# HashiCorp Certified: Terraform Associate (002)

<https://www.hashicorp.com/certification/terraform-associate>

The Terraform Associate certification is for Cloud Engineers specializing in operations, IT, or development who know the basic concepts and skills associated with open source HashiCorp Terraform. Candidates will be best prepared for this exam if they have professional experience using Terraform in production, but performing the exam objectives in a personal demo environment may also be sufficient. This person understands which enterprise features exist and what can and cannot be done using the open source offering. Visit our exam partner to [schedule and take the exam](https://hashicorp-certifications.zendesk.com/hc/en-us/articles/360049382552).

**Prerequisites**

* Basic terminal skills
* Basic understanding of on premises and cloud architecture

**Product Version Tested**

Terraform 1.0 and higher.

**Preparing for the Exam**

Certification preparation learning guides for the new version of the Terraform Associate will be posted soon. For now, use the current [Terraform Associate Tutorial List](https://learn.hashicorp.com/collections/terraform/certification-associate-tutorials) to start your studying.

**Exam Details**

|  |  |
| --- | --- |
| **Assessment Type** | Multiple choice |
| **Format** | Online proctored |
| **Duration** | 1 hour |
| **Price** | $70.50 USD plus locally applicable taxes and fees Free retake **not included** |
| **Language** | English |
| **Expiration** | 2 years |

# Exam Objectives

## **Understand infrastructure as code (IaC) concepts**

## Explain what IaC is

* Human readable files that defince infrastructure for both cloud and on-prem
* Immutable
* declarative
* Providers Utilizes APIs
* Allows scalability to be automated
* Workflow stages (same on any platform)
  + Write
    - Define resources
    - Can be across multiple cloud providers and services
  + Plan
    - Terraform creates an execution plan describing infrastructure it will
      * Create
      * Update
      * Destroy
  + Apply
    - On approval, terraform performs proposed operations in correct order
* Types of IaC
  + AdHoc Scripts
    - Better than nothing still not framework
  + Configuration Management Tools
    - Chef
    - Puppet
    - Ansible
    - SaltStack
    - Install and manage software o existing servers
    - Usually mutable
      * Each server slowly has config creep
  + Server Templating tools
    - Docker
    - Packer
    - Vagrant
    - Full server template including any software
  + Orchestration tools
  + Provisioning Tools
    - Terraform
    - CloudFormation
    - OpenStack
    - Create the servers (infrastructure) themselves
* Procedural vs Declarative
  + Procedural
    - Code defines step by step process
    - When you run the code a second time it creates new resources
    - Does not track state
  + Declarative
    - Desired state
    - To add just add more resources to the code and it will add only new, not change existing
    - Immutable
    - Code always represents the current state

### Describe advantages of IaC patterns

* Allows you to use only what you need instead of keeping all the time
* Immutable
* Versioning
* Reuse components
* Self service
* Configuration consistency
  + Idempotent
  + Consistent
  + Repeatable
  + Predictable
* Minimize risk
  + Automates process
  + Form of documentation
* Increased efficiency in dev
  + Sandbox environment same for all and built quickly
* Reduce cost
  + Tear down infrastructure when not needed
  + elastic

