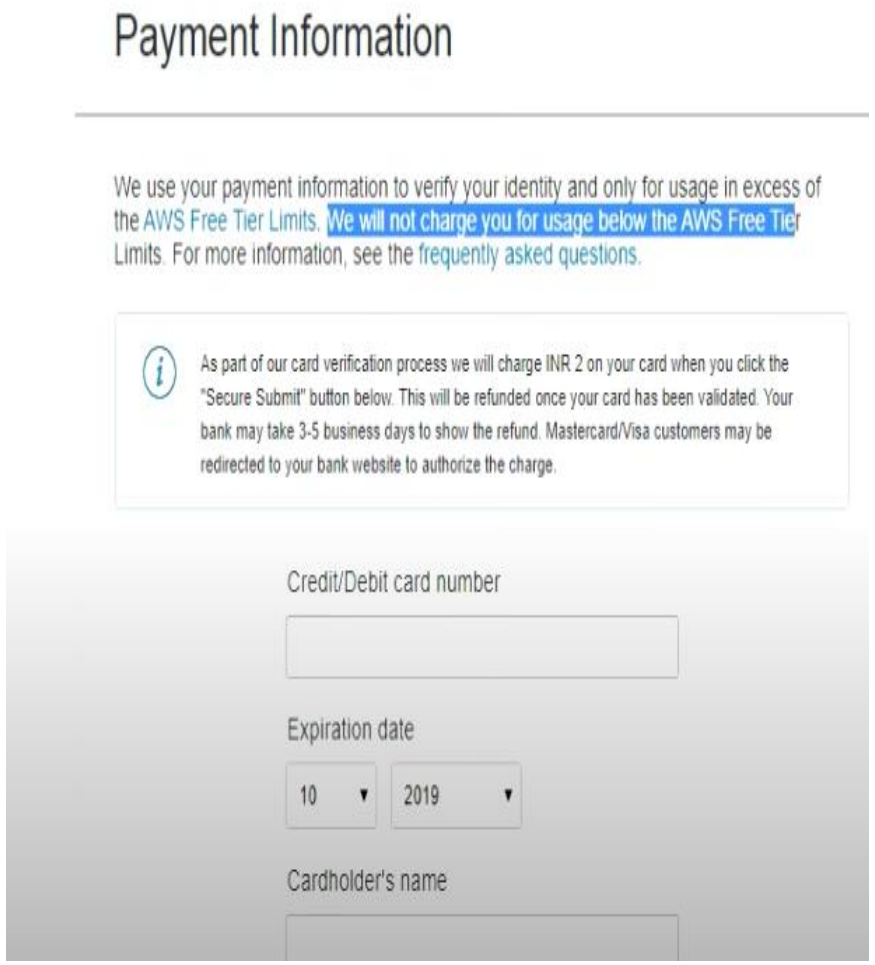
rovince or region

ode

ernet Services Pvt. Ltd. Customer

vith an India contact address are now required to
Amazon Internet Service Private Ltd. (AISPL).
local seller for AWS infrastructure services in

eck here to indicate that you have read
l agree to the terms of the AISPL
stomer Agreement



Payment Information

We use your payment information to verify your identity and only for usage in excess of the AWS Free Tier Limits. We will not charge you for usage below the AWS Free Tier Limits. For more information, see the frequently asked questions.

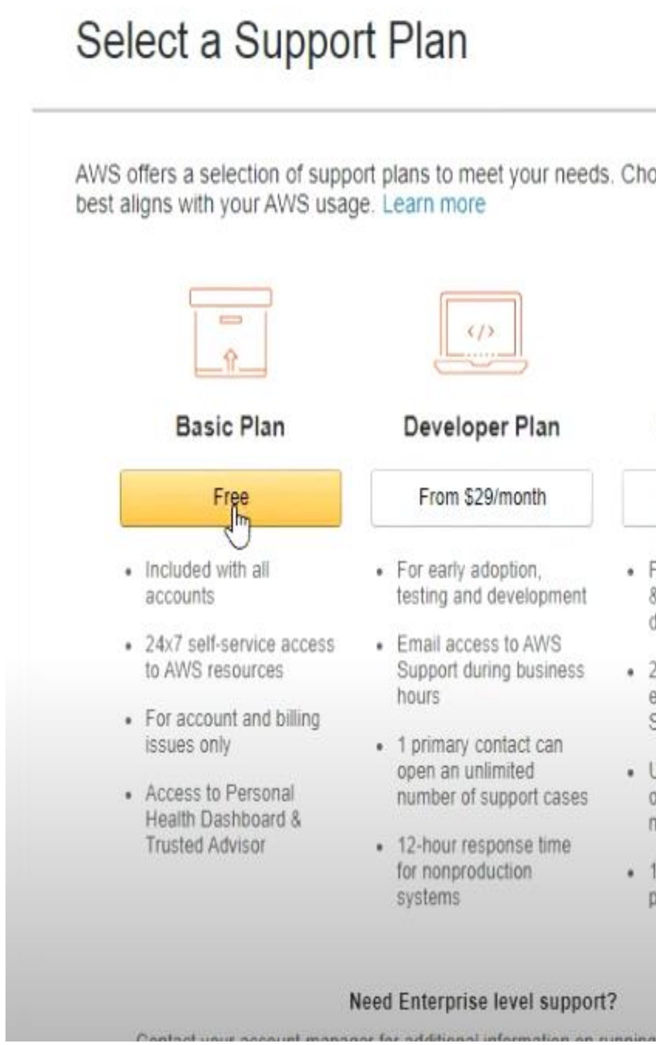
As part of our card verification process we will charge INR 2 on your card when you click the "Secure Submit" button below. This will be refunded once your card has been validated. Your bank may take 3-5 business days to show the refund. Mastercard/Visa customers may be redirected to your bank website to authorize the charge.

Credit/Debit card number

Expiration date

10 2019

Cardholder's name



Select a Support Plan

AWS offers a selection of support plans to meet your needs. Cho
best aligns with your AWS usage. Learn more

Basic Plan	Developer Plan
Free	From $29/month
• Included with all accounts • 24x7 self-service access to AWS resources • For account and billing issues only • Access to Personal Health Dashboard & Trusted Advisor	• For early adoption, testing and development • Email access to AWS Support during business hours • 1 primary contact can open an unlimited number of support cases • 12-hour response time for nonproduction systems

Need Enterprise level support?

Installation of Terraform on AWS Env.

Terraform Fundamentals

AWS CLI

AWS CLI

AWS CLI is a command based utility to manage AWS resources

The primary distribution method for the AWS CLI on Linux, Windows, and macOS is pip, a package manager for Python that provides an easy way to install, upgrade, and remove Python packages and their dependencies

http://docs.aws.amazon.com/cli/latest/userguide/installing.html

Requirements

- Python 2 version 2.6.5+ or Python 3 version 3.3+
- Windows, Linux, macOS, or Unix
- Pip package should be present (else install python-pip)

Install AWSCLI: pip install awscli --upgrade --user
For Windows, directly download the Windows installer from CLI webpage

AWS CLI

Lets install an AWSCLI
https://aws.amazon.com/cli

```
aws --version
```

```
aws help
```

```
aws ec2 help / aws s3 help / aws <anysubcommand> help
```

Configure your default keys and region:

```
root@ip-172-31-28-145:~# aws configure
AWS Access Key ID [None]: ###########
AWS Secret Access Key [None]: ###############
Default region name [None]: us-west-2
Default output format [None]:
root@ip-172-31-28-145:~#
```

LAB 2: AWS CLI

Check the details for all running instances using CLI

- aws ec2 describe-instances | grep -i instanceID

Creation of an AWS Instance using CLI:

- aws ec2 run-instances --image-id ami-05fa00d4c63e32376 --instance-type t2.micro --key-name raman
- aws ec2 stop-instances --instance-ids i-02fedc26aa77154a6
- aws ec2 terminate-instances --instance-ids i-02fedc26aa77154a6
- aws s3 ls
- aws iam list-users

Providers

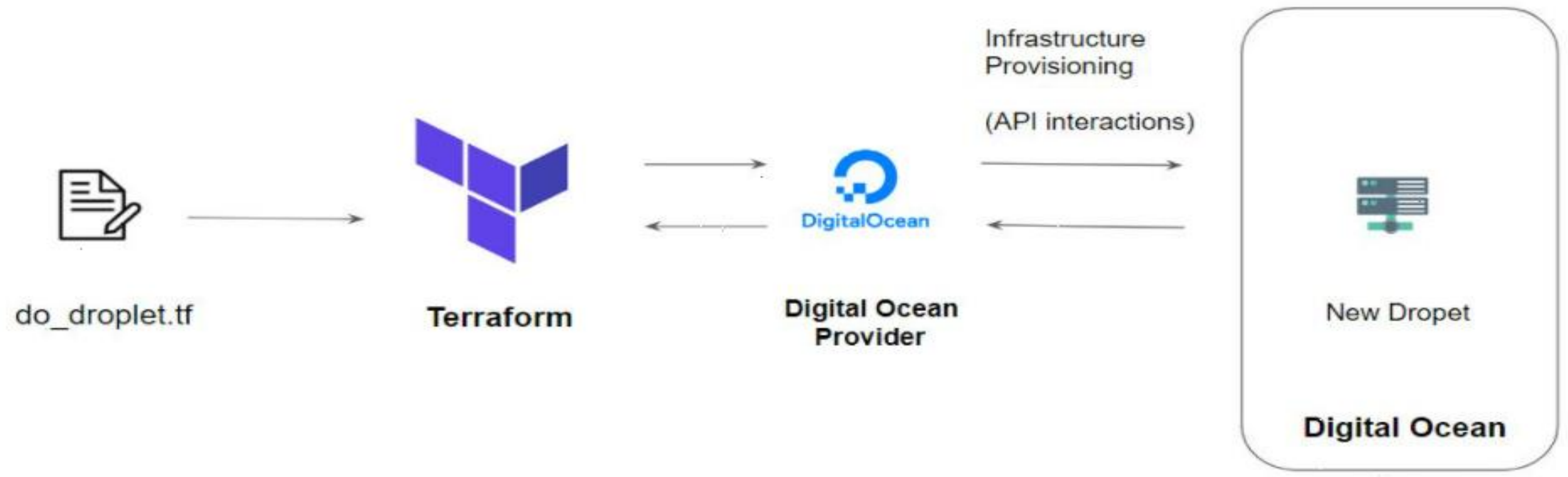
A provider is responsible for understanding API interactions and exposing resources over to a particular cloud service provider. Most providers configure a specific infrastructure platform (either cloud or self-hosted).

