AWS Data Confluence High-Velocity Streaming to Immediate BI

"AWS Real-Time Data Confluence" is a lightweight, serverless data streaming and analytics system built entirely on Amazon Web Services (AWS). The project demonstrates how real-time events generated from a web interface can be ingested, stored, processed, and analyzed using a fully cloud-native pipeline. It uses Amazon S3 as a scalable data lake, AWS Lambda for serverless compute, Amazon API Gateway for secure ingestion, AWS Glue for automated schema discovery, and Amazon Athena for instant SQL analytics. A simple React interface sends event data (such as user activity, transactions, or application logs) directly into the streaming pipeline, making the system easy to test, extend, and visualize.

The user experience begins from the React application, where any event can be triggered through a button click or form submission. The app sends this data in real-time to API Gateway, which acts as a secure entry point. API Gateway forwards the data to a Lambda function, which processes and stores each event into the S3 data lake using time-partitioned folders. This ensures high scalability, low cost, and immediate availability of data for analytical workloads.

AWS Glue automatically crawls the S3 bucket to detect incoming files and build a table structure in the Glue Data Catalog. This turns raw JSON events into queryable datasets without requiring manual schema creation. Once the tables are created, Amazon Athena can run SQL queries directly on top of the S3 data, enabling instant insights such as counting events, categorizing types, or analyzing attributes. Because Athena is serverless, results are delivered instantly without maintaining any servers or databases.

Scenario 1: Live Event Logging

A developer pushes a button in the React application that generates a “user_action” event. The API Gateway receives it instantly, triggering the Lambda function, which stores the event in S3 with a timestamp. Minutes later, the developer runs an Athena SQL query to view all actions logged in real time.

Scenario 2: Application Monitoring

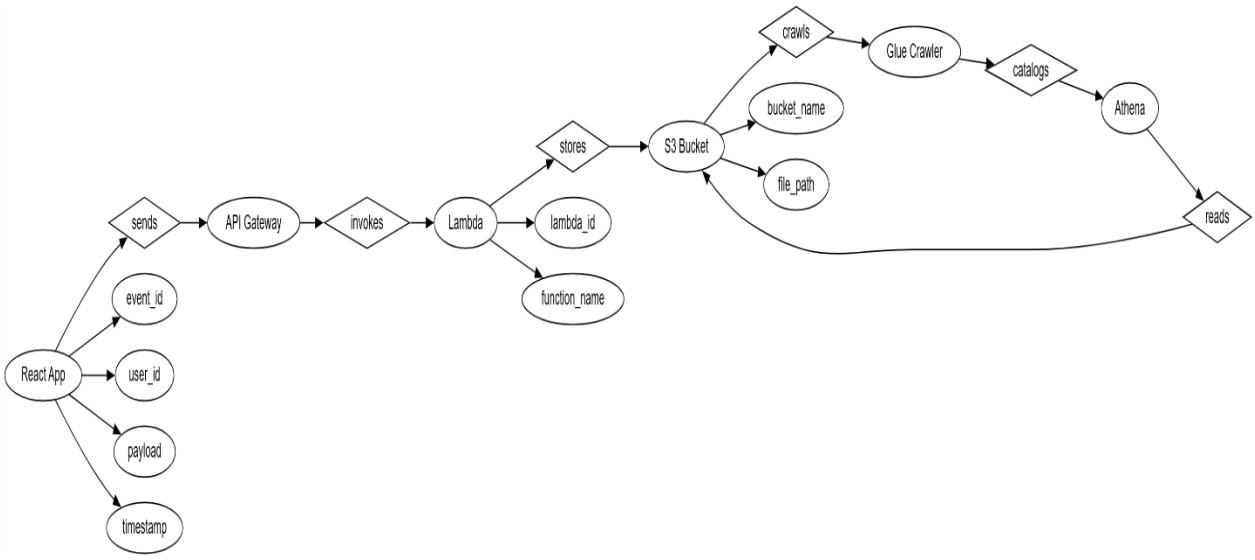
A small web application sends system health logs to the same API endpoint. Without modifying infrastructure, Lambda stores each log entry in S3. Using Athena, the team can check error counts, latency patterns, and usage trends directly through SQL.

Scenario 3: Sales Data Stream

An e-commerce demo app sends mock transaction data (amount, product, time). Glue detects the new schema and updates the catalog. Analysts can instantly query revenue, top-selling categories, or hourly sales trends without any storage provisioning.

Technical Diagram:

ER Diagram:



Prior Knowledge:

1. AWS Account Setup:
https://youtu.be/CjKhQoYeR4Q?si=ui8Bvk_M4FfVM-Dh

2.Web Application Stack : React || Javascript fetch API

3. Amazon S3 (Simple Storage Service):
https://youtu.be/A2N9OIun9dU?si=DguWsoaEqOL8dF1x

4. AWS Lambda:
https://www.youtube.com/results?search_query=aws+lambda+tutorial

5. Amazon S3 (Simple Storage Service):
https://www.youtube.com/results?search_query=aws+s3+tutorial

6. Amazon API Gateway:
https://www.youtube.com/results?search_query=api+gateway+tutorial

7. AWS Glue :
https://www.youtube.com/results?search_query=aws+glue+tutorial

8. Amazon Athena:
https://www.youtube.com/results?search_query=amazon+athena+tutorial

9. AWS CloudWatch:
https://www.youtube.com/results?search_query=aws+cloudwatch+tutorial

10. AWS IAM:
https://youtu.be/_ZCTvmaPgao?si=bydbpAgyRN8x7GhZ

Project Workflow:

1. AWS Account Setup

- Create an AWS account and configure billing settings.
- Access the AWS Management Console to set up services.

2. Create an S3 Bucket (Data Lake Storage)

- Open S3 and create a new bucket to store all application data.
- Enable public access restrictions for security.
- Create folders/prefixes to organize incoming JSON data.
- This bucket becomes the central Data Lake used by Glue and Athena.

3. Create IAM Role for Lambda

- Go to IAM → Create Role.
- Choose trusted entity: **AWS Lambda**.
- Attach only these policies:
- **AWSLambdaBasicExecutionRole**
- **AmazonS3FullAccess** (or restricted S3 access for your bucket)
- Name it: **LambdaS3WriterRole**
- This role allows Lambda to write processed data into S3.

4. Create Lambda Function (Processing Layer)

- Go to Lambda → Create function → Author from scratch.
- Select Python/Node runtime.
- Assign your IAM role (**LambdaS3WriterRole**).
- Add code to receive input, validate it, and upload JSON objects into S3.
- Test the function using sample payloads in the Lambda test console.

5. Create API Gateway (Data Ingestion Endpoint)

- Open API Gateway → Create REST API.
- Create resource: **/stream**.
- Add POST method linked to your Lambda function.
- Enable CORS for your React application.
- Deploy the API to a stage (e.g., **prod**) and copy the Invoke URL.
- This endpoint will act as your real-time streaming input API.

6. Build the React Application (Frontend Layer)

- Create a simple UI using ReactJS.
- Add a form that accepts values and sends them to API Gateway using **fetch()**.
- Display submitted values or acknowledgements from the API.
- Host locally or deploy elsewhere (optional).
- This UI becomes the front-facing ingestion dashboard.

7. Run AWS Glue Crawler (Schema Discovery)

- Go to Glue → Create Crawler.
- Point the crawler to your S3 bucket where Lambda stores JSON files.
- Choose IAM role: **AWSGlueServiceRole** (auto-created or manual).
- Run the crawler to automatically detect schema.
- A Glue table will be created inside the Glue Data Catalog.

8. Create Athena Tables & Execute Queries

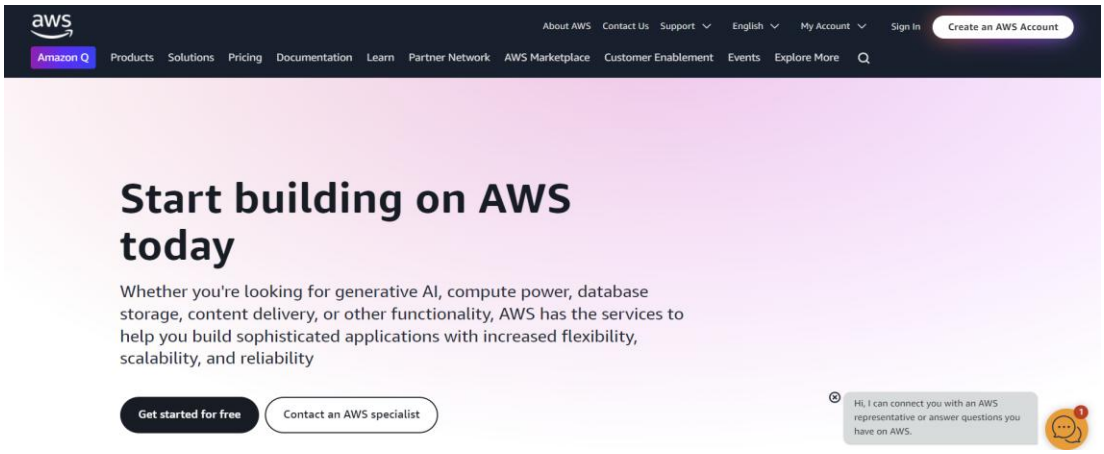
- Open Athena → Set query results location in S3.
- Select the database created by the Glue Crawler.
- Query your S3-stored data using SQL.
- Run queries for search, filtering, ordering, and analytics.
- This gives BI-like insights without the need for QuickSight.

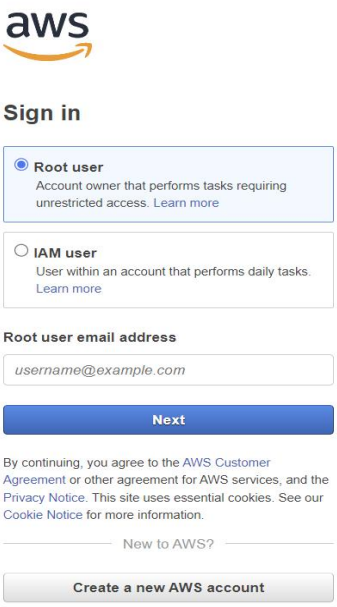
Milestone 1: AWS Account Creation and Login

In this milestone, we will set up an AWS account to access the necessary services for the BloodBridge project.

Activity 1: Create AWS Account

1. Go to the AWS website (https://aws.amazon.com/).
2. Click on the "Create an AWS Account" button.
3. Follow the prompts to enter your email address and choose a password.
4. Provide the required account information, including your name, address, and phone number.
5. Enter your payment information. (Note: While AWS offers a free tier, a credit card or debit card is required for verification.)
6. Complete the identity verification process.
7. Choose a support plan (the basic plan is free and sufficient for starting).
8. Once verified, you can sign in to your new AWS account.

