Murex Cloud Dev Architecture
In-Depth Analysis

Agenda

welcome!

Mission

We're going to analyze the aws murex dev architecture, along with all necessary aws services

It's a challenging and interesting journey, the sessions will in-depth
So follow along with me and try to practice.

Introduction To CloudFormation

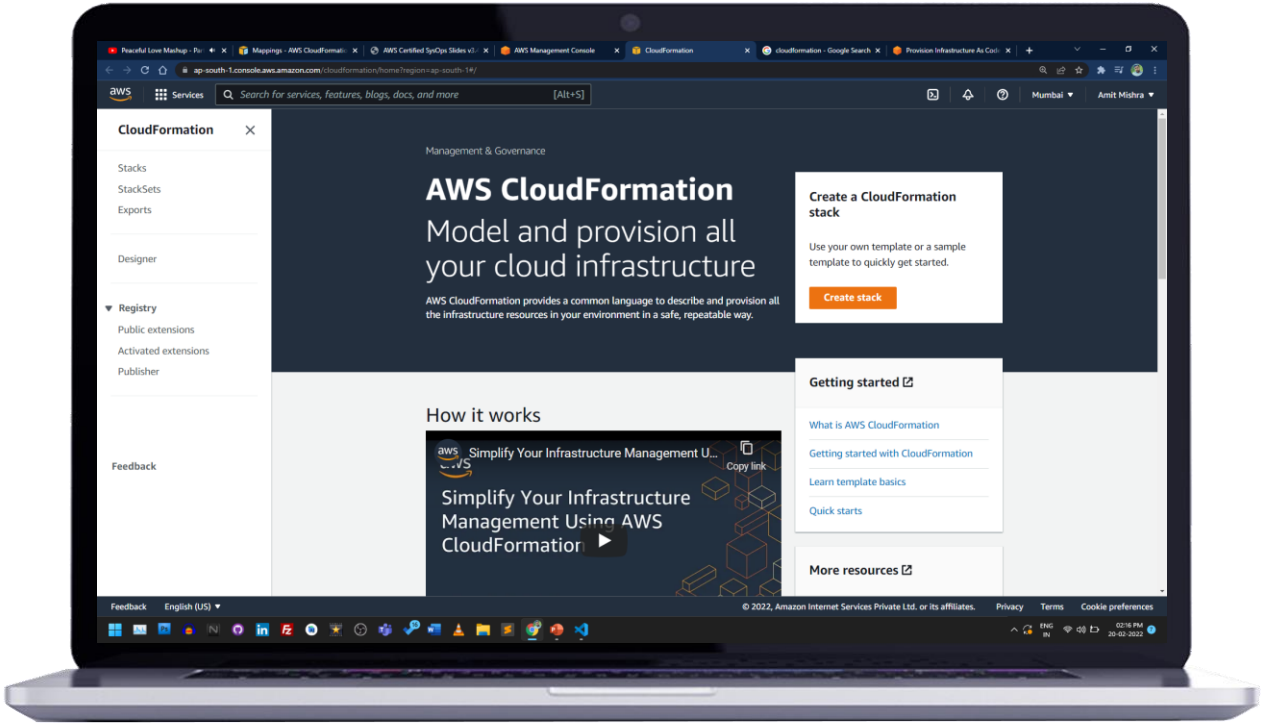
AWS CloudFormation: Managing your infrastructure as code

Infrastructure as Code

- Currently, we have been doing a lot of manual work
- All this manual work will be very tough to reproduce:
  - In another region
  - In another AWS account
- Within the same region if everything was deleted
- Wouldn't it be great, if all our infrastructure was... code?
- That code would be deployed and create / update / delete our infrastructure

What is CloudFormation

- CloudFormation is a declarative way of outlining your AWS
- Most of AWS services are supported.
- For example, within a CloudFormation template, you say:
  - I want a security group
  - I want two EC2 machines using this security group
  - I want two Elastic IPs for these EC2 machines
- Then CloudFormation creates those for you, in the right order, with the exact configuration that you specify



