AWS Lambda, Python and Serverless - Full Course Absolute Beginner to Advanced

No previous Coding Experience Required

AWS Lambda and Python – Beginner to Advanced

12 Months on.... **1330+ Learners** **222+ Ratings**

D DineshEzeikel
Updated 2 months ago

★★★★★

Excellent course.

BN basam nath
Updated 4 months ago

★★★★★

Just superb videos

EK Ebrahim Kamari
Updated 7 months ago

★★★★★

This course helped me alot. Thanks Rahul

TA Terence Atarah
Updated 2 months ago

★★★★★

Yes it was. It gives a clear insight on how to use lambda with python. I have struggled with this over the years and i am finally understanding it from a 3 hour course...Amazing

SJ Shashank j
Updated 5 months ago

★★★★★

best course i have ever taken on AWS lambda. The instructor taught me lot of g

EC Ezeogu Christopher C.
★★★★★ 6 days ago

Great resource. Thanks for putting this together. I learned a lot about Lambda that I was not clear about.

How to maximize your learnings from the Course

1. **Adjust the Speed of the course based on your comfort**
2. **Adjust the Resolution if the content is not visible/clear**
3. **Course Rating and Feedback**
4. **Course Content Download**
5. **Hands-On vs Theory**

Course Pre-Requisites

1. **AWS Free Tier Account**

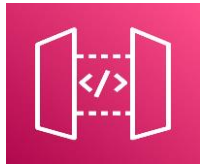
2. **VSCode Download – Free Version**

3. **Basic Knowledge of common AWS Services such as S3, EC2 and so on**

4. ***No coding experience or in-depth AWS Knowledge required***

AWS Lambda, Python and Serverless – Key AWS Services

Application Integration



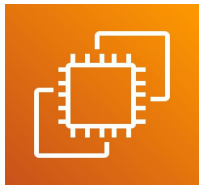
Amazon API Gateway

Amazon EventBridge

Amazon SNS

Compute

AWS Lambda

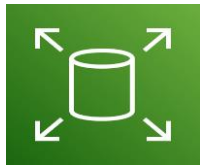


Amazon EC2

Storage

Amazon S3

Amazon FSx



Amazon EBS

Security

AWS Managed Microsoft AD

Amazon Cognito Authorizer

AWS IAM

AWS Directory Service

Lambda Authorizer

AWS Lambda, Python and Serverless – Key AWS Services

Management and Governance

Amazon CloudWatch

AWS Application Auto Scaling

Logs

Alarm

Database

Amazon DynamoDB

Networking

Amazon Virtual Private Cloud (Amazon VPC)

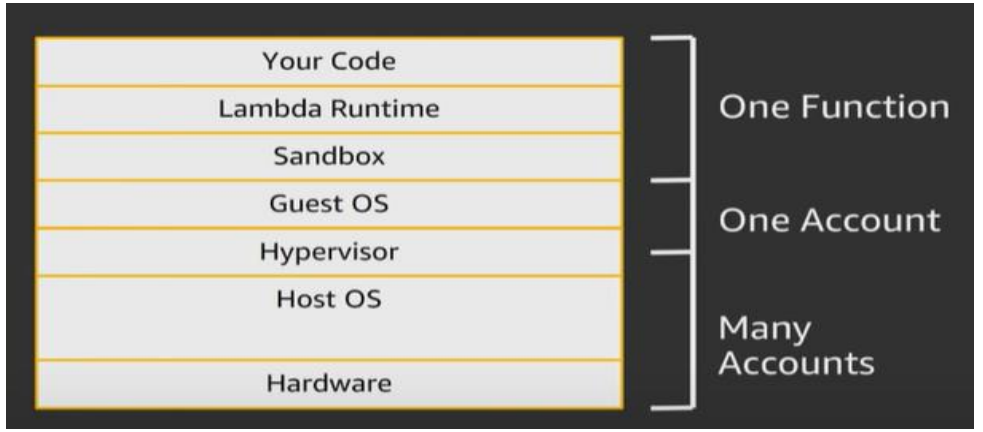
Developers Tools

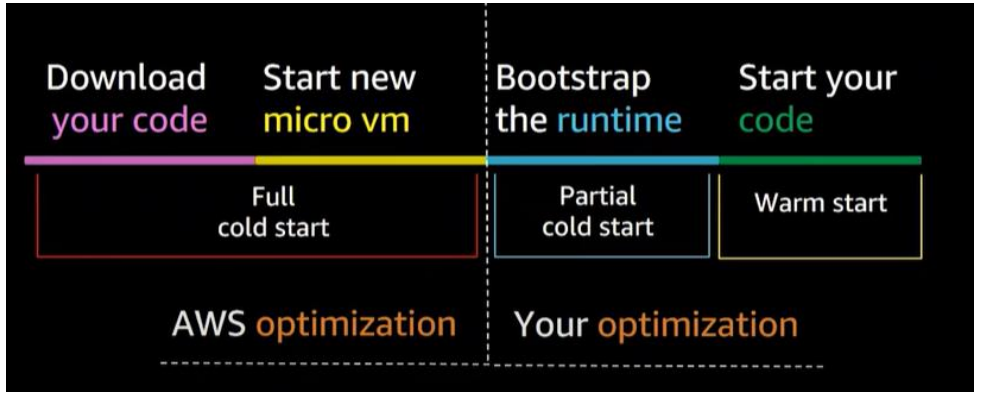
AWS Cloud Development Kit (AWS CDK)

AWS Lambda and Python – Beginner to Advanced

Section 2 : AWS Lambda – Basic Concepts – Part 1

- **Evolution from Physical Servers to AWS Lambda**
- **What is AWS Lambda - Architecture and Use Cases**
- **Lambda Console Walkthrough**
- **Lambda Execution Role**
- **AWS Lambda Limits**





AWS Lambda and Python – Beginner to Advanced

Section 3 : AWS Lambda - Python Basics Refresher

Python Basics_Refresher_Part 1 (Python Print Function, Variables, Data Types Intro, Data Type – Dictionary)

Python Basics_Refresher_Part 2 (Nested Dictionary , List and Nested List , Data Type and Python Functions)

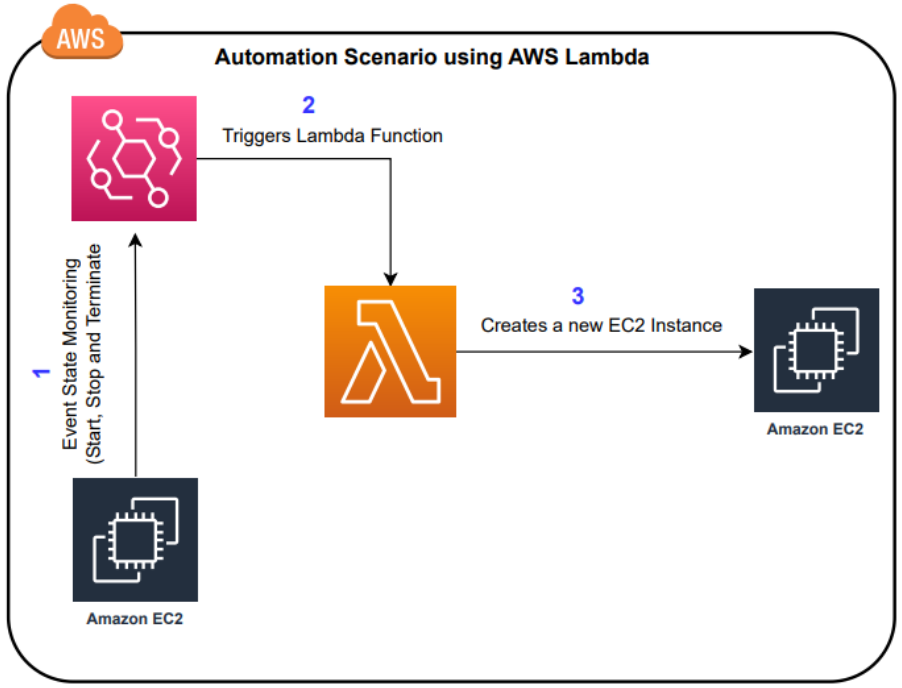
```
####Nested Dictionary

nesteddictionary = {1: 'Python', 2: {'books': 'cloud', 'aws': 'Lambda'}}
print(nesteddictionary[2])
print(nesteddictionary[2]['books'])

### Loops and Dictionary Methods

for k in nesteddictionary.values():
    print(k)

for k in nesteddictionary.keys():
    print(k)
########8 user input

name = input('Please enter your name')
grade = input('Please enter your grade')
print('My name is {} and my grade is {}'.format(name, grade))


##### 9 String Slicing
data = 'ASTRING'
print(data[2:4:1])

for a in data:
    print(a)


# A simple Python function to check
# whether x is even or odd
```

```
def evenOdd(x):
    if (x % 2 == 0):
        print("even")
    else:
        print("odd")


# Driver code to call the function
evenOdd(2)
evenOdd(3)


def square_value(num):
    """This function returns the square
    value of the entered number"""
    return num ** 2

print(square_value(2))
print(square_value(-4))
```

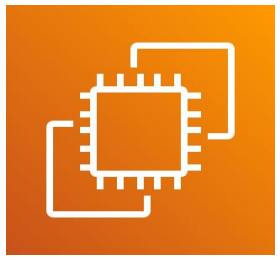
AWS Lambda and Python – Beginner to Advanced

Section 4 : AWS Lambda – Create S3, EC2 and DynamoDB using AWS SDK for Python(Boto3)

- **AWS Lambda Basics – Boto3, Client and Resource, Lambda function handler**
- **AWS Lambda with S3 (List all the buckets, Create new Bucket and Delete Bucket)**
- **AWS Lambda with EC2 (Create EC2 and Stop)**
- **AWS Lambda Automation Scenario – EC2, Lambda and EventBridge**
- **AWS Lambda with DynamoDB (Create Table and Put Items)**



S3



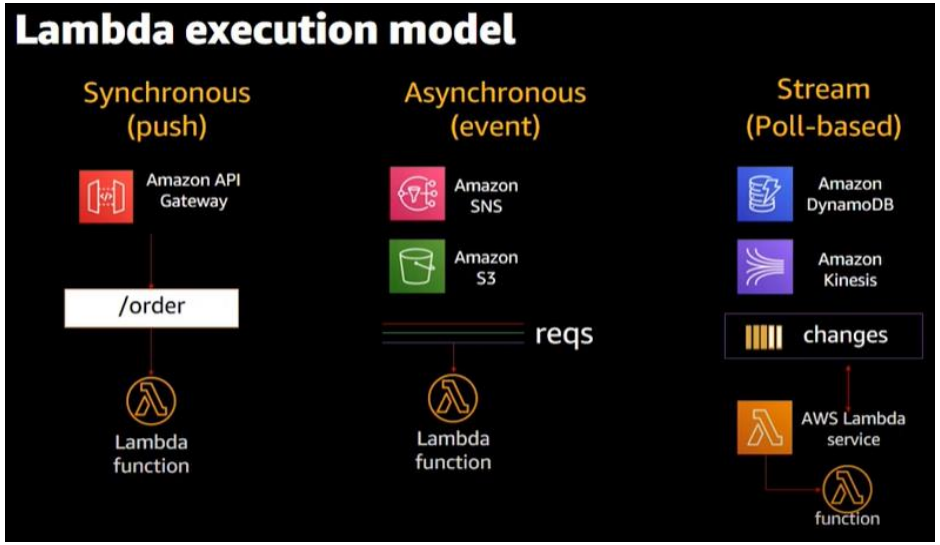
EC2

DynamoDB

AWS Lambda and Python – Beginner to Advanced

Section 5 : AWS Lambda – Basic Concepts – Part 2

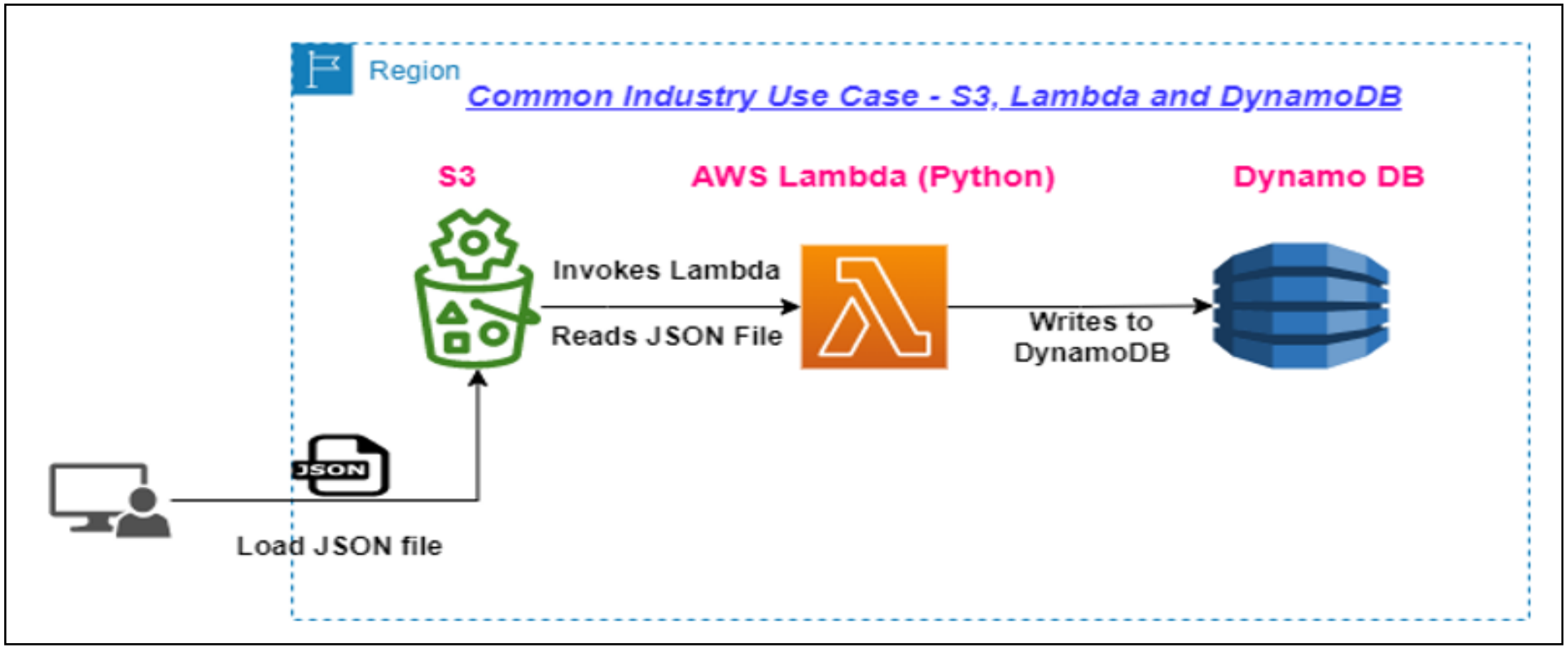
- **AWS Lambda Invocation Models – Theory**
- **AWS Lambda Invocation Models – Hand-on**
- **AWS Lambda Limits - Memory**



Memory	Duration	Cost
128 MB	11.722 s	$0.024628
256 MB	6.678 s	$0.028035
512 MB	3.194 s	$0.026830
1024 MB	1.465 s	$0.024638

AWS Lambda and Python – Beginner to Advanced

Section 6 : Real World Serverless Use Case 1 - using S3, AWS Lambda and DynamoDB

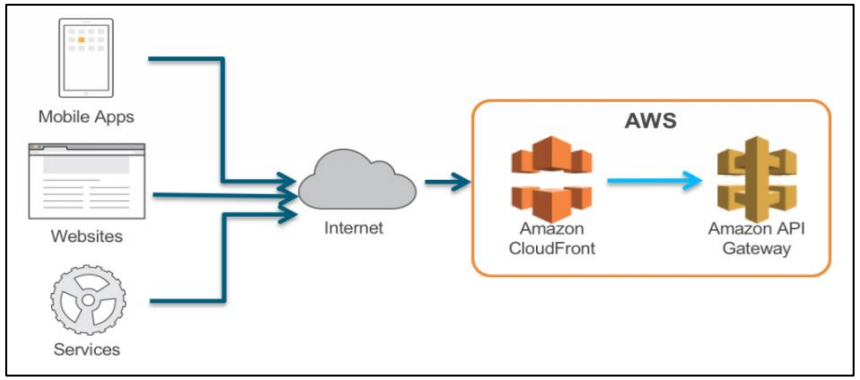


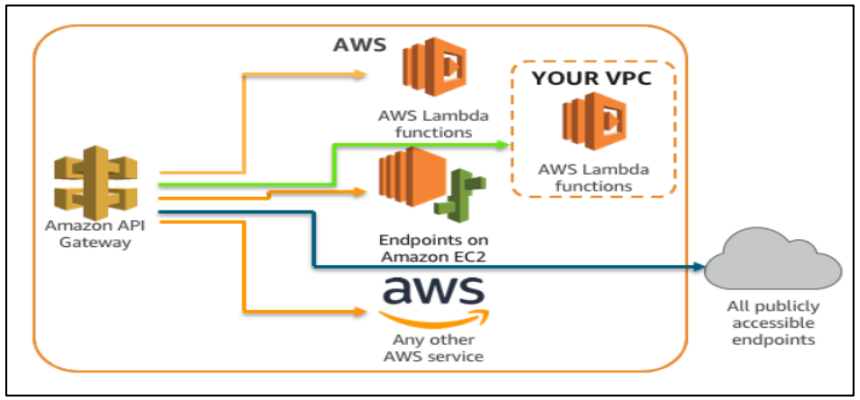
- *S3*
- *AWS Lambda*
- *DynamoDB*

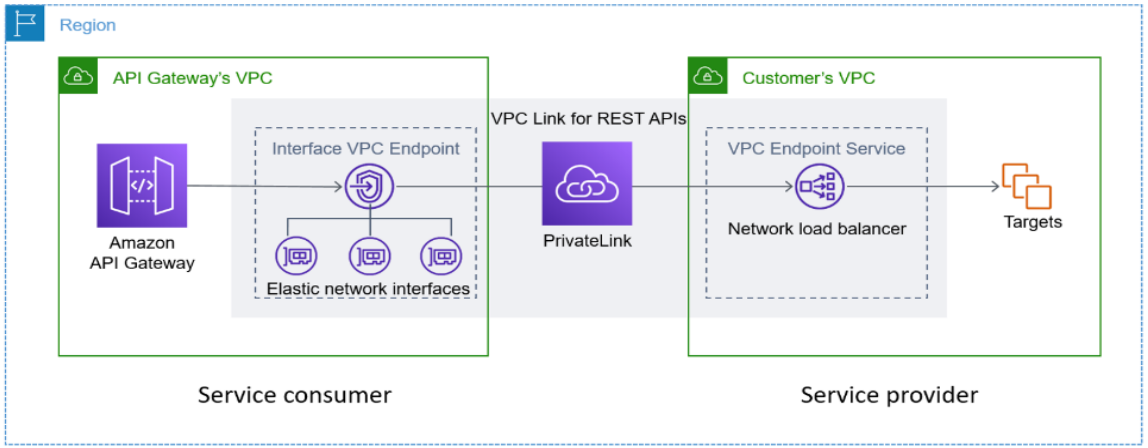
AWS Lambda and Python – Beginner to Advanced

Section 7 : API Gateway Overview

- **API Gateway - Overview, API Types , API Endpoint Types**
- **API Gateway - Resources, Methods and Integration Types**
- **API Gateway - Deployment, API Stages, API Keys and Usage Plans**
- **API Gateway - Authentication and Authorization Methods**
- **API Gateway - Private API's and Private Integration**

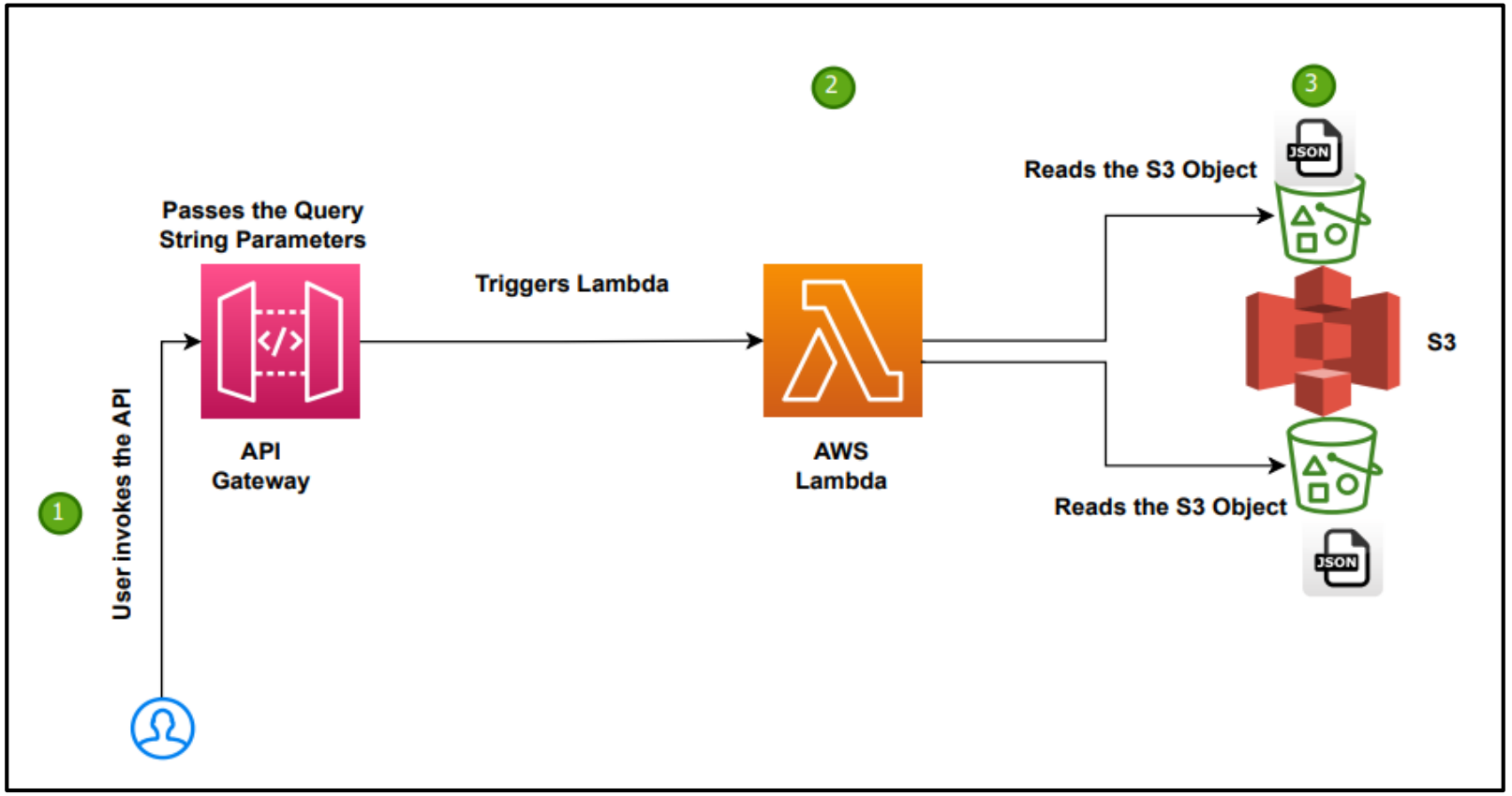






AWS Lambda and Python – Beginner to Advanced

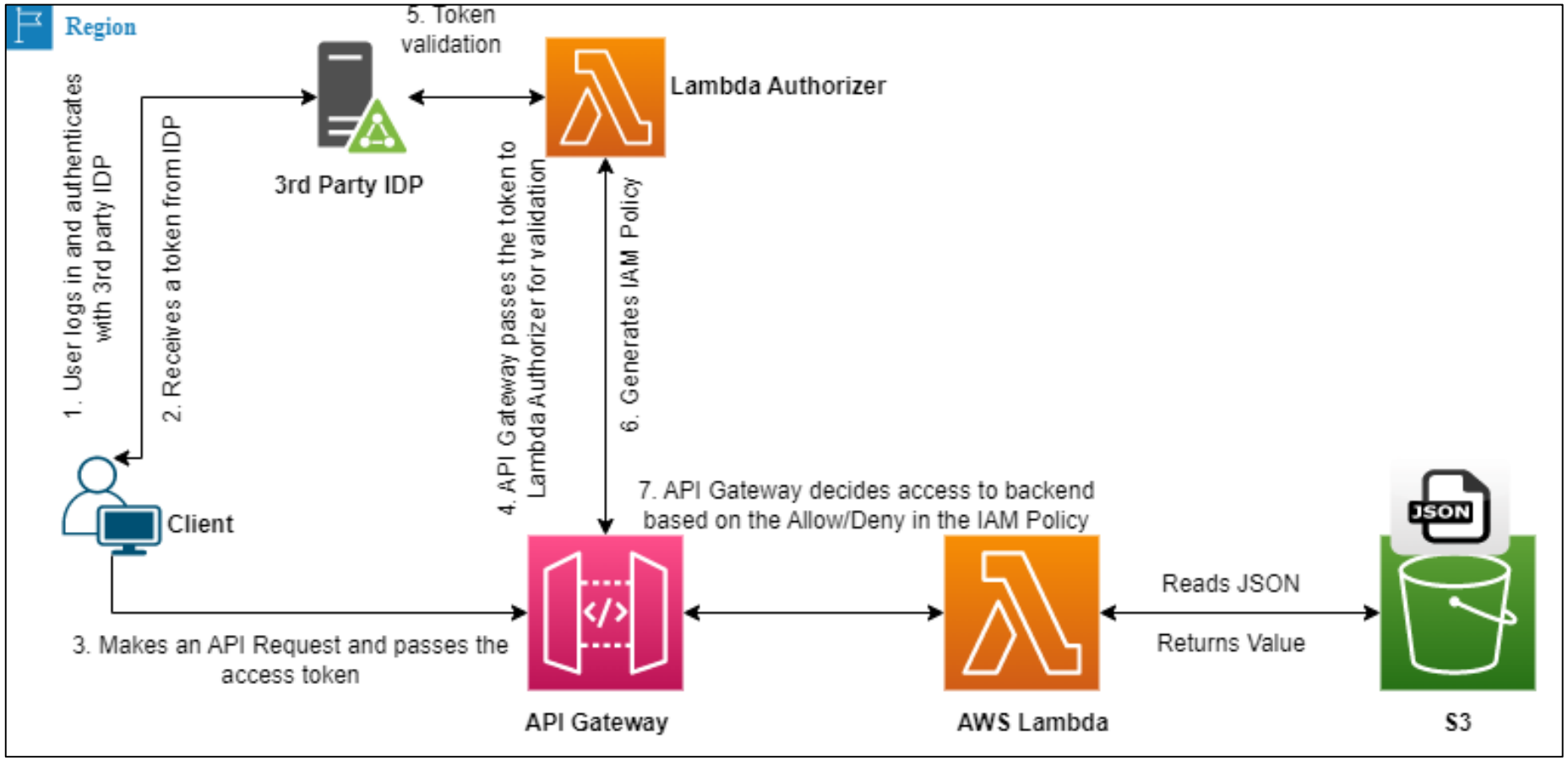
Section 8 : Real World Serverless Use Case 2 - using API Gateway, AWS Lambda and S3



- *API Gateway*
- *AWS Lambda*
- *S3*

Authentication and Authorization with AWS Lambda Authorizer

AWS API Gateway - Authentication and Authorization using Lambda Authorizer



Lambda Authorizer

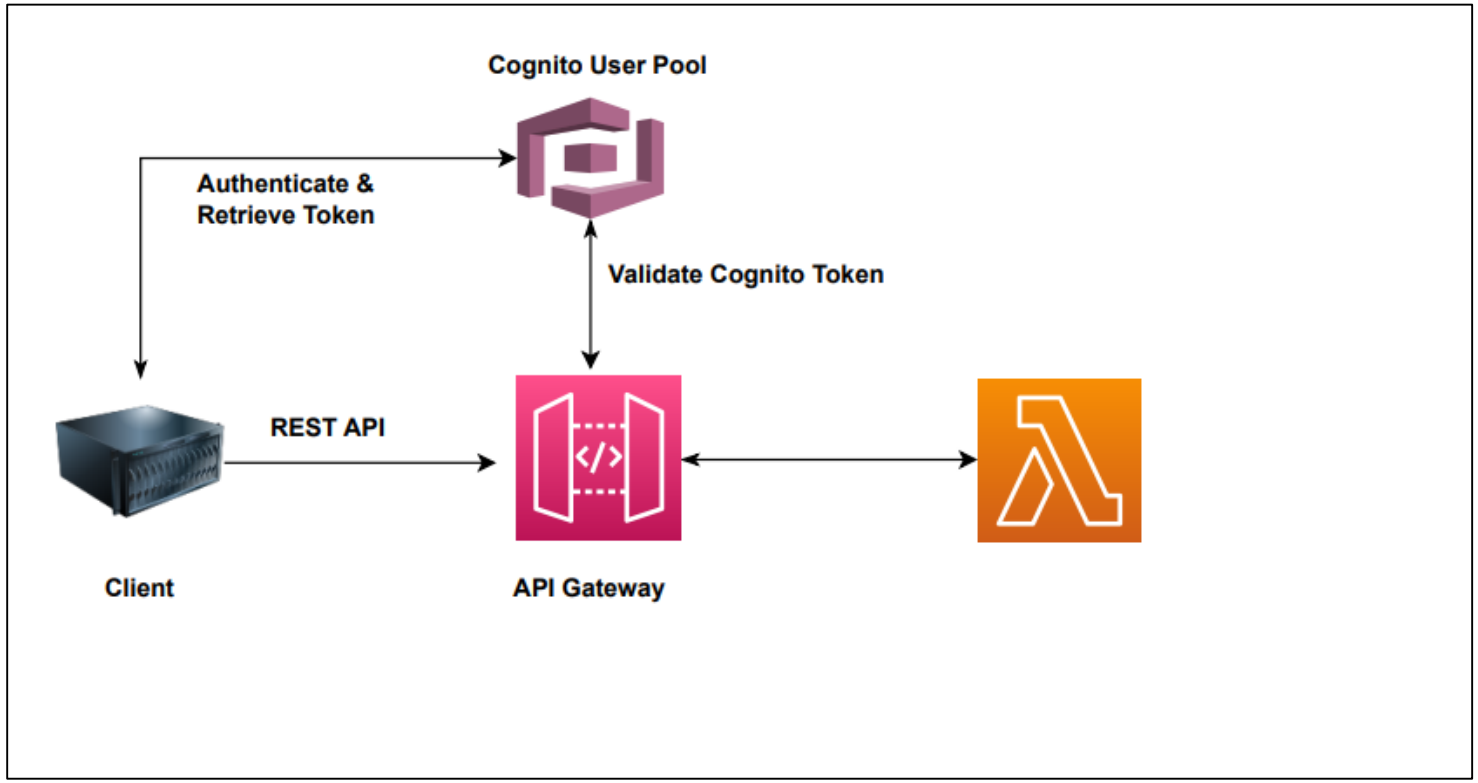
Authentication – External

Authorization – Lambda Function

Use Case : Third Party Identity Provider such as OAuth 2.0

Authentication and Authorization with AWS Cognito

AWS API Gateway - Authentication and Authorization



2. API Security – Cognito

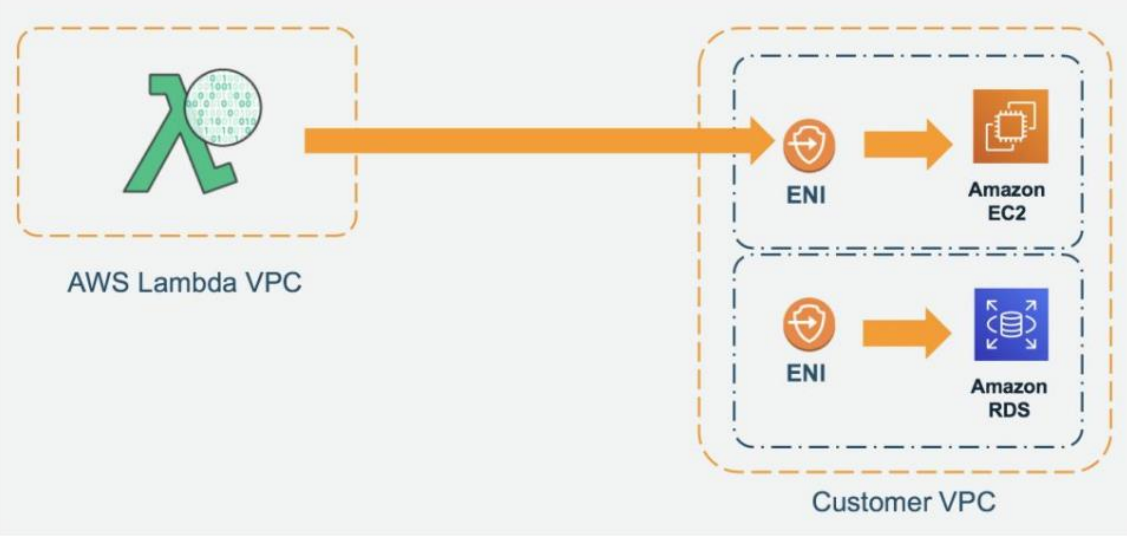
Authentication – Cognito User Pool
Authorization – API Gateway Methods

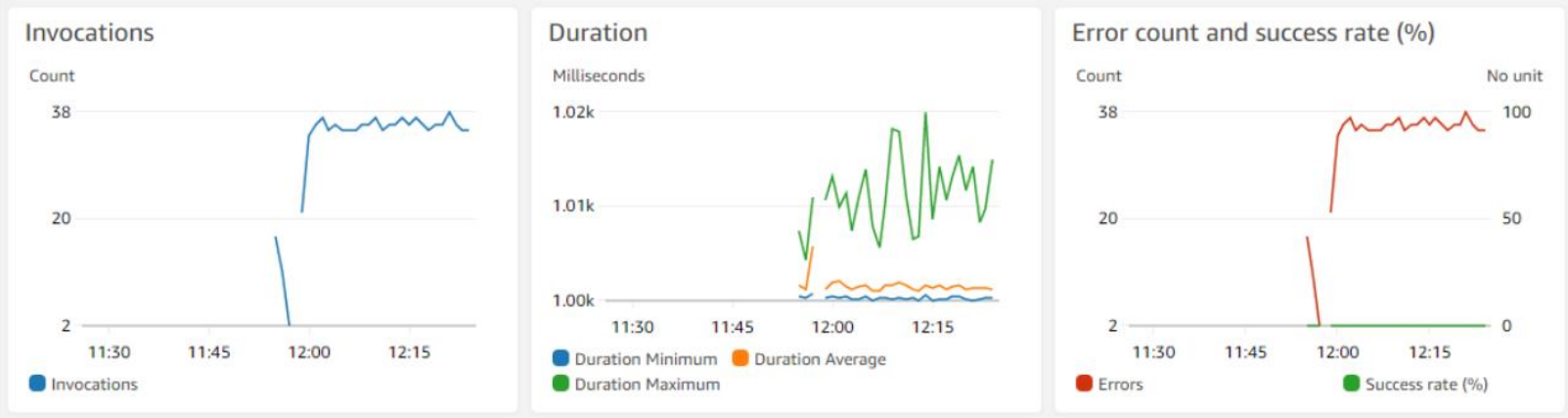
Case : External Users for Web/Mobile Apps

AWS Lambda and Python – Beginner to Advanced

Section 9 : AWS Lambda – Advanced Concepts (Theory and HandsOn)

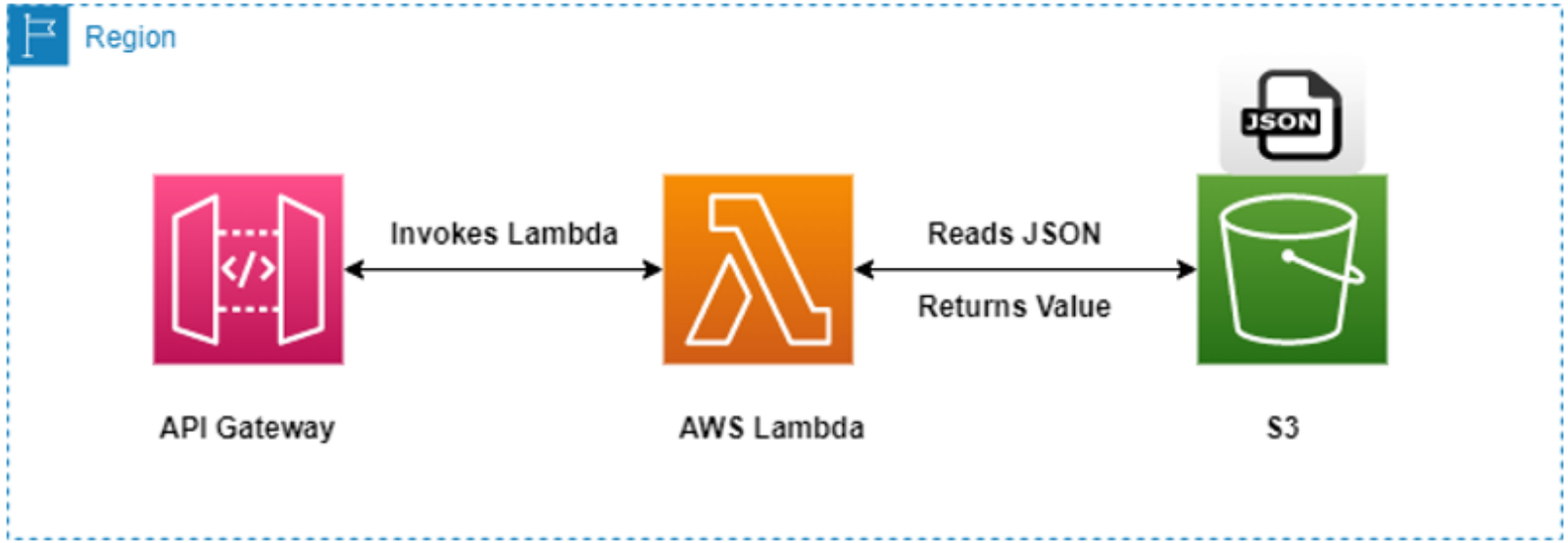
- **Lambda Execution and Concurrency**
- **Lambda - Reserved and Provisioned Concurrency**
- **Lambda - VPC Networking Configuration**
- **Lambda - Environment Variables**
- **Lambda Versions**
- **Lambda Aliases**
- **Lambda Monitoring - CloudWatch Metrics**
- **Lambda Monitoring - CloudWatch Logs**