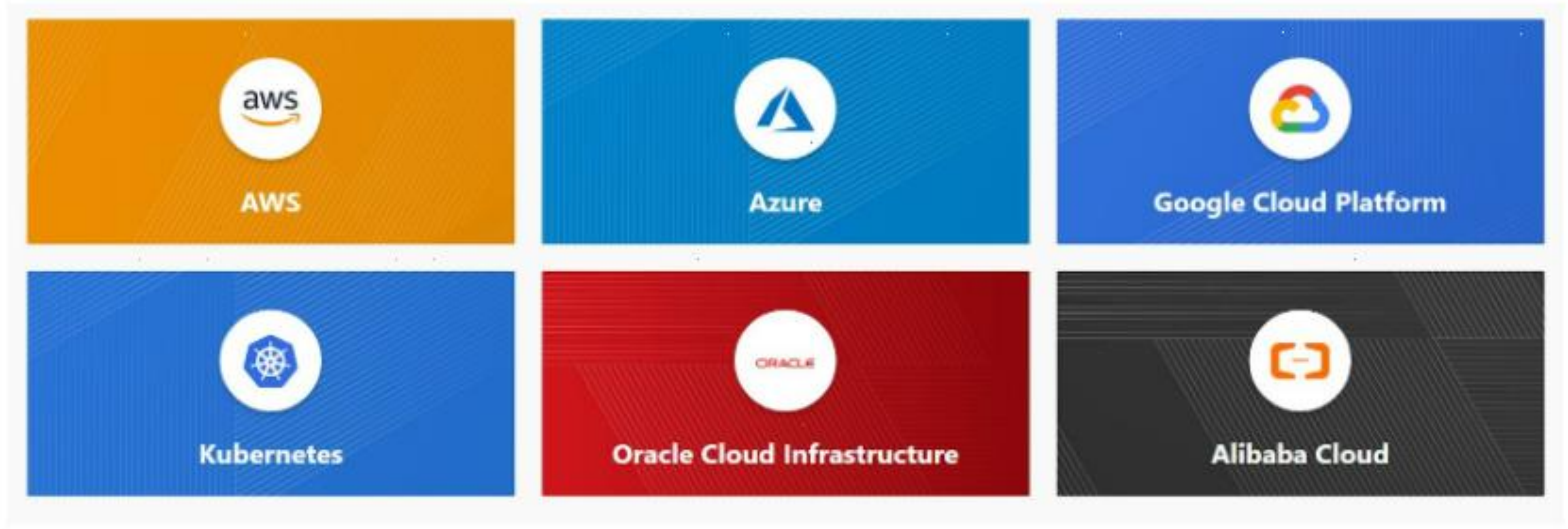
```
provider "aws" {
  region     = "us-east-2"
  access_key = "PUT-YOUR-ACCESS-KEY-HERE"
  secret_key = "PUT-YOUR-SECRET-KEY-HERE"
}
```

A provider is responsible for creating and managing resources.

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

Overview of Provider Architecture :




AWS
Azure
Google Cloud Platform
Kubernetes
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:

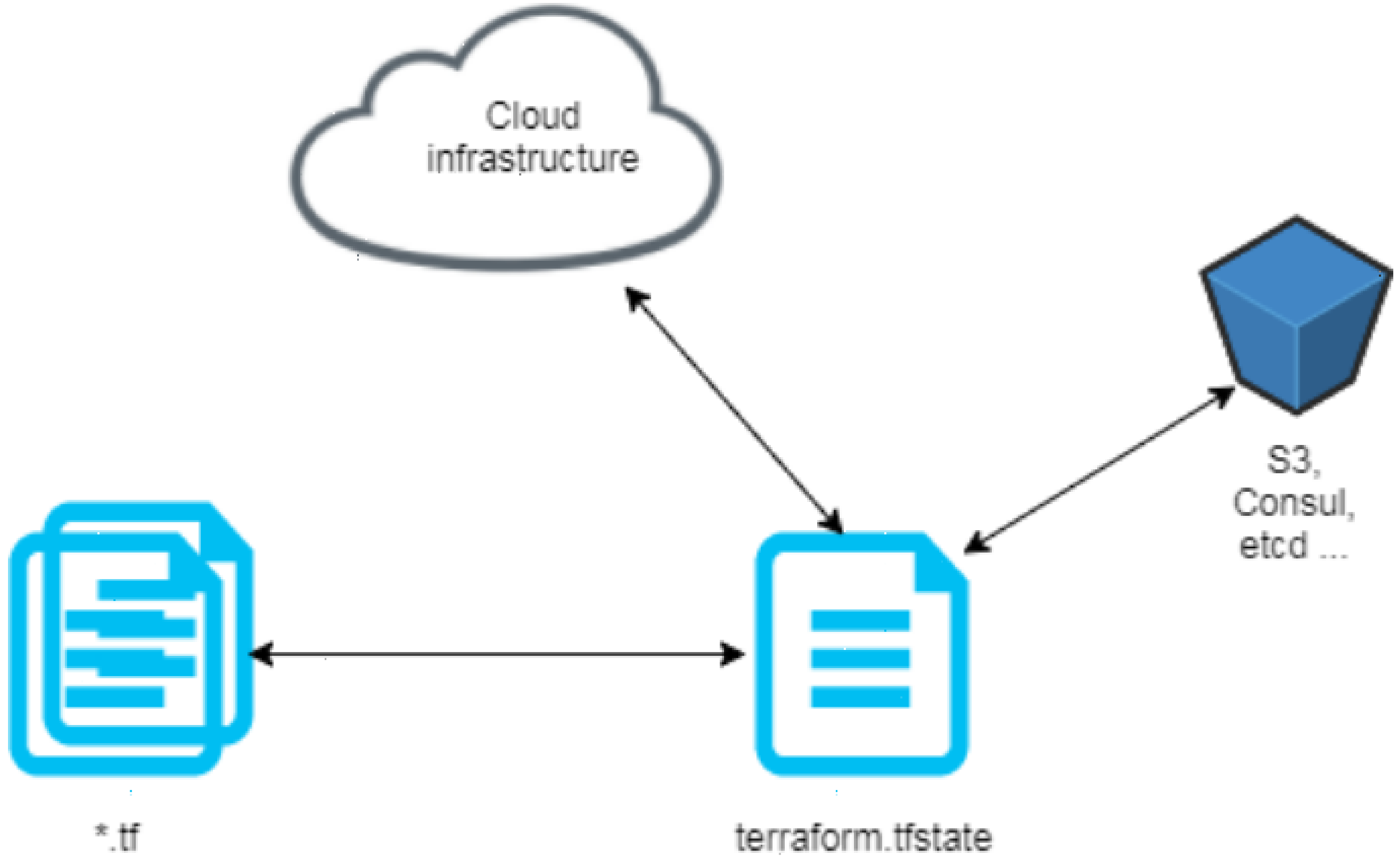
```
[root@TechLanders aws]# ls -l
total 8
-rw-r--r--. 1 root root  234 Aug 15 07:06 myinfra.tf
-rw-r--r--. 1 root root 3209 Aug 15 08:02 terraform.tfstate
[root@TechLanders aws]# cat terraform.tfstate
{
  "version": 4,
  "terraform_version": "0.13.0",
  "serial": 1,
  "lineage": "7f7e0e15-95ef-d8fa-b1cd-12024aed5fa6",
  "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

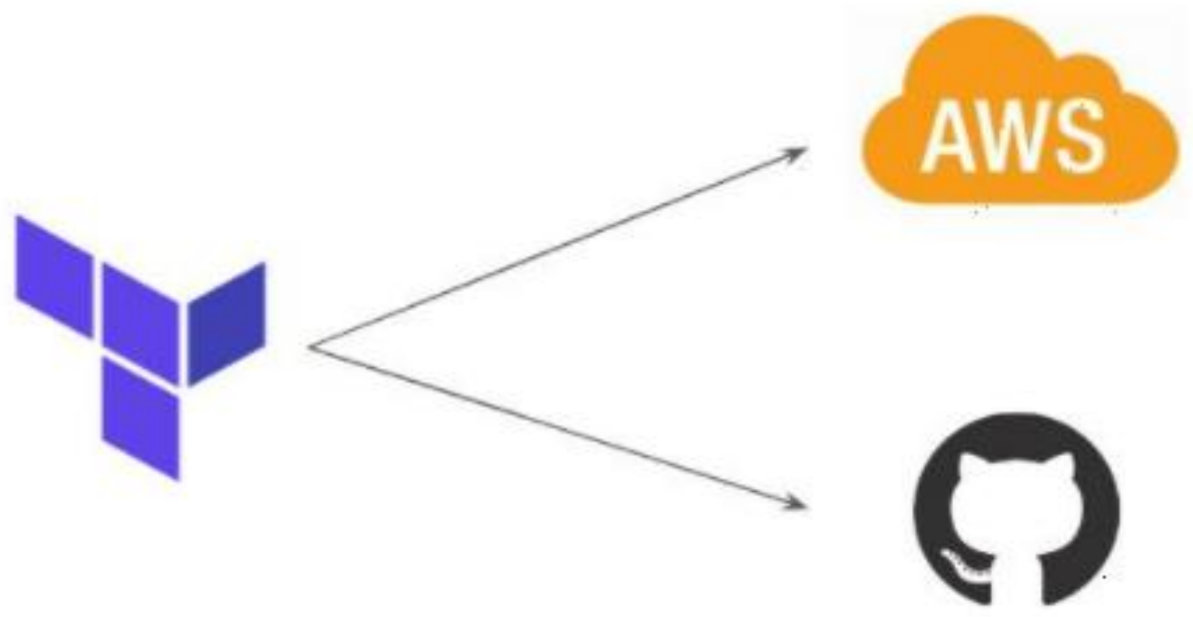
```
[root@TechLanders aws]# terraform apply
aws_instance.myserver: Refreshing state... [id=i-0a1f8a600cb968c7c]
An execution plan has been generated and is shown below.
Resource actions are indicated with the following symbols:
  ~ update in-place
Plan: 0 to add, 1 to change, 0 to destroy.
Do you want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

