

Terraform 1.1 with AWS

Infrastructure as Code

Version: 1.2.1

Course Details 1/2

We have three days to cover the agenda.

- Module 01 - Overview of IaC
- Module 02 - Installation and Setup
- Module 03 - Virtual Private Cloud (VPC)
- Module 04 - Security Groups & EC2
- Module 05 - EC2 with Terraform
- Module 06 - From static to dynamic deployment
- Module 07 - Dependencies and Terraform

Course Details 2/2

- Module 08 - S3 Storage and Terraform
- Module 09 - Terraform and Modules
- Module 10 - Terraform and Elastic Load Balancing
- Module 11 - Terraform and Scaling
- Module 12 - Terraform and RDS
- Module 13 - Remote State / Workspaces
- Module 14 - Terraform and Route53

Goals of the Course

- use Terraform to deploy Infrastructure in AWS
- getting a refresh on AWS services
- Hands-On Time

MOD 01 - of IaC

Manual Configuration Challenges

- Creating and configuring services is often done manually
- Documentation
- Reliability
- Reproducibility
 - Dev
 - Test
 - Prod

What is Infrastructure as Code?

“Infrastructure as Code is the process of managing and provisioning computer data centers through machine-readable definition files, rather than physical hardware configuration or interactive configuration tools”

Source: [Wikipedia](#)

Is Terraform the only one how does IaC?



ANSIBLE



CloudFormation



CHEF



puppet

Terraform – Template Example

This template creates a single EC2 instance in AWS

```
● ● ●

provider "aws" {
  region = "us-east-2"
}

resource "aws_instance" "example-instance" {
  ami          = "ami-0e5b6b6a9f3db6db8"
  instance_type = "t2.micro"
}
```

Terraform – Key capabilities

- Terraform is a tool for provisioning infrastructure
- supports many providers (cloud agnostic)
- many resources for each provider
- define resources as code in terraform templates (HCL)



Announcing HashiCorp Terraform 1.0 General Availability

Terraform 1.0 — now generally available — marks a major milestone for interoperability, ease of upgrades, and maintenance for your automation workflows.

JUN 08 2021 | [KYLE RUDDY](#)

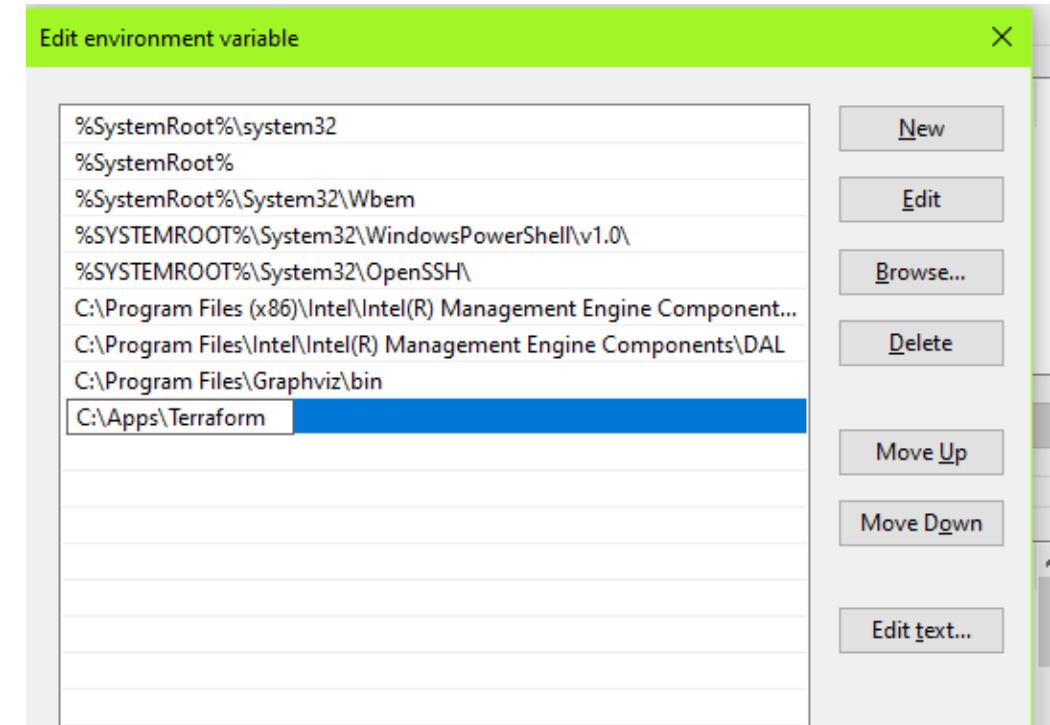
Terraform 1.0 - What are the benefits?

- Extended Maintenance Periods
(1.x releases have 18 month maintenance period)
- More mature and stable
(essentially a 0.15 super-service pack)
- Terraform state is cross-compatible between versions
(0.14.x, 0.15.x, and 1.0.x.)

MOD 02 - Installation and Setup

Windows install

- **Download** the single binary from [terraform-website](#)
- move it to a **Directory** , for example **C:\Apps\Terraform**
- add it to your **Systems-Path**:
Control Panel -> **System** ->
System settings ->
Environment Variables



MacOS/Linux install

- [Download](#) the single binary from terraform-website
- put it in `/usr/local/bin`

```
$ mv ~/Downloads/terraform /usr/local/bin/
```

- have fun

terraform-user setup

- login to AWS-Console
- switch to IAM-Service
- create a new user
- choose only
Access key - Programmatic access
- add the administrator role
- note the access and secret key



IAM Step 1/6

Identity and Access Management (IAM)

x

 Search IAM

Dashboard

▼ Access management

User groups

Users

Roles

Policies

Identity providers

Account settings

IAM Step 2/6

Add user

1 2 3 4 5

Set user details

You can add multiple users at once with the same access type and permissions. [Learn more](#)

User name*

terraform-iac

[+ Add another user](#)

Select AWS access type

Select how these users will primarily access AWS. If you choose only programmatic access, it does NOT prevent users from accessing the console using an assumed role. Access keys and autogenerated passwords are provided in the last step. [Learn more](#)

Select AWS credential type*



Access key - Programmatic access

Enables an **access key ID** and **secret access key** for the AWS API, CLI, SDK, and other development tools.



Password - AWS Management Console access

Enables a **password** that allows users to sign-in to the AWS Management Console.

IAM Step 3/6

Add user

1 2 3 4 5

▼ Set permissions

Add user to group Copy permissions from existing user Attach existing policies directly

Create policy

	Policy name ▾	Type	Used as
<input checked="" type="checkbox"/>	AdministratorAccess	Job function	Permissions policy (2)
<input type="checkbox"/>	AdministratorAccess-Amplify	AWS managed	None
<input type="checkbox"/>	AdministratorAccess-AWSElasticBeanstalk	AWS managed	None
<input type="checkbox"/>	AlexaForBusinessDeviceSetup	AWS managed	None
<input type="checkbox"/>	AlexaForBusinessFullAccess	AWS managed	None
<input type="checkbox"/>	AlexaForBusinessGatewayExecution	AWS managed	None
<input type="checkbox"/>	AlexaForBusinessLifesizeDelegatedAccessPolicy	AWS managed	None
<input type="checkbox"/>	AlexaForBusinessPolyDelegatedAccessPolicy	AWS managed	None

IAM Step 4/6

Add user

- 1
- 2
- 3
- 4
- 5

Add tags (optional)

IAM tags are key-value pairs you can add to your user. Tags can include user information, such as an email address, or can be descriptive, such as a job title. You can use the tags to organize, track, or control access for this user. [Learn more](#)

Key	Value (optional)	Remove
Add new key		

You can add 50 more tags.

IAM Step 5/6

Add user

1 2 3 4 5

Review

Review your choices. After you create the user, you can view and download the autogenerated password and access key.

User details

User name	terraform-iac
AWS access type	Programmatic access - with an access key
Permissions boundary	Permissions boundary is not set

Permissions summary

The following policies will be attached to the user shown above.

Type	Name
Managed policy	AdministratorAccess

Tags

No tags were added.

IAM Step 6/6

Add user

1 2 3 4 5



Success

You successfully created the users shown below. You can view and download user security credentials. You can also email users instructions for signing in to the AWS Management Console. This is the last time these credentials will be available to download. However, you can create new credentials at any time.

Users with AWS Management Console access can sign-in at: <https://833515639939.signin.aws.amazon.com/console>

Download .csv

	User	Access key ID	Secret access key
▶	terraform-iac	AKIA4EELHKSBRGHOIW6F	***** Show

Export the AWS-Credentials

set the value (Linux/MacOS)

```
export AWS_ACCESS_KEY_ID="AKIA4EELHKSBY6NZMA76"  
export AWS_SECRET_ACCESS_KEY="dtnRM/6+0"
```

set the value (PowerShell/Windows)

```
$env:AWS_ACCESS_KEY_ID="AKIA4EELHKSBY6NZMA76"  
$env:AWS_SECRET_ACCESS_KEY="dtnRM/6+0"
```

simple ec2-instance example

```
provider "aws" {
  region = "us-west-2"
}

resource "aws_instance" "app_server" {
  ami           = "ami-830c94e3"
  instance_type = "t2.micro"

  tags = {
    Name = "ExampleAppServerInstance"
  }
}
```

Question: Why is this a weak example in the sense of IaC and **not** AWS perspective?

Terraform Version constraints

specify a range of acceptable versions ("`>= 1.2.0, < 2.0.0`")

for this course we use provider aws 3.72.X, even if the 4.x branch is active now.

```
terraform {  
  required_providers {  
    aws = {  
      source  = "hashicorp/aws"  
      version = ">=3.74"  
    }  
  }  
  required_version = ">=1.0"  
}
```

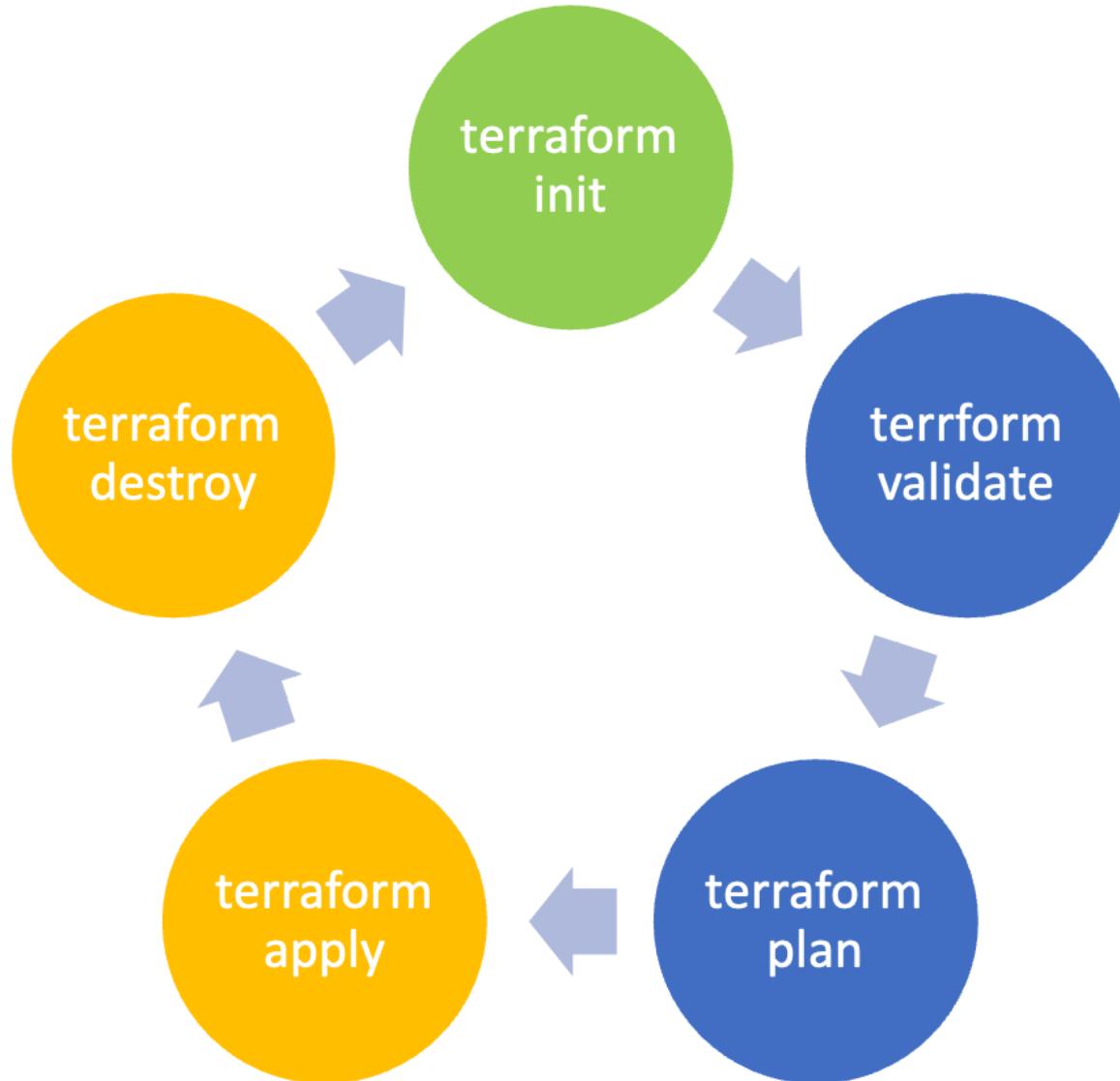
a better approach for a simple ec2-instance

```
terraform {
  required_providers {
    aws = {
      source = "hashicorp/aws"
      version = "~> 3.74"
    }
  }
  required_version = ">= 1.0"
}

provider "aws" {
  region = "us-west-2"
}

resource "aws_instance" "app_server" {
  ami           = "ami-830c94e3"
  instance_type = "t2.micro"
  tags          = {
    Name = "ExampleAppServerInstance"
  }
}
```