Infrastructure as Code - AWS Cloud Development Kit (CDK) v2

Section 10 : Serverless Use Case - using API Gateway, AWS Lambda and S3 using AWS CDK

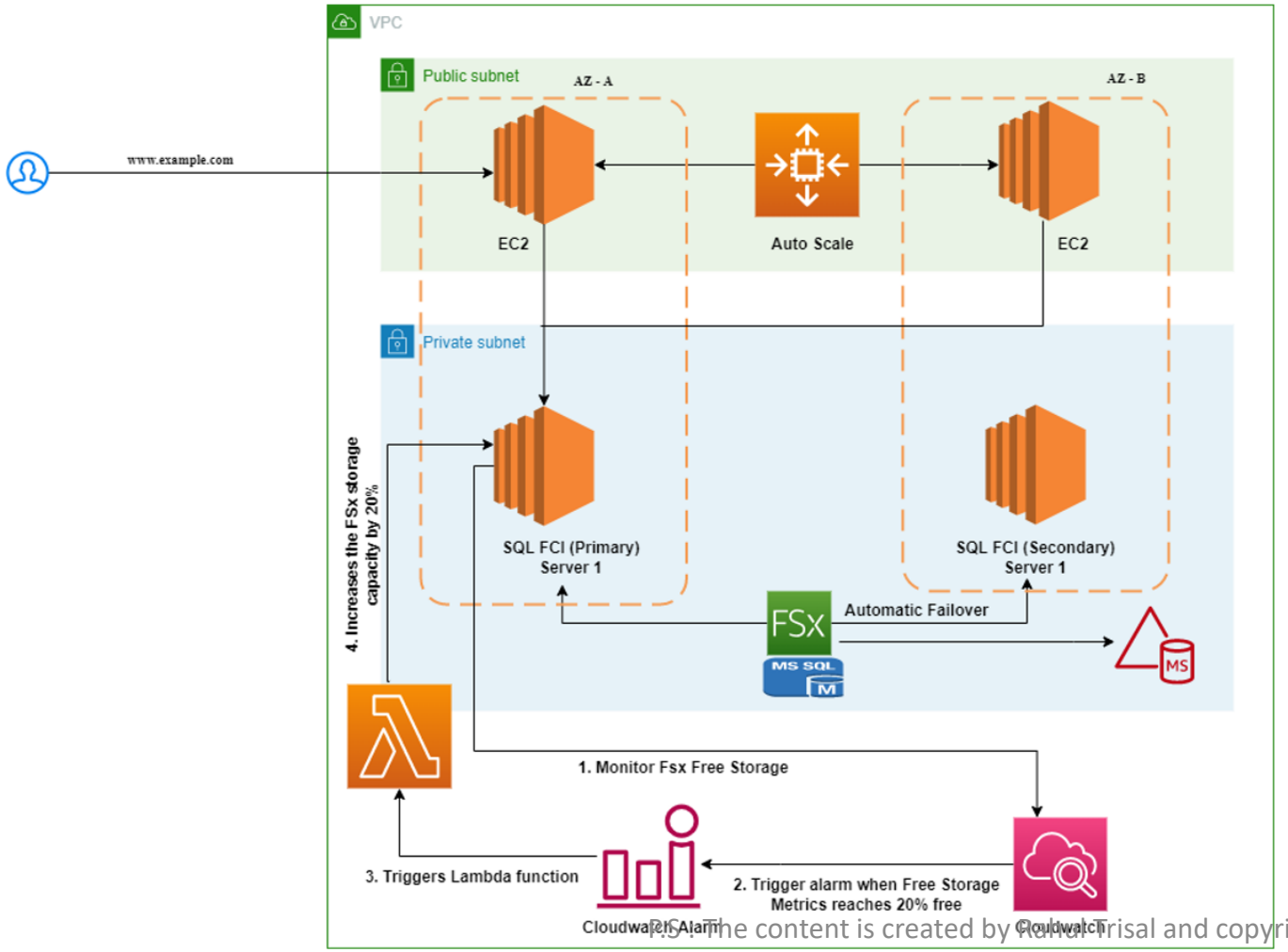


- *S3*
- *IAM Role*
- *AWS Lambda*
- *API Gateway*

Implement the use case using AWS CDK

AWS Lambda and Python – Beginner to Advanced

Section 11 : Use Case 3 – Lambda Automation Monitor & increase free storage for SQL Server FCI Cluster using AWS Lambda- MS AD, EC2, FSx, CloudWatch and CloudWatch Alarm



- *Microsoft AD*
- *EC2*
- *FSx*
- *CloudWatch Metrics*
- *CloudWatch Alarm*

Connect with me and share your AWS Learning Experiences

- I am **Rahul Trisal** working as an **AWS Solution Architect in a** Fortune 500 Organization
- Co-Founder of a AWS focused Startup – TechCloudByte – www.techcloudbyte.com
- 6X Cloud Certified
  - **AWS Solution Architect – Professional**
  - AWS Solution Architect – Associate
  - AWS Certified SysOps
  - AWS Cloud Practitioner
  - Azure Fundamental
  - IBM Bluemix Developer

- 200+ applications migrated working with Fortune 100 customers on large AWS Cloud Migration Programs

I would love to Connect with you and together learn AWS. Connect with me at below links:

- Instagram - https://www.instagram.com/aws_with_rahul/
- Linkedin - https://www.linkedin.com/in/rahul-trisal-7709628/
- Youtube - https://www.youtube.com/@trisalrahul/videos
- AWS Startup - www.techcloudbyte.com
- Follow our LinkedIn page for latest on AWS - https://www.linkedin.com/company/tech-cloud-byte-techclobyte

Section on

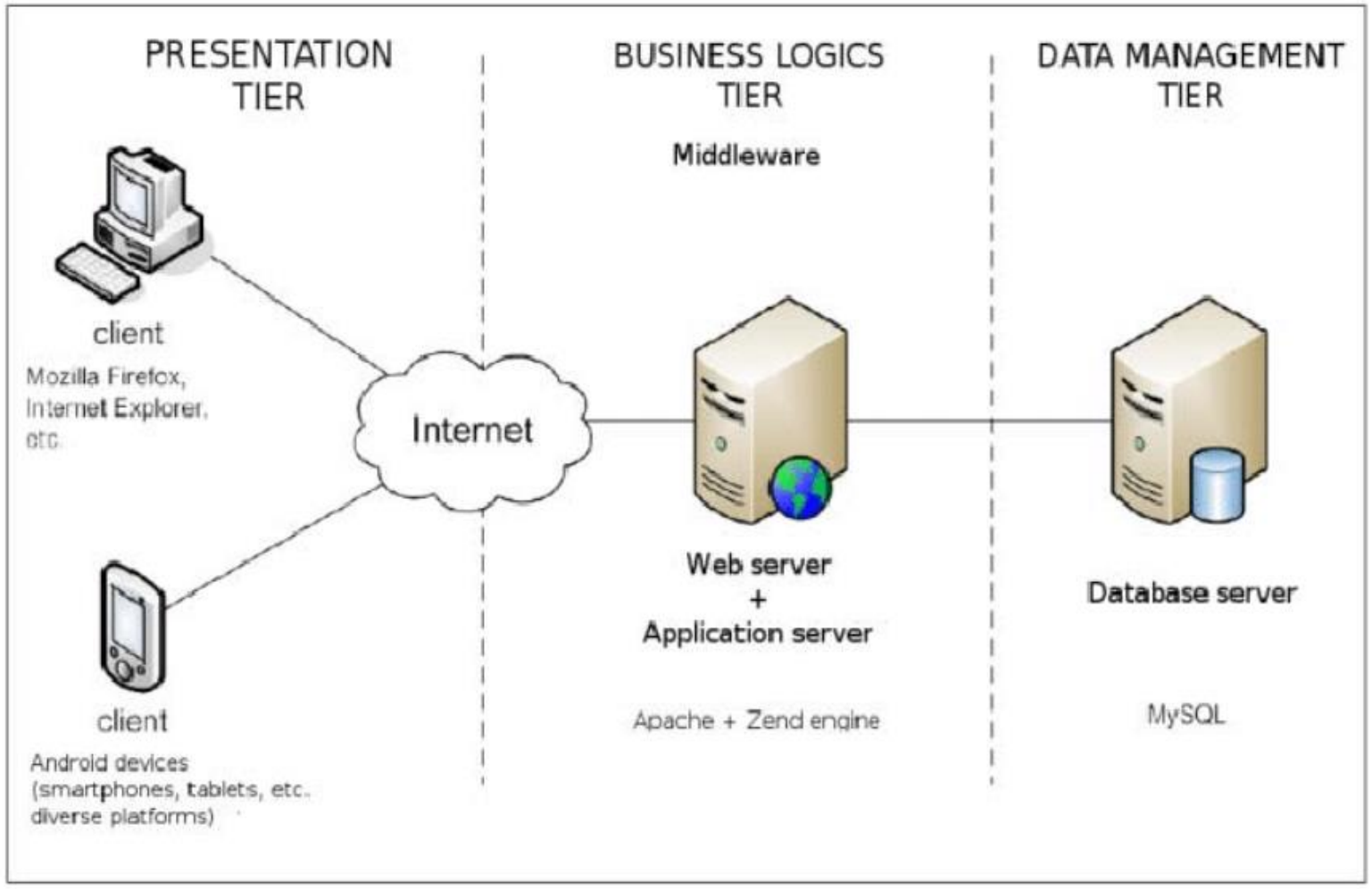
AWS Lambda – Basic Concepts (Part 1)

AWS Lambda and Python – Beginner to Advanced

AWS Lambda – Basic Concepts – Part 1

- Evolution from Physical Servers to AWS Lambda
- What is AWS Lambda - Architecture and Use Cases
- Lambda Console Walkthrough
- Lambda Execution Role
- AWS Lambda Limits - Timeout

Three-Tier Architecture

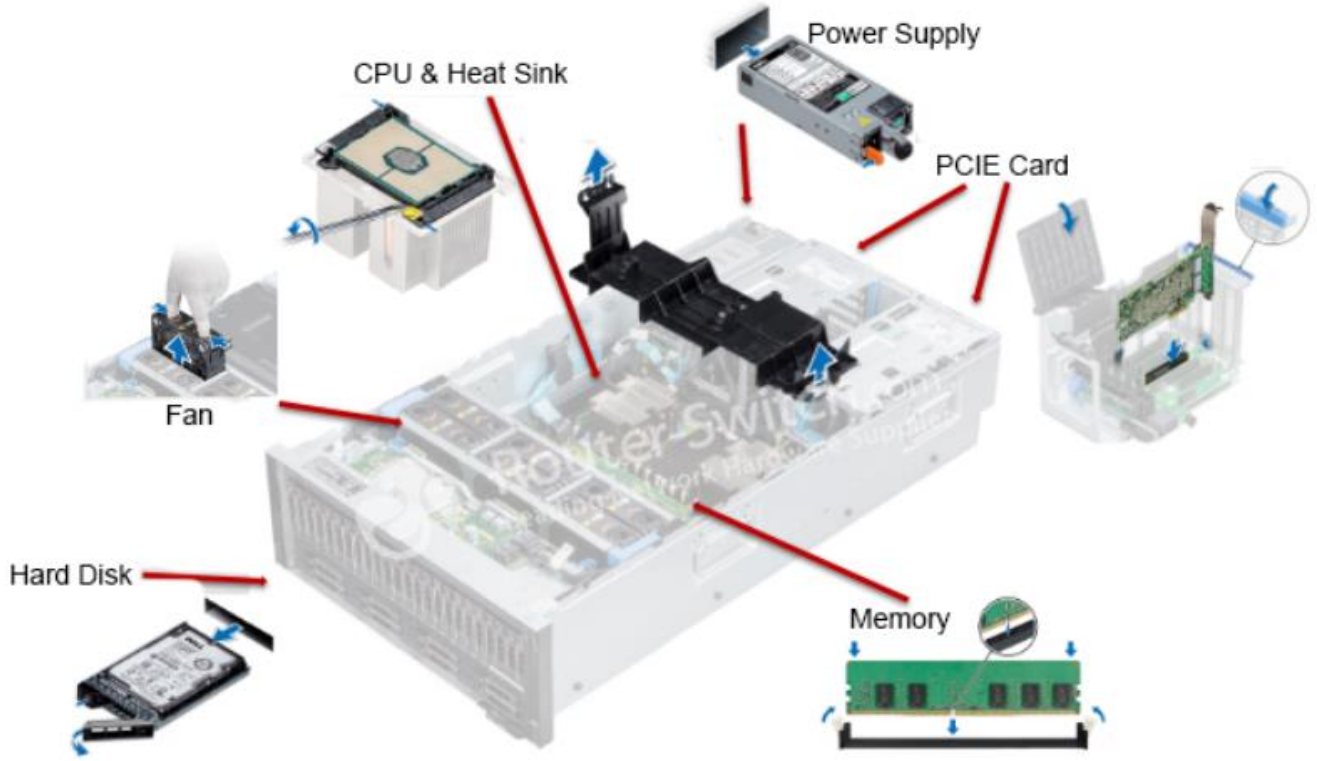


3-tier architecture

Source : Internet

https://martinfowler.com/articles/microservices.html#CharacteristicsOfAMicroserviceArchitecture

Server



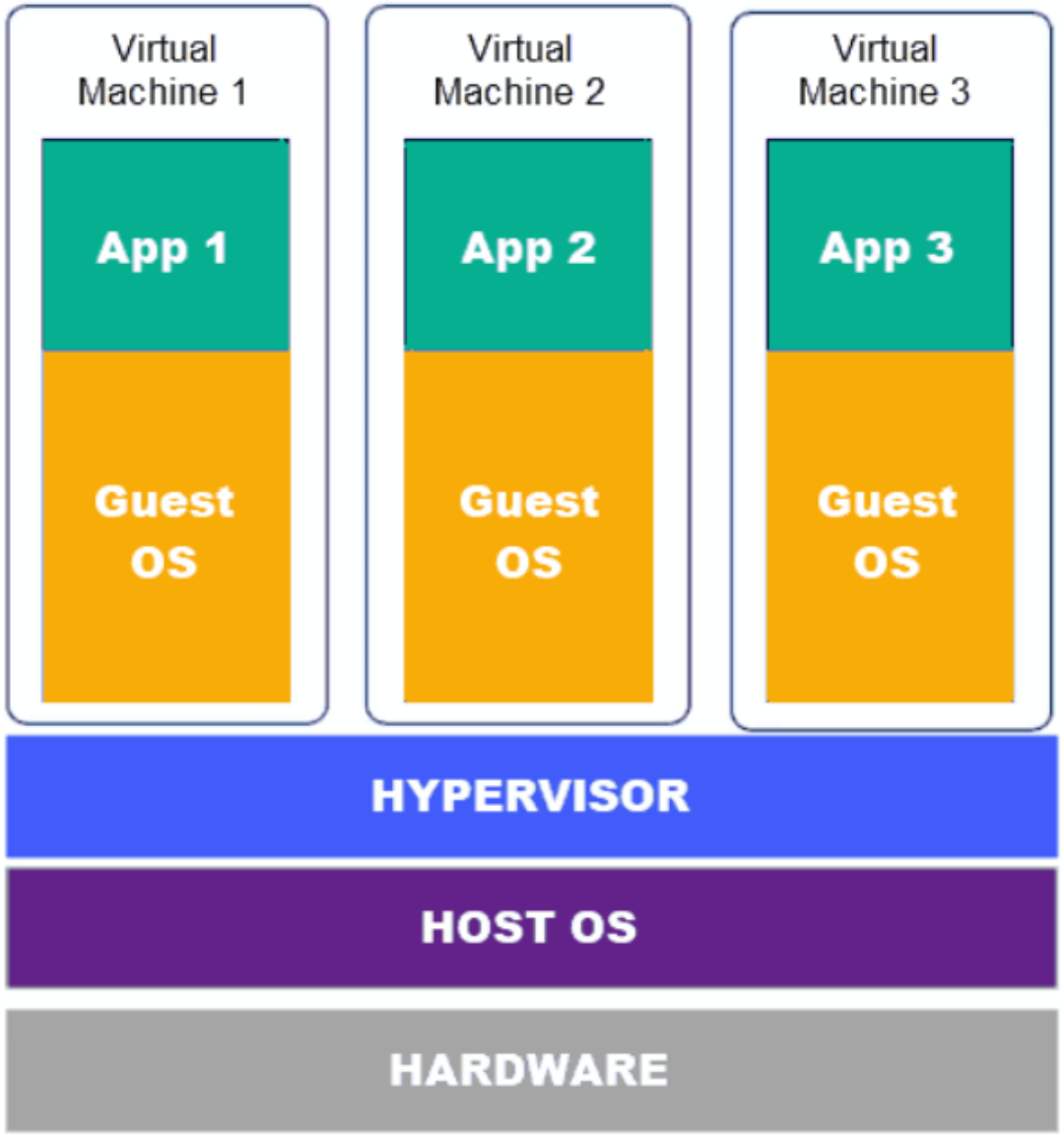
Source : Internet

Source : Internet

Source : Internet

Google data center in Eemshaven, Netherlands | Image credit: Google

Virtualization

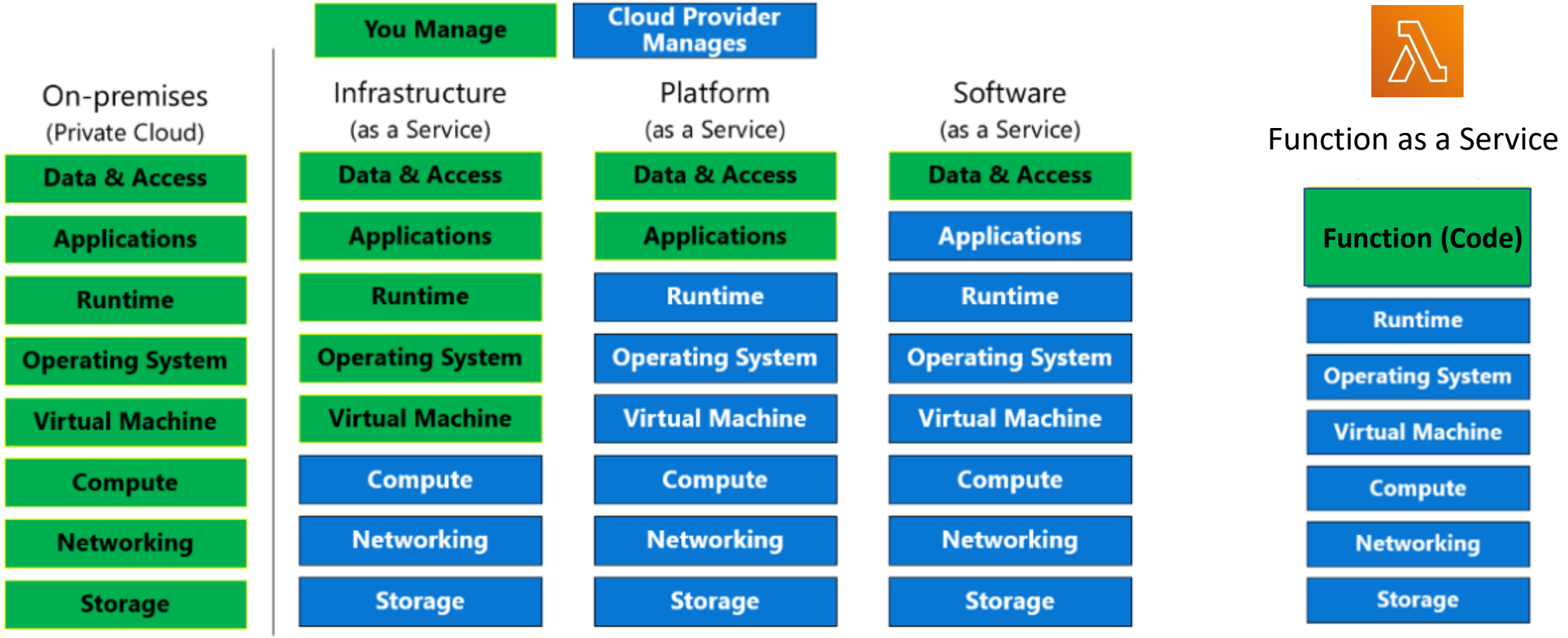


What is Cloud Computing ?

Cloud computing is **the on-demand delivery of IT resources over the Internet with pay-as-you-go pricing**.

Source : Internet

IaaS vs PaaS vs SaaS and FaaS



Source : Internet

AWS Lambda and Python – Beginner to Advanced

AWS Definition of Lambda

Lambda is a **compute service** that lets you **run code without provisioning or managing servers**. Lambda **runs your code on a high-availability** compute infrastructure and performs all of the **administration of the compute resources**, including server and **operating system maintenance, capacity provisioning and automatic scaling, and logging.**

Key Features of Lambda

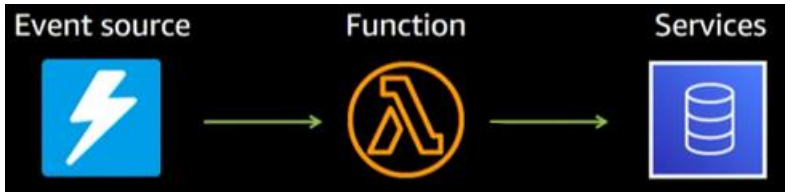
- Compute Service
- Highly Available
- All of the administration of the compute resources, including server and operating system maintenance, automatic scaling, and logging.
- Provisioning done by AWS and Pay as you use
- Bring your code and run on Lambda
- **Lambda is a serverless, event-driven compute service**

Source : AWS

AWS Lambda and Python – Beginner to Advanced

Use Case for AWS Lambda

- **Event Driven**
- **Unpredictable demand**



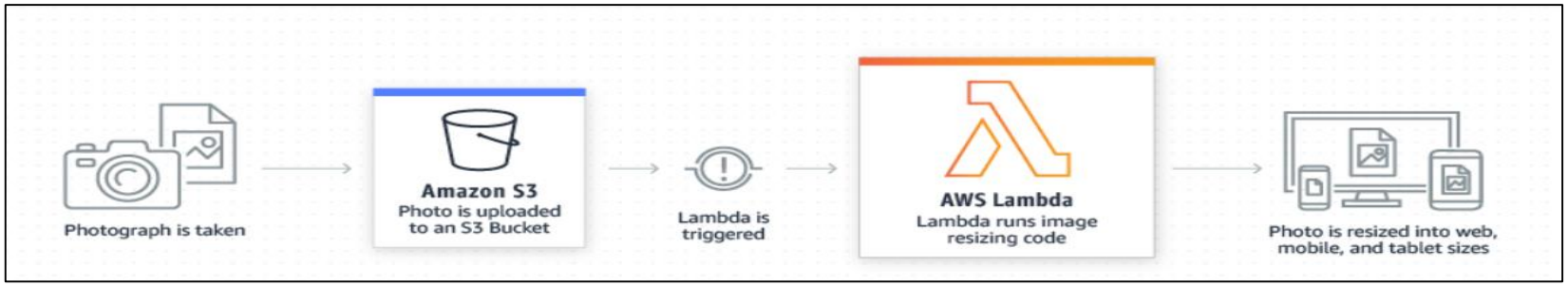
When not to use a AWS Lambda

- **When you need to manage the Infrastructure**
- **Need to run the Server Continuously instead of event driven**

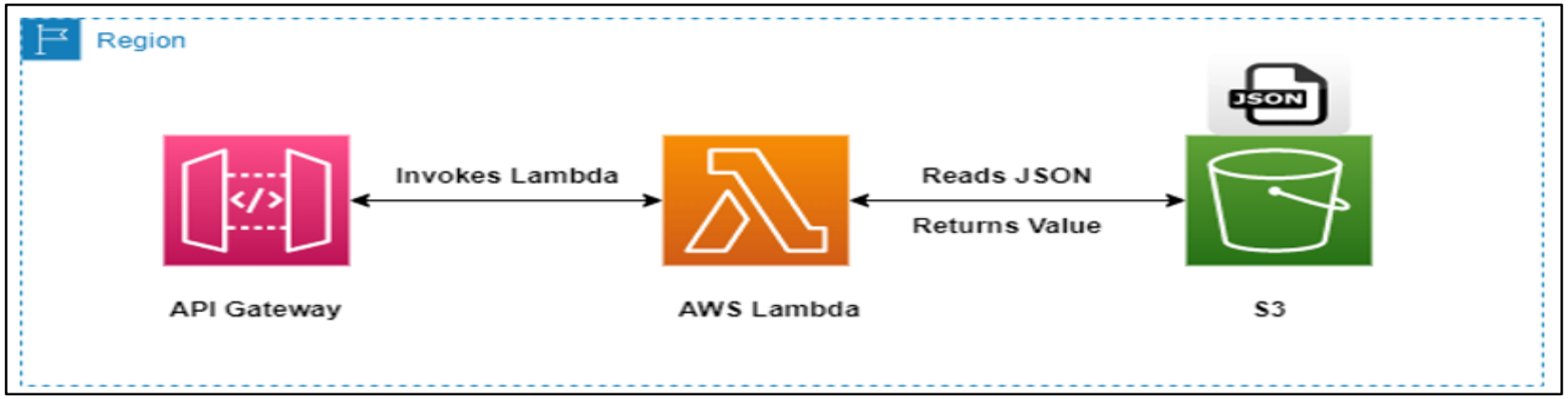
Source : AWS

AWS Lambda and Python – Beginner to Advanced

Image Processing – S3 and AWS Lambda



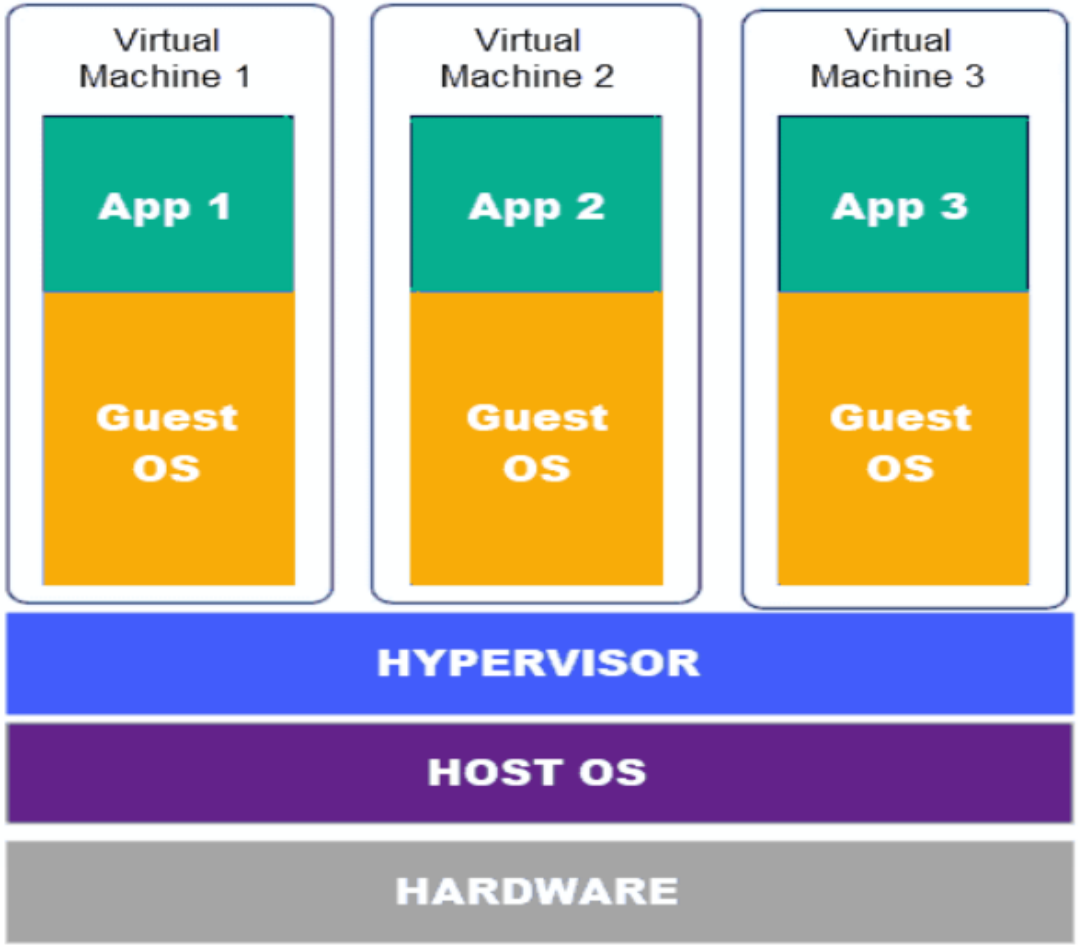
Build REST API with API Gateway, Lambda and S3



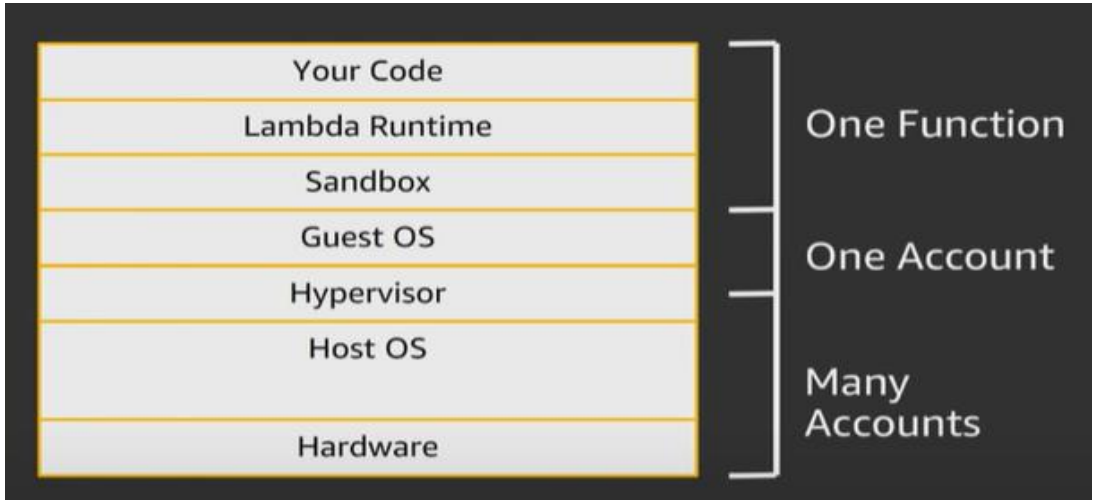
Source : AWS

Virtualization

EC2 Instance



AWS Lambda

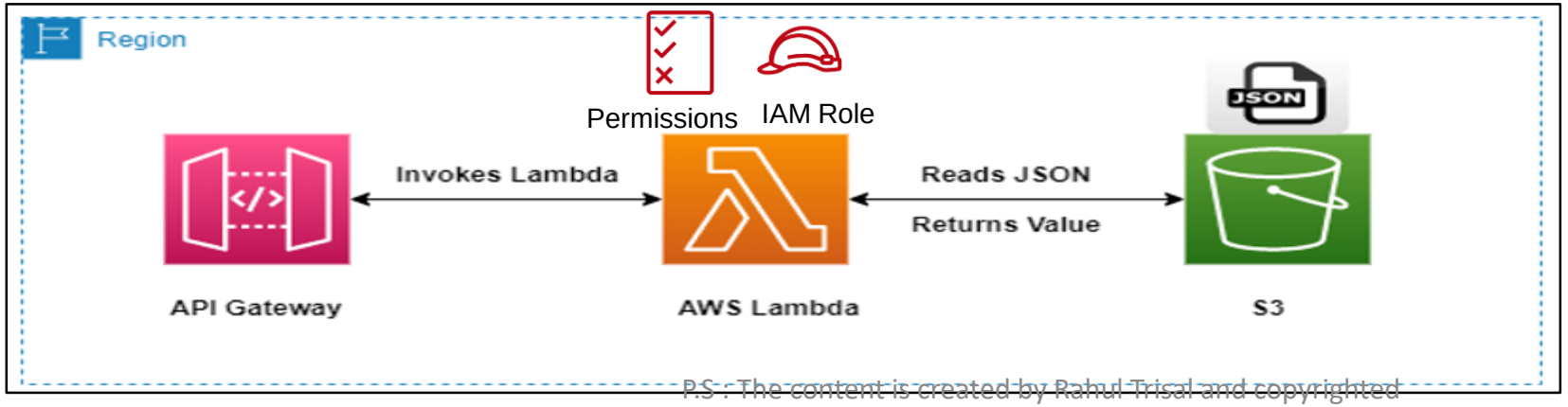


Source : Internet

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Execution Role

- A **Lambda function's execution role** is an AWS Identity and Access Management **(IAM) role that grants the function permission to access AWS services and resources.**
- **Default Lambda Function Role Permissions** :
- **AWSLambdaBasicExecutionRole** : AWSLambdaBasicExecutionRole grants permissions to **upload logs to CloudWatch**.
- Need to provide an execution role when a function is created. Invoke your function, Lambda automatically provides your function with temporary credentials by assuming this role.



