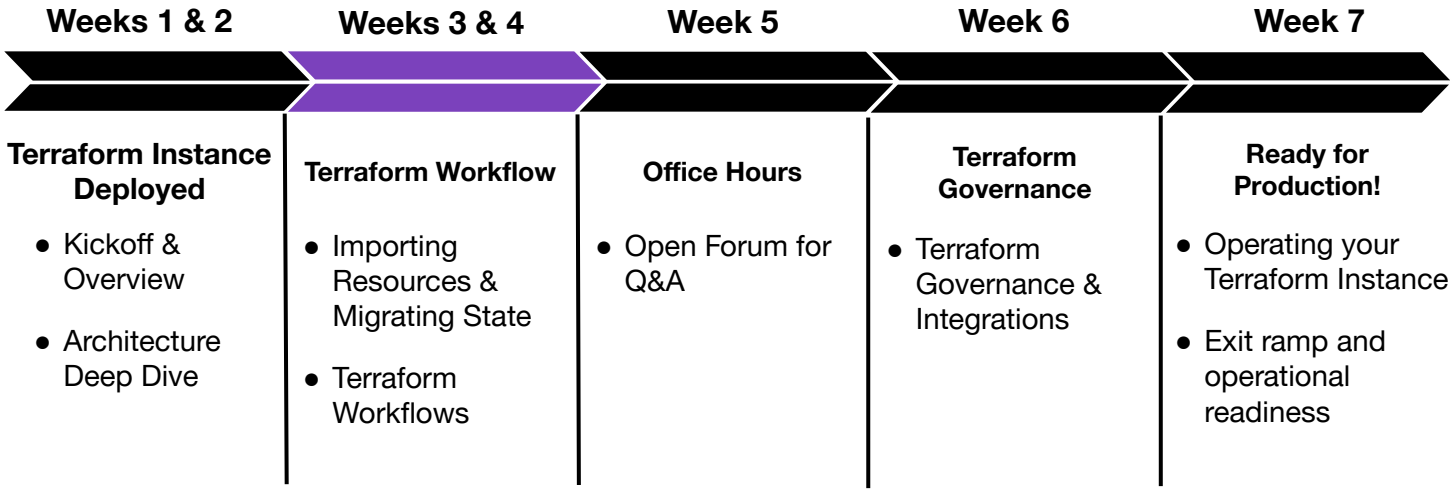
HashiCorp Terraform

Terraform Workflows

March 2023

Terraform Enterprise Path to Production



Agenda

1. Run Workflows
2. Terraform Modules
3. Private Registry
4. Workspaces
5. Variables
6. Git Repo Structure

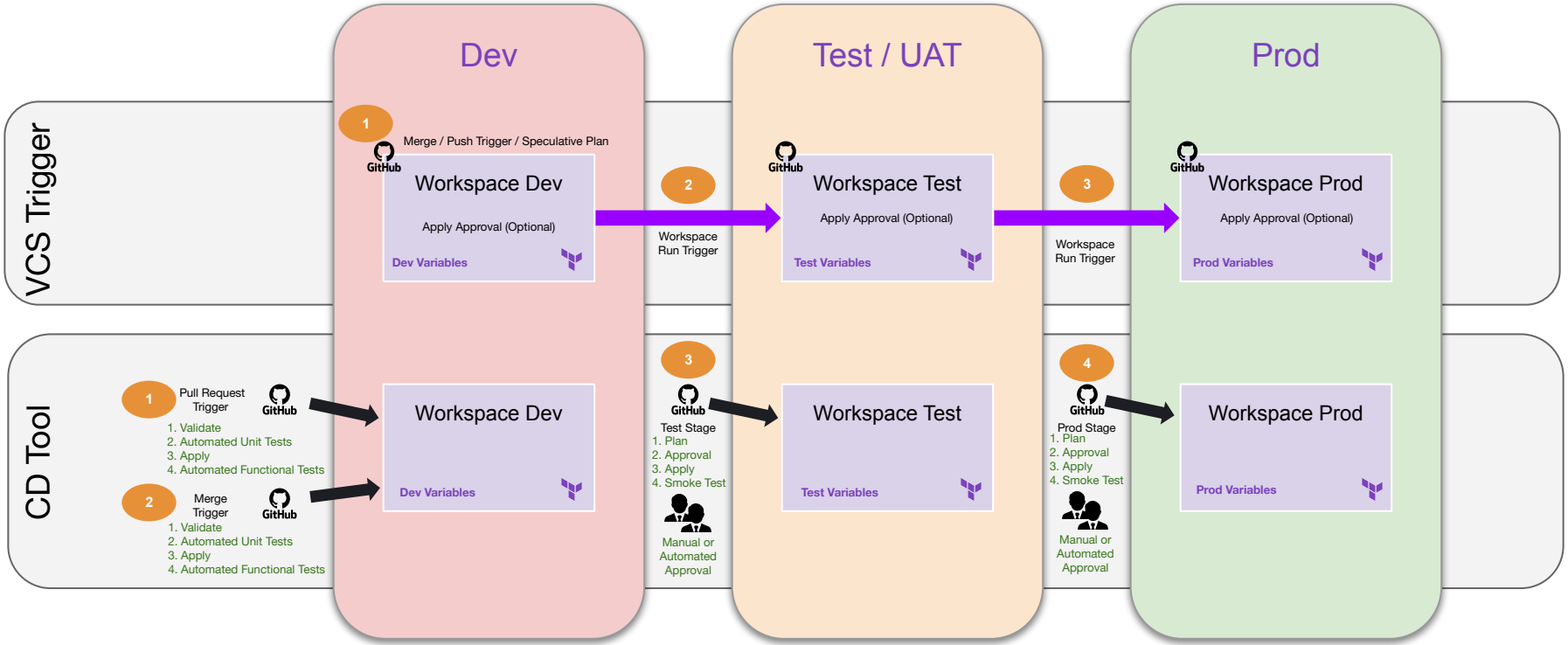
Run Workflows

Terraform Run Workflows

- UI-Driven Runs - manually trigger runs from the TFE web UI
- VCS-Driven Runs - easiest integration, directly connects a Git Repo to a Terraform Workspace, with automatic runs on Git Commit and Pull Request code changes
- CLI-Driven Runs - easy to use, single CLI command to trigger runs, takes files in the local folder, creates a .zip file, and sends the contents to the TFC API
- SDK-Driven Runs - calls to the TFC API, using a Language Specific integration, available for Golang, Python, and .NET
- API-Driven Runs - full control, all features available to the web UI have an API call, but requires custom coding JSON REST HTTP API calls

