

Raman Khanna

Introduction

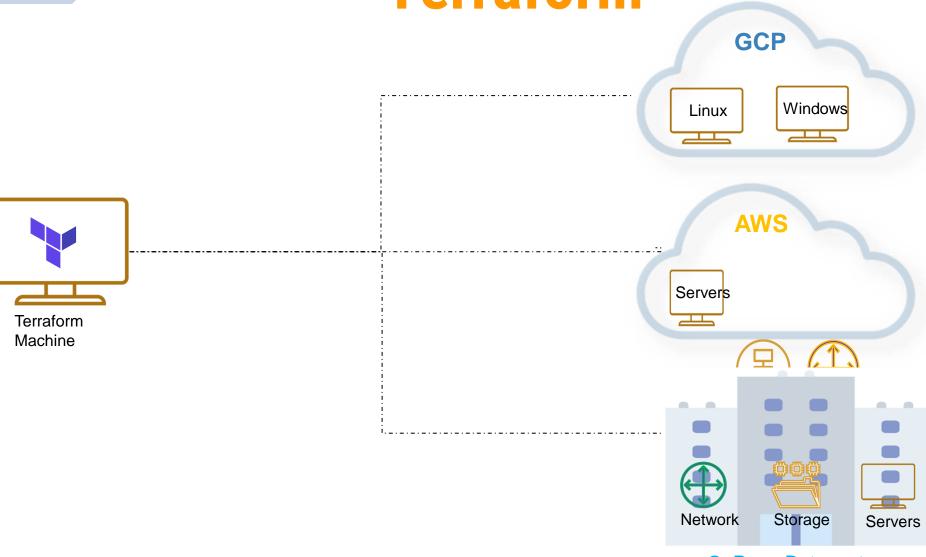
Your Name

Total experience

Background – Development / Infrastructure / Database / Network

Experience on AWS Cloud and Terraform

What is Orchestration?