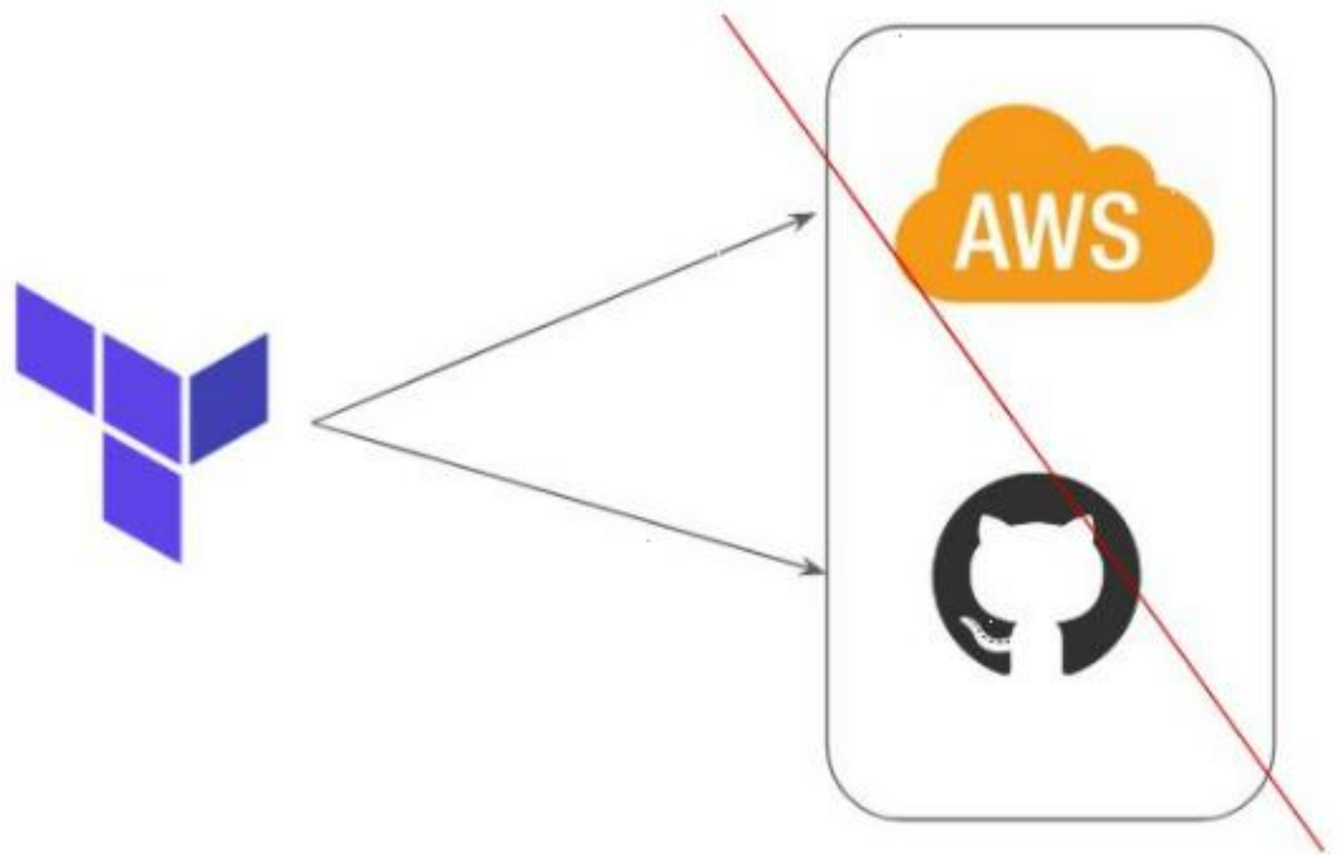
- In case the requirement is to just check for any updates been done in the running environment, we can run terraform refresh command:

```
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 ..



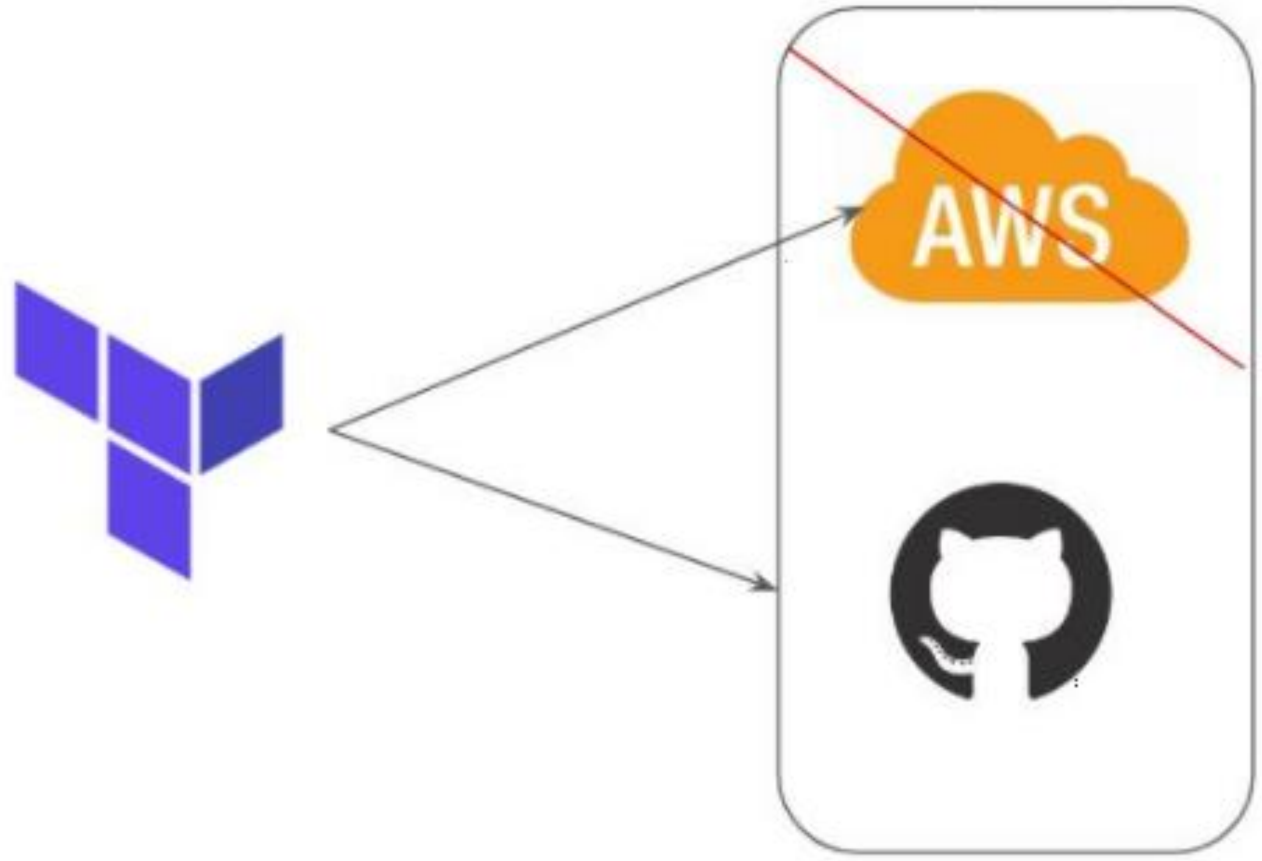
Destroying Infra in one go :



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.

DigitalOcean
Version 1
DigitalOcean
Version 2

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

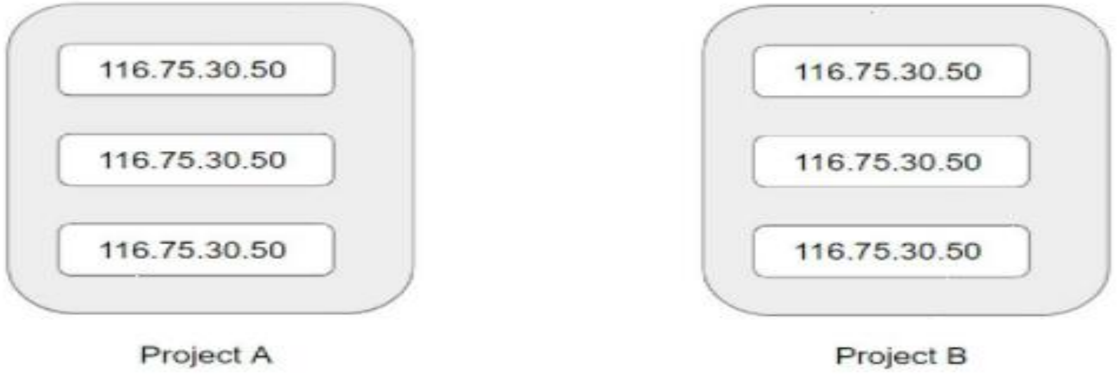
Terraform provides output for every run and same can be used to list the resources details which are created using help of Terraform:

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

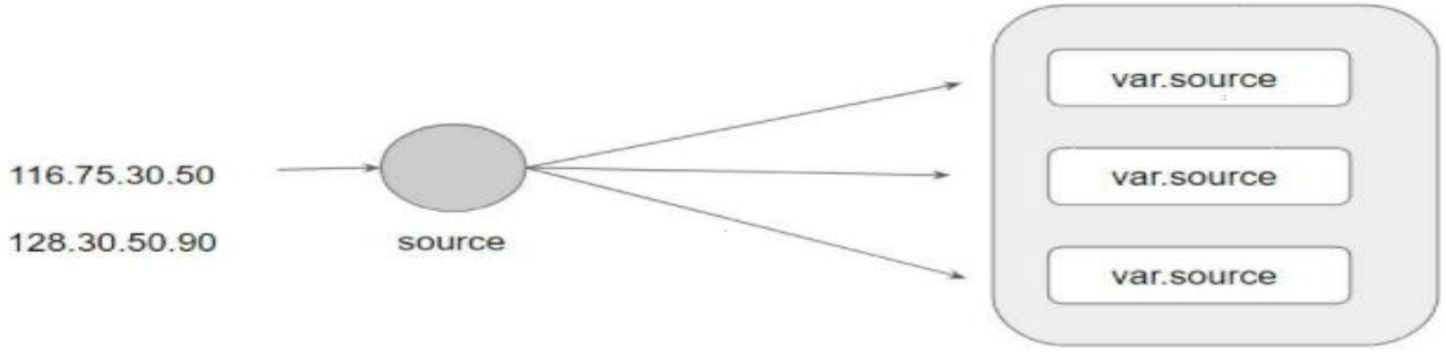
LAB 8 : EC2 instance with output value ..

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

:

LOCAL VALUES :

Terraform locals are named values that you can refer to in your configuration. You can use local values to simplify your Terraform configuration and avoid repetition. Local values (locals) can also help you write more readable configuration by using meaningful names rather than hard-coding values.

LAB 17: LOCAL VALUES .

Terraform Functions

Functions

The Terraform language includes a number of built-in functions that you can call from within expressions to transform and combine values.

Functions help us to perform few specific tasks (i.e. sort, search, reads, dates etc) easily with pre-written programs.

The Terraform language has a number of built-in functions that can be used in expressions to transform and combine values. Functions follow a common syntax:

```
<FUNCTION NAME>(<ARGUMENT 1>, <ARGUMENT 2>)
```

For e.g.

```
min(55, 3453, 2)
```

LAB 18 : Functions

..

LAB 19 : DATA SOURCES ..

DEBUGGING:

Terraform has detailed logs which can be enabled by setting the TF_LOG environment variable to any value. This will cause detailed logs to appear on stderr.
You can set TF_LOG to one of the log levels TRACE, DEBUG, INFO, WARN or ERROR t o change the verbosity of the logs.

LAB 20: DEBUGGING

..

Terraform format

- The terraform fmt command is used to rewrite Terraform configuration files to a canonical format and style. This command applies a subset of the Terraform language style conventions, along with other minor adjustments for readability.

Dynamic Blocks

Terraform dynamic blocks are used to create repeatable nested blocks inside an argument. These dynamic blocks represent separate objects that are related or embedded with the containing object. Dynamic blocks are a lot like the for expression except dynamic blocks iterate over complex values.

DYNAMIC BLOCK LAB 21

..

Node Tainting

Tainting a Node

- In case there is a requirement to delete and recreate a resource, you can mark same in Terraform to tell terraform to do so. Terraform taint does so. We can manually mark a resource as tainted, forcing a destroy and recreate on the next plan/apply.
- Forcing the recreation of a resource is useful when you want a certain side effect of recreation that is not visible in the attributes of a resource. For example: re-running provisioners will cause the node to be different or rebooting the machine from a base image will cause new startup scripts to run.
- Tainting a resource for recreation may affect resources that depend on the newly tainted resource

Tainting a Node

LAB 22: TAINT NODE

Resource Dependencies

- There are two types of dependencies available in terraform:
  - ➢ Implicit - Dependency automatically detected and Hierarchy map automatically created by terraform
  - ➢ Explicit - The depends_on argument can be added to any resource and accepts a list of resources to create explicit dependencies on resources.
- Terraform uses dependency information to determine the correct order in which to create and update different resources.

Implicit Dependencies

- Real-world infrastructure has a diverse set of resources and resource types.
- Dependencies among resources are obvious and should be maintained during provisioning. For e.g. Creating a network first than a Virtual machine; and creating a static IP before a VM is initialized and attaching that IP to it.

You can put your resources here and there in configuration file and terraform will automatically build a dependency map between them.

Explicit Dependencies

- Sometimes there are dependencies between resources that are not visible to Terraform. The depends_on argument can be added to any resource and accepts a list of resources to create explicit dependencies for.
- For example, perhaps an application we will run on our instance expects to use a specific Cloud Storage bucket, but that dependency is configured inside the application code and thus not visible to Terraform. In that case, we can use depends_on to explicitly declare the dependency.

LAB 23: DEPENDENCY ..

Backup

- Just run terraform destroy or terraform apply and cancel it. Cross-check for terraform.tfstate.backup file which is being created as backup for your statefile.

```
C:\Users\gagandeep\terra>dir

16-08-2020  00:24    <DIR>          .
16-08-2020  00:24    <DIR>          ..
16-08-2020  00:12    <DIR>          .terraform
16-08-2020  00:24               226 .terraform.tfstate.lock.info
16-08-2020  00:08               243 myinfra.tf
15-08-2020  11:45        85,426,504 terraform.exe
16-08-2020  00:22             3,203 terraform.tfstate
16-08-2020  00:22             3,205 terraform.tfstate.backup
               5 File(s)     85,433,381 bytes
               3 Dir(s)  735,488,614,400 bytes free

C:\Users\gagandeep\terra>
```

Terraform plan – saving plans

- Even you can save the terraform plan output for a later reference and then apply same to terraform apply command:

```
C:\Users\gagandeep\terra>terraform plan -out t1
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.
---
C:\Users\gagandeep\terra>terraform apply t1
google_compute_address.vm_static_ip: Creating...
```

- You can create multiple plans and then execute one out of them, once you have finalized the stuff.
- After running terraform apply, your plan files become stale and can no longer be used.