AWS Lambda and Python – Beginner to Advanced

AWS Lambda Execution Role

AWSLambdaMSKExecutionRole – Lambda added the kafka:DescribeClusterV2 permission to this policy.	`AWSLambdaMSKExecutionRole` grants permissions to read and access records from an Amazon Managed Streaming for Apache Kafka (Amazon MSK) cluster, manage elastic network interfaces (ENIs), and write to CloudWatch Logs.
AWSLambdaBasicExecutionRole – Lambda started tracking changes to this policy.	`AWSLambdaBasicExecutionRole` grants permissions to upload logs to CloudWatch.
AWSLambdaDynamoDBExecutionRole – Lambda started tracking changes to this policy.	`AWSLambdaDynamoDBExecutionRole` grants permissions to read records from an Amazon DynamoDB stream and write to CloudWatch Logs.
AWSLambdaKinesisExecutionRole – Lambda started tracking changes to this policy.	`AWSLambdaKinesisExecutionRole` grants permissions to read events from an Amazon Kinesis data stream and write to CloudWatch Logs.
AWSLambdaMSKExecutionRole – Lambda started tracking changes to this policy.	`AWSLambdaMSKExecutionRole` grants permissions to read and access records from an Amazon Managed Streaming for Apache Kafka (Amazon MSK) cluster, manage elastic network interfaces (ENIs), and write to CloudWatch Logs.
AWSLambdaSQSQueueExecutionRole – Lambda started tracking changes to this policy.	`AWSLambdaSQSQueueExecutionRole` grants permissions to read a message from an Amazon Simple Queue Service (Amazon SQS) queue and write to CloudWatch Logs.
AWSLambdaVPCAccessExecutionRole – Lambda	`AWSLambdaVPCAccessExecutionRole` grants permissions to manage

Source : AWS

Section on

AWS Lambda - Python Refresher

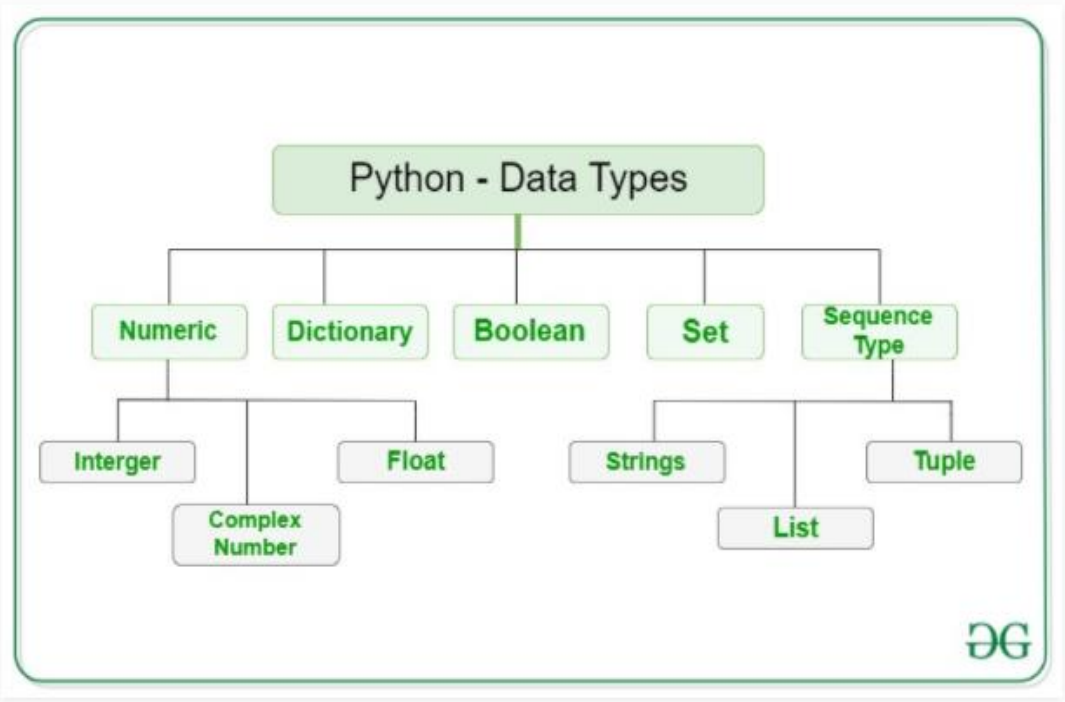
(For detailed refresher go to last section of Course)

Python Basics–Refresher

1. Print Function – print the message to screen or any interface; **Syntax : print( )**

2. Variables - Containers for storing data values string, float or integers and no need to declare; **Syntax : x = 3, greeting = “hello” etc.**

3. Data Type



Source : Internet

Data Type	Example
Int	x = 20
Float	x = 20.5
Dictionary	x = {"name" : "John", "age" : 36}
Strings	x = "Hello World"
List	x = ["apple", "banana", "cherry"]

Image Source - Internet

Python Basics–Refresher

3. Data Types – Dictionary

- curly brackets
- key: pair values
- Nested Dictionary

Dict

response = {1: 'Rahul', 2: 'John', 3: 'Joy'}

Nested Dict

response = {1:'Python', 2:{'books': 'arch' , 'aws':'Lambda'}}

4. Nested Dictionary

Image Source - Internet

Python Basics–Refresher

5. Sample Example from Boto3

Response Syntax

```
{
    'Buckets': [
        {
            'Name': 'string',
            'CreationDate': datetime(2015, 1, 1)
        },
    ],
    'Owner': {
        'DisplayName': 'string',
        'ID': 'string'
    }
}
```

https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/s3/client/list_buckets.html#

Image Source - Internet

Python Basics–Refresher

6. Data Types – List

- Lists in Python can be created by just placing the sequence inside the **square brackets []**
- A single list may contain Data Types like Integers, Strings, as well as Objects.
- List in Python are ordered and have a definite count. The elements in a **list are indexed with 0 being the first index.**
- **slice(start, stop, step)**
- Reverse [: : -1]

……

list = [1, 4, 'For', 6, 'Anisha’]

……

7. Nested List

Nested List => nestedList = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]

Python Basics–Refresher

8. Data Types – List and Dictionary

Response Syntax

```
{
    'Buckets': [
        {
            'Name': 'string',
            'CreationDate': datetime(2015, 1, 1)
        },
    ],
    'Owner': {
        'DisplayName': 'string',
        'ID': 'string'
    }
}
```

9. Data Type Determination

response = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]

print(type(response))

https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/s3/client/list_buckets.html#

Python Basics–Refresher

10. Function

Python Function

A function is a block of code which runs when it is called.

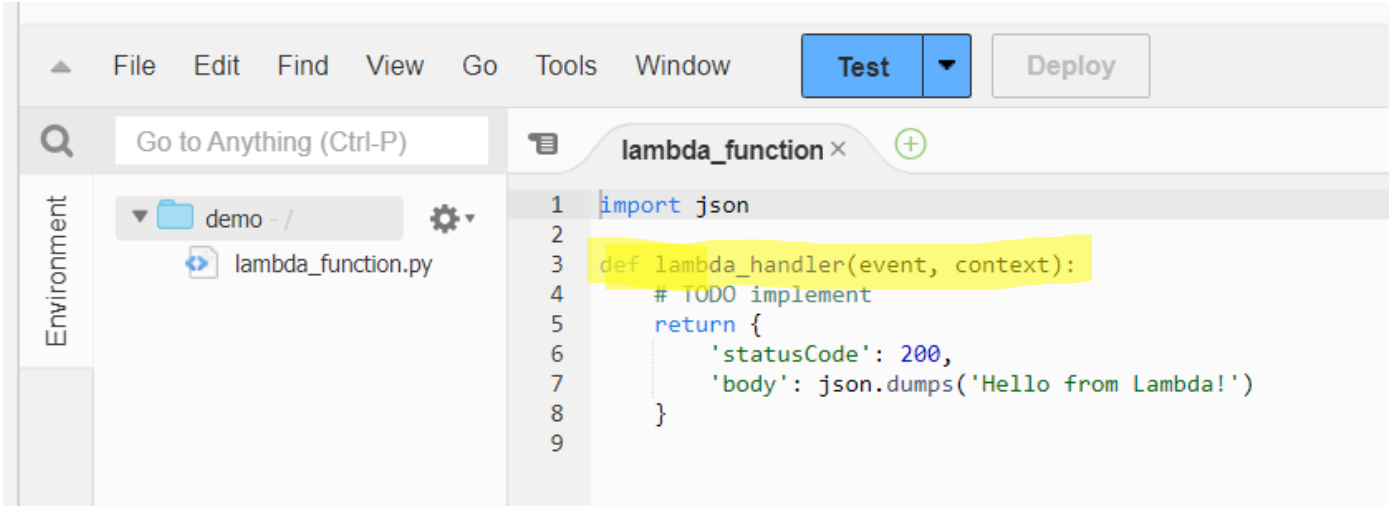
Syntax:

```
def function_name (argument/parameters):
    return expression or value
```

Example

A simple Python function to check whether x is even or odd

```
def evenOdd(x):
    if (x % 2 == 0):
        print("even")
    else:
        print("odd")
# Driver code to call the function
evenOdd(2)
evenOdd(3)
```



Section 4

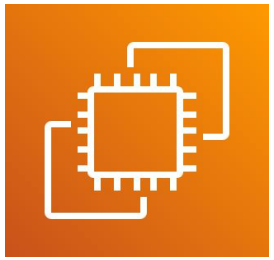
AWS Lambda – Create S3, EC2 and DynamoDB resources using Lambda (Boto3)

AWS Lambda and Python – Beginner to Advanced

Section 4: AWS Lambda – Create S3, EC2 and DynamoDB resources using Lambda (Boto3)

- **AWS Lambda with S3 (Create new Bucket , List all the Buckets and Delete Bucket)**
- **AWS Lambda with EC2 (Create EC2 and Start/Stop)**
- **AWS Lambda with DynamoDB (Create Table and Put Items)**

S3



EC2

DynamoDB

AWS Lambda Hands on - Basics of Lambda Function

AWS SDK for Python (Boto3)

- The **AWS SDK for Python is Boto3**
- **Boto3 library makes** it easy to **integrate with AWS services** including Amazon S3, Amazon EC2, Amazon DynamoDB, and more **using Python.**

Boto3 has two distinct levels of APIs.

Client APIs

- Clients provide a **low-level interface to the AWS service.**
- All AWS service operations supported by clients

```
import boto3

client = boto3.client('s3')
```

Resource APIs

- Resources are a higher-level abstraction compared to clients.
- Few AWS service operations not supported

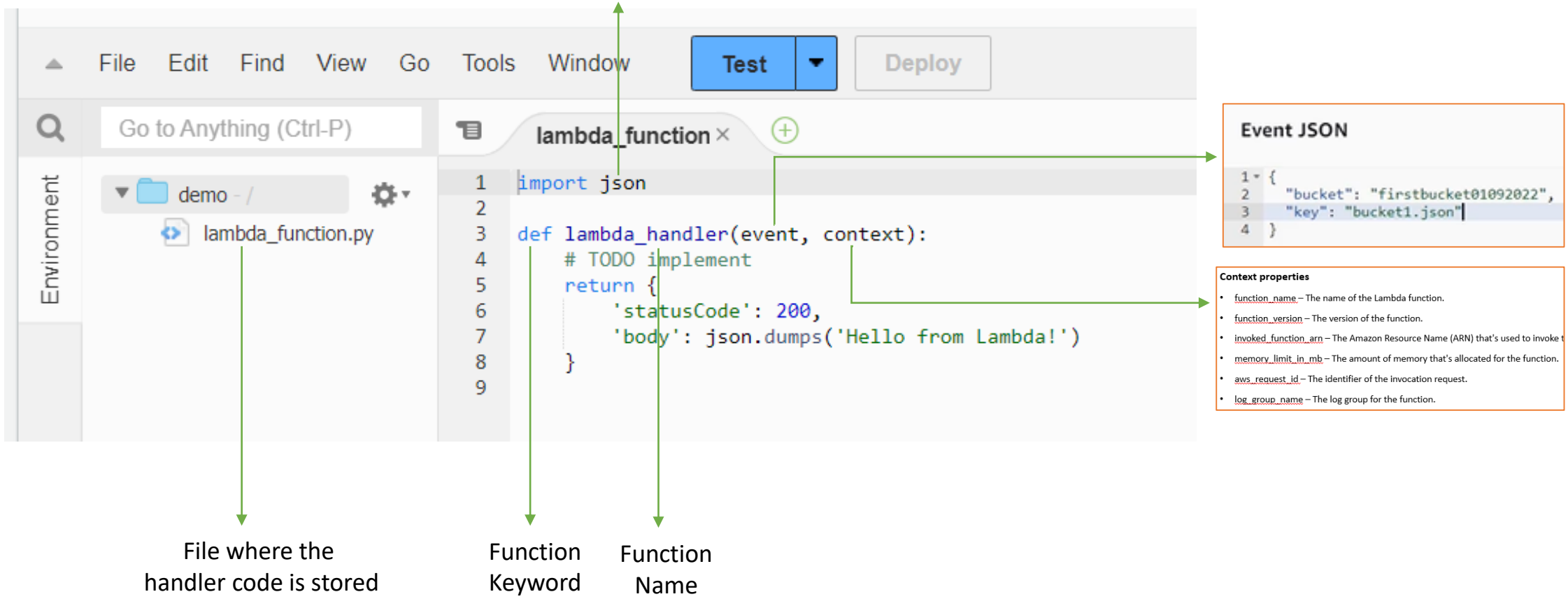
```
import boto3

# Let's use Amazon S3
s3 = boto3.resource('s3')
```


https://aws.amazon.com/sdk-for-python/

AWS Lambda Hands on - Basics of Lambda Function

JSON is an open standard for exchanging data on the web.

Key Value Pair {"name" : “rahul", "employeeid" : 011, "present" : true}



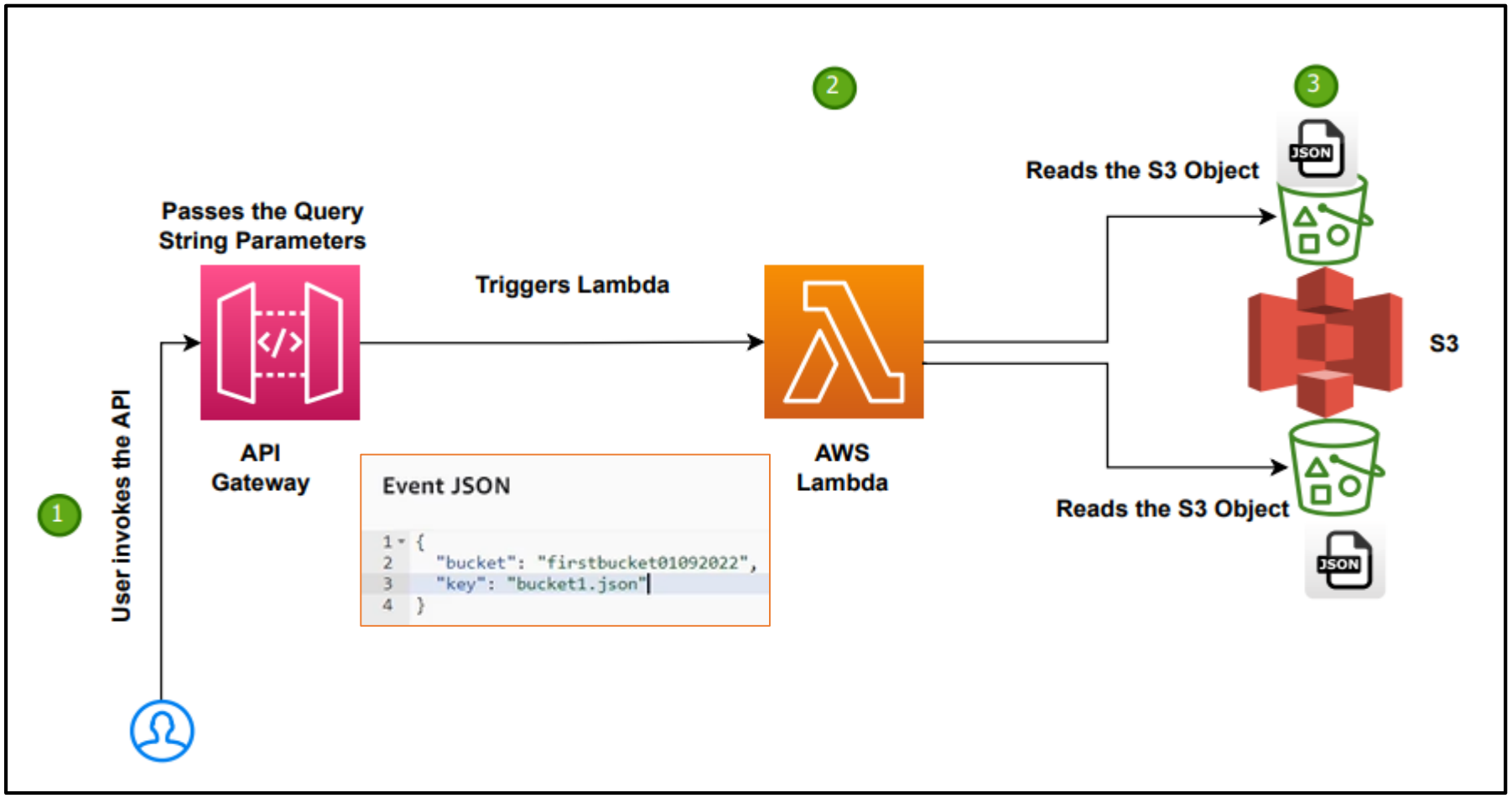
The **Lambda function *handler* is the method in your function code that processes events**. When your **function is invoked**, Lambda runs the **handler method**.

AWS Lambda Hands on - Basics of Lambda Function

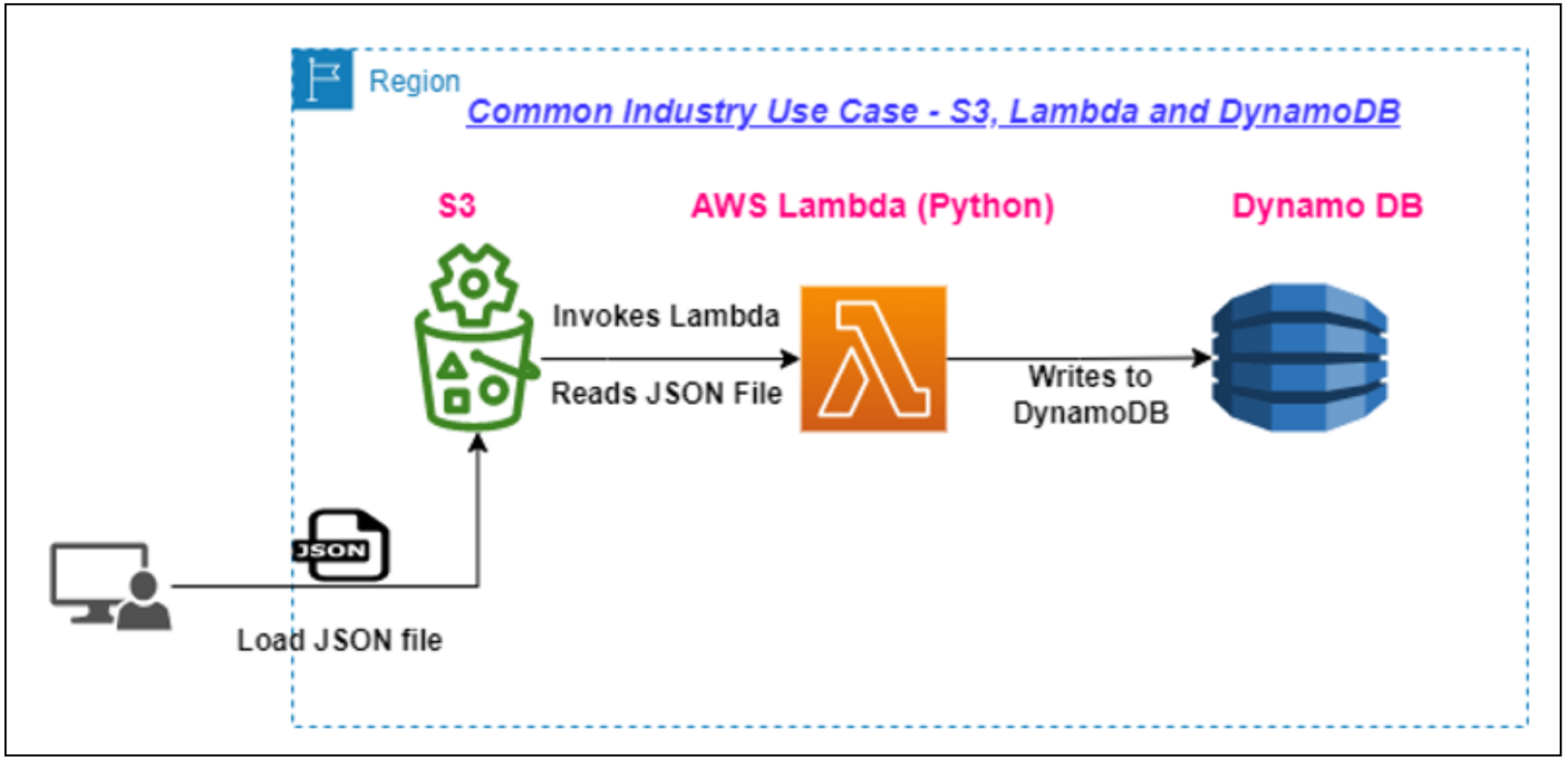
Context properties

- function_name – The name of the Lambda function.
- function_version – The version of the function.
- invoked_function_arn – The Amazon Resource Name (ARN) that's used to invoke the function. Indicates if the invoker specified a version number or alias.
- memory_limit_in_mb – The amount of memory that's allocated for the function.
- aws_request_id – The identifier of the invocation request.
- log_group_name – The log group for the function.
- log_stream_name – The log stream for the function instance.
- identity – (mobile apps) Information about the Amazon Cognito identity that authorized the request.
- cognito_identity_id – The authenticated Amazon Cognito identity.
- cognito_identity_pool_id – The Amazon Cognito identity pool that authorized the invocation.
- client_context – (mobile apps) Client context that's provided to Lambda by the client application.
- client.installation_id
- client.app_title
- client.app_version_name
- client.app_version_code
- client.app_package_name
- custom – A dict of custom values set by the mobile client application.
- env – A dict of environment information provided by the AWS SDK.

AWS Lambda Hands on - Basics of Lambda Function



AWS Lambda Hands on - Basics of Lambda Function



Create S3 using Lambda and Python Boto3 SDK

Create Below Resources through Lambda

S3

S3

- Create new Bucket
- Delete Bucket
- List all the buckets (Inventory Collection within an AWS Account)

Use Case Scenario

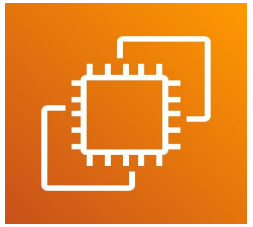
- List the inventory of all the S3 buckets in the Organization AWS Account (Sandbox, Dev etc.)

Create EC2 using Lambda and Python Boto3 SDK

Create Below Resources through Lambda

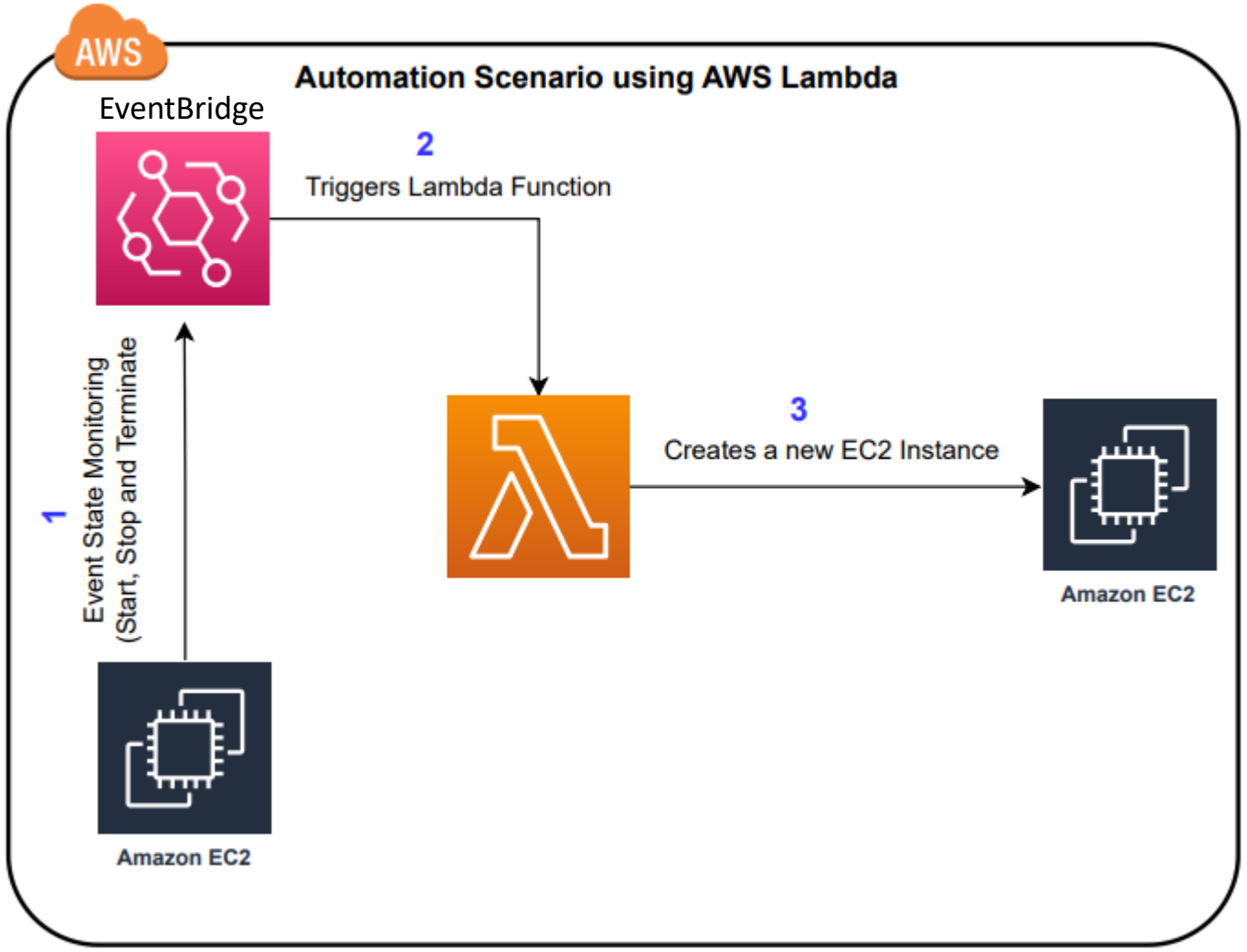
EC2

- Create new EC2
- Stop EC2 Instance
- Start EC2 Instance



Automation Scenario - AWS Lambda, EventBridge and EC2

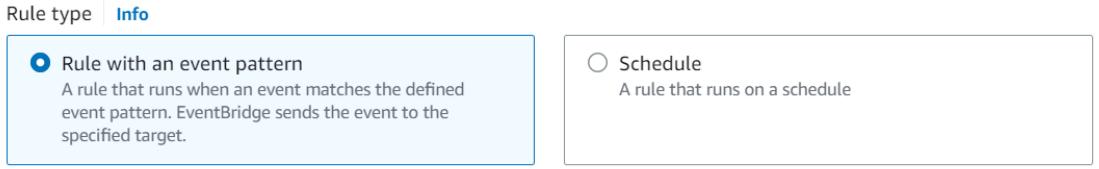
Use Case Scenario

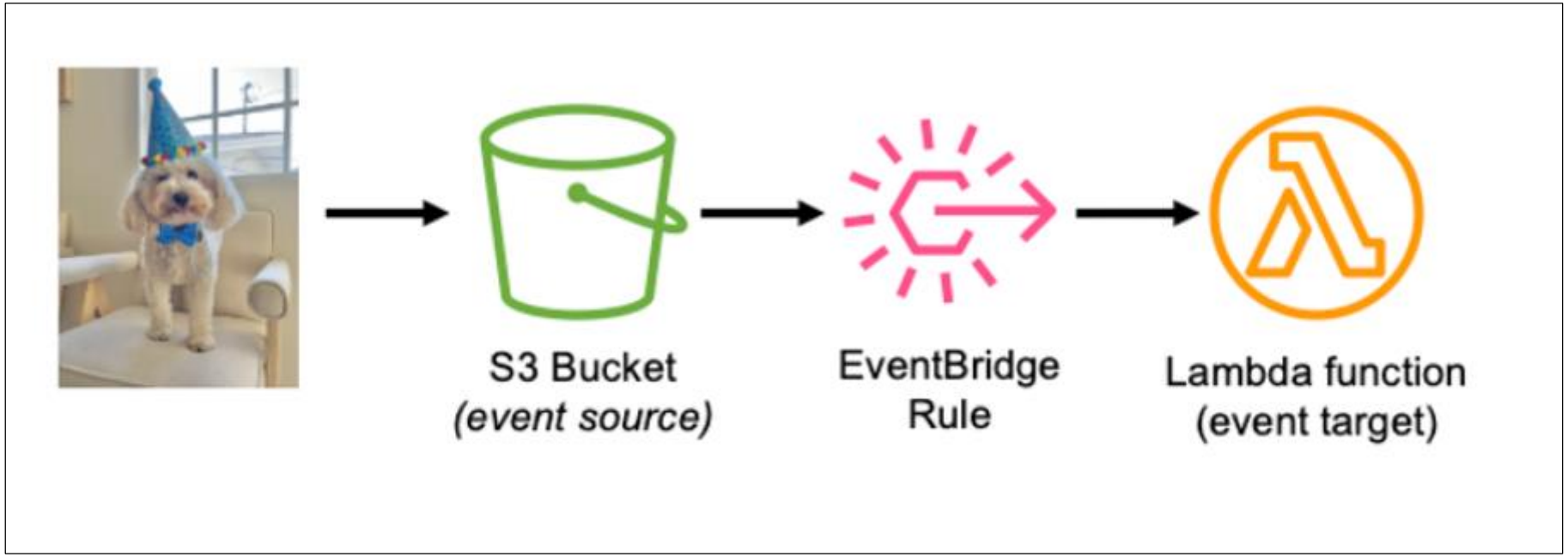


AWS EventBridge - Overview

Amazon EventBridge is serverless service for building event-driven applications

- Event Source ------ > EventBridge (Evaluate Rule) ------- > Event Target and Action
- Schedule Events





Source : AWS

DynamoDB - Overview

Create DynamoDB Table using Lambda & Python Boto3 SDK

Create Below Resources through Lambda

DynamoDB

- Create DynamoDB Table

- Insert data into the DynamoDB Table using Put Item method

DynamoDB

AWS Lambda Hands on – Step by Step Guide - 1

1. **Go to AWS Account, Search for AWS Lambda Service from Console and click on 'Create Function'**

   - Select Author from Scratch
   - Function Name – Meaningful name of the function based on the usage
   - Runtime – The programming language you intent to write the code in
   - Architecture - x86_64
   - Default Execution Role – Permission only to CloudWatch logs
   - Create Function

AWS Lambda Hands on – Step by Step Guide - 2

2. Increase timeout limit

- Go to Configuration --- > General Configuration --- > Change Timeout limit to – 1 min

3. Create/Enhance the IAM Role

- Go to Configuration --- > Permission--- > Click on Role name --- > Add Permission

4. Go to 'Code' Tab and Search for Boto3 Documentation

5. 'import boto3' in the lambda function code

6. Create the Client connection with the service being provisioned

```
import boto3

client = boto3.client('s3')
```

AWS Lambda Hands on – Step by Step Guide - 3

7. Search the API method for AWS Service being created

These are the available methods:

- abort_multipart_upload
- can_paginate
- close
- complete_multipart_upload
- copy
- copy_object
- create_bucket
- create_multipart_upload
- delete_bucket
- delete_bucket_analytics_configuration

8. Write the code for AWS Service to be created

- Copy the Request Syntax
- Identify the relevant attributes to be used to create the AWS Service based on your requirement
- Review the mandatory and optional attributes

Request Syntax

```
response = client.create_bucket(
    ACL='private'|'public-read'|'public-read-write'|'authenticated-read',
    Bucket='string',
    CreateBucketConfiguration={
        'LocationConstraint': 'af-south-1'|'ap-east-1'|'ap-northeast-1'|'ap-northeast-2'|'ap-nort
    },
    GrantFullControl='string',
    GrantRead='string',
    GrantReadACP='string',
    GrantWrite='string',
    GrantWriteACP='string',
    ObjectLockEnabledForBucket=True|False,
    ObjectOwnership='BucketOwnerPreferred'|'ObjectWriter'|'BucketOwnerEnforced'
)
```

AWS Lambda Hands on – Step by Step Guide - 4

9. Evaluate the Response

- Response parameters
- Response Type such as Dictionary

RETURN TYPE:

dict

RETURNS:

Response Syntax

```
{
    'Location': 'string'
}
```

10. Identify the Response parameters to be printed

- Evaluate the attributes that will be returned
- Print the response based on type (Dictionary and so) using print function

AWS Lambda Hands on – Step by Step Guide - 5

11. Click on Deploy to save changes

12. Create a Test Event

13. Test the Function

14. Verify from console if the AWS Service is created as expected.

AWS Lambda and Python – Beginner to Advanced

Section on

AWS Lambda – Basic Concepts (Part 2)

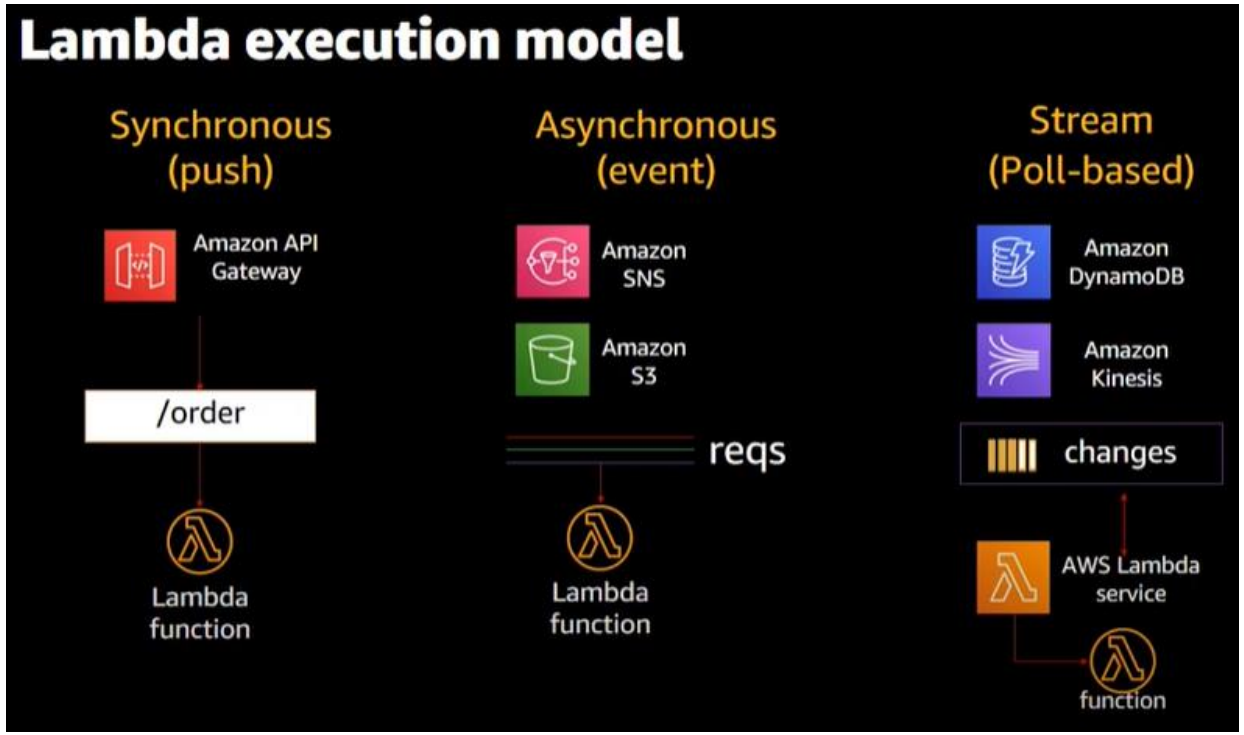
AWS Lambda and Python – Beginner to Advanced

AWS Lambda – Basic Concepts – Part 2

- Evolution from Physical Servers to AWS Lambda
- What is AWS Lambda - Architecture and Use Cases
- Lambda Console Walkthrough
- Lambda Execution Role
- AWS Lambda Limits - Timeout
- **AWS Lambda Invocation Model - Theory**
- **AWS Lambda Invocation Model – Hands-On**
- **AWS Lambda Limits – Memory**

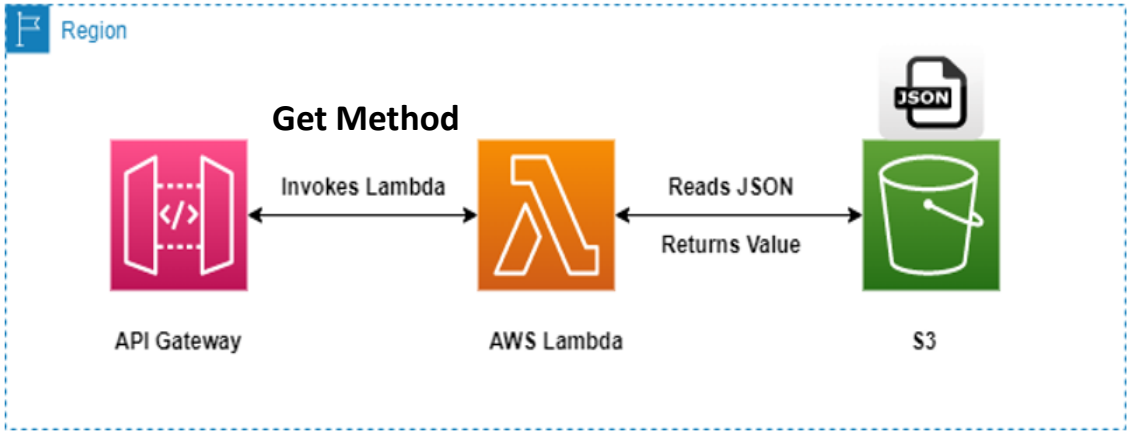
AWS Lambda and Python – Beginner to Advanced