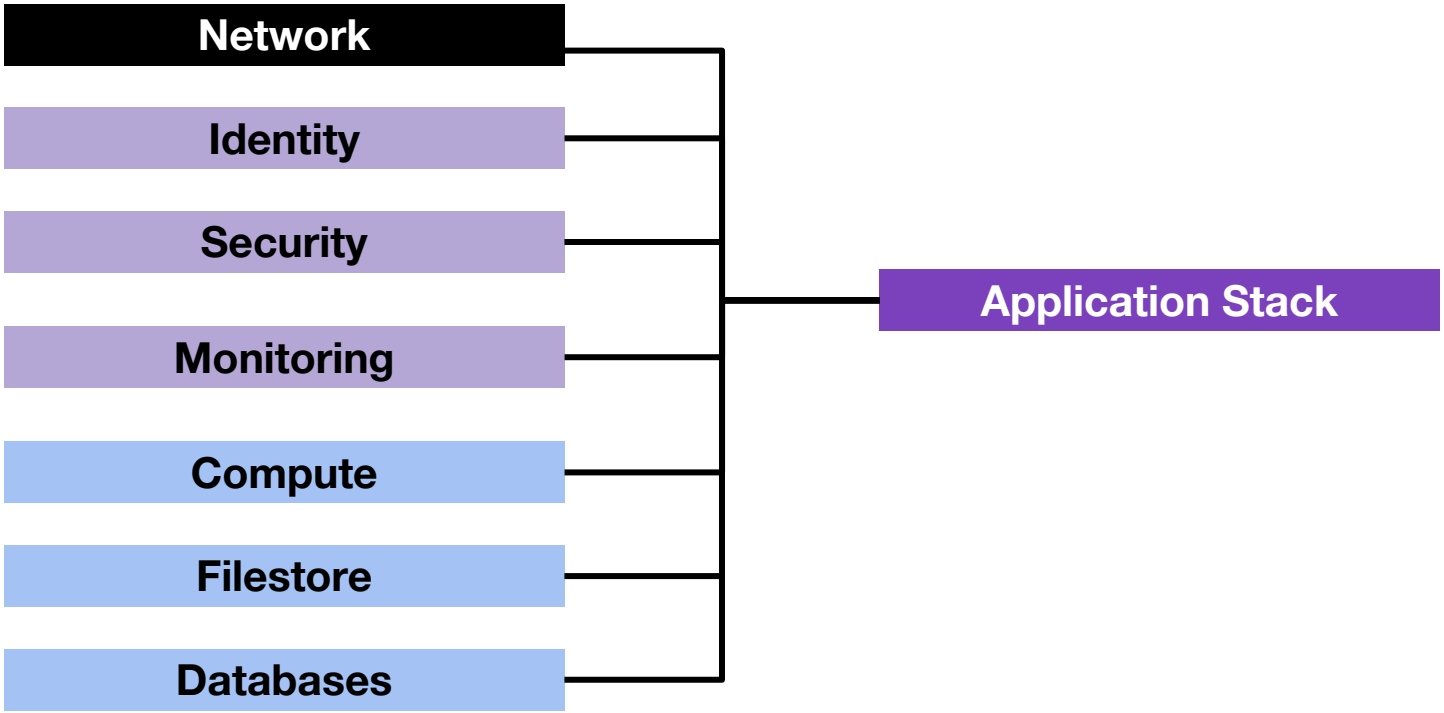
Workflow Types

VCS Trigger vs API in CD Tool



Terraform Modules

Architecture



Code Layout

Static Variables and Dynamically Generated Outputs can be passed between Modules

Root Module

```
# ./main.tf
variable "vpc_cidr" {
 default     = "10.0.0.0/16"
}

module "network" {
 source              = "./network"
 vpc_cidr            =  var.vpc_cidr
 public_subnet_cidr = var.public_subnet_cidr
 region              = var.region
 availability_zones = var.availability_zones
}

module "security-groups" {
 source = "./security-groups"
 vpc_id             =  module.network.vpc_id
 vpc_cidr           = var.vpc_cidr
 public_subnet_ids =  module.network.pub_sub_ids
}
```

Private Sub Module

```
# ./network/vpc.tf
resource "aws_vpc" "default" {
 cidr_block           =  var.vpc_cidr
 enable_dns_hostnames = true
}

output "vpc_id" {
 value = "${aws_vpc.default.id}"
}

resource "aws_subnet" "subnet_public" {
 vpc_id             = aws_vpc.default.id
 cidr_block         = var.public_subnet_cidr
 availability_zone =  var.availability_zones
}

output "pub_sub_ids" {
 value = [ "${aws_subnet.subnet_public.*.id}"
]
}
```

Network

Route 53 DNS, TLS/SSL Certs, Regions, Availability Zones, VPC, Internet Gateway, Public Subnet, Private Subnet, Route Table, Network ACL

VPC, Subnet, Cloud NAT, Compute Route, Cloud Interconnect (on-prem), Public IP, API Gateway

VNet, Network Gateway, NAT Gateway, Route Table, Express Route (on-prem), Public IP, Application Gateway

Infoblox DNS / BIND, Verisign / Microsoft AD / Cloud Foundry CA TLS/SSL certs, Regions, Availability Zones, VLAN, Palo Alto / Checkpoint Firewall, DMZ, Internal VLANs, Cisco / Juniper / HP / Dell Route Table, Network ACL, WAN Link / Dark fiber, VMware ESXi / Tanzu NSX Firewall Rules, VMware vLAN

Security

AWS Config (resource), AWS GuardDuty (NIDS), AWS Macie (S3), VPC Flow Logs

GCP Security Command Center

Azure PolicySets, Network Security Groups, Azure AD Policies

Palo Alto Prisma (resource), Splunk (NIDS), SFlow / NetFlow / Cisco Network Flow Logs, Qualys / Tenable Nessus / Rapid7 Nexpose / Checkpoint (VM, container), Tripwire / OSSEC (FIM)

Identity

IAM Group, IAM Role, IAM User,
IAM Policy (customer-managed)

Service Account, Folder, Roles, Policy

Azure AD (Active Directory),
Azure Resource Group

Microsoft Active Directory, LDAP, SAML,
Okta

Monitoring

AWS CloudTrail (cli/sdk), CloudWatch, CloudWatch Metrics

Network Telemetry, VPC Flow Logs, Cloud Audit Logs

Azure Network Watcher Flow Log, Monitor

DataDog / SignalFX / Nagios / SolarWinds, Splunk / ELK / SumoLogic, HP OpenView

Compute

Load Balancer (ALB, ELB, NLB), Auto-scaling Group + Launch Config + Resource Group + EC2, EKS (K8S), ECS, FarGate (hosted ECS), AWS Lambda

Load Balancer, Managed Instance Group (MIG) + Instance Template + Stateful Configuration + Compute, GCP EKS / K8S

Traffic Manager (global LB), Scale Set + Launch Config + Resource Group + VM, Azure K8S / AKS

F5 / HAProxy / nginx Load Balancers, VMware vRealize, VMware Pivotal Cloud Foundry (PKS, PCS) / K8S

Filestore

S3, CloudFront (CDN)

Cloud Storage, Cloud CDN

Blob Storage, Content Delivery Network

SAN, NAS, GlusterFS, Minio / Ceph / Dell EMC ECS S3-compatible, Akamai

SQL Databases

RDS (MySQL, Aurora, Postgresql, MSSQL, Oracle)

Cloud SQL (PostgreSQL, MySQL, SQL Server)

MSSQL, Oracle, MySQL, Postgres

MS SQL Server, Oracle DB, Sybase DB, DB2, MySQL, Postgresql

NoSQL Databases

ElasticSearch, MongoDB, DocumentDB, Hadoop, DynamoDB

BigQuery, ElasticSearch, MongoDB Atlas, BigTable

ElasticSearch, MongoDB, Azure HDInsight Hadoop

ElasticSearch, MongoDB, Hadoop

In-memory Databases

ElastiCache (Memcached, Redis)

GCP Memorystore (Redis, Memcached)