```
C:\Users\gagandeep\terra>terraform apply t1
Error: Saved plan is stale
```

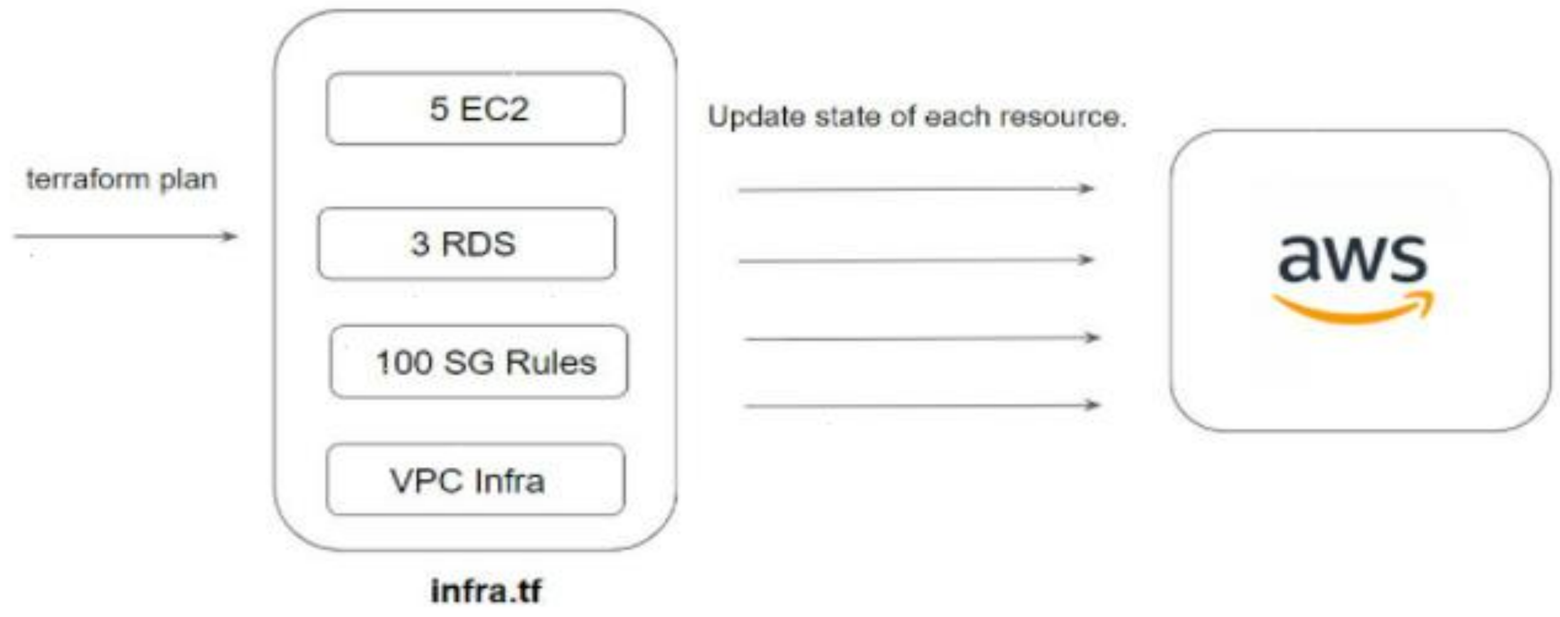
Splat expressions :

- Splat expression [*] allows us to get a list of all the attributes of a resource .

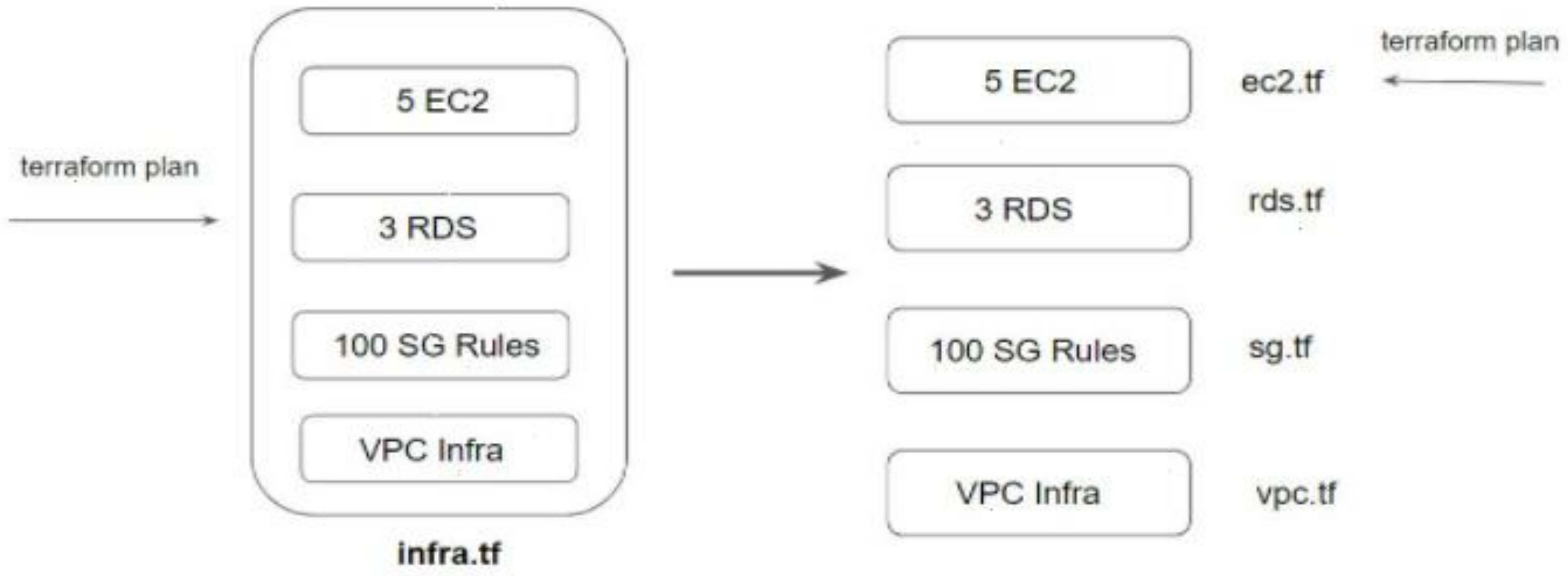
LAB 24 : Splat expression ..

DEALING WITH LARGE INFRA :

When you have a larger infrastructure, you will face issues related to API limits for a provider.

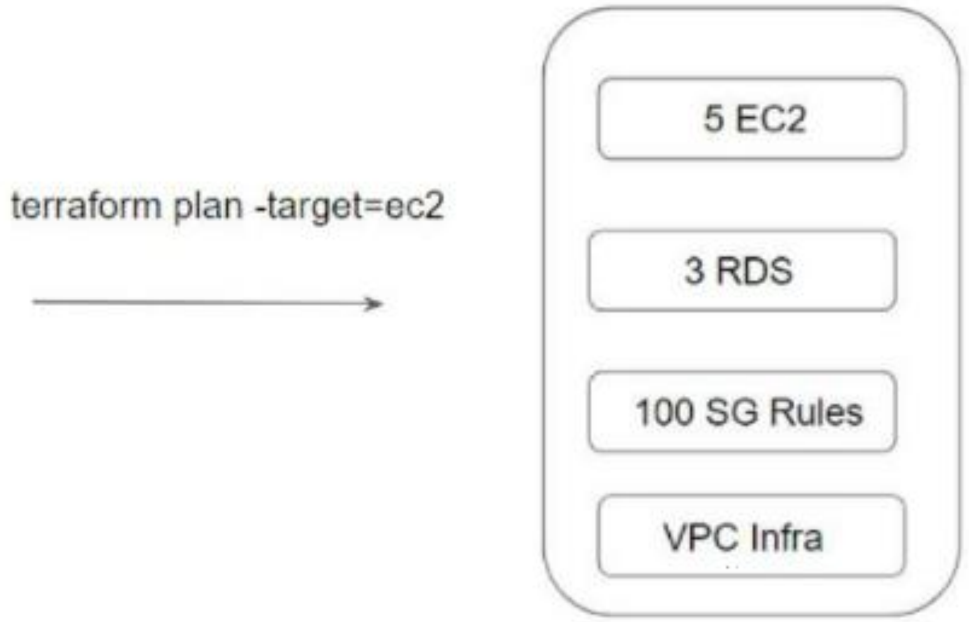


It is important to switch to a smaller configurations were each can be applied independently.



The -target=resource flag can be used to target a specific resource.

Generally used as a means to operate on isolated portions of very large configurations



LAB 25 : LARGE INFRA ..

Alias :Multiple Providers

- Same Providers with multiple alias can be given for region or attributes change:

```
provider "aws" {
  region = "us-east-2"
  access_key = "AKIAJB2KQBDL56XQEYA"
  secret_key = "rNNWuzvBpp+v//XCB10Zr2OVuPI3iayxXXStPs"
  alias  = "useast2"
}

provider "aws" {
  region = "us-east-1"
  access_key = "AKIAJB2KQBD56XQEYA"
  secret_key = "rNNWuzvBpp//B10Zr2OVuPI3iayxXXStPs"
  alias  = "useast1"
}
```

Multiple Providers

- Provide the provider name in resource:

```
resource "aws_instance" "myawsserver1" {
  ami = "ami-0c94855ba95c71c99"
  instance_type = "t2.micro"
  provider = aws.useast1
  tags = {
    Name = "Techlanders-aws-ec2-instance1"
    Env = "Prod"
  }
}
resource "aws_instance" "myawsserver2" {
  ami = "ami-0603cbe34fd08cb81"
  provider = aws.useast2
  instance_type = "t2.micro"