## **Understand the purpose of Terraform (vs other IaC)**

https://developer.hashicorp.com/terraform/intro/vs

## Explain multi-cloud and provider-agnostic benefits

* What is Terraform
  + Open source
  + Masterless
    - No server to hold configs
  + Agentless
  + Used to do this to infrastructure
    - Build
    - Change
    - Manage
  + Used files ending in
    - .tf
    - .tf.json
  + Same workflow
* Multi-Cloud
  + Single workflow
  + Works on public and private clouds
  + Cloud agnostic
* Infrastructure defined as code
  + Shared and reused
  + Modulare
* Execution plan
  + Terraform plan
  + Information about what terraform wil do
  + Shows what will change
* Resource Graph
  + Efficient build
  + Parallel execution of anything not dependent
* Comparison
  + CloudFormation
    - Not Cross Platform only for AWS
    - Uses YAML or JSON
    - Good Conditional functions
    - Wait condition and creation policy
    - Not quite as modular (nested stacks)
    - Not as good validation
    - Harder to read than terraform
    - State file stored native to AWS
  + Azure ARM
    - Only Azure
    - JSON
    - Not as modular
    - Not as good validation
    - Harder to read JSON
    - State stored in Azure
  + Google Cloud Deployment Manager
    - Only GCP
    - YAML, Jinja or Python
    - Not as modular
* Terraform Architecture
  + Terraform Core
    - Binary written in GO
    - Communicates with terraform plugins via RPC (remote procedure calls)
    - Terraform CLI
    - Responsibilities
      * IAC: reading and interpolating configuration files and modules
      * Resource state management
      * Resource graph construction
      * Plan execution
      * Communication with plugins
  + Terraform Plugins
    - Exposes an implementation for a specific service ( AWS, Azure, VMWare etc) or provisioner (BASH)
    - Defined in the terraform configuration file
    - Responsibilities Provider Plugin
      * Init of any included libraries
      * Auth with infra provider
      * Def resources map to specific services
    - Responsibilities Provisioner Plugin
      * Execute commands on resource following creation or destruction
    - Terraform init looks for plugins in default locations
      * Can be overridden with -plugin-dir=<PATH>
    - Upgrading Plugins
      * -upgrade checks found version with hashicorp for newer version

## Explain the benefits of state

* State files are stored on the local file system or remote backend ( think S3 )
* Declarative
* Terraform config always shows the current state
* Maps configurations to real world
  + One remote object mapped to one resource instance
* Stores metadata
  + Dependencies
* Stores cache of all resource values in state
  + For performance
  + State is available in the file so terraform does not have to query the provider.
* Everyone should be working with the same state file (
  + Store it on a shared location
  + Remote locking
    - Only one person can run terraform against state file at a time.
* State keeps track of resources already provisioned and only modifies what needs to be changed
* Backends
  + Local backend
    - Default stored on local directory where terraform config is kept.
    - Workspaces
      * A unique state in the same directory.
  + Remote backend
    - Allows working in teams. Everyone uses same state file
    - Sensitive data stays off local disk
    - Remote operations – some commands can be run remotely so they won’t depend on your system being logged in after you run terraform apply
    - Classes of backends
      * Standard
        + Includes state management and possibly locking
      * Enhanced
        + Includes remote operations on top o standard features
        + Terraform cloud or enterprise
    - Configured in either a terraform / backend block or a backend file
      * $.backendname.tfbackend

