

# Infrastructure as Code

*Software Architecture*

Brae Webb & Richard Thomas

March 16, 2026

- Do a quick poll.
- Who has heard the term IaC before this course?
- Who has used IaC before this course?

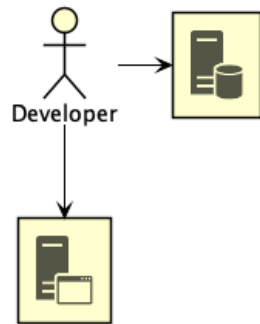
*Infrastructure as Code*

How did we get here?

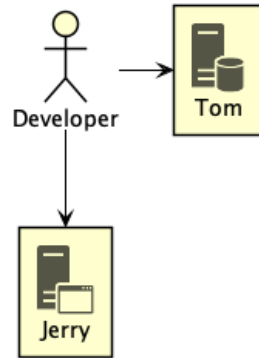
*Pre-2000*

The *Iron Age*

## *Iron Age*

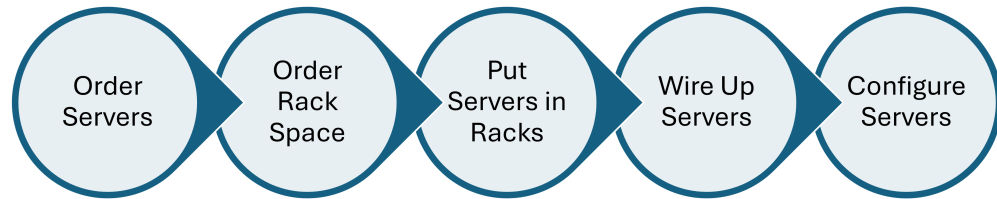


## *Iron Age*



Developer only had a few machines — so few the machines often got fun names.

## *Scaling*

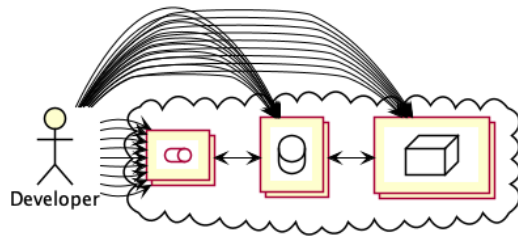


I used to have scheduling examples for software projects, where ordering servers was on the critical path, and had to happen before software development started.

*Introducing...*

The *Cloud Age*

## *The Cloud Age*



- Summarise: things got complicated quickly, we need more hardware and it's easier to provision.
- Largely thanks to virtualisation — no physical activity for a new machine.



*When faced with complexity*

Automate it!

- We have too much to manage to do it manually.
- We're about to start enumerating automation techniques.

# The larger story

Server Config Config Management

# The larger story

Server Config   Config Management

Application Config   Config Files

# The larger story

Server Config    Config Management

Application Config    Config Files

Provisioning    Infrastructure Code

# The larger story

Server Config    Config Management

Application Config    Config Files

Provisioning    Infrastructure Code

Building    Continuous Integration

# The larger story

Server Config    Config Management

Application Config    Config Files

Provisioning    Infrastructure Code

Building    Continuous Integration

Deployment    Continuous Deployment

# The larger story

Server Config    Config Management

Application Config    Config Files

Provisioning    Infrastructure Code

Building    Continuous Integration

Deployment    Continuous Deployment

Testing    Automated Tests

# The larger story

Server Config	Config Management
Application Config	Config Files
Provisioning	Infrastructure Code
Building	Continuous Integration
Deployment	Continuous Deployment
Testing	Automated Tests
Database Administration	Schema Migration



# The larger story

Server Config    Config Management

Application Config    Config Files

Provisioning    Infrastructure Code

Building    Continuous Integration

Deployment    Continuous Deployment

Testing    Automated Tests

Database Administration    Schema Migration

Specifications    Behaviour Driven Development

*Definition 0.* Infrastructure Code

Code that provisions and manages *infrastructure resources*.

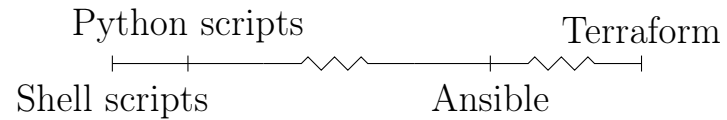
*Definition 0.* Infrastructure Code

Code that provisions and manages *infrastructure resources*.