Benefits of AWS CloudFormation

- Infrastructure as code
  - No resources are manually created, which is excellent for control
  - The code can be version controlled for example using git
  - Changes to the infrastructure are reviewed through code
- Cost
  - Each resources within the stack is tagged with an identifier so you can easily see how much a stack costs you
  - You can estimate the costs of your resources using the CloudFormation template
  - Savings strategy: In Dev, you could automation deletion of stack at 5 PM and recreated at 8 AM next day, safely

Benefits of AWS CloudFormation

- Productivity
  - Ability to destroy and re-create an infrastructure on the cloud on the fly
  - Automated generation of Diagram for your templates!
  - Declarative programming (no need to figure out ordering)
- Separation of concern: create many stacks for many apps, and many layers.
  - VPC stacks
  - Network stacks
  - App stacks
- Don’t re-invent the wheel
  - Leverage existing templates on the web!
  - Leverage the documentation

How CloudFormation Works

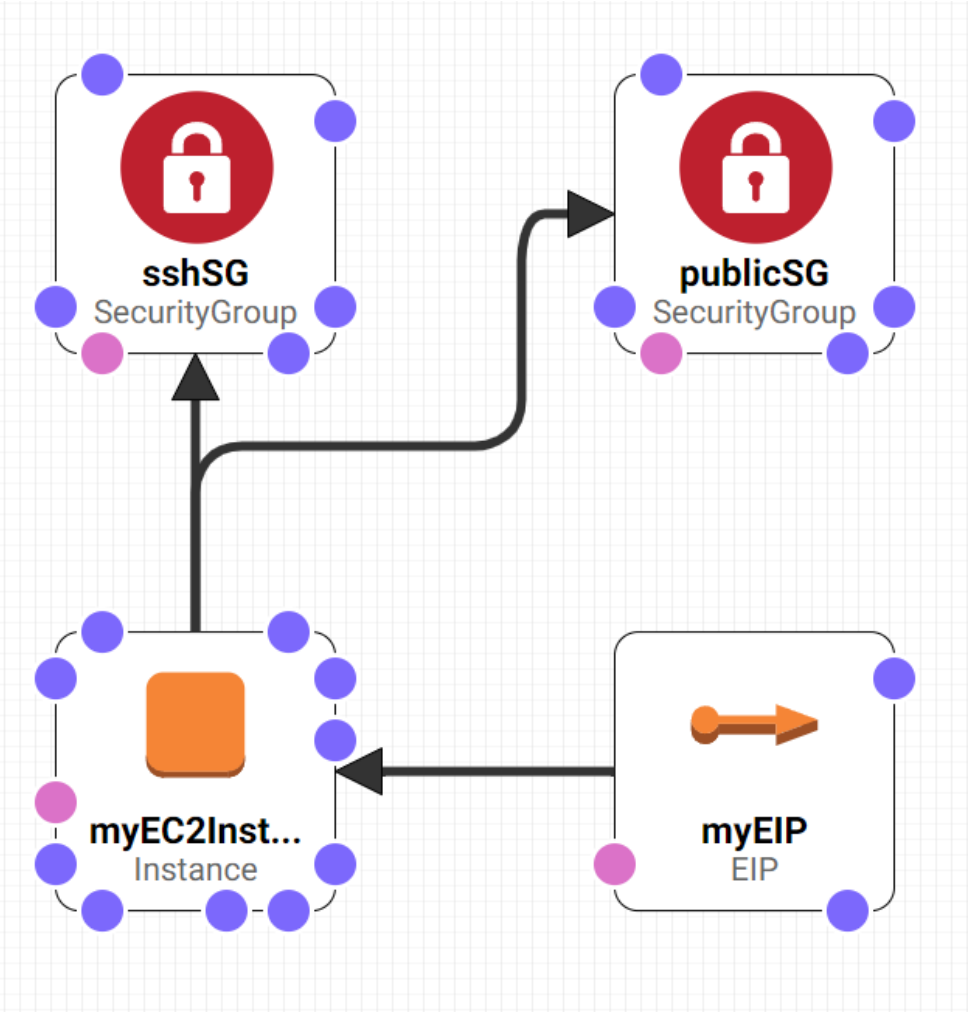
- Templates **must** be uploaded in **S3** and then referenced in CloudFormation
- To update a template, we can't edit previous ones. We have to reupload a new version of the template to AWS
- Stacks are identified by a name
- Deleting a stack deletes every single artifact that was created by CloudFormation.