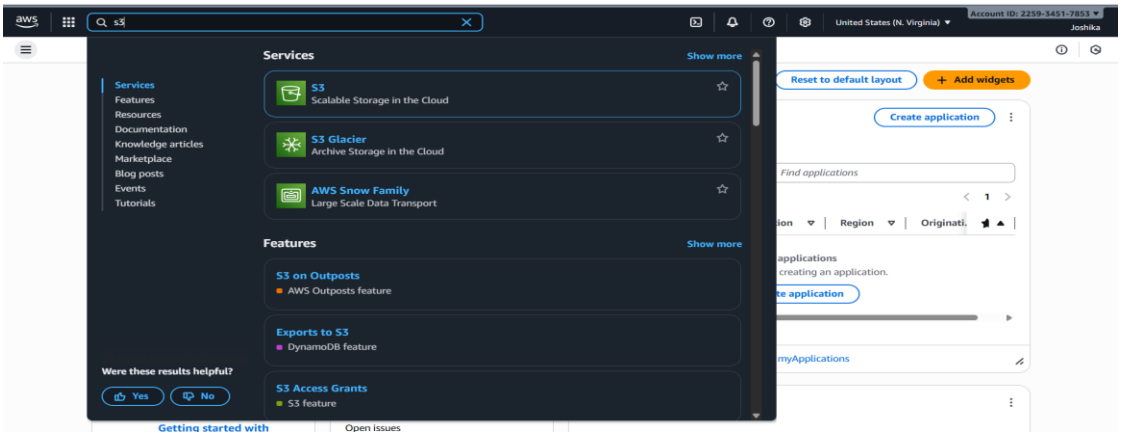




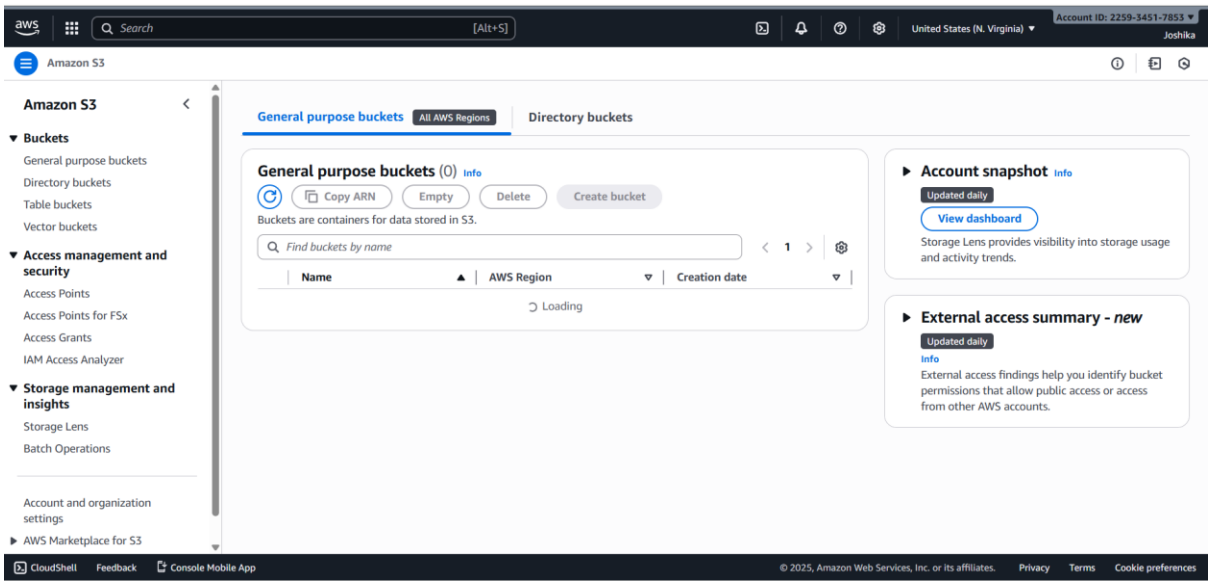
Milestone 2: Amazon S3 Bucket Creation and Setup

In this milestone, we will create and configure an Amazon S3 bucket that will act as the **central data lake** for our serverless streaming pipeline.
All real-time events from the web application will be stored here before being processed by AWS Glue and analyzed using Amazon Athena.

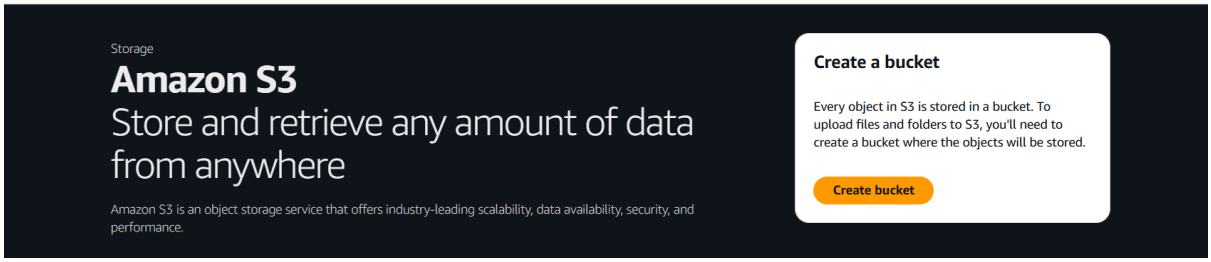
- **Activity 2.1: Access the S3 Console**
  - Log in to the **AWS Management Console**.
  - Search for **S3** in the AWS search bar.
  - Click on **Amazon S3** to open the S3 dashboard.



- The S3 interface



- Click on create bucket

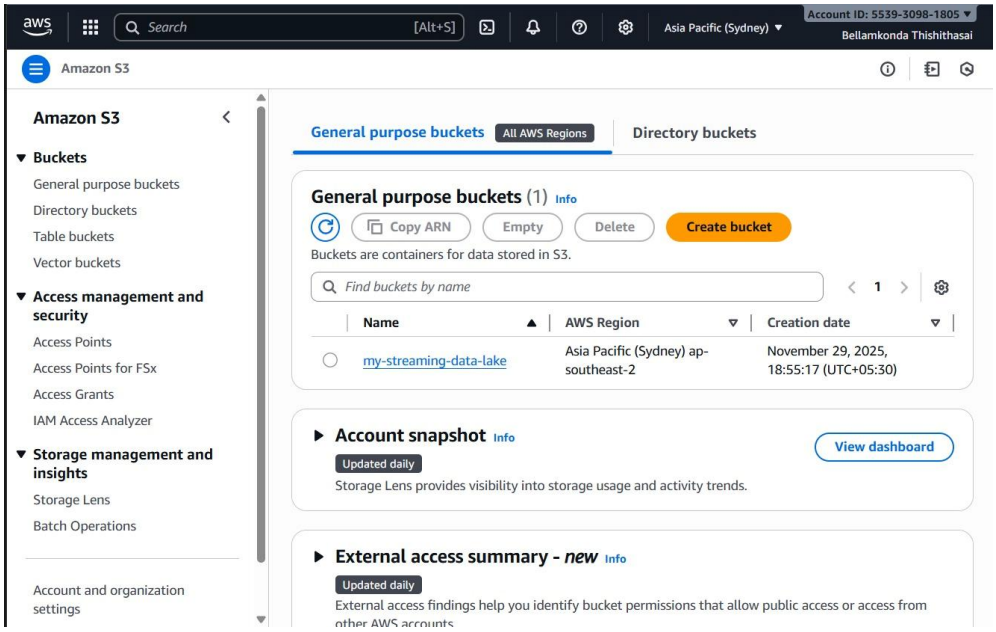


Fill in the following settings:

- **Bucket Details**
  - **Bucket name:** my-streaming-data-lake
    (Bucket names must be unique globally.)
  - **AWS Region:** Select your region
    (In your screenshot: Asia Pacific (Sydney) ap-southeast-2)
- **Bucket Options**

Keep all default settings:

- Block Public Access – **ON (Recommended)**
- Versioning – **Disabled**
- Encryption – **Enabled (Default SSE-S3)**
- Finally , click on the Create Bucket.



- **Activity 2.2: Create Folders in the Bucket**
    - Open the bucket → Click **Create folder**.

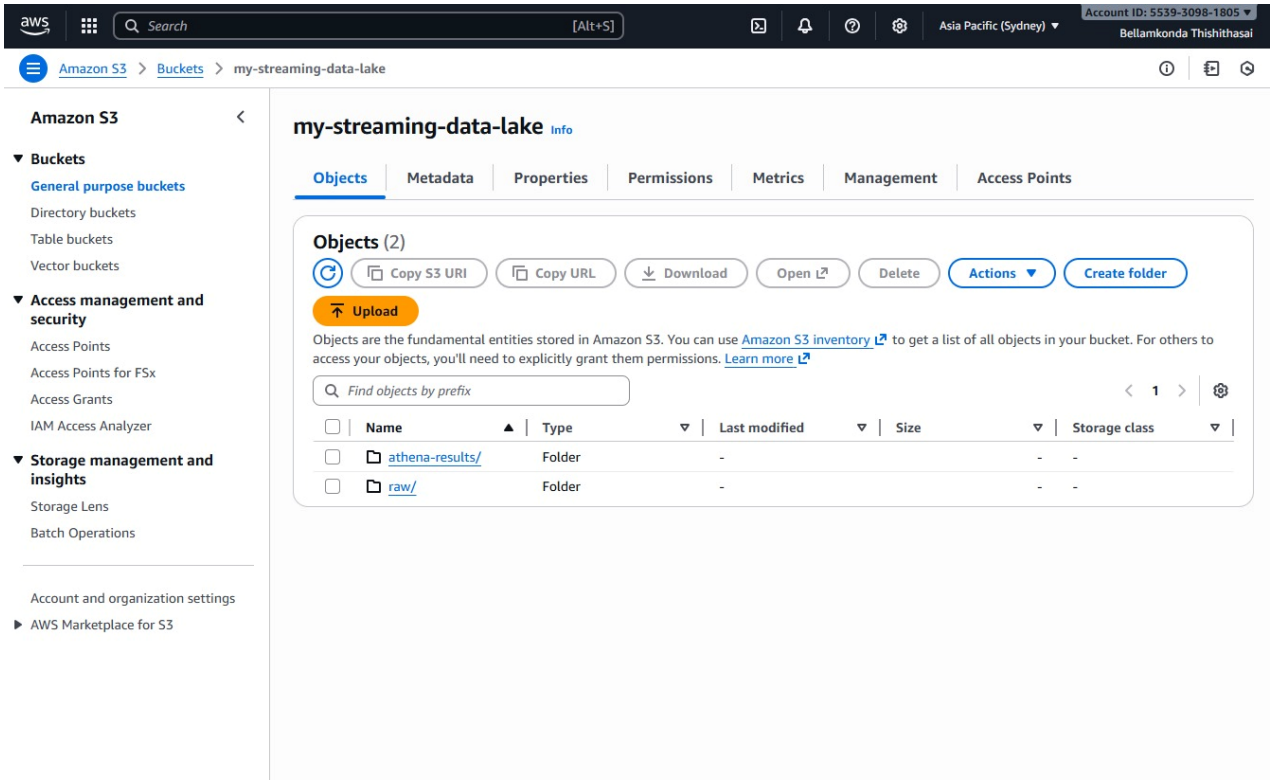
      Inside the newly created bucket:
        - Create folder: **raw**
        - Create folder: **athena-results**

      These folders will later be accessed by:
        - AWS Lambda (writing data)
        - AWS Glue (crawling data)
        - AWS Athena (reading data

    - Create two folders:

📁 Folder Structure

raw/
athena-results/



MILESTONE 3: IAM Role Creation and AWS Lambda Setup

In this milestone, we configure the backend services required for our real-time data streaming pipeline.
We start by creating an IAM role that provides permissions for Lambda to interact with Amazon S3.
Next, we configure the Lambda function **json_event_ingestor**, which processes incoming JSON events and stores them inside the S3 Data Lake.

