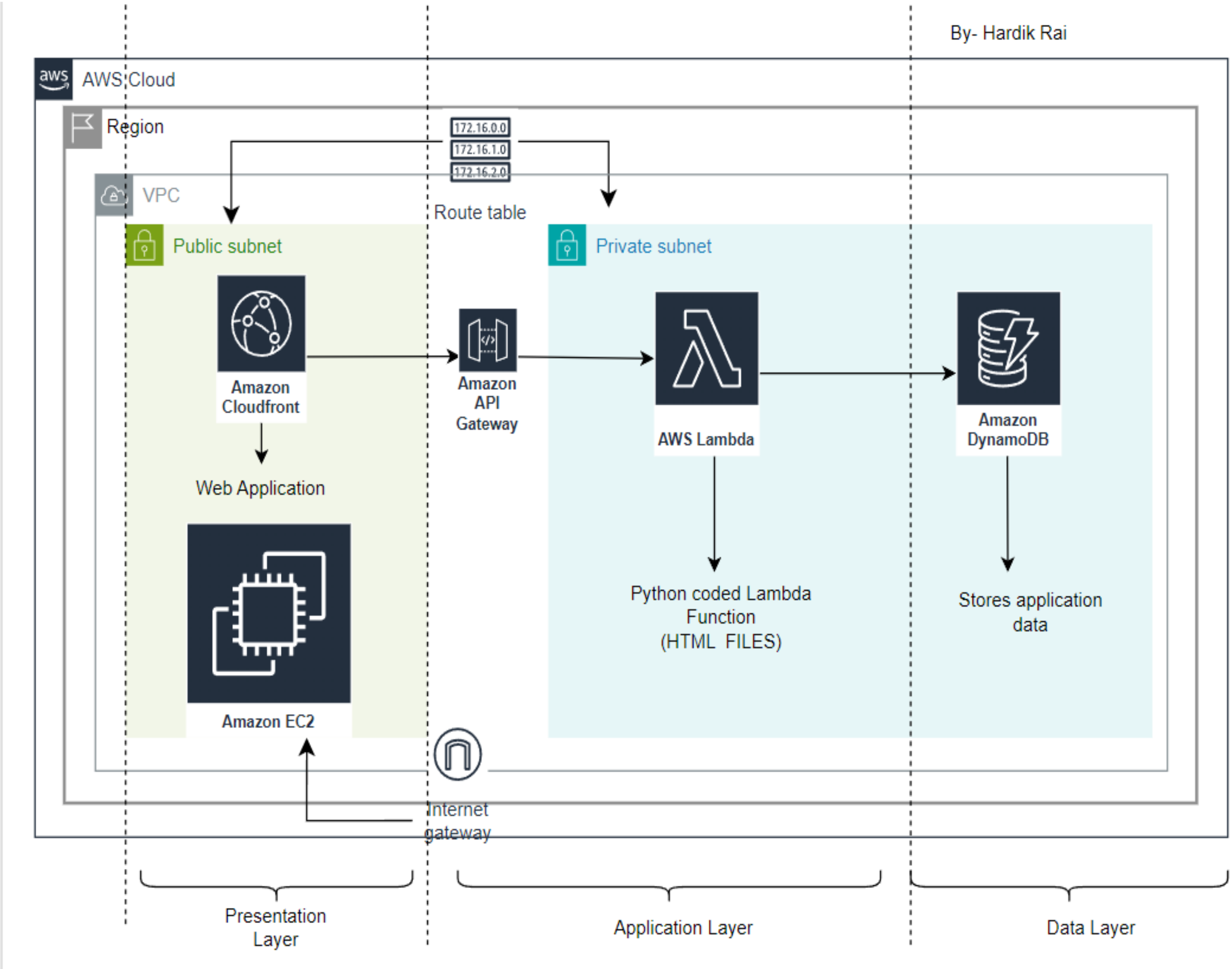
Deploying a Three-Tier Architecture on AWS with VPC

BY- HARDIK RAI

1. Architecture Diagram

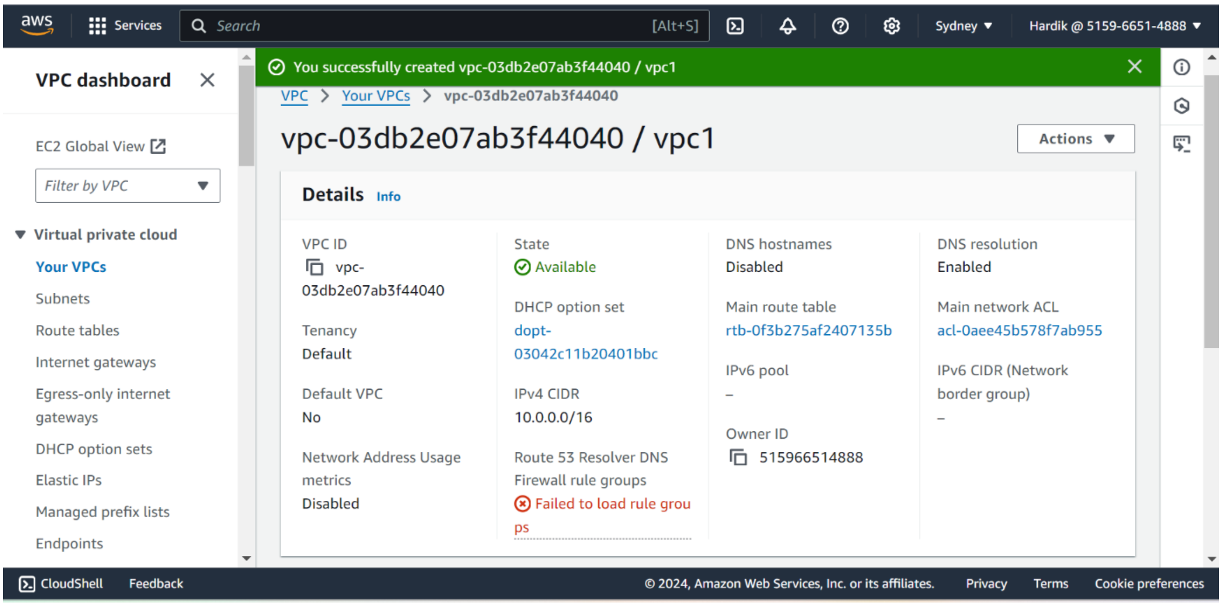
The architecture consists of a three-tier setup, following the structure:

- **Presentation Layer**: Hosted on an **Amazon EC2** instance, serving static HTML files.
- **Application Layer**: **AWS Lambda** functions process requests, triggered by an API Gateway.
- **Data Layer**: **Amazon RDS** or **DynamoDB** (based on the choice made during the project configuration) for storing data.
- **Network Layer**: The resources are isolated in a **Virtual Private Cloud (VPC)** for security.



VPC Configuration Details

- **VPC CIDR Block**: 10.0.0.0/16
- **Subnets**:
  - **Public Subnet (EC2)**: 10.0.1.0/24
  - **Private Subnet (Lambda & Database)**: 10.0.2.0/24