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



Communication









Planning



Monitoring



Automation

DevOps in Action

Continuous Feedback

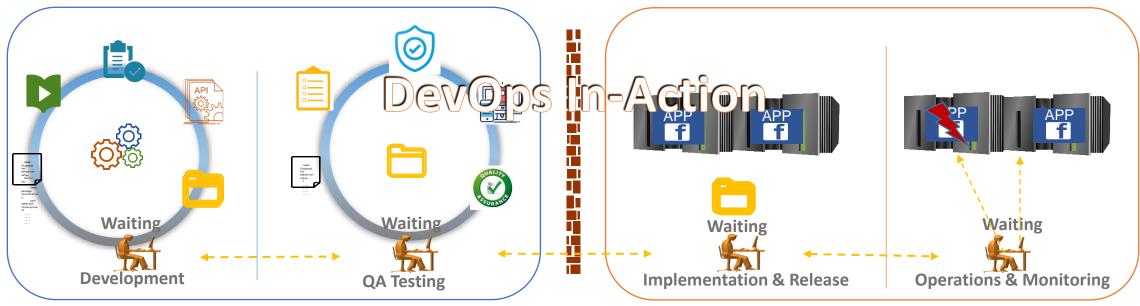
Continuous Improvement

Continuous Planning

Continuous Continuous Delivery

Continuous Deployment

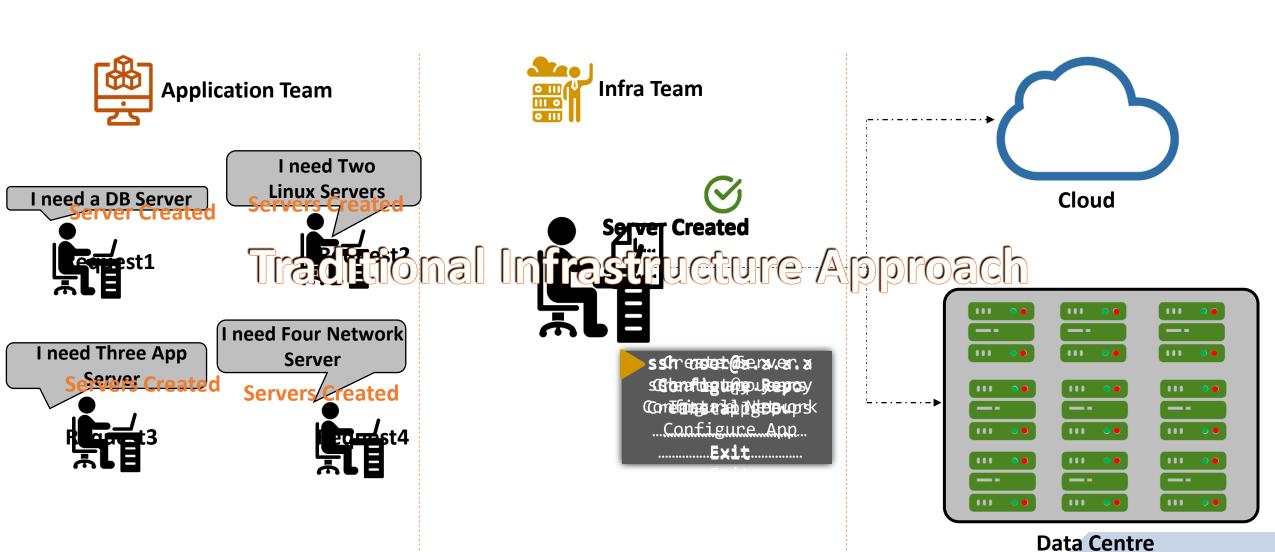
Continuous Monitoring



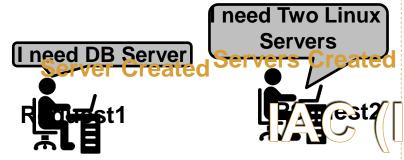
Development

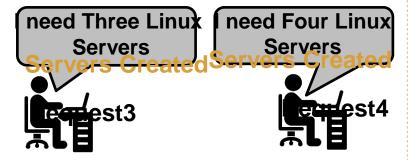
Opsrations

Why DevOps IaC









```
Infra Team
      File is: main.tf
      provider "aws" {
        region = "us-east-1"
                                                        Cloud
      resource "aws_instance" "requestfour" {
        instance_type = "t2.micro"
        tags = {
          Name = "DevOpsInAction"
      output "myawsserver" {
        value =
       "${aws_instance.myawsserver.public_ip}"
                                                          111
                                                  •
                                                                 laC is Managing Infrastructure in files rather than
```

manually configuring resources in a user interface

Data Centre

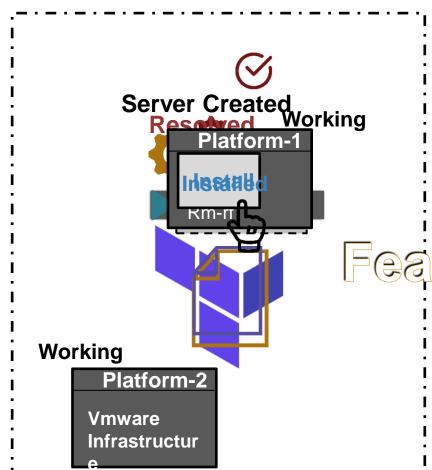
Terraform is an easy-to-use IT Orchestration & Automation Software for System Administrators & DevOps Engineers.