Activity 3.1: Create IAM Role for Lambda

In this activity, we will create the IAM role that allows the Lambda function to write to S3 and generate CloudWatch logs.

Steps:

1. Log in to AWS Console → Go to **IAM**.
2. Select **Access Management → Roles** from the left menu.
3. Click on **Create role**.
4. Choose **Trusted Entity: AWS Service**.
5. Select **Lambda** as the use case.
6. Click **Next** to add permissions.

Attach the following policies:

- **AWSLambdaBasicExecutionRole**
  (Allows writing logs to CloudWatch)
- **LambdaS3WritePolicy** *(Your inline policy)*
  This policy allows your Lambda function to upload JSON files into your S3 bucket my-streaming-data-lake.

Name the Role: LambdaS3WriterRole

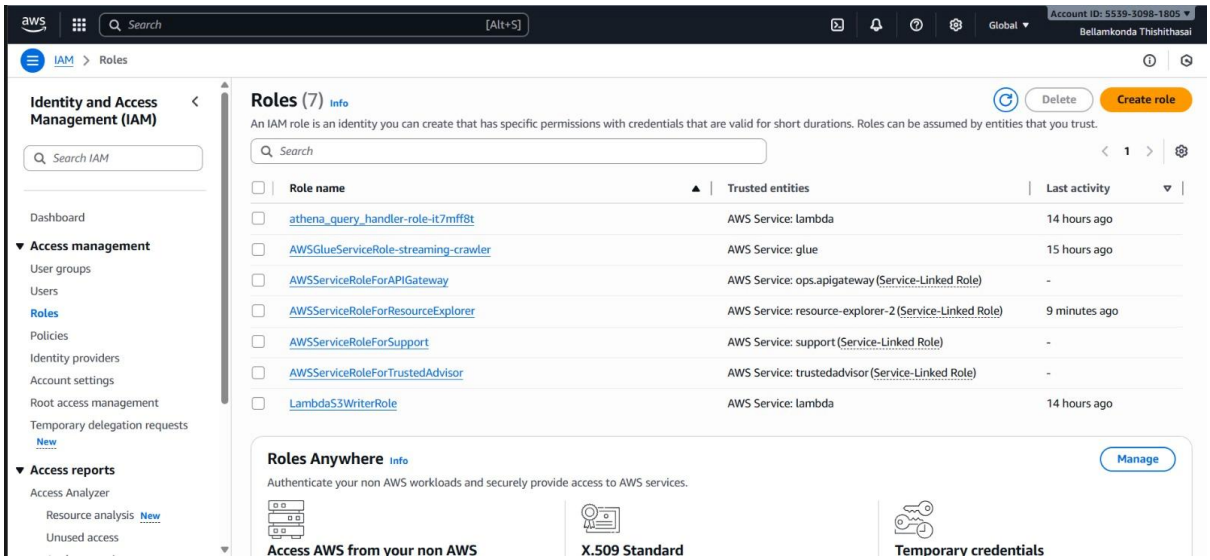


Figure: IAM roles list displaying the newly created LambdaS3WriterRole.

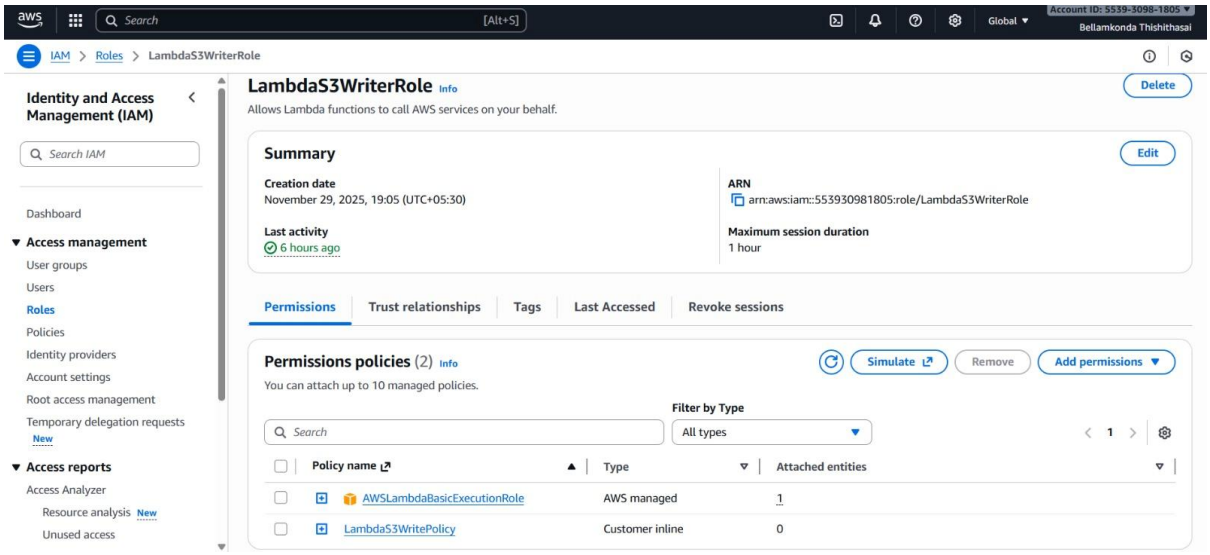


Figure: Attached permission policies for LambdaS3WriterRole.

Activity 3.2: AWS Lambda Function Creation

In this activity, we create the Lambda function that receives incoming event data and stores it in the S3 Data Lake with timestamp-based folder structure.

Steps:

1. Go to **AWS Console → Lambda → Functions**.
2. Click on **Create Function**.
3. Choose:

   Author from scratch
   Function name: json_event_ingestor
   Runtime: Python 3.9

4. Under **Execution Role**, select:

   Use existing role → LambdaS3WriterRole

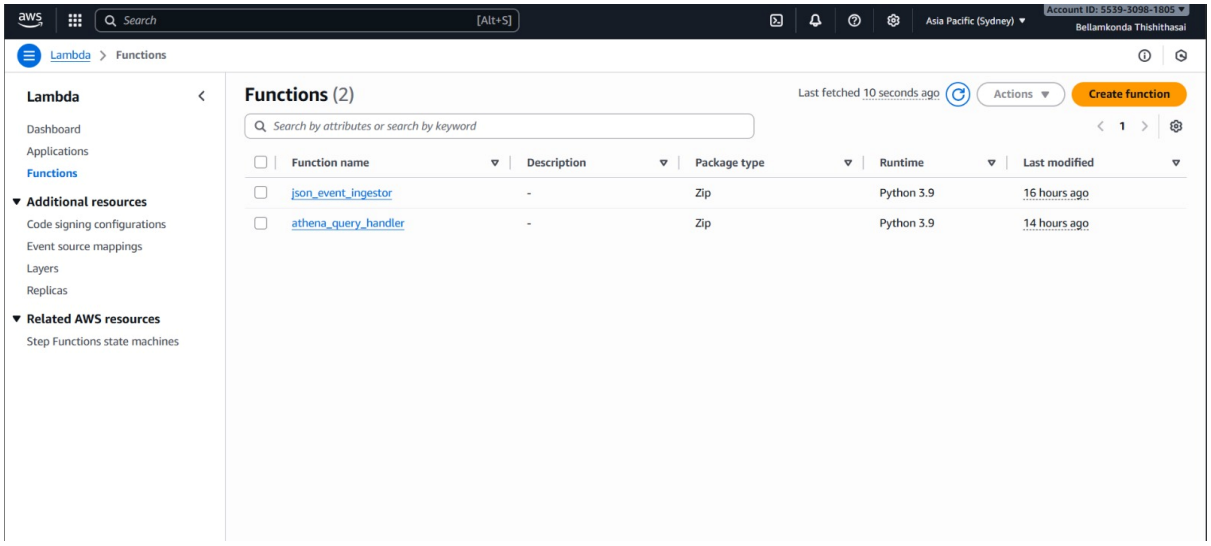


Figure: Lambda functions list showing json_event_ingestor.

Activity 3.3: Lambda Function Configuration & Code Upload

Once the Lambda function is created, we configure triggers and upload the event ingestion code.