You successfully created vpc-03db2e07ab3f44040 / vpc1

VPC > Your VPCs > vpc-03db2e07ab3f44040

vpc-03db2e07ab3f44040 / vpc1

Details Info

VPC ID: vpc-03db2e07ab3f44040

State: Available

DNS hostnames: Disabled

DNS resolution: Enabled

Tenancy: Default

DHCP option set: dopt-03042c11b20401bbc

Main route table: rtb-0f3b275af2407135b

Main network ACL: acl-0aee45b578f7ab955

Default VPC: No

IPv4 CIDR: 10.0.0.0/16

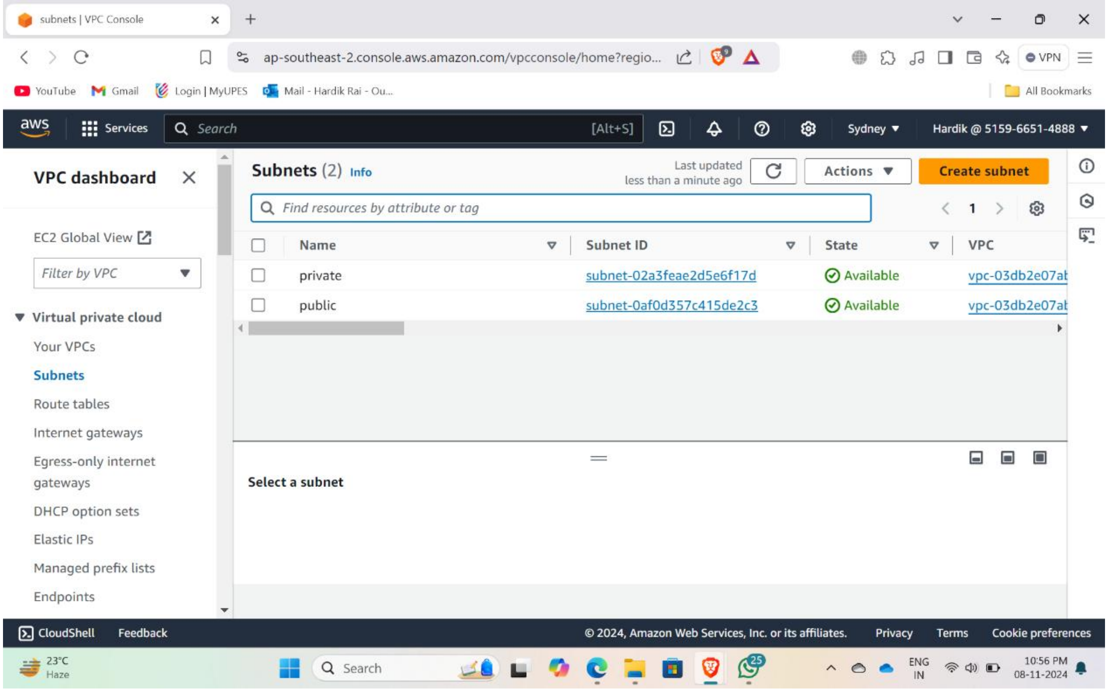
IPv6 pool: –

IPv6 CIDR (Network border group): –

Network Address Usage metrics: Disabled

Route 53 Resolver DNS Firewall rule groups: Failed to load rule groups

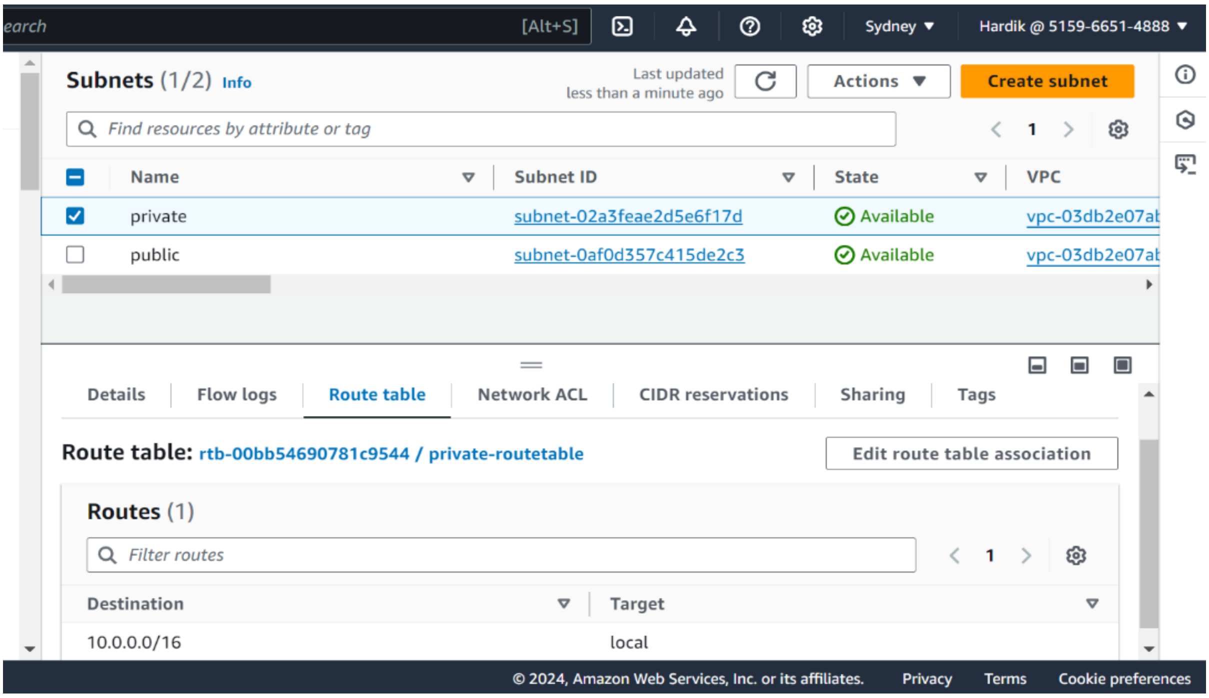
Owner ID: 515966514888



Subnets (2) Info

Name	Subnet ID	State	VPC
private	subnet-02a3feae2d5e6f17d	Available	vpc-03db2e07ab
public	subnet-0af0d357c415de2c3	Available	vpc-03db2e07ab

Select a subnet



Subnets (1/2) Info

Last updated less than a minute ago

	Name	Subnet ID	State	VPC
☑	private	subnet-02a3feae2d5e6f17d	✓ Available	vpc-03db2e07al
□	public	subnet-0af0d357c415de2c3	✓ Available	vpc-03db2e07al

Route table: rtb-00bb54690781c9544 / private-routetable

Routes (1)

Destination	Target
10.0.0.0/16	local

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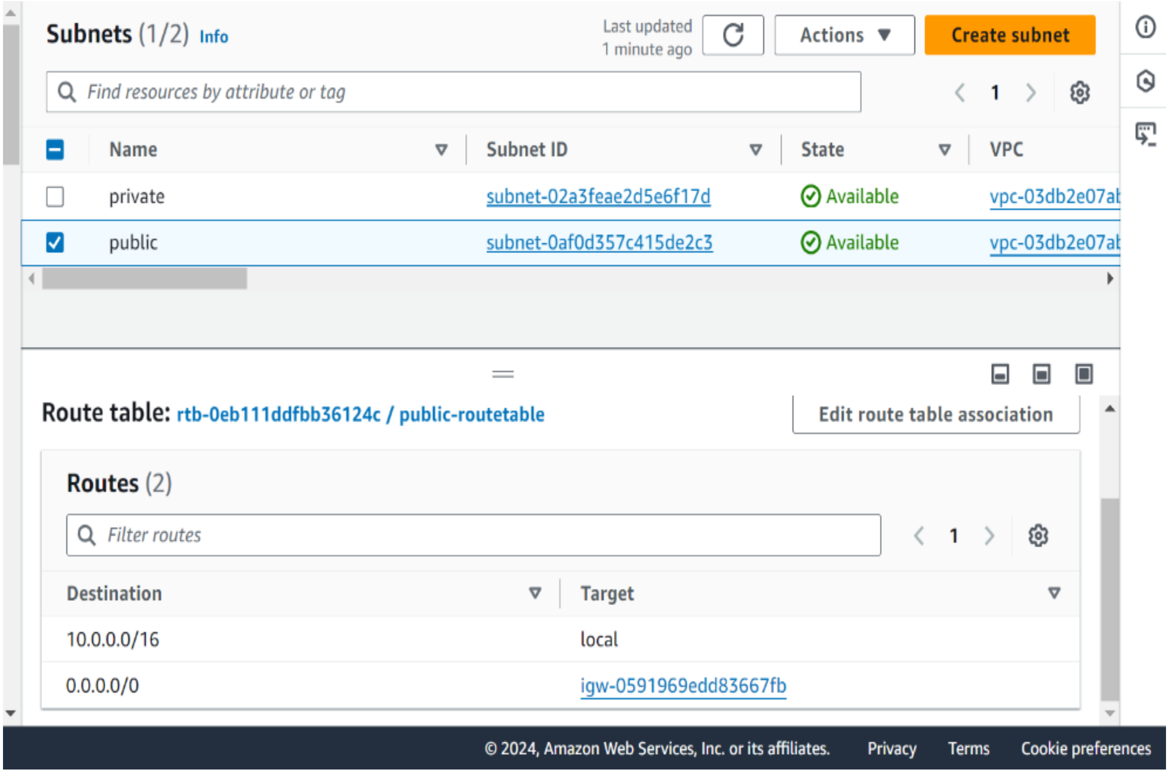

Subnets (1/2) Info

Last updated 1 minute ago

Actions ▼
Create subnet
Find resources by attribute or tag
‹ 1 ›

	Name	Subnet ID	State	VPC
□	private	subnet-02a3feae2d5e6f17d	✓ Available	vpc-03db2e07al
☑	public	subnet-0af0d357c415de2c3	✓ Available	vpc-03db2e07al

Route table: rtb-0eb111ddfbb36124c / public-routetable

Edit route table association

Routes (2)

Destination	Target
10.0.0.0/16	local
0.0.0.0/0	igw-0591969edd83667fb

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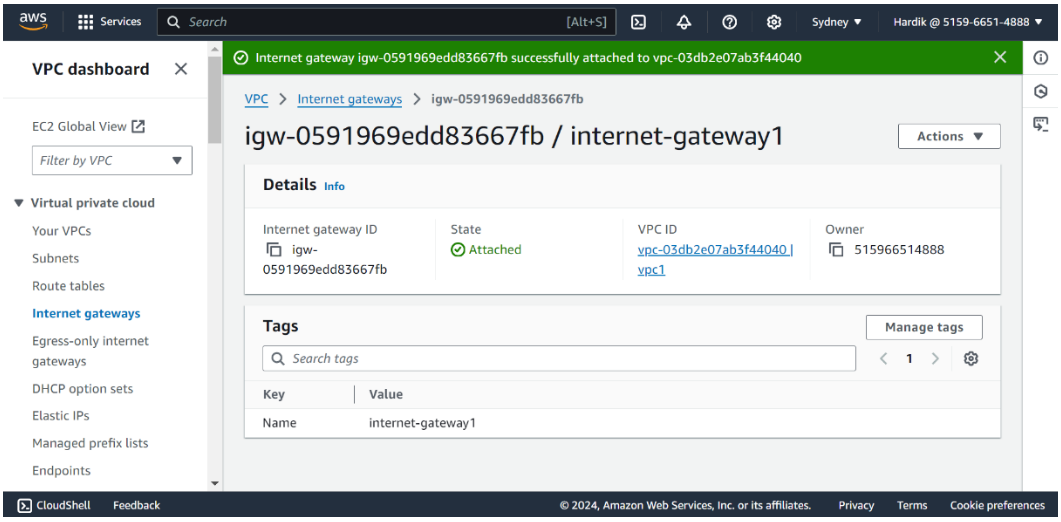
Internet Gateway: Attached to the VPC to allow the EC2 instance to access the internet.



