

Terraform



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Introduction

Your Name

Total experience

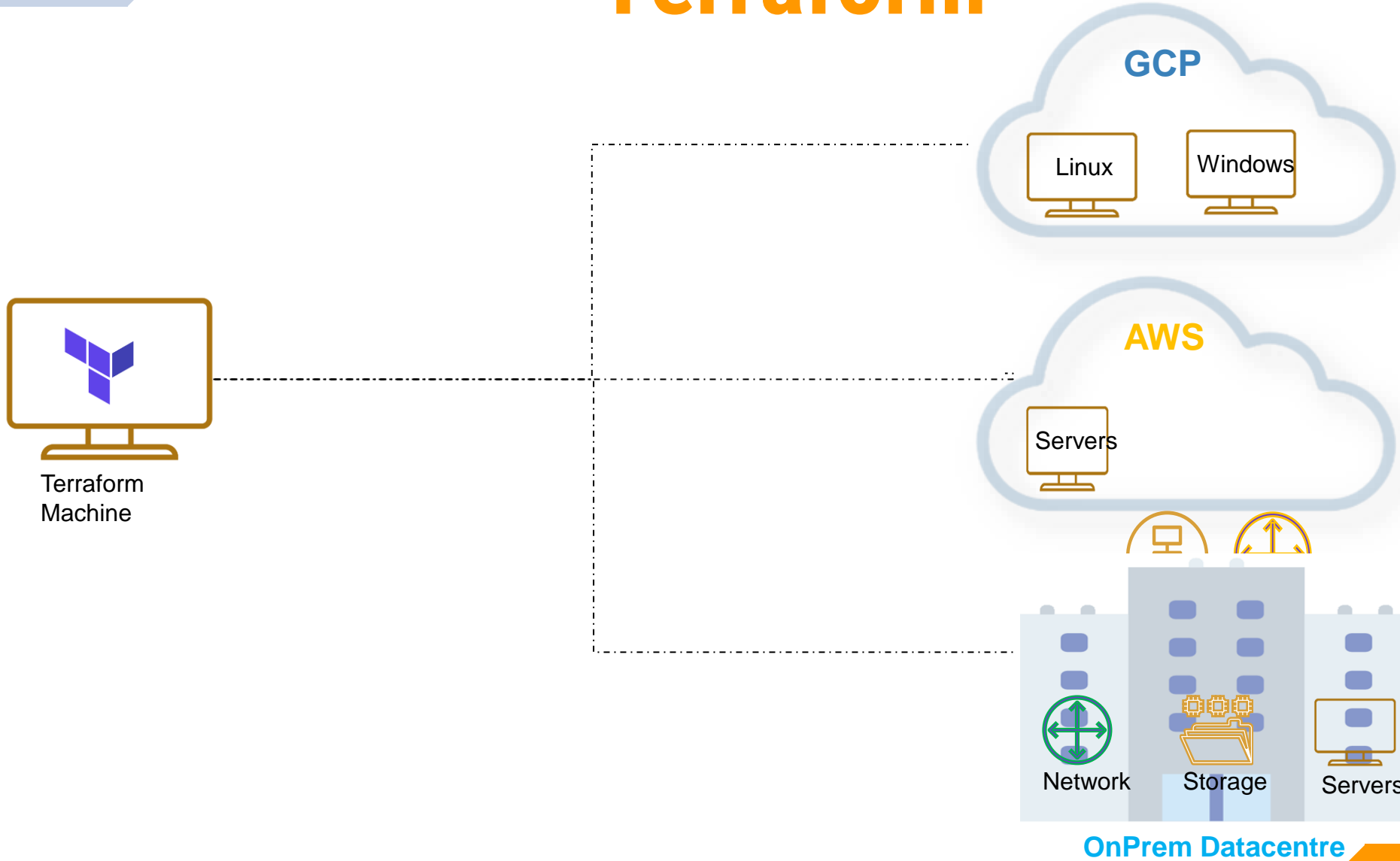
Background – Development / Infrastructure / Database / Network

Experience on AWS Cloud and Terraform



What is Orchestration?