Terraform – Core Loop



LAB

Setup & "Hello Infra"

- Install and Setup Terraform
- create IAM User in AWS (AWS-CLI/Console)
- Initialize the aws-Provider
- define EC2-Instance and apply

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = Util.getTransitionDuration(this._config)
      $activeElement.one(Util.TRANSITION_END, function() {
        $nextElement.removeClass(nextElementClass)
        $activeElement.removeClass(activeElementClass)
        _this4._isSliding = false
        setTimeout(function () {
          return $_this4._element.trigger('slideEnd')
        }, 0);
      }).emulateTransitionEnd(transitionDuration)
    } else {
      $activeElement.removeClass(activeElementClass)
      $nextElement.addClass(nextElementClass)
    }
  }
}

export default class SlidingPanel extends React.Component {
  constructor(props) {
    super(props)
    this.state = {
      activeElement: this.props.activeElement || 'left',
      isSliding: false
    }
  }
}
```

Working with a state file

- Terraform saves everything about the instance to special file(s)
- Same directory as template file with `.tfstate` extension
 - `terraform.tfstate`
 - `terraform.tfstate.backup`
- The statefile should **not** be committed into version control
- This can be a problem on multi-developer env's (more about that tomorrow)

Create a .gitignore for state-files

```
# Local .terraform directories
**/.terraform/*

# .tfstate files
*.tfstate
*.tfstate.*

# Crash log files
crash.log

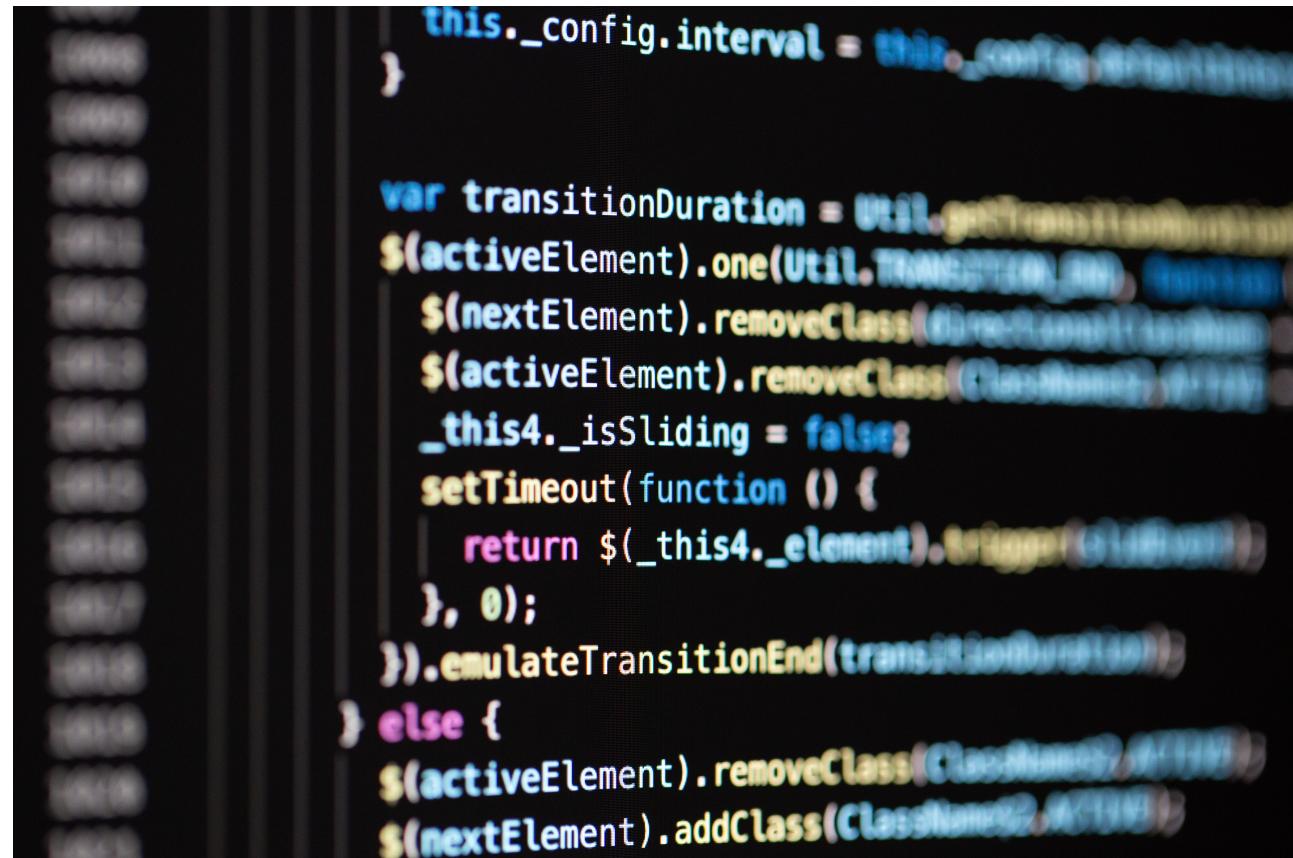
# Exclude all .tfvars files, which are likely to contain sensitive data
*.tfvars
```

Source: [GitHub](#)

LAB

manage drift with Terraform

- check `terraform.tfstate`
- change Instance-Type to `t3.micro`
- add a `costcenter=42` Tag
- apply changes
- check the statefile again
- change costcenter via Dashboard
- `terraform plan` and check if TF can manage this drift



```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getTransitionDuration();
    $activeElement.one(Util.TRANSITION_END, function() {
        $nextElement.removeClass(nextElementClass);
        $activeElement.removeClass(activeElementClass);
        _this4._isSliding = false;
        setTimeout(function() {
            return $_this4._element.trigger('slideEnd');
        }, 0);
    }).emulateTransitionEnd(transitionDuration);
} else {
    $activeElement.removeClass(activeElementClass);
    $nextElement.addClass(nextElementClass);
}
```

Terraform *Standard* Filelayout

File / Folder	Purpose
main.tf	Terraform Config and Constraints
outputs.tf	Output like IPs, Addresses, etc
providers.tf	Provider-Specific (Cred.)
resources.tf	for small projects
variables.tf	place for specifying variables
README.md	Documentation
env	folder place for tfvar-files

LAB

please refactor your code

- add `providers.tf` and refactor
 - add `ressources.tf` and refactor
 - create empty file `variables.tf`
 - create empty file `outputs.tf`
 - create an `env` folder

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getTransitionDuration(this._config)
    $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(this._config.className2)
        $(activeElement).removeClass(this._config.className1)
        _this4._isSliding = false
        setTimeout(function () {
            return $_this4._element.trigger('slideEnd')
        }, 0);
    }).emulateTransitionEnd(transitionDuration)
} else {
    $(activeElement).removeClass(this._config.className1)
    $(nextElement).addClass(this._config.className2)
}
```

MOD 03 - Virtual Private Cloud (VPC)

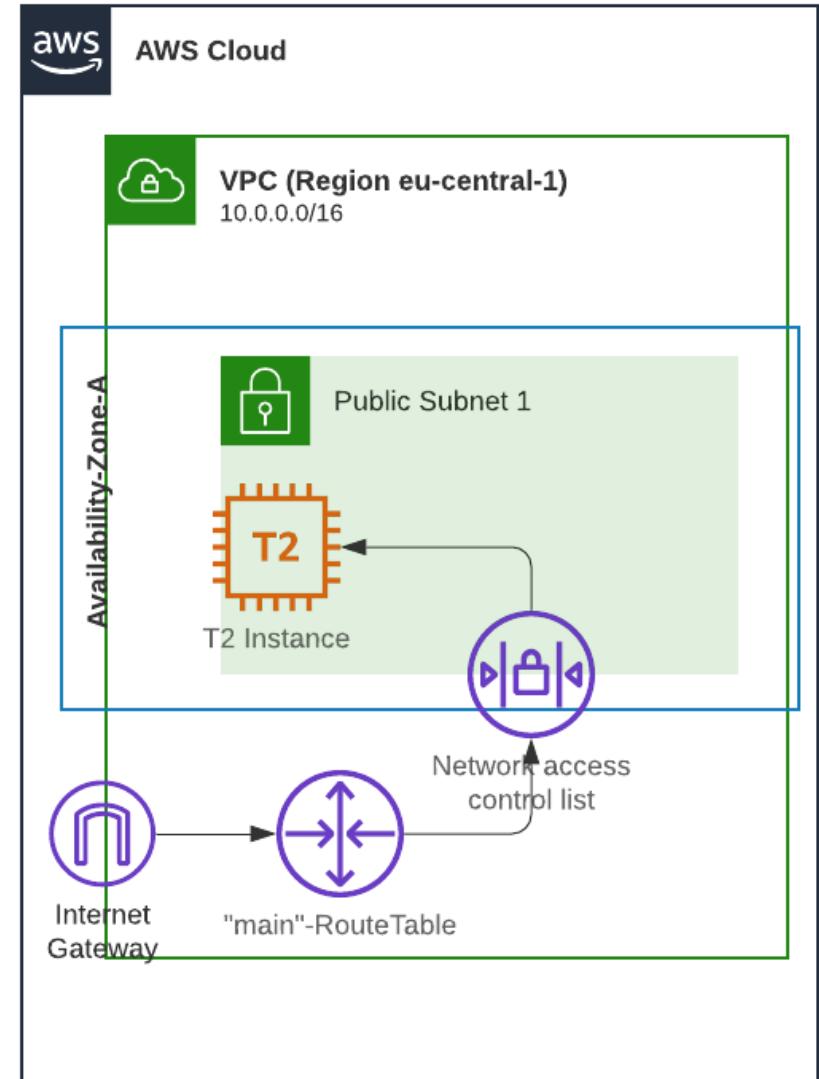
Virtual Private Cloud

- A VPC is a virtual network dedicated to your AWS account
- Requires an IPv4 address space and optionally IPv6 address ranges
- Enables you to create specific CIDR ranges for your resources to occupy
- Provides strict access rules for inbound and outbound traffic.