- > 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

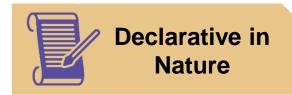




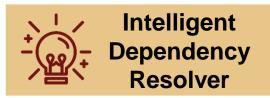
















Providers

Variables



Provisioners

DataSources

Outputs

Modules

File extension .tf

```
main.tf
provider "aws" {
 region = "us-east-1"
                             Provider Block
resource "aws_instance" "myserver" {
 ami _ "ami-030ff268bd7b4e8bE" | Sample Code |
tags = {

Resource Block
    Name = "DevOpsInAction"
output "myserveroutputs" {
 description = "Display Servers Public IP"
                                                   Output
 value = "${aws_instance.myserver.public_ip}"
                                                    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
Гуре	Config Mgmt	Config Mgmt	Config Mgmt	Config Mgmt	Orchestration	Orchestration
nfrastructure	Mutable	Mutable	Mutable	Mutable	Immutable	Immutable
anguage	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

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 laaS, 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.

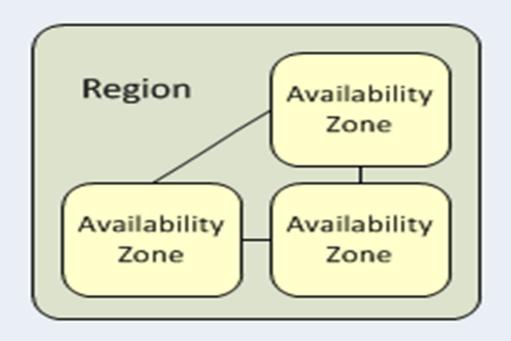
Scalability: Facing some resource issues, no problem within seconds you can scale up the resources and improve your application performance. This cannot be compared with traditional IT datacenters.

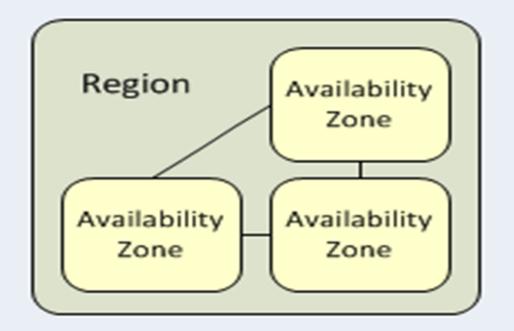
Multiple OS's: Choice and use any supported Operating systems.

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. Infact systems based on AWS are usually more secure than in-house IT infrastructure systems.

Amazon Web Services



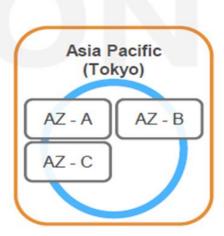


At least 2 AZs per region.

- 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.

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.

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.

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.

Current:

22 AWS Regions

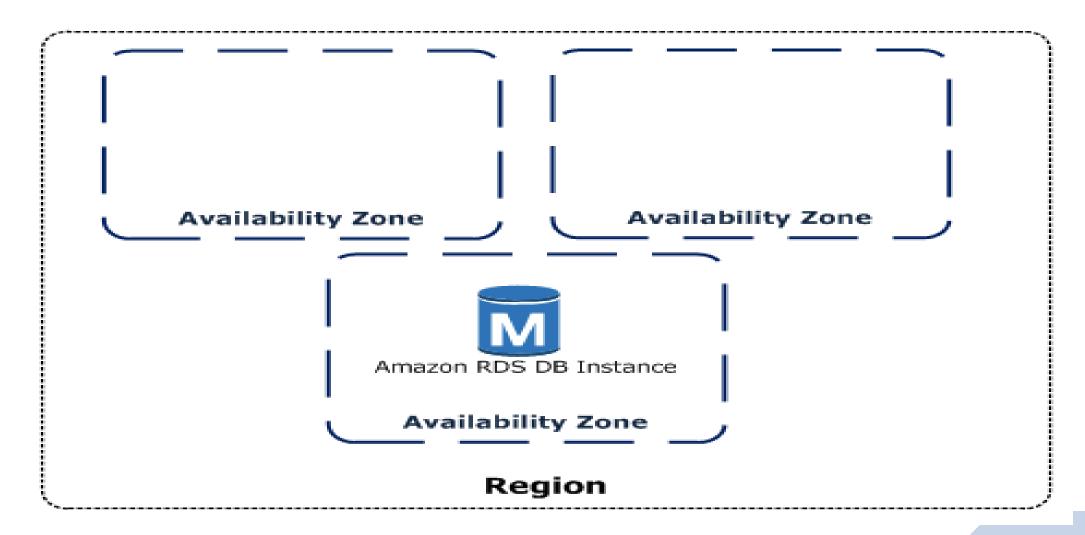
69 AZs

Upcoming:

4 Regions

