HashiCorp Terraform

Terraform Workflows

Agenda

- Run Workflows
- Terraform Modules
- Workspaces
- Variables
- Git Repo Structure
- Q+A

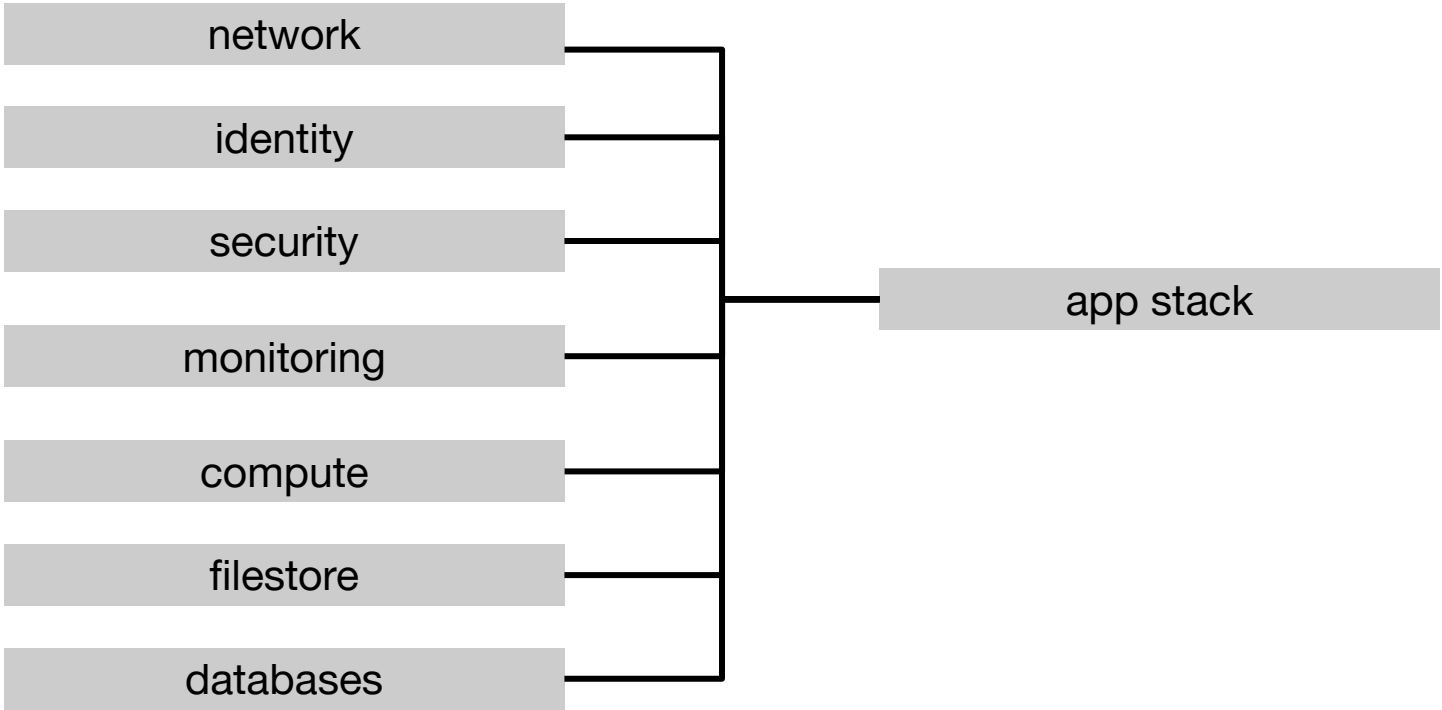
Runs Workflows

Run Workflows

- UI-Driven Runs - manually trigger runs from the TFC 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.