Steps:

- Open **json_event_ingestor** function.
- In the function overview diagram, verify that **API Gateway** is connected as a trigger.
- Open the **Code** tab.
- Replace the default Python code with your implementation.

```
import json

import uuid

import datetime

import boto3

s3 = boto3.client("s3")

BUCKET = "my-streaming-data-lake"

def lambda_handler(event, context):

    body = json.loads(event["body"])

    now = datetime.datetime.utcnow()

    prefix = now.strftime("raw/%Y/%m/%d/%H/")

    filename = f"{uuid.uuid4()}.json"

    key = prefix + filename

    s3.put_object(

        Bucket=BUCKET,

        Key=key,

        Body=json.dumps(body),

        ContentType="application/json"

    ) return {

        "statusCode": 200,

        "headers": {"Access-Control-Allow-Origin": "*"},

        "body": json.dumps({"message": "Event stored", "file": key})

    }
```

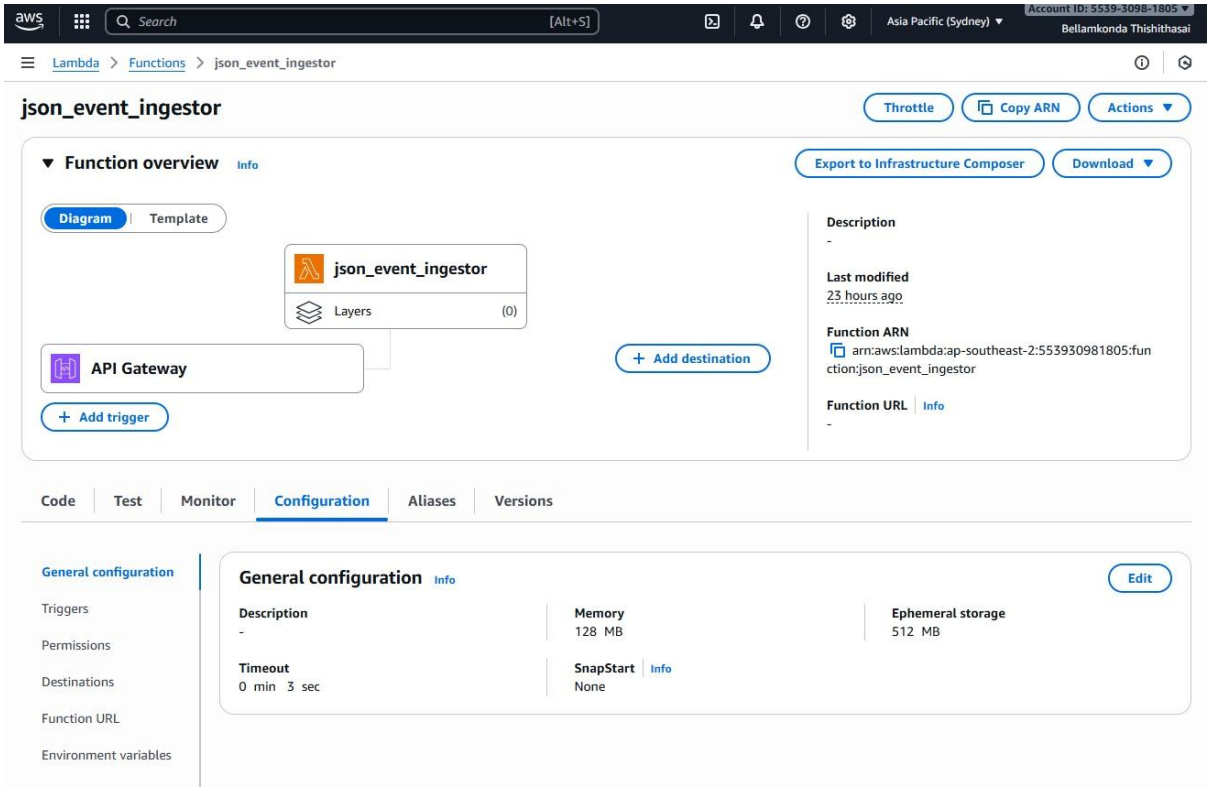


Figure: Configuration details of json_event_ingestor Lambda function.

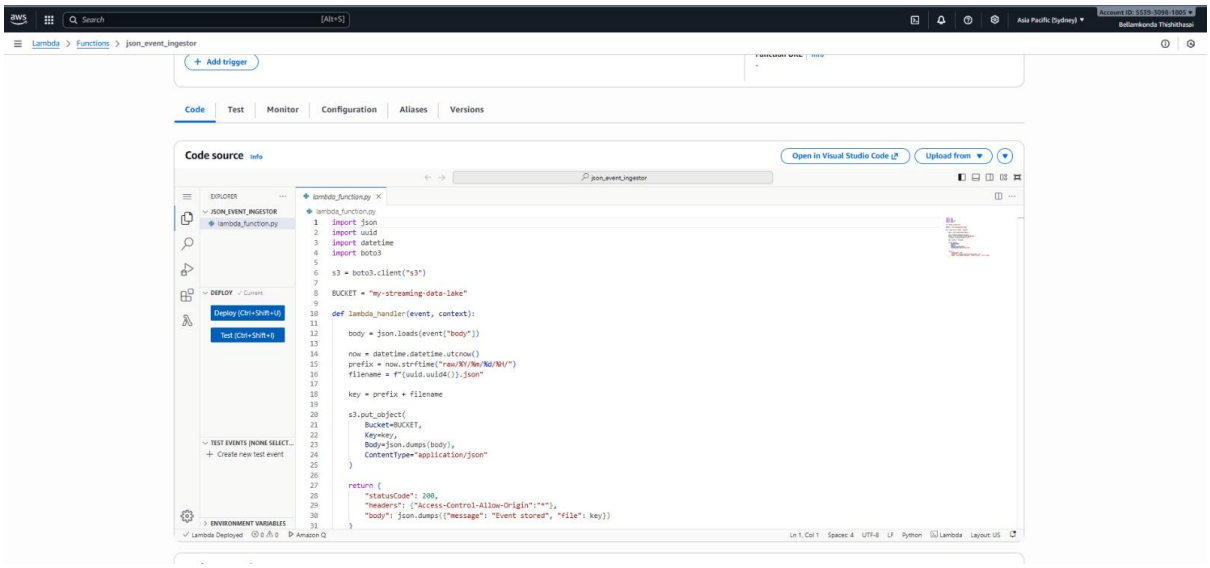


Figure: Python code inside the json_event_ingestor Lambda function.

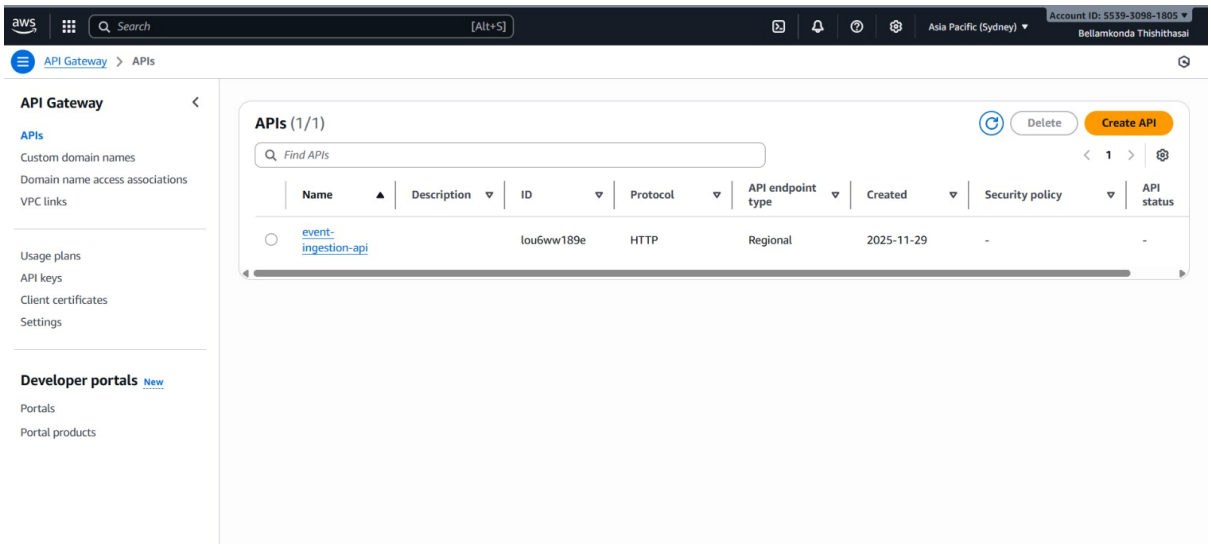
MILESTONE 4: API Gateway Setup (Real-Time Data Ingestion Endpoint)

In this milestone, we create the HTTP API that acts as the entry point for the real-time streaming pipeline.
This API receives JSON data from the React frontend and forwards it to the Lambda function **json_event_ingestor**.

Activity 4.1: Access API Gateway Console

Steps:

1. Log in to AWS Management Console.
2. Search for **API Gateway**.
3. Open the API Gateway dashboard.



Activity 4.2: Create a New HTTP API

You created an **HTTP API** (not REST API), as per the steps you followed.

Steps:

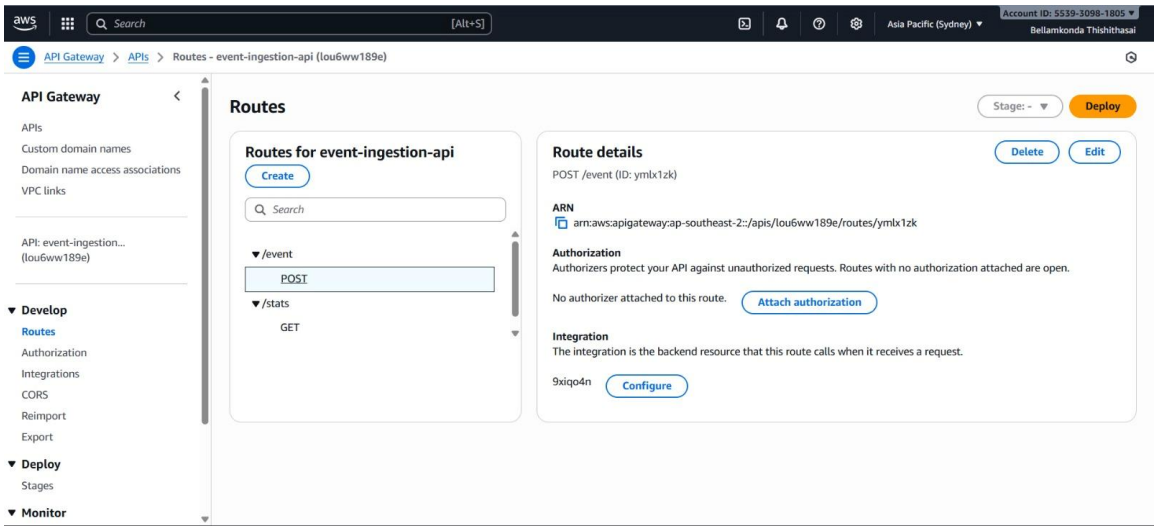
1. Click **Create API**.
2. Choose **Build → HTTP API**.
3. Select **Add Integration** → choose **Lambda**.
4. Select your Lambda function: json_event_ingestor

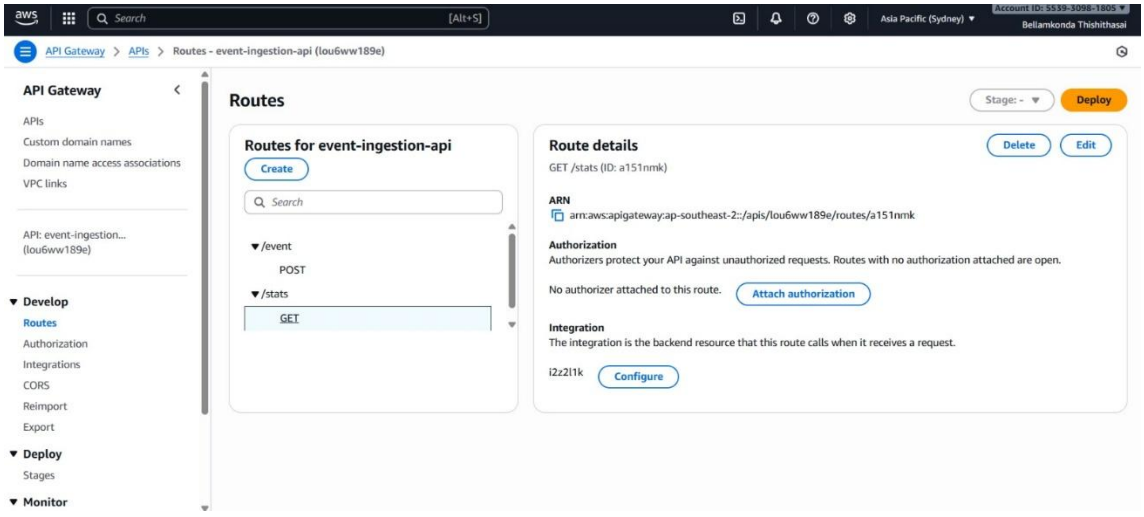
Activity 4.3: Create Route

You created a single route for accepting events:

Route:POST /event

This route ensures that your React app can send events using POST requests.