*Definition 0.* Infrastructure Resources

Compute resources, networking resources, and storage resources.

## *Infrastructure Code*



IC often thought of as the right-hand side but includes all.

## Shell Scripts

```
1  #!/bin/bash

3  SG=$(aws ec2 create-security-group ...)

5  aws ec2 authorize-security-group-ingress --group-id "$SG"

7  INST=$(aws ec2 run-instances --security-group-ids "$SG" \
8      --instance-type t2.micro)
```

Using AWS CLI to create EC2 access like the practical.

# Python

```
1  import boto3

3  def create_instance():
4      ec2_client = boto3.client("ec2", region_name="us-east-1")
5      response = ec2.create_security_group(...)
6      security_group_id = response['GroupId']

8      data = ec2.authorize_security_group_ingress(...)

10     instance = ec2_client.run_instances(
11         SecurityGroups=[security_group_id],
12         InstanceType="t2.micro",
13         ...
14     )
```

Using AWS Python library (boto3).

## Terraform

```
1 resource "aws_instance" "hextris-server" {
2     instance_type = "t2.micro"
3     security_groups = [aws_security_group.hextris-server.name]
4     ...
5 }
6
7 resource "aws_security_group" "hextris-server" {
8     ingress {
9         from_port = 80
10        to_port = 80
11        ...
12    }
13    ...
14 }
```

Finally, Terraform.

*Question*

Notice anything different?

- Prompting for declarative.
- Might notice verbosity.



*The main difference*

## Imperative vs. Declarative

- *Imperative* – Describe the steps to take to deploy the infrastructure
- *Declarative* – Describe the desired infrastructure
- IC is heading towards a more *declarative* paradigm.

## *Declarative IaC*

- Define your *desired* infrastructure state
  - as code
- Engine interprets difference between the *desired* and *actual* state
  - Modifying infrastructure to deliver *desired* state

## *Infrastructure Code*

- Provisions and manages *infrastructure resources*.

## *Infrastructure Code*

- Provisions and manages *infrastructure resources*.
- Only one part of the movement to *automate* the complexities of development.

## *Infrastructure Code*

- Provisions and manages *infrastructure resources*.
- Only one part of the movement to *automate* the complexities of development.
- Ranges from simple shell scripts up to...?

## *Infrastructure Code*

- Provisions and manages *infrastructure resources*.
- Only one part of the movement to *automate* the complexities of development.
- Ranges from simple shell scripts up to...?
- Tendency to be *declarative*.

Summarising what we've already covered.

*Typo?*

Infrastructure Code  $\neq$  Infrastructure *as* Code

- Mention that this distinction is ours.
- Real world unfortunately mixes the two.

*Definition 0.* Infrastructure as Code

Following the same *good coding practices* to manage Infrastructure Code as standard code.



*Warning!*

Infrastructure as Code still *early* and quite *bad*.

- Code reuse is low.
- Importing existing resources is non-trivial.
- Refactoring is painful.
- State management can be tricky.

*Question*

What are *good coding practices*?

Ask the class.

*Good Coding Practice #1*  
*Everything* as Code

A practice we do but barely discuss in ‘regular’ programming because it doesn’t make sense not to do it.

```
1  #!/bin/bash
```

```
3  ./download-dependencies
```

```
4  ./build-resources
```

```
5  cp -r output/* artifacts/
```

```
1  #!/bin/bash
3  ./download-dependencies
4  ./build-resources
5  cp -r output/* artifacts/
```

```
$ cp: directory artifacts does not exist
```

An example of relying on external state in ‘regular’ programming.

```
1 resource "aws_instance" "hextris-server" {  
2     instance_type = "t2.micro"  
3     security_groups = ["sg-6400"]  
4     ...  
5 }
```

Draw a parallel to the bash example and this, which relies on ‘sg-6400’ existing.

```
1 resource "aws_instance" "hextris-server" {
2     instance_type = "t2.micro"
3     security_groups = [aws_security_group.hextris-server.name]
4     ...
5 }

7 resource "aws_security_group" "hextris-server" {
8     ingress {
9         from_port = 80
10        to_port = 80
11        ...
12    }
13    ...
14 }
```

The better approach.

*Everything as code avoids*  
Configuration drift



*Configuration drift creates*  
Snowflakes

- Snowflakes: magical machines that ‘just work’ and everyone is afraid to touch.
- Snowflake because they’re unique and easy to break, because no one knows how it works.