Terraform Modules

Architecture



Code Layout

Static Variables and Dynamically Generated Outputs can be passed between Modules.

```
# ./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
}
```

```
# ./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

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

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

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

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

Azure
Azure PolicySets, Network Security Groups, Azure AD Policies

GCP
GCP Security Command Center

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

Identity

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

Azure
Azure AD (Active Directory), Azure Resource Group

GCP
Service Account, Folder, Roles, Policy

VMware
Microsoft Active Directory, LDAP, SAML, Okta

Monitoring

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

Azure
Azure Network Watcher Flow Log, Monitor

GCP
Network Telemetry, VPC Flow Logs, Cloud Audit Logs

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

Compute

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

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

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

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

Filestore

AWS
S3, CloudFront (CDN)

Azure
Blob Storage, Content Delivery Network

GCP
Cloud Storage, Cloud CDN

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

SQL Databases

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

Azure
MSSQL, Oracle, MySQL, Postgres

GCP
Cloud SQL (PostgreSQL, MySQL, SQL Server)

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

NoSQL Databases

AWS
ElasticSearch, MongoDB, DocumentDB, Hadoop, DynamoDB

Azure
ElasticSearch, MongoDB, Azure HDInsight Hadoop

GCP
BigQuery, ElasticSearch, MongoDB Atlas, BigTable

VMware
ElasticSearch, MongoDB, Hadoop

In-memory Databases

AWS
ElastiCache (Memcached, Redis)

Azure
Azure Cache for Redis

GCP
GCP Memorystore (Redis, Memcached)

VMware
Memcached, Redis

Private Module Registry

Private Module Registry (PMR)

Terraform Cloud's private module registry works similarly to the public Terraform Registry and helps you share Terraform modules across your organization. It includes support for module versioning, a searchable and filterable list of available modules, and a configuration designer to help you build new workspaces faster.

You can add both private and public modules to the registry:

- Private modules are hosted on the registry and are only available to members of that organization. In Terraform Enterprise, they are also available to other organizations that are configured to share modules with that organization.
- Public modules are automatically synchronized from the Terraform Registry where they are hosted. Public modules are not supported in Terraform Enterprise.

- https://learn.hashicorp.com/tutorials/terraform/module-private-registry-add?in=terraform/modules
- https://learn.hashicorp.com/tutorials/terraform/module-private-registry-share?in=terraform%2Fmodules
- https://www.terraform.io/docs/registry/index.html
- https://www.terraform.io/docs/cloud/registry/publish.html
- https://www.terraform.io/docs/cloud/registry/add.html

Workspaces

Considerations

- **Blast-Radius**: Do not put everything in one place.
- **Least Privilege**: Divide cloud resources into multiple Workspaces so that a Team cannot change another Team's cloud resources.
- **Rate of Change**: The Networking layer will not change as often as the Compute layer. Common changes should not affect uncommonly changing resources.
- **Ease of Maintenance**: Group similar resources to ensure maintenance changes don't affect other components, ex: upgrading all instances of Postgres / MySQL / MS SQL / Oracle / ElasticSearch should not affect the Networking resource.

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/ Shared App Layers

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

8. 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

Workspace Creation Automation

```
# Configure a TF Workspace Variable called
# "tf_token" with the TFC 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 (beta)
5. **terraform_remote_state** data source, read between Workspaces
6. Workspace Variable, Sensitive
7. Workspace Environment Variable, Sensitive
8. CI/CD Inject Credentials at Run-time

https://www.hashicorp.com/blog/managing-credentials-in-terraform-cloud-and-enterprise