  tags = {
    Name = "Techlanders-aws-ec2-instance2"
    Env = "Prod"
  }
}
```

LAB 28 : MULTIPLE PROVIDERS ..

- Create two servers in two different regions using the same code using alias.

Provisioners

- Terraform uses provisioners to upload files, run shell scripts, or install and trigger other software like configuration management tools.
- Multiple provisioner blocks can be added to define multiple provisioning steps.
- Terraform treats provisioners differently from other arguments. Provisioners only run when a resource is created but adding a provisioner does not force that resource to be destroyed and recreated.

Provisioners

- Provisioners can be used to model specific actions on the local machine or on a remote machine in order to prepare servers or other infrastructure objects for service.
- Running Provisioners can help you to execute stuff as per requirement
- The local-exec provisioner executes a command locally on the machine running Terraform, not the VM instance itself.
- Terraform don't encourage the use of provisioners, as they add complexity and uncertainty to terraform usage. Hashicorp recommends resolving your requirement using other techniques first, and use provisioners only if there is no other option left.
- When deploying virtual machines or other similar compute resources, we often need to pass in data about other related infrastructure that the software on that server will need to do its job.
- **Note:** Provisioners should only be used as a last resort. For most common situations there are better alternatives.

Provisioners

- Provisioners also add a considerable amount of complexity and uncertainty to Terraform usage.
- Firstly, Terraform cannot model the actions of provisioners as part of a plan because they can in principle take any action.
- Secondly, successful use of provisioners requires coordinating many more details than Terraform usage usually requires - direct network access to your servers, issuing Terraform credentials to log in, making sure that all of the necessary external software is installed, etc.
- Some use cases:
    - Passing data into virtual machines and other compute resources
    - Running configuration management software

Remote-Exec Provisioners

- Remote-Exec provisioner helps you to execute commands on remote machine:

LAB 26: REMOTE EXEC .

Local-exec Provisioners

- Running Provisioners can help you to execute stuff as per requirement
- The local-exec provisioner executes a command locally on the machine running Terraform, not the VM instance itself.

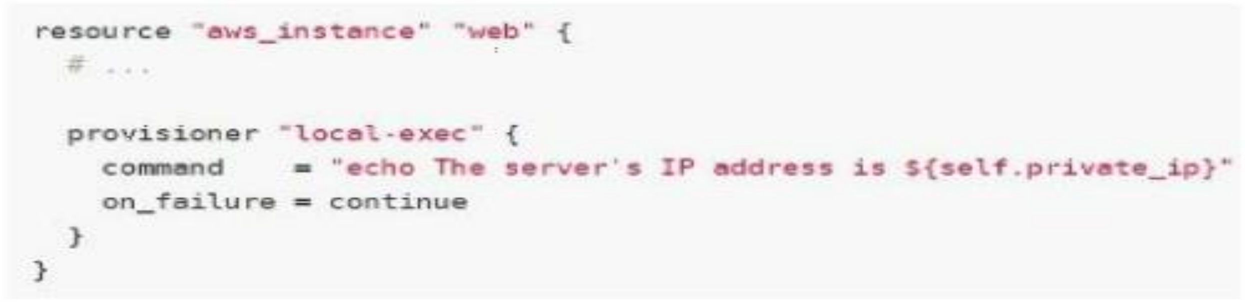
LAB 27 : LOCAL–EXEC ..

FAILURE BEHAVIOR :

By default, provisioners that fail will also cause the terraform apply itself to fail.

The on_failure setting can be used to change this. The allowed values are:

Allowed Values	Description
continue	Ignore the error and continue with creation or destruction.
fail	Raise an error and stop applying (the default behavior). If this is a creation provisioner, taint the resource.



```
resource "aws_instance" "web" {
  # ...

  provisioner "local-exec" {
    command    = "echo The server's IP address is ${self.private_ip}"
    on_failure = continue
  }
}
```

Terraform Modules

Terraform Modules

A module is a container for multiple resources that are used together. Modules can be used to create lightweight abstractions, so that you can describe your infrastructure in terms of its architecture, rather than directly in terms of physical objects.

The .tf files in your working directory when you run terraform plan or terraform apply together form the root module. That module may call other modules and connect them together by passing output values from one to input values of another.

Usual Structure:

```
$ tree minimal-module/
.
├── README.md
├── main.tf
├── variables.tf
├── outputs.tf
```

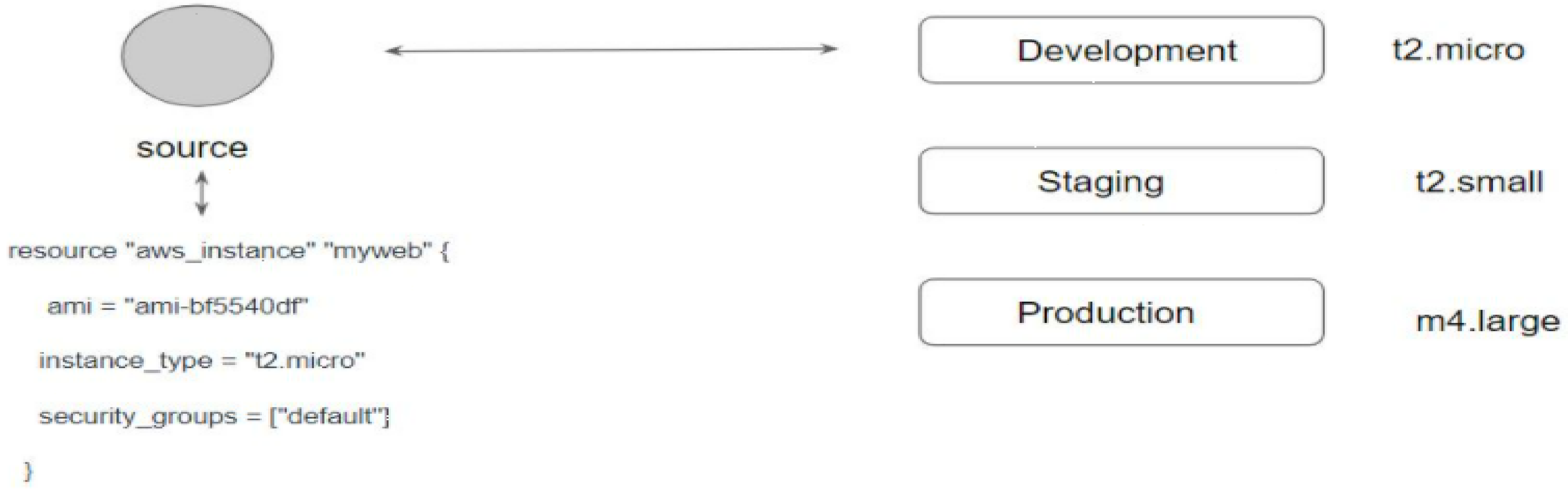
We can centralize the terraform resources and can call out from TF files whenever required.

module "source"
source

```
resource "aws_instance" "myweb" {
    ami = "ami-bf5540df"
   instance_type = "t2.micro"
   security_groups = ["default"]
 }
```

LAB 29 : Creating local MODULES ..

CHALLENGES WHEN THERE ARE DIFF ENVs



```
resource "aws_instance" "myweb" {
   ami = "ami-bf5540df"
  instance_type = "t2.micro"
  security_groups = ["default"]
 }
```

LAB 30: Using variables to solve the problem ..

Terrafrom Registry :

- For Terraform users, the Terraform Registry enables the distribution of Terraform modules, which are reusable configurations. The Terraform Registry acts as a centralized repository for module sharing, making modules easier to discover and reuse.

LAB 31: Remote modules using tf registry.

https://registry.terraform.io/modules/terraform-aws-modules/ec2-instance/aws/latest

LAB 32 : WORKSPACE ..

LAB 33 : INTEGRATING GIT FOR TEAM MGMT ..

LAB 34: Module sources in TF.(to make github repo as source of module and not local path)

LAB 35: .gitignore

- .gitignore is used to restrict commiting all the files to github

Statefiles

- 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 lockfile for security

- Terraform acquires a state lock to protect the state from being written by multiple users at the same time.
- Just run terraform apply or destroy and don’t provide any input on its confirmation command. Open a new terminal and look for .terraform.tfstate.lock.info file being created in the directory.

```
C:\Users\gagandeep\terra>dir
16-08-2020  00:24    <DIR>          .
16-08-2020  00:24    <DIR>          ..
16-08-2020  00:12    <DIR>          .terraform
16-08-2020  00:24               226 .terraform.tfstate.lock.info
16-08-2020  00:08               243 myinfra.tf
15-08-2020  11:45        85,426,504 terraform.exe
16-08-2020  00:22             3,203 terraform.tfstate
16-08-2020  00:22             3,205 terraform.tfstate.backup
               5 File(s)     85,433,381 bytes
               3 Dir(s)  735,488,614,400 bytes free
C:\Users\gagandeep\terra>
```

- State locking happens automatically on all operations that could write state. You won't see any message that it is happening. If state locking fails, Terraform will not continue.
- You can disable state locking for most commands with the -lock flag but it is not recommended.
- You can unlock terraform with terraform force-unlock LOCK_ID command.

State files

- Terraform must store state about your managed infrastructure and configuration. This state is used by Terraform to map real world resources to your configuration, keep track of metadata, and to improve performance for large infrastructures.
- Terraform uses this local state to create plans and make changes to your infrastructure. Prior to any operation, Terraform does a refresh to update the state with the real infrastructure.
- This state is stored by default in a local file named "terraform.tfstate", but it can also be stored remotely, which works better in a team environment.
- State snapshots are stored in JSON format
- What will happen if multiple people from a team are working on the requirement?
- How code will me managed and how state file will be maintained?

Remote State

- When working with Terraform in a team, use of a local file makes Terraform usage complicated because each user must make sure they always have the latest state data before running Terraform and make sure that nobody else runs Terraform at the same time.

- With remote state, Terraform writes the state data to a remote data store, which can then be shared between all members of a team. Terraform supports storing state in Terraform Cloud, HashiCorp Consul, Amazon S3, Alibaba Cloud OSS, and more.

- Here are some of the benefits of backends:
  - **Working in a team:** Backends can store their state remotely and protect that state with locks to prevent corruption. Some backends such as Terraform Cloud even automatically store a history of all state revisions.
  - **Keeping sensitive information off disk**: State is retrieved from backends on demand and only stored in memory. If you're using a backend such as Amazon S3, the only location the state ever is persisted is in S3.
  - **Remote operations:** For larger infrastructures or certain changes, terraform apply can take a long, long time. Some backends support remote operations which enable the operation to execute remotely. You can then turn off your computer and your operation will still complete. Paired with remote state storage and locking above, this also helps in team environments.

Lab 36: Remote State - AWS

```
[root@ip-172-31-19-15 ec2]# cat backend.tf
terraform {
  backend "s3" {
    bucket = "techlanders-statefile"
    key    = "terraform/state"
    region = "us-east-1"
  }
}

#terraform init

Initializing the backend...