Internet gateway igw-0591969edd83667fb successfully attached to vpc-03db2e07ab3f44040

VPC > Internet gateways > igw-0591969edd83667fb

igw-0591969edd83667fb / internet-gateway1

Details Info

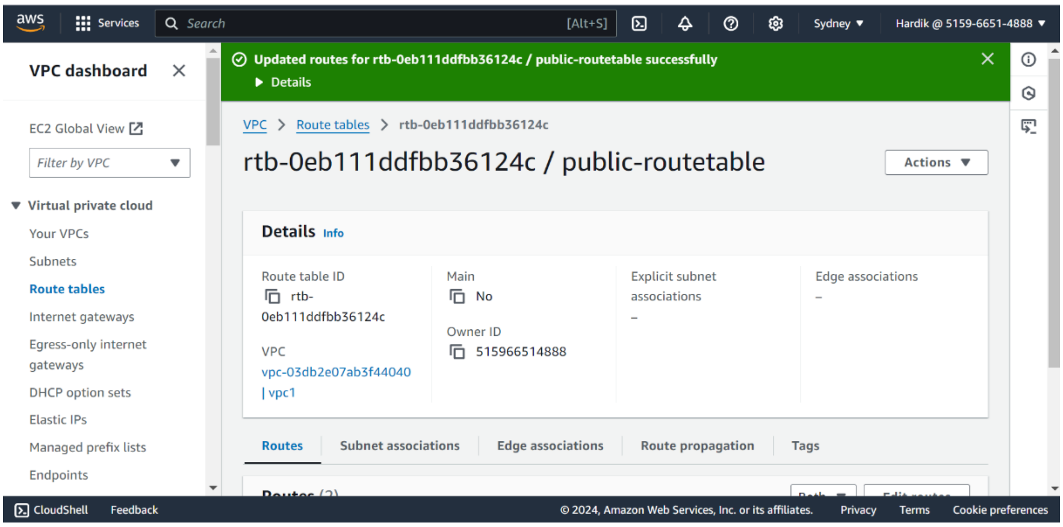
Internet gateway ID	State	VPC ID	Owner
igw-0591969edd83667fb	Attached	vpc-03db2e07ab3f44040 | vpc1	515966514888

Tags

Key	Value
Name	internet-gateway1

Route Tables:

- **Public Route Table**: Routes traffic from the public subnet to the internet via the Internet Gateway.
- **Private Route Table**: Routes traffic to the private subnet and restricts access to only authorized components.



Updated routes for rtb-0eb111ddfbb36124c / public-routetable successfully

Details

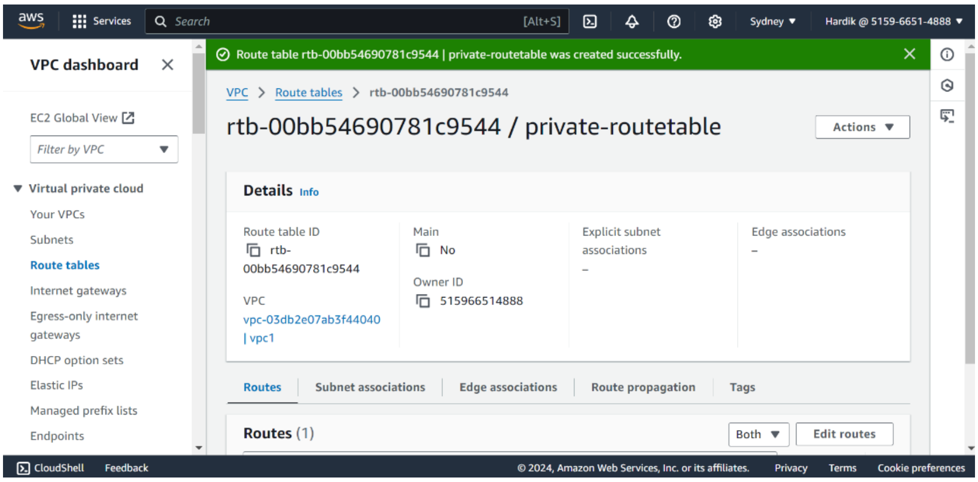
VPC > Route tables > rtb-0eb111ddfbb36124c

rtb-0eb111ddfbb36124c / public-routetable

Details Info

Route table ID	Main	Explicit subnet associations	Edge associations
rtb-0eb111ddfbb36124c	No	–	–
VPC	Owner ID		
vpc-03db2e07ab3f44040 | vpc1	515966514888		

Routes (2)



Route table rtb-00bb54690781c9544 | private-routetable was created successfully.

VPC > Route tables > rtb-00bb54690781c9544

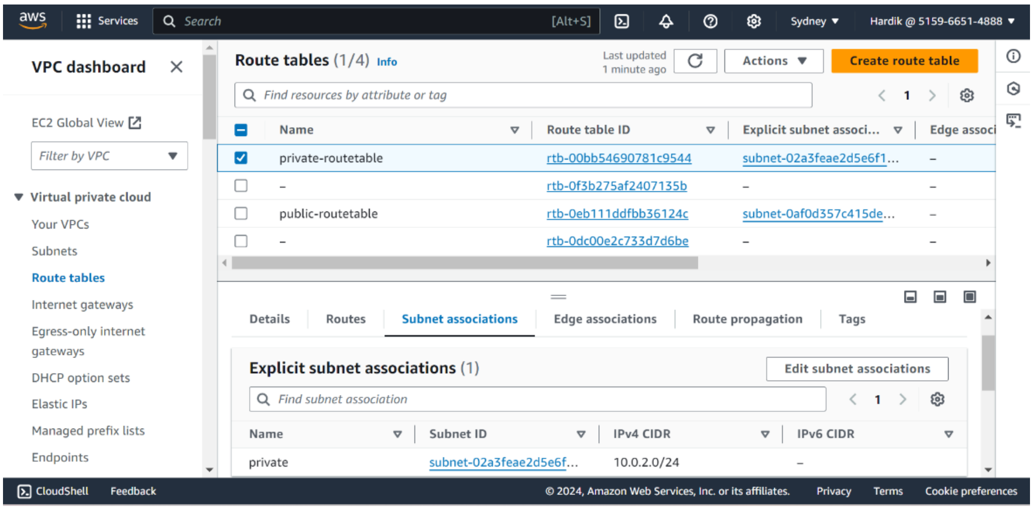
rtb-00bb54690781c9544 / private-routetable

Details Info

Route table ID	Main	Explicit subnet associations	Edge associations
rtb-00bb54690781c9544	No	–	–
VPC	Owner ID		
vpc-03db2e07ab3f44040 | vpc1	515966514888		

Routes | Subnet associations | Edge associations | Route propagation | Tags

Routes (1)



Route tables (1/4) Info

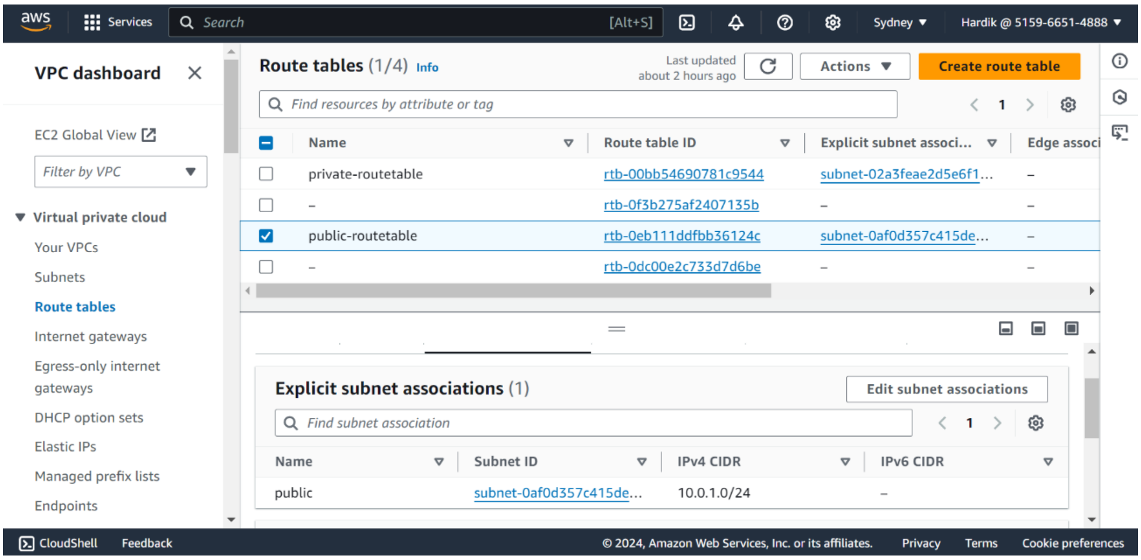
Last updated 1 minute ago

	Name	Route table ID	Explicit subnet associ...	Edge associ
☑	private-routetable	rtb-00bb54690781c9544	subnet-02a3feae2d5e6f1...	–
□	–	rtb-0f3b275af2407135b	–	–
□	public-routetable	rtb-0eb111ddfbb36124c	subnet-0af0d357c415de...	–
□	–	rtb-0dc00e2c733d7d6be	–	–

Details | Routes | Subnet associations | Edge associations | Route propagation | Tags

Explicit subnet associations (1)

Name	Subnet ID	IPv4 CIDR	IPv6 CIDR
private	subnet-02a3feae2d5e6f...	10.0.2.0/24	–