Git Repository Structure

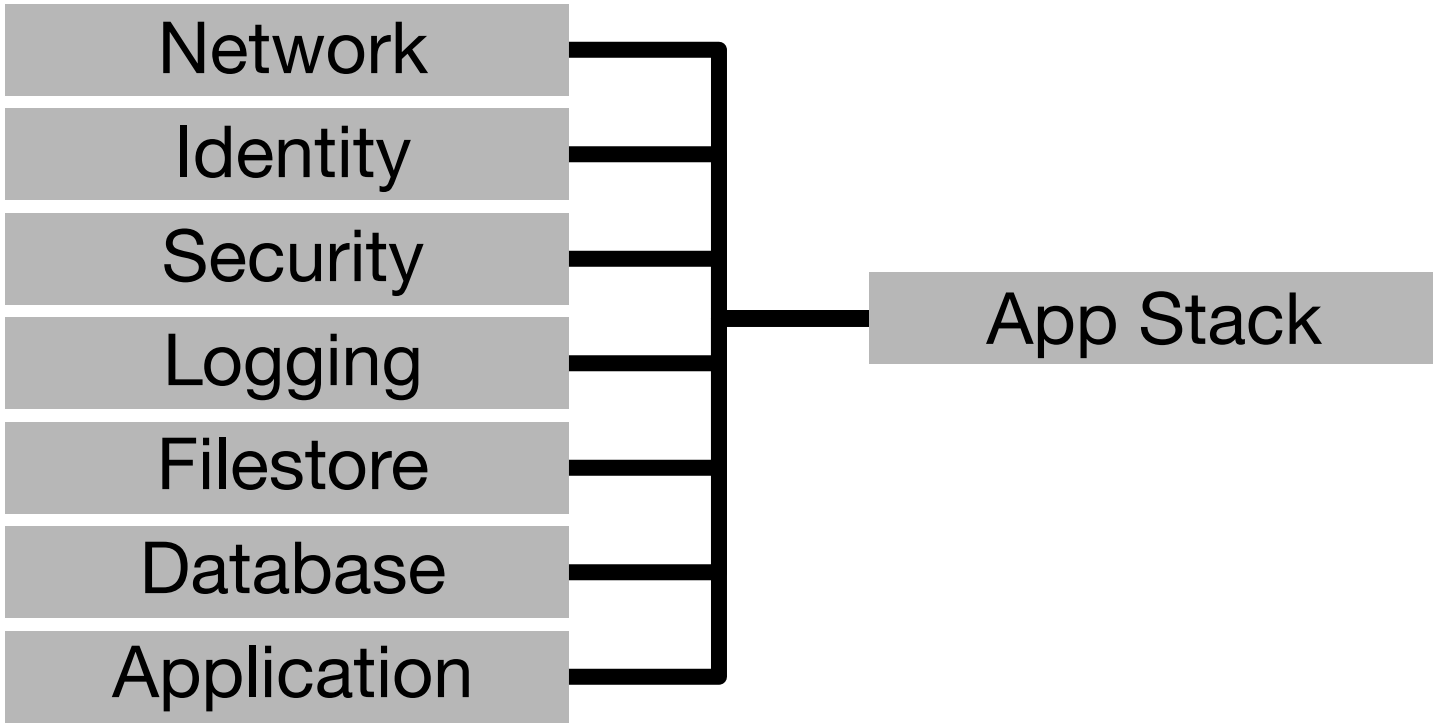
Linus Torvalds Quote

“So git scales really badly if you force it to look at everything as one _huge_ repository. I