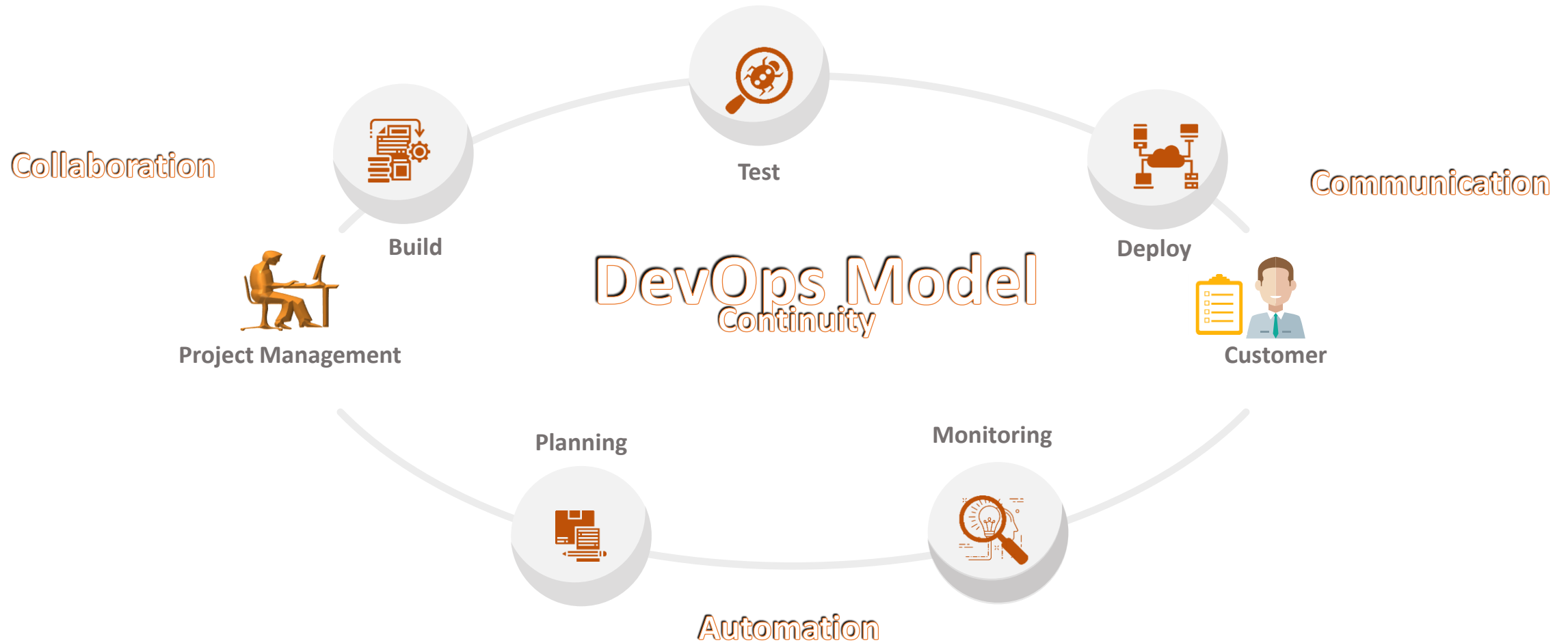
Terraform



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



DevOps in Action

Continuous Feedback

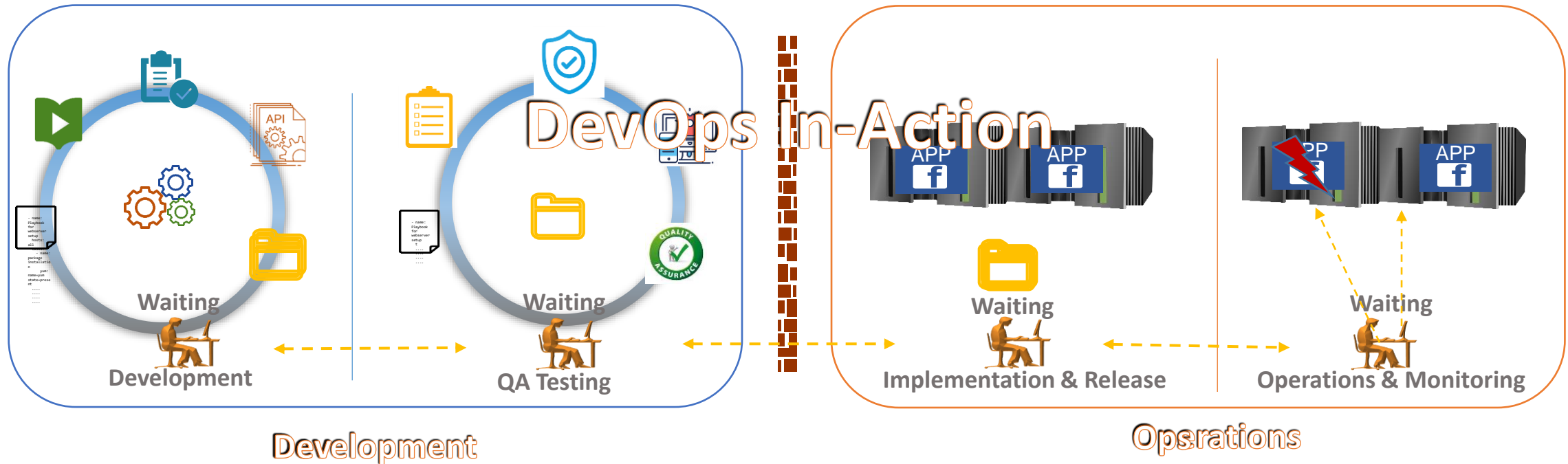
Continuous Improvement

Continuous Planning

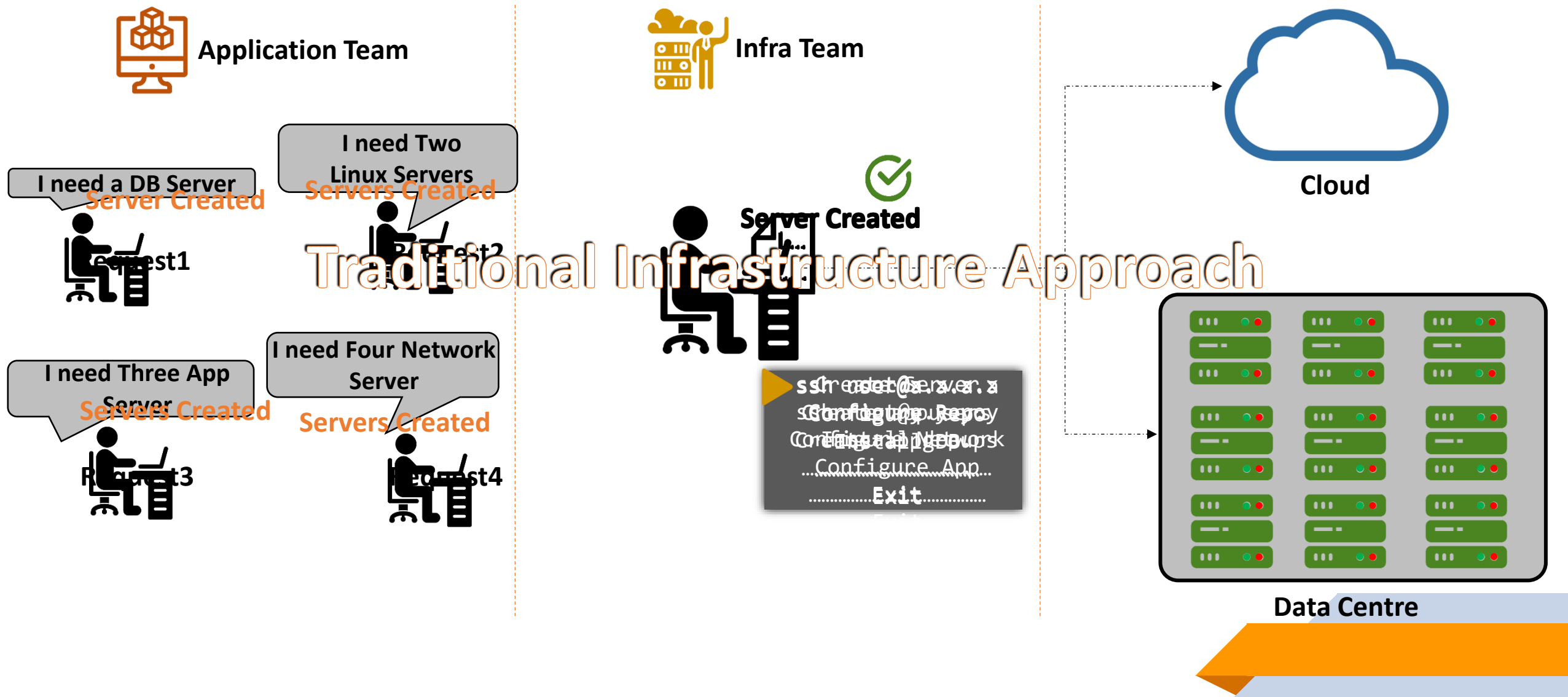
Continuous Delivery

Continuous Deployment

Continuous Monitoring



Why DevOps IaC





Application Team

I need DB Server

Server Created