AWS Lambda Execution/Invocation Model

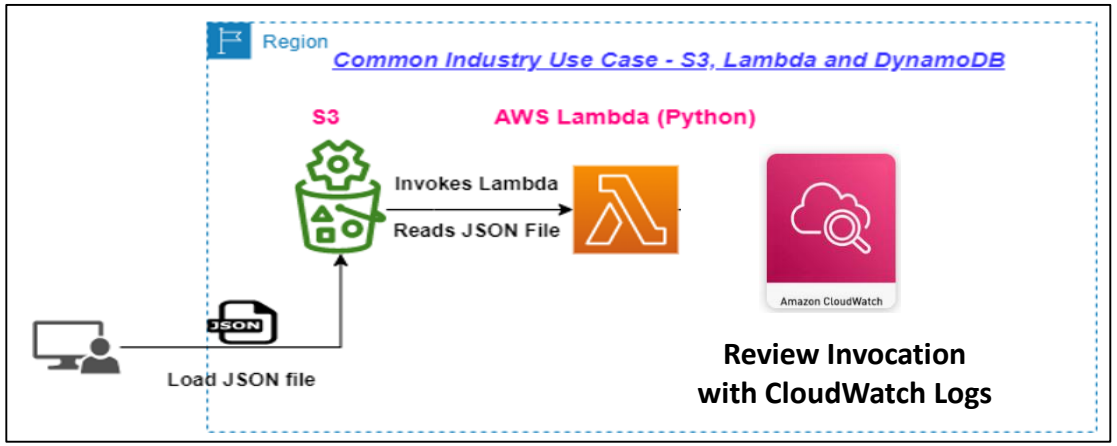


Source : AWS

1. Synchronous Invocation – API Gateway with AWS Lambda

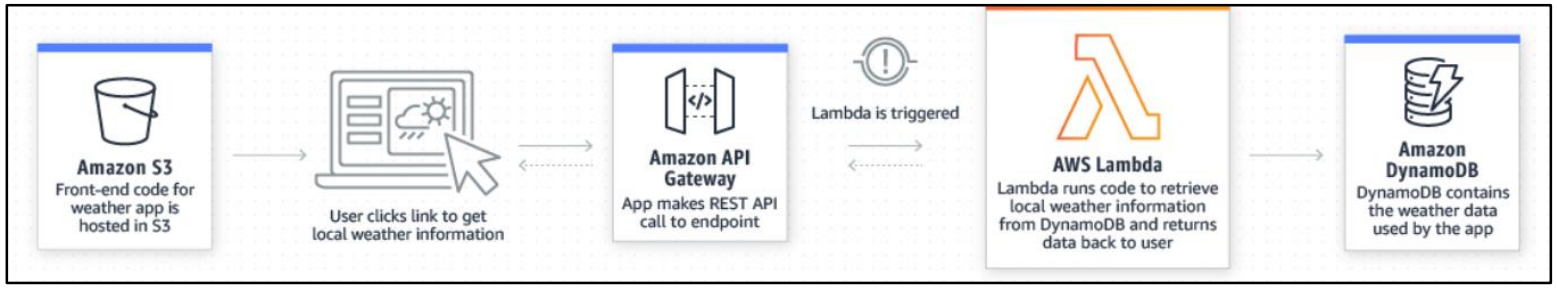


2. Asynchronous Invocation – S3 with AWS Lambda

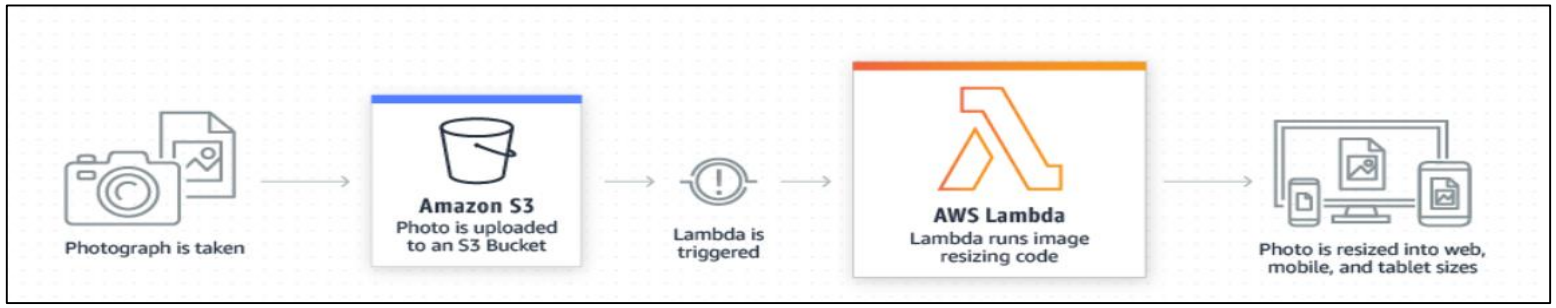


AWS Lambda and Python – Beginner to Advanced

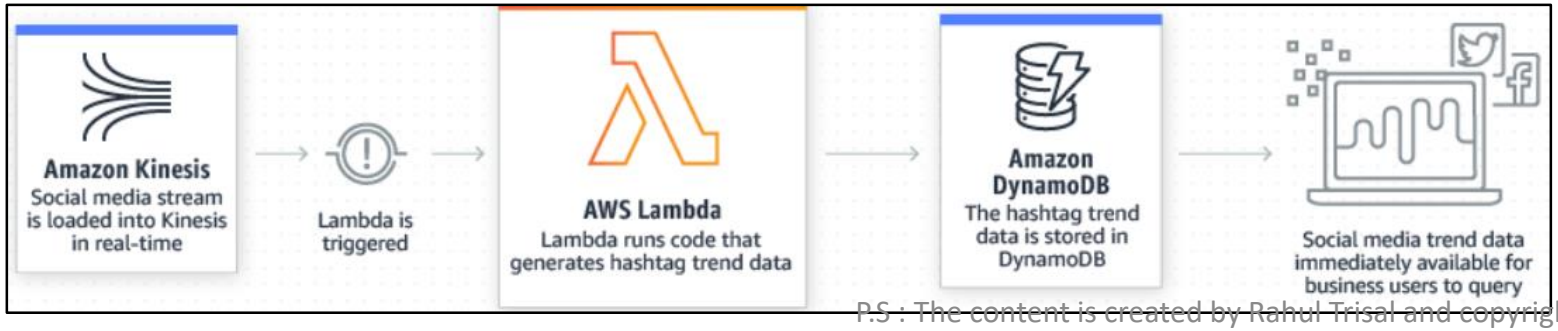
1. Synchronous Invocation – API Gateway with AWS Lambda



2. Asynchronous Invocation – S3 with AWS Lambda



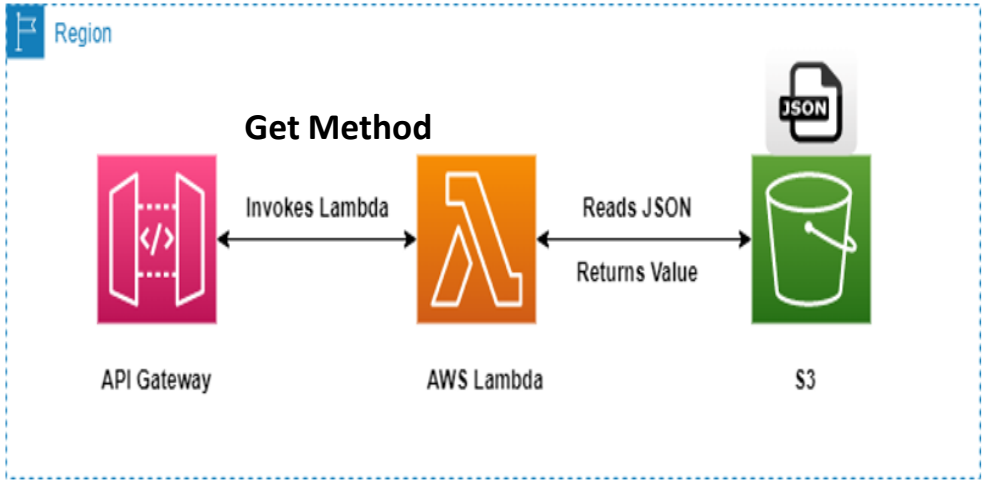
3. Stream based (Polling) Invocation – Kinesis or SQS with AWS Lambda



AWS Lambda and Python – Beginner to Advanced

AWS Lambda Limits - Timeout

- Lambda runs your code for a **set amount of time** before timing out.
- When the specified timeout is reached, Amazon Lambda terminates execution of your Lambda function.
- The **default value** for this setting is **3 seconds**
- **Maximum value of 900 Sec (15 minutes)**



Best Practice:

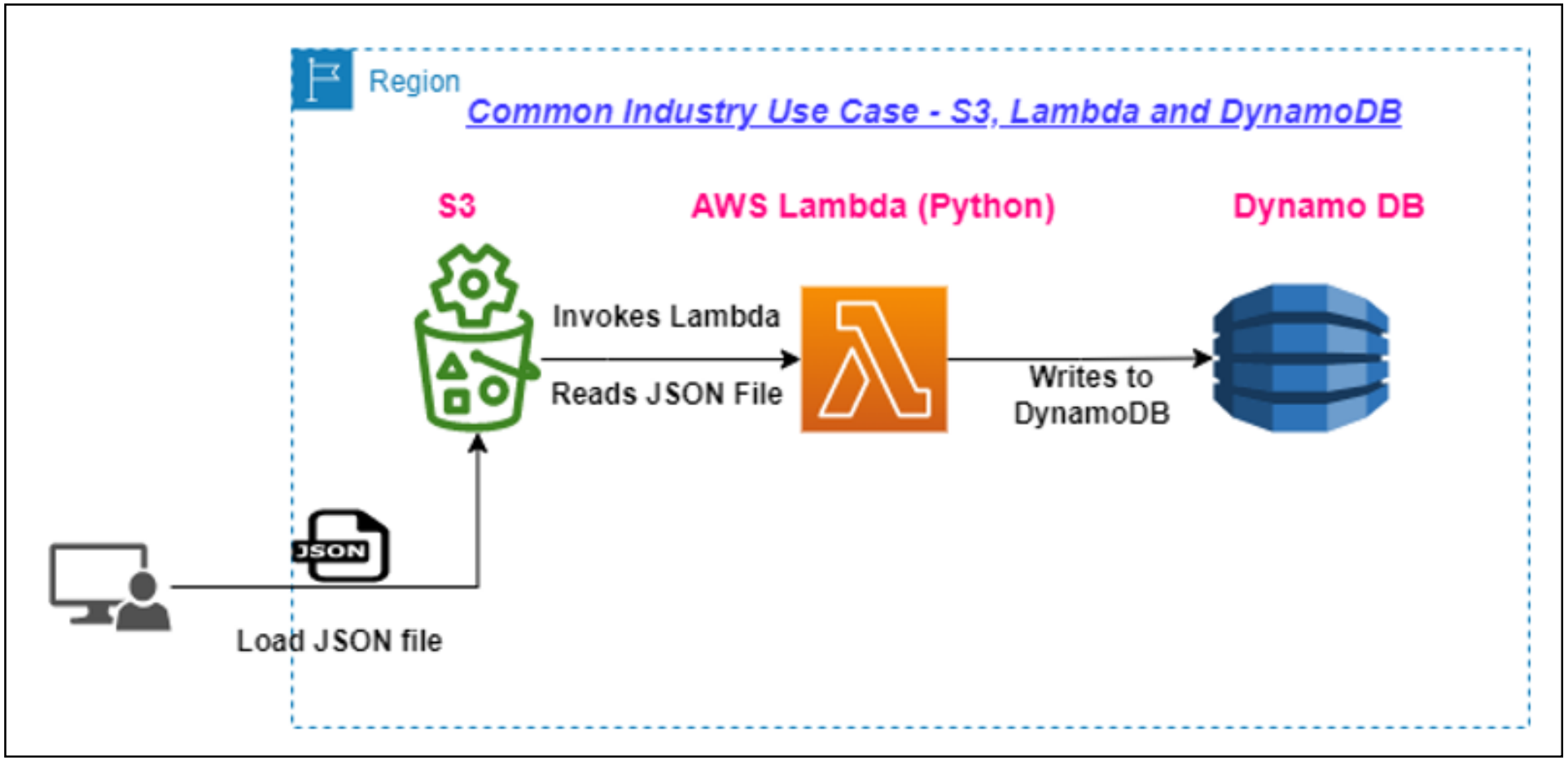
- Performance and cost are two key parameters for setting the Timeout limit
- Edge Cases can impact cost

Section on

Real World Serverless Use Case 1 - using S3, AWS Lambda and DynamoDB

Serverless Architecture – 1

AWS Lambda and Python – Target Architecture



S3

- s3demo01022022abc

DynamoDB Table

- RetailSales02032022

- CustomerID
- Product

Very Important :

Please change the name of the S3 Bucket and DynamoDB Table with your own and substitute the names in the Lambda Python Code. The S3 bucket names need to be globally unique and same names that were highlighted in the video will not work.

AWS Lambda and Python – Beginner to Advanced

Section on

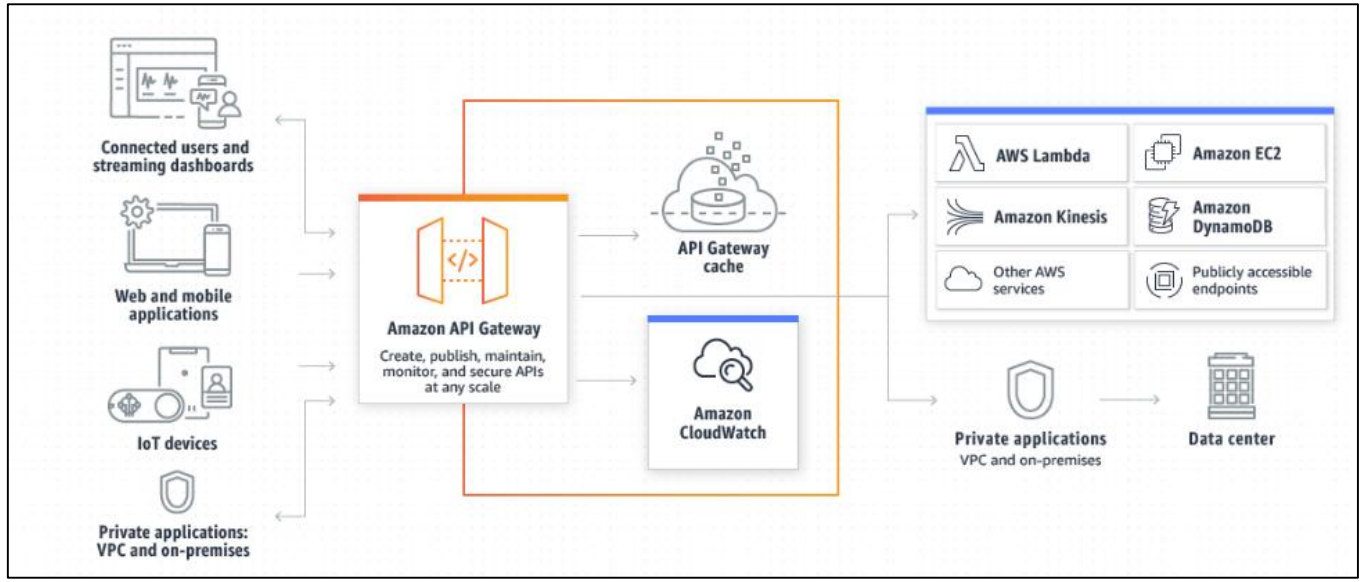
API Gateway Overview

AWS API Gateway - Overview

What is API Gateway

Amazon API Gateway is an AWS service for **creating, publishing, maintaining, monitoring, and securing REST,**

HTTP, and WebSocket APIs at any scale.



Sample Architecture - RESTful microservices

AWS API Gateway - Overview

Key Features Of API Gateway

1. API Types

1. HTTP API

Build **low-latency and cost-effective REST APIs** with built-in features such as OIDC and OAuth2, and native CORS support.

2. WebSocket API

Build a WebSocket API using **persistent connections for real-time use cases such as chat applications or dashboards.**

3. REST API 

Develop a REST API where you gain complete control over the request and response along with **API management capabilities.**

4. REST API (Private)

Create a REST API that is **only accessible from within a VPC**.

https://aws.amazon.com/blogs/compute/introducing-amazon-api-gateway-private-endpoints/

AWS API Gateway - Overview

Key Features of API Gateway

REST API's vs HTTP API's

- REST APIs support **more features** than HTTP APIs, while HTTP APIs are designed with **minimal features** and offered at a **lower price**.
- Choose **REST APIs** if you need features such as **API keys, per-client throttling, request validation, AWS WAF integration, or private API endpoints.**
- Choose **HTTP APIs** if you don't need the features included with **REST APIs.**

- https://aws.amazon.com/blogs/compute/introducing-amazon-api-gateway-private-endpoints/

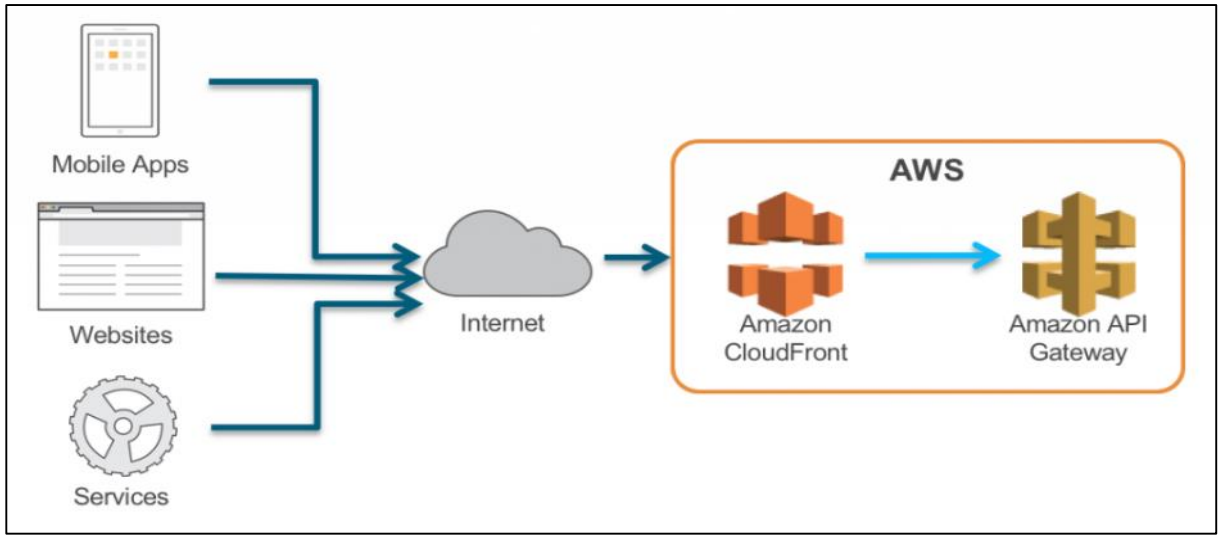
API Gateway - Overview

2. API Endpoint Types

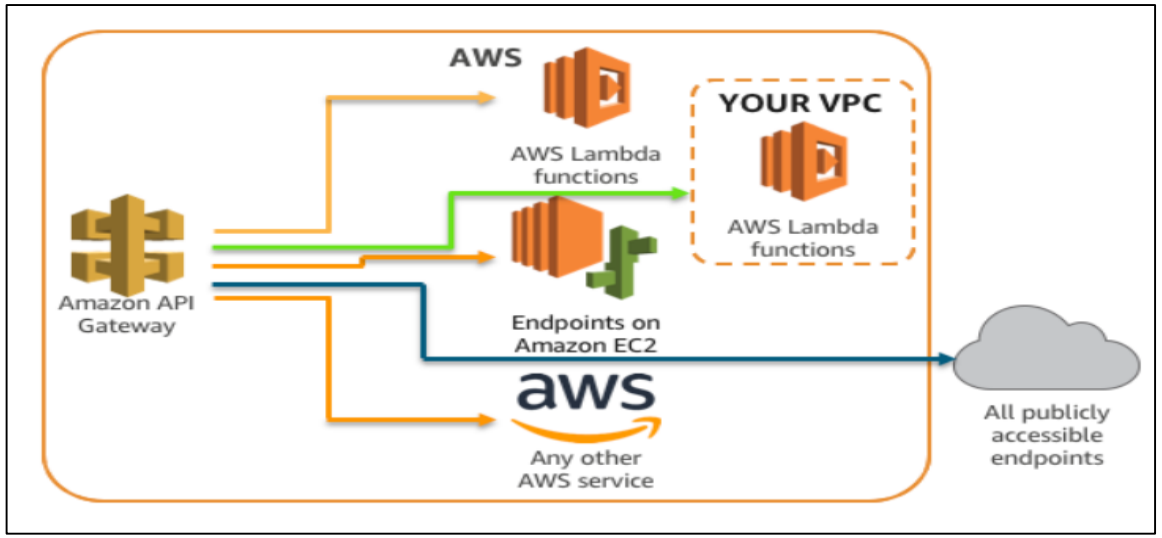
An ***API endpoint* type** refers to the **hostname of the API**.

The API endpoint type can be ***edge-optimized*, *regional*, or *private*,** depending on where the majority of your API traffic originates from.

Edge Optimized



Regional

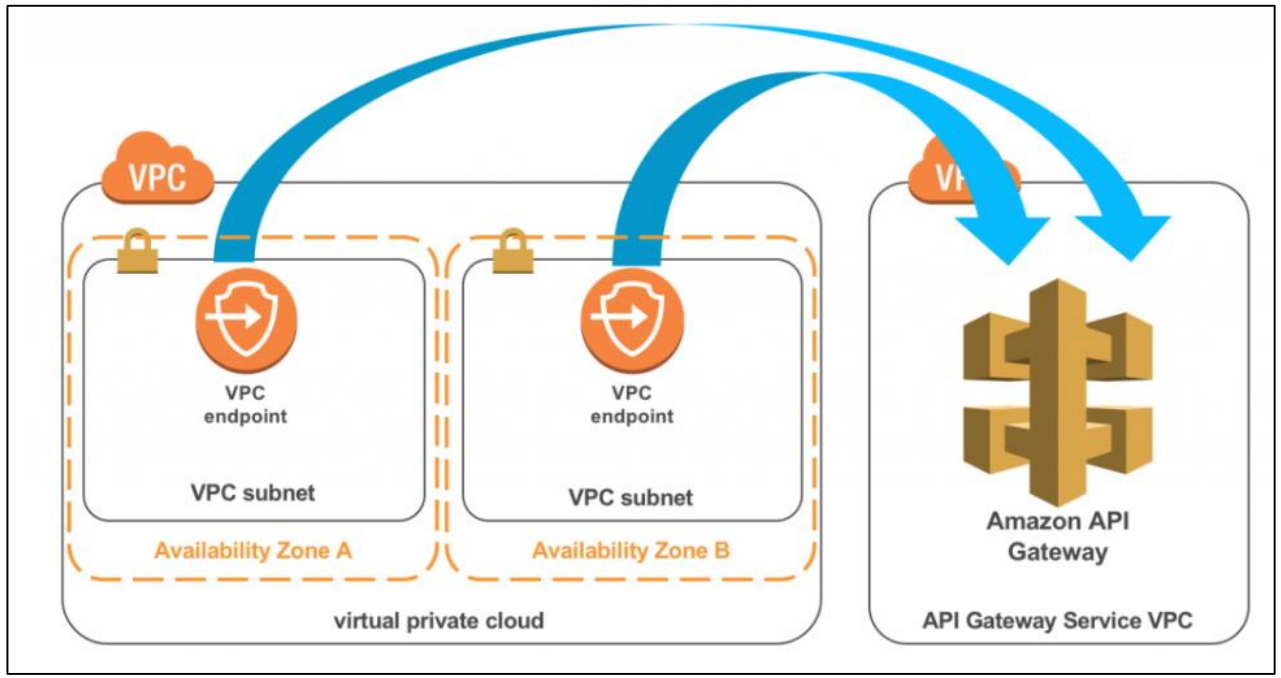


Source : AWS

API Gateway - Overview

2. API Endpoint Types

Private



Source : AWS

API Gateway - Overview

3. Resources

REST architecture treats every content as a **resource**.

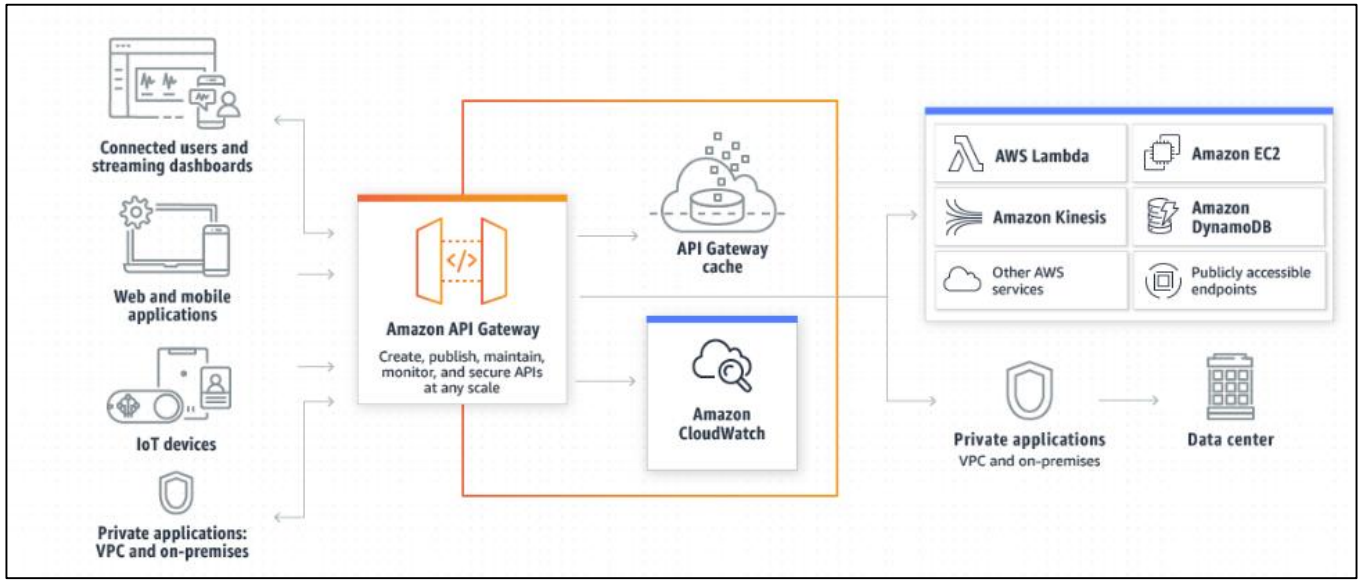
These resources can be Text Files, Html Pages, Images, Videos or Business Data.

4. Methods

Method	Description
GET	Retrieve information about the REST API resource
POST	Create a REST API resource
PUT	Update a REST API resource
DELETE	Delete a REST API resource or related component

API Gateway - Overview

5. Integration Type



Lambda Function

This type of integration lets an API method

be integrated with the Lambda function

HTTP

- Allows integration with existing HTTP endpoint
- This type of integration lets an API expose HTTP endpoints in the backend.

Mock

- This type of integration lets API Gateway return a response without sending the request further to the backend.

API Gateway - Overview

5. Integration Type

AWS Service

This type of integration lets an API expose AWS service actions.

VPC Link

A VPC link is a resource in Amazon API Gateway that allows for connecting API routes to private resources inside a VPC

API Gateway - Overview

5. Deployment

After **creating your API**, you must **deploy it** to make it callable by your users.

To **deploy an API**, you **create an API deployment** and **associate it with a stage**.

Important Tip :

Every time you update an API, you must redeploy the API to an existing stage or to a new stage.

Updating an API includes modifying routes, methods, integrations, authorizers, and anything else other than stage settings.

6. Stages

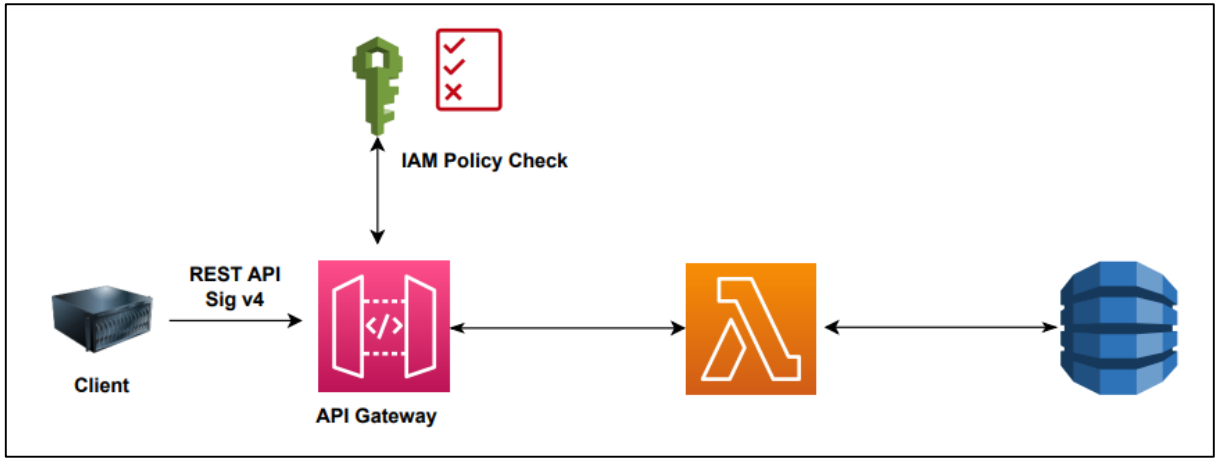
A logical reference to a **lifecycle state of your API** (for example, 'dev', 'prod', 'beta', 'v2').

https://{restapi-id}.execute-api.{region}.amazonaws.com/{stageName}

https://ent94mc14j.execute-api.us-east-1.amazonaws.com/dev/students

API Gateway - Overview

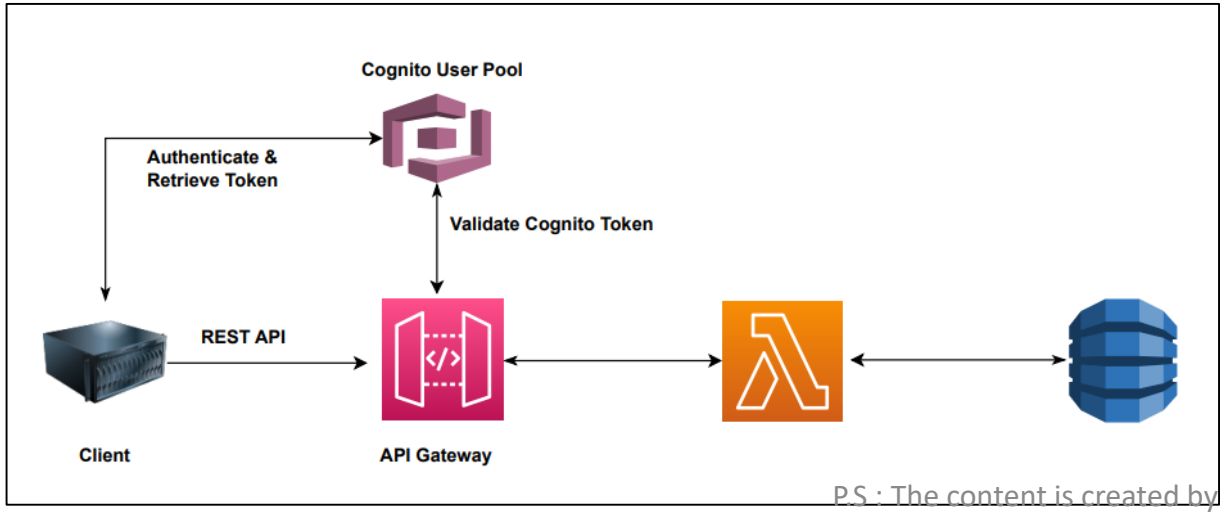
7. AWS API Gateway - Authentication and Authorization



1. API Security – IAM

Authentication – IAM
Authorization – IAM Policy

Use Case : Internal AWS Services, Cross Account Access



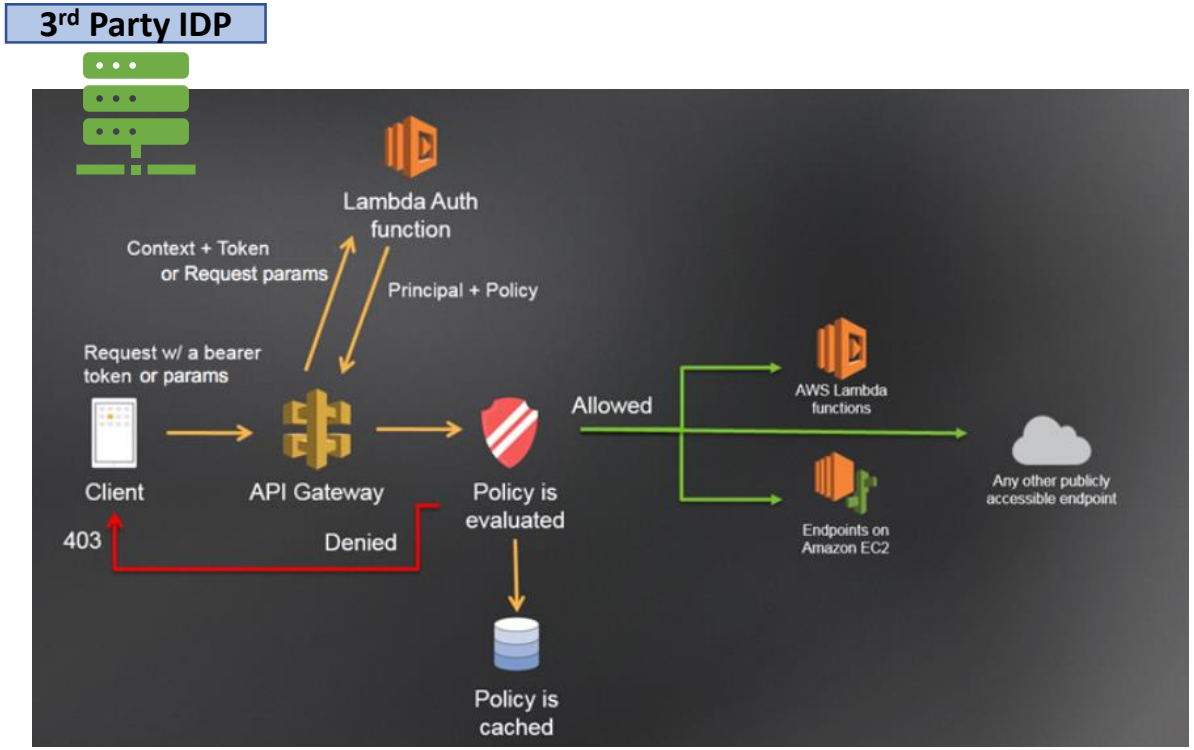
2. API Security – Cognito

Authentication – Cognito User Pool
Authorization – API Gateway Methods

Use Case : External Users for Web/Mobile Apps

API Gateway - Overview

7. AWS API Gateway - Authentication and Authorization



3. API Security – Lambda Authorizer

Authentication – External

Authorization – Lambda Function

Use Case : Third Party Identity Provider such as OAuth 2.0

https://docs.aws.amazon.com/apigateway/latest/developerguide/apigateway-use-lambda-authorizer.html

API Gateway - Overview

8. Usage Plans

Usage Plans

Use Case : Differentiate between Basic and Premium Customers

Sets the **target request rate - Throttling, Burst and Quota Limit for each API Key**

9. API Keys

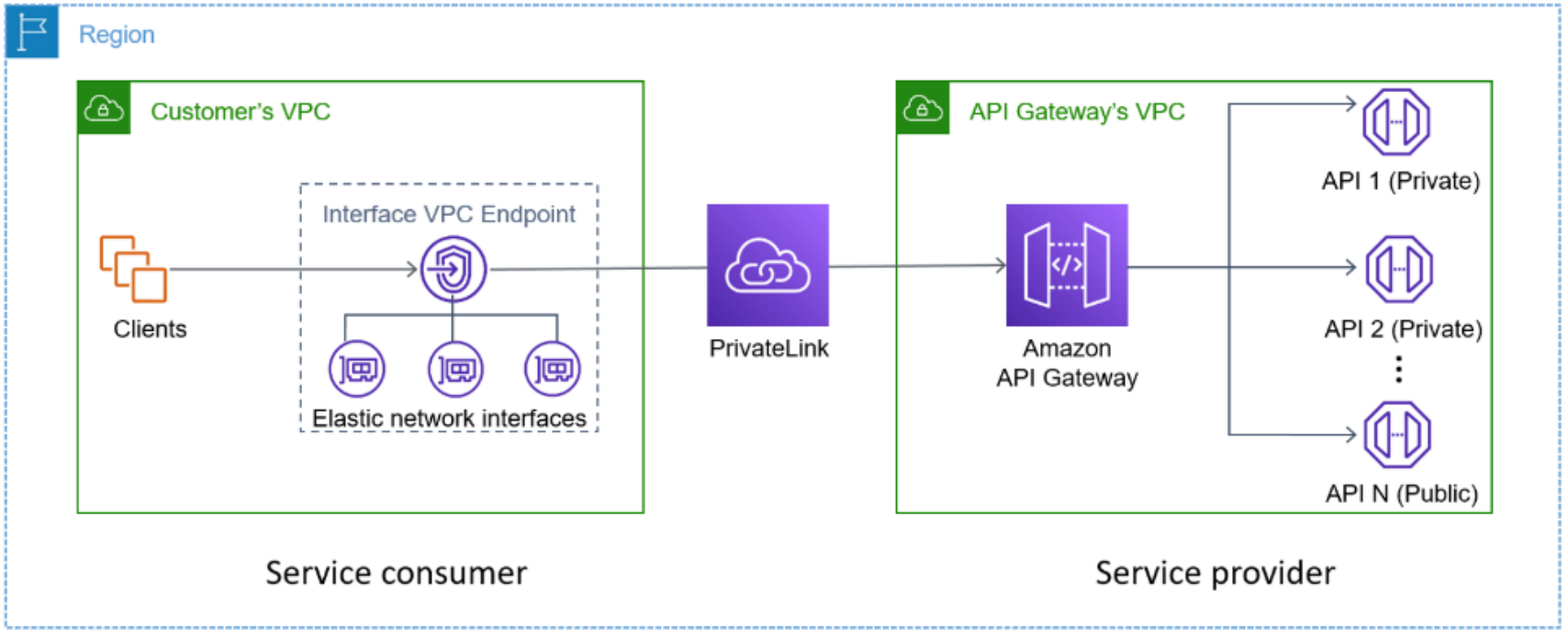
- An **alphanumeric string that API Gateway uses to identify an app developer** who uses your REST or WebSocket API.
- You can use API keys together with Lambda authorizers or usage plans to control access to your APIs.