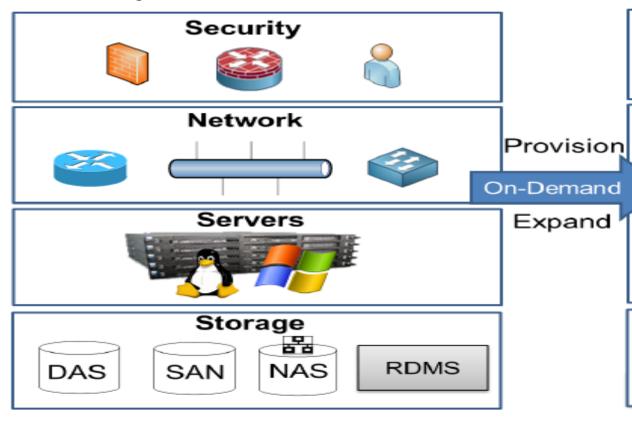
13 AZs



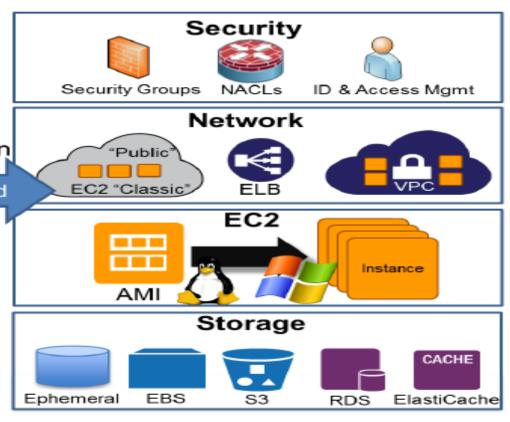


AWS

Enterprise Infrastructure



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

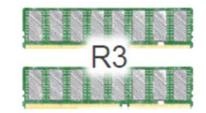












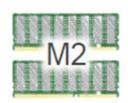


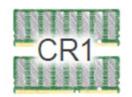












EC2 Security Group

Security Group is a Virtual Firewall Protection.

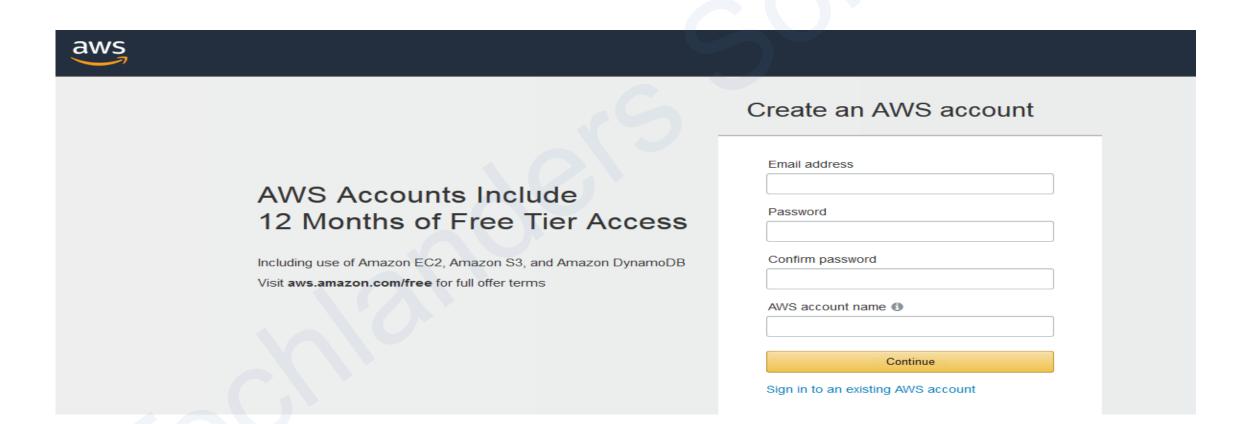
AWS allows you to control traffic in and out of your instances through virtual firewalls called security groups.

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



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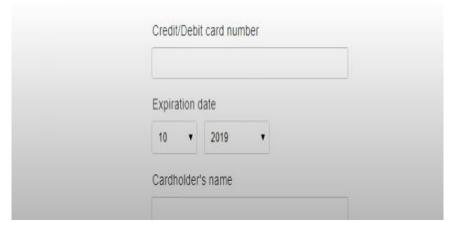
er creating the account
andhi Nagar
t suite, unit, building, floor, etc
rovince or region
nde
oue
ernet Services Pvt. Ltd. Customer
with an India contact address are now required to Amazon Internet Service Private Ltd. (AISPL). local seller for AWS infrastructure services in