don't think that part is really fixable, although we can probably improve on it.”

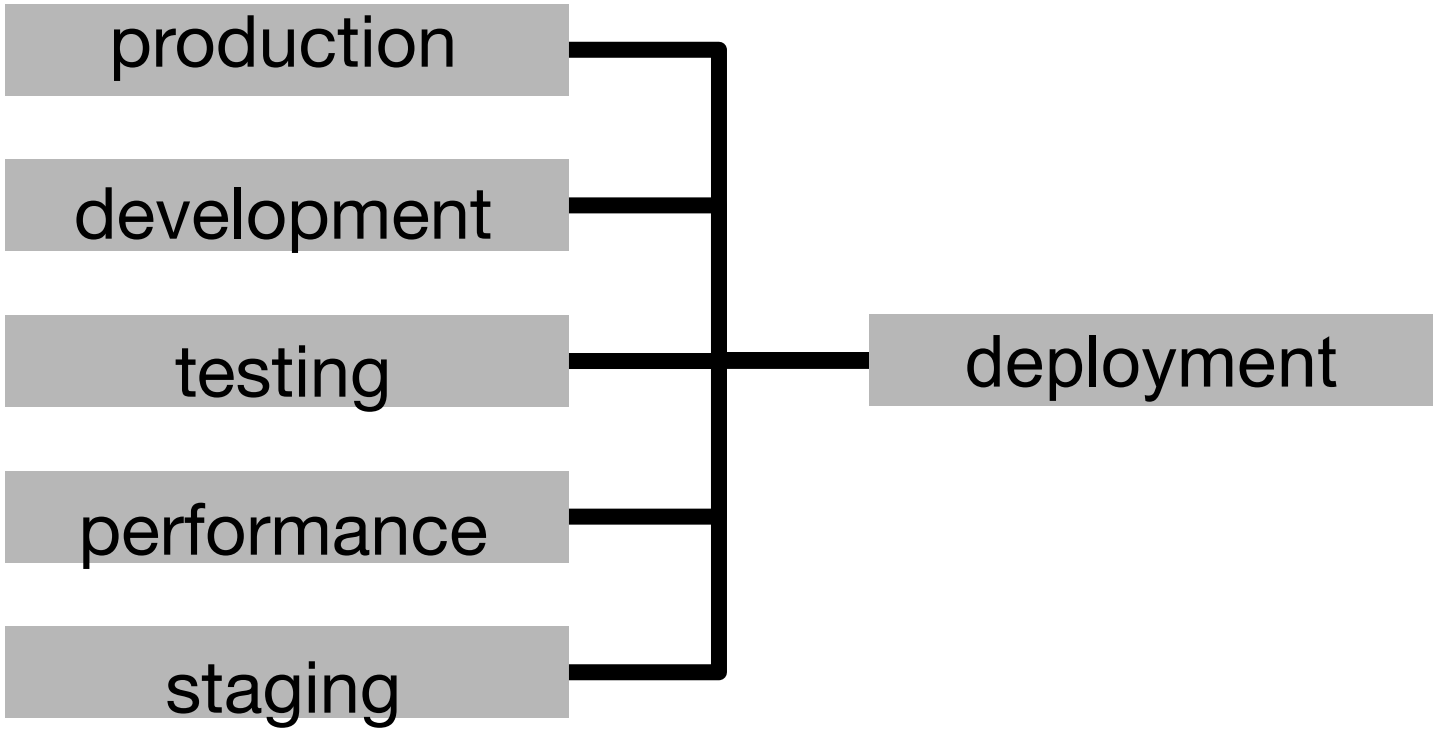
- **Linus Torvalds** (2009-05-01), Creator of Linux and Git