need Three Linux Servers

Servers Created



need Two Linux Servers

Servers Created



need Four Linux Servers

Servers Created



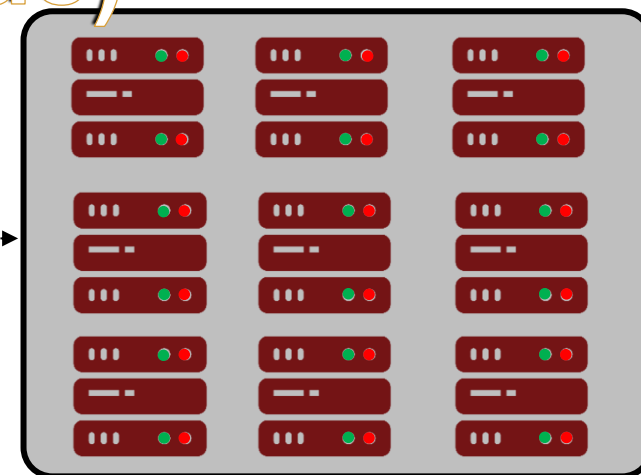
Infra Team

```
File is: main.tf
provider "aws" {
  region = "us-east-1"
}
resource "aws_instance" "requestfour" {
  count = "4"
  ami = "ami-0301261bd1c1e8b2a"
  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



Cloud



Data Centre