API Gateway - Overview

10. API Integration and Private API's

Private API's

A private API means that the **API endpoint is reachable only through the VPC**. Private APIs are **accessible only** from **clients within the VPC** or from clients that have **network connectivity to the VPC**.



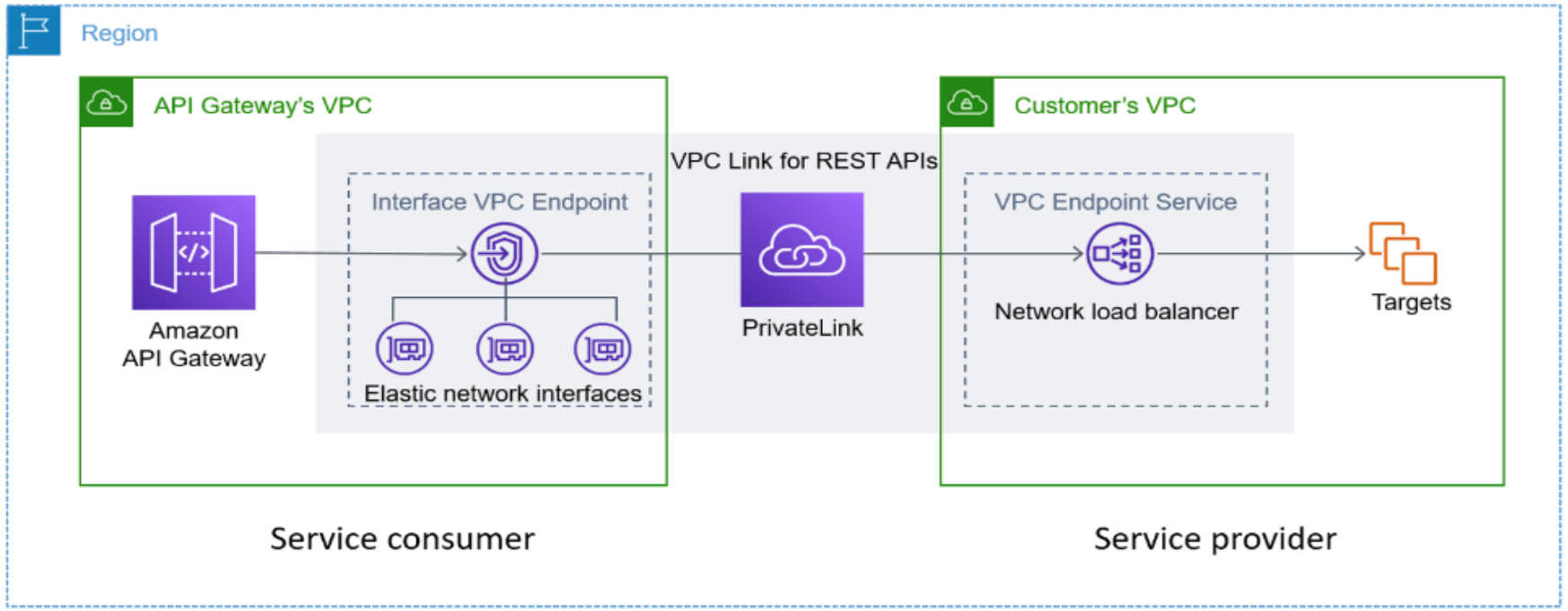
Source : AWS

API Gateway - Overview

10. API Integration, Private API's and VPC Link

Private Integration

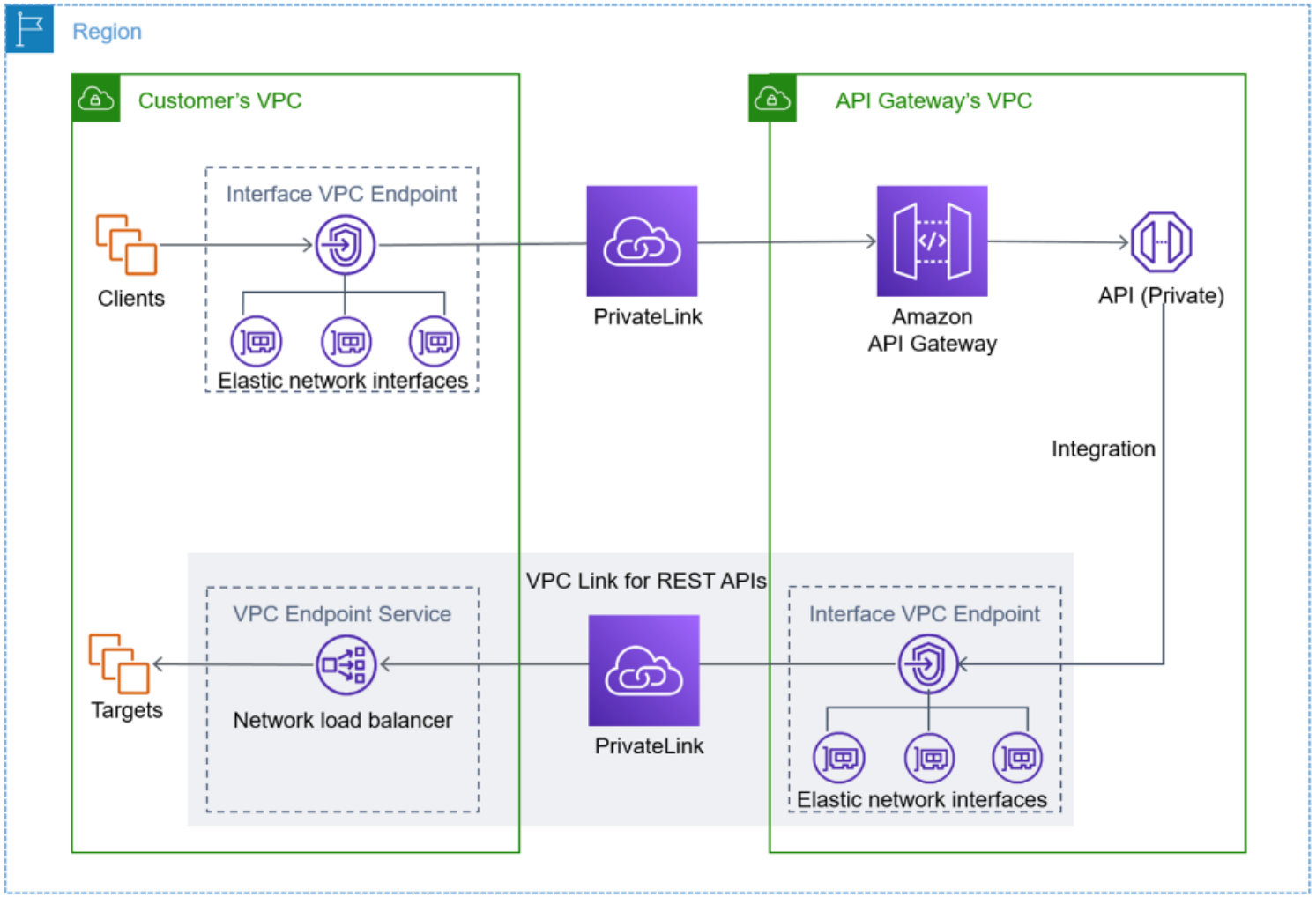
An API Gateway integration type for a client to access resources inside a customer's VPC through a private REST API endpoint without exposing the resources to the public internet.



Source : https://aws.amazon.com/blogs/compute/understanding-vpc-links-in-amazon-api-gateway-private-integrations/

API Gateway - Overview

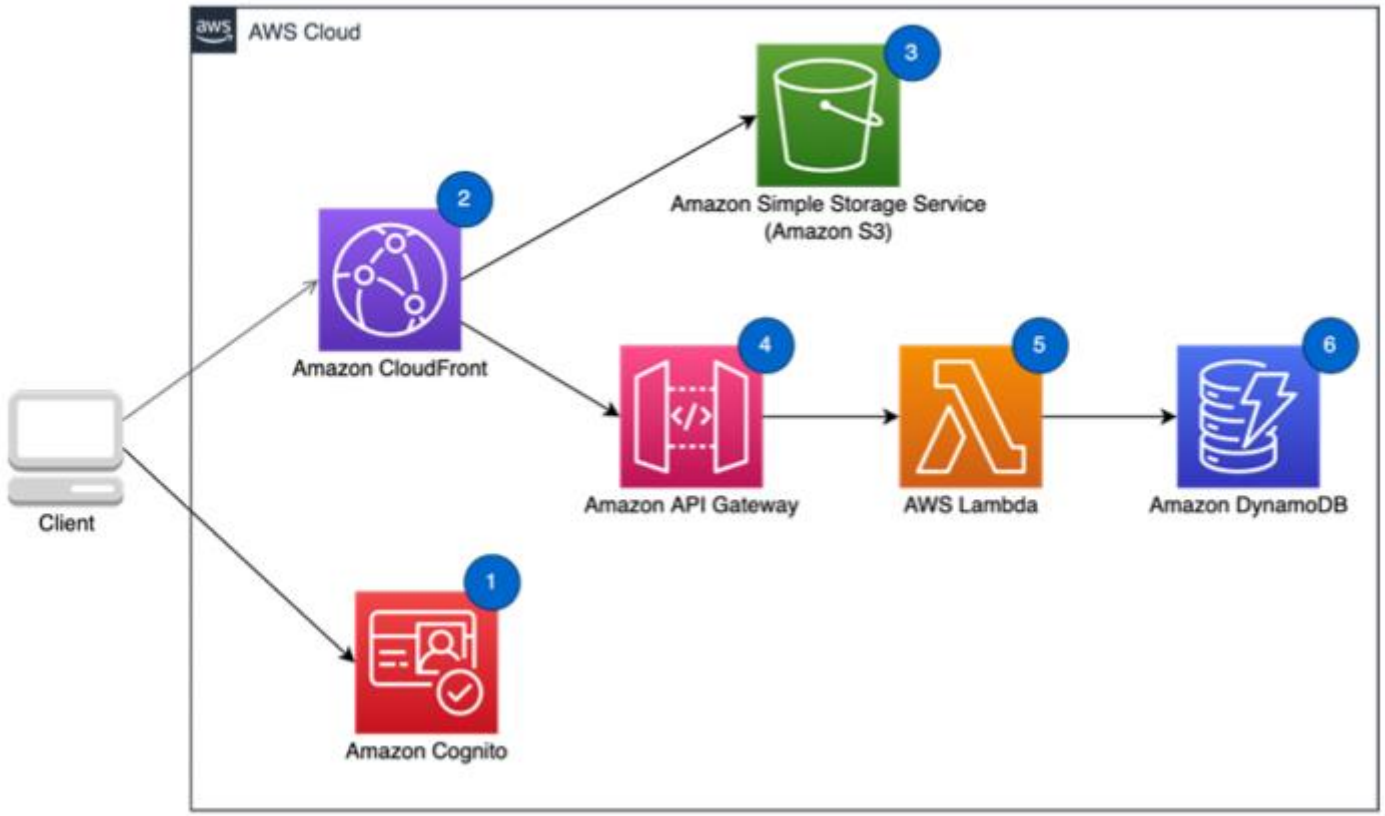
10. API Integration and Private API's



Source : AWS

API Gateway - Overview

Sample Architecture



Source : AWS

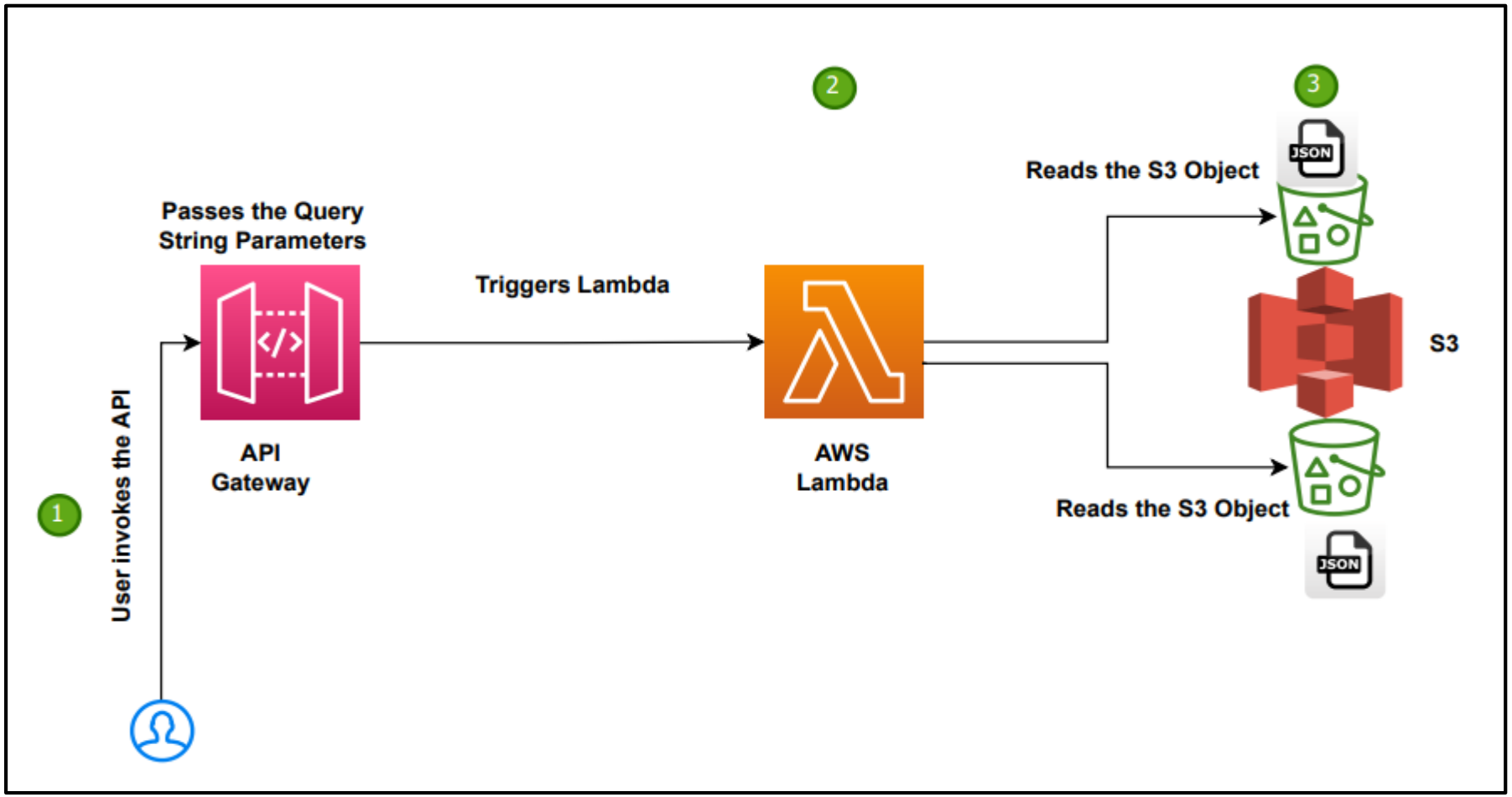
AWS Lambda and Python – Beginner to Advanced

Section on

Real World Serverless Use Case 2 - using API Gateway, AWS Lambda and S3

Serverless Architecture – 2:

Target Architecture – API Gateway, Lambda and S3



Resources to be Created

- **S3 buckets – 2**
- **Lambda Function**
- **API Gateway**

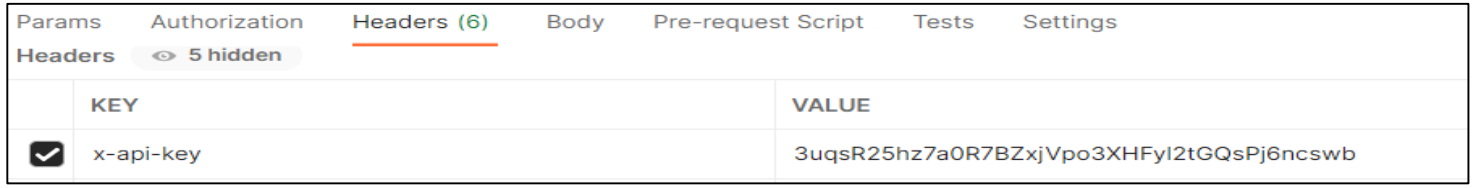
Very Important :

Please change the name of the S3 Bucket with your own and substitute the names in the Lambda Python Code.
The S3 bucket names need to be globally unique and same names that were highlighted in the video will not work.

AWS Lambda and Python – API Keys

API Keys

- API keys are **alphanumeric string values** that you **distribute to application developer** customers to grant **access to your API**.
- An API key has a **name and a value.**

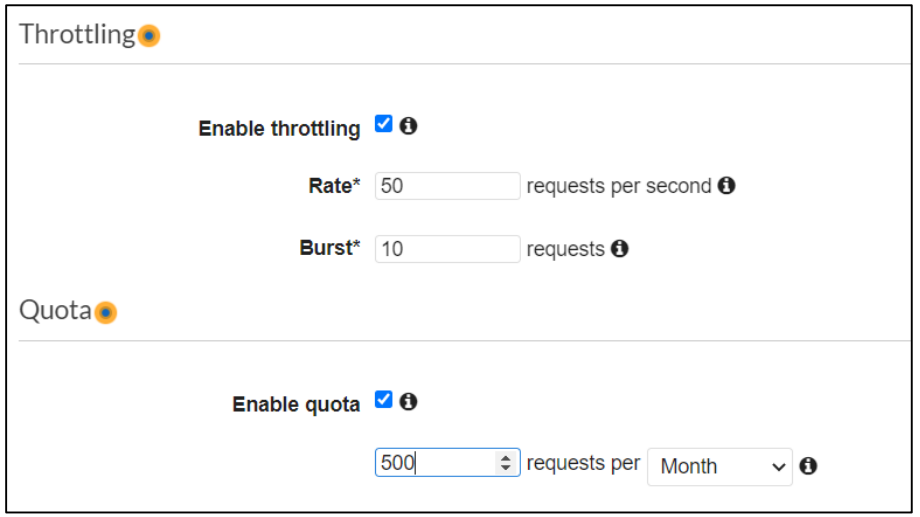


- API Gateway can **generate API keys on your behalf** or **import it** into API Gateway from an **external source**.
- API Key can be used along with **Usage Plan** for Throttling and Quotas to differentiate between Basic and Premium Users
- You can use API keys together with **Lambda authorizers or usage plans** to control access to your APIs.
- **Don't use API keys for authentication or authorization for your APIs.**
- Instead, use an **IAM role, a Lambda authorizer, or an Amazon Cognito user pool.**

AWS Lambda and Python – Throttling and Quota

Throttling Limit

- API throttling is the process of **limiting the number of API requests a user** can make in a certain period.
- This can be set at the **API or API method** level.



Quota

- Quota limit sets the **target maximum number of requests with a given API key** that can be submitted within a specified time interval.
- Throttling and quota limits apply to requests for **individual API keys that are aggregated across all API stages within a usage plan**

AWS Lambda and Python – Usage Plans

A **usage plan**

Use Case : Differentiate between Basic and Premium Customers

- Sets the **target request rate - Throttling, Burst and Quota Limit for each API Key**
- Specifies who can **access one or more deployed API stages and methods through the API Keys**

API Key -- >Usage Plan --- > Throttling, Burst and Quota ---- >Set at [API --- > Deployment Stage -- > Resources -- > Method]

AWS Lambda and Python – Usage Plans Sample Scenario

Sample Enterprise Scenario

1. **Basic Plan**
    - Throttling Limit – 5 Requests/Second
    - Burst – 2 Requests/Second
    - Quota – 150 Requests/Month
    - API (Resource – Students, Method – GET)
    - Stage – Beta
    - API Key – x-api-key = xyz

2. **Premium Plan**
    - Throttling Limit – 50 Requests/Second
    - Burst – 20 Requests/Second
    - Quota – 1500 Requests/Month
    - API(Resource – Students, Method – GET)
    - Stage – Prod
    - API Key - abc

AWS Lambda and Python – Usage Plans

Steps to configure a usage plan

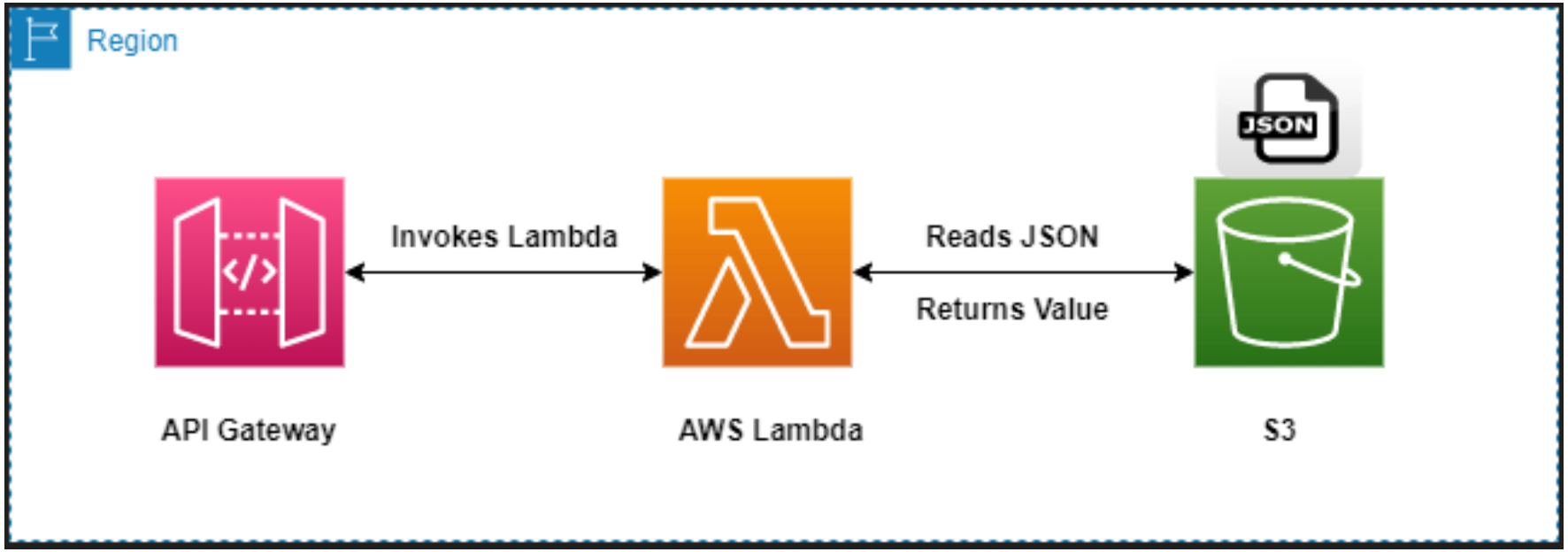
- Create API Gateway with one or more APIs
- Configure the Resources and methods
- Deploy the APIs to stages.
- Generate or import API keys to distribute to application developers (your customers) who will be using your API.
- Create the usage plan with the desired throttle and quota limits.
- Associate API stages and API keys with the usage plan.
- Callers of the API must supply an assigned API key in the x-api-key header in requests to the API.

Section on

API Security - Securing API's with AWS Lambda Authorizer & Cognito Authorizer

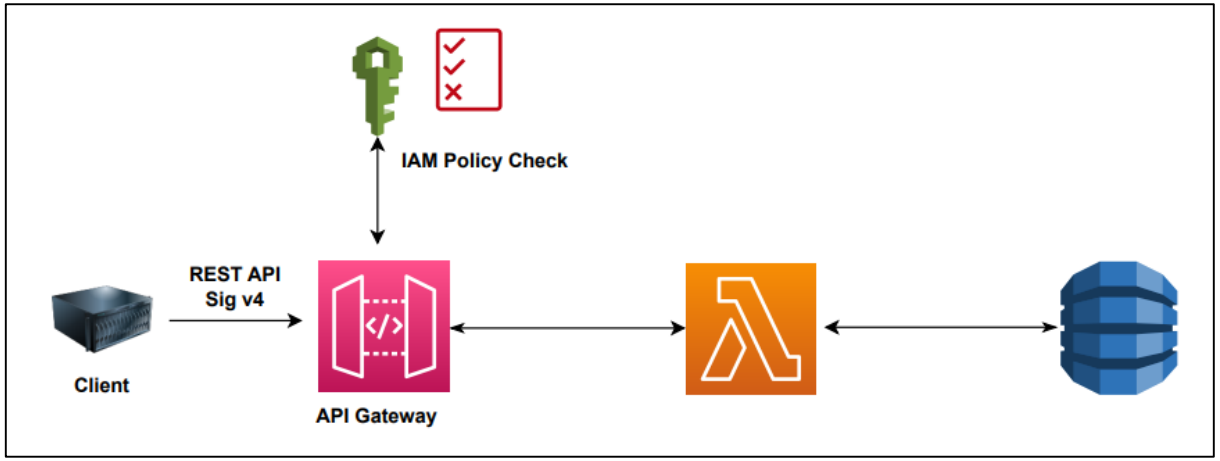
AWS Lambda Authorizer

AWS API Gateway - Authentication and Authorization using Lambda Authorizer



AWS Lambda Authorizer

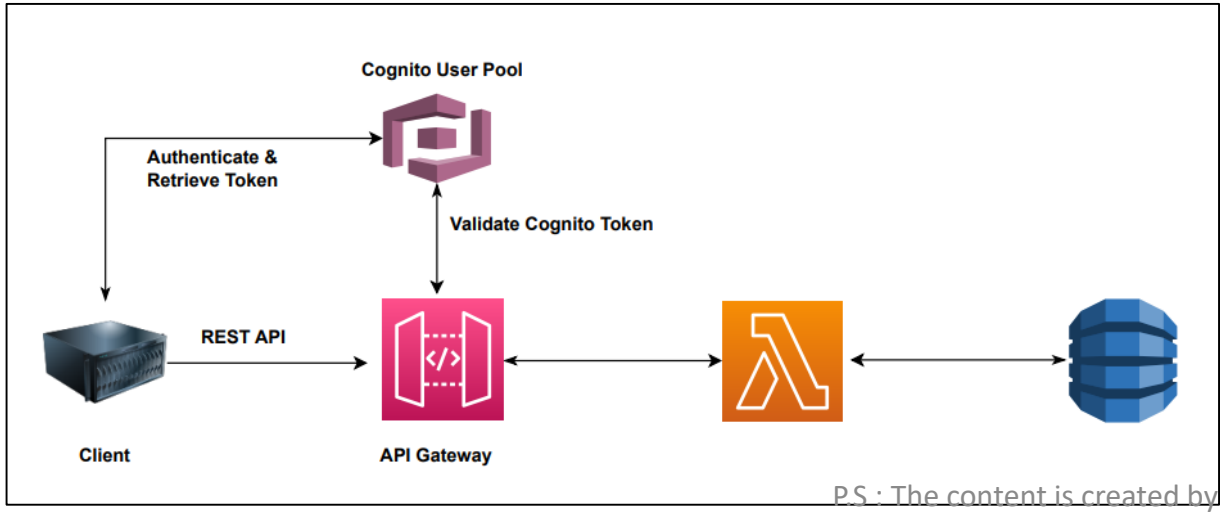
AWS API Gateway - Authentication and Authorization



1. API Security – IAM

Authentication – IAM
Authorization – IAM Policy

Use Case : Internal AWS Services, Cross Account Access



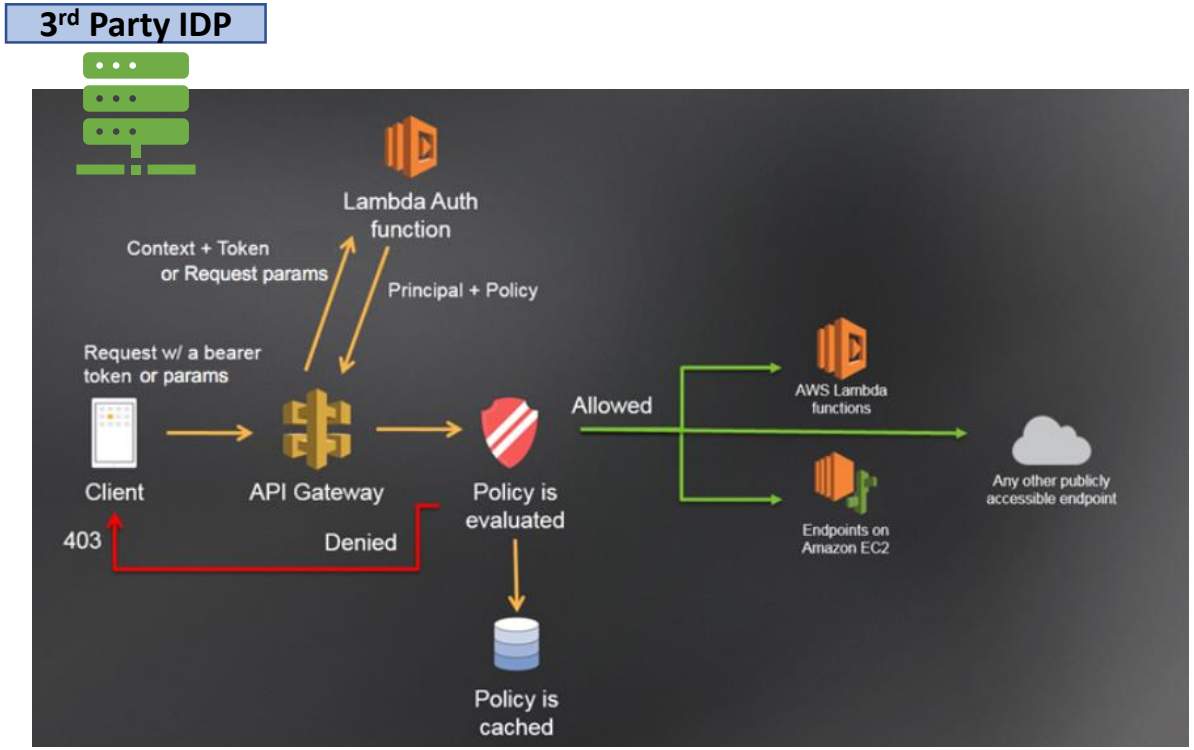
2. API Security – Cognito

Authentication – Cognito User Pool
Authorization – API Gateway Methods

Use Case : External Users for Web/Mobile Apps

AWS Lambda Authorizer

AWS API Gateway - Authentication and Authorization



3. API Security – Lambda Authorizer

Authentication – External

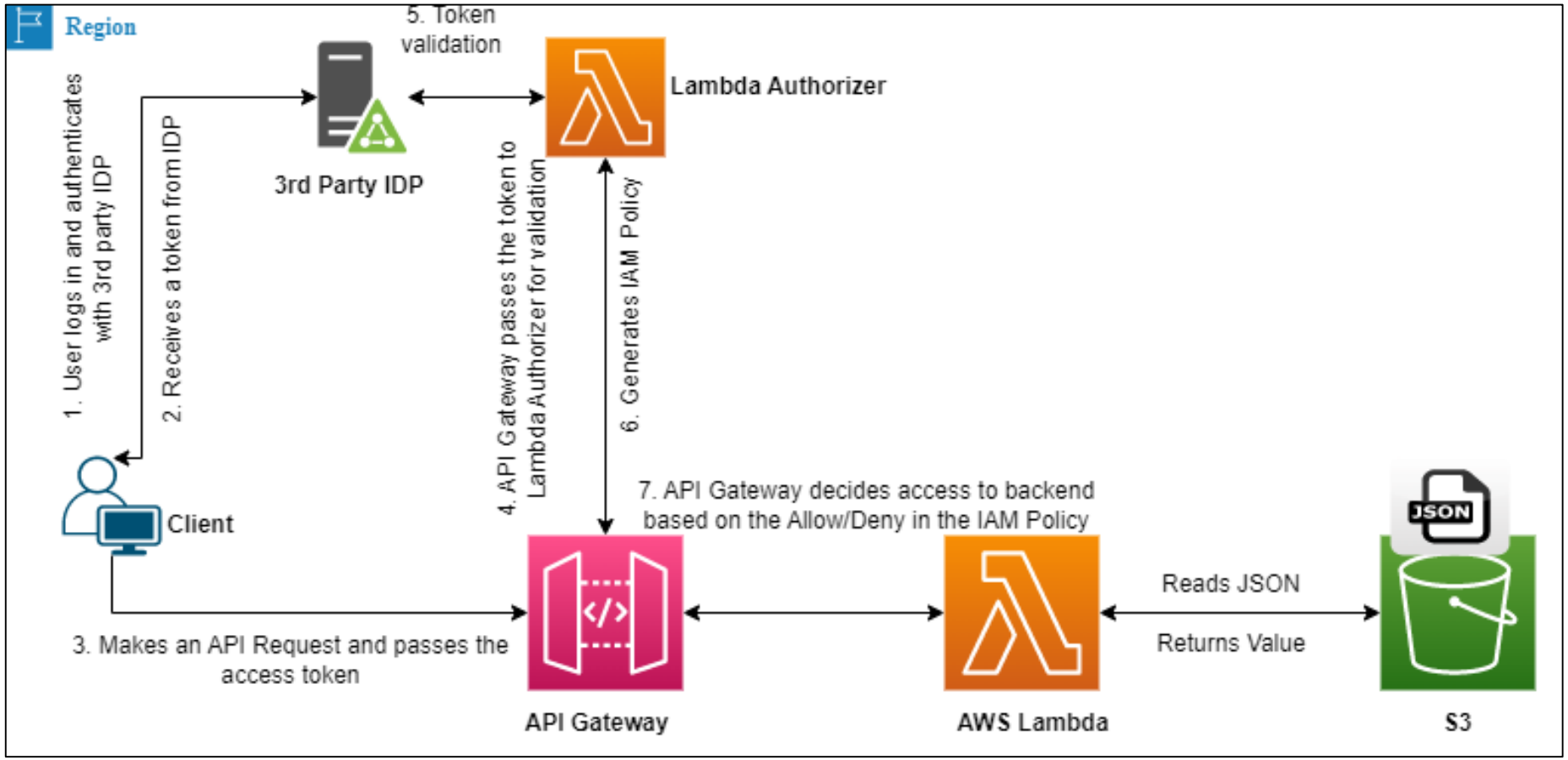
Authorization – Lambda Function

Use Case : Third Party Identity Provider such as OAuth 2.0

https://docs.aws.amazon.com/apigateway/latest/developerguide/apigateway-use-lambda-authorizer.html