Deploying CloudFormation templates

- Manual way:
  - Editing templates in the CloudFormation Designer
  - Using the console to input parameters, etc
- Automated way:
  - Editing templates in a YAML file
  - Using the AWS CLI (Command Line Interface) to deploy the templates
  - Recommended way when you fully want to automate your flow

Introductory Example

- We're going to create a simple EC2 instance.
- Then we're going to create to add an Elastic IP to it
- And we're going to add two security groups to it
- We'll see how in no-time, we are able to get started with CloudFormation



Question Time???

There is an iam user named mishra12 having following iam policy attached to this user profile

cfn_access

Policy summary | { } JSON | Edit policy

```
1  {
2      "Version": "2012-10-17",
3      "Statement": [
4          {
5              "Sid": "VisualEditor0",
6              "Effect": "Allow",
7              "Action": [
8                  "ec2:*",
9                  "cloudformation:*"
10             ],
11             "Resource": "*"
12         }
13     ]
14 }
```

The question is that whether he will be able to launch a t2.micro ec2 instance using cloudformation?

Explain your answer with valid reason.

YAML Crash Course

```yaml
---
Parameters:
  SecurityGroupDescription:
    Description: Security Group Description
    Type: String

Resources:
  MyInstance:
    Type: AWS::EC2::Instance
    Properties:
      AvailabilityZone: us-east-1a
      ImageId: ami-009d6802948d06e52
      InstanceType: t2.micro
      SecurityGroups:
        - !Ref SSHSecurityGroup
        - !Ref ServerSecurityGroup

  # an elastic IP for our instance
  MyEIP:
    Type: AWS::EC2::EIP
    Properties:
      InstanceId: !Ref MyInstance
```

- YAML and JSON are the languages you can use for CloudFormation.
- JSON is horrible for CF
- YAML is great in so many ways
- Let's learn a bit about it!
- Yaml Syntax:

```
<key>: <value>
```

YAML Crash Course

- Comments

```
# comments Syntax example in YAML file
or
#### comments example
```

- Scalars

```
integer: 25
hex: 0x12d4 #evaluates to 4820
octal: 023332 #evaluates to 9946
float: 25.0
exponent: 12.3015e+05 #evaluates to 1230150.0
boolean: Yes
string: "25"
infinity: .inf # evaluates to infinity
neginf: -.Inf #evaluates to negative infinity
not: .NAN #Not a Number
```

YAML Crash Course

- Strings

```yaml
str: Hello World
data: |
  These
  Newlines
  Are broken up
data: >
  This text is
  wrapped and is a
  single paragraph
```

- Array

```yaml
shopping:
- milk
- eggs
- juice
```

YAML Crash Course

- Dictionaries

```yaml
Employees:
 - mishra12:
     name: Amit Mishra
     job: Support Executive
     team: MES
```

CloudFormation Building Blocks

Templates components (IMPORTANT):

1. **Resources**: your AWS resources declared in the template (MANDATORY)
2. **Parameters**: the dynamic inputs for your template
3. **Mappings**: the static variables for your template
4. **Outputs**: References to what has been created
5. **Conditionals**: List of conditions to perform resource creation
6. **Metadata**

Templates helpers:

- References
- Functions

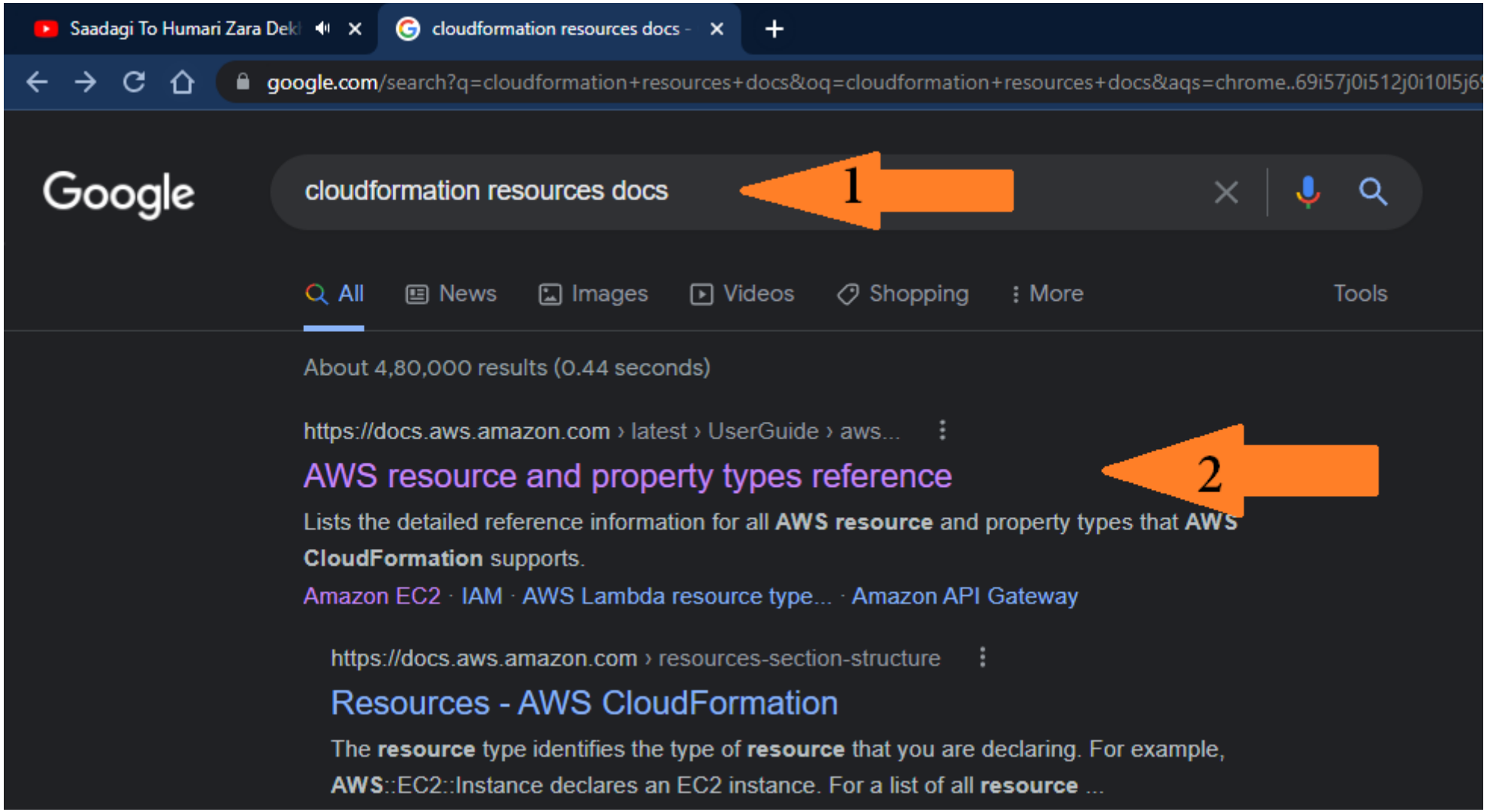
What are resources?

- Resources are the core of your CloudFormation template (MANDATORY)
- Represent AWS Services that can be created and configured
- Resources are declared and can be connected to each other
- AWS figures out creation, updates and deletes of resources for us
- There are over 224 types of resources (!)
- Resource types identifiers are of the form:

  AWS::aws-product-name::data-type-name

  - AWS::EC2::Instance
  - AWS::EC2::SecurityGroup
  - AWS::EC2::EIP

How do I find resources documentation?



FAQ for resources

- Can I create a dynamic number of resources?

  No, you can't. Everything in the CloudFormation template has to be declared.

  You can't perform code generation there

- Is every AWS Service supported?

