Hands-on Cloud Computing Services

Lezione 4

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Beyond AWS CLI

- AWS CLI enables faster interaction compared to the web console
- Commands can be arranged into scripts to solve tasks
- Complex use cases may need a more flexible approach
  - e.g., how to programmatically interact with Cloud resources?

Boto: Python API for AWS

- Boto: AWS SDK for Python
- Enables developers to create, configure, and manage AWS services
- Easy to use, object-oriented API
- Similar APIs available for other languages as well
- We'll use **boto3**:
  `https://boto3.amazonaws.com/v1/documentation/api/latest/index.html`

Configuring boto3

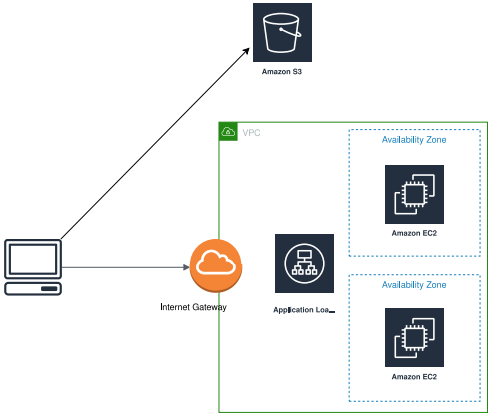
- Boto shares the same configuration of AWS CLI (default region, …)
  - If CLI has been configured on your PC, boto3 works out-of-the-box
  - Can be overridden using environment variables or hard-coded settings
- Important issue: providing credentials to Boto
  - Especially important when using boto on remote servers
- Several ways to provide credentials (and configs): `https://boto3.amazonaws.com/v1/documentation/api/latest/guide/credentials.html`

Examples

1. List objects in our bucket: `s3list.py`
2. List EC2 instances: `ec2list.py`

Example: Photogallery

- Extend PhotoGallery with the following features:
  - display pictures stored in a S3 bucket, along with their upload time
  - users can upload pictures



Solution

- Source code: `photogallery_v2`
- How to provide credentials to boto3 to access the bucket?
  - Create a IAM Role for EC2
  - Attach the pre-defined *S3FullAccess* policy
  - Associate the EC2 instance(s) with the new role
- (Check alternative methods in the previous slides)

CloudFront

- CDN provided by AWS
- Easy to integrate with S3 buckets and ELBs

How to use it in Photogallery:

- Create a **distribution** for our S3 bucket
- Replace picture URLs as follows:
  `http://bucketname.s3.amazonaws.com/imagename.jpg`
  `http://distributionname.cloudfront.net/imagename.jpg`

Note: to delete a distribution, you need to Disable it first (and wait a couple of minutes)

Cloud Automation

We have introduced a few tools for automation:

- Ansible (with dynamic inventories)
- AWS CLI
- AWS SDK (e.g., boto3)

Enough for infrastructure management?

Infrastructure-as-Code (IaC)

- Define and manage the infrastructure by means of a set of text files, instead of a user interface (CLI, Web, …)
- Use simple text files to describe your resources (e.g., VMs, security groups, networks)
- Update the files to update the infrastructure
- Benefits:
  - Reduced costs
  - Reduced risks
  - Faster operations
  - Important to enable DevOps practices

Terraform

- Free multi-platform tool for IaC (`www.terraform.io`)
- Can be used with several target platforms (AWS, Azure, VMWare, CloudFlare, …)
- Infrastructure defined using the *HashiCorp Configuration Language* (HCL)
- Key concepts: Providers + Resources (e.g., “AWS” and “ec2_instance”)

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Terraform is free to use, but not fully open-source since 2023. An open alternative exists: OpenTofu

Terraform + AWS

Requirements:

- AWS CLI installed and configured
- Terraform installed (I am using Terraform 1.10)

We create `example.tf` and run:

- `$ terraform init`
- `$ terraform validate # check syntax`
- `$ terraform apply`
- `$ terraform show`
- `$ terraform apply # nothing to do`

Terraform + AWS

We now **update** `example.tf` adding a tag to the instance:

- Edit `example.tf` adding a tag to the instance
- `$ terraform apply`
- Edit `example.tf` changing the instance type
- `$ terraform apply`
- Let's destroy all the created resources: `terraform destroy`

Terraform: beyond this example

- Resource definitions not limited to EC2 instances!
- Remote storage for `tf.state`
- Versioning Terraform code (e.g., git repo)
- Variables to make code more reusable

AWS CloudFormation

- IaC code solution by AWS
- Stack + Template (YAML/JSON) + Resources
- `https://docs.aws.amazon.com/AWSCloudFormation/latest/UserGuide/GettingStarted.Walkthrough.html`

AWS CloudFormation: Example

```
{
  "AWSTemplateFormatVersion" : "2010-09-09",
  "Description" : "A sample template",
  "Resources" : {
    "MyEC2Instance" : {
      "Type" : "AWS::EC2::Instance",
      "Properties" : {
        "ImageId" : "ami-0ff8a91507f77f867",
        "InstanceType" : "t2.micro",
        "KeyName" : "testkey",
        "BlockDeviceMappings" : [
          {
            "DeviceName" : "/dev/sdm",
            "Ebs" : {
              "VolumeType" : "io1",
...
```

AWS: Database Services

AWS provides several database-oriented services. Among them:

- DynamoDB (Key-Value NoSQL tables)
- Aurora (relational DBMS)
- ElastiCache (in-memory databases: Memcached, Redis)
- Neptune (graph database)
- Timestream (for time series)
- RDS (Relational Database Service): easily deploy MariaDB, Aurora, PostgreSQL, …

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We'll use DynamoDB to store picture metadata in PhotoGallery

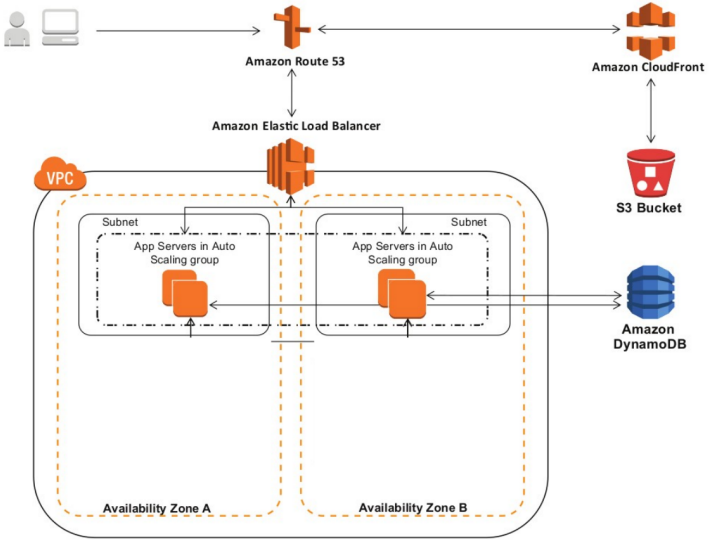
DynamoDB

- Schemaless
- Tables, Items, Attributes
- Primary Key + (optional) Sorting Key
- 2 pricing models:
  - provisioned capacity (default)
  - on-demand
- 2 consistency models:
  - eventual
  - strong

Example: `dynamodb_example/`

Photogallery + DynamoDB

Use DynamoDB to store image tags



Photogallery + DynamoDB: Solution

- Solution: `photogallery_v3`