Azure Cache for Redis

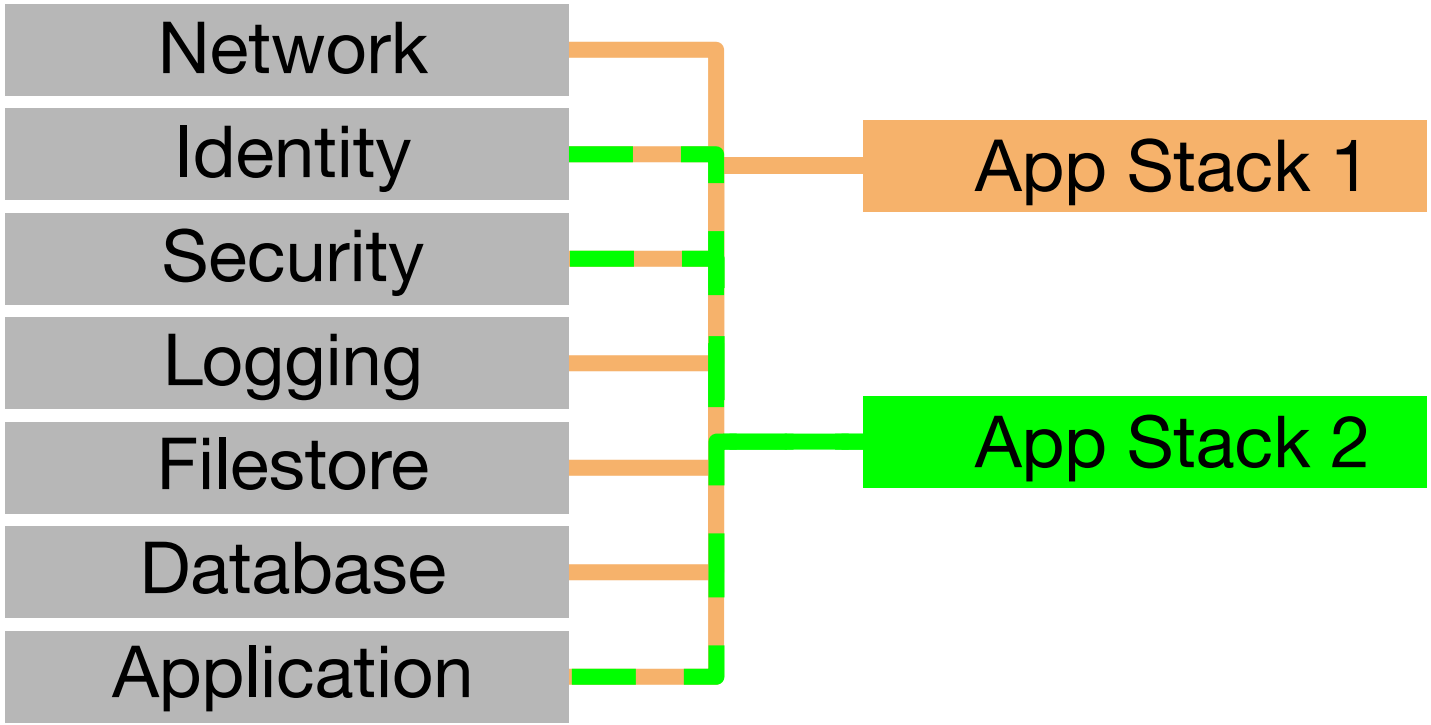
Memcached, Redis

Private Registry

Private Registry

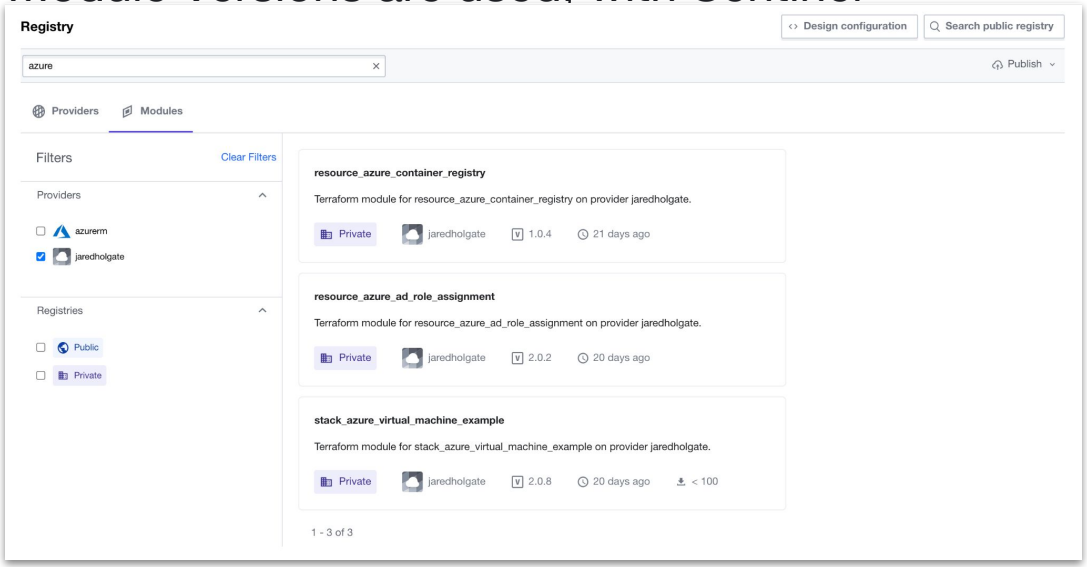
- Hosts private providers and private modules which are only available to members of an organization unless explicitly shared to another organization
- Includes support for module versioning, a filterable list, and a configuration designer for rapid workspace build
- Uses configured VCS integrations and defers to the VCS provide for most management tasks like version releases
- Both public and private modules can be added to the registry and are only available to members of the organization
- Public modules are automatically synchronized from the Terraform Registry where they are hosted

Module Sharing



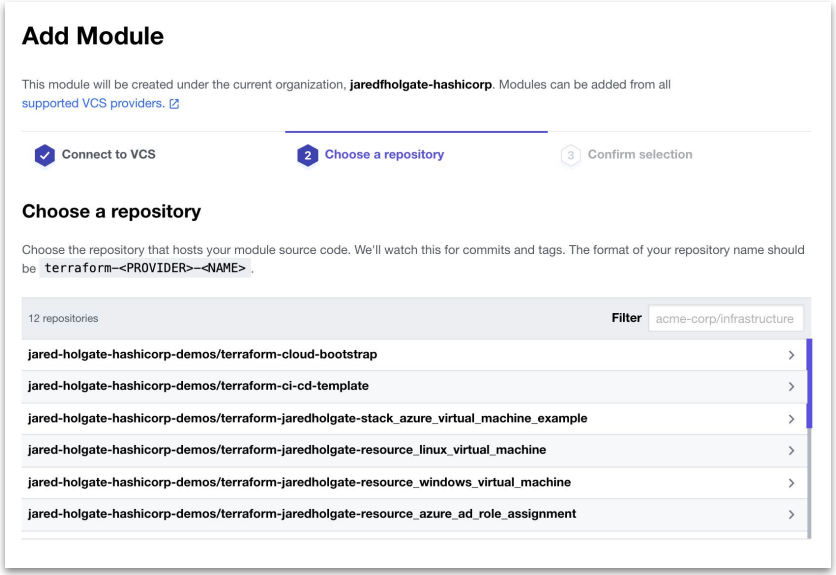
Private Module Registry

- VCS integration
- Versioning based on VCS tags
- Restrict which Modules and Module Versions are used, with Sentinel