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



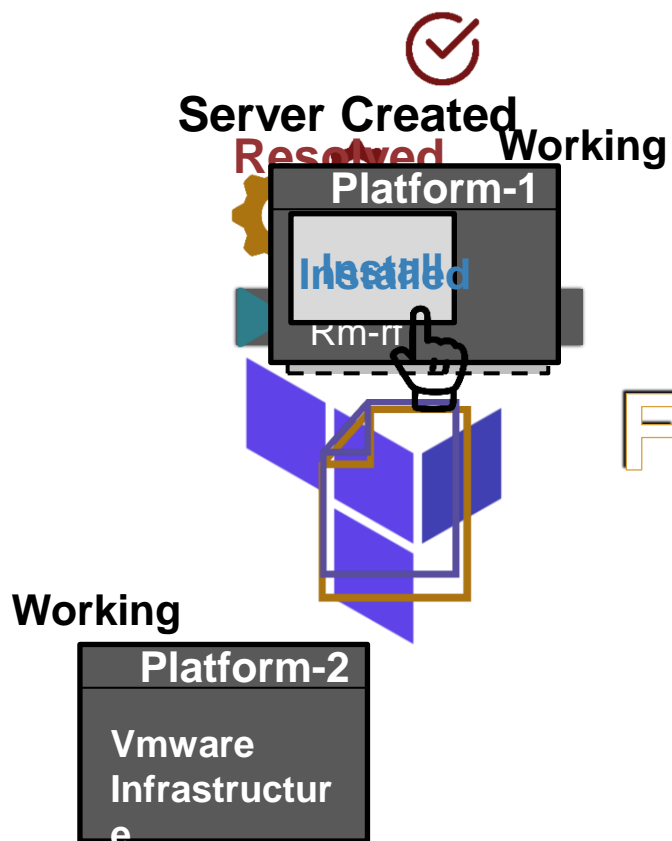
Intelligent
Dependency
Resolver



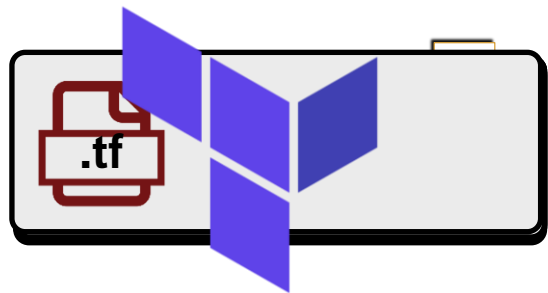
Platform Agnostic



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"  
  }  
}
```

Terraform File (Sample Code)

Resource Block

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

Output
Block

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.