Activity 4.4: Enable CORS

To allow communication between your React app and API Gateway, CORS needs to be enabled.

Settings:

Access-Control-Allow-Origin: *
Access-Control-Allow-Methods: POST
Access-Control-Allow-Headers: *

Activity 4.5: Deploy the API

Steps:

1. Click **Deploy**.
2. Choose stage: prod
3. Copy the **Invoke URL**.
   This URL will be used in your React App in the fetch() call.

MILESTONE 5: React Frontend – Real-Time Event Sender

In this milestone, we create a simple React web application that sends JSON events to the AWS API Gateway endpoint.
This frontend behaves like a **streaming producer**, generating test events in real-time.

Activity 5.1: Create the React Application

Open a terminal in VS Code and run:

npx create-react-app frontend

Move into the folder:

cd frontend

Start the development server:

npm start

This launches the app at:

👉 **http://localhost:3000**

Activity 5.2: Verify Folder Structure

After successfully creating the React project, the following folder structure is generated:

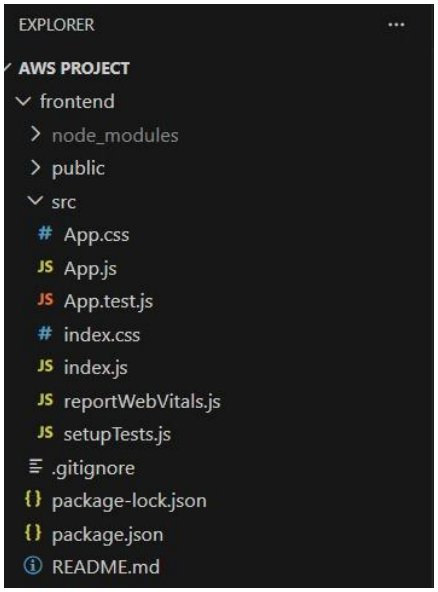


Figure: ***React project folder structure created using Create React App***

MILESTONE 6: AWS Glue Crawler Setup & Schema Discovery

In this milestone, we configure AWS Glue to automatically detect the schema of the JSON files stored in our S3 Data Lake.
The Glue Crawler scans the raw/ folder inside the bucket, identifies fields in incoming events, and creates a table (raw_events) inside the AWS Glue Data Catalog.
This allows Athena to query the data using SQL.

Activity 6.1: Create AWS Glue Crawler

Steps:

1. Log in to AWS Console → Search for **Glue**
2. In the left menu, click **Crawlers**
3. Click **Create crawler**
4. Enter name:
   streaming-data-crawler
5. Choose **Data source → S3**
6. Enter S3 path:
   s3://my-streaming-data-lake/raw/
7. Choose IAM Role:
   AWSGlueServiceRole-streaming-crawler
8. Choose database:
   streaming_lake
9. Click **Create** and then **Run Crawler**