  Almost. Only a select few niches are not there yet

  You can work around that using AWS Lambda Custom Resources

What are parameters

- Parameters are a way to provide inputs to AWS CloudFormation template
- They're important to know about if:
  - Some inputs can not be determined ahead of time
- Parameters are extremely powerful, controlled, and can prevent errors from happening in your templates thanks to types.
- When should you use a parameter?
  - Ask yourself this:
    - Is this CloudFormation resource configuration likely to change in the future?
    - If so, make it a parameter.
  - You won't have to re-upload a template to change its content

Parameters Settings

Parameters can be controlled by all these settings:

- Type:
  - String
  - Number
  - Comma Delimited List
  - List<Type>
  - AWS Parameter (to help catch invalid values – match against existing values in the AWS Account)
- Description
- Min/MaxLength
- Min/MaxValue
- Defaults
- AllowedValues (array)
- AllowedPattern (regexp)
- NoEcho (Boolean)

```yaml
Parameters:
  InstanceTypeParameter:
    Type: String
    Default: t2.micro
    AllowedValues:
      - t2.micro
      - m1.small
      - m1.large
    Description: Choose EC2 Instance Type.
```

How to Reference a Parameter

- The Fn::Ref function can be leveraged to reference parameters
- Parameters can be used anywhere in a template.
- The shorthand for this in YAML is !Ref
- The function can also reference other elements within the template

```yaml
---
Parameters:
  myEC2InstanceType:
    Type: String
    Default: t2.micro
    AllowedValues:
      - t2.micro
      - m1.small
      - m1.large
    Description: Choose EC2 Instance Type.

Resources:
  myEC2Instance:
    Type: AWS::EC2::Instance
    Properties:
      InstanceType: !Ref myEC2InstanceType
      ImageId: "ami-0c6615d1e95c98aca"
      AvailabilityZone: "ap-south-1a"
```

Concept: Pseudo Parameters

- AWS offers us pseudo parameters in any CloudFormation template.
- These can be used at any time and are enabled by default

Pseudo Parameter	Result
AWS::AccountId	1234567890
AWS::NotificationARNs	[arn:aws:sns:us-east1:123456789012:MyTopic]
AWS::NoValue	Does not return a value
AWS::Region	us-east-2
AWS::StackId	arn:aws:cloudformation:us-east1:123456789012:stack/MyStack/1c2fa62 0-982a-11e3-aff7-50e2416294e0
AWS::StackName	MyStack

What are mappings?

- Mappings are fixed variables within your CloudFormation Template.
- They're very handy to differentiate between different environments (dev vs prod), regions (AWS regions), AMI types, etc
- All the values are hardcoded within the template
- Example:

```yaml
Mappings:
  Mapping01:
    Key01:
      Name: Value01
    Key02:
      Name: Value02
    Key03:
      Name: Value03
```

```yaml
RegionMap:
    us-east-1:
      HVM64: ami-0ff8a91507f77f867
      HVMG2: ami-0a584ac55a7631c0c
    us-west-1:
      HVM64: ami-0bdb828fd58c52235
      HVMG2: ami-066ee5fd4a9ef77f1
    eu-west-1:
      HVM64: ami-047bb4163c506cd98
      HVMG2: ami-0a7c483d527806435
```

Mappings vs Parameters: when to use

- Mappings are great when you know in advance all the values that can be taken and that they can be deduced from variables such as
  - Region
  - Availability Zone
  - AWS Account
  - Environment (dev vs prod)
  - Etc...
- They allow safer control over the template.
- Use parameters when the values are really user specific
- i.e Mapping are static and Parameters are Dynamic variables

Accessing Mapping Values

- We use Fn::FindInMap to return a named value from a specific key
- !FindInMap [MapName, TopLevelKey, SecondLevelKey]

```yaml
Mappings:
  RegionMap:
    us-east-1:
      HVM64: ami-0ff8a91507f77f867
      HVMG2: ami-0a584ac55a7631c0c
    us-west-1:
      HVM64: ami-0bdb828fd58c52235
      HVMG2: ami-066ee5fd4a9ef77f1
Resources:
  myEC2Instance:
    Type: "AWS::EC2::Instance"
    Properties:
      ImageId: !FindInMap [RegionMap, !Ref "AWS::Region", HVM64]
      InstanceType: t2.micro
```

What are outputs?