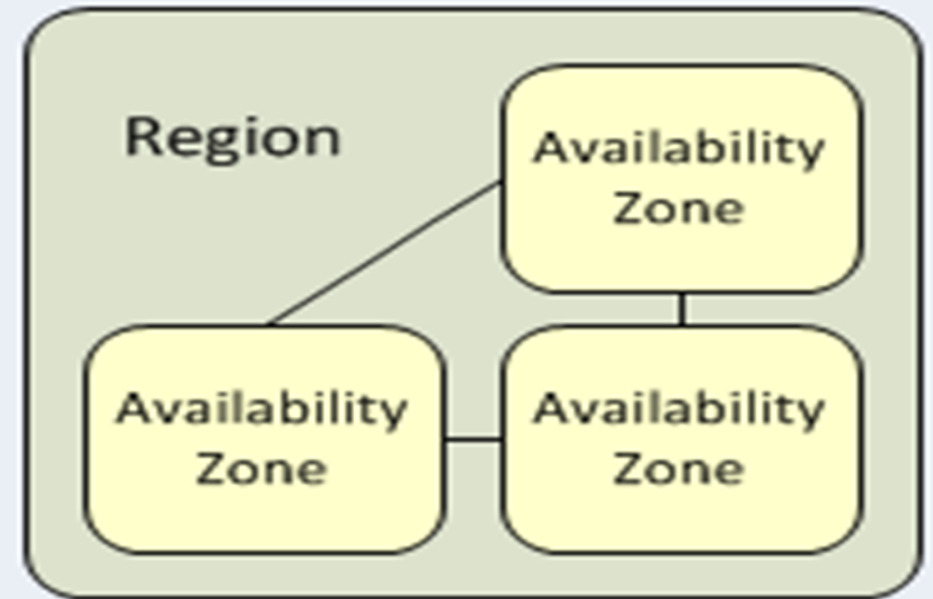
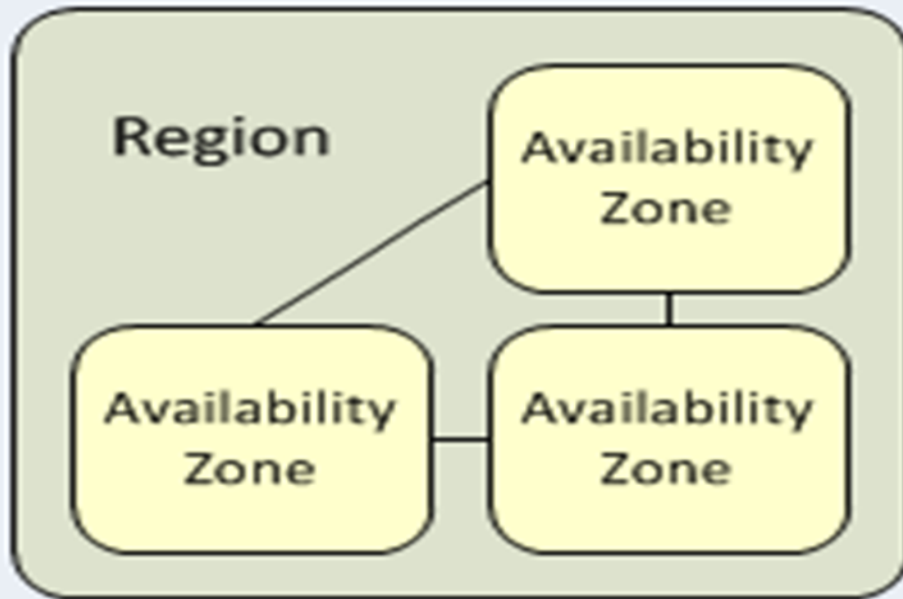
Multiple OS's: Choice and use any supported Operating systems.

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



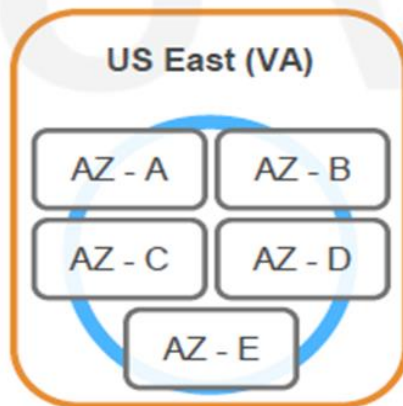
Amazon Web Services

At least 2 AZs per region.

Examples:

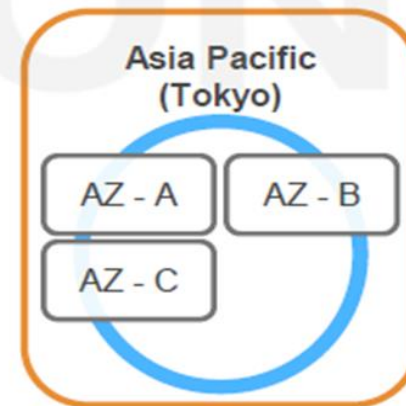
➤ US East (N. Virginia)