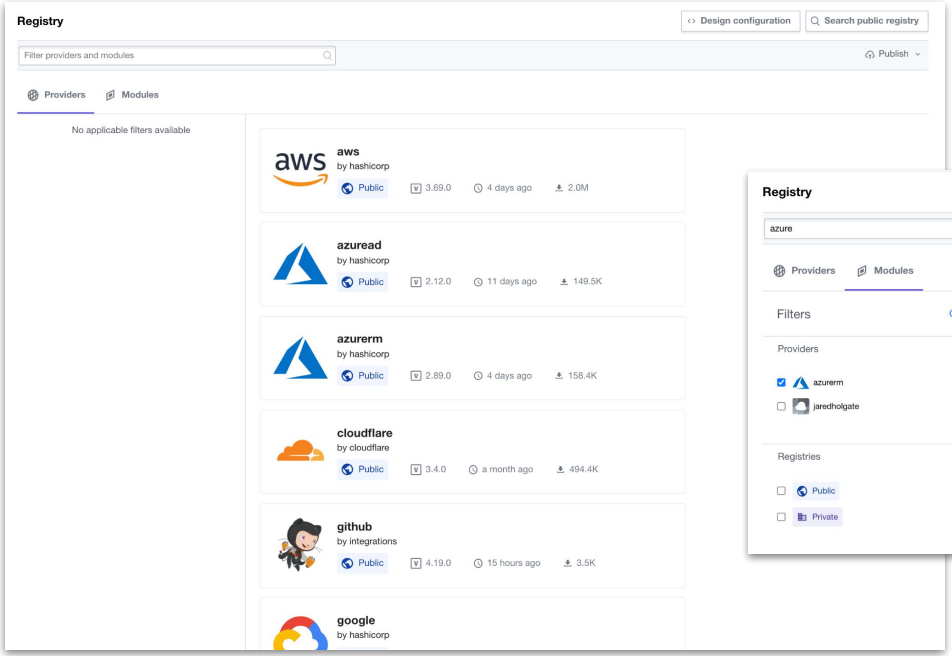
Private Module Registry

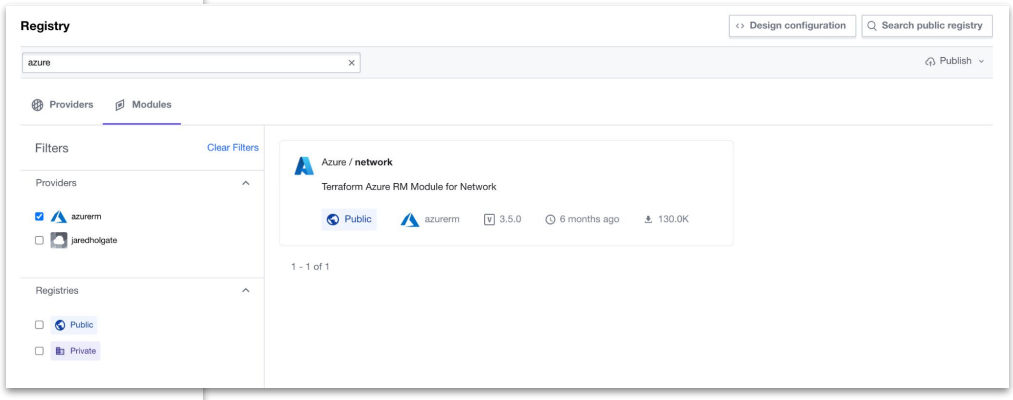
- Repo name must follow the convention: terraform-<provider>-<module name> e.g. terraform-myorganisation-azure_network
- Must have a README.md
- Must have a main.tf file
- Must have a version tag in x.y.z format



Public Providers and Modules

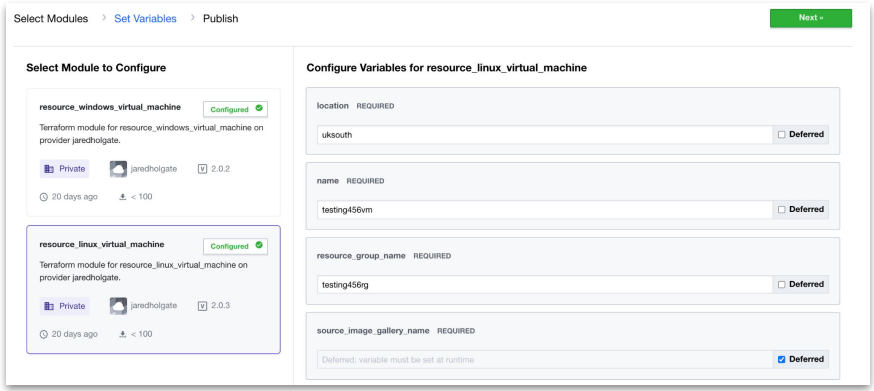
- Specify which providers and modules are recommended
- Restrict using Sentinel

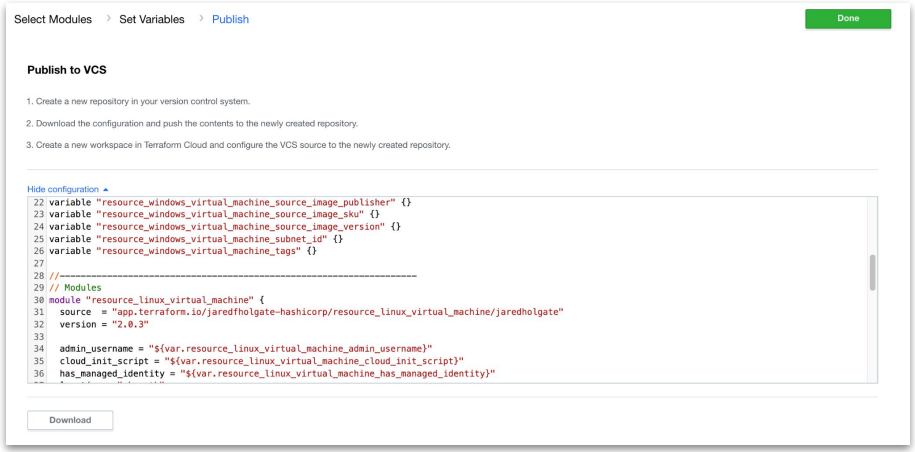




Configuration Designer

- Helps to write HCL
- Still need to source control and have a workspace





Workspaces

Considerations

- **Blast-Radius**: Do not put everything in one place
- **Least Privilege**: Divide resources into multiple Workspaces so that a Team cannot change another Team's resources
- **Rate of Change**: Common changes should not affect uncommonly changing resources

  Example: In many environments the Networking layer will not change as often as the Compute layer
- **Ease of Maintenance**: Group similar resources to ensure maintenance changes don't affect other components

  Example: upgrading all instances of Postgres / MySQL / MS-SQL should not affect change to Networking resources

1. Monolithic Workspace

Production	Staging	QA	Dev
network	network	network	network
security	security	security	security
identity	identity	identity	identity
compute	compute	compute	compute
filestore	filestore	filestore	filestore
sql	sql	sql	sql

2. Production vs. Non-production

Production	Staging	QA	Dev
network	network	network	network
security	security	security	security
identity	identity	identity	identity
compute	compute	compute	compute
filestore	filestore	filestore	filestore
sql	sql	sql	sql

3. Prod vs. Non-prod w/ Landing Zones

Production	Staging	QA	Dev
network	network	network	network
security	security	security	security
identity	identity	identity	identity
compute	compute	compute	compute
filestore	filestore	filestore	filestore
sql	sql	sql	sql

4. Divided by Environments (Envs)

Production	Staging	QA	Dev
network	network	network	network
security	security	security	security
identity	identity	identity	identity
compute	compute	compute	compute
filestore	filestore	filestore	filestore
sql	sql	sql	sql

5. Isolated Envs w/ Landing Zones (LZs)

Production	Staging	QA	Dev
network	network	network	network
security	security	security	security
identity	identity	identity	identity
compute	compute	compute	compute
filestore	filestore	filestore	filestore
sql	sql	sql	sql

6. Isolated Envs w/ LZs and App Layers

Production	Staging	QA	Dev
network	network	network	network
security	security	security	security
identity	identity	identity	identity
compute	compute	compute	compute
filestore	filestore	filestore	filestore
sql	sql	sql	sql

7. Isolated Envs w/ Isolated Layers

Production	Staging	QA	Dev
network	network	network	network
security	security	security	security
identity	identity	identity	identity
compute	compute	compute	compute
filestore	filestore	filestore	filestore
sql	sql	sql	sql

Terraform tfe Provider

Automate Terraform Cloud Configuration

- Terraform Cloud/Enterprise Provider
- tfe = terraform enterprise
- Works with Terraform Cloud and Terraform Enterprise
- Requires a Token argument, which is the API token
- Comprehensive resource and data source coverage

Workspace Creation Automation

```
# Configure a TF Workspace Variable called
# "tf_token" with the TFE API Token
terraform {
  required_providers {
    tfe = {
      source = "hashicorp/tfe"
      version = "~> 0.25.3"
    }
    null = {
      source = "hashicorp/null"
      version = "~> 3.1.0"
    }
  }
}
# https://registry.terraform.io/providers/hashicorp/tfe/latest/docs
provider "tfe" {
  hostname = var.tf_hostname
  token    = var.tf_token
}
```

Workspace Creation Automation

```
variable "tf_organization" {
  type = string
  default = "Pyrocumulus"
}

variable "tf_workspaces" {
  type = set(string)
  default = ["workspaceA", "workspaceB",
    "workspaceC"]
}

resource "tfe_workspace" "test" {
  for_each = var.tf_workspaces
  name = each.key
  organization = var.tf_organization
}

output "tf_workspace_ids" {
  value = { for k, v in tfe_workspace.test :
    k => v.id }
}
```

```
resource "tfe_variable" "test" {
  for_each = { for k, v in
tfe_workspace.test:
    k => v.id }
  key = "test_key_name"
  value = "test_value_name"
  category = "terraform"
  workspace_id = each.value
}

resource "tfe_team" "test" {
  name = "test-team-name"
  organization = var.tf_organization
}

resource "tfe_team_access" "test" {
  for_each = { for k, v in
tfe_workspace.test:
    k => v.id }
  access = "read"
  team_id = tfe_team.test.id
  workspace_id = each.value
}
```