Components of a basic VPC

- VPC CIDR Block
- public Subnet
- Internet-Gateway (or NAT)
- "main"-Route Table
- Network Access Control List



Ressource aws_vpc

Amazon Virtual Private Cloud (Amazon VPC) enables you to launch AWS resources into a virtual network that you've defined.

```
resource "aws_vpc" "my_vpc" {
  cidr_block          = "10.0.0.0/16"
  enable_dns_hostnames = true

  tags = {
    Name = "My VPC"
  }
}
```

Ressource aws_subnet

A subnet is a range of IP addresses in your VPC. After creating a VPC, you can add one or more subnets in each Availability Zone.

```
resource "aws_subnet" "public" {
  vpc_id          = aws_vpc.my_vpc.id
  cidr_block      = "10.0.0.0/24"
  availability_zone = "eu-central-1a"

  tags = {
    Name = "Public Subnet"
  }
}
```

Ressource aws_internet_gateway

An internet gateway is a horizontally scaled, redundant, and highly available VPC component that enables communication between your VPC and the internet.

```
resource "aws_internet_gateway" "my_vpc_igw" {  
  vpc_id = aws_vpc.my_vpc.id  
  
  tags = {  
    Name = "My VPC – Internet Gateway"  
  }  
}
```

Ressource aws_route_table

A route table contains a set of rules, called routes, that are used to determine where network traffic from your subnet or gateway is directed.

```
resource "aws_route_table" "my_vpc_eu_central_1a_public" {
  vpc_id = aws_vpc.my_vpc.id

  route {
    cidr_block = "0.0.0.0/0"
    gateway_id = aws_internet_gateway.my_vpc_igw.id
  }

  tags = {
    Name = "Public Subnet Route Table."
  }
}
```

Ressource aws_route_table_association

```
resource "aws_route_table_association" "my_vpc_eu_central_1a_public" {  
    subnet_id      = aws_subnet.public.id  
    route_table_id = aws_route_table.my_vpc_eu_central_1a_public.id  
}
```

LAB

create a basic VPC

- create a VPC in `eu-central-1`
- create one `public` Subnet for one Availability Zone
- create an `Internet-Gw`
- create a `Route Table`
- associate the Route-Table with a Subnet

```
this._config.interval = this._config.interval || 1000
}

var transitionDuration = util.getTransitionDuration();
$(activeElement).one(Util.TRANSITION_END, function() {
  $(nextElement).removeClass(nextElement.hasClass() ? 'is-active' : 'is-previous');
  $(activeElement).removeClass(activeElement.hasClass() ? 'is-active' : 'is-next');
  _this4._isSliding = false;
  setTimeout(function() {
    return $_this4._element.trigger('slideEnd');
  }, 0);
}).emulateTransitionEnd(transitionDuration);
} else {
  $(activeElement).removeClass(activeElement.hasClass() ? 'is-active' : 'is-next');
  $(nextElement).addClass(nextElement.hasClass() ? 'is-active' : 'is-previous');
}
```

MOD 04 - Security Groups & EC2

Security Groups

- acts as a virtual firewall
- controls your EC2 instances inbound and outbound traffic
- act at the instance level, not the subnet level
- assign up to five security groups to an instance
- by default, they allow all outbound traffic

Create Security Groups- and Rule-Objects

```
resource "aws_security_group" "web_access" {  
  name          = "web_access"  
  description   = "Allow port 80 access from outside world"  
}  
  
resource "aws_security_group_rule" "allow_webserver_access" {  
  type          = "ingress"  
  from_port     = 80  
  to_port       = 80  
  protocol      = "tcp"  
  cidr_blocks   = ["0.0.0.0/0"]  
  security_group_id = aws_security_group.web_access.id  
}
```

Use Security Groups with blocks

```
resource "aws_security_group" "ssh_access" {
  name          = "web_security_group"
  description   = "Terraform web security group"
  vpc_id        = "vpc-47111266642"

  egress {
    from_port    = 0
    to_port      = 0
    protocol     = "-1"
    cidr_blocks = ["0.0.0.0/0"]
  }

  ingress {
    from_port    = 22
    to_port      = 22
    protocol     = "tcp"
    cidr_blocks = ["0.0.0.0/0"]
  }
}
```

LAB

Security Groups

- create a security-group "webserver-access"
 - add ingress-rule for port 22 and port 80 open to the world
 - add egress-rule for everything open to the world (if necessary)
 - attach it to app_server-ressource

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getTransitionDuration(this._config)
    $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(direction);
        $(activeElement).removeClass(classNames[0]);
        _this4._isSliding = false;
        setTimeout(function () {
            return $_this4._element.trigger('slideEnd');
        }, 0);
    }).emulateTransitionEnd(transitionDuration)
} else {
    $(activeElement).removeClass(classNames[0]);
    $(nextElement).addClass(classNames[1]);
}
```

MOD 05 - EC2 with Terraform

Attach a Security-Group to EC2

Security Groups including Roles needs to be attached to EC2-Instance for use. You can easily achieve this in Terraform with,

- a reference

```
vpc_security_group_ids = [aws_security_group.allow_ssh.id]
```

- or use of the ID

```
vpc_security_group_ids = "sg-4711"
```

Deploy an EC2 instance to a VPC/Subnet

if you are don't want the `default` -VPC as the EC2 target, you need to specifiy a Subnet-
Id from the VPC of your choice in the `aws_instance` -Ressource

```
subnet_id = "subnet-0c58bb979af8269a7"
```

This will handle the deployment to the associated VPC of the Subnet.

SSH-Key-Pair

A key pair, consisting of a public key and a private key, is a set of security credentials that you use to prove your identity when connecting to an Amazon EC2 instance. Amazon EC2 stores the public key on your instance, and you store the private key

```
resource "aws_key_pair" "my-pub-key" {
  key_name    = "aws-pub-key"
  public_key = "ABCDEFXXXXXX"
}
```

for aws_instance usage

reference it `key_name = aws_key_pair.my-pub-key.key_name`

or use the name `key_name = "aws-pub-key"`

create a keypair

This template creates a new keypair and download the `*.pem` File.

```
resource "tls_private_key" "pk" {
  algorithm = "RSA"
  rsa_bits  = 4096
}

resource "aws_key_pair" "kp" {
  key_name    = "myDemoKey" # Create a "myDemoKey" to AWS !!
  public_key  = tls_private_key.pk.public_key_openssh
}

resource "local_file" "ssh_key" {
  filename = "${aws_key_pair.kp.key_name}.pem"
  content  = tls_private_key.pk.private_key_pem
}
```

Bootstrap with user_data

Usually we can use SSH-Access to install software manually or use something like Ansible. Here we will use the cloud-init-hook `user_data` from an EC2-Ressource.

```
user_data = << EOF
#!/bin/bash
sudo apt-get update
sudo apt-get install -y apache2
sudo systemctl start apache2
sudo systemctl enable apache2
echo "<h1>Deployed via Terraform</h1>" > /var/www/html/index.html
EOF
```

getting replicas with `count` and simple expressions

This template creates 4 single EC2 instances in AWS

```
resource "aws_instance" "app_server" {
  count          = 4
  ami            = "ami-830c94e3"
  instance_type = "t2.micro"

  tags = {
    Name = "App Server ${count.index+1}"
  }
}
```

Cloudwatch - basics

- Cloudwatch is the AWS Monitoring Service
- you can create alarms for metrics
- The level of CloudWatch monitoring could be
 - basic (5 Min./Datapoint)
 - detailed (1 Min./Datapoint)
- Instances will be monitored by default in basic-level
- to enable detailed monitoring use

```
monitoring = true
```

Cloudwatch Alarms

```
resource "aws_cloudwatch_metric_alarm" "alarm-foobar" {
  count                      = 3
  alarm_name                 = "SRV-Alarm-${count.index}"
  comparison_operator         = "GreaterThanOrEqualToThreshold"
  evaluation_periods          = "2"
  metric_name                = "CPUUtilization"
  namespace                   = "AWS/EC2"
  period                      = "120"
  statistic                   = "Average"
  threshold                   = "80"
  alarm_description           = "This metric monitors ec2 cpu utilization"
  insufficient_data_actions  = []

  dimensions = {
    "InstanceId" = aws_instance.app_server[count.index].id
  }
}
```

LAB

more attributes

create an EC2-Instance

- add a subnet-id from your VPC
 - enable detailed monitoring
 - deploy a basic webserver
 - create two instances

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getTransitionDuration(
        $(activeElement).one(Util.TRANSITION_END, function() {
            $(nextElement).removeClass(direction);
            $(activeElement).removeClass(reverse);
            _this4._isSliding = false;
            setTimeout(function() {
                return $_this4._element.trigger('slideEnd');
            }, 0);
        }).emulateTransitionEnd(transitionDuration)
    ) else {
        $(activeElement).removeClass(className);
        $(nextElement).addClass(className);
    }
}
```

MOD 06 - from static to dynamic deployment

Variables - simple types

There are simple types of variables you can set:

- string
- number
- bool

define a Variable (variables.tf)

```
variable "app_server_instance_type" {  
  type        = string  
  default     = "t2.micro"  
  description = "The aws instance-type"  
}
```

use a Variable (main.tf)

```
resource "aws_instance" "app_server" {  
  count        = var.app_server_count  
  ami          = var.ami_id  
  instance_type = var.app_server_instance_type  
  
  tags = {  
    Name = "App Server ${count.index+1}"  
  }  
}
```

Custom validation with Rules I (variables.tf)

using a validation block nested within the variable block

```
variable "image-id" {
  type      = string
  description = "The id of the machine image (AMI) to use for the server."
  validation {
    condition    = length(var.image_id) > 4 && substr(var.image_id, 0, 4) == "ami-"
    error_message = "Image-id value must be a valid ami id, does it start with 'ami-?'"
  }
}
```

Custom validation with Rules II ([variables.tf](#))

you can even use regex for this

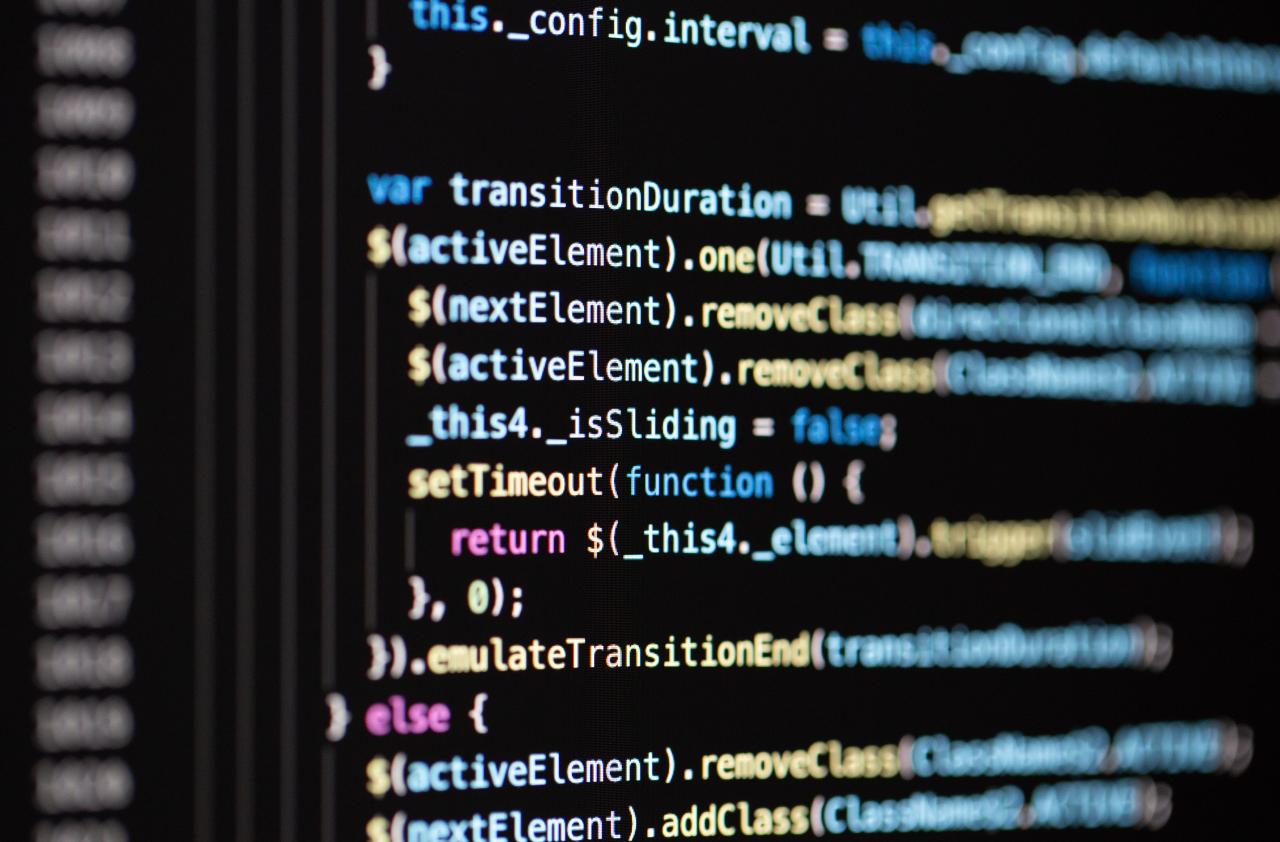
```
variable "image-id" {
  type      = string
  description = "The id of the machine image (AMI) to use for the server."
  validation {
    # regex(...) fails if it cannot find a match
    condition    = can(regex("^ami-", var.image_id))
    error_message = "Image-id value must be a valid ami id, does it start with 'ami-?'"
  }
}
```