AWS Lambda Authorizer

AWS API Gateway - Authentication and Authorization using Lambda Authorizer



Lambda Authorizer

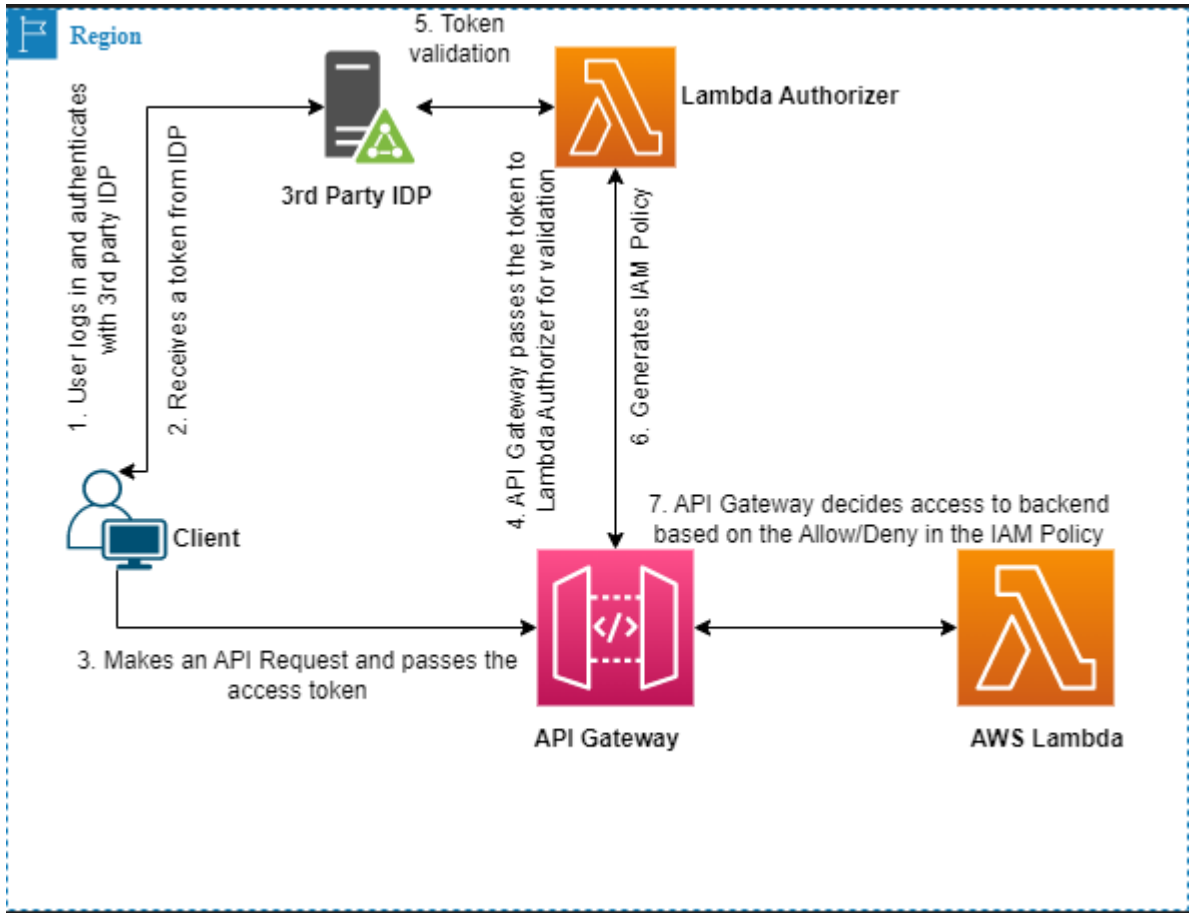
Authentication – External

Authorization – Lambda Function

Use Case : Third Party Identity Provider such as OAuth 2.0

AWS Lambda Authorizer

AWS API Gateway - Authentication and Authorization using Lambda Authorizer



AWS Lambda Authorizer - Steps

1. Create backend service which client needs to access such as Lambda - **Backend Lambda – demolambda_authorizer**
2. Create the API Gateway
3. Resource - **students**
4. Method - **GET**
5. Deploy to a Stage - **dev**
6. Test the API GW + Lambda
7. Create the Authorizer in the API Gateway Console (Authorization Token : **Key – authorizationToken, Value - 123456**)
8. Create the Lambda function corresponding to the Authorizer –
   - **Lambda Authorizer Function – lambdaauthtest** (1. Log event, 2. Validate Token, 3. **Return the Policy**)
9. Test from the API Gateway Authorizer
10. Test end to end flow using Postman

AWS Lambda Authorizer – Policy Document

.....

```
{
  "principalId": "yyyyyyyy", // The principal user identification associated with the token sent by the client.
  "policyDocument": {
    "Version": "2012-10-17",
    "Statement": [
      {
        "Action": "execute-api:Invoke",
        "Effect": "Allow|Deny",
        "Resource": "arn:aws:execute-api:{regionId}:{accountId}:{apiId}/{stage}/{httpVerb}/[{resource}/[{child-resources}]]"
      }
    ]
  },
```

.....

```
"Resource": "arn:aws:execute-api:{regionId}:{accountId}:{apiId}/{stage}/{httpVerb}/[{resource}"]
```

.....

```
"Resource": ["arn:aws:execute-api:regionId:accountId:apiId/stage/httpVerb/resource"]
```

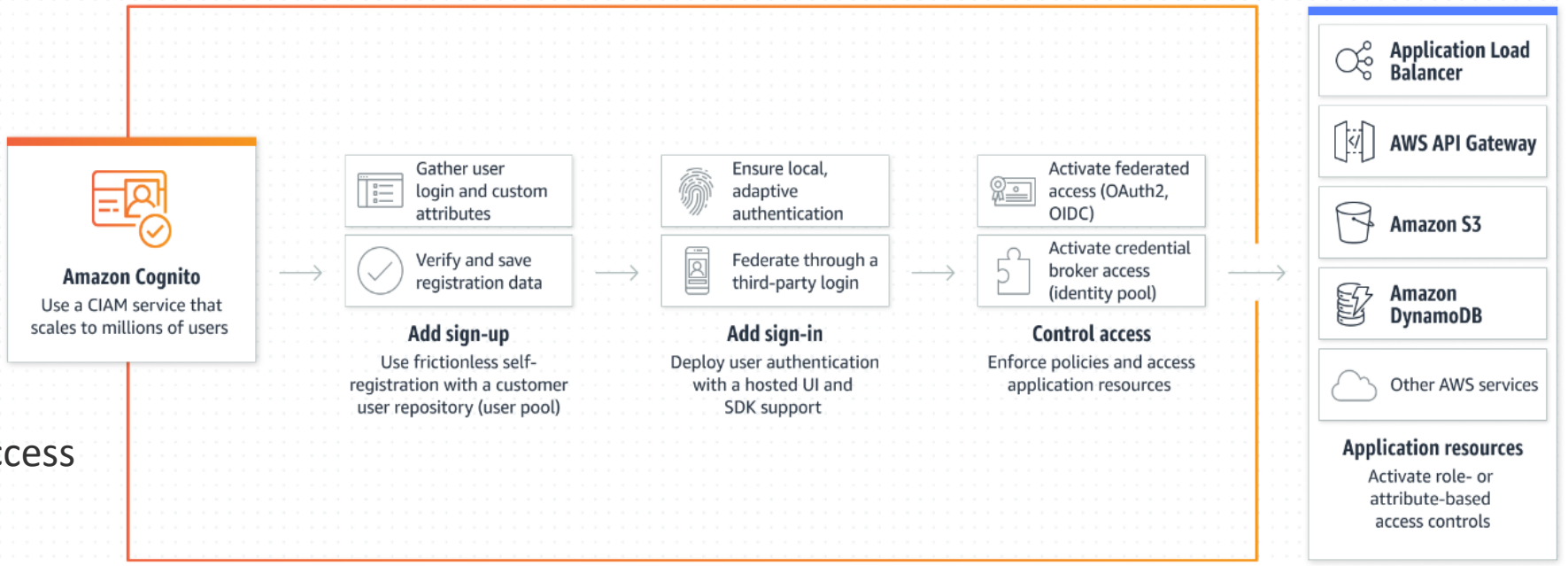
```
{ "principalId": "demorahul", "policyDocument": { "Version": "2012-10-17", "Statement": [{"Action": "execute-api:Invoke", "Resource":
["arn:aws:execute-api:us-east-1:196715057542:kiwmj0bs7e/test/GET/students"], "Effect": auth}] }}
```

.....

Source : https://docs.aws.amazon.com/apigateway/latest/developerguide/api-gateway-lambda-authorizer-output.html

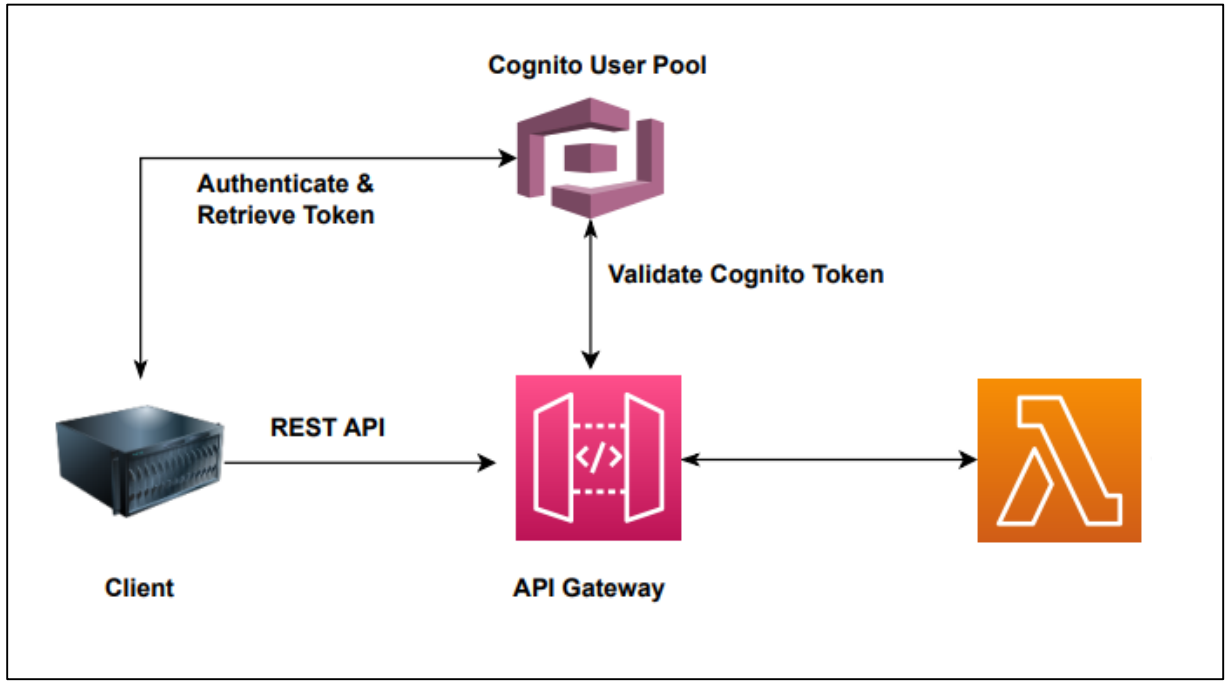
AWS Cognito - Overview

- Amazon Cognito is a developer-centric and cost-effective **customer identity and access management** (CIAM) service.
- Provides a **secure identity store and federation options** that can scale to millions of users.
- Amazon Cognito **supports login** with **social identity providers** and SAML or OIDC-based identity providers
- Supports various **compliance standards**, operates on open identity standards (OAuth2.0, SAML 2.0 and OpenID Connect)
- Create User Pool
- Self-registration of users
- Sign-in through custom UI
- Policy Enforcement
- Multiple Clients/Apps can access the User Pool



API Gateway Authentication and Authorization with Cognito

7. AWS API Gateway - Authentication and Authorization



2. API Security – Cognito

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Use Case : External Users for Web/Mobile Apps

Authentication and Authorization with Cognito- Steps

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2. Create the API Gateway
3. Resource - **students**
4. Method - **GET**
5. Deploy to a Stage - **dev**
6. Test the API GW + Lambda
7. **Create** the Amazon Cognito **User Pool**
    - Create User Pool
    - Configure app client
    - Configure implicit grant
8. **Create Users in User Pool**
9. **Generate id_token and access token from call back url**
10. **Create Authorizers in API Gateway**
11. **Validate using access token**

AWS Lambda and Python – Beginner to Advanced

Section on

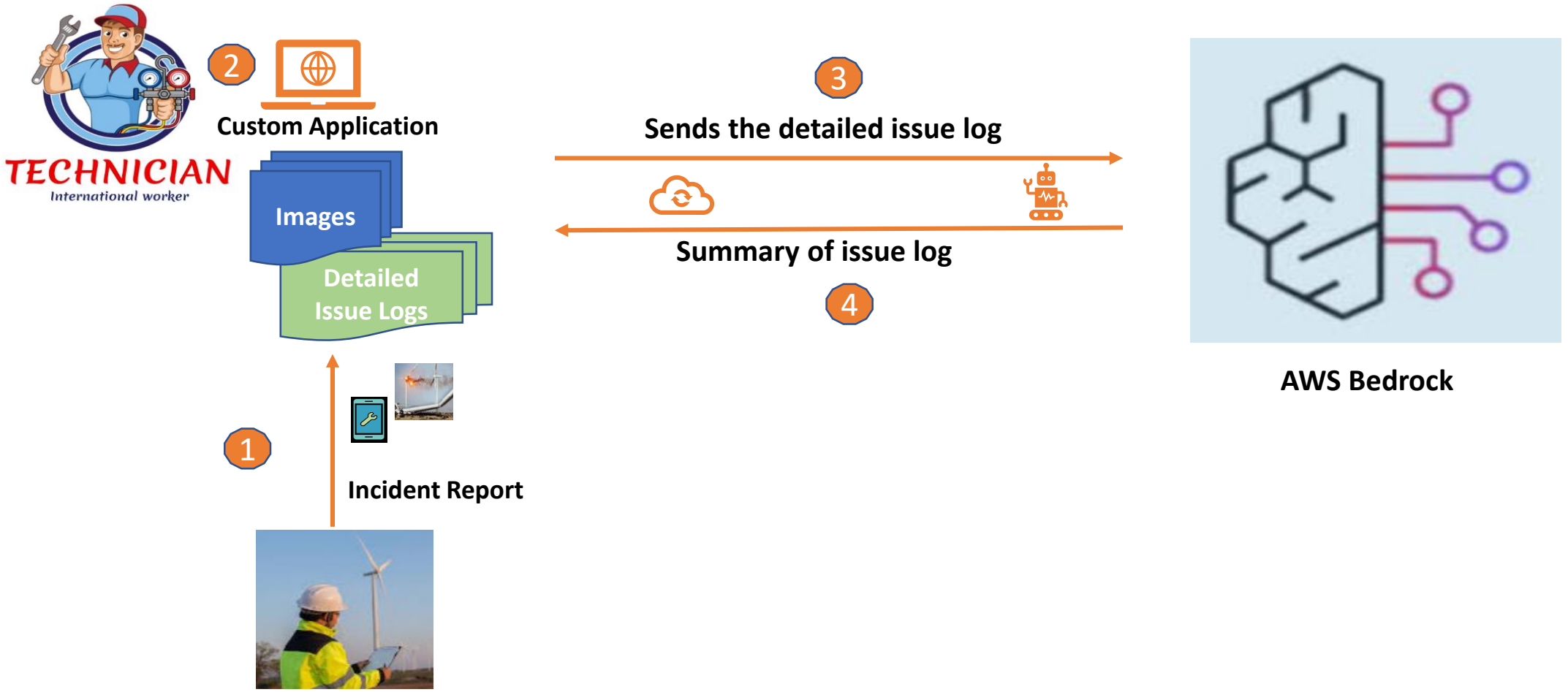
AWS Generative AI :

AWS Bedrock , API Gateway, and AWS Lambda

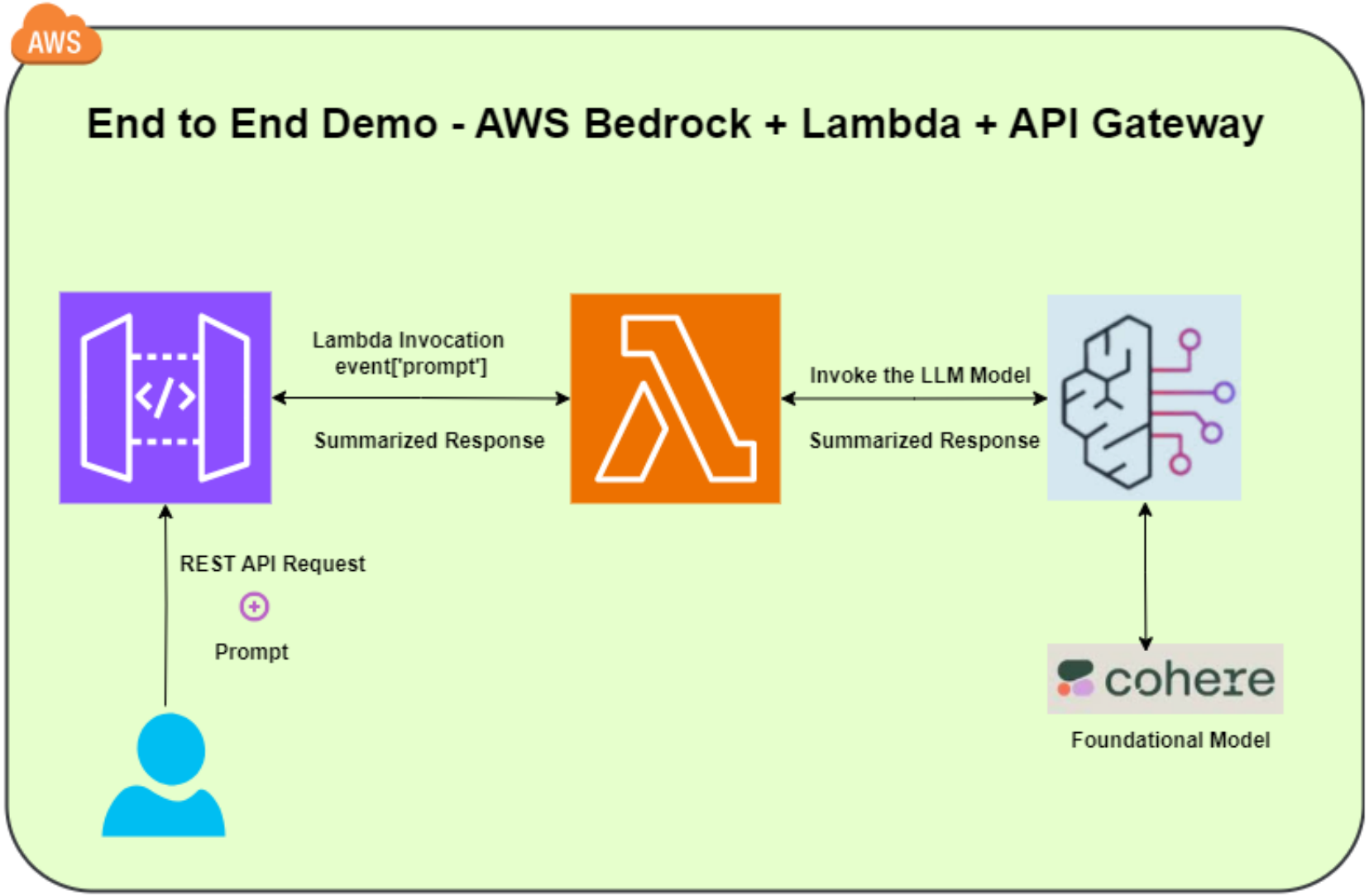
Generative AI – Manufacturing Industry Use Case

Use Case :

Text Summarization using **AWS Bedrock** for **faster issue resolution to improve productivity** of technicians.



Generative AI – Use Case Architecture



Limitation : Size of the Input Prompt for Summarization

Generative AI – Console Overview

1. How to get access to Bedrock Models

2. Models Supported

Model providers Info

Amazon Bedrock is a fully managed service that makes FMs from leading AI startups and Amazon available via an API, so you can choose from a wide range of FMs to find the model that is best suited for your use case.

AI21 Labs | Amazon | Anthropic | Cohere | Stability AI

Generative AI with Bedrock : Step by Step – Pre-Requisites

1. Create a AWS Lambda Function - demo-bedrock

2. Check the boto3 version. Should be >= 1.28.63

3. Use following command to check version - print(boto3.__version__)

4. Upgrade the boto3 version for AWS Lambda Function using Lambda Layer -

   https://repost.aws/knowledge-center/lambda-python-runtime-errors

   - Add Layer Version ARN

   - Check the boto3 version. Should be > 1.28.63

Generative AI with Bedrock : Step by Step Guide

1. Code for Bedrock invocation from AWS Lambda Function

   - Link - https://boto3.amazonaws.com/v1/documentation/api/latest/reference/services/bedrock-runtime.html

2. Create an IAM Role and Increase timeout limit

3. Configure Test Event

```
{  "prompt": "How is weather in Bengaluru"}
```

Generative AI with Bedrock : Step by Step Guide

Broad Steps for writing Lambda Function

#1 **Import boto3** and create **client connection** with bedrock

#2. Create a **Request Syntax** - Get details from **console** and **body** should be json object

#3 Convert **Streaming Body** to Byte and then Byte to **String**

#4 a. Print the event , b. Store the input in a variable, c. Update the response body

Generative AI with Bedrock : Step by Step Guide

4. Create an REST API from API Gateway

- Resource – demoBedrock
- Method - GET

5. API Gateway - Method Request

- URL query string parameters – Add input parameter
- Enable - Request Validation

Generative AI with Bedrock : Step by Step Guide

6. API Gateway - Integration Request

- application/json

```
{
"prompt" : "$input.params('prompt')"
}
```

7. Deploy the API to a Stage

8. Test using API Gateway Console

9. Sample Text - Link

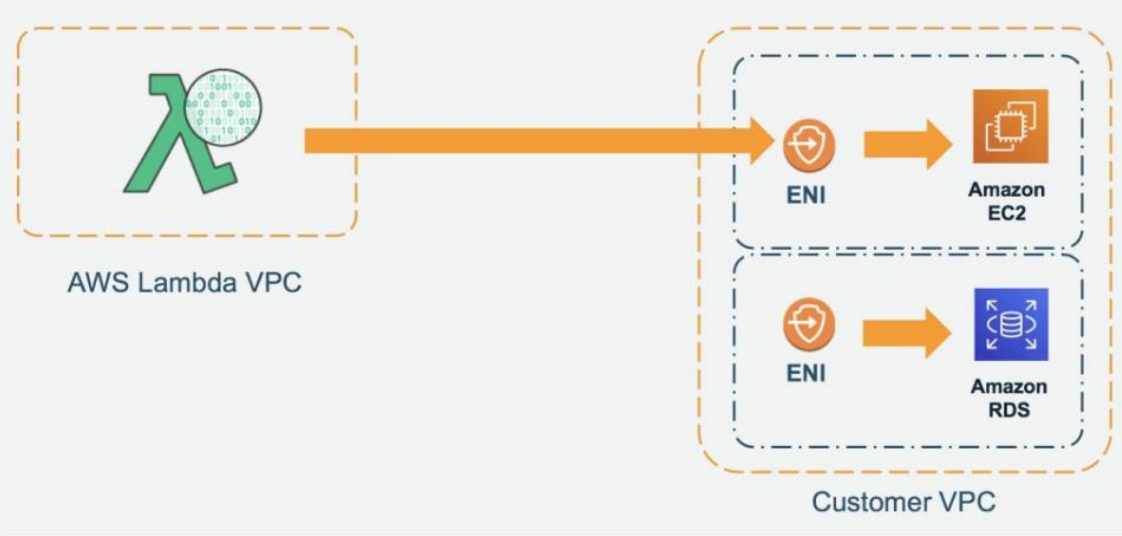
Section on

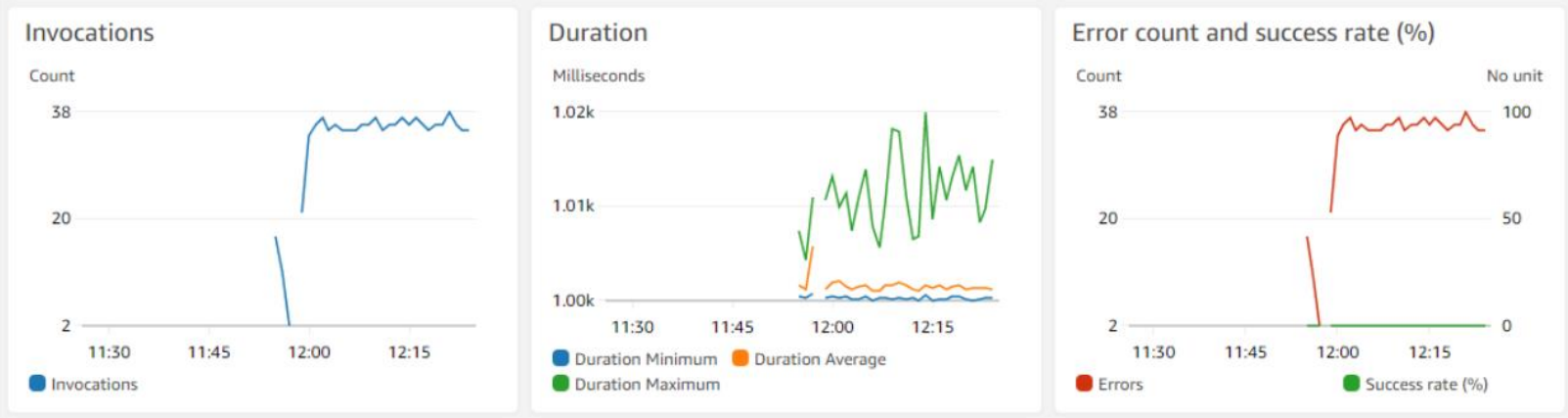
Lambda Advanced Concepts

AWS Lambda and Python – Beginner to Advanced

AWS Lambda – Advanced Concepts (Theory and HandsOn)

- **Lambda Execution and Concurrency**
- **Lambda - Reserved and Provisioned Concurrency**
- **Lambda - VPC Networking Configuration**
- **Lambda Monitoring - CloudWatch Metrics**
- **Lambda Monitoring - CloudWatch Logs**
- **Lambda Versions**
- **Lambda Aliases**
- **Lambda - Environment Variables**

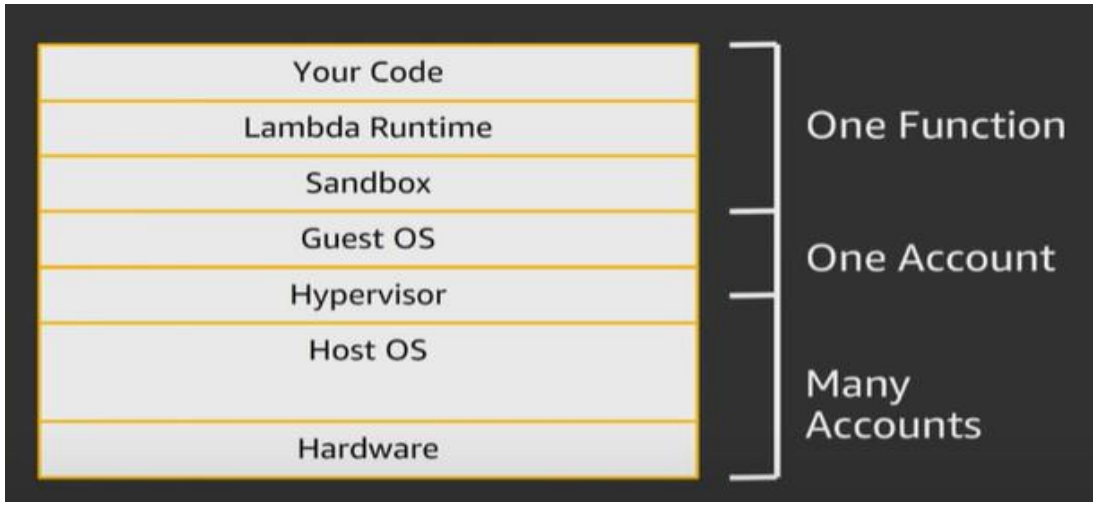


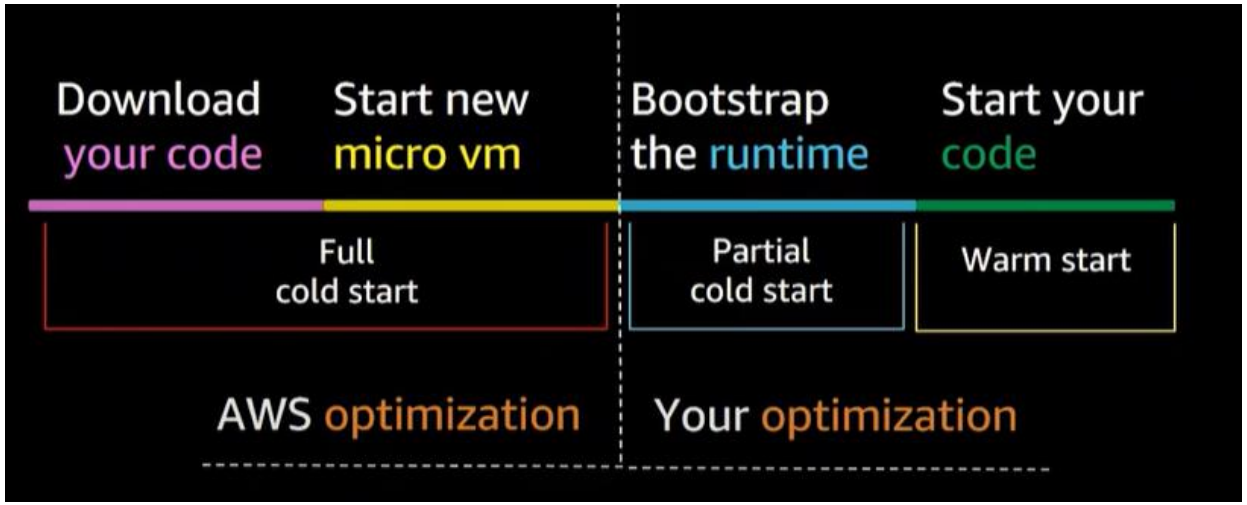


AWS Lambda and Python – Beginner to Advanced

AWS Lambda – Concurrency, Reserved Concurrency and Provisioned Concurrency

AWS Lambda Function Execution and Cold Start:





Source : AWS

AWS Lambda and Python – Beginner to Advanced

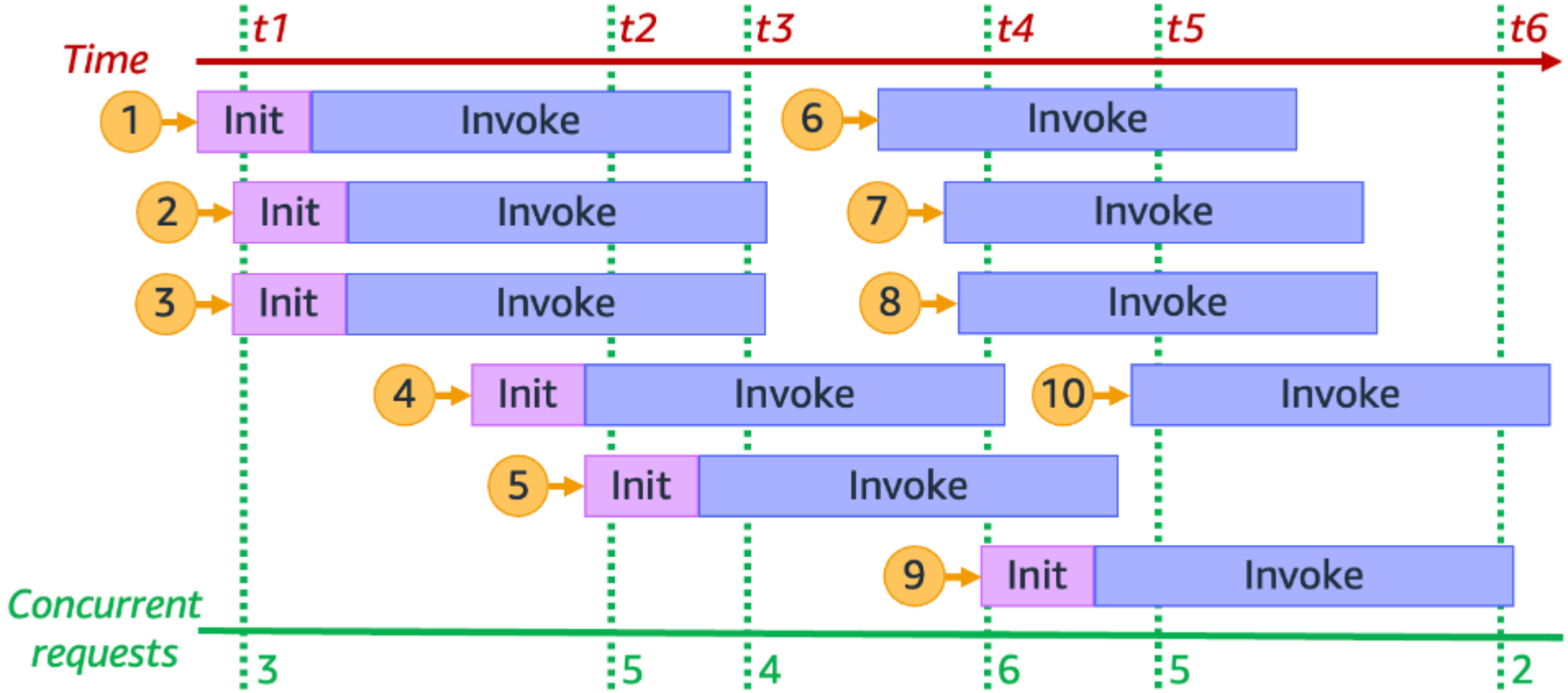
AWS Lambda Concurrency

- **Concurrency** is the **number of in-flight requests** your AWS Lambda function is handling at the same time.
- For **each concurrent request**, Lambda provisions a **separate instance of your execution environment**.
- As the functions receive more requests, Lambda automatically handles **scaling the number of execution environments** until account's concurrency limit.
- By default, Lambda provides account with a **total concurrency limit of 1,000** across all functions in a region.

Source : AWS

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Concurrency



Source : AWS

AWS Lambda and Python – Beginner to Advanced

AWS Lambda - Concurrency

How to calculate Concurrency

- **Concurrency** = (average requests per second) * (average request duration in seconds)
- If the average request duration is **500 ms**, the concurrency is :
- **Concurrency** = (100 requests/second) * (0.5 second/request) = 5**0**
- Concurrency Implication :
- A concurrency of 50 means that Lambda must provision **50 execution environment instances** to efficiently handle this workload without any throttling.

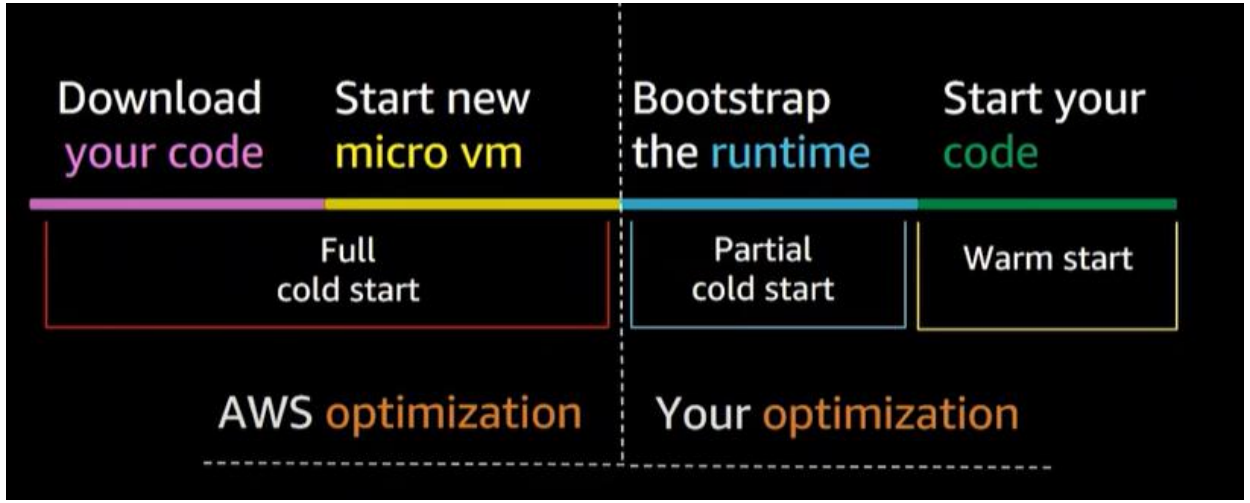
Source : AWS

AWS Lambda and Python – Beginner to Advanced

Provisioned Concurrency and Reserved Concurrency

Provisioned Concurrency

- Set number of **pre-provisioned execution environment** instances for your function.
- Use **provisioned concurrency to pre-initialize** a number of environment instances for a function. This is useful for **reducing cold start latencies**.