- The Outputs section declares optional outputs values that we can import into other stacks (if you export them first)!
- You can also view the outputs in the AWS Console or in using the AWS CLI
- They're very useful for example if you define a network CloudFormation, and output the variables such as VPC ID and your Subnet IDs
- It's the best way to perform some collaboration cross stack, as you let expert handle their own part of the stack
- You can't delete a CloudFormation Stack if its outputs are being referenced by another CloudFormation stack

Outputs Example

- Creating a SSH Security Group as part of one template
- We create an output that references that security group

```yaml
---
Resources:
  SGPing:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: SG to test ping
      SecurityGroupIngress:
      - IpProtocol: tcp
        FromPort: 22
        ToPort: 22
        CidrIp: 0.0.0.0/0
Outputs:
  StcakSSHSG:
    Description: The Instance ID
    Value: !Ref SGPing
    Export:
      Name: myInstanceSSHSG
```

Cross Stack Reference : Importing Outputs

- We then create a second template that leverages that security group
- For this, we use the Fn::ImportValue function
- You can't delete the underlying stack until all the references are deleted too.

```
---
Resources:
  Ec2Instance:
    Type: AWS::EC2::Instance
    Properties:
      InstanceType: t2.micro
      ImageId: 'ami-0c6615d1e95c98aca'
      SecurityGroups:
        - !ImportValue myInstanceSSHSG
```

What are conditions used for?

- Conditions are used to control the creation of resources or outputs based on a condition.
- Conditions can be whatever you want them to be, but common ones are:
  - Environment (dev / test / prod)
  - AWS Region
  - Any parameter value
- Each condition can reference another condition, parameter value or mapping

How to define a condition?

- The logical ID is for you to choose. It's how you name condition
- The intrinsic function (logical) can be any of the following:
  - Fn::And
  - Fn::Equals
  - Fn::If
  - Fn::Not
  - Fn::Or

```yaml
---
Parameters:
  todaysDay:
    Type: String
    Default: monday
    AllowedValues:
      - monday
      - tuesday
      - wednesday
      - thrusday
      - friday
    Description: Choose todays day.

Resources:
  Ec2Instance:
    Type: AWS::EC2::Instance
    Condition: checkDay
    Properties:
      InstanceType: t2.micro
      ImageId: 'ami-0c6615d1e95c98aca'

Conditions:
  checkDay: !Equals [ !Ref todaysDay, friday]
```

Using a Condition

- Conditions can be applied to resources / outputs / etc…

```yaml
---

Conditions:
  CreateBucket: !Not [!Equals [!Ref BucketName, ‘’]]
```

```yaml
---
Parameters:
  BucketName:
    Default: ''
    Type: String

Conditions:
  CreateBucket: !Not
    - !Equals
      - !Ref BucketName
      - ''

Resources:
  Bucket:
    Type: 'AWS::S3::Bucket'
    Condition: CreateBucket
    Properties:
      BucketName: !Ref BucketName
```

Must Know Intrinsic Functions

- Ref
- Fn::GetAtt
- Fn::FindInMap
- Fn::ImportValue
- Fn::Join
- Fn::Sub
- Condition Functions (Fn::If, Fn::Not, Fn::Equals, etc...)

Fn::Ref

- The Fn::Ref function can be leveraged to reference
  - Parameters => returns the value of the parameter
  - Resources => returns the physical ID of the underlying resource (ex: EC2 ID)
- The shorthand for this in YAML is !Ref

```yaml
---
Resources:

  ec2Instance:
    Type: AWS::EC2::Instance
    Properties:
      ImageId: "ami-0c6615d1e95c98aca"
      InstanceType: t2.micro

  MyEIP:
    Type: AWS::EC2::EIP
    Properties:
      InstanceId: !Ref ec2Instance
```

Fn::GetAtt

- Attributes are attached to any resources you create
- To know the attributes of your resources, the best place to look at is the documentation.
- For example: the AZ of an EC2 machine!

```yaml
---
Resources:

  ec2Instance:
    Type: AWS::EC2::Instance
    Properties:
      ImageId: "ami-0c6615d1e95c98aca"
      InstanceType: t2.micro

  publicSG:
    Type: AWS::EC2::SecurityGroup
    Properties:
        GroupDescription:
          Fn::Sub:
          - 'EC2-${IP}-Address'
          - IP: !GetAtt ec2Instance.PublicIp
        SecurityGroupIngress:
        - IpProtocol: tcp
          FromPort: 80
          ToPort: 80
          CidrIp: 0.0.0.0/0
```