LAB

use Variables & Functions I

refactor the solution with

- variable `node_count`
- variable `ami_id`
- variable `instance_type`
- 3 replicas of your EC2 per default



```
        this._config.interval = this._config.interval || 1000;
    }

    var transitionDuration = Util.getTransitionDuration();
    $(activeElement).one(Util.transitionEnd, function() {
        $(nextElement).removeClass(nextElement.hasClass() ? 'is-active' : 'is-previous');
        $(activeElement).removeClass(activeElement.hasClass() ? 'is-active' : 'is-previous');
        _this4._isSliding = false;
        setTimeout(function() {
            return $_this4._element.trigger('slideEnd');
        }, 0);
    }).emulateTransitionEnd(transitionDuration);
} else {
    $(activeElement).removeClass(activeElement.hasClass() ? 'is-active' : 'is-previous');
    $(nextElement).addClass(nextElement.hasClass() ? 'is-previous' : 'is-active');
}
```

Variables - Type Map

A Map is a lookup table, where you specify multiple keys with different values

```
# define a map of images
variable "images" {
  type = map(string)

  default = {
    eu-central-1 = "image-1234"
    us-west-1    = "image-4567"
  }
}

# getting the value for region eu-central-1
image_id = var.images["eu-central-1"]

# getting the correct value via a lookup
image_id = lookup(var.images, var.region)
```

Variables - Type List

A list value is an ordered sequence of strings indexed by integers starting with zero.

```
# define a map of images
variable "user_names" {
  type = "list(string)"
  default = ["Admin", "Jane", "Dane"]
}

# getting the value for the first entry
user = var.user_names[0]

# loop through in a ressource
count = length(var.user_names)
user  = var.user_names[count.index]
```

LAB

use Variables & Functions II

refactor the solution with

- variable `region`, default to `eu-central-1`
- change variable type `ami_id` to `map`

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = util.getTransitionDuration(this._config)
    $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(nextElement.hasClass('is-active') ? 'is-active' : 'is-previous')
        $(activeElement).removeClass(activeElement.hasClass('is-active') ? 'is-active' : 'is-previous')
        _this4._isSliding = false
        setTimeout(function () {
            return $_this4._element.trigger('slideEnd')
        }, 0);
    }).emulateTransitionEnd(transitionDuration)
} else {
    $(activeElement).removeClass(activeElement.hasClass('is-active') ? 'is-active' : 'is-previous')
    $(nextElement).addClass(nextElement.hasClass('is-active') ? 'is-active' : 'is-previous')
}
```

Setting Values with tfvars-Files

place Terraform variables in a special file (`*.tfvars`) and load them with the Terraform command:

```
foo = "bar"

somelist = ["one","two"]

somemap = {
  foo = "bar"
  bax = "qux"
}
```

Linux: `$ terraform apply -var-file=env/development.tfvars`

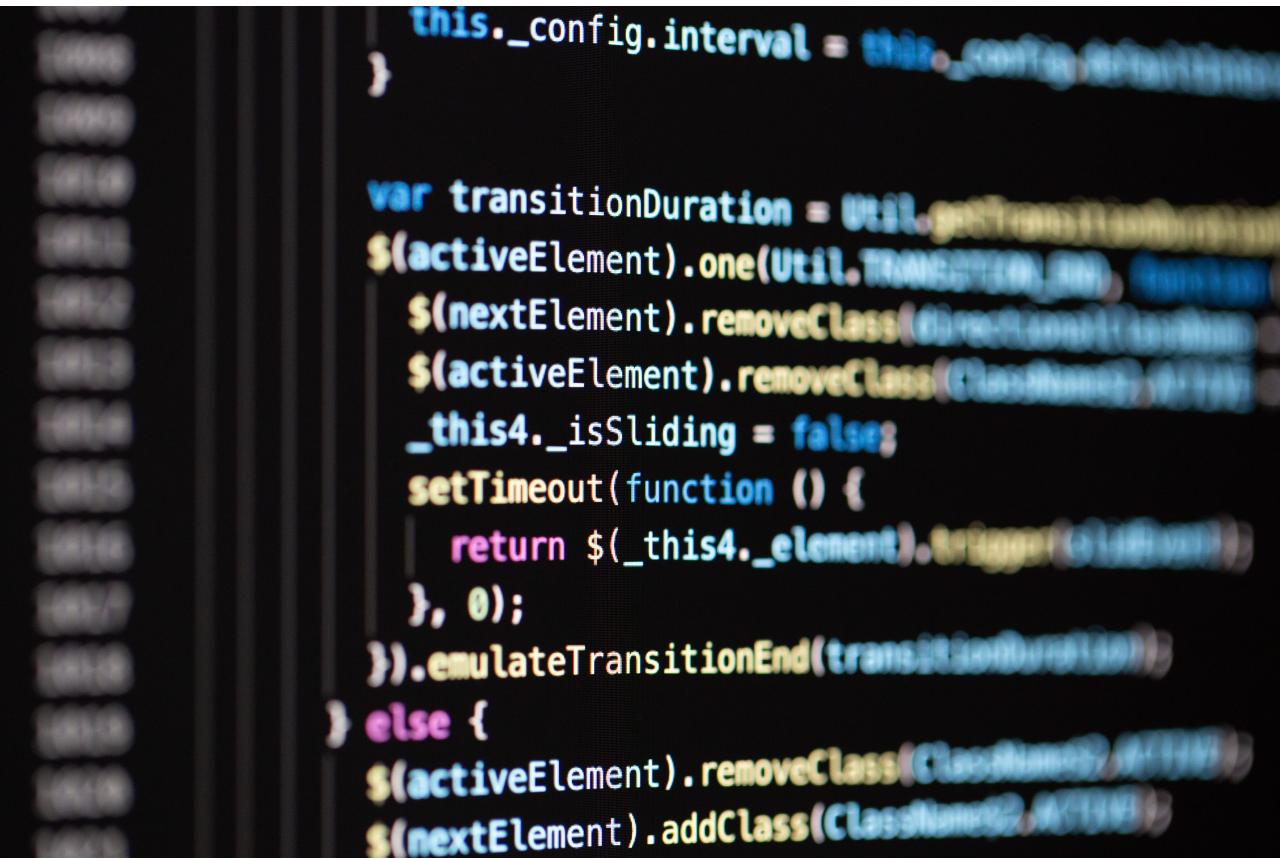
Windows: `$ terraform apply --var-file=env/development.tfvars`

LAB

use Variable-Files

refactor the solution with

- create `production.tfvars`
 - `region` to 'eu-central-1'
 - `instance_type` to `t3.micro`
 - `node_count` to 2
- create `development.tfvars`
 - `region` to 'eu-west-1'
 - `instance_type` to `t2.micro`
 - `node_count` to 1



use of environment variables

you can also supply values to your variables by using environment variables

Terraform will automatically read all environment variables with the `TF_VAR_` prefix

Example `variables.tf`

```
variable db_password {  
  type = string  
}
```

set the value (Linux)

```
export TF_VAR_db_password=Secret123
```

set the value (PowerShell)

```
$env:TF_VAR_db_password=Secret123
```

use Variables on the Commandline

To specify individual variables on the command line, use the `-var` option when running the `terraform plan` and `terraform apply` commands:

```
$ terraform apply -var="db_engine=mysql"  
$ terraform apply -var='user_names_list=["Peter","Paul","Marry"]'  
$ terraform apply -var='image_id_map={"us-east-1":"ami-abc123","us-east-2":"ami-def456"}
```

Variable Definition Precedence

Terraform loads variables in the following order (later sources taking precedence over earlier ones):

1. Environment variables
2. The `terraform.tfvars` file, if present.
3. The `terraform.tfvars.json` file, if present.
4. Any `_.auto.tfvars` or `_.auto.tfvars.json` files, processed in lexical order of their filenames.
5. Any `-var` and `-var-file` options on the command line, in the order they are provided.
(This includes variables set by a Terraform Cloud workspace.)

Conditional Expressions

A conditional expression uses the value of a bool expression to select one of two values.

The syntax of a conditional expression is as follows:

```
condition ? true_val : false_val
```

Example with a region-default value if not set:

```
var.region != "" ? var.region : "eu-central-1"
```

LAB

use conditionals

- create a variable
var.server_build
- create a conditional-expression if
server should be build

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getTransitionDuration(
        $(activeElement).one(Util.TRANSITION_DURATION),
        $(nextElement).removeClass(ClassName),
        $(activeElement).removeClass(ClassName),
        _this4._isSliding = false
    )
    setTimeout(function () {
        return $_this4._element.trigger('slide')
    }, 0);
}).emulateTransitionEnd(transitionDuration)
} else {
    $(activeElement).removeClass(ClassName),
    $(nextElement).addClass(ClassName)
}
```

Declaring an Output Value

Each output block that will be declared is exported after each `apply` :

What is the difference and when we use a) or b):

a)

```
output "app_server_ip_addr" {  
  value = aws_instance.app_server.*.public_ip  
}
```

b)

```
output "app_server_ip_addr" {  
  value = aws_instance.app_server.public_ip  
}
```

Terraform output on the commandline

You can use `terraform output` to get the latest info from the **state-file**

Output everything variable:

```
$ terraform output
app_server_public_ip = [
  "18.192.194.218",
]
```

output as JSON Object with [jq](#)-parsing

```
$ terraform output -json app_server_public_ip | jq -r '.[0]'
```

Sensitive Variables

Setting a variable as `sensitive` prevents Terraform from showing its value in the plan or apply output.

```
variable admin_password {  
  type      = string  
  sensitive = true  
}
```

```
$ terraform apply -var=admin_password="Geheim123"
```

Sensitive Data and Output-Variables

try the difference of using sensitive on the output definition

```
output "db_admin_password" {
  description = "Admin Password"
  value       = var.admin_password
}
```

```
output "db_admin_password" {
  description = "Admin Password"
  value       = var.admin_password
  sensitive   = true
}
```

sensitive is NOT enough

Terraform will still record sensitive values in the **statefile**, and so anyone who can access the state data will have access to the sensitive values in cleartext.

```
$ grep -2 "password" terraform.tfstate
```

use Tools like:

[Vault](#) / [AWS Secrets Mgmt.](#) / [Mozilla SOPS](#)

more functions and dynamic blocks

using a more then one Tag for each Instance

```
variable "common_tags" {
  type = map(string)
  default = {
    Department  = "Global Infrastructure Services"
    Team        = "EMEA Delivery"
    CostCenter  = "12345"
    Application = "Intranet-Portal"
  }
}
```

use of a map with common tags

use it just as a variable:

```
resource "aws_instance" "app_server" {  
  ...omitted output...  
  tags = var.common_tags  
  ...omitted output...  
}
```

use it with the merge()-function

```
tags = merge(var.common_tags, {  
  Name = "AppSrv-${count.index + 1}"  
})
```

LAB

use some common_tags

- create a map-variable

```
var.common_tags
```

- set the tags:

CostCenter = "12345"

DeployedBy = "Terraform"

SLA = "High"

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = util.getTransitionDuration(
        $(activeElement).one(Util.transitionEnd, function() {
            $(nextElement).removeClass(nextElement.hasClass ? 'Classname2' : 'Classname1')
            $(activeElement).removeClass(activeElement.hasClass ? 'Classname2' : 'Classname1')
            _this4._isSliding = false;
            setTimeout(function () {
                return $_this4._element.trigger('slideEnd')
            }, 0);
        }).emulateTransitionEnd(transitionDuration)
    ) else {
        $(activeElement).removeClass(activeElement.hasClass ? 'Classname2' : 'Classname1')
        $(nextElement).addClass(nextElement.hasClass ? 'Classname2' : 'Classname1')
    }
}
```

file()-Function

we can use the file-function to dynamically load **local** files during deployment:

Example `install_webserver.sh`

```
#!/bin/bash
yum install httpd -y
/sbin/chkconfig --levels 235 httpd on
service httpd start
instanceId=$(curl http://169.254.169.254/latest/meta-data/instance-id)
region=$(curl http://169.254.169.254/latest/meta-data/placement/region)
echo "<h1>$instanceId from $region</h1>" > /var/www/html/index.html
```

Example `main.tf` in ressource `ec2-instance`