https://marc.info/?l=git&m=124121401124923&w=2

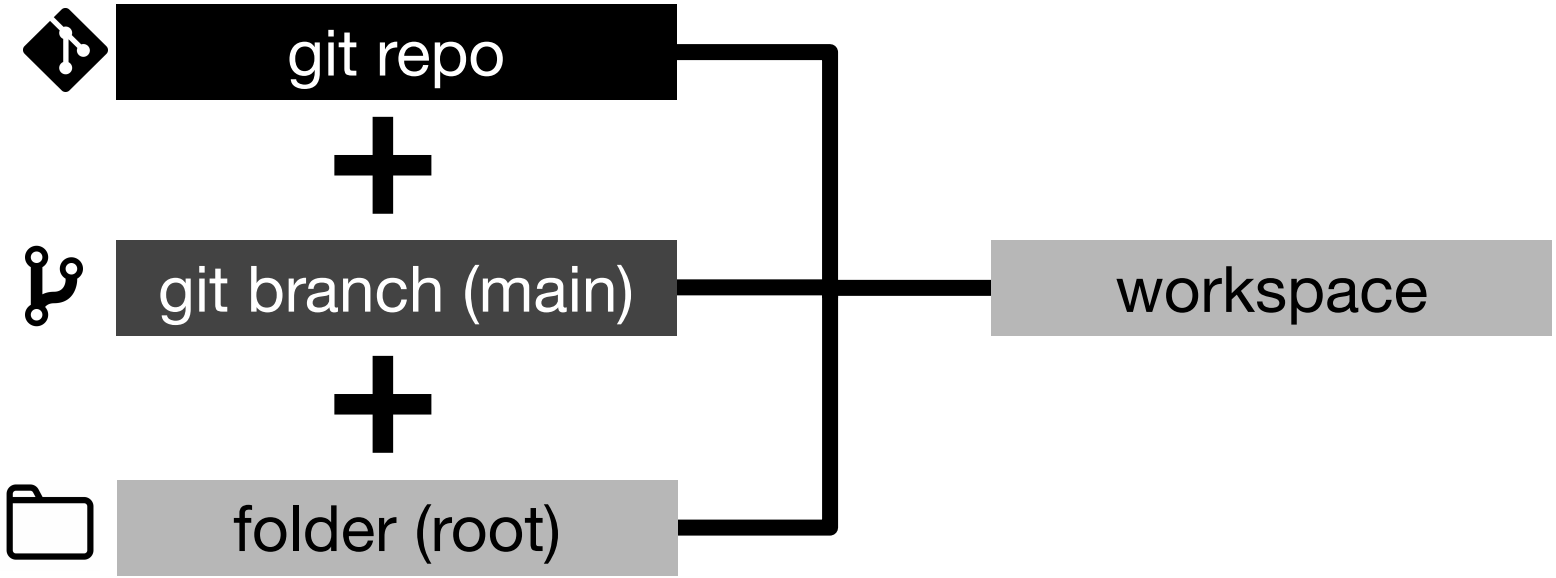
Shared Modules



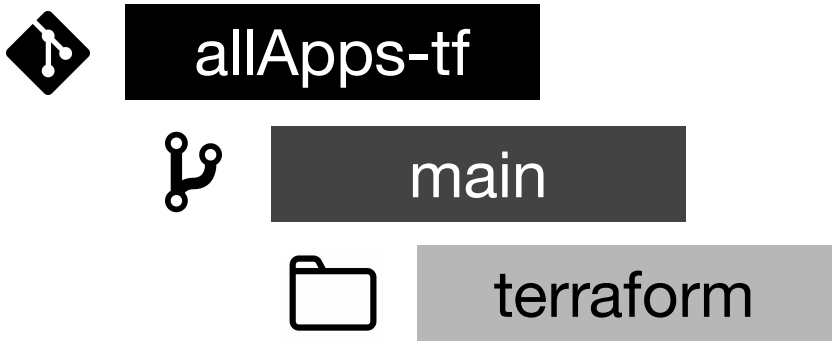
Environments



Components, for VCS-Driven Runs

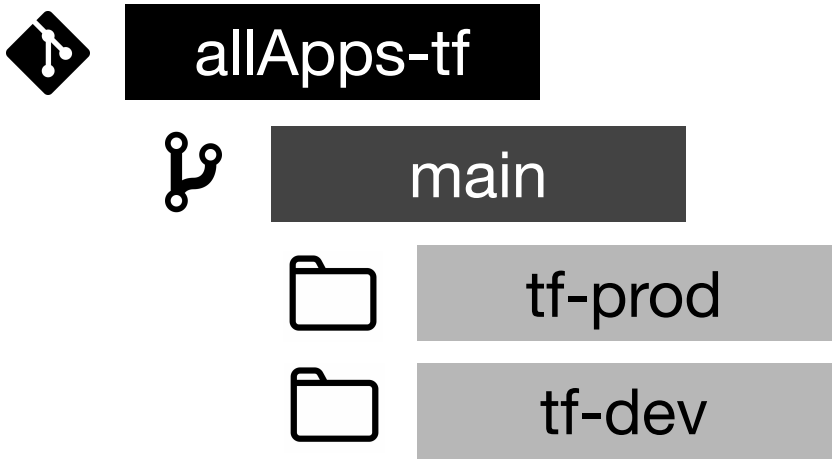


Monorepo, One Branch, One Folder



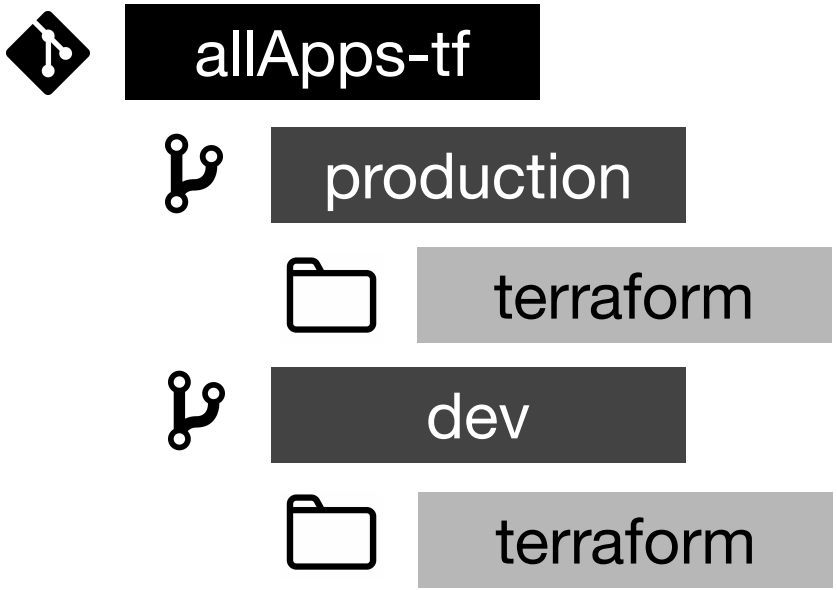
- Workspace per Env
- One folder for all Envs
- impractical
- any errors would take down all infrastructure