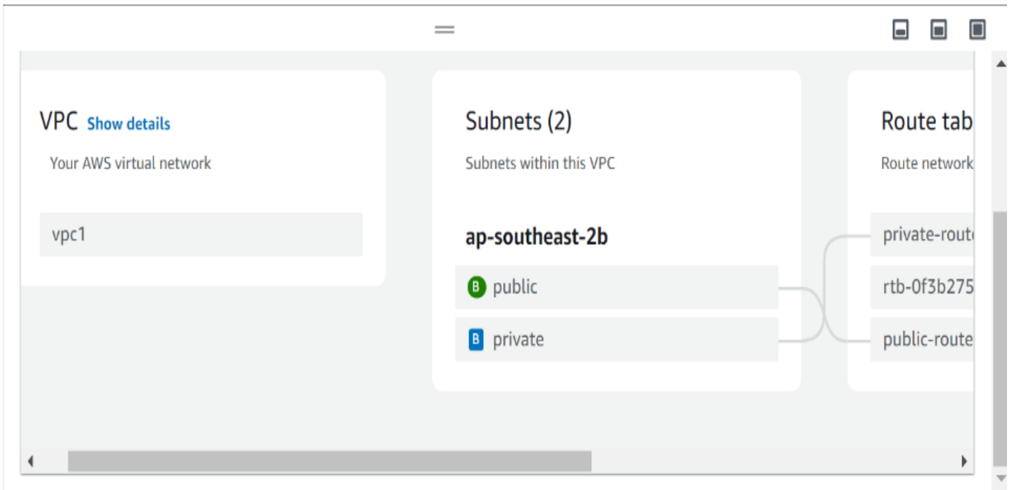
Route tables (1/4) Info

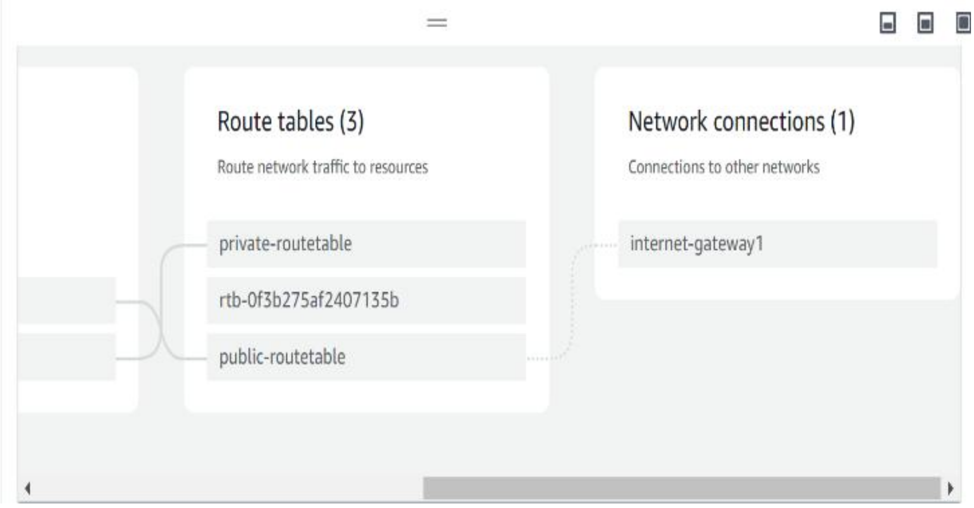
Last updated about 2 hours ago

	Name	Route table ID	Explicit subnet associ...	Edge associ
□	private-routetable	rtb-00bb54690781c9544	subnet-02a3feae2d5e6f1...	–
□	–	rtb-0f3b275af2407135b	–	–
☑	public-routetable	rtb-0eb111ddfbb36124c	subnet-0af0d357c415de...	–
□	–	rtb-0dc00e2c733d7d6be	–	–

Explicit subnet associations (1)

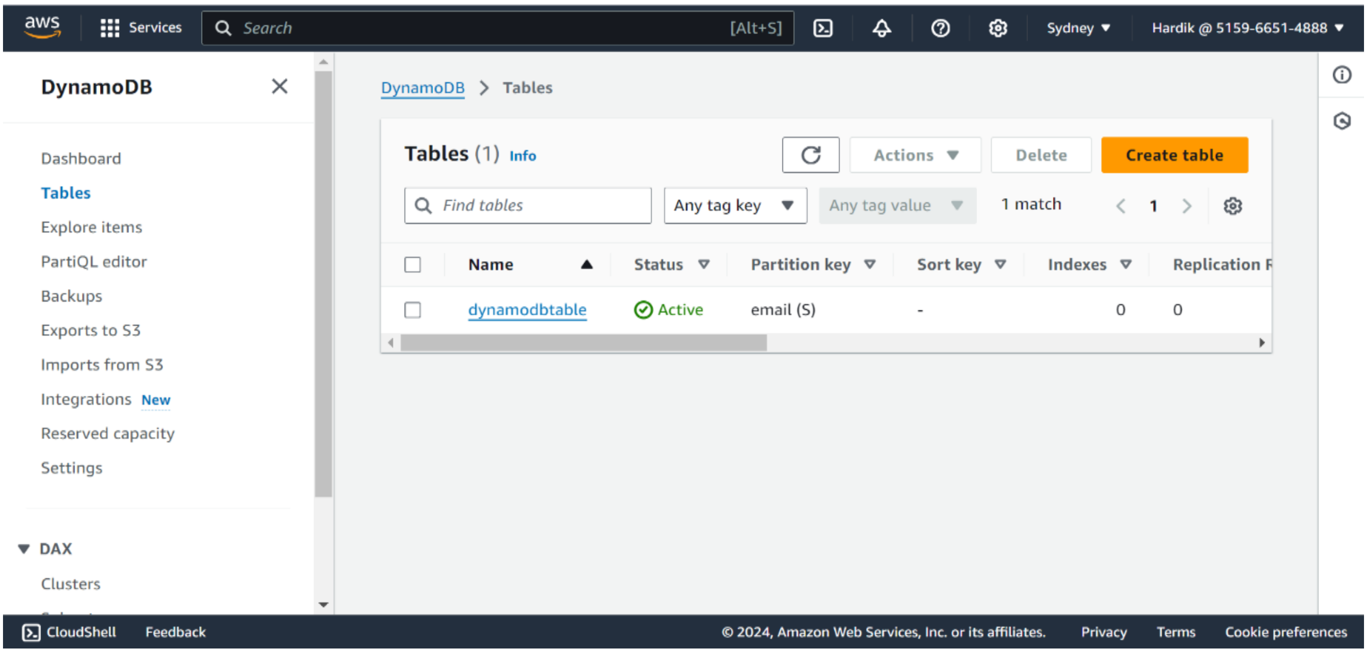
Name	Subnet ID	IPv4 CIDR	IPv6 CIDR
public	subnet-0af0d357c415de...	10.0.1.0/24	–



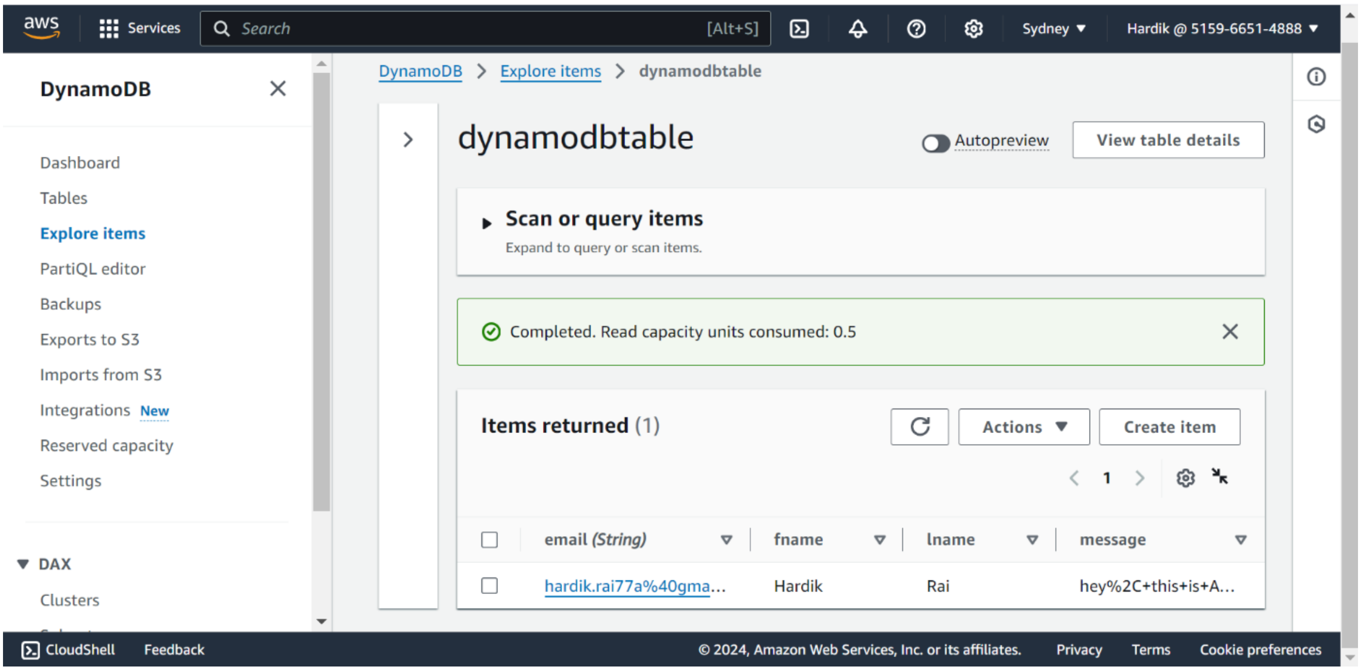


DYNAMODB-

- **Primary Key**: Email (String) – Unique identifier for each user.
- **Lambda** interacts with **DynamoDB** to perform operations like adding, updating, and retrieving user data.
- **EC2** communicates with **API Gateway**, which triggers **Lambda** to fetch or store data in **DynamoDB**.