```
user_data = file("install_webserver.sh")
```

LAB

install a webserver at startup

refactor the solution

- create an install script for Apache
- add a user-data section to ec2
- use file-function to load the script
- check the webserver on the host

curl localhost

```
        this._config.interval = this._config.interval || 1000;
    }

    var transitionDuration = util.getTransitionDuration();
    $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(nextElement.hasClass() ? 'active' : 'previous');
        $(activeElement).removeClass(activeElement.hasClass() ? 'active' : 'previous');
        _this4._isSliding = false;
        setTimeout(function () {
            return $_this4._element.trigger('slideEnd');
        }, 0);
    }).emulateTransitionEnd(transitionDuration);
} else {
    $(activeElement).removeClass(activeElement.hasClass() ? 'active' : 'previous');
    $(nextElement).addClass(nextElement.hasClass() ? 'active' : 'previous');
}
```

dynamic Blocks in Terraform

Within top-level block constructs like resources, expressions can usually be used only when assigning a value to an argument using the `name = expression` form. This covers many uses, but some resource types include repeatable **nested blocks** in their arguments, which typically represent separate objects that are related to (or embedded within) the containing object:

Create Security Groups with dynamic blocks (simple)

```
variable "ports" {
  default = [80, 443, 22]
}

resource "aws_security_group" "dynamic-demo" {
  name      = "demo-sg-dynamic"
  description = "Dynamic Blocks for Ingress"

  dynamic "ingress" {
    for_each = var.ports
    content {
      description = "description ${ingress.key}"
      from_port   = ingress.value
      to_port     = ingress.value
      protocol    = "tcp"
      cidr_blocks = ["0.0.0.0/0"]
    }
  }
}
```

Create Security Groups with dynamic blocks (with maps)

```
variable "sg_config" {
  type = map(any)
  default = {
    "web access" = {
      port = 80,
      cidr_blocks = ["0.0.0.0/0"],
    }
    "ssh access" = {
      port = 22,
      cidr_blocks = ["10.0.0.0/16"],
    }
  }
}

resource "aws_security_group" "map" {
  name      = "demo-map"
  description = "demo-map"

  dynamic "ingress" {
    for_each = var.sg_config
    content {
      description = ingress.key # IE: "description 0"
      from_port   = ingress.value.port
      to_port     = ingress.value.port
      protocol    = "tcp"
      cidr_blocks = ingress.value.cidr_blocks
    }
  }
}
```

LAB

using dynamic blocks:

- refactor the security-group "webserver-access" to use dynamic blocks
- add the following ingress-rules

Port	CIDR-Block	Description
22	only within VPC	ssh access
80	open to the world	web access
443	open to the world	tls web access

Datasources

Data sources allow Terraform use information defined outside of Terraform.

Examples: VPC-ID, AMI-ID, KeyPair, Hosted Zone Info, Textfiles, etc.

This is defined by another separate Terraform configuration, or modified by functions. Each provider may offer data sources alongside its set of resource types.

Datasource aws_ami

Use this data source to get the ID of a registered AMI for use in other resources.

```
data "aws_ami" "amazon-linux-2" {
  owners      = ["amazon"]
  most_recent = true

  filter {
    name    = "name"
    values = ["amzn2-ami-hvm-*-*x86_64-gp2"]
  }
}
```

Datasource aws_vpc

`aws_vpc` provides details about a specific VPC.

This resource can prove useful when a module accepts a vpc id as an input variable and needs to, for example, determine the CIDR block of that VPC.

```
data "aws_vpc" "selected" {
  tags = {
    Owner = "Terraform"
    Name  = "terraform-example-vpc"
  }
}
```

Datasource aws_subnets_ids

`aws_subnet_ids` provides a set of ids for a `vpc_id`

This resource can be useful for getting back a set of subnet ids for a vpc.

```
data "aws_subnet_ids" "selected" {  
  vpc_id = data.aws_vpc.selected.id  
}
```

The following example retrieves a set of all subnets in a VPC with a custom tag of `Tier` set to a value of "Private".

```
data "aws_subnet_ids" "private" {  
  vpc_id = var.vpc_id  
  tags = {  
    Tier = "Private"  
  }  
}
```

LAB

use a datasource

refactor the solution

- create a datasource to query the newest Amazon Linux 2 AMI
- create an ec2-instance and use the AMI dynamically

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = util.getTransitionDuration(this._config)
      $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(nextElement.hasClass() ? 'next' : 'prev')
        $(activeElement).removeClass(activeElement.hasClass() ? 'prev' : 'next')
        _this4._isSliding = false
        setTimeout(function() {
          return $_this4._element.trigger('slideEnd')
        }, 0);
      }).emulateTransitionEnd(transitionDuration)
    } else {
      $(activeElement).removeClass(activeElement.hasClass() ? 'next' : 'prev')
      $(nextElement).addClass(nextElement.hasClass() ? 'next' : 'prev')
    }
  }
}
```

Datasource template_file 1/2

The template_file data source renders a template from a template string, which is usually loaded from an external file.

```
data "template_file" "userdata" {
  template = file("${path.module}/userdata.sh")
  vars = {
    DOCKER_VERSION  = var.DOCKER_VERSION
    ANSIBLE_VERSION = var.ANSIBLE_VERSION
  }
}
```

Datasource `template_file` 2/2

File `userdata.sh`

```
#!/bin/bash -xe
yum update -y

amazon-linux-extras install docker=${DOCKER_VERSION} -y
amazon-linux-extras install ansible2=${ANSIBLE_VERSION} -y
yum install -y zip unzip
```

use the datasource in `ec2.tf`

```
resource "aws_instance" "webserver" {
  user_data  = data.template_file.userdata.rendered
  ...
}
```

MOD 07 - Dependencies and Terraform

Dependency Graphs in Terraform

- Terraform uses dependency graphs to determine the build and deletion order of resources
- Three different types of nodes in a Terraform graph:
 - Resource node
 - Provider configuration node
 - Resource meta-node



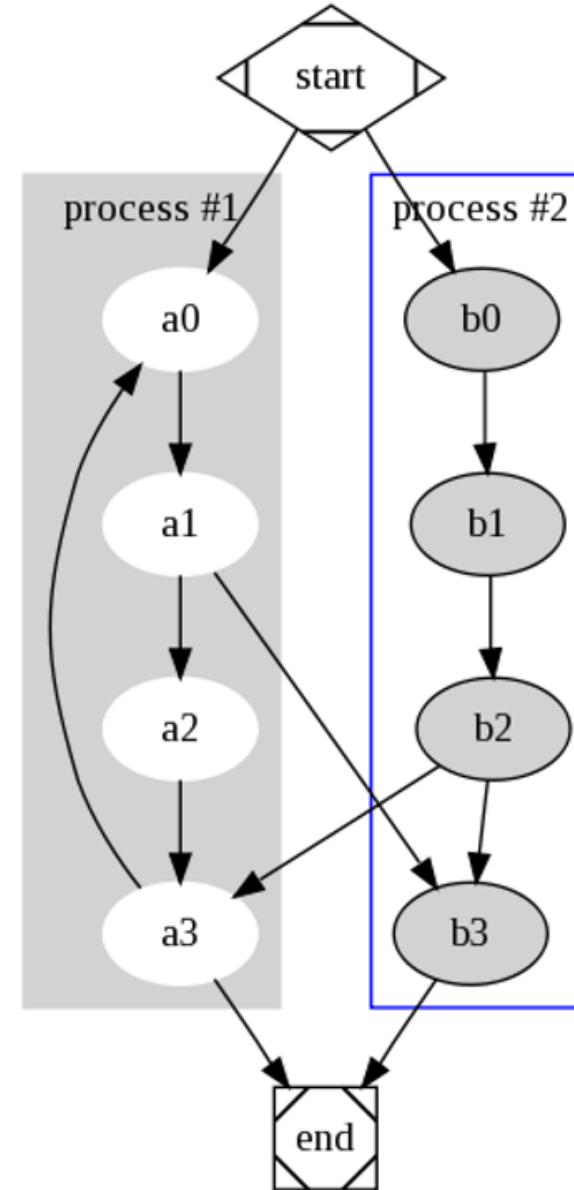
Controlling dependencies with `depends_on`

- Terraform will resolve dependencies automatically
- Sometimes built-in dependency resolution leads to unwanted behavior
- Enforce dependencies: `depends_on`
 - Accepts a list of resources that this resource depends on
 - Resource won't be created until the ones listed inside this parameter are created

```
resource "aws_instance" "app_server" {  
  ami           = var.ami_id  
  instance_type = var.instance_type  
  
  depends_on = [  
    aws_instance.db_server  
  ]  
}
```

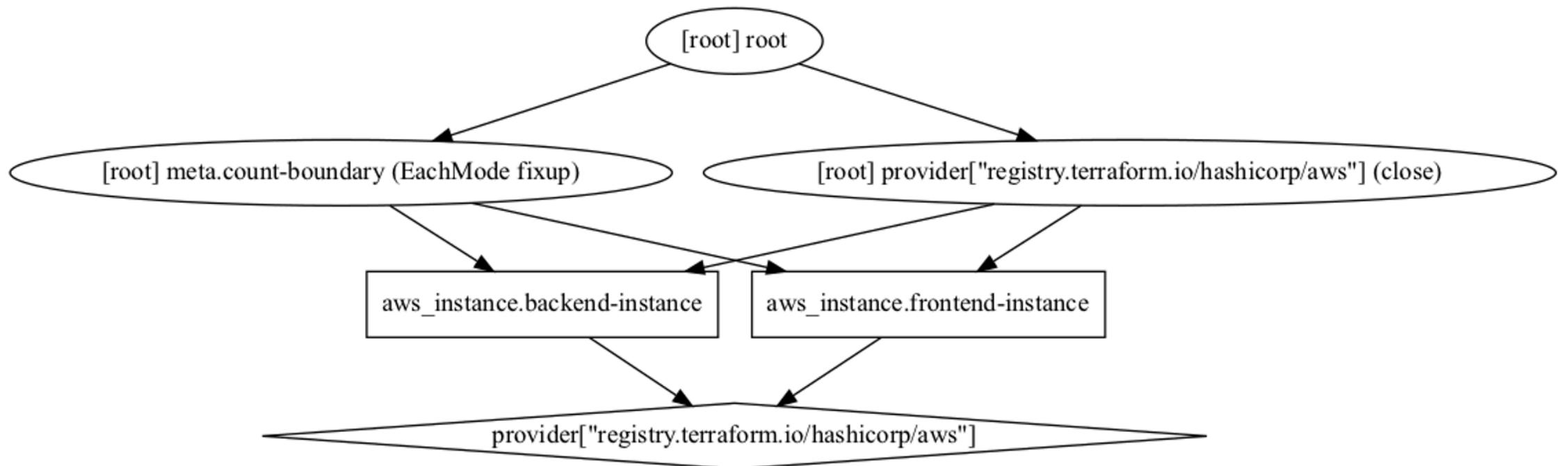
Terraform Graph Visualization

- Dot-Files are Text-Based
- Use [Graphviz](#) to visualize
- Possible output
 - Several pixel images
 - SVG
 - PDF
 - Postscript