## *Benefits*

### 1. Reproducible

*Good Coding Practice #2*

Version Control

### *Benefits*

1. Restorable
2. Accountable

*Good Coding Practice #3*  
Automation

## *Benefits*

### 1. Consistent

Automatically applying or checking IC is in sync means the main branch is consistent with reality.

*Good Coding Practice #4*

Code Reuse

### *Benefits*

1. Better<sup>1</sup> code
2. Less work
3. Only one place to update (or verify)

---

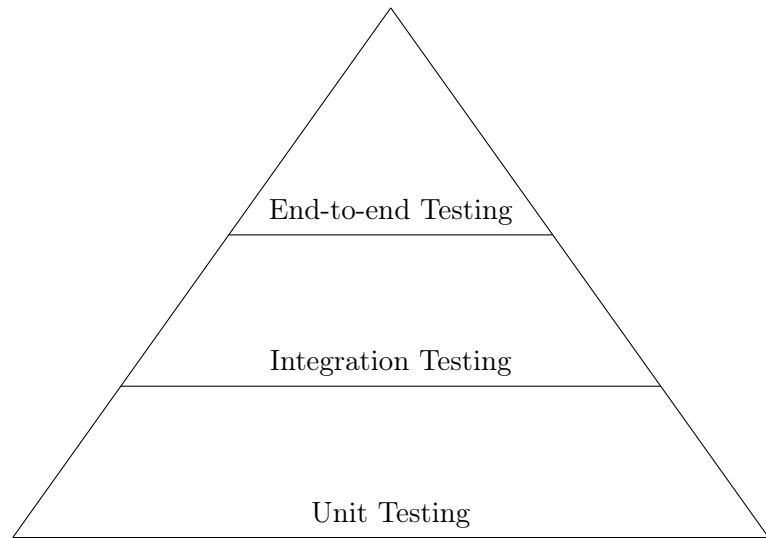
<sup>1</sup>generally



*Good Coding Practice #5*

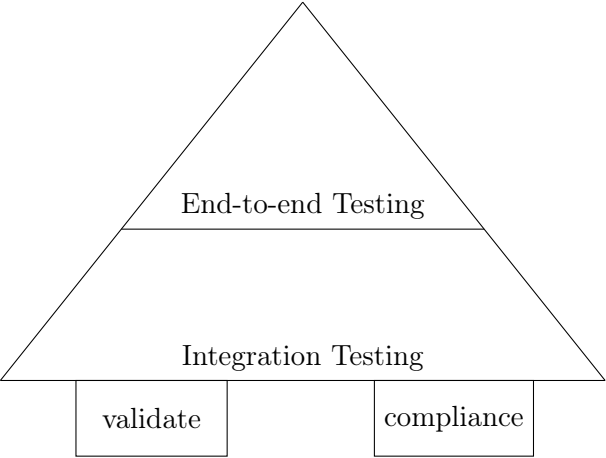
Testing

## Test Pyramid



- Traditional test pyramid.
- Unit testing relies on isolated testing.
- But...isolated testing doesn't make *much* sense for IaC.

# IaC Test Pyramid



```
1 func TestTerraformAwsInstance(t *testing.T) {
2     terraformOptions := terraform.WithDefault(t, &terraform.Options{
3         TerraformDir: "../week03/",
4     })
5
6     defer terraform.Destroy(t, terraformOptions)
7     terraform.InitAndApply(t, terraformOptions)
8
9     publicIp := terraform.Output(t, terraformOptions, "public_ip")
10    url := fmt.Sprintf("http://%s:8080", publicIp)
11
12    http_helper.HttpGetWithCustomValidation(t, url, nil, 200,
13        func(code, resp) { code == 200 &&
14            strings.Contains(resp, "hextris")})
15 }
```

An example of validation.

```
1  Feature: Define AWS Security Groups
```

```
3  Scenario: Only selected ports should be publicly open
```

```
4      Given I have AWS Security Group defined
```

```
5      When it contains ingress
```

```
6      Then it must only have tcp protocol and port 22,443 for 0.0.0.0/0
```

An example of compliance testing.

## *Benefits*

### 1. Trust

### *Prac Next Week*

Learn how to use Terraform to write IaC and deploy resources on AWS.