- 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

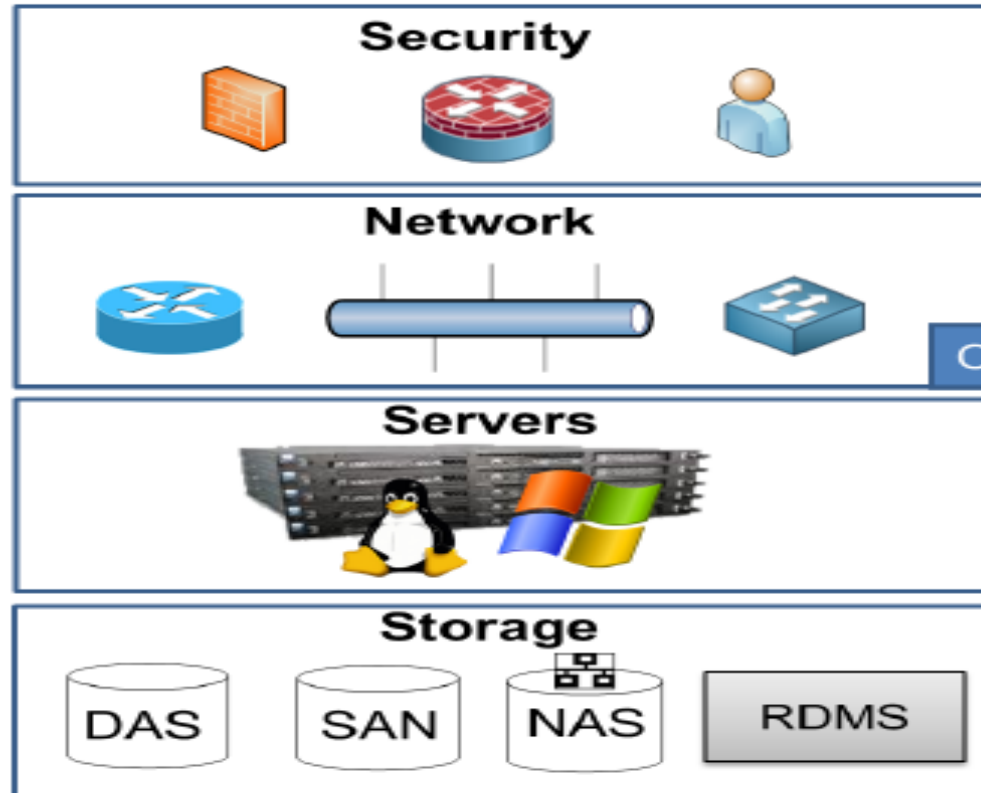


Amazon Web Services



AWS

Enterprise Infrastructure

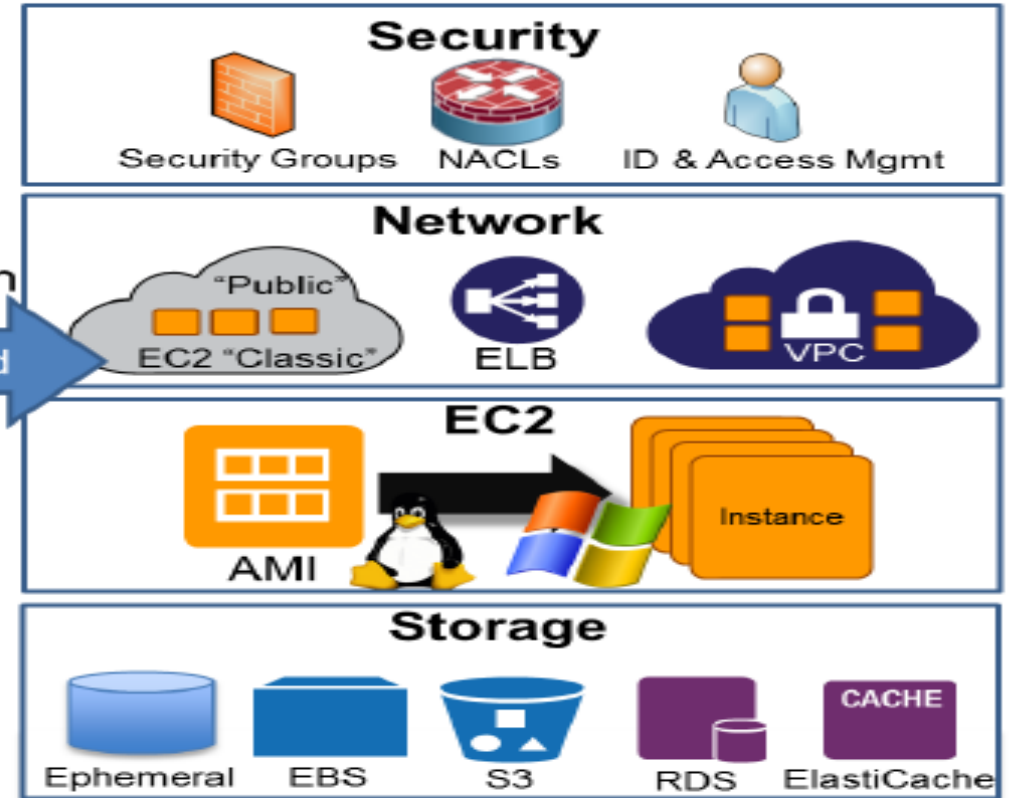


Provision

On-Demand

Expand

Amazon Web Services





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

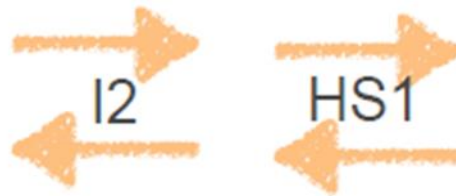
General
purpose



Compute
optimized



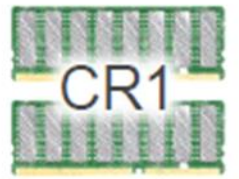
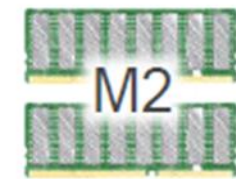
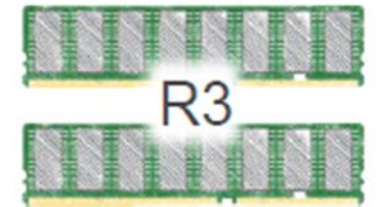
Storage and IO
optimized