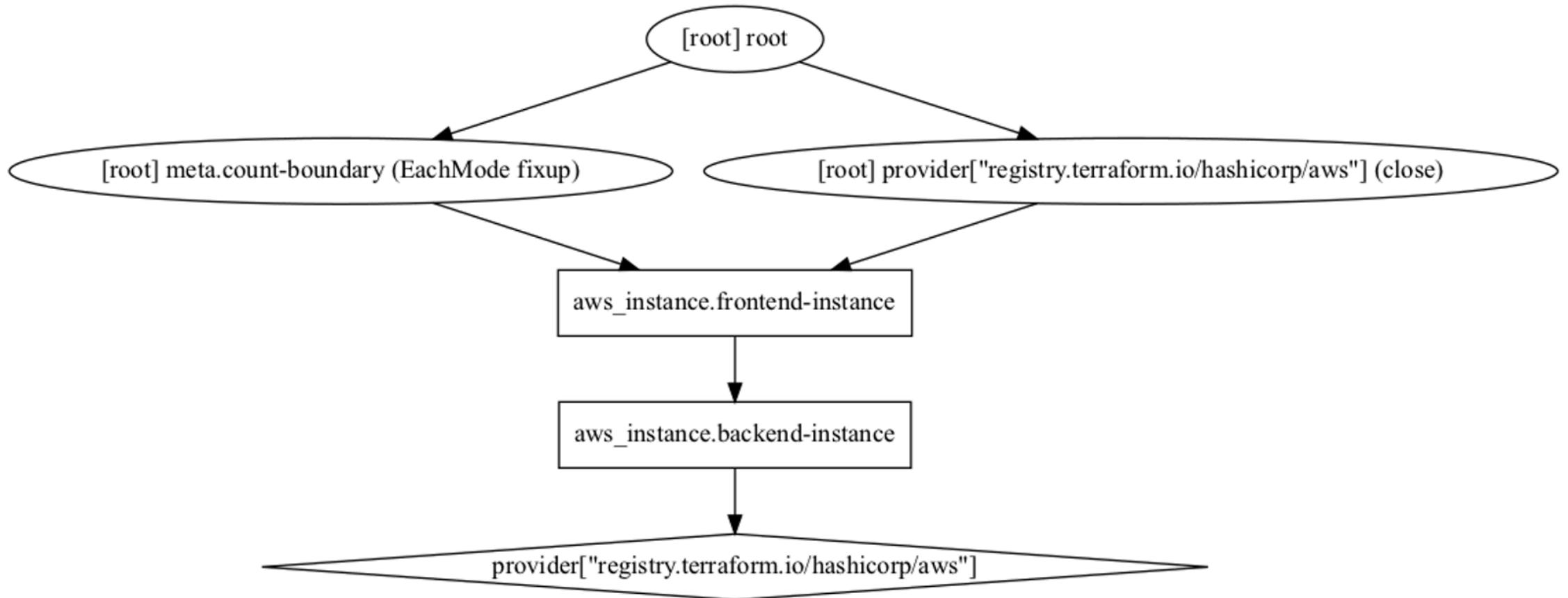
No dependency graph representation

```
$ terraform graph | dot -Tpng > no-dep-graph.png
```



Dependency graph representation

```
$ terraform graph | dot -Tpng > dep-graph.png
```



LAB

dependencie visualization

- create a second ec2 ressource in terraform
 - create a graph no-dep.png
 - change the second ec2 ressource with depends_on
 - create a graph dep.png

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getComputedStyle(this._activeElement).transitionDuration
    this._activeElement.one(Util.TRANSITION_END, function() {
        this._nextElement.removeClass(this._activeElement.className)
        this._activeElement.removeClass(this._nextElement.className)
        this._isSliding = false
        setTimeout(function() {
            return this._element.trigger('slideEnd')
        }, 0)
    }).emulateTransitionEnd(transitionDuration)
} else {
    this._activeElement.removeClass(this._activeElement.className)
    this._nextElement.addClass(this._nextElement.className)
}
```

MOD 08 - S3 Storage and Terraform

S3 Bucket-Ressource

```
resource "aws_s3_bucket" "bucket" {
  bucket = var.s3bucket_name
  acl    = "private" # Default-Value

  versioning {
    enabled = true
  }
}
```

S3 Bucket Upload

```
resource "aws_s3_bucket_object" "video_upload_object" {
  bucket = var.s3bucket_name
  key    = "video.mp4"
  source = "video.mp4"

  # The filemd5() function is available in Terraform 0.11.12 and later
  # For Terraform 0.11.11 and earlier, use the md5() function and the file() function:
  # etag = "${md5(file("path/to/file"))}"
  etag = filemd5("video.mp4")

  depends_on = [
    aws_s3_bucket.bucket
  ]
}
```

LAB

S3 essentials

- create a unique-bucket
- upload a file to it

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = Util.getTransitionDuration(this._config)
      $activeElement.one(Util.TRANSITION_END, function() {
        $nextElement.removeClass(nextElementClass)
        $activeElement.removeClass(activeElementClass)
        _this4._isSliding = false
        setTimeout(function () {
          return $_this4._element.trigger('slideEnd')
        }, 0);
      }).emulateTransitionEnd(transitionDuration)
    } else {
      $activeElement.removeClass(activeElementClass)
      $nextElement.addClass(nextElementClass)
    }
  }
}
```

use S3 lifecycle

```
resource "aws_s3_bucket" "bucket" {
  bucket = "terraform-2018121904031645290000001"
  acl = "private"

  lifecycle_rule {
    enabled = true
    transition {
      days = 30
      storage_class = "STANDARD_IA"
    }
    transition {
      days = 60
      storage_class = "GLACIER"
    }
  }
}
```

after 30 days move the objects to STANDARD_IA and after 60 days to GLACIER .

S3 Hosting a Website

```
resource "aws_s3_bucket" "static_bucket" {
  bucket = var.static_bucket_name
  acl    = "public-read"

  website {
    index_document = "index.html"
    error_document = "error.html"
  }
}
```

Create a Policy with Placeholders

```
{  
  "Version": "2012-10-17",  
  "Statement": [  
    {  
      "Sid": "Allow Public Access to All Objects",  
      "Effect": "Allow",  
      "Principal": "*",  
      "Action": "s3:GetObject",  
      "Resource": "arn:aws:s3:::${bucket_name}/*"  
    }  
  ]  
}
```

S3 Create a Policy / using templatefile()

```
resource "aws_s3_bucket_policy" "bucket_policy" {
  bucket = aws_s3_bucket.static_bucket.id

  policy = templatefile("bucket_policy.tpl", {
    bucket_name = var.static_bucket_name
  })
}
```

Upload a website-Assets

```
resource "aws_s3_bucket_object" "html_object" {
  bucket      = var.static_bucket_name
  key         = "index.html"
  source      = "index.html"
  content_type = "text/html"

  # The filemd5() function is available in Terraform 0.11.12 and later
  # For Terraform 0.11.11 and earlier, use the md5() function and the file() function:
  # etag = "${md5(file("path/to/file"))}"
  etag = filemd5("index.html")

  depends_on = [
    aws_s3_bucket_policy.bucket_policy,
    aws_s3_bucket.static_bucket
  ]
}
```

LAB

Hosting a website on S3

- create an unique-bucket
 - create a bucket-policy
 - upload an index.html
 - try to access the html-page

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getTransitionDuration(this._config)
    $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(direction);
        $(activeElement).removeClass(classNames[0]);
        _this4._isSliding = false;
        setTimeout(function () {
            return $_this4._element.trigger('slideEnd');
        }, 0);
    }).emulateTransitionEnd(transitionDuration)
} else {
    $(activeElement).removeClass(classNames[0]);
    $(nextElement).addClass(classNames[1]);
}
```

Use a random-Provider for unique Buckets

define the random-provider ([provider.tf](#))

```
provider "random" {  
}
```

create a random-ressource ([rand.tf](#))

```
resource "random_uuid" "s3_random_id" {  
}
```

use the random-ressource with a bucket ([s3.tf](#))

```
resource "aws_s3_bucket" "bucket" {  
  bucket = "${var.s3_bucket_name}-${random_id.s3_random_id.result}"  
}
```

LAB

refactor with random

- use the random-provider
- implement a random-bucket-name

```
        this._config.interval = this._config.interval || 1000
    }

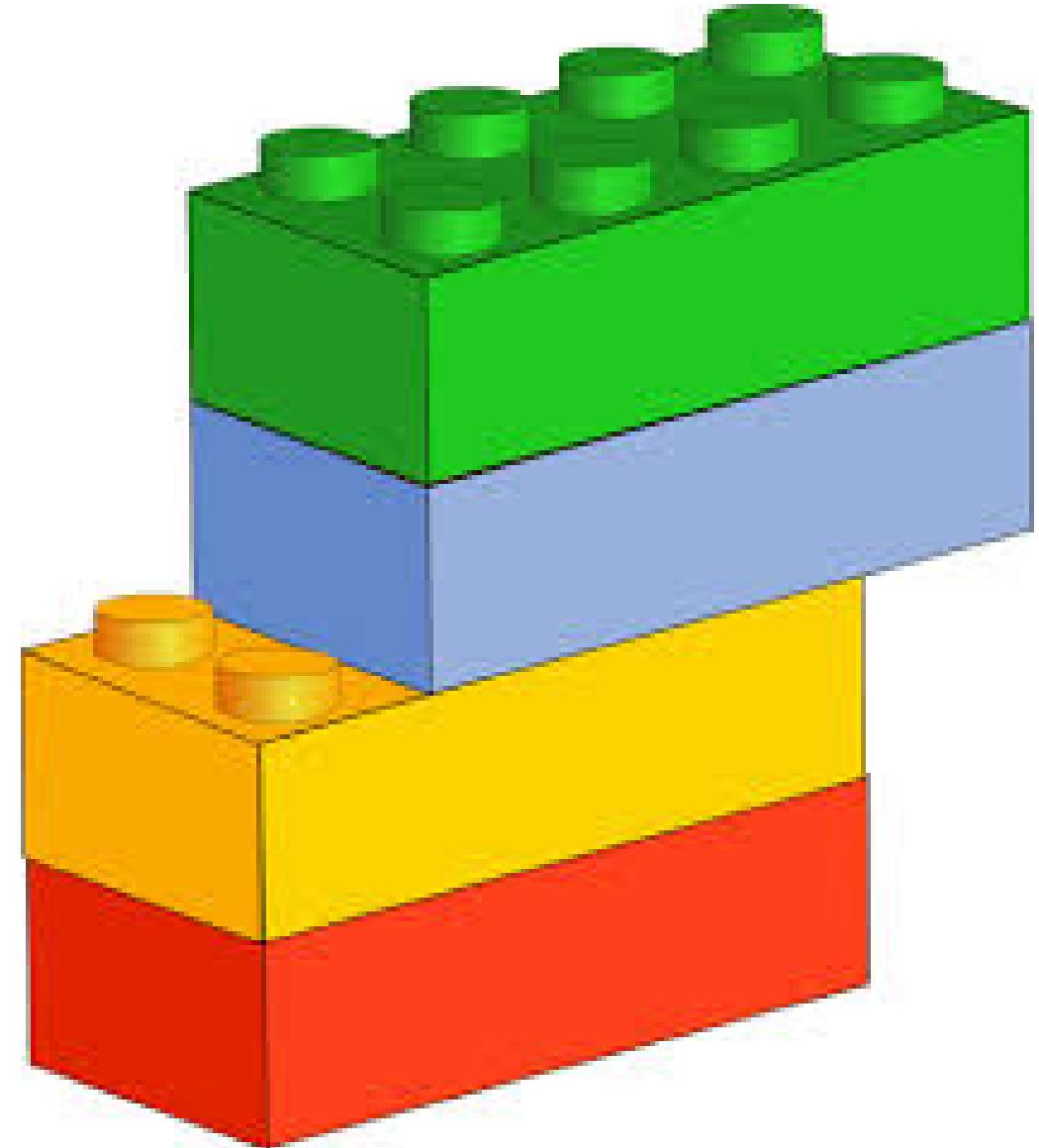
    var transitionDuration = Util.getTransitionDuration(this._config)
    $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(nextElement.hasClass ? 'ClassA' : 'ClassB')
        $(activeElement).removeClass(activeElement.hasClass ? 'ClassA' : 'ClassB')
        _this4._isSliding = false
        setTimeout(function () {
            return $_this4._element.trigger('slideEnd')
        }, 0);
    }).emulateTransitionEnd(transitionDuration)
} else {
    $(activeElement).removeClass(activeElement.hasClass ? 'ClassA' : 'ClassB')
    $(nextElement).addClass(nextElement.hasClass ? 'ClassA' : 'ClassB')
}
```

MOD 09 - Terraform and Modules

the power of modules

A module is a container for multiple resources that are used together.

Modules can be used to create lightweight abstractions, so that you can describe your infrastructure in terms of its architecture.



vpc-module example