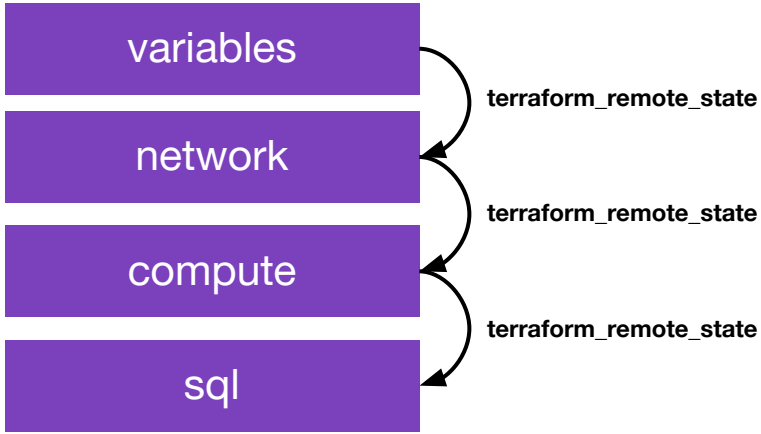
Workspace Variables

Workspaces, Secrets / Credentials

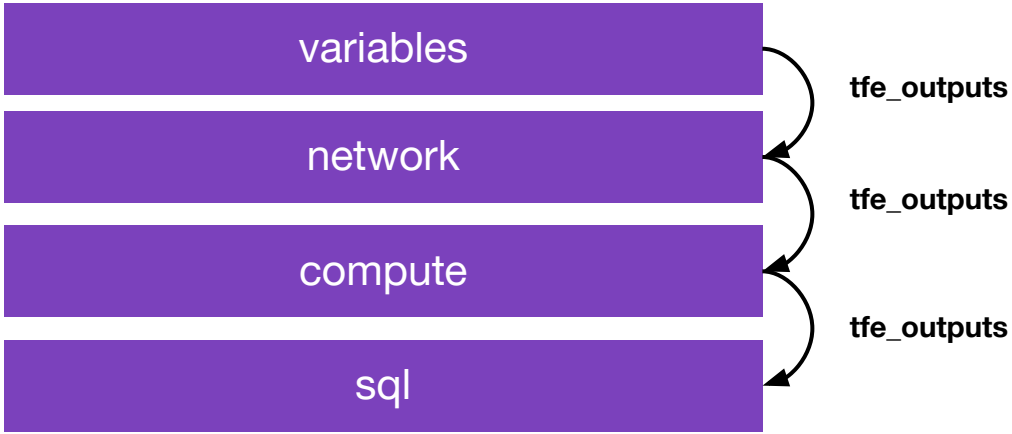
1. Vault Enterprise
2. Vault Open Source
3. Cloud Agents, with Cloud Identity Credentials (ex: AWS IAM Instance Profile)
4. Variable Sets
5. **tfe_outputs** data source, read between Workspaces
6. Workspace Variable, Sensitive
7. Workspace Environment Variable, Sensitive
8. CI/CD Inject Credentials at Run-time

Managing Credentials in Terraform Cloud & Enterprise

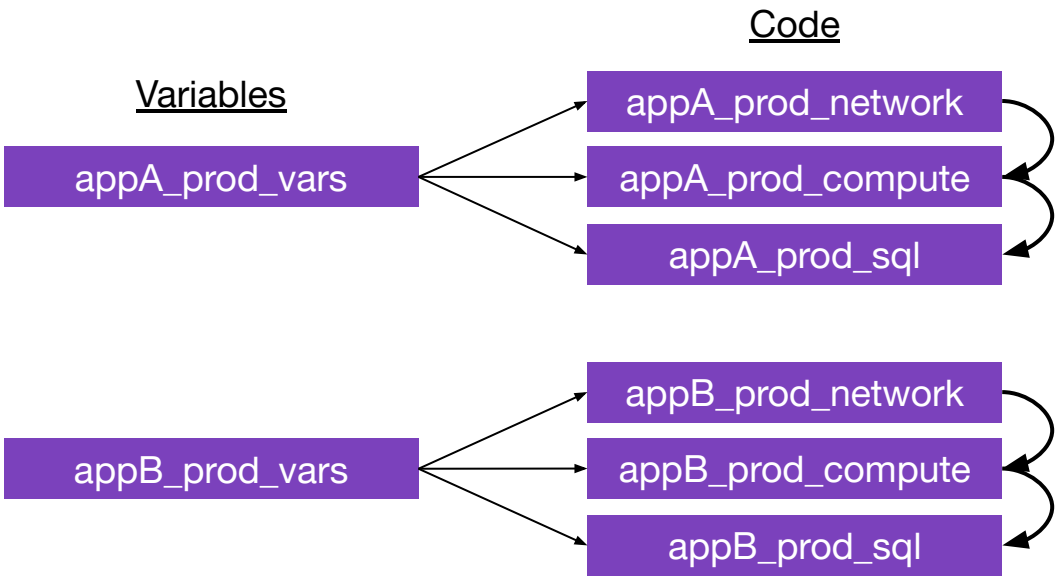
Changes Across Workspaces with Run Triggers



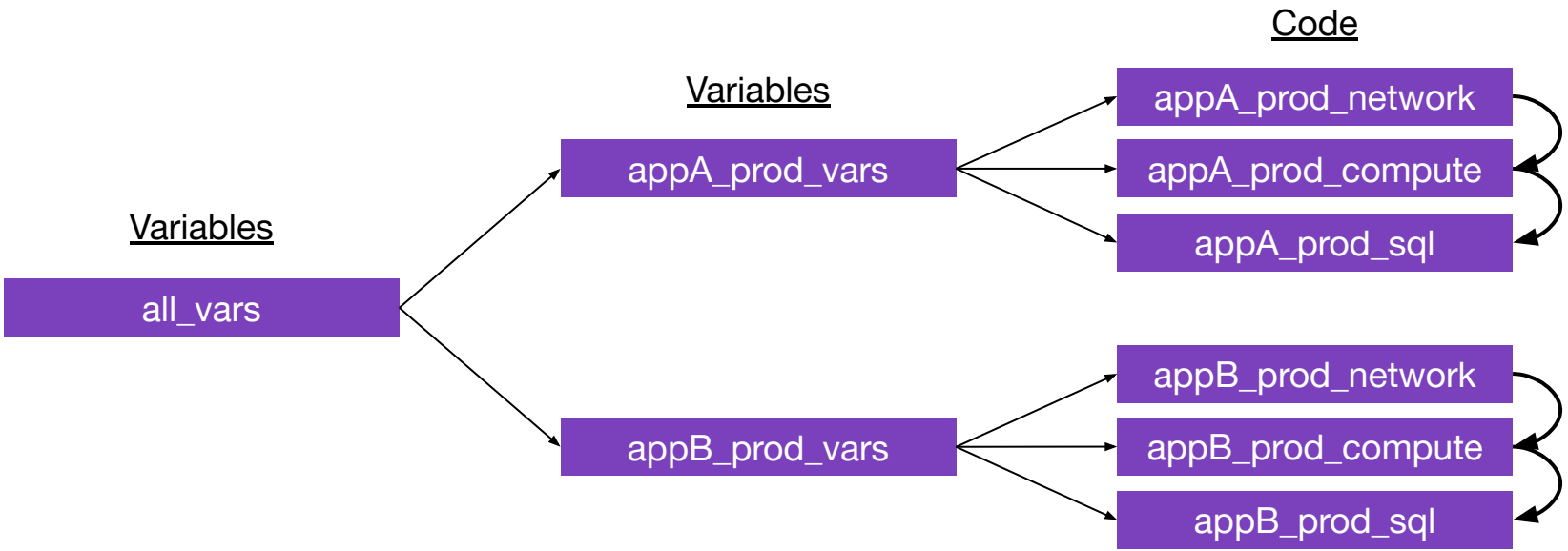
Changes Across Workspaces with Run Triggers