Monorepo, One Branch, Many Folders



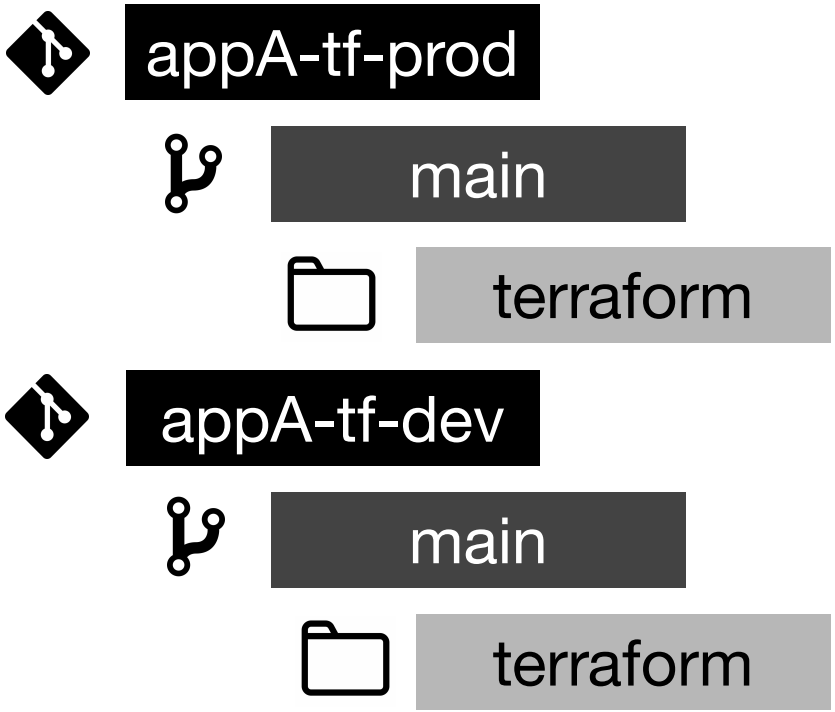
- Workspace per Env
- Folder per Env
- one git repo
- one git branch
- large git clones
- duplicate code
- difficult git PR merges
- cannot git tag / version

Monorepo, Many Branches, One Folder



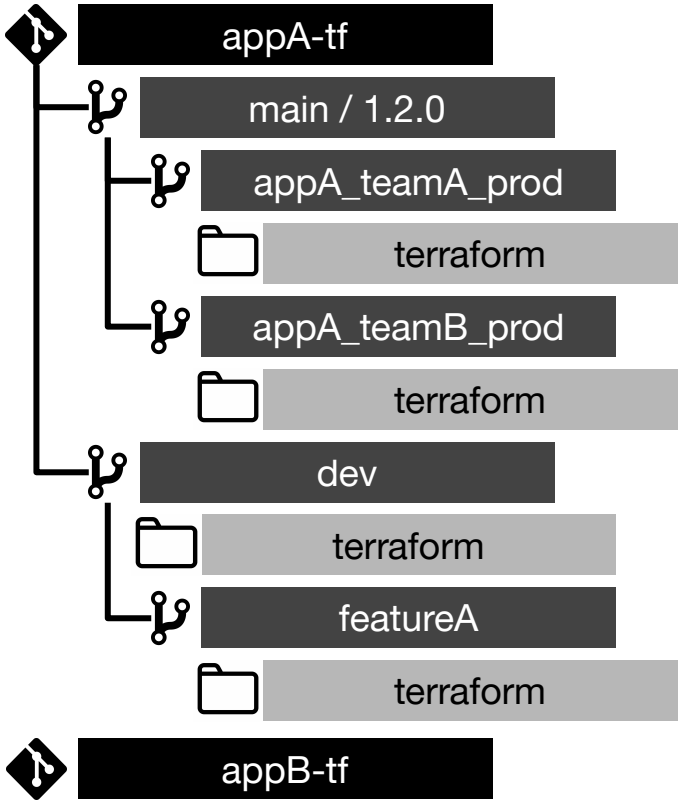
- Workspace per Env
- Git Branch per Env
- many git branches
- no duplicate code
- one git repo
- large git clones
- difficult git PR merges

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

Poll time

Q: Are you migrating from a mono-repo today?

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. Use Git Branches for each App Instance, and each Environment (production, dev, etc.)
5. Use folders for the TF Modules / “App Layers”
6. Use a GitOps Workflow, using Git Branches, and a Terraform “VCS-Driven Workflow” to update and modify code and configuration changes.

Q & A

Thank You

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