

# Infrastructure as Code

*Software Architecture*

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

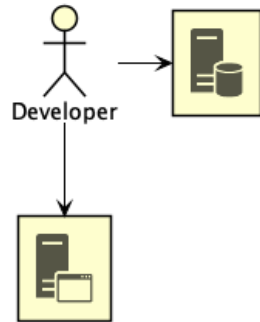
*Infrastructure as Code*

How did we get here?

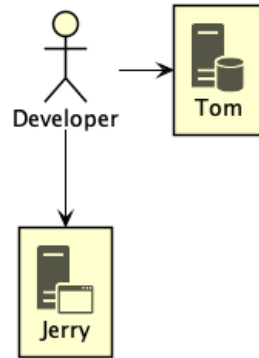
*Pre-2000*

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

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Provisioning    Infrastructure Code

Building    Continuous Integration

# The larger story

- Server Config Config Management
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- Deployment Continuous Deployment

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# The larger story

Server Config    Config Management

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Building    Continuous Integration

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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 }

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*.

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## *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/
```

```
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```

```
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)

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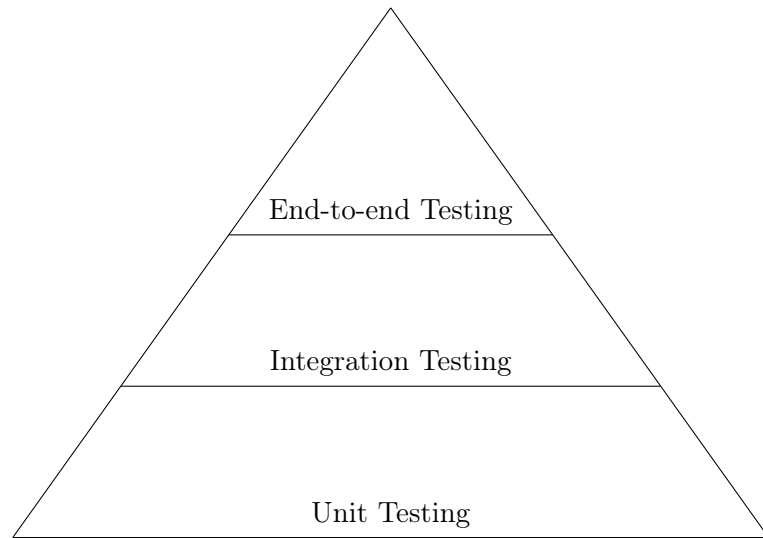
<sup>1</sup>generally



*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.