Changes Across Workspaces with Run Triggers



Changes Across Workspaces with Run Triggers



Git Repository Structure

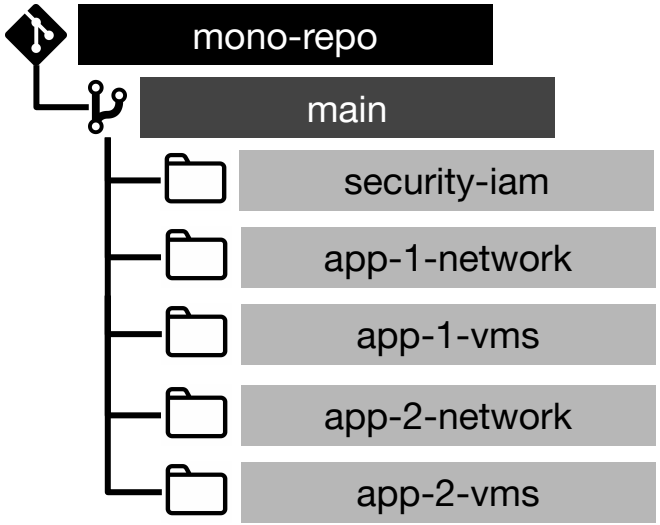
MonoRepo vs MultiRepo

TFE Supports both models

- **MonoRepo:** Single Repo organised by folder
- **MultiRepo:** Repo per application / component
- For Private Registry Modules you must use a repo per module when using VCS integration

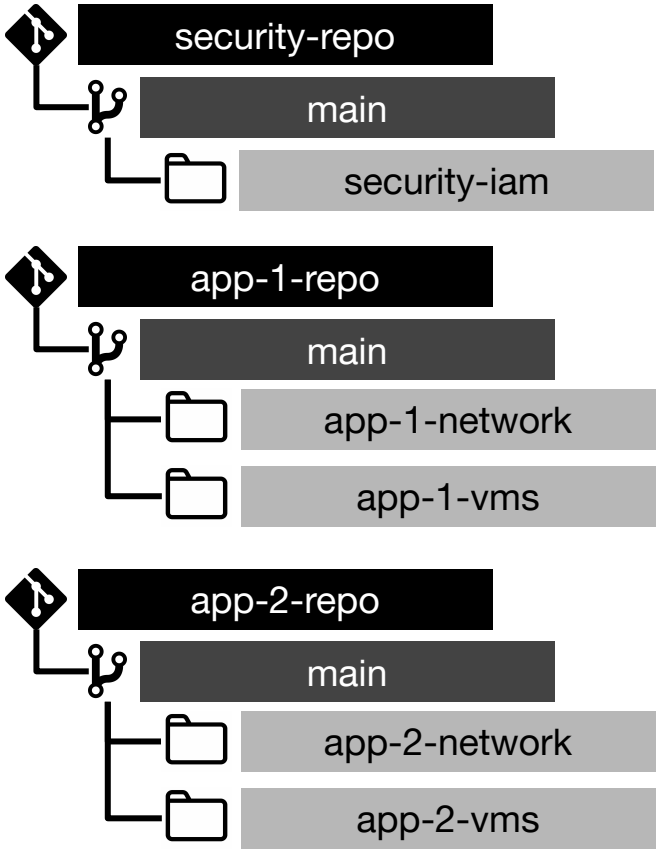
Caution: Managing a large MonoRepo can be complex and may impact performance

Repository Structure MonoRepo



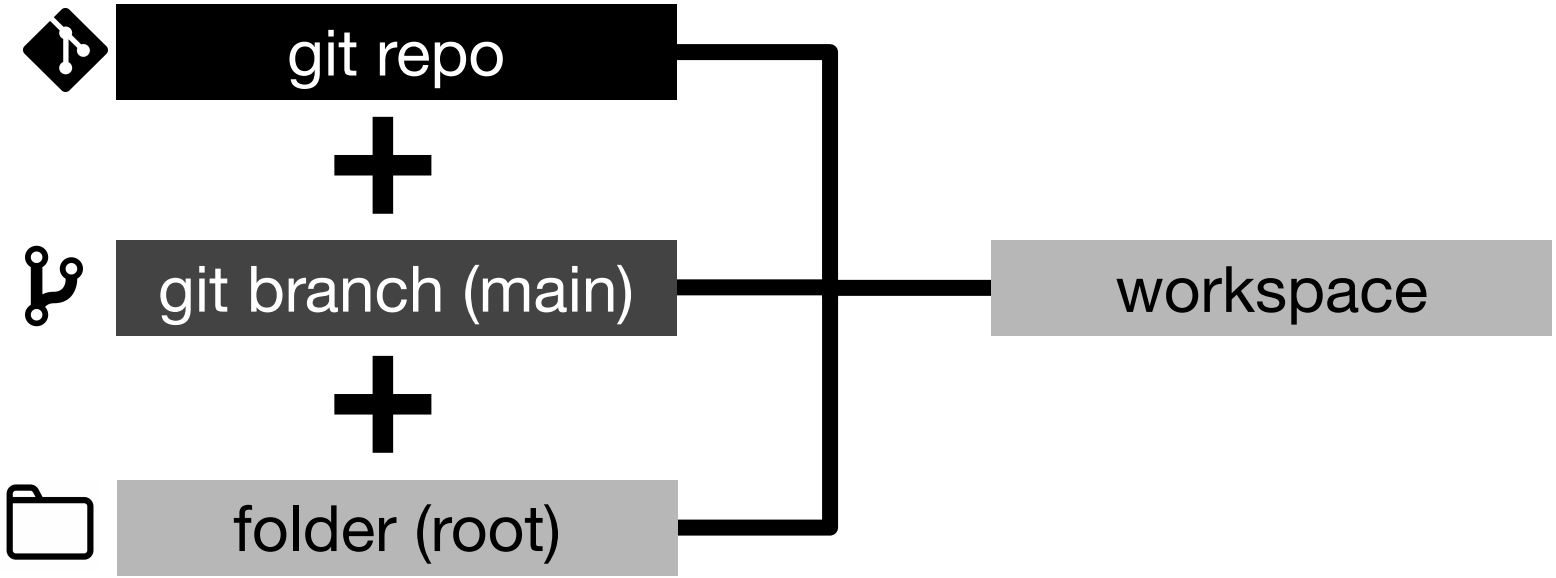
- Workspace per Env
- Single Git Repo
- Large git clones
- git tag / version is applied across the whole repo

Repository Structure MultiRepo



- Workspace per Env
- Multi Git Repo
- Small git clones
- git tag / version is per application

Components, for VCS-Driven Runs

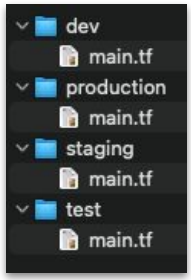


Code Structure for Environments

Three main options

Many Code copies with hard coded variables

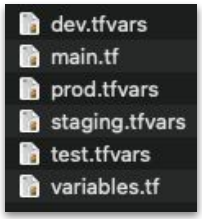
Do not use variables, simply hard code the differences between environments directly in the HCL files.



Single Code copy with variable files (API / CLI)

Use variables in the code and store any non-secret variables in source control per environment.

This pattern can be used for API / CLI driven workflows. You can specify the tfvars file on the command line or copy it to a *.auto.tfvars file.