□	Name	Status	Partition key	Sort key	Indexes	Replication R
□	dynamodbtable	✓ Active	email (S)	-	0	0

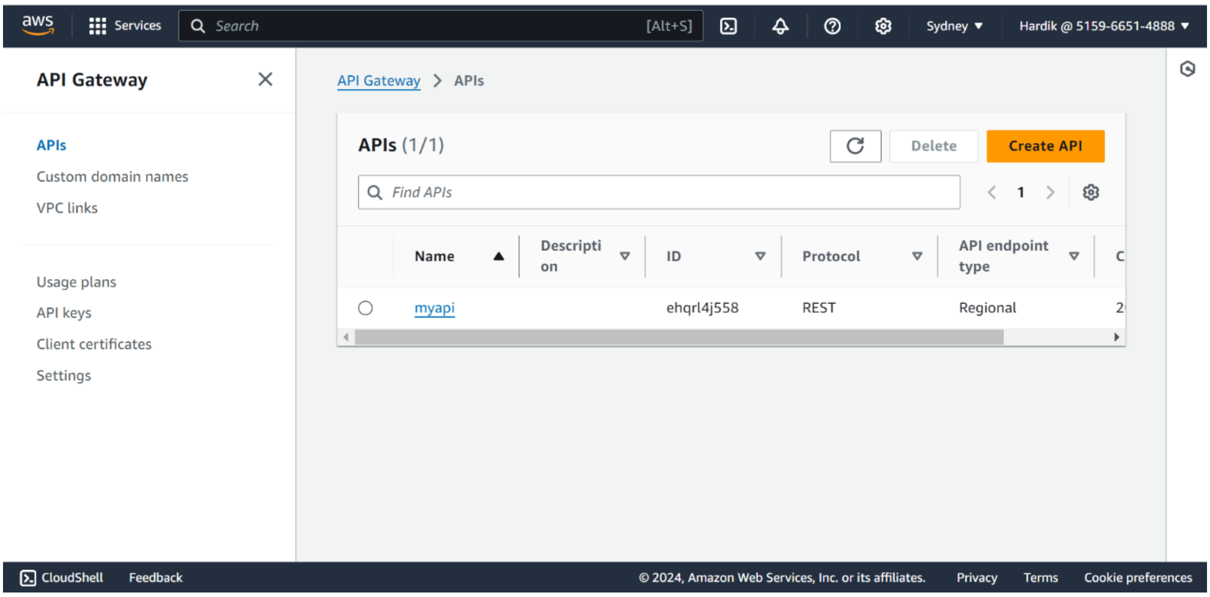


✓ Completed. Read capacity units consumed: 0.5

Items returned (1)

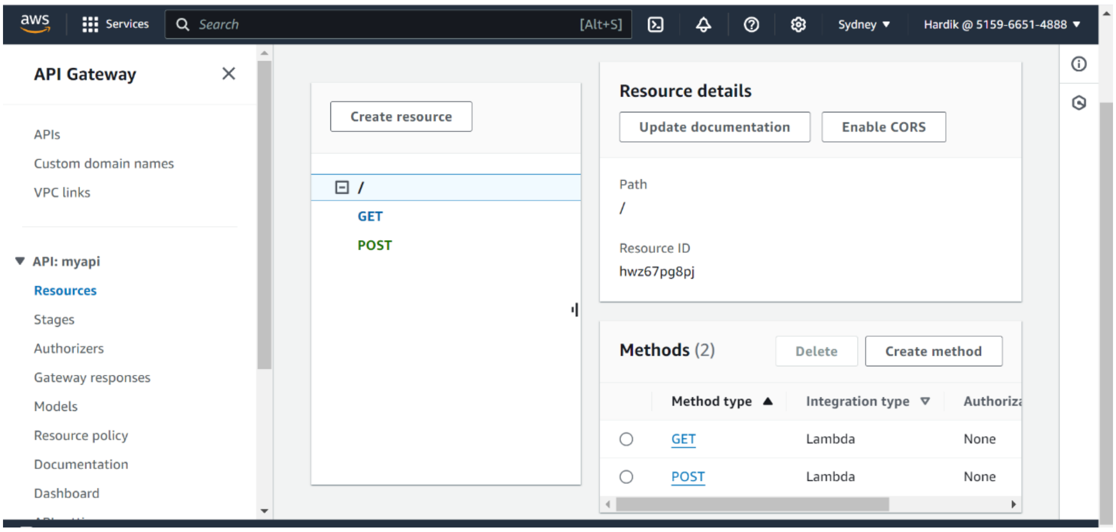
□	email (String)	fname	lname	message
□	hardik.rai77a%40gma...	Hardik	Rai	hey%2C+this+is+A...

API Gateway: Manages HTTP requests to trigger the Lambda functions.



APIs (1/1)

	Name	Description	ID	Protocol	API endpoint type	C
○	myapi		ehqrl4j558	REST	Regional	2



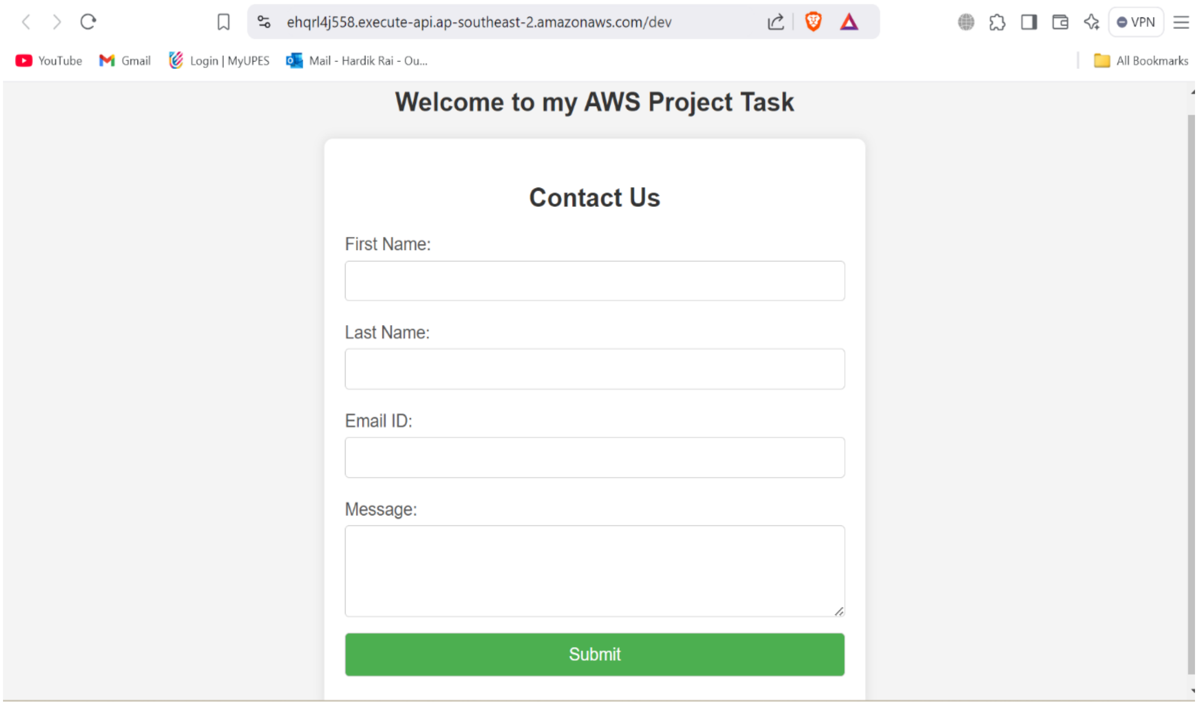
Resource details

Path
/

Resource ID
hwz67pg8pj

Methods (2)

	Method type	Integration type	Authoriz
○	GET	Lambda	None
○	POST	Lambda	None


ehqrl4j558.execute-api.ap-southeast-2.amazonaws.com/dev
YouTube
Gmail
Login | MyUPES
Mail - Hardik Rai - Ou...
All Bookmarks
VPN
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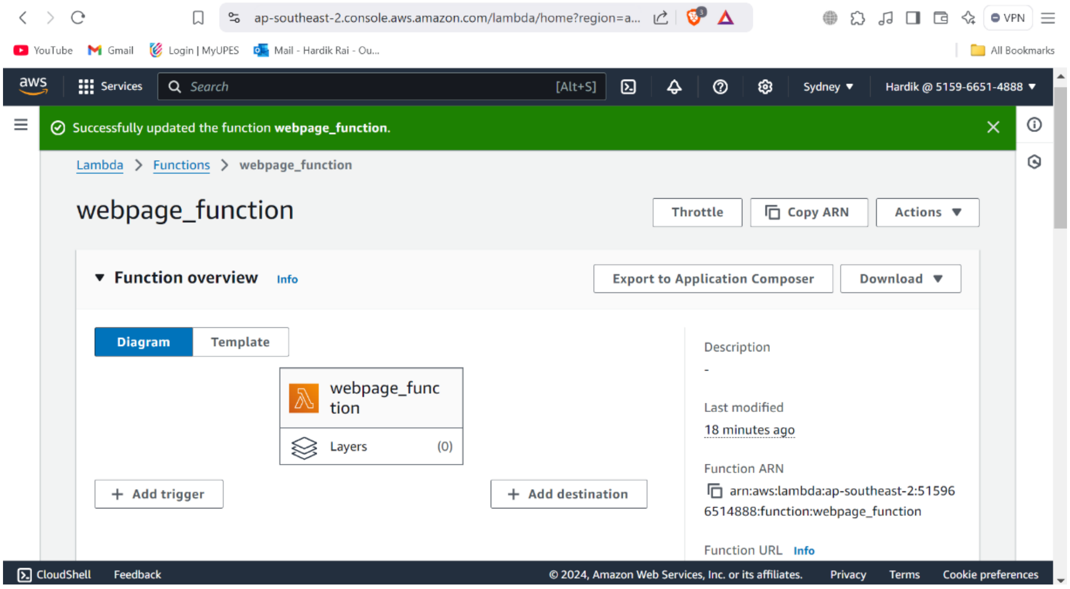
Email ID:

Message:

AWS Lambda:

- **Runtime**: Python/Node.js (depending on the project)
- **Memory**: 128 MB (adjust based on function size)
- **Timeout**: 10 seconds (adjustable)
- **API Gateway Integration**: Linked to Lambda via a REST API.