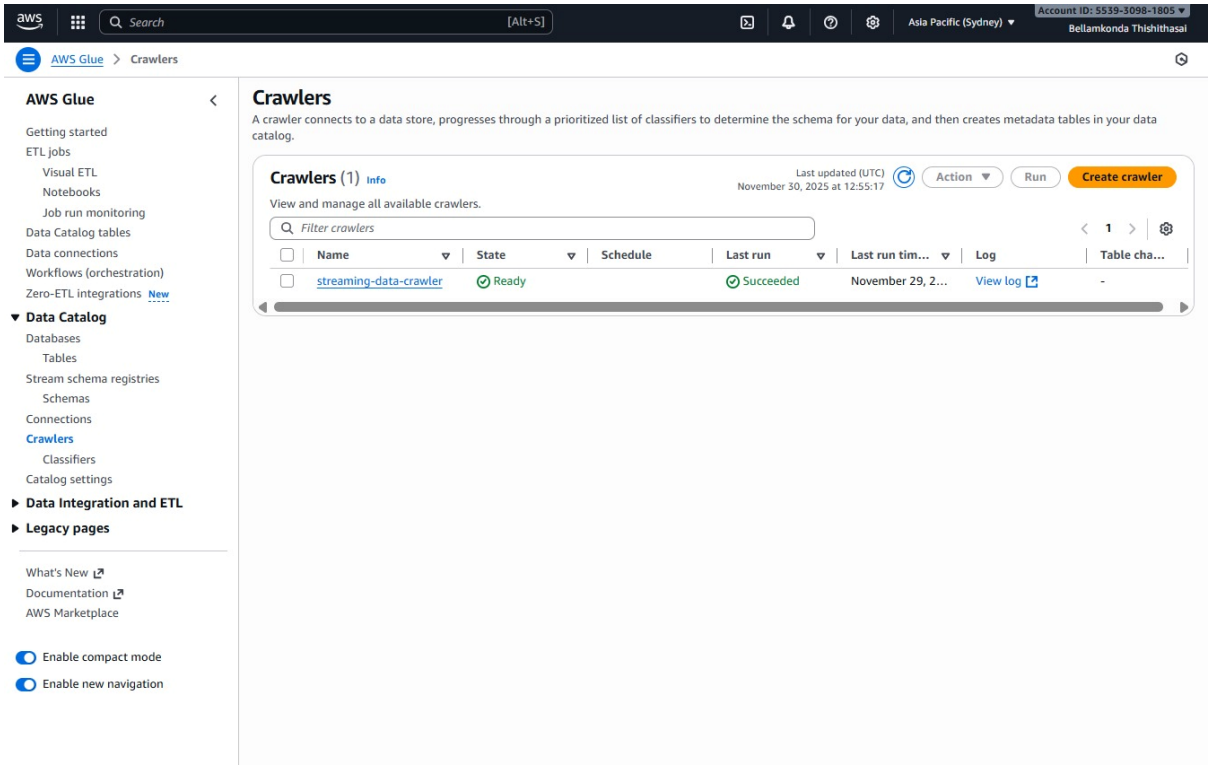


Figure: Showing the crawler name **streaming-data-crawler** with state READY

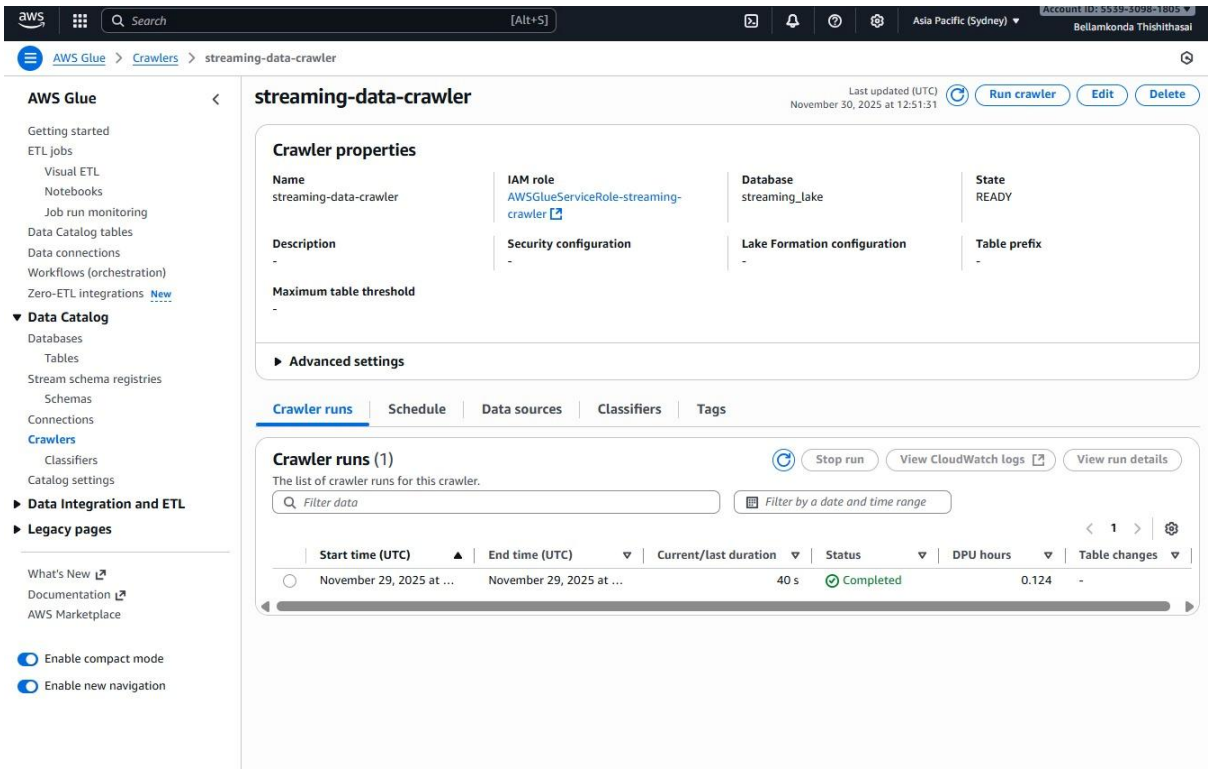


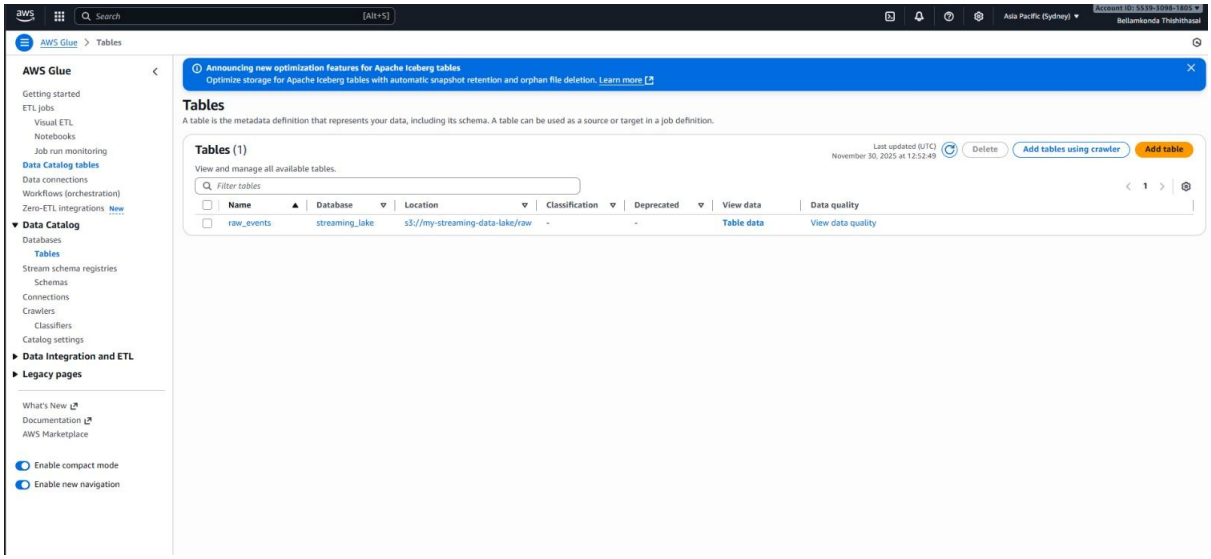
Figure: showing crawler properties, IAM role, database, and last run status "Completed".

Activity 6.2: View Tables Generated by Crawler

After the crawler runs successfully, it creates a table inside the Data Catalog.

Steps:

1. Go to **Glue → Data Catalog → Tables**
2. Select database: **streaming_lake**
3. You should see the table:
   raw_events



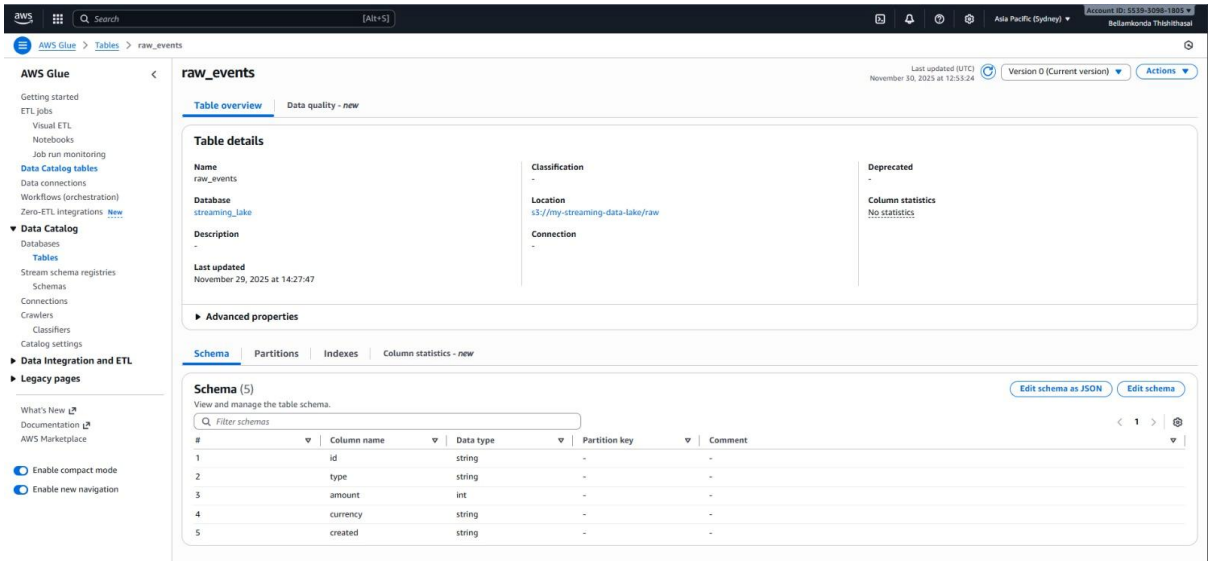
Activity 6.3: Inspect Table Schema

Click on **raw_events** to view the schema Glue discovered.

Expected columns:

Column	Type
id	string
type	string
amount	int
currency	string
created	string

Glue extracts this automatically.



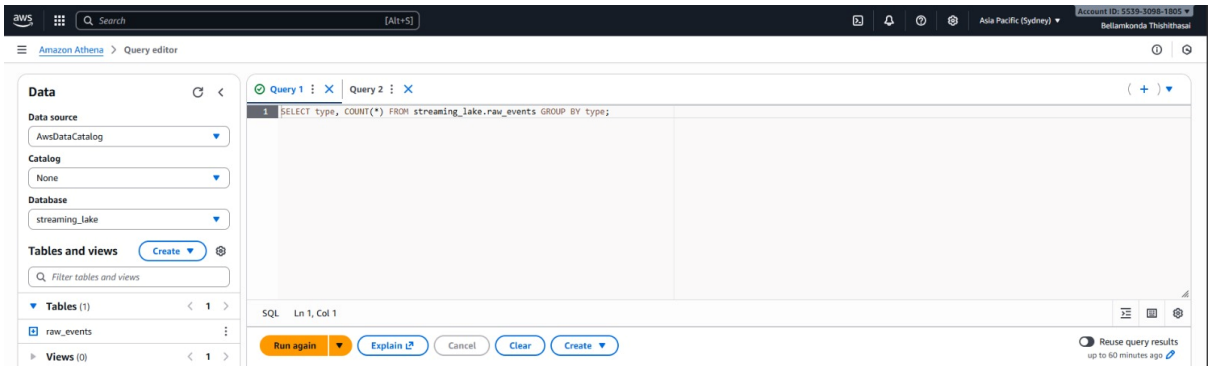
Activity 6.4: Verify Data Availability via Athena

To ensure the Glue table works properly:

1. Go to AWS → Athena
2. Select database: **streaming_lake**
3. Run sample queries:

Query 1: List all events

SELECT * FROM streaming_lake.raw_events LIMIT 10;

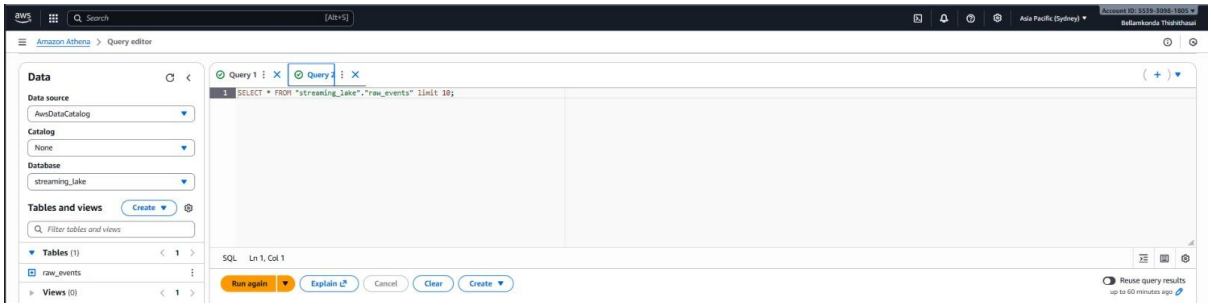


Query 2: Group by event type

SELECT type, COUNT(*)

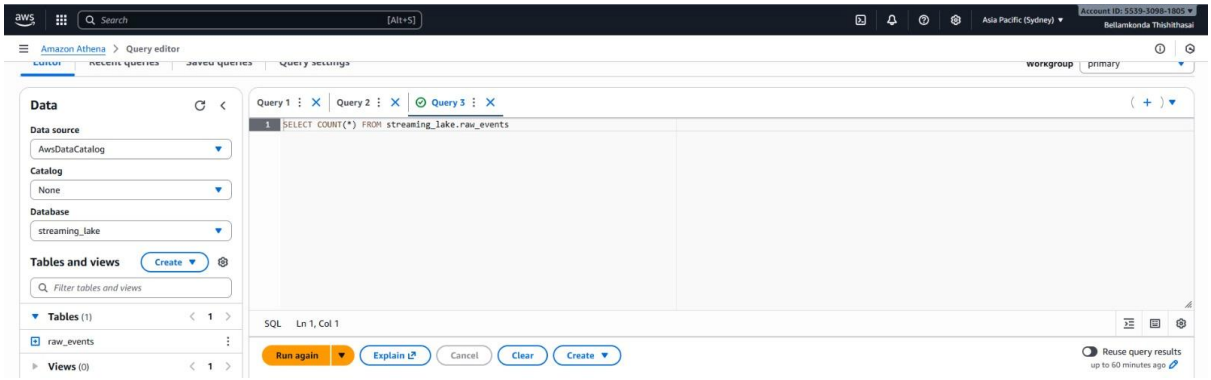
FROM streaming_lake.raw_events

GROUP BY type;



Query 3: Count total events

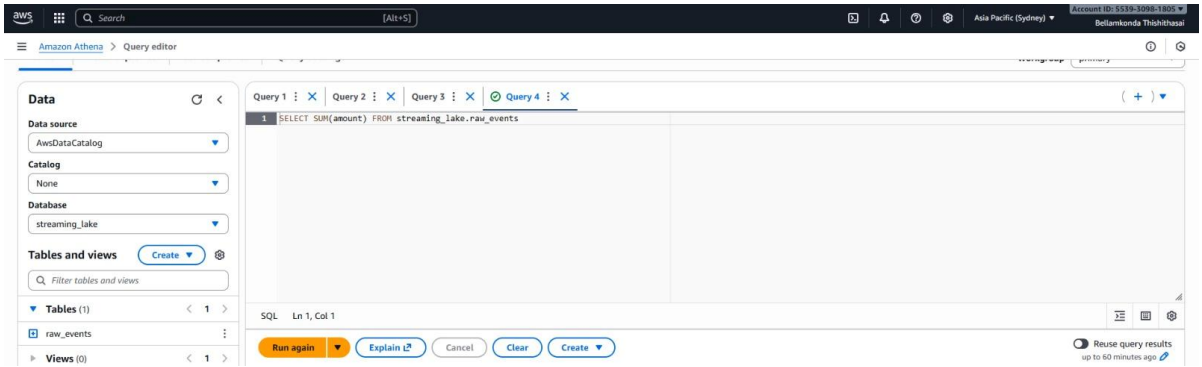
SELECT COUNT(*) FROM streaming_lake.raw_events;