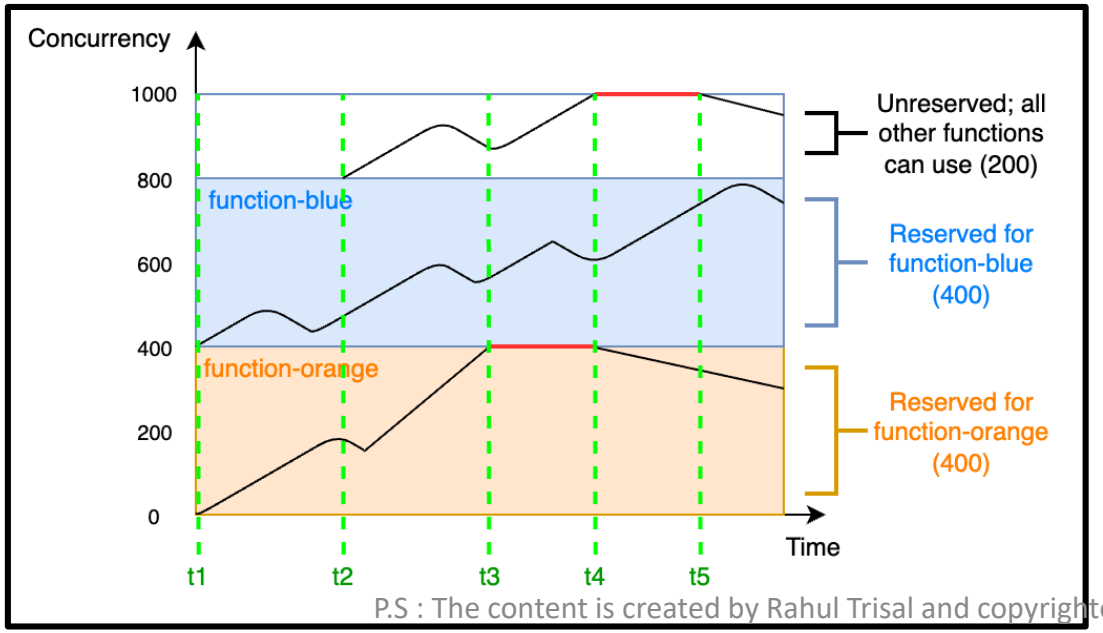
Source : AWS

AWS Lambda and Python – Beginner to Advanced

Reserved concurrency vs. Provisioned concurrency

Reserved Concurrency

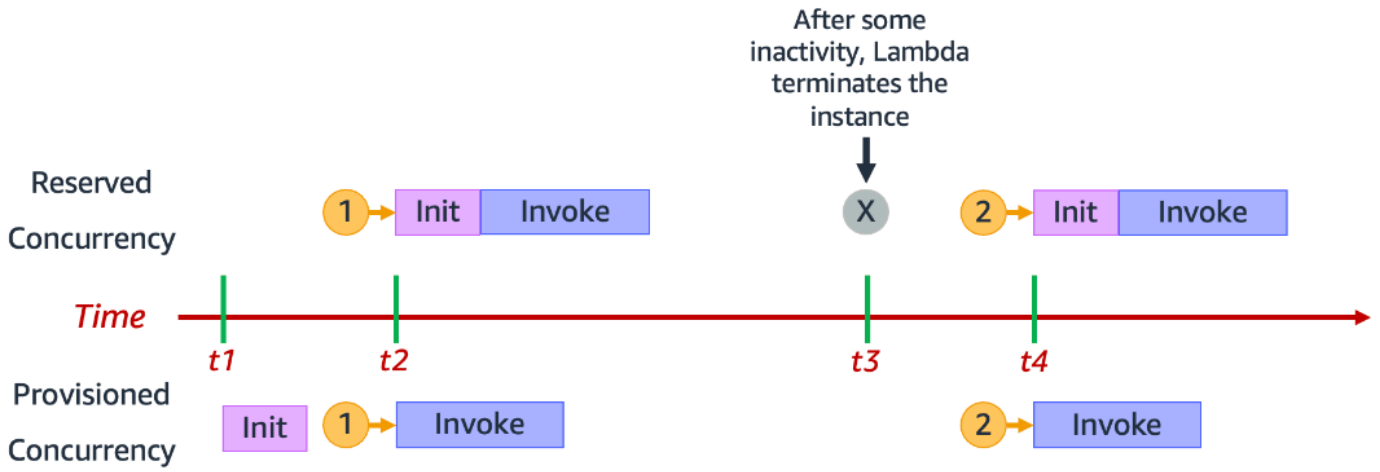
- Maximum number of execution environment instances for **a particular function**.
- Use **reserved concurrency to reserve a portion of your account's concurrency** for a function. This is useful if you don't want other functions taking up all the available unreserved concurrency.



Source : AWS

AWS Lambda and Python – Beginner to Advanced

Provisioned concurrency vs Reserved concurrency



The diagram has four points of interest:

Time	Reserved concurrency	Provisioned concurrency
t1	Nothing happens.	Lambda pre-initializes an execution environment instance.
t2	Request 1 comes in. Lambda must initialize a new execution environment instance.	Request 1 comes in. Lambda uses the pre-initialized environment instance.
t3	After some inactivity, Lambda terminates the active environment instance.	Nothing happens.
t4	Request 2 comes in. Lambda must initialize a new execution environment instance.	Request 2 comes in. Lambda uses the pre-initialized environment instance.

Source : AWS

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Limits - Memory

- Lambda allocates **CPU power in proportion to the amount of memory** configured.
- Default Memory – **128 MB**

- **Maximum Memory - 10,240 MB**, in 1-MB increments.
- At **1,769 MB**, a function has the equivalent of **one vCPU**.
- More memory = more CPU
- **Lambda Pricing – Number of invocations * Memory Allocated * Execution Time**

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Limits - Memory

Chart based on per 1000 Invocations

Memory	Duration	Cost
128 MB	11.722 s	$0.024628
256 MB	6.678 s	$0.028035
512 MB	3.194 s	$0.026830
1024 MB	1.465 s	$0.024638

- One-thousandth of a cent cost difference, the function has a 10-fold improvement in performance.
- Choosing the memory allocated to Lambda functions is an optimization process that balances speed (duration) and cost.
- AWS Lambda Power Tuning tool allows to automate the process.

Best Practice

- Derive the balance between Function Time out and Memory allocated (think about the edge cases)
- Over-Provision Memory, If required but Not Function Timeout

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Limits - Memory

Chart based on per 1000 Invocations

Memory	Duration	Cost
128 MB	11.722 s	$0.024628
256 MB	6.678 s	$0.028035
512 MB	3.194 s	$0.026830
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- One-thousandth of a cent cost difference, the function has a 10-fold improvement in performance.
- Choosing the memory allocated to Lambda functions is an optimization process that balances speed (duration) and cost.
- AWS Lambda Power Tuning tool allows to automate the process.

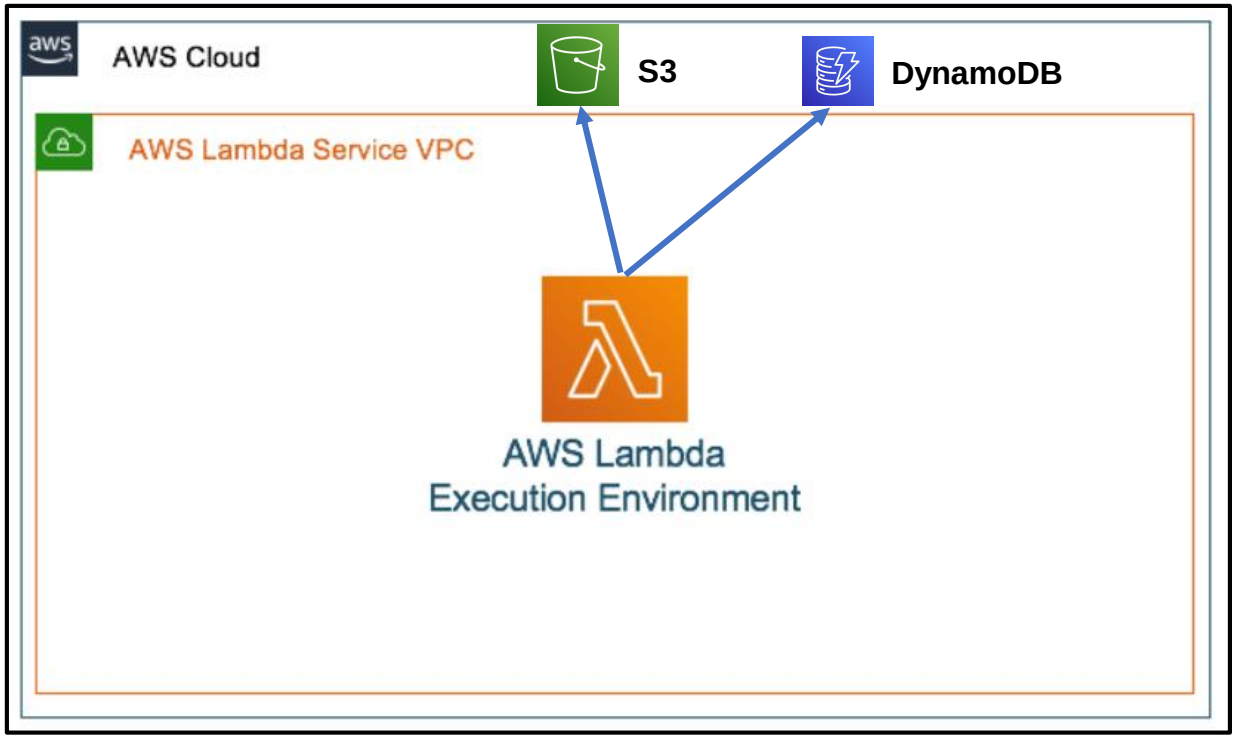
Best Practice

- Derive the balance between Function Time out and Memory allocated (think about the edge cases)
- Over-Provision Memory, If required but Not Function Timeout

AWS Lambda and Python – Beginner to Advanced

AWS Lambda – Deployment Options – Default and VPC Private Resources

Where is AWS Lambda Deployed – Option 1

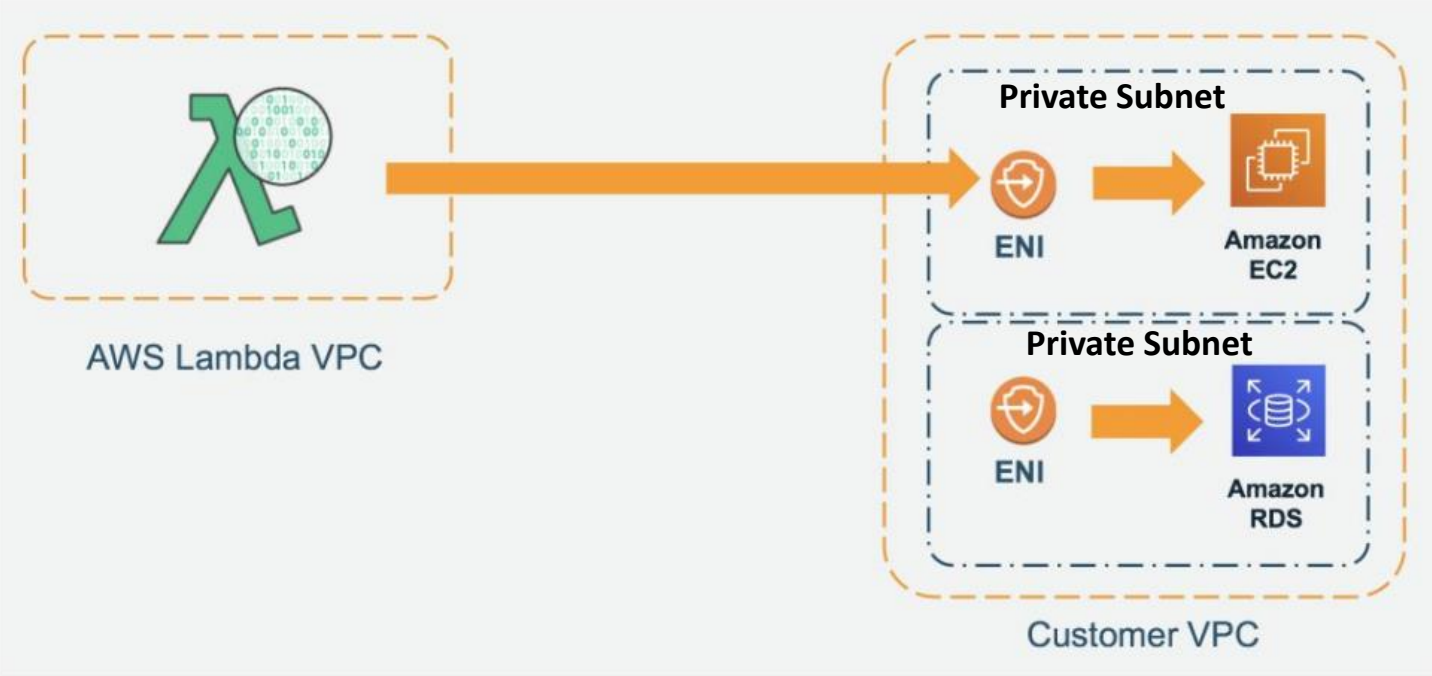


- All Lambda functions run securely inside a **default system-managed virtual private cloud (VPC)**.
- **Not** in Customer VPC
- Has access to all the services that can be accessed on **Internet – S3, DynamoDB** etc.

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Deployment and access to Private Subnet Resources

How does Lambda access AWS Services in Customer VPC in Private Subnet such as RDS DB or EC2

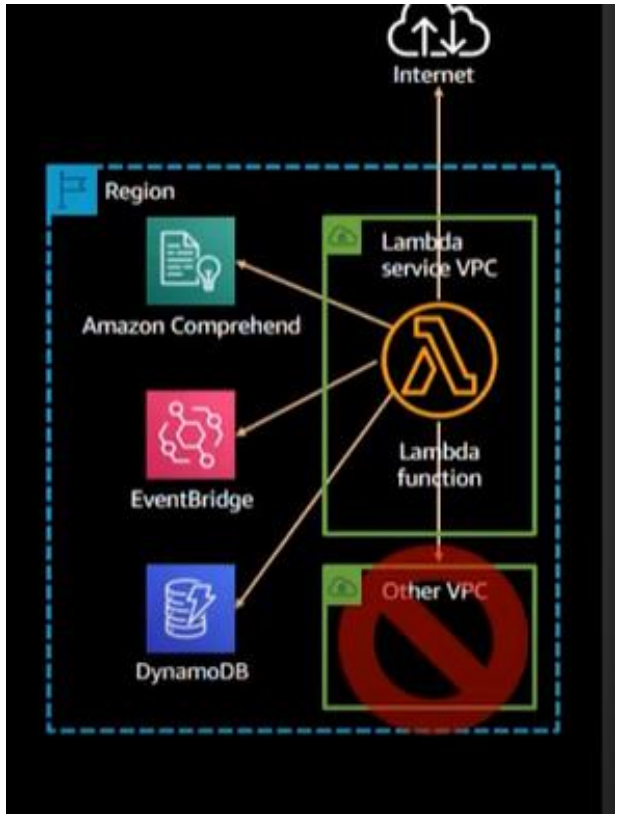


- Lambda need the **IAM permissions** required to create and delete network interfaces in your VPC - AWSLambdaVPCAccessExecutionRole
- Control the **subnet and security group configur**ations of these network interfaces.
- **Use a NAT device to give a function internet access or use VPC endpoints to connect to services outside of your VPC.**

AWSLambdaVPCAccessExecutionRole AWS managed Provides minimum permissions for a Lambda function to execute while accessing a resource within a VPC - create, de

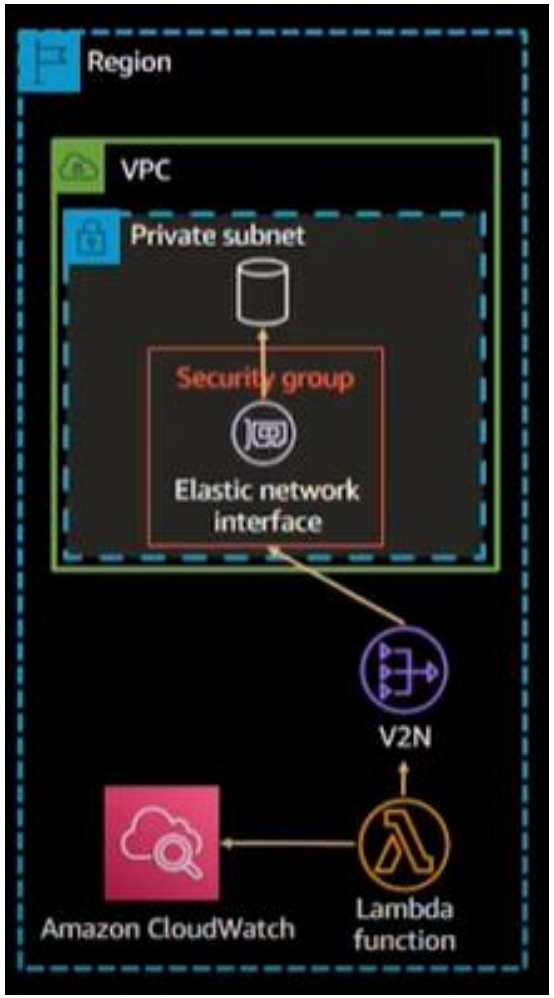
AWS Lambda and Python – Beginner to Advanced

AWS Lambda – Deployment Options



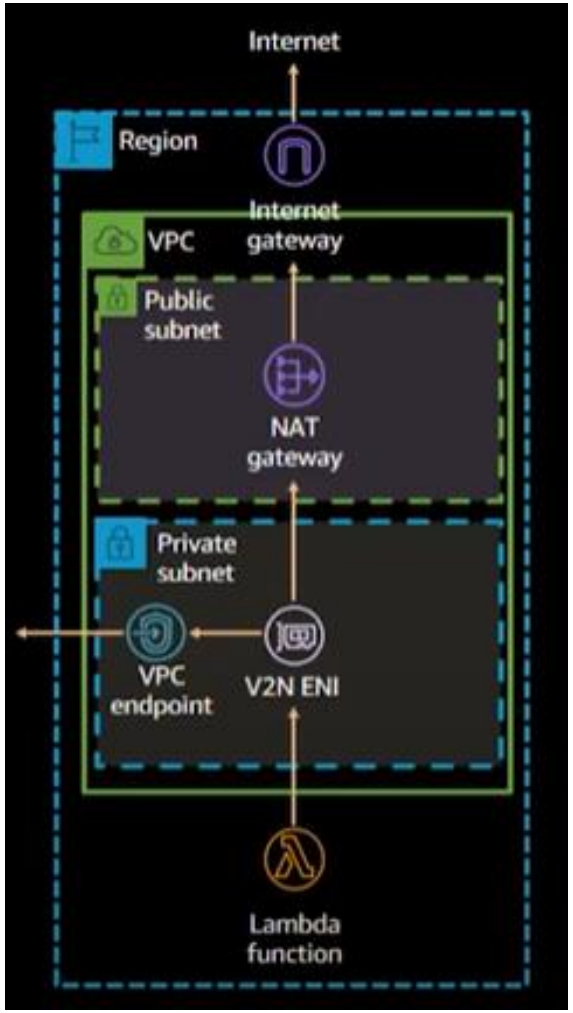
Scenario 1

(Access to Public Internet)



Scenario 2

(Access to Private Subnet VPC)



Scenario 3

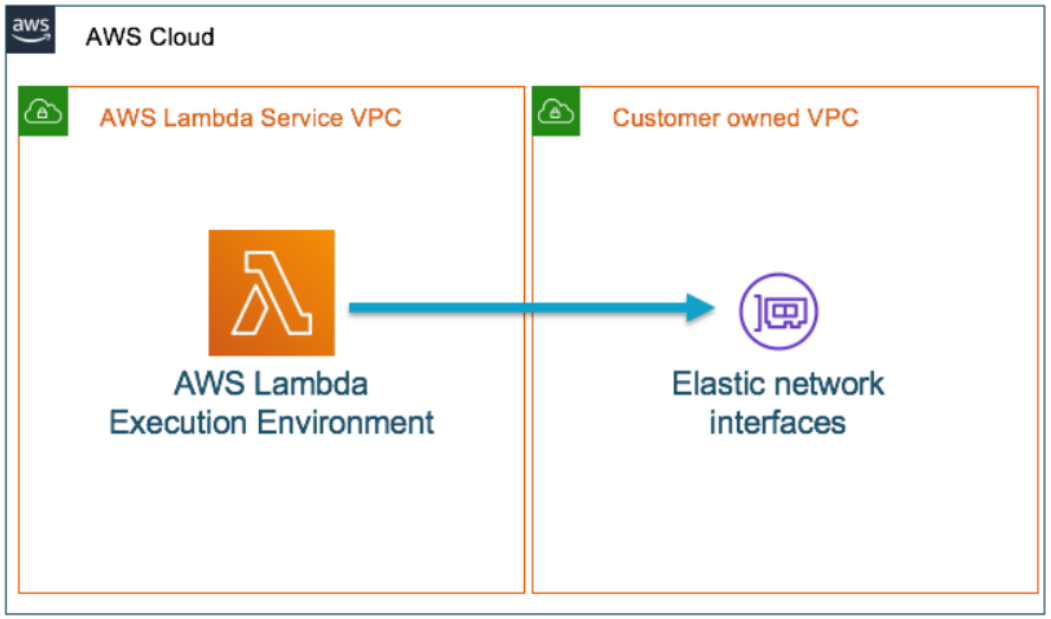
(Access to Private Subnet and Public Internet/ Access AWS Services Privately)

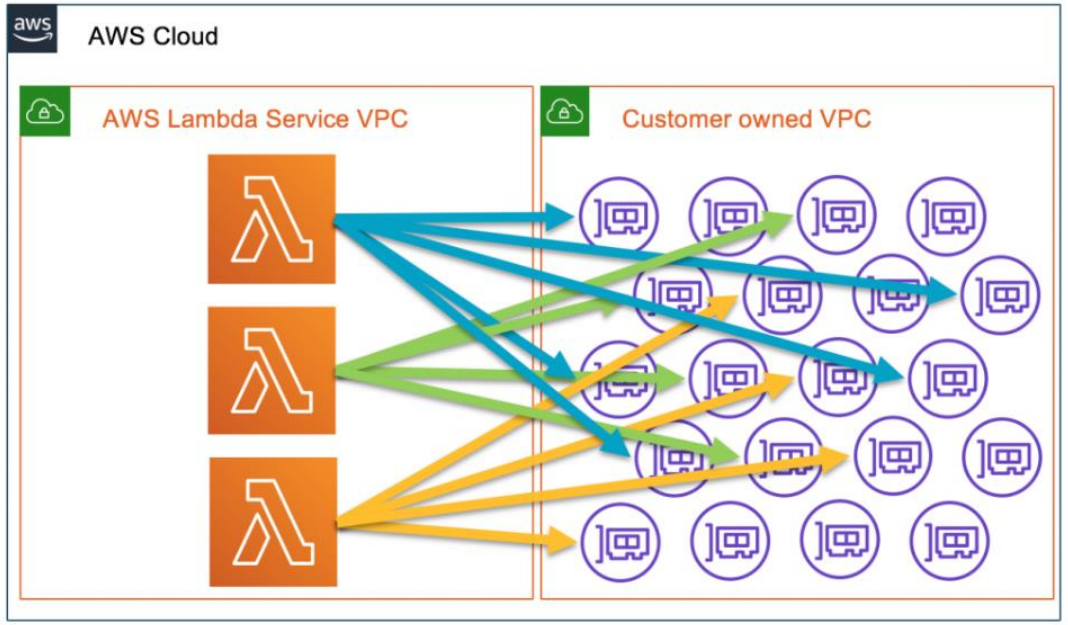
Source : AWS

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Deployment and access to Private Subnet Resources

How does Lambda access AWS Services in Customer VPC in Private Subnet – Option 2

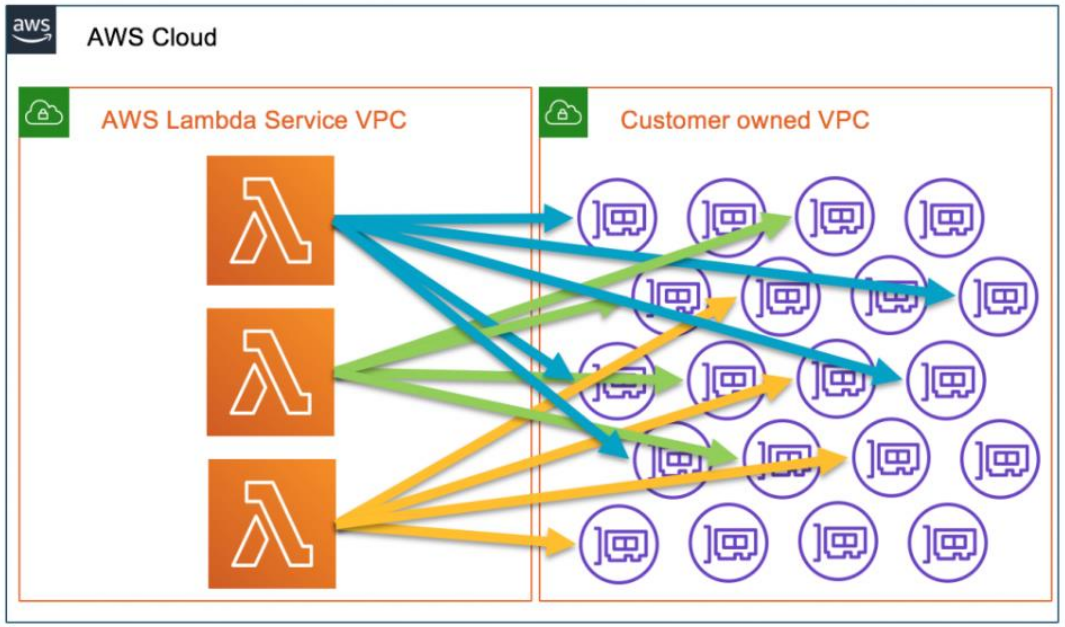


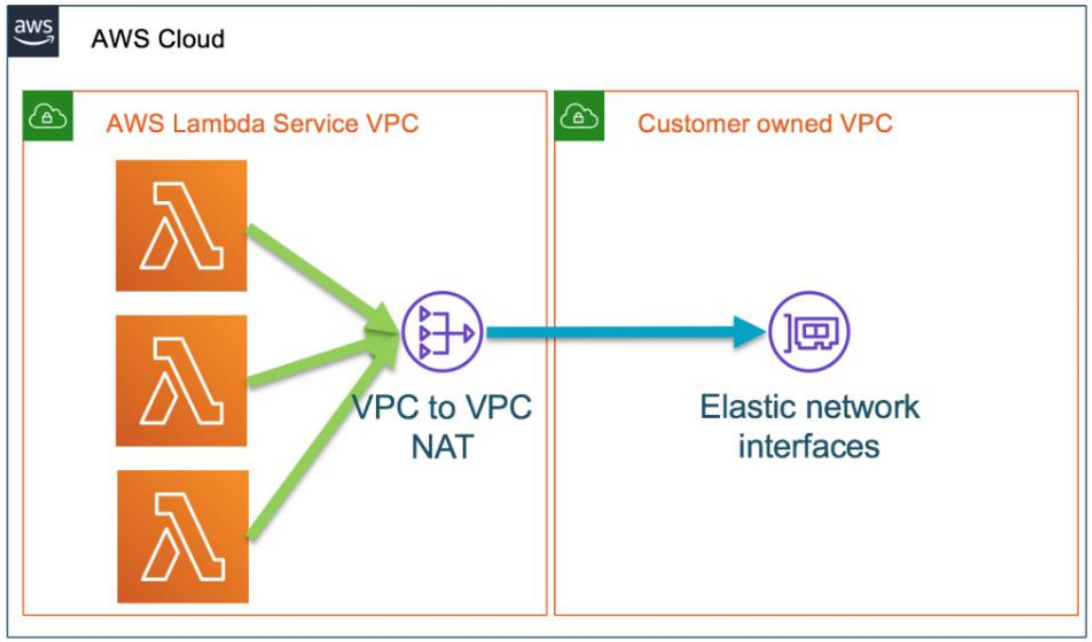


AWS Lambda and Python – Beginner to Advanced

AWS Lambda Deployment and access to Private Subnet Resources

How does Lambda access AWS Services in Customer VPC in Private Subnet – Option 2





Using **Hyperplane** (the Network Function Virtualization platform) ENI, a managed network resource that the Lambda service controls, allowing multiple execution environments to securely access resources inside of VPCs in your account.

Managed under the hood by AWS but need to be aware of configuration settings –

Whether Lambda accesses Public or Private Resources

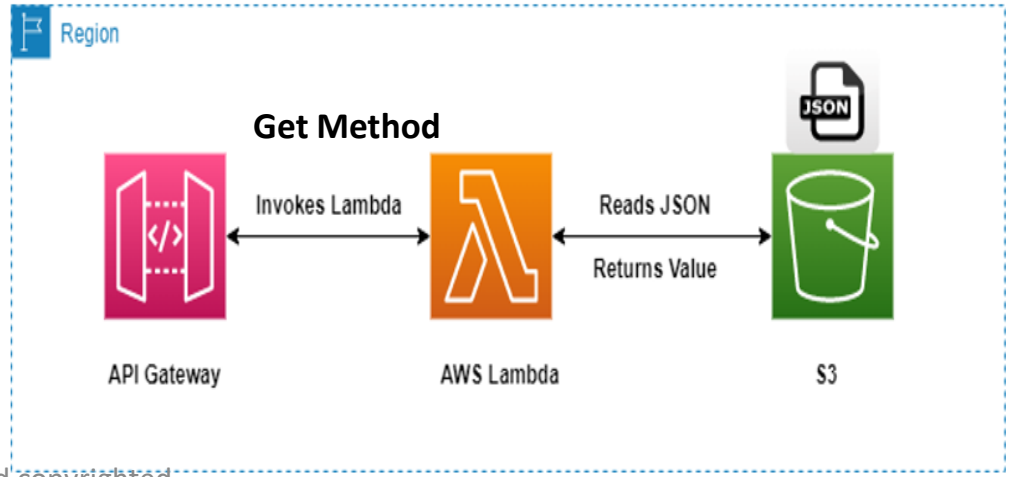
AWS Lambda and Python – Beginner to Advanced

AWS Lambda Monitoring – Use CloudWatch Metrics, Logs and Dashboard

- Lambda service **automatically monitors Lambda functions** and sends function **Metrics and Logs** to **CloudWatch.**
- On processing an **event**, Lambda sends **metrics about the invocation** to CloudWatch and generate logs.
- **Graphs and dashb**oards can be built with these metrics on the CloudWatch console
- **Set alarms to respond to changes** in utilization, performance, or error rates.
- Lambda sends metric data to **CloudWatch in 1-minute intervals (min)**.

Sample Event

{ "bucket": "firstbucket01092022", "key": "bucket1.json"}



AWS Lambda and Python – Beginner to Advanced

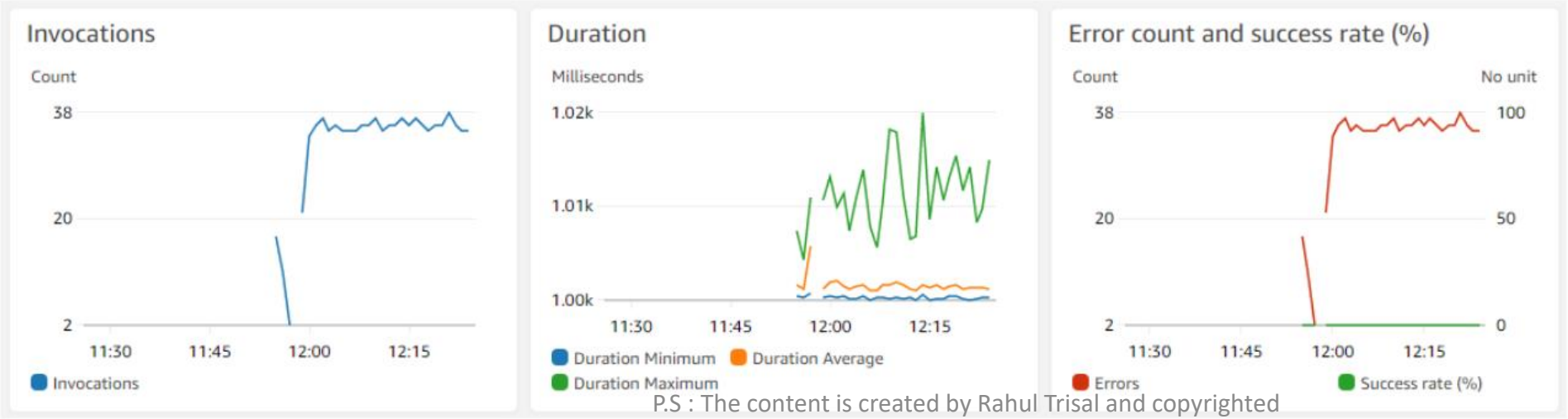
AWS Lambda Metrics in CloudWatch

There are **eight important Lambda metrics to monitor** to understand the performance of your workload:

1. **Invocations**: The **number of times that your function code is invoked**, including successful invocations and invocations that result in a function error.

2. **Duration**: The **amount of time** that your function code spends processing an event.

3. **Errors**: This logs the number of **errors thrown by a function**.



AWS Lambda and Python – Beginner to Advanced

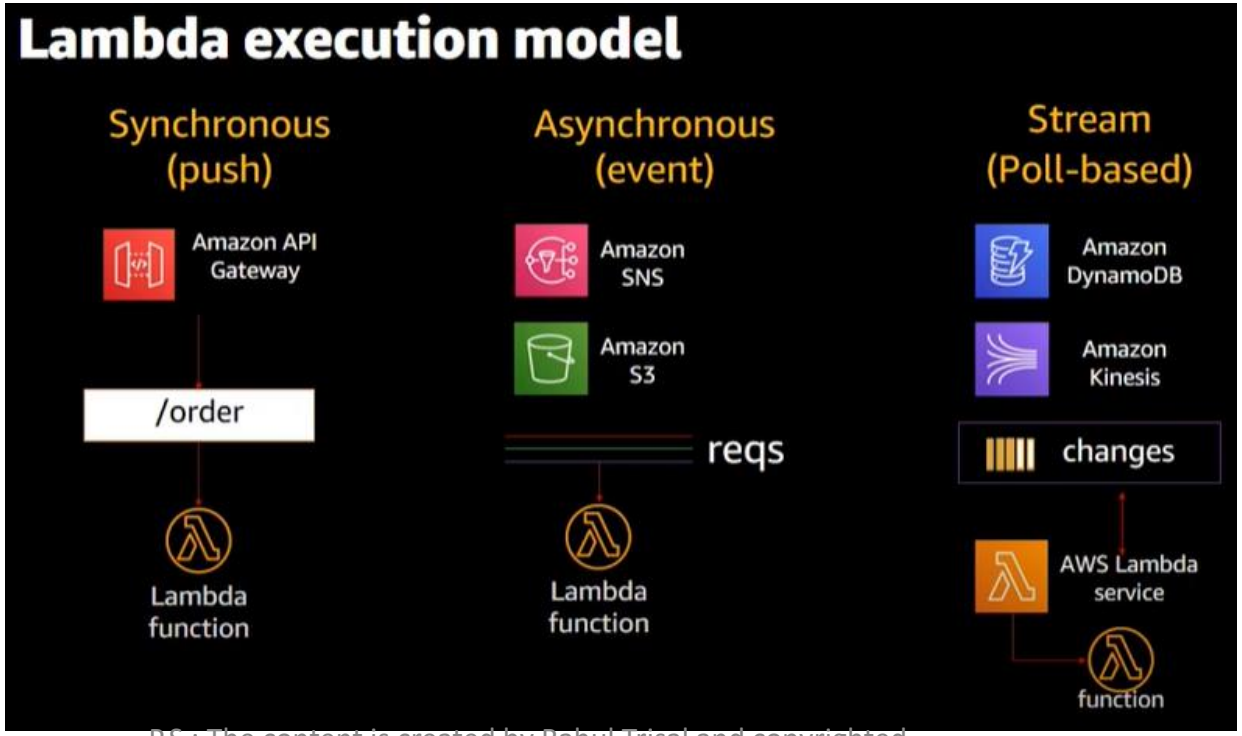
CloudWatch Metrics

4. **Throttles**: Set **alarms** on this metric for any **non-zero value** since this only occurs if the number of invocations exceeds concurrency in your account.
5. **ConcurrentExecutions**: monitor this value to ensure that your functions are not running close to the total **concurrency limit** for your AWS account.
6. **UnreservedConcurrentExecutions**: Similar to the previous metric but excludes functions using reserved concurrency.
7. **DeadLetterErrors**: An error is triggered if Lambda cannot write to the designated dead-letter queue, **set alarm on any non-zero values** for this metric.

AWS Lambda and Python – Beginner to Advanced

CloudWatch Metrics

8. **IteratorAge**: For Lambda functions that poll streaming sources, such as Kinesis or DynamoDB streams, the value indicates **when events are being produced faster than they are being consumed by Lambda.** IteratorAge is the difference between the current time and when the last record of the *GetRecords* call was written to the stream.



AWS Lambda and Python – Beginner to Advanced

AWS Lambda CloudWatch Logs

- Lambda function comes with a **CloudWatch Logs log group (**/aws/lambda/function name) and a **log stream** for each instance of your function.
- The Lambda runtime environment sends details about **each invocation** to the **log stream**, and **relays logs and other output** from your function's code.
- To **output logs** from your function code, use the **print method**, or any **logging library** that writes to stdout or stderr.