Successfully updated the function **webpage_function**.

Lambda > Functions > webpage_function

webpage_function

▼ Function overview Info

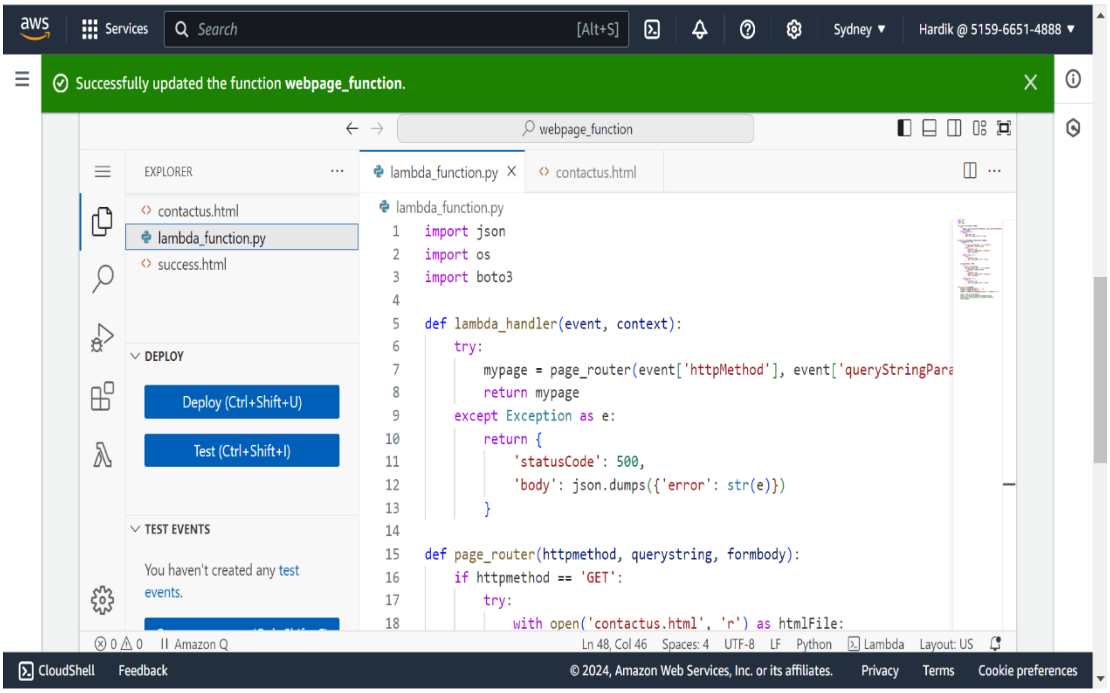
webpage_function

Description
-

Last modified
18 minutes ago

Function ARN
arn:aws:lambda:ap-southeast-2:515966514888:function:webpage_function

Function URL Info



Successfully updated the function **webpage_function**.

lambda_function.py

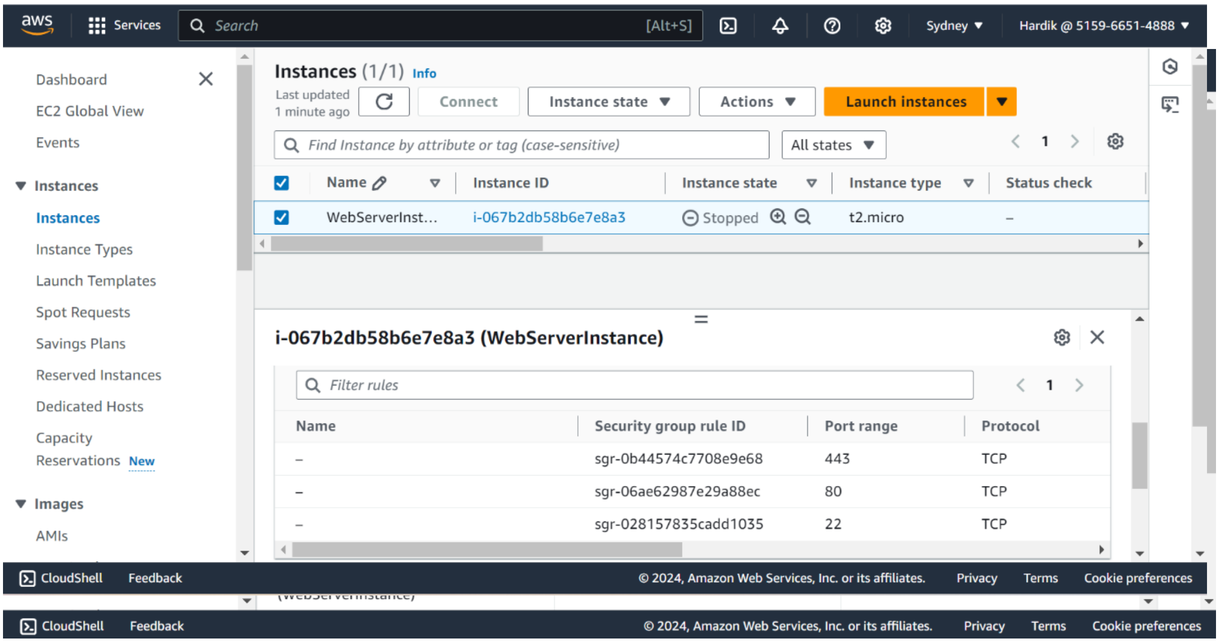
```python
import json
import os
import boto3

def lambda_handler(event, context):
    try:
        mypage = page_router(event['httpMethod'], event['queryStringPara
        return mypage
    except Exception as e:
        return {
            'statusCode': 500,
            'body': json.dumps({'error': str(e)})
        }

def page_router(httpmethod, querystring, formbody):
    if httpmethod == 'GET':
        try:
            with open('contactus.html', 'r') as htmlFile:
```

<u>EC2 Instance</u>:

- **Instance Type**: t2.micro (Free Tier)
- **OS**: Amazon Linux/Ubuntu
- **Web Server**: Apache/Nginx
- **Security Group**: Allows inbound HTTP/HTTPS traffic (ports 80 and 443)

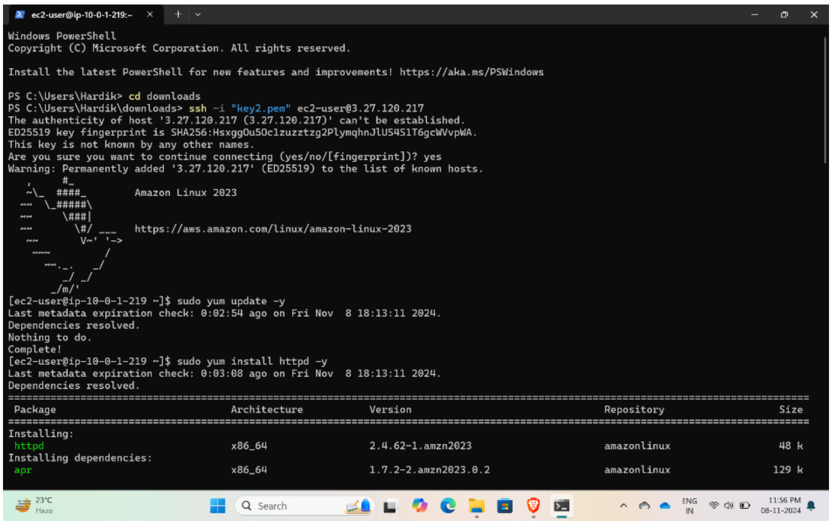


Instances (1/1) Info

	Name	Instance ID	Instance state	Instance type	Status check
☑	WebServerInst…	i-067b2db58b6e7e8a3	Stopped	t2.micro	–

i-067b2db58b6e7e8a3 (WebServerInstance)