```
module "vpc" {
  source  = "terraform-aws-modules/vpc/aws"
  version = "3.7.0"

  name = "my-vpc"
  cidr = "10.0.0.0/16"
  azs    = ["${var.region}a", "${var.region}b", "${var.region}c"]
  private_subnets = ["10.0.1.0/24", "10.0.2.0/24", "10.0.3.0/24"]
  public_subnets  = ["10.0.101.0/24", "10.0.102.0/24", "10.0.103.0/24"]
  enable_vpn_gateway = false
}
```

and don't forget to `$ terraform init`

LAB

Setup your VPC (Module-Support)

- create a VPC in eu-central-1
 - create three public & private Subnets with each AZ
 - create an Internet-Gatway
 - create a NAT-Gateway
 - create a Route Table

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getComputedStyle(this._activeElement).transitionDuration
    this._activeElement.one(Util.TRANSITION_END, function() {
        this._nextElement.removeClass(this._classNames[0])
        this._activeElement.removeClass(this._classNames[1])
        this._isSliding = false
        setTimeout(function() {
            return this._element.trigger('slideEnd')
        }, 0)
    }).emulateTransitionEnd(transitionDuration)
} else {
    this._activeElement.removeClass(this._classNames[1])
    this._nextElement.addClass(this._classNames[0])
}
```

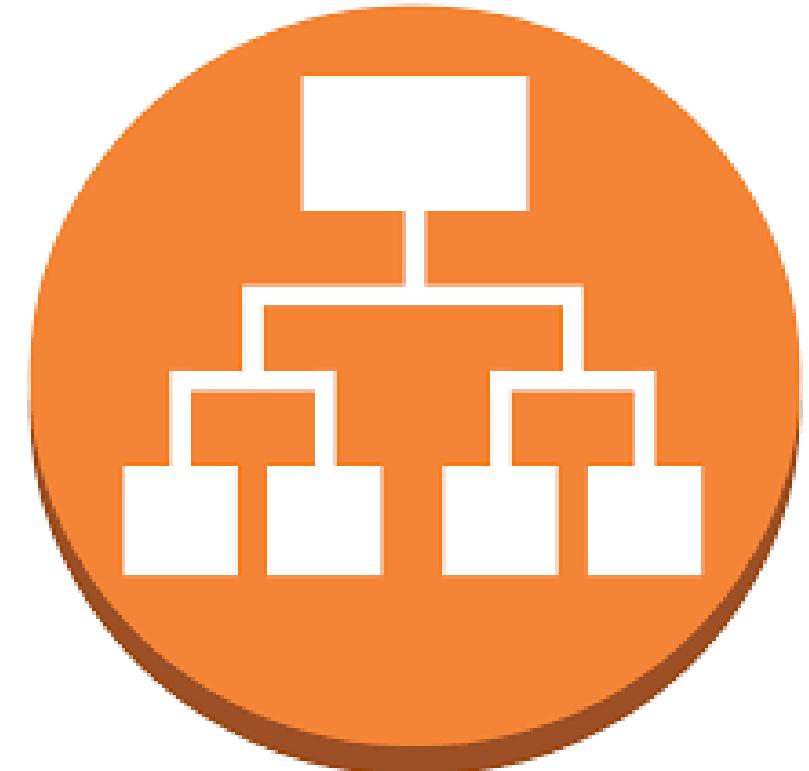
MOD 10 - Terraform and Elastic Load Balancing

AWS Elastic Load Balancing

- automatically distributes incoming traffic across multiple targets
 - EC2 instances
 - containers
 - IP addresses
- targets one or more Availability Zones
- monitors the health of its targets
- routes traffic only to healthy targets
- scales load balancer if incoming traffic changes over time

Application Load Balancer

- internet-/internal-facing
- Layer 4
- fully managed by AWS
- routable to private Subnets
- SSL-Offload possible
- HTTP/2 Proxy possible
- uses Target-Groups and Healthchecks



Classic-Loadbalancer Ressource (simple)

```
resource "aws_elb" "elb-appserver" {
  name          = "elb-appserver"
  availability_zones = ["us-west-2a", "us-west-2b", "us-west-2c"]
  instances      = aws_instance.app_server.*.id
  security_groups = [aws_security_group.elb-appserver-sg.id]

  listener {
    instance_port      = 80
    instance_protocol = "http"
    lb_port           = 80
    lb_protocol       = "http"
  }

  tags = {
    Name = "terraform-elb"
  }
}
```

Application-Loadbalancer Ressource

```
resource "aws_alb" "alb" {  
  name          = "terraform-example-alb"  
  security_groups = [aws_security_group.alb.id]  
  subnets        = ["subnet-04c352b2400a7c891",  
                  "subnet-0d752b61d8c0072d6",  
                  "subnet-0b516a2ea3f89bdf4"]  
}
```

```
resource "aws_alb_listener" "listener_http" {  
  load_balancer_arn = aws_alb.alb.arn  
  port              = "80"  
  protocol          = "HTTP"  
  default_action {  
    target_group_arn = aws_alb_target_group.web-group.arn  
    type             = "forward"  
  }  
}
```

Target-Group

Each target group is used to route requests to one or more registered targets. When you create each listener rule, you specify a target group and conditions. When a rule condition is met, traffic is forwarded to the corresponding target group.

```
resource "aws_alb_target_group" "web-group" {
  name      = "terraform-example-alb-target"
  port      = 80
  protocol = "HTTP"
  vpc_id    = var.vpc_id
  health_check {
    path = "/"
    port = 80
  }
}
```

Attach Instances to a Target-Group

This ressource does the work of adding EC2 Instances to the Target-Group of the LoadBalancer.

```
resource "aws_lb_target_group_attachment" "alb-attachment" {
  count          = var.node_count
  target_group_arn = aws_alb_target_group.web-group.arn
  target_id       = aws_instance.webserver-instance[count.index].id
  port            = 80
}
```

LAB

create an alb + webserver cluster

- create 2 webserver replicas with metadata-instance-id
- add ingress-rule for port 80 open to the world
- create an internet-facing alb with target-groups
- add a DNS-Entry for the ALB (optional)

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = util.getTransitionDuration();
      $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(nextElementClass);
        $(activeElement).removeClass(activeElementClass);
        _this4._isSliding = false;
        setTimeout(function () {
          return $_this4._element.trigger('slideEnd');
        }, 0);
      }).emulateTransitionEnd(transitionDuration);
    } else {
      $(activeElement).removeClass(activeElementClass);
      $(nextElement).addClass(nextElementClass);
    }
  }
}
```

MOD 11 - Terraform and Scaling

AWS Auto Scaling Service

Auto Scaling groups are collections of Amazon EC2 instances that enable automatic scaling and fleet management features. These features help you maintain the health and availability of your applications.

Launch configuration

Defines an instance configuration template. The Auto Scaling group uses it to launch EC2 instances.

```
resource "aws_launch_configuration" "launch_config" {
  name_prefix      = "terraform-example-web-instance"
  image_id         = "ami-04c921614424b07cd"
  instance_type    = "t2.micro"
  key_name         = aws_key_pair.my-pub-key.key_name
  security_groups  = [aws_security_group.allow_web_from_anywhere.id]
  user_data        = file("install_webserver.sh")

  lifecycle {
    create_before_destroy = true
  }
}
```

Auto Scaling Groups (ASG)

```
resource "aws_autoscaling_group" "autoscaling_group" {
  launch_configuration = aws_launch_configuration.launch_config.id
  min_size              = var.autoscaling_group_min_size
  max_size              = var.autoscaling_group_max_size
  target_group_arns     = [aws_alb_target_group.web_group.arn]
  vpc_zone_identifier   = [module.vpc.private_subnets.0,
                          module.vpc.private_subnets.1,
                          module.vpc.private_subnets.2]

  tag {
    key      = "Name"
    value    = "terraform-example-autoscaling-group"
    propagate_at_launch = true
  }
}
```

LAB

auto-scale web-server

- extend the example with ASG
- min 2 / max 5 Instances

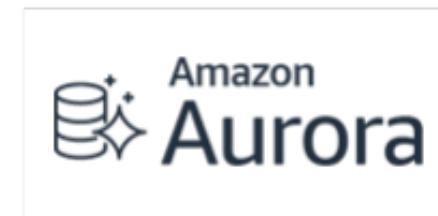
```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = util.getTransitionDuration();
      $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(nextElement.hasClass() ? 'active' : 'sliding');
        $(activeElement).removeClass(activeElement.hasClass() ? 'sliding' : 'active');
        _this4._isSliding = false;
        setTimeout(function () {
          return $_this4._element.trigger('slideEnd');
        }, 0);
      }).emulateTransitionEnd(transitionDuration);
    } else {
      $(activeElement).removeClass(activeElement.hasClass() ? 'sliding' : 'active');
      $(nextElement).addClass(nextElement.hasClass() ? 'active' : 'sliding');
    }
  }
}
```

MOD 12 - Terraform and RDS

AWS RDS Databases

- managed PaaS by AWS
- scale up on demand
- Multi-AZ / Read-Replica
- Backups managed by AWS
- EC2 underneath (one exception)



MySQL RDS Example

```
resource "aws_db_instance" "rds_mysql" {
  allocated_storage      = 20
  max_allocated_storage = 100
  storage_type           = "gp2"
  engine                 = "mysql"
  engine_version         = "5.7"
  instance_class          = var.db_instance_type
  name                   = var.db_name
  username               = var.db_user
  password               = var.db_password
  parameter_group_name   = "default.mysql5.7"
  skip_final_snapshot    = true
  vpc_security_group_ids = [aws_security_group.mysql-access.id]
  publicly_accessible    = true
}
```

LAB

Setup a MySQL RDS

- create a mysql database
 - create a security-group
 - create access to public
 - test the access via db-client
(optional)

```
        this._config.interval = this._config.interval || 1000
    }

    var transitionDuration = Util.getTransitionDuration(this._config)
    $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(direction);
        $(activeElement).removeClass(classNames[0]);
        _this4._isSliding = false;
        setTimeout(function () {
            return $_this4._element.trigger('slideEnd');
        }, 0);
    }).emulateTransitionEnd(transitionDuration)
} else {
    $(activeElement).removeClass(classNames[0]);
    $(nextElement).addClass(classNames[1]);
}
```

AWS Aurora

- MySQL and PostgreSQL-compatible database
- five times faster than MySQL
- three times faster than PostgreSQL
- built native on AWS
- provisioned **and** serverless
- **NO** public-access when serverless!

AWS Aurora Serverless via Module 1/3

As an alternative for the `aws_rds_cluster` -Ressource, we use a Module for the serverless approach.

```
module "aurora_postgresql" {
  source  = "terraform-aws-modules/rds-aurora/aws"
  version = "6.1.4"
  name                = "serverless-aurora-postgresql"
  engine              = "aurora-postgresql"
  engine_mode         = "serverless"
  storage_encrypted  = true
  master_username     = "admin"
  master_password     = "Admin123"
  create_random_password = false
  vpc_id              = module.vpc.vpc_id
  subnets              = module.vpc.database_subnets
  create_security_group = true
  ...
}
```

AWS Aurora Serverless via Module 2/3

```
...
  allowed_cidr_blocks = module.vpc.private_subnets_cidr_blocks
  monitoring_interval = 60
  enable_http_endpoint= true # cool for querying via HTTP
  apply_immediately   = true
  skip_final_snapshot = true

  db_parameter_group_name      = aws_db_parameter_group.example_postgresql.id
  db_cluster_parameter_group_name = aws_rds_cluster_parameter_group.example_postgresql.id
  # enabled_cloudwatch_logs_exports = # NOT SUPPORTED

  scaling_configuration = {
    auto_pause              = true # cluster can be paused when idle
    min_capacity            = 2   # capacity units
    max_capacity            = 8   # capacity units
    seconds_until_auto_pause = 300 # time before cluster is paused
    timeout_action          = "ForceApplyCapacityChange"
  }
}
```

AWS Aurora Serverless via Module 3/3

```
resource "aws_db_parameter_group" "example_postgresql" {  
  name      = "${var.demo-name}-aurora-db-postgres-parameter-group"  
  family    = "aurora-postgresql10"  
  description = "${var.demo-name}-aurora-db-postgres-parameter-group"  
}  
  
resource "aws_rds_cluster_parameter_group" "example_postgresql" {  
  name      = "${var.demo-name}-aurora-postgres-cluster-parameter-group"  
  family    = "aurora-postgresql10"  
  description = "${var.demo-name}-aurora-postgres-cluster-parameter-group"  
}
```

MOD 13 - Terraform and Serverless

Lambda-Functions

- run code without infrastructure
- automatically scale on demand
- pay-as-you-use-Modell
 - by seconds of cpu
 - by amount of memory
- upload code as
 - a .zip file
 - container image

Lambda essential Ressource