GPU
enabled



Memory
optimized



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



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

Create an AWS account

Email address

Password

Confirm password

AWS account name ⓘ

Continue

[Sign in to an existing AWS account](#)

After creating the account

andhi Nagar

at, suite, unit, building, floor, etc

Province or region

Code

Amazon Internet Services Pvt. Ltd. Customer

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

Click here to indicate that you have read and agree to the terms of the [AISPL Customer Agreement](#)

Create Account and Continue

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. Choose the plan that best aligns with your AWS usage. [Learn more](#)



Basic Plan

Free

- Included with all accounts
- 24x7 self-service access to AWS resources
- For account and billing issues only
- Access to Personal Health Dashboard & Trusted Advisor



Developer Plan

From \$29/month

- 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

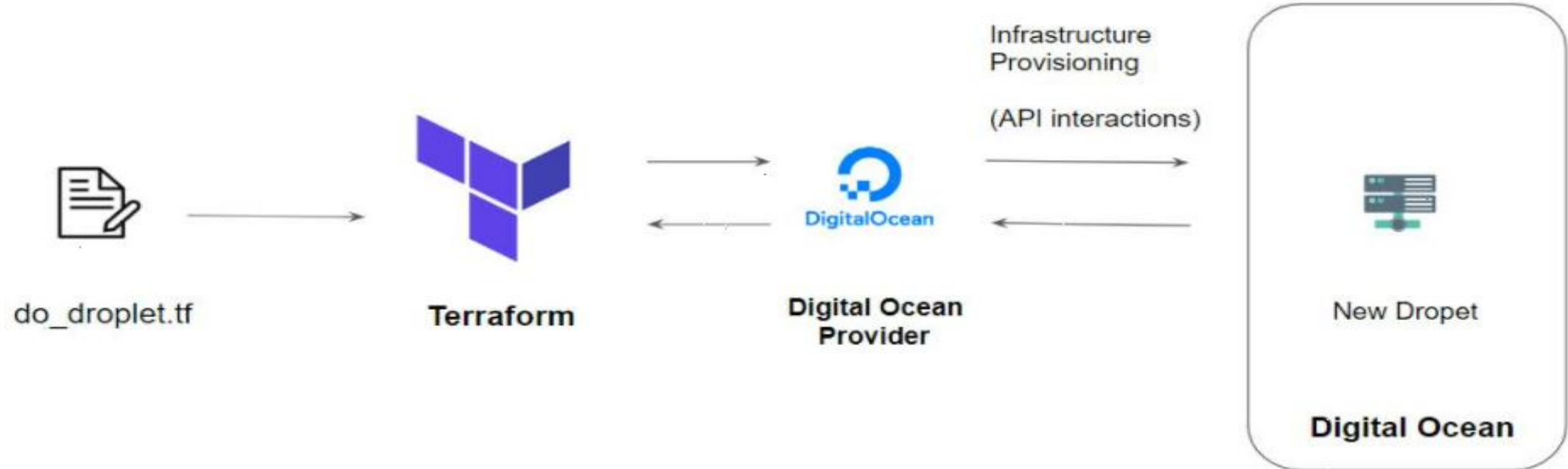
A provider is responsible for understanding API interactions and exposing resources over to a particular cloud service provider. Most providers configure a specific infrastructure platform (either cloud or self-hosted).

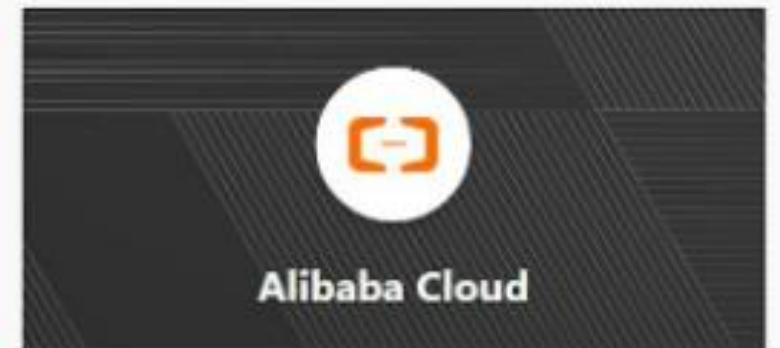
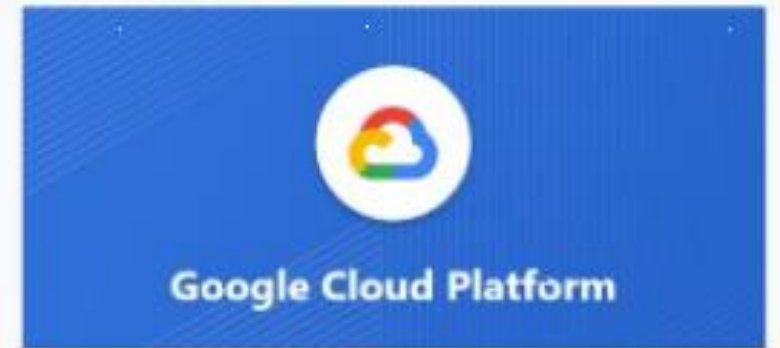
```
provider "aws" {  
  region    = "us-east-2"  
  access_key = "PUT-YOUR-ACCESS-KEY-HERE"  
  secret_key = "PUT-YOUR-SECRET-KEY-HERE"  
}
```