Name	Security group rule ID	Port range	Protocol
–	sgr-0b44574c7708e9e68	443	TCP
–	sgr-06ae62987e29a88ec	80	TCP
–	sgr-028157835cadd1035	22	TCP



```
Windows PowerShell
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Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\Hardik> cd downloads
PS C:\Users\Hardik\downloads> ssh -i "key2.pem" ec2-user@3.27.120.217
The authenticity of host '3.27.120.217 (3.27.120.217)' can't be established.
ED25519 key fingerprint is SHA256:HsxggOu5Oc1zuzztzg2PlymqhnJlUS4S1T6gcWVvpWA.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '3.27.120.217' (ED25519) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
[ec2-user@ip-10-0-1-219 ~]$ sudo yum update -y
Last metadata expiration check: 0:02:54 ago on Fri Nov  8 18:13:11 2024.
Dependencies resolved.
Nothing to do.
Complete!
[ec2-user@ip-10-0-1-219 ~]$ sudo yum install httpd -y
Last metadata expiration check: 0:03:08 ago on Fri Nov  8 18:13:11 2024.
Dependencies resolved.
======================================================================================================================
 Package                           Architecture         Version                              Repository          Size
======================================================================================================================
Installing:
 httpd                             x86_64               2.4.62-1.amzn2023                    amazonlinux         48 k
Installing dependencies:
 apr                               x86_64               1.7.2-2.amzn2023.0.2                 amazonlinux        129 k
```
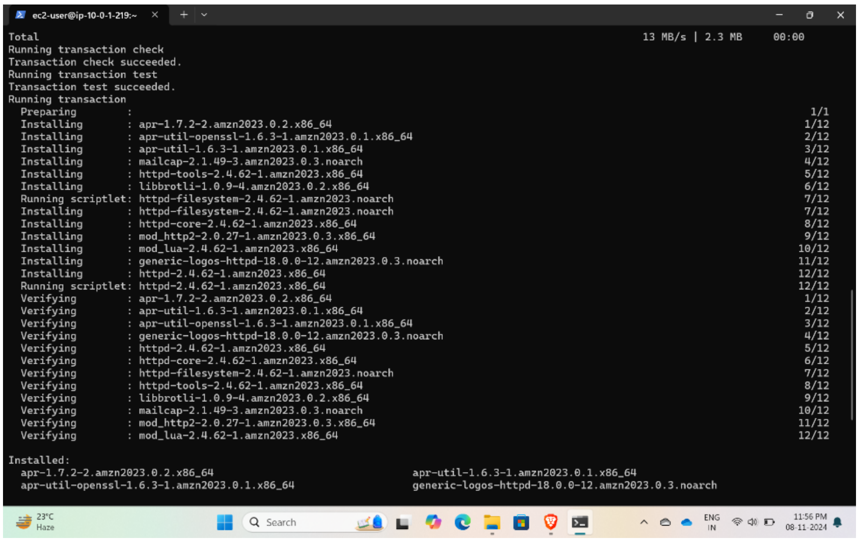
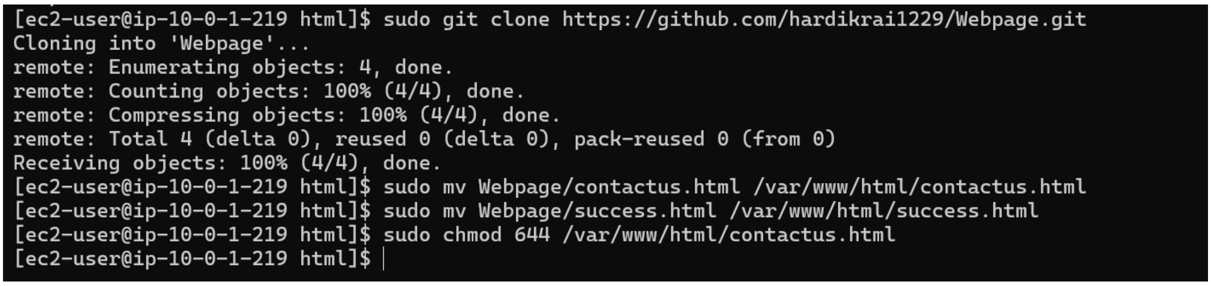
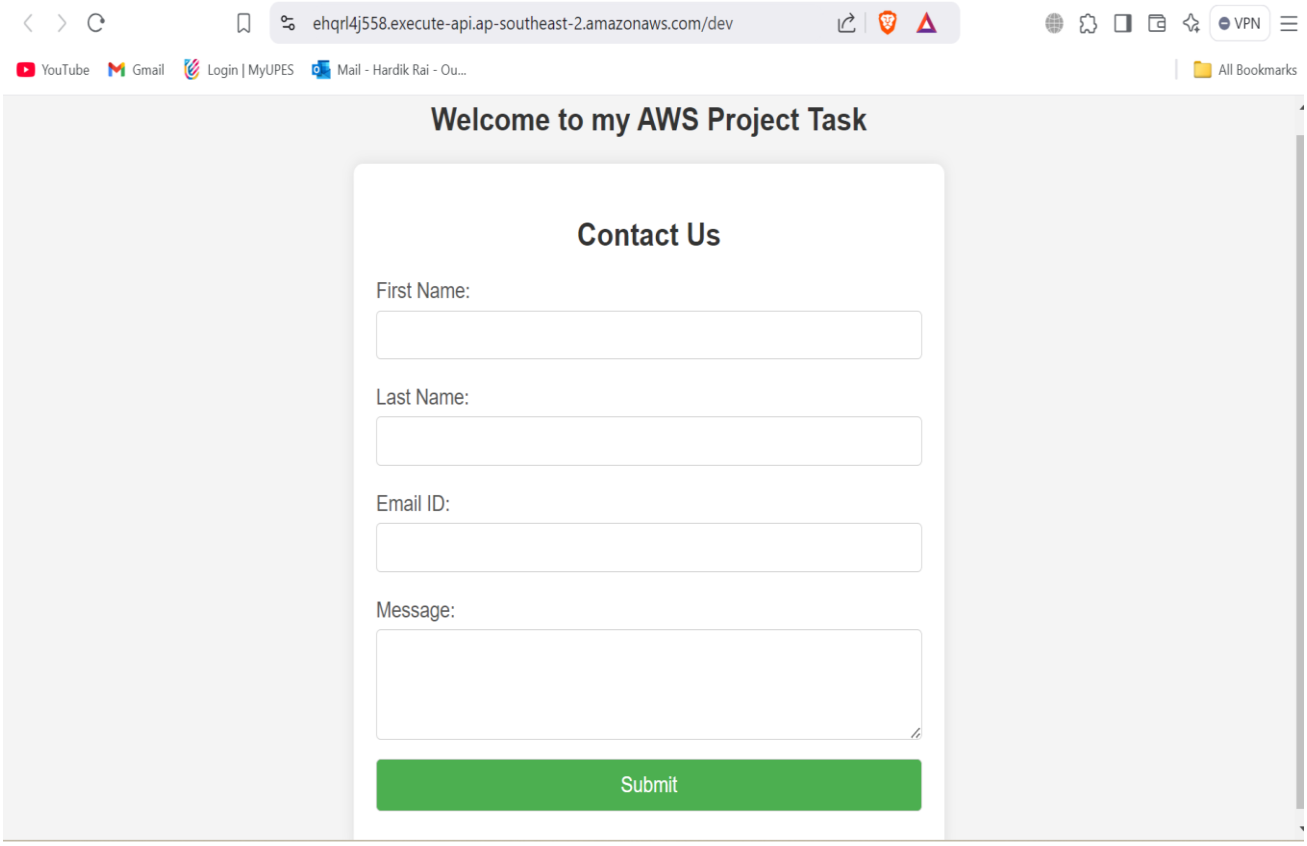



```
Total                                                                              13 MB/s | 2.3 MB     00:00
Running transaction check
Transaction check succeeded.
Running transaction test
Transaction test succeeded.
Running transaction
  Preparing        :                                                                                          1/1
  Installing       : apr-1.7.2-2.amzn2023.0.2.x86_64                                                          1/12
  Installing       : apr-util-openssl-1.6.3-1.amzn2023.0.1.x86_64                                             2/12
  Installing       : apr-util-1.6.3-1.amzn2023.0.1.x86_64                                                     3/12
  Installing       : mailcap-2.1.49-3.amzn2023.0.3.noarch                                                     4/12
  Installing       : httpd-tools-2.4.62-1.amzn2023.x86_64                                                     5/12
  Installing       : libbrotli-1.0.9-4.amzn2023.0.2.x86_64                                                    6/12
  Running scriptlet: httpd-filesystem-2.4.62-1.amzn2023.noarch                                                7/12
  Installing       : httpd-filesystem-2.4.62-1.amzn2023.noarch                                                7/12
  Installing       : httpd-core-2.4.62-1.amzn2023.x86_64                                                      8/12
  Installing       : mod_http2-2.0.27-1.amzn2023.0.3.x86_64                                                   9/12
  Installing       : mod_lua-2.4.62-1.amzn2023.x86_64                                                        10/12
  Installing       : generic-logos-httpd-18.0.0-12.amzn2023.0.3.noarch                                       11/12
  Installing       : httpd-2.4.62-1.amzn2023.x86_64                                                          12/12
  Running scriptlet: httpd-2.4.62-1.amzn2023.x86_64                                                          12/12
  Verifying        : apr-1.7.2-2.amzn2023.0.2.x86_64                                                          1/12
  Verifying        : apr-util-1.6.3-1.amzn2023.0.1.x86_64                                                     2/12
  Verifying        : apr-util-openssl-1.6.3-1.amzn2023.0.1.x86_64                                             3/12
  Verifying        : generic-logos-httpd-18.0.0-12.amzn2023.0.3.noarch                                        4/12
  Verifying        : httpd-2.4.62-1.amzn2023.x86_64                                                           5/12
  Verifying        : httpd-core-2.4.62-1.amzn2023.x86_64                                                      6/12
  Verifying        : httpd-filesystem-2.4.62-1.amzn2023.noarch                                                7/12
  Verifying        : httpd-tools-2.4.62-1.amzn2023.x86_64                                                     8/12
  Verifying        : libbrotli-1.0.9-4.amzn2023.0.2.x86_64                                                    9/12
  Verifying        : mailcap-2.1.49-3.amzn2023.0.3.noarch                                                    10/12
  Verifying        : mod_http2-2.0.27-1.amzn2023.0.3.x86_64                                                  11/12
  Verifying        : mod_lua-2.4.62-1.amzn2023.x86_64                                                        12/12

Installed:
  apr-1.7.2-2.amzn2023.0.2.x86_64                               apr-util-1.6.3-1.amzn2023.0.1.x86_64
  apr-util-openssl-1.6.3-1.amzn2023.0.1.x86_64                  generic-logos-httpd-18.0.0-12.amzn2023.0.3.noarch
```



```
[ec2-user@ip-10-0-1-219 html]$ sudo git clone https://github.com/hardikrai1229/Webpage.git
Cloning into 'Webpage'...
remote: Enumerating objects: 4, done.
remote: Counting objects: 100% (4/4), done.
remote: Compressing objects: 100% (4/4), done.
remote: Total 4 (delta 0), reused 0 (delta 0), pack-reused 0 (from 0)
Receiving objects: 100% (4/4), done.
[ec2-user@ip-10-0-1-219 html]$ sudo mv Webpage/contactus.html /var/www/html/contactus.html
[ec2-user@ip-10-0-1-219 html]$ sudo mv Webpage/success.html /var/www/html/success.html
[ec2-user@ip-10-0-1-219 html]$ sudo chmod 644 /var/www/html/contactus.html
[ec2-user@ip-10-0-1-219 html]$ |
```



ehqrl4j558.execute-api.ap-southeast-2.amazonaws.com/dev
YouTube
Gmail
Login | MyUPES
Mail - Hardik Rai - Ou...
All Bookmarks
VPN