```
resource "aws_lambda_function" "http_crud_lambda" {  
  filename          = "lambda_function.zip"  
  function_name    = "http-crud-tutorial-function"  
  role              = aws_iam_role.iam_for_lambda_tf.arn  
  handler           = "index.handler"  
  source_code_hash = data.archive_file.lambda_zip.output_base64sha256  
  runtime           = "nodejs14.x"  
  architectures     = ["arm64"]  
}
```

DynamoDB

- fully managed by aws
- key-value and document database
- delivers predictable performance at scale

DynamoDB Ressource

```
resource "aws_dynamodb_table" "http-crud-tutorial-table" {
  name          = "http-crud-tutorial-items"
  hash_key      = "id"
  billing_mode = "PAY_PER_REQUEST"

  attribute {
    name = "id"
    type = "S"
  }
}
```

AWS API-Gateway

- fully managed service
- "front door" for applications
- RESTful APIs
- WebSocket APIs
- supported workloads
 - containerized
 - serverless
 - web applications

API-Gateway essential Ressources

```
resource "aws_apigatewayv2_api" "http-crud-tutorial-api" {  
  name          = "http-crud-tutorial-api"  
  protocol_type = "HTTP"  
}
```

```
resource "aws_apigatewayv2_route" "route-1" {  
  api_id      = aws_apigatewayv2_api.http-crud-tutorial-api.id  
  route_key   = "GET /items/{id}"  
  target      = "integrations/${aws_apigatewayv2_integration.http-crud-tutorial-api.id}"  
}
```

LAB

Setup a API

- create a dynamo-db table
- create a lambda function
- create an api-gateway
- test the api with `curl`

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = Util.getTransitionDuration(this._config)
      $activeElement.one(Util.transitionEnd, function() {
        $nextElement.removeClass(nextElementClass)
        $activeElement.removeClass(activeElementClass)
        _this4._isSliding = false
        setTimeout(function() {
          return $_this4._element.trigger('slideEnd')
        }, 0);
      }).emulateTransitionEnd(transitionDuration)
    } else {
      $activeElement.removeClass(activeElementClass)
      $nextElement.addClass(nextElementClass)
    }
  }
}
```

MOD 14 - EKS with Terraform

AWS Elastic Kubernetes Service

- a managed service to run Kubernetes
- runs and scales Kubernetes across multiple AZs
- can be node-based or serverless (fargate)

EKS Ressources

TODO: CODE HERE

How to **kubectl** into the EKS-cluster

```
# get the kubeconfig-Data
$ aws eks --region $(terraform output -raw region) update-kubeconfig --name $(terraform output -raw cluster_name)

# check the nodes in the cluster
$ kubectl cluster-info

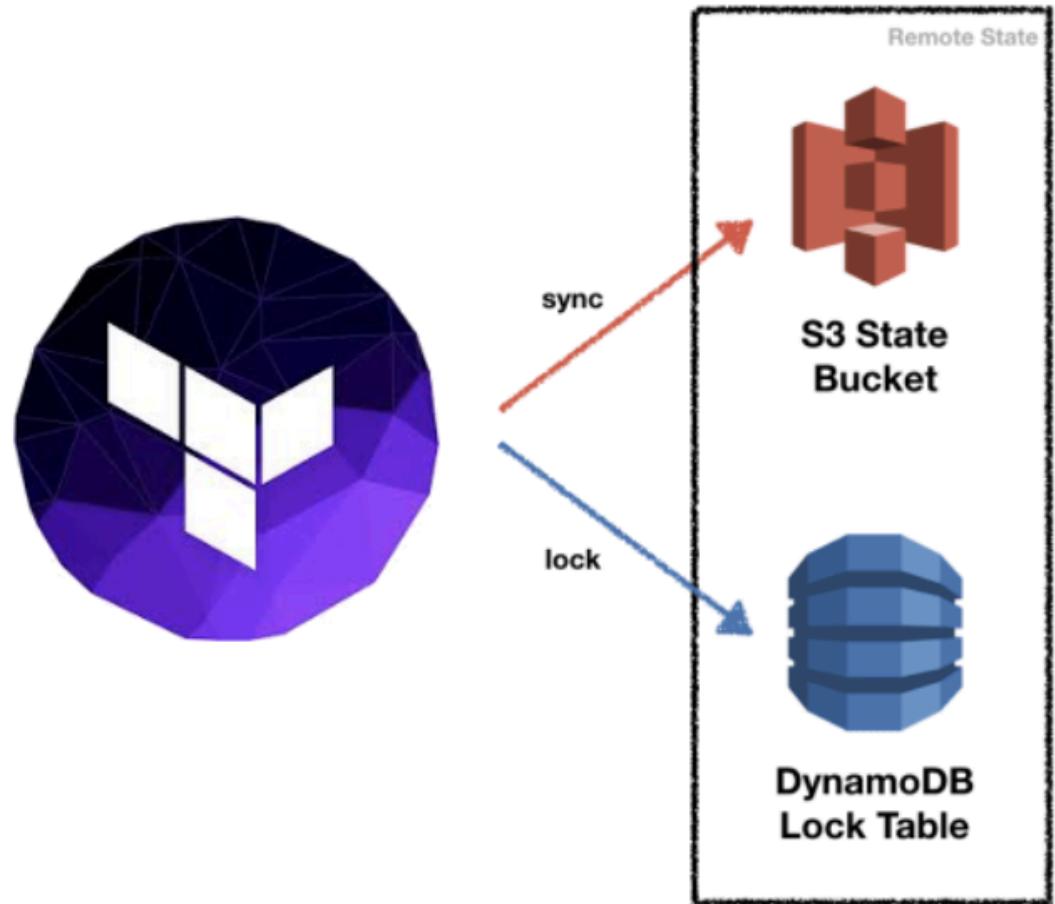
# check the nodes in the cluster
$ kubectl get nodes

# check if pods are running
$ kubectl get pods
```

MOD 15 - Remote State / Workspaces

Remote State File

- Stores the state at a key in a bucket on S3
- Lock the State via Dynamo DB



Backend Configuration with S3 & DynamoDB

```
terraform {  
  backend "s3" {  
    bucket          = "s3-terraform-backend"  
    key             = "example-app/terraform.tfstate"  
    region          = "eu-central-1"  
    encrypt         = true  
    dynamodb_table = "terraform-state-lock-dynamo"  
  }  
}
```

To start the initialization/migration use:

```
$ terraform init
```

bootstrap the backend-resources (optional)

```
resource "aws_s3_bucket" "s3-state" {  
  bucket = "s3-terraform-backend"  
  acl = "private"  
}
```

```
resource "aws_dynamodb_table" "dynamodb-terraform-state-lock" {  
  name = "terraform-state-lock-dynamo"  
  hash_key = "LockID"  
  read_capacity = 20  
  write_capacity = 20  
  
  attribute {  
    name = "LockID"  
    type = "S"  
  }  
}
```

LAB

Setup remote state

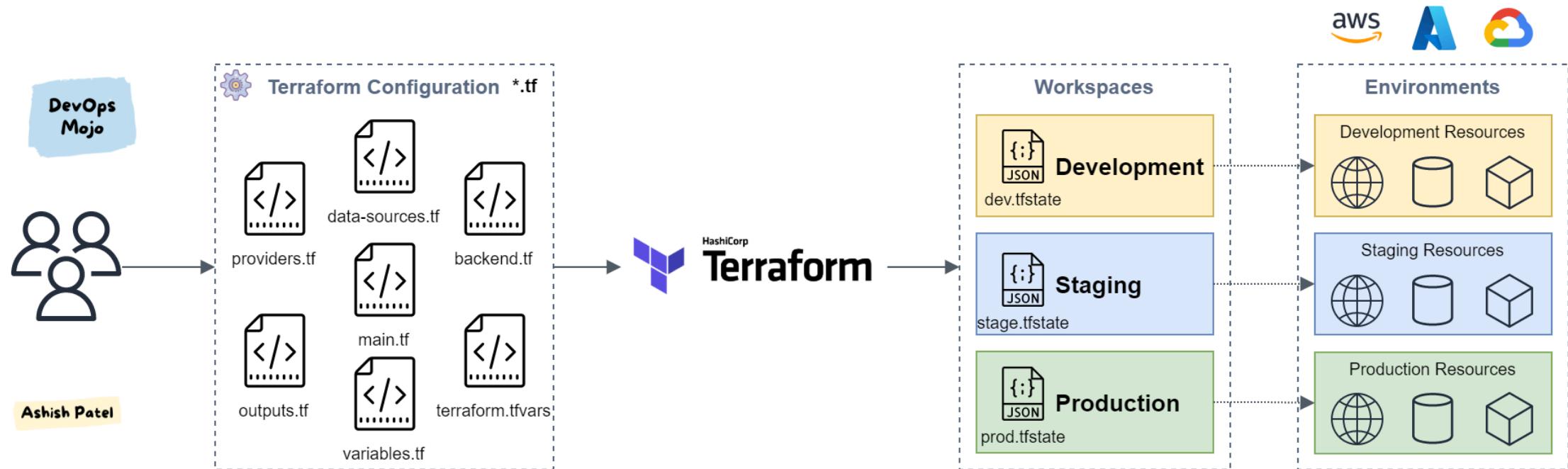
- create a s3-bucket
- create a dynamodb-table with LockID
- configure the s3-backend in terraform
- Test it :)

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = Util.getTransitionDuration(this._config)
      $activeElement.one(Util.TRANSITION_END, function() {
        $nextElement.removeClass(nextElementClass)
        $activeElement.removeClass(activeElementClass)
        _this4._isSliding = false
        setTimeout(function () {
          return $_this4._element.trigger('slideEnd')
        }, 0);
      }).emulateTransitionEnd(transitionDuration)
    } else {
      $activeElement.removeClass(activeElementClass)
      $nextElement.addClass(nextElementClass)
    }
  }
}
```

Workspaces

With a remote backend and locking, collaboration is no longer a problem.



Source

Isolating State Files

However, there is still one more problem remaining: **isolation**.

Isolate State via [workspaces](#)

```
$ terraform workspace show
$ terraform workspace new production
$ terraform apply -var-file=env/production.tf
$ terraform workspace new development
$ terraform apply -var-file=env/development.tf
$ terraform workspace list
$ terraform workspace select production
```

LAB

manage workspaces

- create a remote backend (opt.)
- configure two different workspaces
 - production
 - development

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = Util.getTransitionDuration(this._config)
      $(activeElement).one(Util.TRANSITION_END, function() {
        $(nextElement).removeClass(nextElement.hasClass ? 'next' : 'previous')
        $(activeElement).removeClass(activeElement.hasClass ? 'active' : 'previous')
        _this4._isSliding = false
        setTimeout(function() {
          return $_this4._element.trigger('slideEnd')
        }, 0);
      }).emulateTransitionEnd(transitionDuration)
    } else {
      $(activeElement).removeClass(activeElement.hasClass ? 'active' : 'previous')
      $(nextElement).addClass(nextElement.hasClass ? 'next' : 'previous')
    }
  }
}
```

MOD 15 - Terraform and Route53

The Route53 Record Resource

```
resource "aws_route53_record" "tf-alb-record" {
  zone_id = data.aws_route53_zone.zone.zone_id
  name    = "tf-alb.${var.route53_hosted_zone_name}"
  type    = "A"
  alias {
    name          = aws_alb.alb.dns_name
    zone_id       = aws_alb.alb.zone_id
    evaluate_target_health = true
  }
}
```

How to obtain hosted zone information

you can create a new hosted zone (not usual)

```
resource "aws_route53_zone" "my-test-zone" {  
  name = "example.com"  
  vpc {  
    vpc_id = "${var.vpc_id}"  
  }  
}
```

you can use a datasource here to find pre-deployed information

```
data "aws_route53_zone" "zone" {  
  name = "aws.zhtraining.de"  
}
```

LAB

use Route53 (DNS)

- use hosted zone info
- create a friendly dns entry for the static s3-bucket
- try that on your browser

```
        this._config.interval = this._config.interval || 1000
      }

      var transitionDuration = Util.getTransitionDuration(this._config)
      $activeElement.one(Util.transitionEnd, function() {
        $nextElement.removeClass(nextElementClass)
        $activeElement.removeClass(activeElementClass)
        _this4._isSliding = false
        setTimeout(function () {
          return $_this4._element.trigger('slideEnd')
        }, 0);
      }).emulateTransitionEnd(transitionDuration)
    } else {
      $activeElement.removeClass(activeElementClass)
      $nextElement.addClass(nextElementClass)
    }
  }
}
```

Thank you