## **Understand Terraform basics**

### Install and version Terraform providers

* Provider
  + Plugin downloaded when you run Terraform Init
  + Provides the code so terraform knows what to do to interact with APIs and resources
  + Can be defined in any .tf or tf.json file
    - BEST PRACTICE
      * Create providers.tf or required\_providers.tf
  + Can also specify version
    - Or range of versions for the provider
  + Required\_Provider block
    - Sets the provider version for all nested configs
    - Can have multiple provider blocks for each provider
    - Can reference variables but not resource attributes
  + Alias:
    - Multiple configurations for the same provider
    - Muttiple regions of a cloud provider
    - Configuration\_alias in required\_providers defines alias
    - Procider without the configuration\_alias is considered default.
      * If all have alias then implied empty provider is default
* Provisioner
  + Terraform cannot track state of these as they are usually scripts
  + Recommended as last resort
  + Run time (only on init)
  + Destroy time (only on destroy)
  + Can have multiple per resource
    - Will be executed in order
  + Can use with Null resource if you want to run provisioner outside of a ‘real’ resource.
  + Use case
    - Loading data into a VM
    - Bootstrappin a VM for a config manager
    - Saving data locally on your system
  + Provisioner types
    - Local-exec
      * Runs code locally to extract some information.
      * Can also define what to do when this local code fails
        + On\_failure
      * What to do during destroy
        + When = destroy
        + Destroy provisioners are run before resorce is destroyed
        + If fails will rerun when you run terraform apply
      * Can have multiple local-exec in same resource block
    - File
      * Copies files or directories from the machine where terraform is running to the new resource.
      * Ssh or winrm connection
    - Remote-exec
      * Run script on remote resource after it is created
      * SSH or WINRM
      * Inline
        + Commands executed in sequence
* Resources
  + Part of configuration
  + Block create, update, destroy actual resources
  + Use plug-in to do the actual work
  + Lifecycle setting
    - Tell terraform how to create / update / delete
* Variables
  + Input Variable
    - Defined in main.tf or variables.tv
    - Defined but no value and during runtime you will be queried for input
  + Can reference resources by what I call pseudo vars
    - <Resource Name>.<Attribute>
  + Environment Variables
    - <https://developer.hashicorp.com/terraform/cli/config/environment-variables>
    - TF\_VAR\_Name
      * Export TV\_VAR\_rgname=example-rg
    - TF\_LOG
      * Logging level
    - TF\_LOG\_PATH
      * Path to where log is written
    - TF\_INPUT
      * Sets the input flag
      * 0 = false
        + Disable prompts for variables that haven’t had the values specified
    - TF\_CLI\_ARGS and TF\_CLI\_ARGS\_name
      * Supplies addition args to the command line
      * Affect all terraform command
    - TF\_DATA\_DIR
      * Changes per-working directory data.
      * Default it is written to .terraform
    - TF\_WORKSPACE
      * Same as terraform workspace
    - TF\_IN\_AUTOMATION
      * If non empty, output will not suggest what commands to run next
    - TF\_REGISTRY\_DISCOVERY\_RETRY
      * Max number of requests retries remote registry client will attempt for connection errors
    - TF\_REGISTRY\_CLIENT\_TIMEOUT
      * Timeout for requests to remote registry
      * Default 10s
    - TF\_CLI\_CONFIG\_FILE
      * Location of cli config file
    - TF\_IGNORE
      * If set to trace
        + Output debug messages to display ignored files and folders
  + Defined in file
    - Terraform.tfvars
    - Terraform.tfvars.json
    - Or ending in .auto.tfvars or .auto.tfvars.json
    - Any other file name and it will need to be called out in the terraform execution command
* Output
  + Return values of a Terraform resource / module /data
  + Use case
    - The output of one resource etc can be used in another if there is a dependency
    - Print output to CLI by running Terraform Apply
    - With remote state, other configs can help with root module outputs
  + Helps you expose some info from resource blocks
  + Optional arguments
    - Description
      * Describes the output
    - Sensitive
      * Prevents output from showing on the CLI via Terraform apply
      * Could still be seen via other ways
    - Depends\_on
* Data Sources
  + Allow you to extract output or info from already existing resources provisione by any other terraform config or manually or by any other means.
  + Data sources evaluated during plan phase (or apply if you skip plan)

### Describe plugin-based architecture

* [Plugin Development - How Terraform Works With Plugins | Terraform | HashiCorp Developer](https://developer.hashicorp.com/terraform/plugin/how-terraform-works)
* Terraform Core
  + Binary written in GO
  + Communicates with terraform plugins via RPC (remote procedure calls)
  + Terraform CLI
  + Responsibilities
    - IAC: reading and interpolating configuration files and modules
    - Resource state management
    - Resource graph construction
    - Plan execution
    - Communication with plugins
* Terraform Plugins
  + Exposes an implementation for a specific service ( AWS, Azure, VMWare etc) or provisioner (BASH)
  + Defined in the terraform configuration file
  + Responsibilities Provider Plugin
    - Init of any included libraries
    - Auth with infra provider
    - Def resources map to specific services
  + Responsibilities Provisioner Plugin
    - Execute commands on resource following creation or destruction
  + Terraform init looks for plugins in default locations
    - Can be overridden with -plugin-dir=<PATH>
  + Upgrading Plugins
    - -upgrade checks found version with hashicorp for newer version

### Write Terraform configuration using multiple providers

### Describe how Terraform finds and fetches providers

## **Use Terraform outside of core workflow**

### Describe when to use terraform import to import existing infrastructure into your Terraform state

* If you create infrastructure outside of terraform, you must create a configuration matching this and then import using terraform import

### Use terraform state to view Terraform state

* Terraform\_remote\_state
  + Use to retrive output from state another state file

### Describe when to enable verbose logging and what the outcome/value is

* Debugging
  + TF\_LOG
    - Environment variable to enable detailed logging
    - Trace
      * Default
      * Most detailed
    - Debug
    - Info
    - Warn
    - Error
  + TF\_LOG\_PATH
    - Environment variable where to save logs
  + Crash.log
    - Log file create if terraform crashes
      * Includes crash log
        + Not useful to us on devs
      * Panic message and backtrace