Successfully configured the backend "s3"! Terraform will automatically

use this backend unless the backend configuration changes.
```

Note : create the bucket before doing terraform init

LAB:36 State Locking- AWS

```
[root@ip-172-31-19-15 ec2]# cat backend.tf
terraform {
  backend "s3" {
    bucket = "techlanders-statefile"
    key    = "terraform/state"
    region = "us-east-1"
    dynamodb_table = "tflock"
  }
}
```

** dynamodb_table = "tflock"   //create a dynamodb table with LockID column –type String for State Locking

```
[root@ip-172-31-38-249 loops]# terraform init

Initializing the backend...

Successfully configured the backend "s3"! Terraform will automatically

use this backend unless the backend configuration changes.
```

-- try locking the state , then unlock the state : terraform force-unlock LOCK_ID (check dynamodb for lock id)

STATE MODIFICATION :

As your Terraform usage becomes more advanced, there are some cases where you may need to modify the Terraform state.

It is important to never modify the state file directly. Instead, make use of terraform state command.

There are multiple sub-commands that can be used with terraform state, these include:

State Sub Command	Description
list	List resources within terraform state file.
mv	Moves item with terraform state.
pull	Manually download and output the state from remote state.
push	Manually upload a local state file to remote state.
rm	Remove items from the Terraform state
show	Show the attributes of a single resource in the state.

Importing Resources

Importing existing resources

- You can import existing resources – which are not created using terraform command, into terraform state using terraform import command.
- The current implementation of Terraform import can only import resources into the state. It does not generate configuration. A future version of Terraform will also generate configuration.
- Because of this, prior to running terraform import it is necessary to write a resource configuration block for the resource manually, to which the imported object will be attached.
- This command will not modify your infrastructure, but it will make network requests to inspect parts of your infrastructure relevant to the resource being imported.

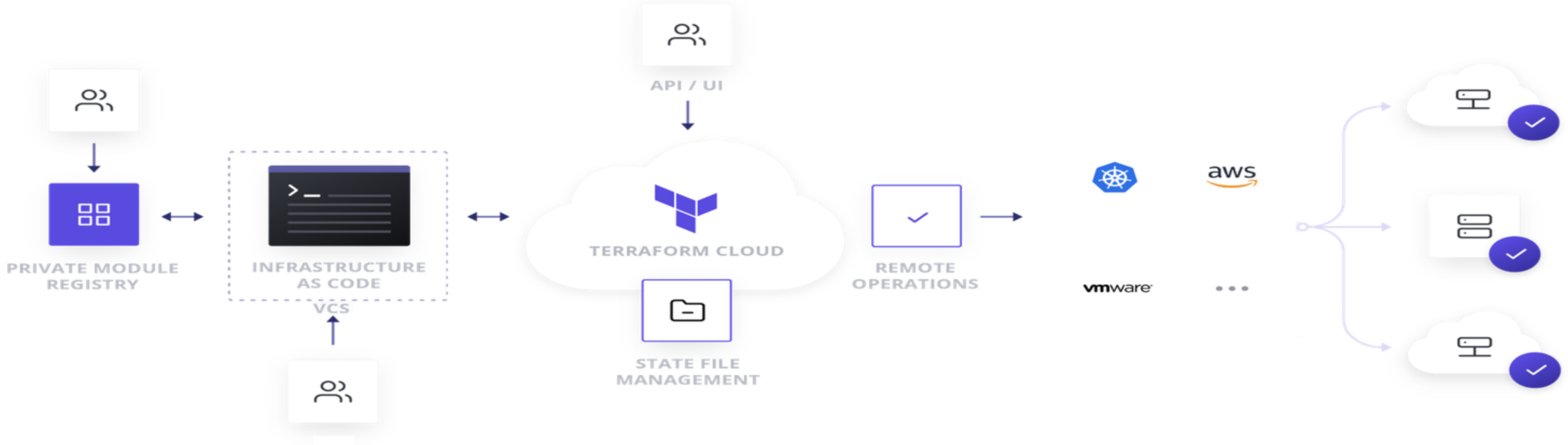
LAB 37: IMPORT ..

LAB 38: FOR & FOR-EACH LAB ..

Terraform Cloud

Terraform Cloud

Terraform Cloud is an application that helps teams use Terraform together. It manages Terraform runs in a consistent and reliable environment and includes easy access to shared state and secret data, access controls for approving changes to infrastructure, a private registry for sharing Terraform modules, detailed policy controls for governing the contents of Terraform configurations, and more.



Terraform Cloud

It is a platform that performs Terraform runs to provision infrastructure, either on demand or in response to various events

Terraform Cloud offers a **team-oriented remote Terraform workflow**, designed to be comfortable for existing Terraform users and easily learned by new users. The foundations of this workflow are remote Terraform execution, a **workspace-based organizational model**, **version control integration**, **command-line integration, remote state management** with cross-workspace data sharing, and a **private Terraform module registry.**

Terraform Cloud runs Terraform on **disposable virtual machines in its own cloud infrastructure**. **Remote Terraform execution** is sometimes referred to as "remote operations."

Terraform Cloud

- Terraform cloud is a GUI based Cloud SaaS solution. It is offered as a multi-tenant SaaS platform and is designed to suit the needs of smaller teams and organizations.
- Benefits of Terraform Cloud:
  - It manages Terraform runs in a consistent and reliable environment.
  - Best for bigger teams, as it provides secure and easy access to shared state and secret data.
  - It offers Remote State Management, Data Sharing, Run Triggers, and Private registry for Terraform modules.
  - Role Based Access Controls (RBAC) for approving changes to infrastructure.
  - Version Control Integration with Major VCS providers like Github, Gitlab, Bitbucket, Azure DevOps
  - Full APIs support for all operations to integrate this with other tools and environments.

Terraform Cloud

- Notifications can be configured with services which support webhooks
- You can run the configuration from existing environment or from terraform cloud-based server.
- **Sentinel Policies:** Terraform Cloud embeds the Sentinel policy-as-code framework, which lets you define and enforce granular policies for how your organization provisions infrastructure. You can limit the size of compute VMs, confine major updates to defined maintenance windows, and much more. Policies can act as firm requirements, advisory warnings, or soft requirements that can be bypassed with explicit approval from your compliance team.