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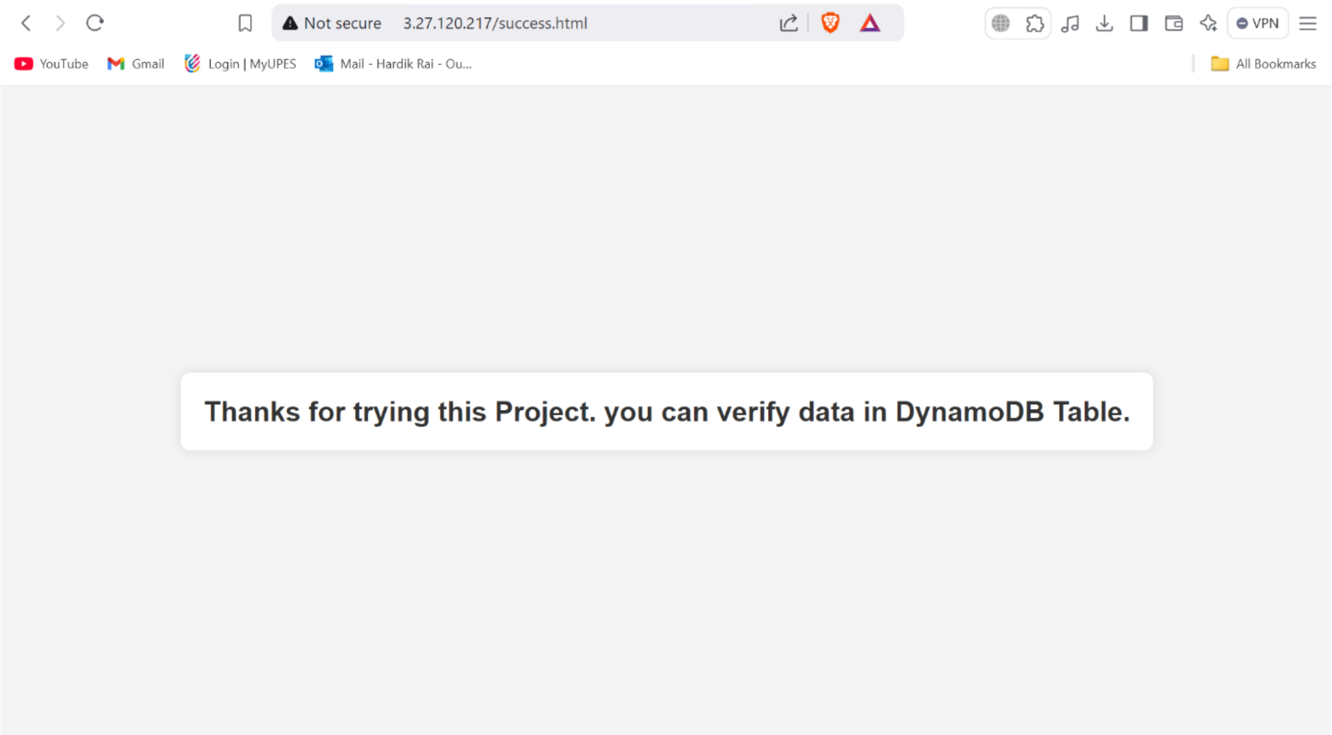
Last Name:

Email ID:

Message:

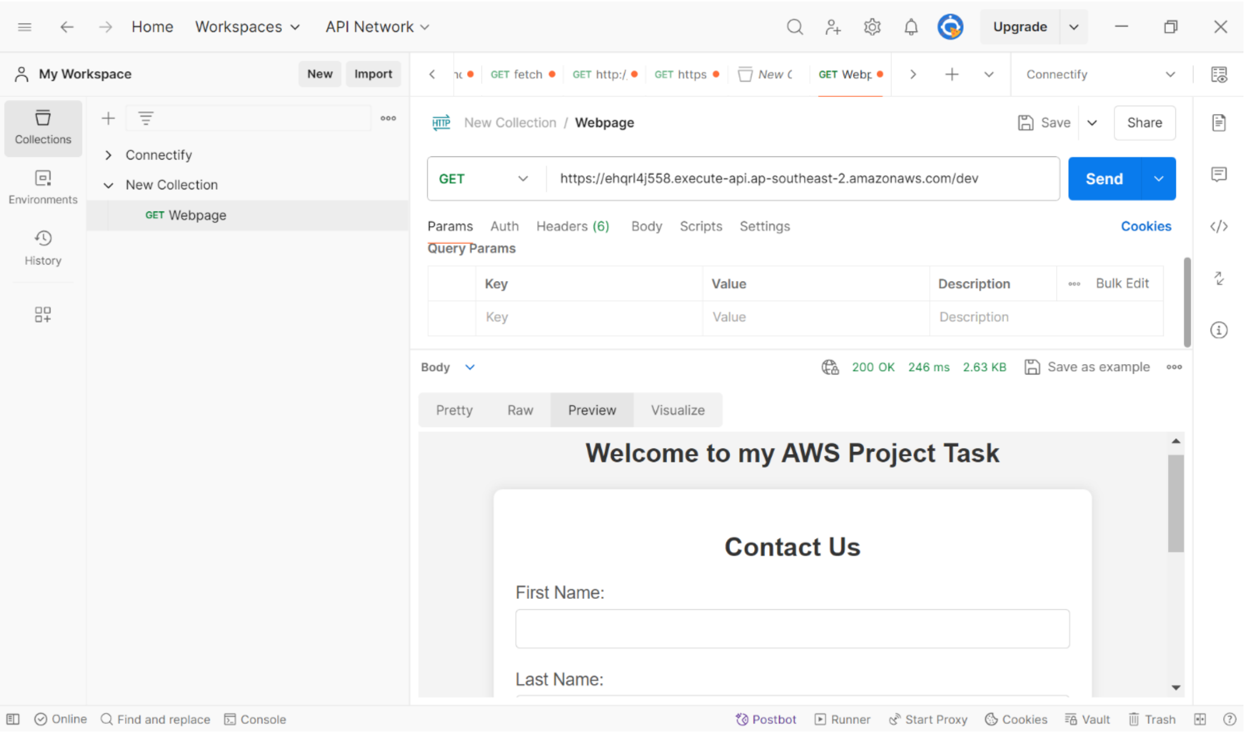


Not secure 3.27.120.217/success.html
YouTube
Gmail
Login | MyUPES
Mail - Hardik Rai - Ou...
All Bookmarks
VPN

Thanks for trying this Project. you can verify data in DynamoDB Table.

Using **Postman** to test the complete cycle:

- Create a new user with a POST request.
- Retrieve the user with a GET request.
- Check DynamoDB to ensure data consistency



GET https://ehqrl4j558.execute-api.ap-southeast-2.amazonaws.com/dev

Key	Value	Description
Key	Value	Description

200 OK 246 ms 2.63 KB

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Last Name:

Technologies Used

- **Amazon EC2**: Virtual servers running a web server (Apache/Nginx) for hosting the frontend application (HTML files).
- **AWS Lambda**: Serverless functions to process backend logic, triggered by API requests.
- **Amazon RDS** or **DynamoDB**: Used for data storage. MySQL/PostgreSQL (RDS) or DynamoDB based on the project's requirements.
- **AWS VPC**: Provides a secure network layer, ensuring isolation between the application, database, and internet.
- **API Gateway**: Manages HTTP requests to trigger the Lambda functions.
- **Git**: Used for cloning the repository containing the web application files.

Challenges Faced and Solutions Implemented

- **Challenge 1**:
  - **Issue**: Unable to clone the repository due to the lack of git on the EC2 instance.
  - **Solution**: Installed git using sudo yum install git -y and successfully cloned the repository.
- **Challenge 2**:
  - **Issue**: Permission denied when transferring HTML files to the EC2 instance using scp.
  - **Solution**: Adjusted file permissions on the .pem key using chmod 400 and successfully transferred the files using the correct scp command.
- **Challenge 3**:
  - **Issue**: Incorrect security group settings leading to connection issues.
  - **Solution**: Adjusted the EC2 instance's security group to allow inbound HTTP (port 80) and HTTPS (port 443) traffic.
- **Challenge 4**:
  - **Issue**: Lambda function not connecting to DynamoDB
  - **Solution**: Ensured that the Lambda function had the correct IAM permissions to access DynamoDB and verified VPC/subnet configurations to allow secure communication between Lambda and DynamoDB

Github Link for the code - https://github.com/hardikrai1229/Webpage.git

PRESENTATION LINK - https://upesstd-my.sharepoint.com/:p:/r/personal/hardik_102001_stu_upes_ac_in/_layouts/15/Doc.aspx?sourcedoc=%7B1F0CBCFB-9137-47CE-9AB4-229B3C841BB2%7D&file=Assignment_2_ppt.pptx&action=edit&mobileredirect=true