## **Interact with Terraform modules**

### Contrast and use different module source options including the public Terraform Module Registry

* Module
  + Config file ending in tf or tf.json
  + Consists of
    - Resources
    - Inputs
    - Outputs
* Source
  + Mandatory
  + Local path of the module config file
    - Or
  + Remote reference URL
* Terraform get
  + Retrieves updated or new module.
  + Better than init as that also deals with plugins and backends
* Location
  + Remote modules downloaded to the .terraform directory
  + Local modules are used from the local path
    - Because of this updates to local modules automatically discovered. No need to rerun init or get
* Can reference modules from: <https://developer.hashicorp.com/terraform/language/modules/sources>
  + Local path
  + Terraform Registry
    - Published modules by community members
    - Public registry
    - Supports versioning
  + Github
    - Clones github repo
    - HTTPS or SSH
    - Use ref argument
  + Bitbucket
    - Clones repo
  + Generic GIT
    - Points to any git repo
    - Clones
  + Git Mercurial Repo
    - Mercurial Git
    - clones
  + HTTP Urls
    - Performs GET from URL
    - Can read
      * Zip
      * Tar.bz2 and tbz2
      * Tar.gz and tgz
      * Tar.xz and txz
  + S3
    - Uses S3 API to download
    - Looks for aws credentials
      * Environment variables
      * .aws/credentials file in home dir
  + Google Cloud Storage (GCS)
    - Uses Google Cloud SDK
* Version
  + Optional
  + Can’t use for local path
* Module Meta-arguments
  + Count
    - Number of instances to create from module
  + For\_each
    - Loops thru module
  + Providers
    - Allows you to define multiple providers in multiple configs
  + Depends-on
    - Defines explicit dependency
    - Should be last resort
    - Forcefully sets dependency
* Publish modules
  + Terraform registry supports versioning
  + Generates documentation
  + Requirements
    - Github
      * Public repo
    - Named
      * Expected name syntax
        + Terraform-<provider>-<NAME>
    - Repository description
      * One line description of repo
    - Standard module structure
      * Allows terraform registry to generate documentation, track resource usage, pars submodules, etc
    - X.y.z tags for releases
  + Log into terraform registry with Github account and publish
* Gotchas
  + File paths
    - Relative to current working directory
    - If file function in not the current working directory this causes issues
    - Path Reference
      * Path.<TYPE>
        + Path.module

Returns filesystem path of the module where the expression is defined

* + - * + Path.root

Root module path

* + - * + Path.cwd

Path of current working directory

* + Inline Blocks
    - Can’t mix inline and separate resources on same resource.
    - Use separate resources as best practice

### Interact with module inputs and outputs

* Terraform.tvars
  + Initializes variables declared elsewhere
  + Input can either be thru this file or via terraform cli
* Input variables
  + Defined in module
  + Passed in module block
* Outputs
  + Returns values from module
  + Module.modulename.outputname

### Describe variable scope within modules/child modules

* Local variables
  + Only used within module
  + No exposed outside
  + Locals {} block

### Set module version

* Easiest way to version
  + Place module in separate git repository
  + Set source to the git repo
  + And ref the tag / release in the source url

## **Use the core Terraform workflow**

### Describe Terraform workflow ( Write -> Plan -> Create )

* Workflows
  + Lifecycle
    - Terraform init
    - Terraform plan
    - Terraform apply
    - Terraform destroy
* Loops
  + Count
    - Iterates resource x number of times
    - Can use Count.index to make unique names
      * Can use array index to make names unique
    - Can use length of list to tell count how many
    - Limitations
      * Can’t use nested counts
      * When modify resource that has a count, terraform treats count as an array, and as it is change it will need to destroy and recreate
      * Can’t reference any resource output
        + Any ref must be available during the plan phase
  + For\_each
    - Loop over sets, and maps (for resources)
      * Can convert list to set using function: toset()
    - Can create multiple copies of entire resource
    - Multiple copies of inline code
    - For\_each returns a map of resources instead of a list so removing a middle resource does not cause destroy and recreate
    - Limitations
      * Can’t reference any resource output
        + Any ref must be available during the plan phase
  + For
    - Use for both lists and maps
      * Applies a function to each item in the list / map
    - String – loop lists and maps within string
      * String directive
        + %{}
* Conditionals
  + Count
    - If using Count
      * Use in place of if
      * Count = 0
        + Nothing created (false)
      * Count = 1
      * Count = var.somevar ? 1 : 0
      * Count = format(…
    - If else
      * Use two resources
        + If