A provider is responsible for creating and managing resources.

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

Overview of Provider Architecture :





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 end up 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",
```

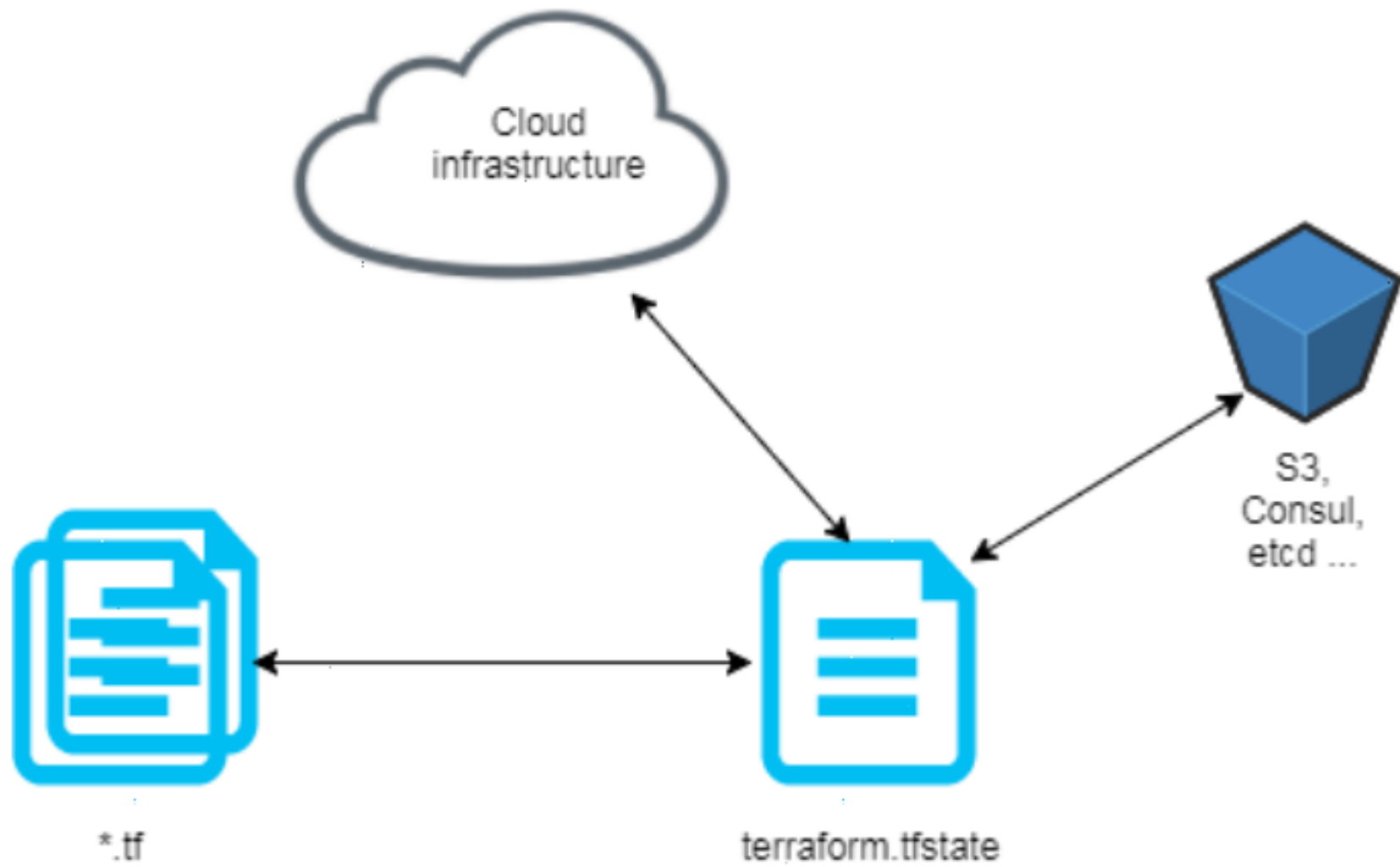
- Note: -auto-approve option can be given alongwith terraform apply to avoid the human intervention.

# 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


```



# 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>
```