- **Cost Estimation**: Before making changes to infrastructure in the major cloud providers, Terraform Cloud can display an estimate of its total cost, as well as any change in cost caused by the proposed updates.

Lab 39: Cloud

1) Open webpage https://app.terraform.io and create an account there

2) Create an Organization by providing name and Email address

3) Create a workspace

Select workflow with VCS (another options like CLI and API driven can also be used)

Integrate your version control system (I have selected Github for this example)

To integrate Github, open link https://github.com/settings/applications/new and provide information been provided by terraform registration page

Setup Oauth authentication as guided by setting up the details

Authorise Terraform cloud to have admin access on your repositories

4) Skip the ssh-keypair as same is not required to setup. SSH-keypair is basically to connect to git repos via ssh, which sometimes required when you have private submodules.

5) Select the repositories where you have your terraform code placed. Don't forget to select the working directory(under advanced section)

(/ec2 not /home/app/module/ec2)

where you want to work on, especially when you have multiple terraform folders inside the repo. Terraform working directory can be changed lateron from Settings -> General tab.

6) Click on create workspace and finish the creation.

7) Add Terraform Environment Variable and set AWS AK/SK(AWS_ACCESS_KEY_ID, AWS_SECRET_ACCESS_KEY). Don't forget to select sensitive option on the right side, especially for Secret Access Key.

8) Click on Queue Plan and provide a reason(just any description and better to have though optional) for queuing same.

9) Apply the changes and look at the output segment of apply logs

10) Cross-check the state under state section post your apply is completed. You can verify your state file outcome, run state and version of the source code etc. You can even download the tfstate file, by clicking on download button.

11) Below add-features can be enabled/disabled/modified:

a) Auto-approve, Remote/Local execution, Terraform version, working directory : Under settings -> General Tab.

b) Manually locking a project. By default Lock is auto-applied during terraform apply. : Under settings -> Locking

c) Source Code Integration and SSH key setup, can be done via : Settings -> SSH/Version control

Automated pipelining:

13) Change the configuration to auto-approve and do the modification on github under your configuration change and cross-check the terraform apply.

Best Practices

Best Practices

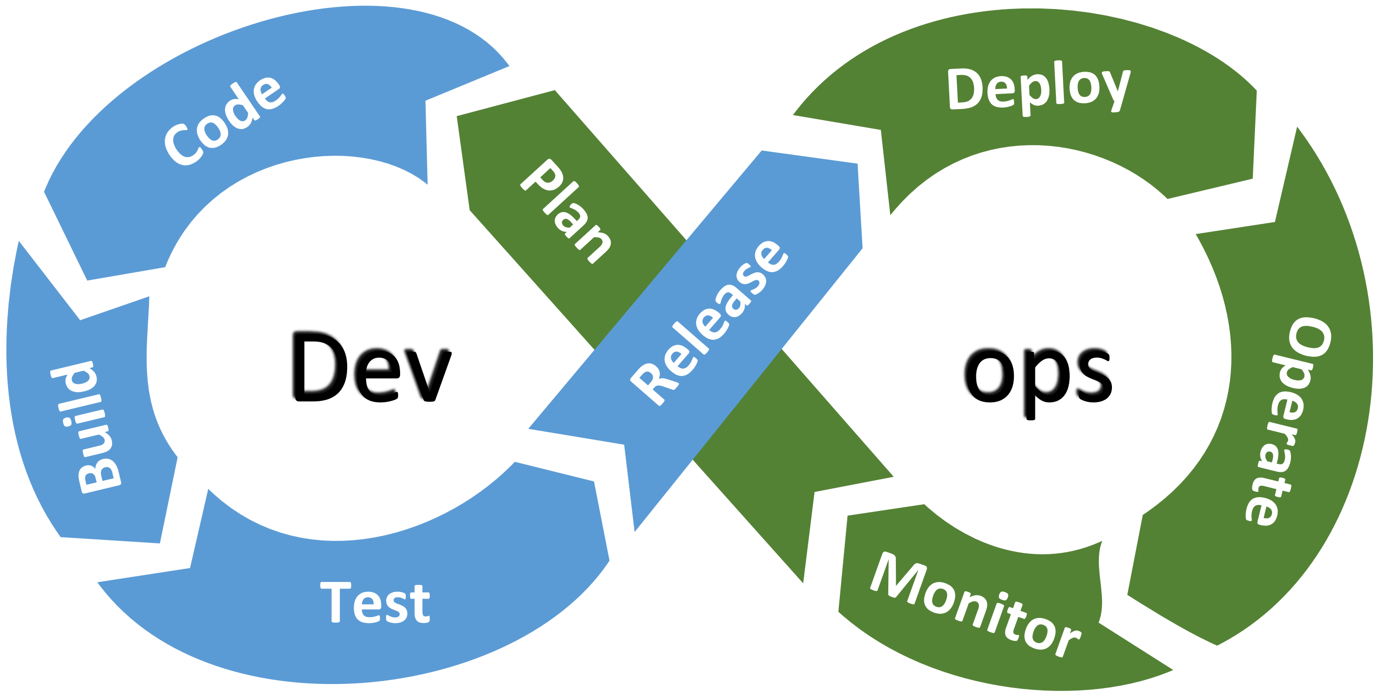
- Terraform recognizes files ending in .tf or .tf.json as configuration files and will load them when it runs. When run, Terraform loads all configuration files from the current directory. So it's a good idea to organize your configurations into separate files like variable.tf, output.tf, main.tf etc
- Successful execution of terraform plan doesn't mean actual implementation will be always successful. It may fail due to provider parameters issue. For example in case you provide an image name which doesn't exists, terraform will take it and assume it'll be available, and plan will get successful. So a real run can only provide you better assurance.
- Even a Real run sometime will not be helpful if your backend environment is changing. For example, a perfect execution of infrastructure deployment in your aws environment doesn't mean it'll work in client environment too, if you have hardcoded the things. For example, in case you hardcode keypair or network in your configuration file.
- Sometimes even configuration parameters become hardcode and creates problem. For example a bucket name must be globally unique in GCP. If you have used that name already somewhere in your test/dev account, same can not be used in prod or client accounts – which is configured under bucket name section under terraform configuration file. So consider this factor too.

Best Practices

- During working inside a team, always keep your configuration files on Github or similar VCS.
- Keep your remote state on S3/GCS (with versioning enabled) for HA and collaborative working.
- **Follow DRY Principle. The DRY principle is stated as "Every piece of knowledge must have a single, unambiguous, authoritative representation within a system".**
- Have thumb rule- **Let the expert do its job**. Use Terraform for Infra provisioning only, not for Configuration management. Same rules applied to CM tools (for not to use them for Infra provisioning).
- Do the automation wherever possible.
- Hardcoding will hinder the real automation needs. So make sure to put the things in variables wherever possible.

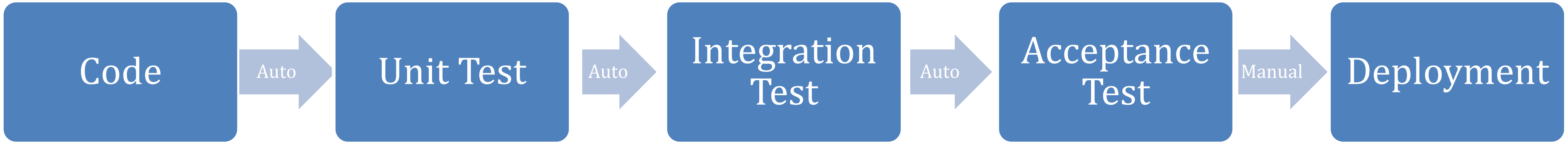
Terraform in DevOps

Terraform in DevOps

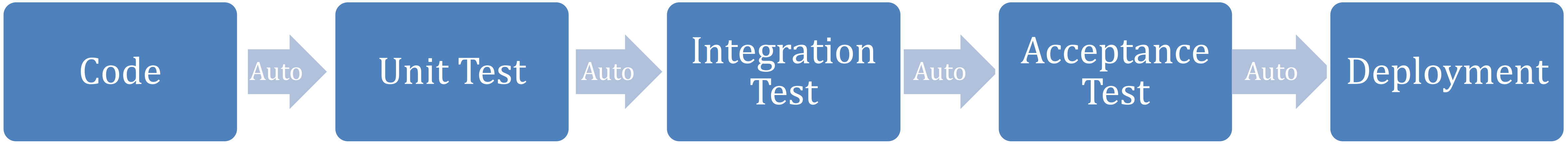


Terraform in DevOps

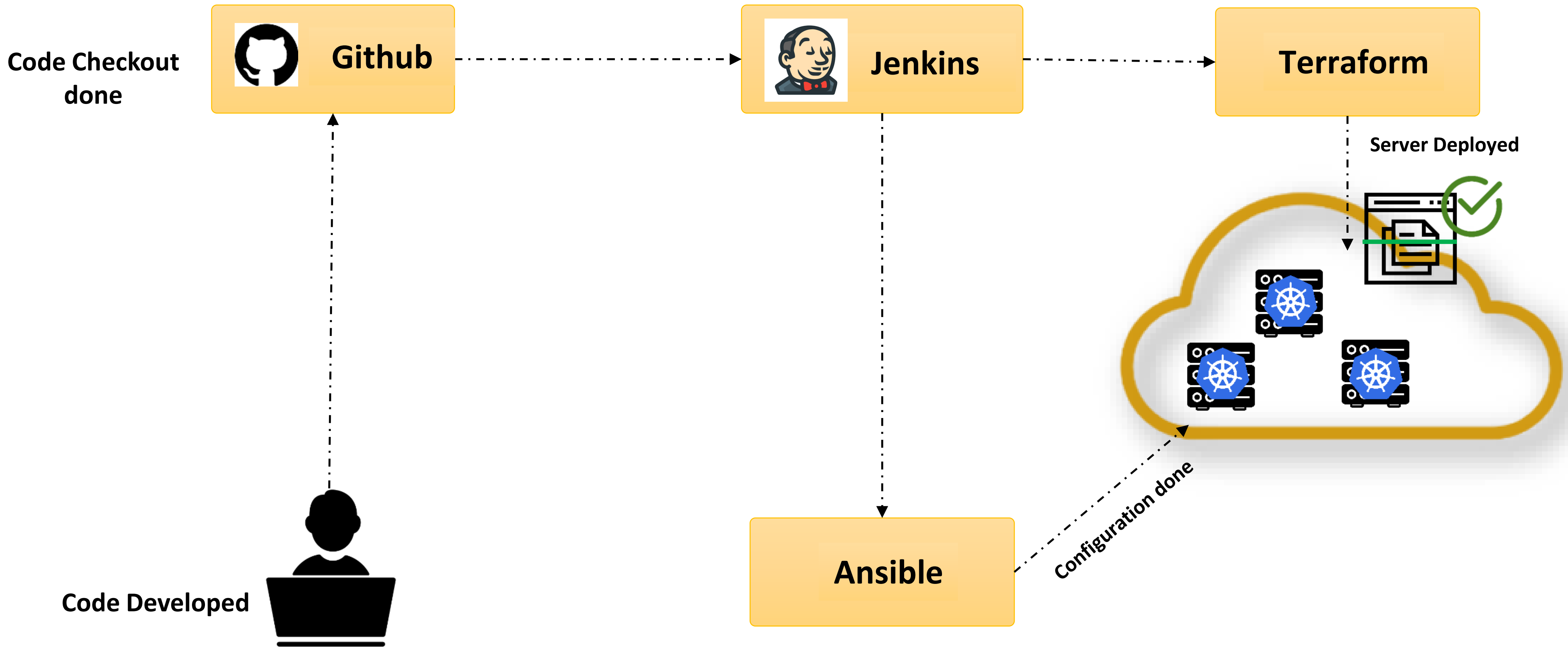
Continuous Integration



Continuous Deployment



Terraform in DevOps



LAB 40: Terraform-ansible-Jenkins pipeline

Questions & Answers

THANK YOU