Count = var.example ? 1 : 0

* + - * + Else

Count = var.example ? 0 : 1

* + For\_each
    - If you pass a for\_each expression as empty collection it will produce 0 resources or inline blockes
    - Can use a for expression (with if) to condition within for\_each
  + If string directive
    - %{if <CONDITION>}<TRUEVAL>%{else} <FALSEVAL>%{endif}
* Terraform CLI
  + Terreform console
    - Test or get the output from the code of certain functions
  + Terraform fmt
    - Rewrite config files to canonical format and style
    - Adjusts the config code so it is in readable format
    - Style conventions
      * Indent 2 spaces
      * Align = sign
      * Place arguments together at the top before blocks
      * Separate with black line to separate logical groups
      * Blocks with arguments and meta-arguments, list meta-arguments first and separate from arguments with blank line
      * Top level blocks separate by blank lines
      * Nested blocks separate by blank line
  + Terreform graph
    - Generate visual representation of terraform config or execution plan
    - DOT format that can be converted to image using graphviz
  + Terraform refresh
    - Update state file
    - Compares state to real world infrastructure
    - No changes to infrastructure made
    - Helps to figure out drift
  + Terraform show
    - Shows output from state file
  + Terraform taint
    - Mark specific resources to get destroyed and recreated
    - Useful if encounter deployment error
    - Makes changes to state file instead of making real changes
    - Terraform apply then destroys resource and recreates
    - Deprecated use terraform apply -replace
  + Terraform workspace
    - Subcommands
      * Terraform workspace new <NAME>
        + Creates multiple landscapes (workspaces)
      * Terraform workspace select
        + Switch to different workspace
    - Method to isolate configs
    - Each workspace has its own state file
      * Local
        + State stored in directory terraform.tfstate.d
      * Remote
        + Stored on remote backend
        + Current workspace is stored locally as well
    - Default workspace named default
    - Can reference workspace from within terraform config
      * ${terraform.workspace}
  + Terraform force-unlock
    - <https://developer.hashicorp.com/terraform/cli/commands/force-unlock>
    - Unlocks a state file
    - Only works on remote backend
  + Terraform validate
    - <https://developer.hashicorp.com/terraform/cli/commands/validate>
    - Shows detailed info about error in config file
    - Auto ran when you run plan or apply
    - Requires configured backedn
  + Terraform import
    - Import already existing resource into state file
* DevOps

### Initialize a Terraform working directory (terraform init)

* Downloads the required providers
* Initializes terraform in working directory
* Reasons to run
  + Added new
    - Module
    - Provider
    - Provisioner
  + Updated required version
    - Module
    - Provider
    - Provisioner
  + Want to change or migrate the configured backend
* Sub-commands
  + -backend=true
    - Configures backedn for this config
  + -backend-config=path
    - Path to HCL file with key/value assignments
    - Merged with config file
    - Backend must be in config file
  + -from-module=SOURCE
    - Copies given module to target direcetory
    - Before init
  + -lock=true
    - Locks state file
  + -no-color
    - Output won’t have color
  + -plugin-fir
    - Dir of plugin binaries
    - Overrides default search path
    - Can be used multiple times
  + -reconfigure
    - Reconfigures backend ignoring saved config
  + -upgrade=false
    - If installing modules or plugins ignores previously downloaded objects and installs latest version allowed within config contraints
  + -verify-plugin=true
    - Verifies authenticity and integrity of auto downloaded plugins

### Validate a Terraform configuration (terraform validate)

* Check for errors in config
* Can run by itself or runs during plan or apply
* Does not check format syntax

### Generate and review an execution plan for Terraform (terraform plan)

* Shows what terraform wil do before actually making any changes
* Determines which actions need to be taken
* Performs a refresh of the backend
* Sub-commands
  + -destroy
    - plan to destroy all resources in config
  + -input=true
    - Asks for input for variables if not set
  + -out=path
    - Writes plan file to given path
    - Can be used to input apply
  + -state=statefile
    - Path to terraform state file
  + -target=resource
    - Resource to target
    - Plan will be limited to this resource
  + -var ‘foo=bar’
    - Sets variable
  + -var-file=foo
    - Sets variables from a file