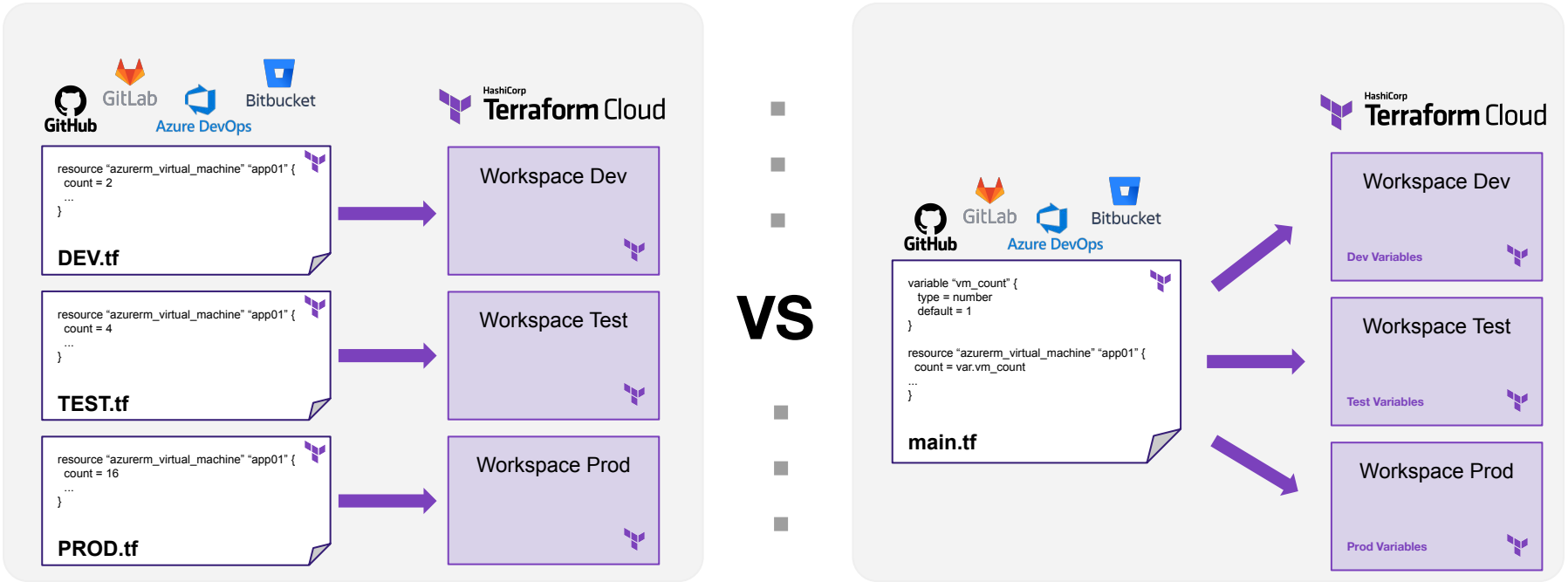


Single Code copy with deploy time variables

Use variables in the code and inject from the workspace or CD tool at deploy time.

Code Structure for Environments

Many Copies vs Single Copy



Branching Strategies

Main options for Branching with TFE

Trunk based

- Trunk based branching refers to having a single branch that you deploy from
- Changes get into the trunk branch via a Pull Request from a short lived feature branch
- Run Triggers or a CD tool are used to promote to environments

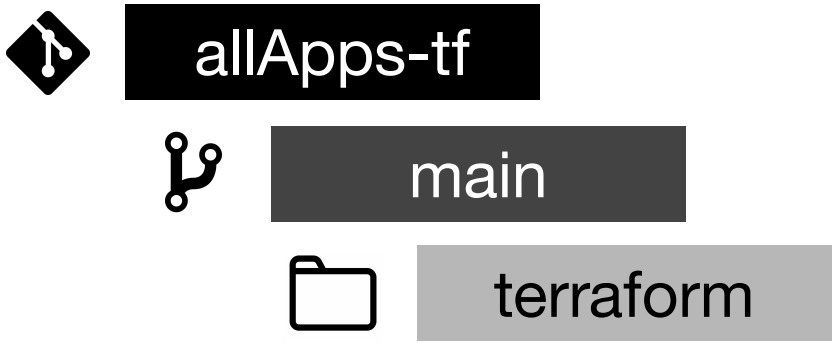
Git Flow or similar

- More complicated structure, you may have a dev branch that deploys to dev environment and release and hotfix branches that go to staging and production
- You would still likely use Run Triggers or a CD tool to get from staging to production

Branch per Environment

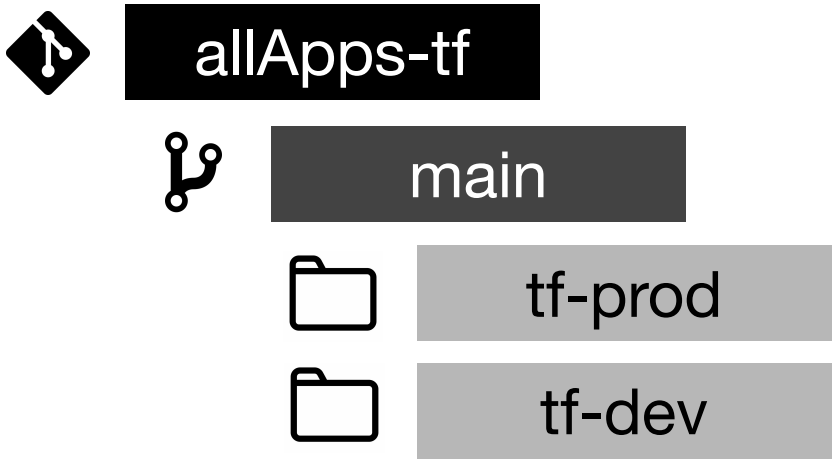
- Each environment has its own branch associated with a workspace
- To kick off runs to different environments, the branches are merged into each other going up the chain

Monorepo, One Branch, One Folder



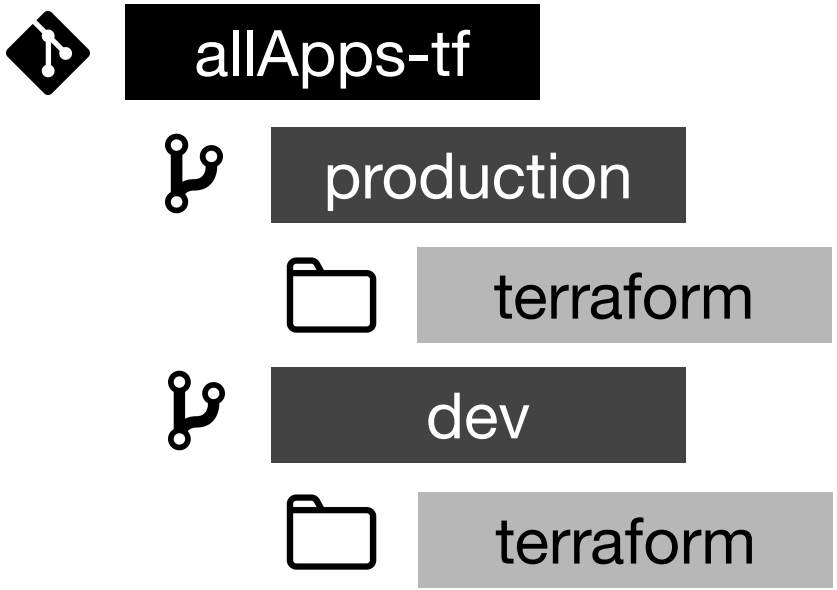
- Workspace per Env
- One folder for all Envs
- impractical
- any errors would take down all infrastructure

Monorepo, One Branch, Many Folders



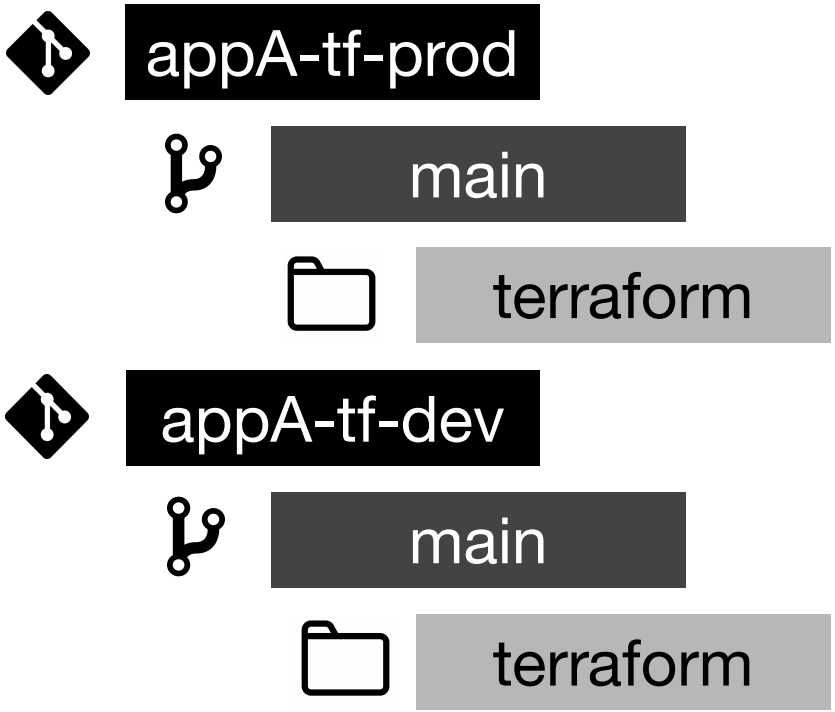
- Workspace per Env
- Folder per Env
- one git repo
- one git branch
- large git clones
- duplicate code
- difficult git PR merges
- cannot git tag / version