AWS Lambda and Python – Beginner to Advanced

AWS Lambda CloudWatch Logs

```
import os

def lambda_handler(event, context):
    print('## ENVIRONMENT VARIABLES')
    print(os.environ)
    print('## EVENT')
    print(event)
```

START **RequestId**: 8f507cfc-xmpl-4697-b07a-ac58fc914c95 Version: $LATEST

ENVIRONMENT VARIABLES

environ({'AWS_LAMBDA_LOG_GROUP_NAME': '/aws/lambda/my-function', 'AWS_LAMBDA_LOG_STREAM_NAME': '2020/01/31/[$LATEST]3893xmpl7fac4485b47bb75b671a283c', 'AWS_LAMBDA_FUNCTION_NAME': 'my-function', ...})

EVENT

{'key': 'value'}

END RequestId: 8f507cfc-xmpl-4697-b07a-ac58fc914c95

REPORT RequestId: 8f507cfc-xmpl-4697-b07a-ac58fc914c95 **Duration**: 15.74 ms **Billed Duration**: 16 ms

Memory Size: 128 MB Max **Memory Used**: 56 MB **Init Duration**: 130.49 ms

XRAY TraceId: 1-5e34a614-10bdxmplf1fb44f07bc535a1 **SegmentId:** 07f5xmpl2d1f6f85 Sampled: true

Report Log

1. **RequestId**
2. **Duration**
3. **Billed Duration**
4. **Memory Size**
5. **Max Memory Used**
6. **Init Duration**
7. **XRAY TraceId**
8. **SegmentId**

AWS Lambda and Python – Beginner to Advanced

Lambda function – Use Cloud Watch Logs and CloudWatch Metrics

```
import os

def lambda_handler(event, context):
    print('## ENVIRONMENT VARIABLES')
    print(os.environ)
    print('## EVENT')
    print(event)
```

```
START RequestId: 8f507cfc-xmpl-4697-b07a-ac58fc914c95 Version: $LATEST
## ENVIRONMENT VARIABLES
environ({'AWS_LAMBDA_LOG_GROUP_NAME': '/aws/lambda/my-function',
'AWS_LAMBDA_LOG_STREAM_NAME':
'2020/01/31/[$LATEST]3893xmpl7fac4485b47bb75b671a283c',
'AWS_LAMBDA_FUNCTION_NAME': 'my-function', ...})
## EVENT
{'key': 'value'}
END RequestId: 8f507cfc-xmpl-4697-b07a-ac58fc914c95
REPORT RequestId: 8f507cfc-xmpl-4697-b07a-ac58fc914c95  Duration: 15.74 ms  Billed
Duration: 16 ms Memory Size: 128 MB Max Memory Used: 56 MB  Init Duration: 130.49
ms
XRAY TraceId: 1-5e34a614-10bdxmplf1fb44f07bc535a1   SegmentId: 07f5xmpl2d1f6f85
Sampled: true
```

Report Log

- **RequestId** – The unique request ID for the invocation.
- **Duration** – The amount of time that your function's handler method spent processing the event.
- **Billed Duration** – The amount of time billed for the invocation.
- **Memory Size** – The amount of memory allocated to the function.
- **Max Memory Used** – The amount of memory used by the function.
- **Init Duration** – For the first request served, the amount of time it took the runtime to load the function and run code outside of the handler method.
- **XRAY TraceId** – For traced requests, the AWS X-Ray trace ID.
- **SegmentId** – For traced requests, the X-Ray segment ID.
- Sampled – For traced requests, the sampling result.

AWS Lambda and Python – Beginner to Advanced

AWS Lambda Versions and Aliases

AWS Lambda Version

- Lambda **versions** are used for **deployment of functions**.
- For example, you can publish a **new version of a function in Dev, QA and Prod**
- Lambda creates a new version of your function each time we publish the function.

A function version includes the following information:

- The **function code** and all associated dependencies.
- The **Lambda runtime** that invokes the function.
- All the **function settings**, including the environment variables.
- A **unique Amazon Resource Name (ARN)** to identify the specific version of the function.

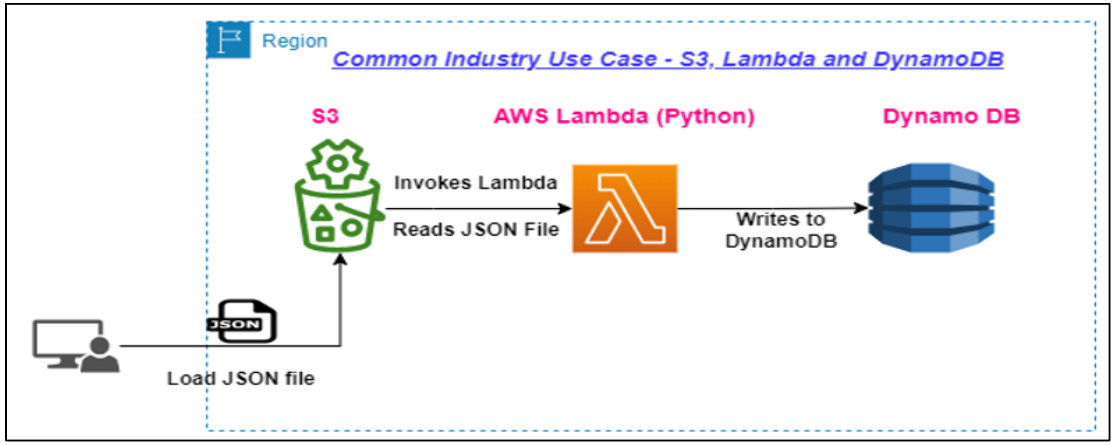
AWS Lambda and Python – Beginner to Advanced

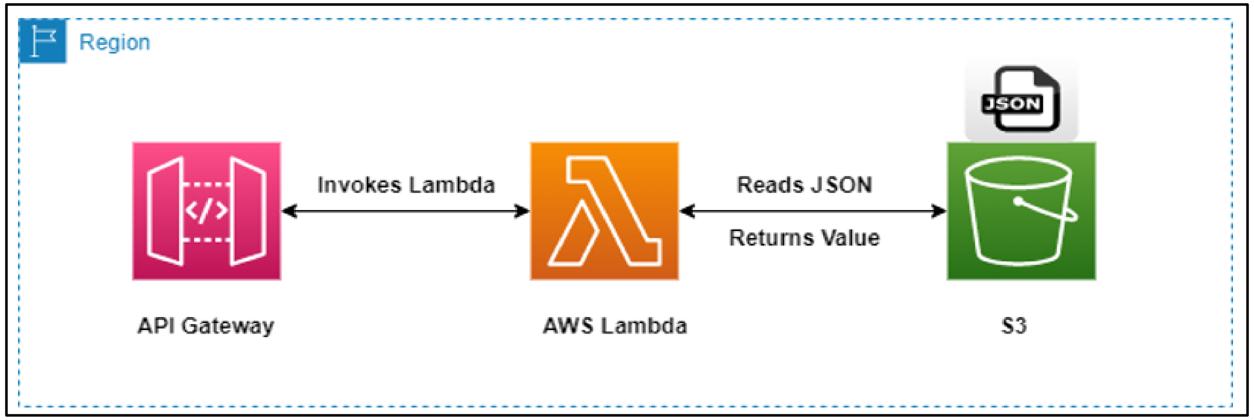
AWS Lambda Aliases

- A Lambda alias is like a **pointer to a specific function version**.
- Users can **access the function version using the alias Amazon Resource Name (ARN).**
- Each **alias has a unique ARN**. An alias can point only to a function version, not to another alias.
- You can **update an alias to point to a new version of the function.**

AWS Lambda and Python – Beginner to Advanced

Use Case for Aliases





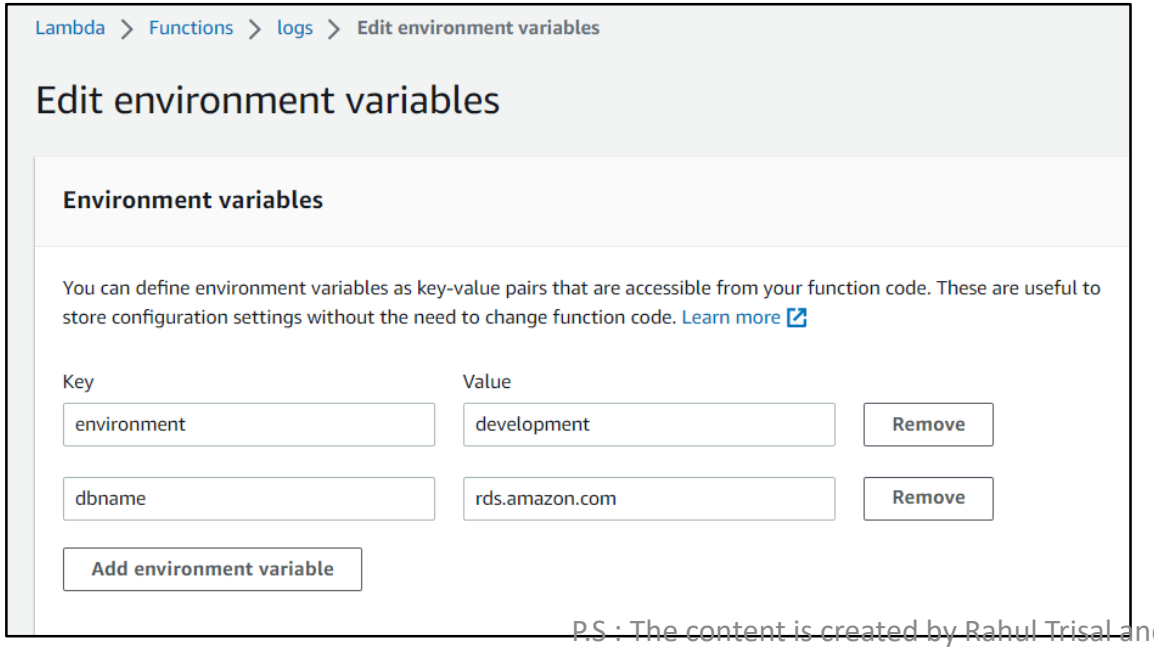
- Event sources such as Amazon Simple Storage Service (Amazon S3) invoke your Lambda function. These **event sources maintain a mapping that identifies the function to invoke when events occur**. If you specify a Lambda **function alias in the mapping configuration**, you don't need to **update the mapping when the function version changes.**

- In a **resource policy**, you can grant permissions for event sources to use your Lambda function. If you specify an **alias ARN in the policy**, you don't need to update the policy when the function version changes.

AWS Lambda and Python – Beginner to Advanced

AWS Lambda – Environment Variables

- Environment variables can be used to adjust your **function's behavior without updating code**.
- Most common use case is storing and **retrieving hostname and other connection details for the database in test and prod environments**
- **Environment variable** for your function can be **defined by using a key and a value**.
- The Lambda runtime makes environment variables available to your code.
- Your function uses the **name of the key to retrieve the value of environment variable**.



AWS Lambda and Python – Beginner to Advanced

Example scenario for environment variables

- Environment variables to **customize function behavior** in **test environ**ment and **production environment**.
- W can create two functions with the **same code but different configurations**.
- One function connects to **a test database**, and the other connects to a **production database**.
- Environment variables can be used for function to **retrieve hostname and other connection details for the database**.

Section on

Serverless Use Case-using API Gateway, AWS Lambda and S3 (Balance Status Application)

AWS CDK v2 – Pre-Requisites

1. Signup for AWS Account

2. IDE – Visual Code Studio - https://code.visualstudio.com/

3. Install AWS CLI - https://docs.aws.amazon.com/cli/latest/userguide/getting-started-install.html

   Check using open Start -- > cmd -- > Run following command > *aws* ***- - version****; output : aws-cli/2.7.24…*

4. Install the AWS CDK Toolkit for VS Code :

```
C:\Users\ADMIN>aws --version
aws-cli/1.27.40 Python/3.8.10 Windows/10 botocore/1.29.40
```

https://docs.aws.amazon.com/toolkit-for-visual-studio/latest/user-guide/setup.html#install

Install the AWS CDK

Install the AWS CDK Toolkit globally using the following Node Package Manager command.

```
npm install -g aws-cdk
```

Run the following command to verify correct installation and print the version number of the AWS CDK.

```
cdk --version
```

Output : 2.59.0 (build b24095d)

In case of error : Run following command >> “Set-ExecutionPolicy -Scope Process -ExecutionPolicy Bypass” and then execute other commands

AWS CDK v2 – Pre-Requisites

5. Install Node.js - https://nodejs.org/en/ (Check by running following command >> **node - - version**, output should be > v10.3.0)

```
PS C:\Users\ADMIN> node --version
v18.12.1
```

To download for other Programming Languages – Use this link : https://cdkworkshop.com/15-prerequisites.html

6. AWS Account User - Configure Credentials to access AWS services from Visual Studio - https://docs.aws.amazon.com/toolkit-for-vscode/latest/userguide/establish-credentials.html

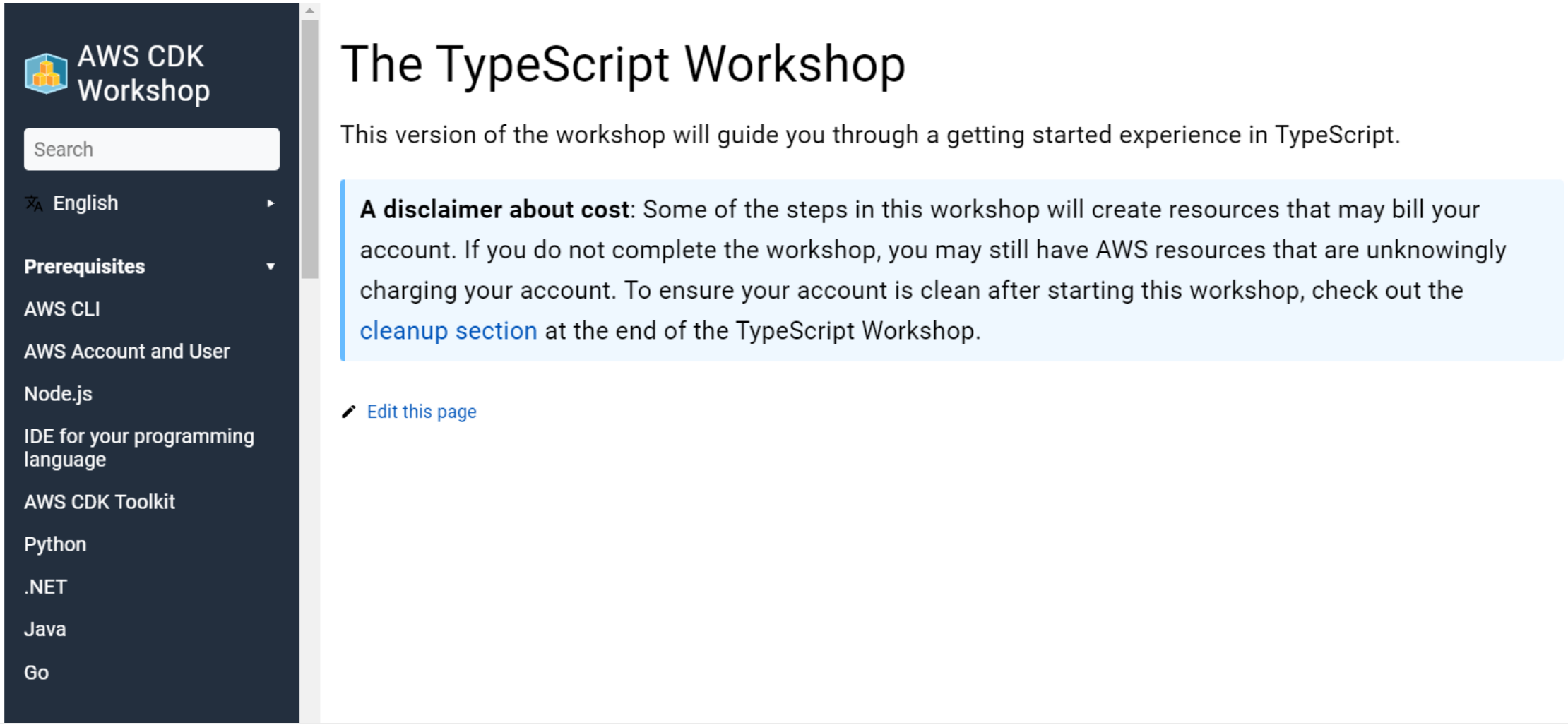
- Create an IAM User
- Configure Credentials

```
$ aws configure
AWS Access Key ID [None]: AKIAIOSFODNN7EXAMPLE
AWS Secret Access Key [None]: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY
Default region name [None]: us-west-2
Default output format [None]: json
```

- Test using following command If configured properly – > aws s3 ls (should return all s3 buckets)

```
C:\Users\ADMIN>aws s3 ls
```

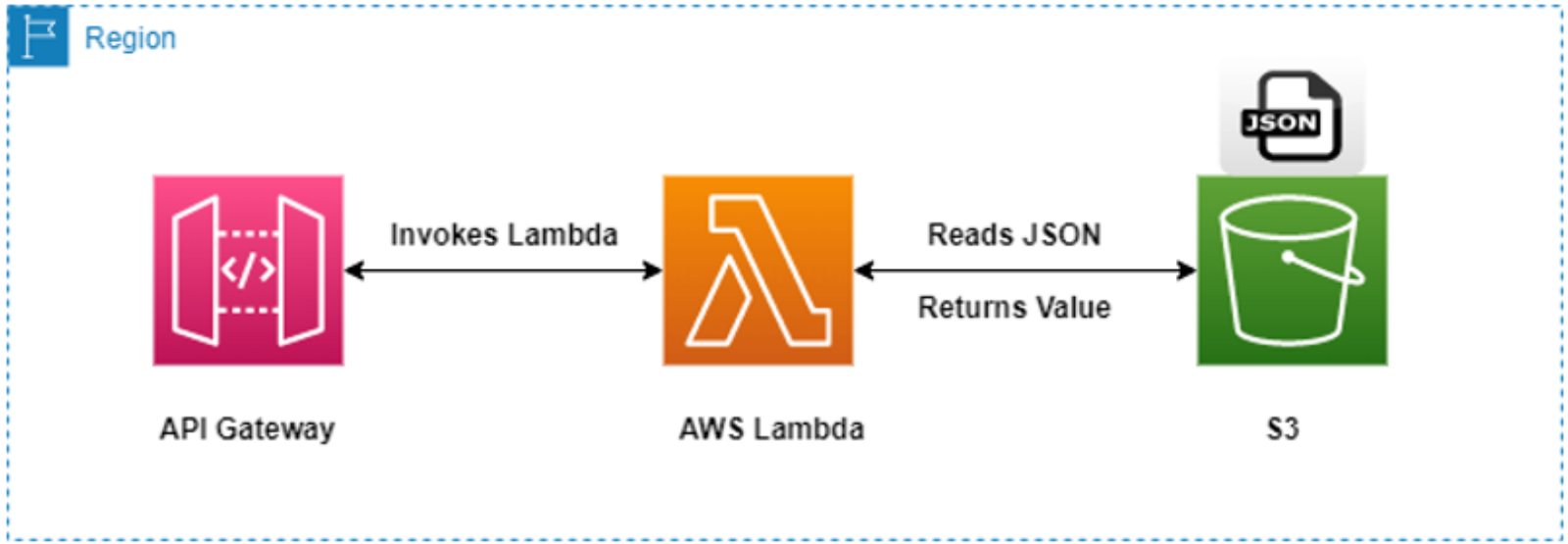
AWS CDK – Pre-Requisites



https://cdkworkshop.com/15-prerequisites/100-awscli.html

AWS Cloud Development Kit (CDK) v2 – Serverless Use Case

Serverless Use Case - using API Gateway, AWS Lambda and S3



- ***S3***
- ***IAM Role***
- ***AWS Lambda***
- ***API Gateway***

AWS CDK v2 – Serverless Use Case

Serverless Use Case-using API Gateway, AWS Lambda and S3 (Balance Status Application)

1. S3

- *bucketName – 'balanceStatus-0125'*

2. IAM Role

- *roleName*
- *assumedBy*
- *description*
- *IAM Policy attached to Role -* **AmazonS3FullAccess**

3. AWS Lambda

- *handler -* **lambda_function.lambda_handler**
- *role*
- *code*
- *runtime*
- *LambdaCode file –* ***lambda_function.py and Method – lambda_handler***

AWS CDK v2 – Serverless Use Case

Serverless Use Case - using API Gateway, AWS Lambda and S3

4. API Gateway

- *handler*
- *restApiName*
- *proxy*
- *deploy*

- *Resource - balanceStatus*
- *Method – GET*
- *Construct - LambdaRestAPI*

Summary of Steps to create any AWS Resource using CDK v2

Step 1. – Open the new folder in Visual Studio Code Editor and open Terminal

Step 2. – Create the app: Create Infra & Services Folder - ***mkdir infra, mkdir services and cd infra***

Step 3. – Initialize the CDK with ***cdk init app --language typescript***

Step 4. – *Import the module* for aws service being created - **Link**

Step 5. – *Define Scope, Logical ID and Props* – ***(this, 'logical id', {props})***

Step 6. – *Build the app* (Optional) with ***npm run build***

Step 7. – *Bootstrap* (One Time) with ***cdk bootstrap***

Step 8. – *Synthesize* an AWS CloudFormation template for the app with ***cdk synth***

Step 9. – *Deploying* the stack with ***cdk deploy***

AWS Lambda and Python – Beginner to Advanced

Section on

AWS CloudFormation- API GW, Lambda, S3- (From my Udemy Course on CloudFormation)

AWS CloudFormation – Template Anatomy

YAML

The following example shows a YAML-formatted template fragment.

```yaml
---
AWSTemplateFormatVersion: "version date"

Description:
  String

Metadata:
  template metadata

Parameters:
  set of parameters

Rules:
  set of rules

Mappings:
  set of mappings

Conditions:
  set of conditions

Transform:
  set of transforms

Resources:
  set of resources

Outputs:
  set of outputs
```

All Sections Optional except Resources

Source:

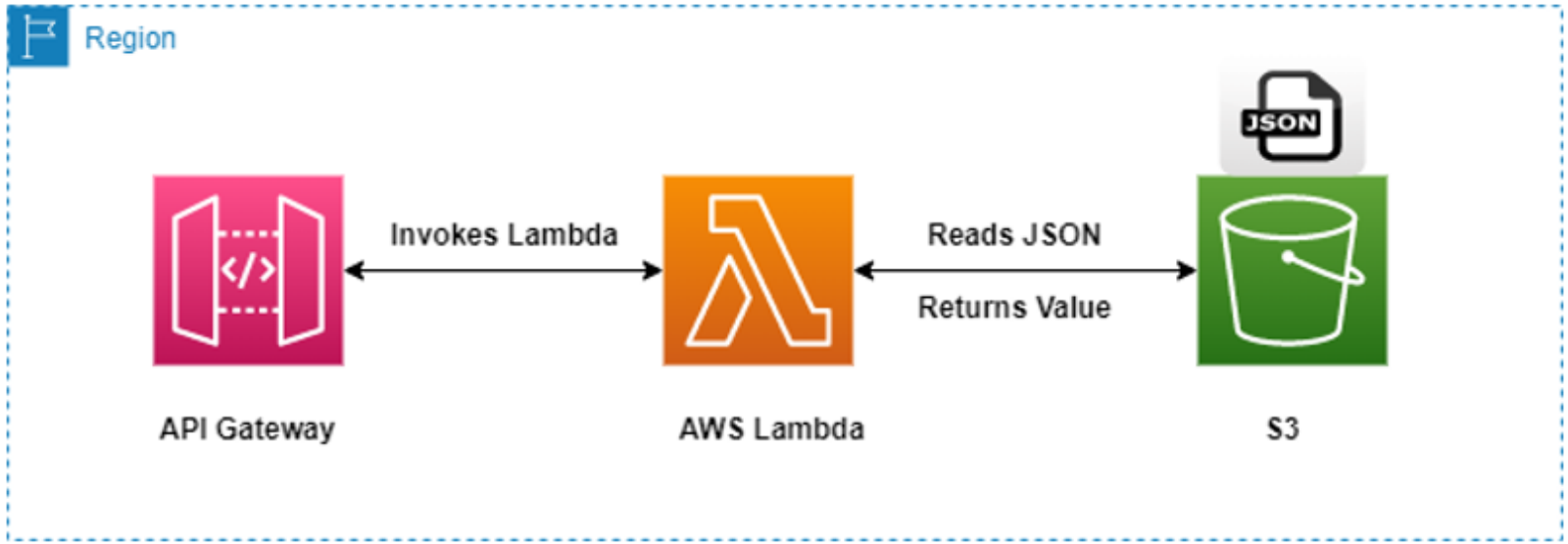
https://docs.aws.amazon.com/AWSCloudFormation/latest/UserGuide/template-anatomy.html

YAML

```yaml
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
            Iops: 200
            DeleteOnTermination: false
            VolumeSize: 20
```

AWS CloudFormation – Serverless Banking Use Case 2

Serverless Use Case - using API Gateway, AWS Lambda and S3



- *S3*
- *IAM Role/Lambda*

  Execution Role
- *AWS Lambda*
- *API Gateway*
- *LambdaInvokePermission*

Account Balance Status

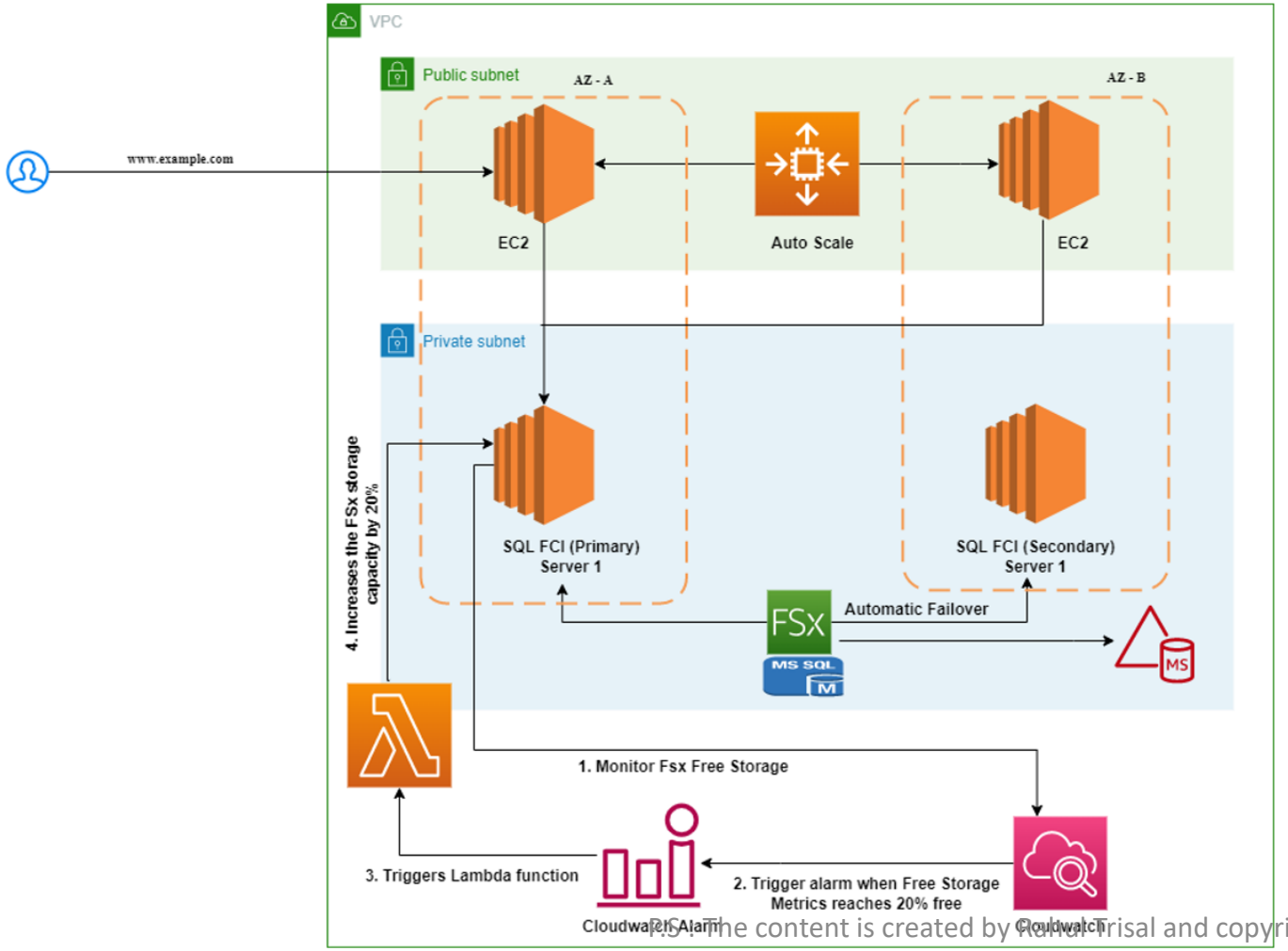
AWS Lambda and Python – Beginner to Advanced

Section on

Real World Serverless Use Case 3 - Monitor & increase free storage for SQL Server FCI Cluster

AWS Lambda and Python – Beginner to Advanced

Monitor & increase free storage for SQL Server FCI Cluster using AWS Lambda- MS AD, EC2, FSx, CloudWatch and CloudWatch Alarm



- *Microsoft AD*
- *EC2*
- *FSx*
- *CloudWatch Metrics*
- *CloudWatch Alarm*

Python Basics – 1 (Print Function, Variables, .Format, User Input)

1. Print Function – print the message to screen or any interface; Syntax : print( )

```
>> print(“Hello Rahul”)
>> print(30.5)
```

2. Variable - Containers for storing data values string, float or integers and no need to declare; Syntax : x = 3, greeting = “hello” etc.

```
>> demo = "hi“
>> x = 30
```

3. User Input - Allow user to provide an input; Syntax - input(“ “)

```
>> schoolName = input(“Please enter your School Name")
>> grade = input(“Please enter your Grade")
>>  print(“My schoolName is : {}  and grade is {}".format(schoolName, grade))
```

4. Print variables in Strings---- ‘format()’ method - .format(a,b)

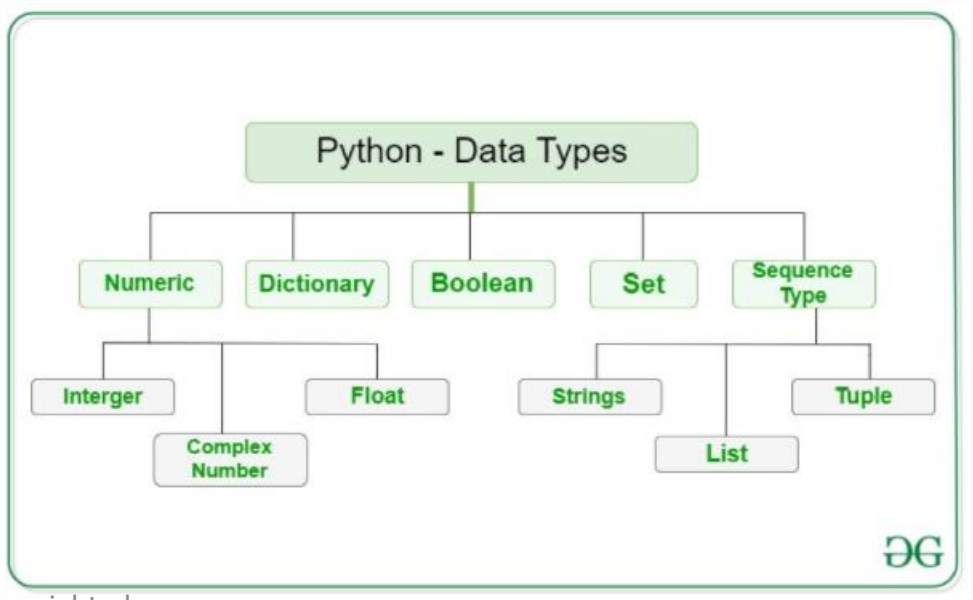
```
>>  grade = 4,
>> section = ‘A’
>>  print(“My class is : {}  and section is {}".format(grade, section))
```

Python Basics – 2 (Data Types Introduction)

5. Data Types Introduction

Data types are the **classification or categorization of data items**. It represents the **kind of value that tells what operations can be performed on a particular data**.

- **Numeric (Integer, Complex Number, Float)**
- **Dictionary – Most Important;** Key-value pairs; Dict = {1: 'Rahul', 2: 'John', 3: 'Joy'}
- Boolean (True or False)
- Set - Sets are used to store multiple items in a single variable; fruits = {"apple", "banana", "cherry"}
- Sequence Type (String, List and Tuple)
- **Strings** is a sequence of characters internally stored as binary ("Aaron")
  - ASCII value of the letter 'A' is 65.
- **List -** Lists in Python can be created by just placing the sequence inside the square brackets[]
  - ["Rahul", "John", "Joy"]



Source : Internet

6. Determine Data Type – **Syntax - type(variable)**

>> type(variable)

AWS Lambda with Python – Basics - 3

12. Function

Python Functions is a block of related statements designed to perform a computational, logical, or evaluative task.

Syntax:

def function_name(argument/parameters):

return expression or value

Example

```
# A simple Python function to check whether x is even or odd

def evenOdd(x):
    if (x % 2 == 0):
        print("even")
    else:
        print("odd")
# Driver code to call the function
evenOdd(2)
evenOdd(3)
```

Python Basics – 2 (Dictionary)

10. Data Types – Dictionary

- curly brackets
- key: pair values
- Its mutable but keys immutable
- Nested Dictionary

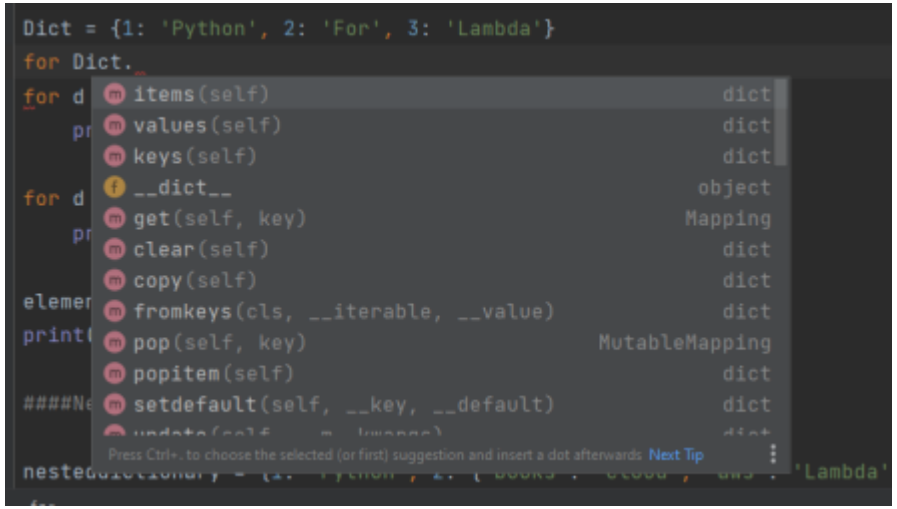
……

d = {1: 'Python', 2: 'For', 3: 'Lambda'}

Nested Dictionary

nd = {1:'Python', 2:{'books': 'arch' , 'aws':'Lambda'}}

……



- Items
- Keys
- Values
- **Elements in Dictionary – Getting specific values from Key Names**
- **Elements in Dictionary – Getting specific values from Key Names in a Nested Dictionary**
- **Adding an element to dictionary - d[3] = "red"**
- **Dictionary Methods**

Python Basics – 2 (Loops and Slicing)

7. Loop (for loop)

For loops are used for sequential traversal. For example: traversing a list or string or array etc.

>> data = “length”

Syntax :

>> **for k in data :**

print(k) **-----> k, colon, spacing (4 or 5)**

8. String length function - returns the length of a string: Syntax – len()

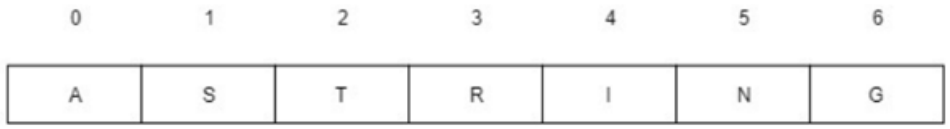
a = "Hello“

print(len(a))

9. String Slicing in Python

Python slicing is about obtaining a sub-string from the given string by slicing it respectively from start to end. **Syntax: var[start: stop: step]**

- data = "john"
- print(data[0:2:1])



Python Basics – 3 (List) with Loop and if/else statement

11. Data Types – List

- Lists in Python can be created by just placing the sequence inside the **square brackets []**
- A single list may contain Data Types like Integers, Strings, as well as Objects.
- List in Python are ordered and have a definite count. The elements in a **list are indexed with 0 being the first index.**
- slice(start, stop, step)
- Reverse [: : -1]

……

- l = [1, 4, 'For', 6, 'Anisha’]
- **Nested List** => nestedList = nestedList = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]

……

- By positional value
  - list = [2,3,4] or [2]
  - k = list[0:2:1]
  - print(k)
- For Loop and if statement

Python Basics – 2 (Loops and Slicing)

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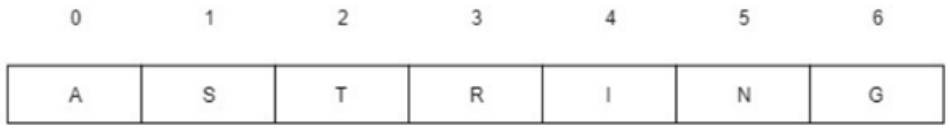

Python Basics – 1 (Pre-Req– Install PyCharm)

1. **Install PyCharm(Community edition) – Free**

https://www.jetbrains.com/pycharm/download/#section=windows

2. **Get a free tier AWS account – Free**

https://aws.amazon.com/free/?all-free-tier.sort-by=item.additionalFields.SortRank&all-free-tier.sort-order=asc&awsf.Free%20Tier%20Types=*all&awsf.Free%20Tier%20Categories=*all

AWS Lambda with Python – Basics - 3

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Python Basics – 2 (Loops and Slicing)

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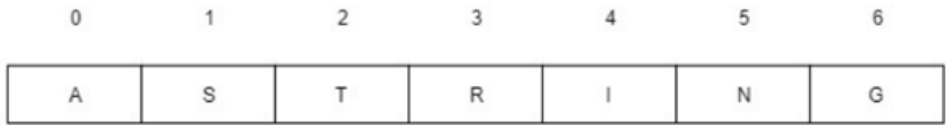

Thank You