### Execute changes to infrastructure with Terraform (terraform apply)

* Actually performs any changes specified by the terraform files
* Provisions or updates infrastructure
* Updates state file
* Sub-commands
  + -auto-approve
    - Skip interactive plan approval
  + -backup=path
    - Back up existing state before modifying
  + -compact-warnings
    - Non-error warnings will be shortend
  + -input=true
    - Ask for input for variables
  + -lock=true
    - Locks state file
  + -no-color
    - If specified output willnot have color
  + -parallelism=n
    - Limits number of concurrent operations
    - Default = 10
  + -refresh=true
    - Updates state prior to checking for differences
  + -replace = [resource]
    - Replace the resource instance
    - Used when one or more resources have become degraded or not working correctly
    - Use if resource would normally be updated or no action when apply
  + – state=path
    - Path to read and save state
  + State-out=path
    - Path to write state to that is diff than -state
    - Used to preserve old state
  + -target=resource
    - Provides a resource to target
    - Limits apply to this resource and dependencies
  + -var ‘foo=bar’
    - Sets variable
  + -var-file=foo
    - Sets variables from file
* Zero-Downtime Deployment
  + Create\_before\_destroy
    - Will create resource before destroying to prevent downtime
  + Will roll back if deployment does not complete
  + Limitations
    - Resets ASG size back to minimum

### Destroy Terraform managed infrastructure (terraform destroy)

* Deletes all resources in config file
* Sub-commands
  + -backup=path
    - Path to backup current state before destroy
  + -auto-approve
    - Skip interactive approval
  + -refresh=true
    - Update state prior to checking diff
  + -state=path
    - Path to read and save state
  + -state-out=path
    - Path to write state that is different from -state
  + -target=resource
    - Target resource
    - Limit to this resource and dependencies
  + -var ‘foo=bar’
    - Set variable
  + -var-file=foo
    - Sets variables from file

### Apply formatting and style adjustments to a configuration (terraform fmt)

## **Implement and maintain state**

### Describe default local backend

* Terraform.tfstate
* Located in the directory you run terraform init from
* Json file
* Terraform plan is a diff between running resources and state file
* Terraform import
  + Imports into state
  + If you have existing infrastructure use this command
* Terraform state command
  + <https://developer.hashicorp.com/terraform/cli/commands/state>
  + Advanced state management
    - Use instead of modifying state file directly
  + Inspecting State
    - Terraform state list [options] [address…]
      * List resources within state matching address
        + Or all resources
    - Terraform state show [options] ADDRESS
      * Show attributes of a single resource or all
    - Terraform state refresh
      * Reads current settings from all managed remote objects and updates state to match
      * Deprecated (use terraform apply -refresh-only)
  + Force Re-creation (Tainting)
    - Terraform Taint
      * Marks state resource as tainted. Will be recreated on next apply
      * Deprecated – use terraform apply -replace=<resource>
    - Terraform Untaint
      * Removes taint status from taint if you determined the resource is functioning correctly
  + Moving resources
    - Terraform state mv [options] SOURCE DESTINATION
      * Retain resource but track it as a different resource instance address
        + Rename resource block or moved to diff module
    - Terraform state rm [options] ADDRESS
      * Remove from state the resource so state thinks it has already been destroyed
      * Can be used to keep resource when destroying
    - Terraform state replace-provider [options] FROM\_PROVIDER\_FQDN TO\_PROVIDER\_FQDN
      * Can change provider even if resources in state
  + Disaster Recovery
    - Terraform force-unlock [options] LOCK\_ID
      * Manually unlock the state
    - Terraform state pull
      * Downloads state
      * Updates local copy
    - Terraform state push
      * Pushes state to remote
* Do not store state files in version control
  + Easy to forget to pull down latest changes
  + Do not provide locking
  + All data stored in plain text
    - Secrets could be included
  + Arguments
    - Address of the resource
    - Resource specific ID
  + Terraform uses the API to find the resource and add it to your state file
* Doesn’t work well with teams. Need to use shared storage