Monorepo, Many Branches, One Folder



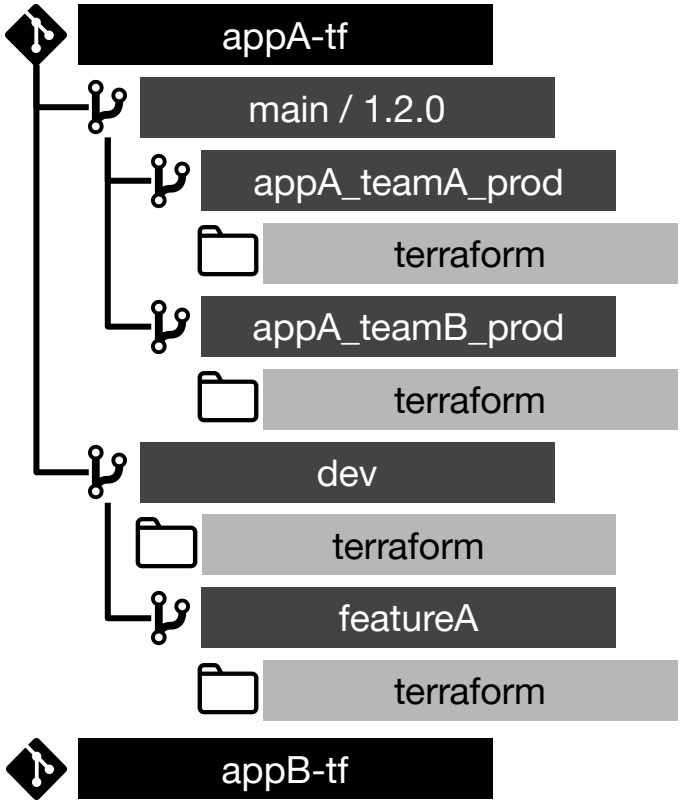
- Workspace per Env
- Git Branch per Env
- many git branches
- no duplicate code
- one git repo
- large git clones
- difficult git PR merges

Many Repos, One Branch, One Folder



- Workspace per Env
- Git Repo per Env
- many git repos
- small git clones
- easy git PR merges
- one Folder per Env
- one git branch per repo
- duplicate code
- can’t tag / version

Many Repos, Many Branches, One Folder



- Workspace per Env
- Git Branch per Env
- many Git Repos
- many Git Branches
- small git clones
- easy git PR merges
- no duplicate Code
- easily git tag / version

How refactor a Git Monorepo

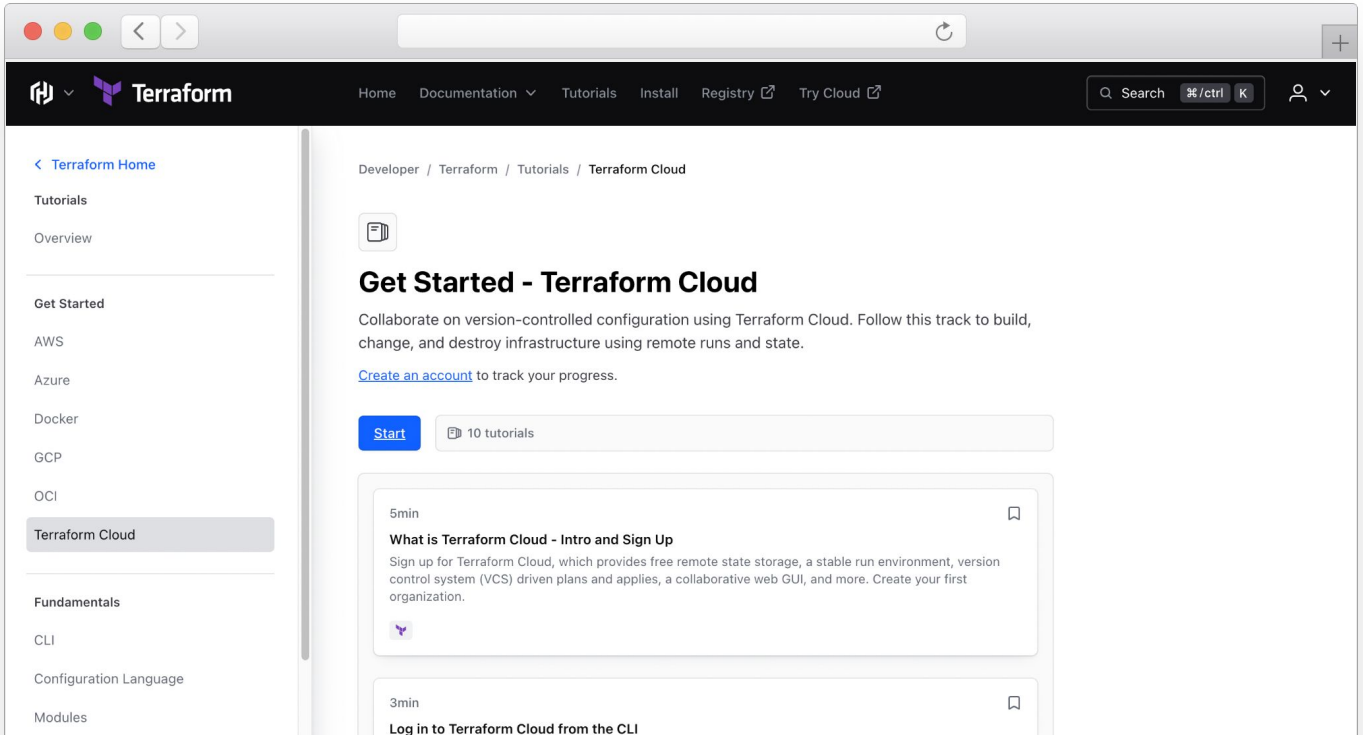
1. Refactor to use Terraform Modules
2. Create Git Repos for each Terraform Module
3. Created Git Repos of Terraform Code for each App
4. Migrate the code from the MonoRepo folder into the new repository
5. Update the Workspace VCS configuration

Next Steps

Tutorials

https://developer.hashicorp.com/terraform/tutorials

Step-by-step guides to accelerate deployment of Terraform Enterprise



Resources

- Module Creation - Recommended Pattern
- Add Public Providers & Modules to your Private Registry
- Share Modules in the Private Registry
- Terraform Registry Publishing
- Managing Credentials in Terraform Cloud & Enterprise
- Terraform Mono Repo vs. Multi Repo: The Great Debate
- Refactor Monolithic Terraform Configuration

Need Additional Help?

Customer Success

Contact our Customer Success Management team with any questions. We will help coordinate the right resources for you to get your questions answered.

customer.success@hashicorp.com

Technical Support

Something not working quite right? Engage with HashiCorp Technical Support by opening a ticket for your issue at support.hashicorp.com.

Discuss

Engage with the HashiCorp Cloud community including HashiCorp Architects and Engineers

discuss.hashicorp.com

Upcoming Webinars

Office Hours

Bring your questions to Office Hours!

Terraform Governance

Learn best practices and guidance for implementing key TFE features like Cloud Agents, RBAC, Sentinel, and run triggers and notifications

Operating your Terraform Instance

Learn best practices for operating and managing your Terraform Enterprise instances, content includes guidance on backup/restore, upgrades, monitoring, and auditing

Action Items

- Share to customer.success@hashicorp.com
  - Authorized technical contacts for support
  - Stakeholders contact information (name and email addresses)
- Plan your workspace strategy & structure
- Begin creating some reusable modules
- Formulate your repository structure & migration plan if required

Q & A

Thank You

customer.success@hashicorp.com
www.hashicorp.com