Fn::FindInMap Accessing Mapping Values

- We use Fn::FindInMap to return a named value from a specific key
- !FindInMap [MapName, TopLevelKey, SecondLevelKey]

```
Mappings:
  EnvironmentMap:
    "285691513880":
      EnvOwner Email: MurexEnvironmentSupport@cba.com.au
      MurexBucketType: dev
    "387335949527":
      EnvOwner Email: MurexEnvironmentSupport@cba.com.au
      MurexBucketType: stg
Resources:
  CFNS3Bucket:
    Type: 'AWS::53::Bucket'
    Properties:
      BucketName:
        Fn::Sub:
        - 'cba-mx-${AccType}-${AWS::AccountId}-admin-cfntemplates'
        - AccType: !FindInMap [EnvironmentMap, !Ref "AWS::AccountId", "MurexBucketType" ]
```

Fn::ImportValue

- Import values that are exported in other templates
- For this, we use the Fn::ImportValue function

```yaml
---
#STACK A
Resources:
  SGPing:
    Type: AWS::EC2::SecurityGroup
    Properties:
      GroupDescription: SG to test ping
      SecurityGroupIngress:
      - IpProtocol: tcp
        FromPort: 22
        ToPort: 22
        CidrIp: 0.0.0.0/0
Outputs:
  StcakSSHSG:
    Description: The Instance ID
    Value: !Ref SGPing
    Export:
      Name: myInstanceSSHSG
```

```yaml
---
#STACK B
Resources:
  Ec2Instance:
    Type: AWS::EC2::Instance
    Properties:
      InstanceType: t2.micro
      ImageId: 'ami-0c6615d1e95c98aca'
      SecurityGroups:
        - !ImportValue myInstanceSSHSG
```

Fn::Join

- Join values with a delimiter

```
!Join [ ":", [ a, b, c ] ]
```

- This creates “a:b:c”

```
!Join
  - ''
  - - 'arn:'
    - !Ref AWS::Partition
    - ':iam::'
    - !Ref AWS::AccountId
    - ':mfa/root-account-mfa-device'
```

- This creates “arn:aws:iam::625675576357:mfa/root-account-mfa-device”

Function Fn::Sub

- Fn::Sub, or !Sub as a shorthand, is used to substitute variables from a text. It's a very handy function that will allow you to fully customize your templates.
- For example, you can combine Fn::Sub with References or AWS Pseudo variables!
- String must contain ${VariableName} and will substitute them
- For Example see slide #37

```
Name: !Sub
  - 'www.${Domain}'
  - Domain: !Ref RootDomainName
```

Condition Functions

- The logical ID is for you to choose. It's how you name condition
- The intrinsic function (logical) can be any of the following:
  - Fn::And
  - Fn::Equals
  - Fn::If
  - Fn::Not
  - Fn::Or

User Data in EC2 for CloudFormation

- We can have user data at EC2 instance launch through the console
- We can also include it in CloudFormation
- The important thing to pass is the entire script through the function

  Fn::Base64
- Good to know: user data script log is in /var/log/cloud-init-output.log
- Let's see how to do this in CloudFormation

User Data in EC2 for CloudFormation

```yaml
Resources:
  ec2Instance:
    Type: AWS::EC2::Instance
    Properties:
      ImageId: "ami-0c6615d1e95c98aca"
      InstanceType: t2.micro
      SecurityGroups:
      - !Ref publicSG
      UserData:
        Fn::Base64:
          !Sub |
            #!/bin/bash
            yum update -y
            yum install -y httpd.x86_64
            systemctl start httpd.service
            systemctl enable httpd.service
            echo ?Hello World from $(hostname -f)? > /var/www/html/index.html

  publicSG:
    Type: AWS::EC2::SecurityGroup
    Properties:
        GroupDescription: Allow http to client host
        SecurityGroupIngress:
        - IpProtocol: tcp
          FromPort: 80
          ToPort: 80
          CidrIp: 0.0.0.0/0
```

more slides coming soon

thanks!

You can find me on

/mishracodes

Amit Kumar Mishra

Murex Technical Analyst

and

System Engineer at Tata Consultancy Services