### Describe state locking

### Handle backend and cloud integration authentication methods

* Azure
  + Auth methods
    - Azure cli
    - Managed service identity (MSI)
    - Service Principal and a Client Cert
    - Service Principal and client secret
      * Create new app in Azure (Service Principal)
      * Remember
        + Application (client) ID
        + Directory (tenant) ID
      * Create service principal secret
      * Provide contributor access
  + Add azurerm as required provider
* AWS
  + Auth methods
    - Static credentials
      * Access key and secret
    - Environment variables
    - Shared credentials/configuration files
    - Codebuild, ECS, EKS roles
    - EC2 Instance Metadata Service (IMDS) and IMDSv2
* GCP
  + Auth methods
    - Google cloud software development kit (SDK) cli
    - Google service account by storing credentials in separate file
      * Create project
      * Create service account
      * Grant editor role
      * Create key in json format
    - Google service account by defining values in the environment varsiable
    - Google service account by means of a valid token

### Differentiate remote state back end options

* <https://developer.hashicorp.com/terraform/language/settings/backends/configuration>
* Shared storage states
* Allows teamwork
* Usually requires authentication to access remote backend
* Supported backends
  + Local
  + Remote
  + Consul
  + AWS S3
  + Azure storage
  + Google cloud storage - GCS
  + Terraform cloud
  + Terraform pro
  + Terraform enterprise
  + http
  + Kubernetes
* Provides shared storage
* Provide locking
  + AWS requires DynamoDB for locking
* Provide encryption
* Add to terraform block to poin state to remote backend
  + Backend = {}
  + Rerun terraform init
* Terraform automatically pulls and pushes state from / to this location
* Limitations
  + Must create the shared location prior to configuring terraform to use it.
  + Backend block does not allow use of variable
    - Remote info must be copied into each modules terraform config
    - Must not copy key. This must be unique for each module otherwise you will overwrite an existing state
    - Can use partial config and then pass repeated info via terraform init -backend-config=…
* Isolation
  + You should not have the same file for all environments
  + Isolation by workspaces
    - Quick, isolated tests on same config
    - Separate named workspaces
    - Terraform workspace to switch between workspaces
    - Can reference workspace in config and modify depending on the workspace
    - Drawbacks
      * Not very isolated
        + Uses same key
        + Depends on folder structure
      * not visible in the code or terminal
        + difficult to maintain
      * error prone
  + Isolation via file layout
    - Production use cases with strong separation between environments
    - Puts each environment in separate folder
    - Configure different backend for each environment

### Manage resource drift and Terraform state

### Describe backend block and cloud integration in configuration

### Understand secret management in state files

* Should store secrets in config
* No matter how you deal with storing passwords, they are always stored in state file in plain text
* Terraform data source
  + AWS secrets manager and secret version
  + Aws systems manager parameter store
  + Aws key management service
  + Google cloud KMS
  + Azure key vault
  + Hashicorp vailt
* Manage outside of terraform
  + Lastpass etc and pass the password via environment variable

## **Read, generate, and modify configuration**

### Demonstrate use of variables and outputs

### Describe secure secret injection best practice

* Can use vault to save long lived credentials that then generate short lived credentials
* Secrets are still shown in the state file

### Understand the use of collection and structural types

### Create and differentiate resource and data configuration

### Use resource addressing and resource parameters to connect resources together

### Use HCL and Terraform functions to write configuration

* Functions
  + Convert data
  + Terraform Console
    - Allows you to test terraform functions
    - Does not change the stat file
  + Lookup(map, key, default)
    - Retrieves value of single element from a map
      * Given key
    - Returns default if key not found
  + Tostring
    - Converts arg to string
    - Not a string function

### Describe built-in dependency management (order of execution based)

## **Understand Terraform Cloud capabilities**

## Explain how Terraform Cloud helps to manage infrastructure

* SaaS version to manage terraform
* Can run terraform commands remotely
* Terraform can be run locally and stored in cloud repo
* Uses workspaces
  + Can use output from one as input to another
    - Terraform\_remote\_state
  + Dependencies
    - Run triggers

## Describe how Terraform Cloud enables collaboration and governance

* Version control (built in repo)
* Private repo to publish modules
* Policies to govern config code

## Overview

* Terraform OSS
  + Open Source
* Terraform Cloud (free)
  + Does not include SSO
    - SSO
    - Sentinal
    - Audit Logging
* Terraform Cloud for Business
* Terraform Enterprise