eck here to indicate that you have read I agree to the terms of the AISPL stomer 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.



Select a Support Plan

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



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:

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

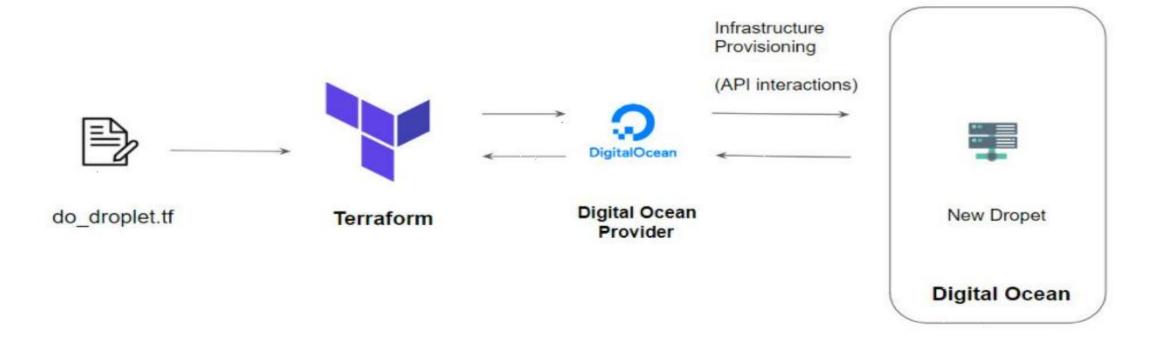
A provider is responsible for understanding API interactions and exposing resources over to a particular cloud service provider. Most providers configure a specific infrastructure platform (either cloud or self-hosted).

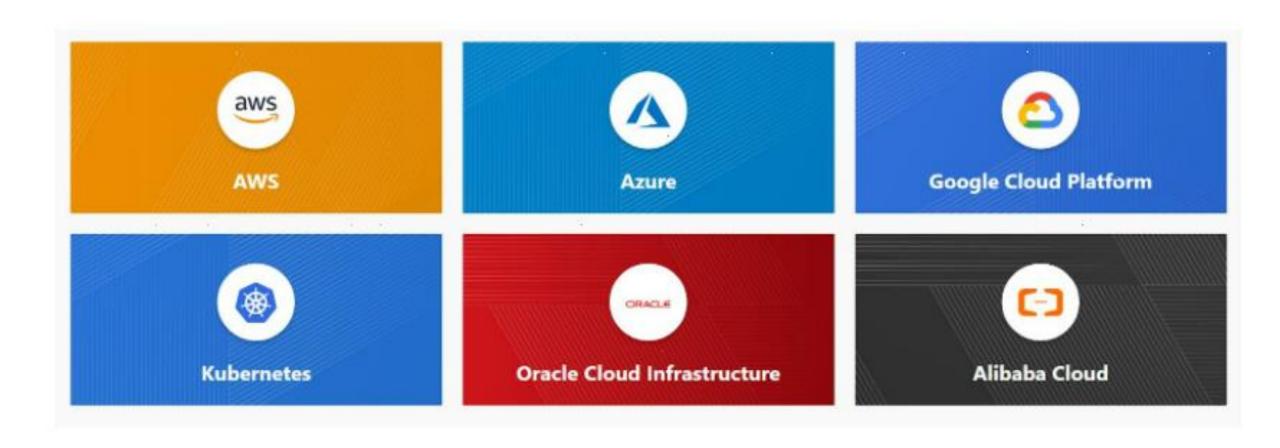
```
provider "aws" {
  region = "us-east-2"
  access_key = "PUT-YOUR-ACCESS-KEY-HERE"
  secret_key = "PUT-YOUR-SECRET-KEY-HERE"
}
```

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 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:

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

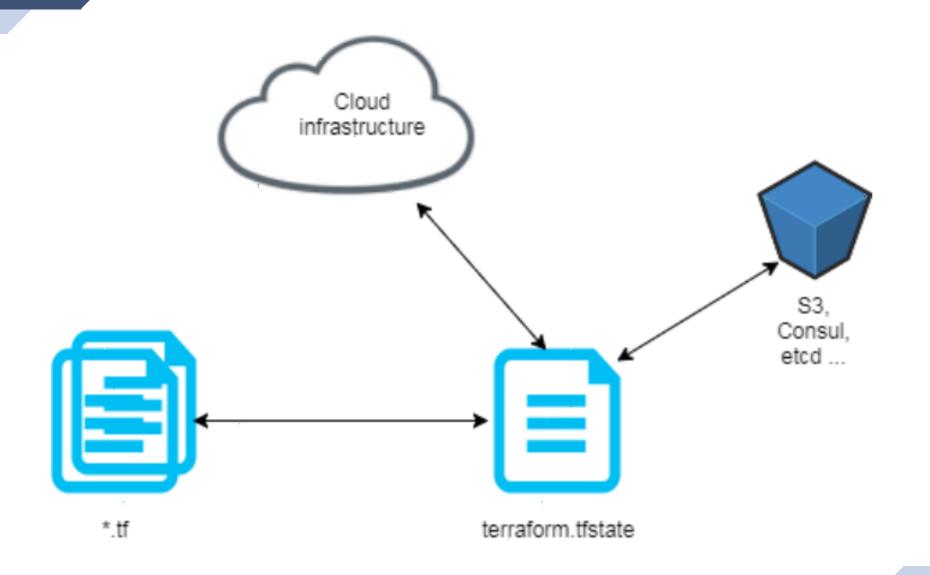
• Terraform apply will create **tfstate** file to maintain the desired state:

```
[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:



Desired State Maintenance (DSC)

• Delete the newly created server and then check for the 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" {
```

[root@TechLanders aws]# terraform plan

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]
```

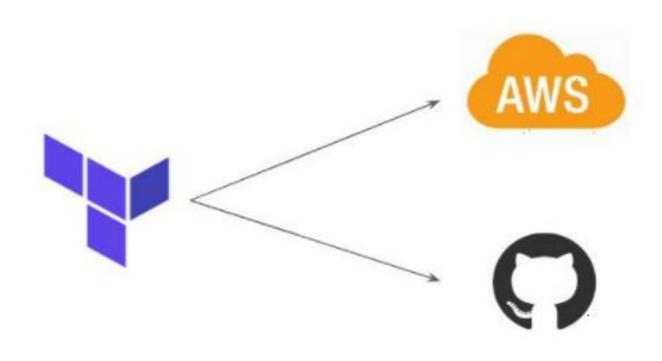
Refreshing the state

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

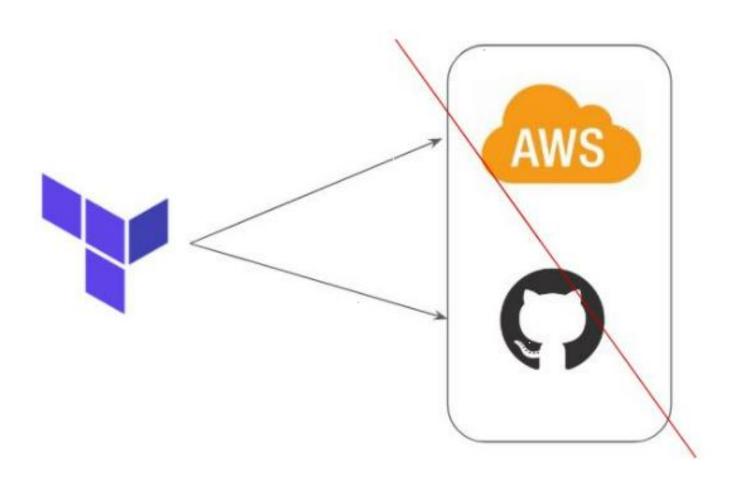
C:\Users\gagandeep\Desktop\terraform>terraform refresh
google_compute_network.vpc_network: Refreshing state... [id=projects/accenture-286519/global/networks/terraform-net3]
google_compute_address.vm_static_ip: Refreshing state... [id=projects/accenture-286519/regions/us-central1/addresses/terraform-static-ip1]
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:

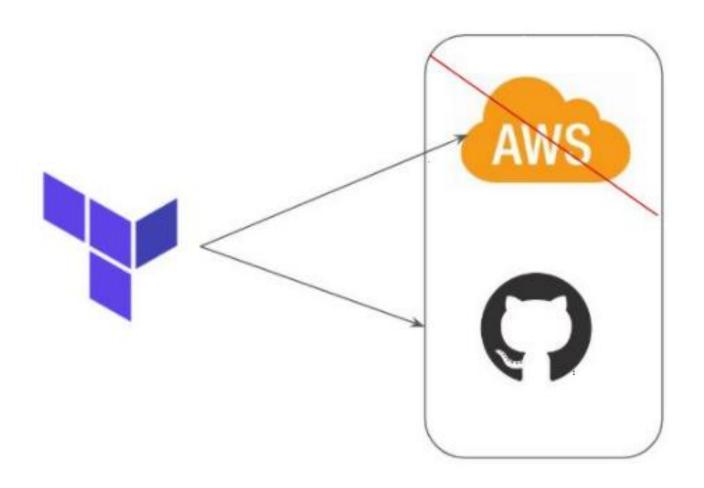


Destroying Infra in one go

• 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.
```



Destroying Infra

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

terraform destroy -target github_repository.repo

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

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

- destroy

Terraform will perform the following actions:

```
\# github_repository.repo will be destroyed
```

```
- resource "github_repository" "repo" {
```

- allow_auto_merge = false -> null

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

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

Note: Multiple –target options are supported as well.

Lab 5: Desired ,current state and last known configuration

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

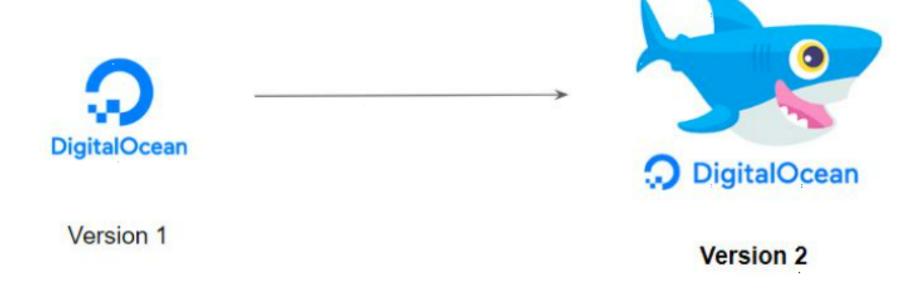
If there is a difference between the two, terraform plan presents a description of the changes necessary to achieve the desired state.



LAB 6:CHALLENGE WITH DESIRED AND CURRENT STATE ...

Provider plugins are released separately from Terraform itself.

They have a different set of version numbers.



PROVIDER VERSIONING:

- Different Version Parameters :
- version = "2.7"
- version = ">= 2.8"
- version = " $\sim > 2.x$ "
- version = "<= 2.8"</pre>
- version = ">=2.10,<=2.30"</pre>

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.