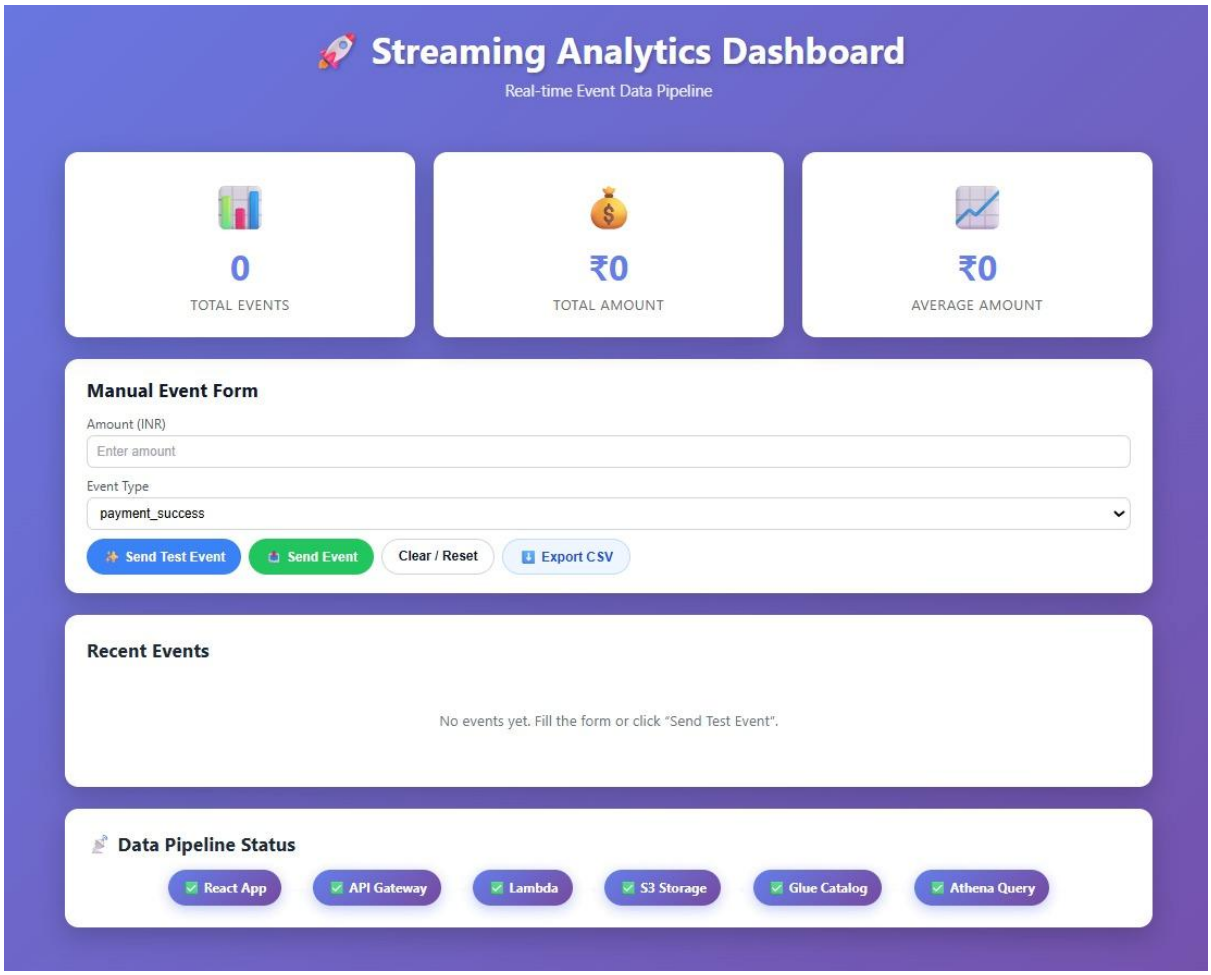
Query 4: Sum of all transaction amounts

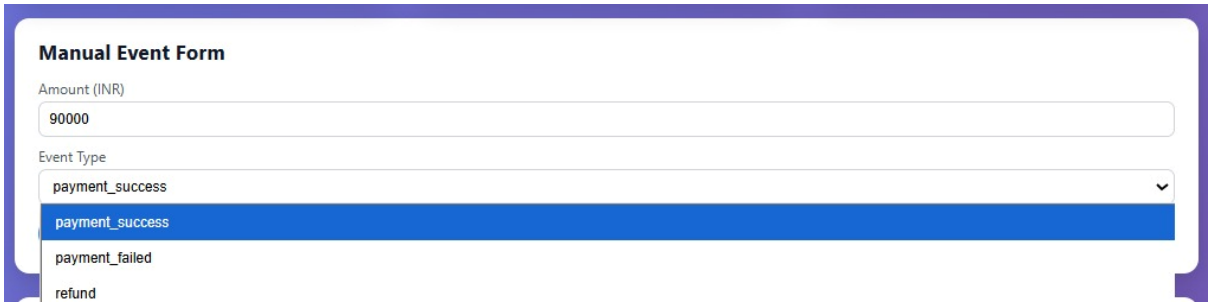
SELECT SUM(amount)

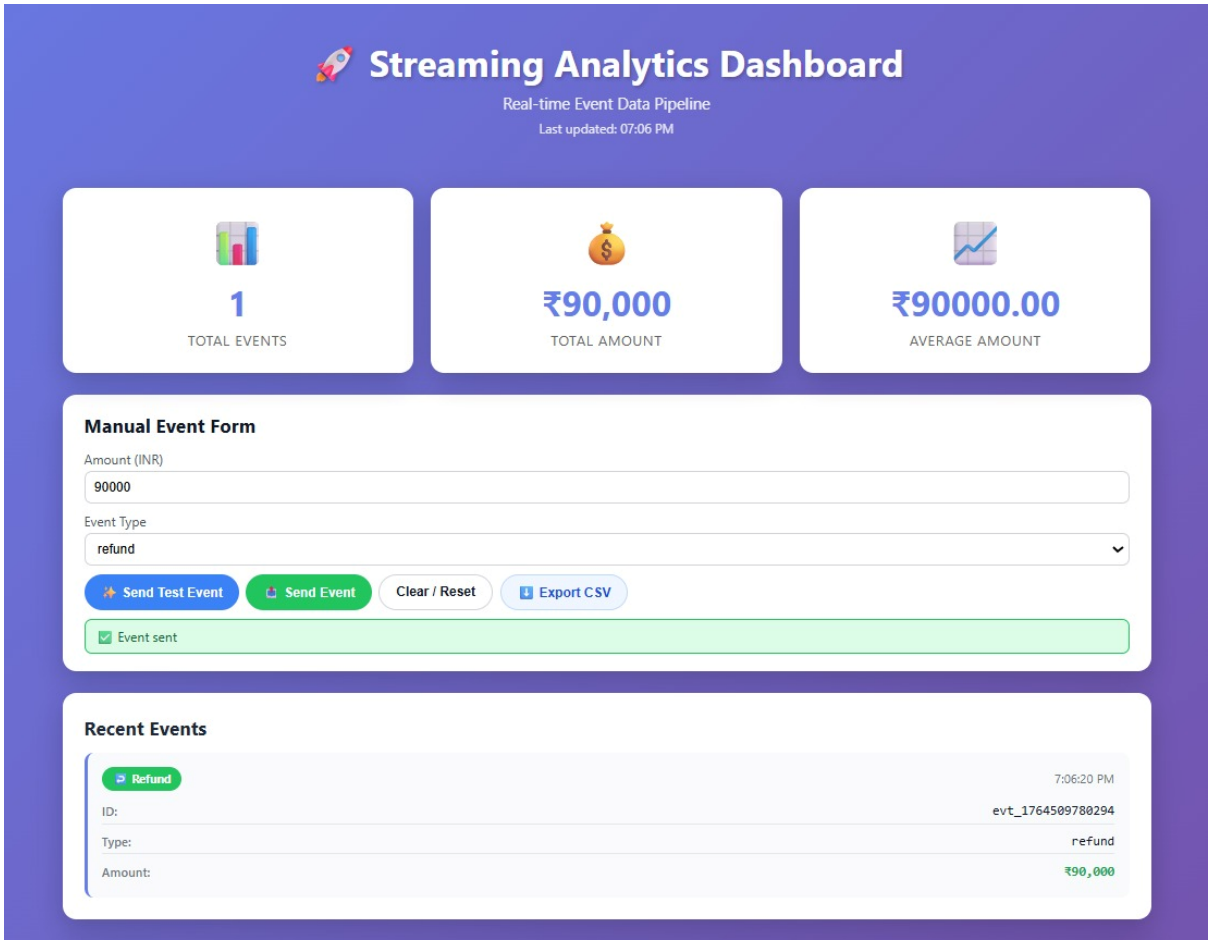
FROM streaming_lake.raw_events;



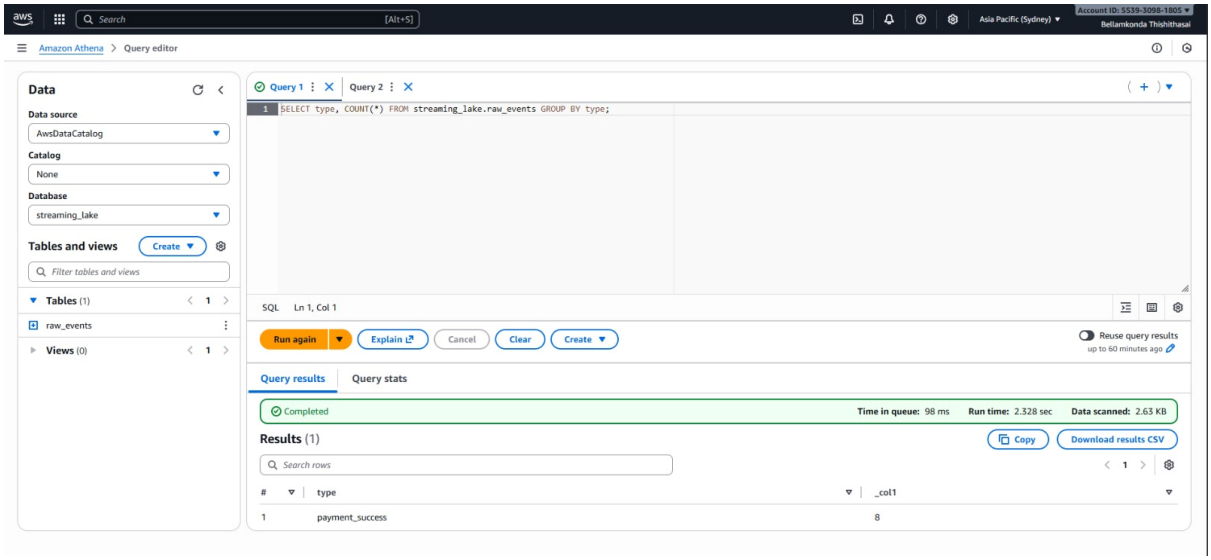
Outputs:

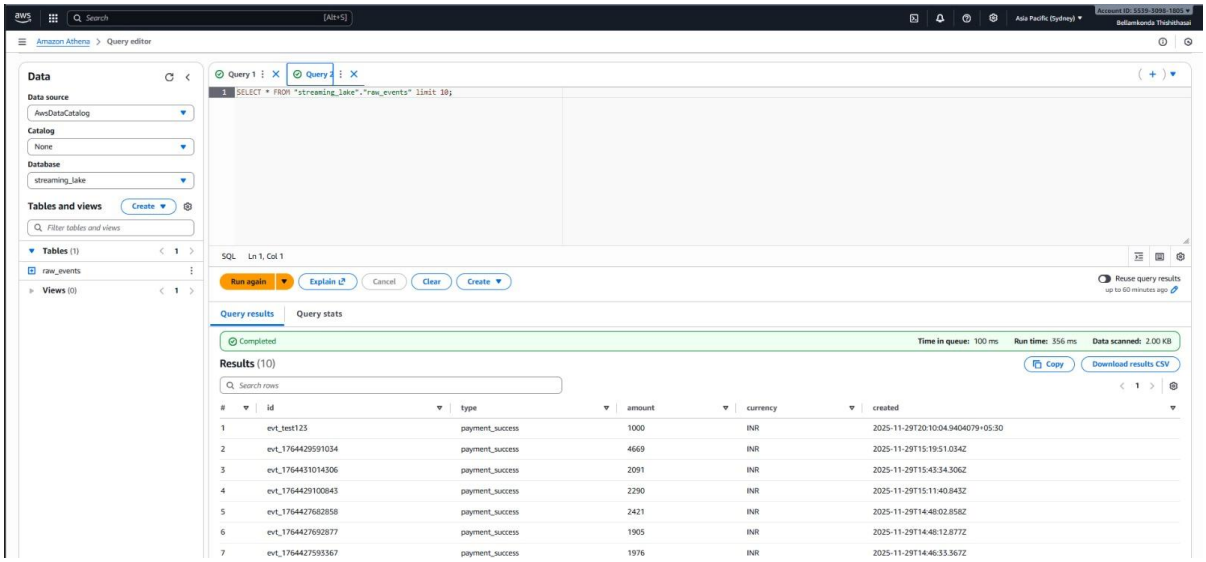

Streaming Analytics Dashboard
Real-time Event Data Pipeline
0
TOTAL EVENTS
₹0
TOTAL AMOUNT
₹0
AVERAGE AMOUNT
Manual Event Form
Amount (INR)
Enter amount
Event Type
payment_success
Send Test Event
Send Event
Clear / Reset
Export CSV
Recent Events
No events yet. Fill the form or click "Send Test Event".
Data Pipeline Status
React App
API Gateway
Lambda
S3 Storage
Glue Catalog
Athena Query

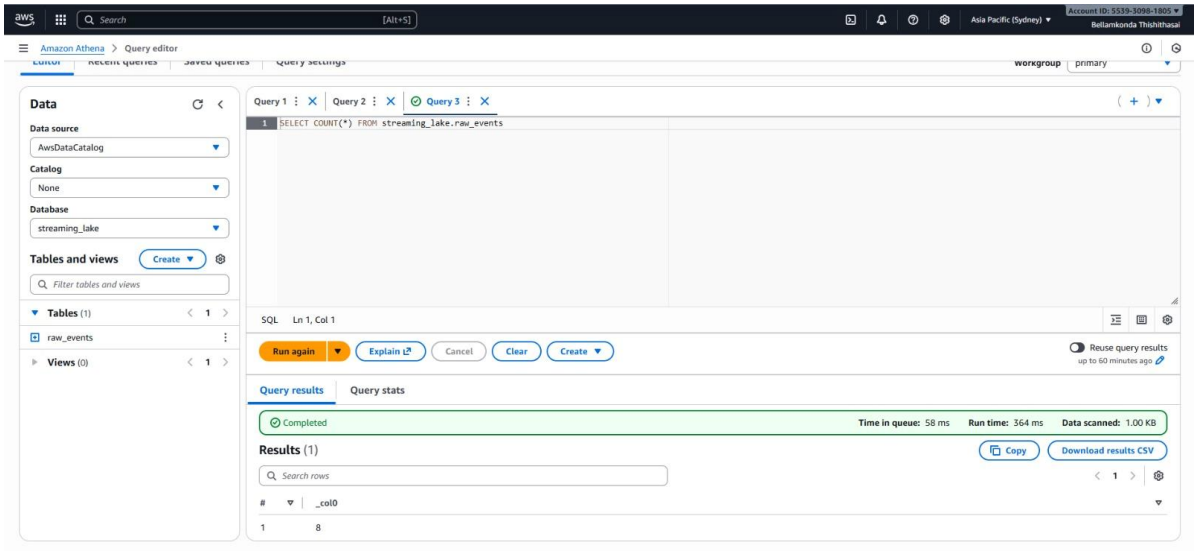

Manual Event Form
Amount (INR)
90000
Event Type
payment_success
payment_success
payment_failed
refund

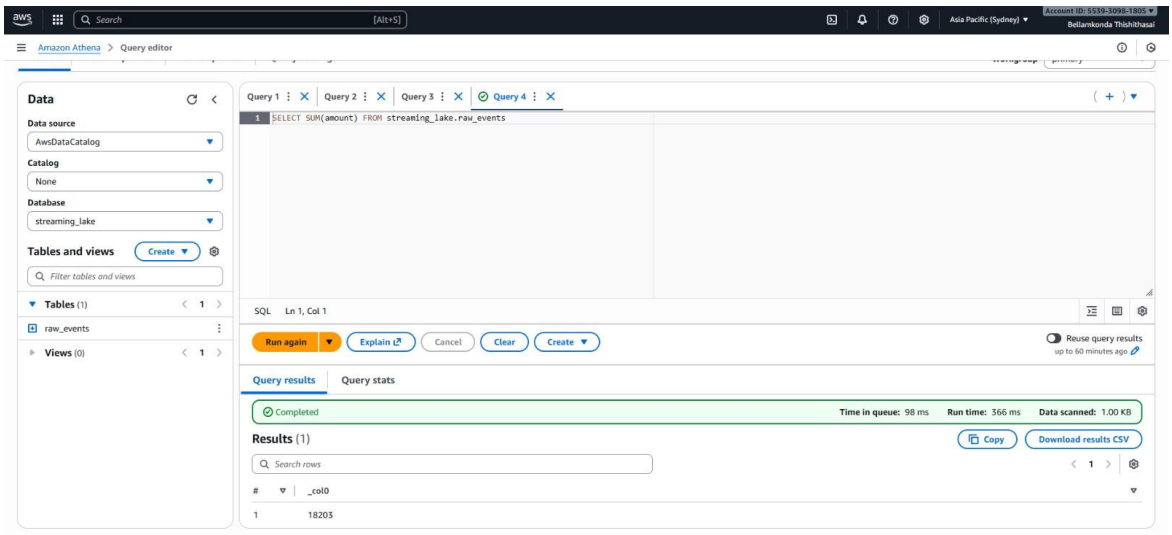


SQL Queries for Real-Time Data Analysis:




Amazon Athena > Query editor
Data
Data source
AwsDataCatalog
Catalog
None
Database
streaming_lake
Tables and views
Create
Filter tables and views
Tables (1)
raw_events
Views (0)
Query 1
Query 2
1 SELECT * FROM "streaming_lake"."raw_events" limit 10;
SQL Ln 1, Col 1
Run again
Explain
Cancel
Clear
Create
Reuse query results
up to 60 minutes ago
Query results
Query stats
Completed
Time in queue: 100 ms
Run time: 356 ms
Data scanned: 2.00 KB
Results (10)
Copy
Download results CSV
Search rows
id type amount currency created
1 evt_test123 payment_success 1000 INR 2025-11-29T20:10:04.9404079+05:30
2 evt_1764429591034 payment_success 4669 INR 2025-11-29T15:19:51.034Z
3 evt_1764431014306 payment_success 2091 INR 2025-11-29T15:43:34.306Z
4 evt_1764429100843 payment_success 2290 INR 2025-11-29T15:11:40.843Z
5 evt_1764427682858 payment_success 2421 INR 2025-11-29T14:48:02.858Z
6 evt_1764427692877 payment_success 1905 INR 2025-11-29T14:48:12.877Z
7 evt_1764427593367 payment_success 1976 INR 2025-11-29T14:46:33.367Z


Amazon Athena > Query editor
Data
Data source
AwsDataCatalog
Catalog
None
Database
streaming_lake
Tables and views
Create
Filter tables and views
Tables (1)
raw_events
Views (0)
Query 1
Query 2
Query 3
1 SELECT COUNT(*) FROM streaming_lake.raw_events
SQL Ln 1, Col 1
Run again
Explain
Cancel
Clear
Create
Reuse query results
up to 60 minutes ago
Query results
Query stats
Completed
Time in queue: 58 ms
Run time: 364 ms
Data scanned: 1.00 KB
Results (1)
Copy
Download results CSV
Search rows
_col0
1 8


Amazon Athena > Query editor
Data
Data source
AwsDataCatalog
Catalog
None
Database
streaming_lake
Tables and views
Create
Filter tables and views
Tables (1)
raw_events
Views (0)
Query 1
Query 2
Query 3
Query 4
1 SELECT SUM(amount) FROM streaming_lake.raw_events
SQL Ln 1, Col 1
Run again
Explain
Cancel
Clear
Create
Reuse query results
up to 60 minutes ago
Query results
Query stats
Completed
Time in queue: 98 ms
Run time: 366 ms
Data scanned: 1.00 KB
Results (1)
Copy
Download results CSV
Search rows
_col0
1 18203

Conclusion:

The AWS Data Confluence project successfully demonstrates a fully serverless, scalable, and real-time data ingestion and analytics pipeline. By integrating **React**, **API Gateway**, **Lambda**, **S3**, **Glue**, **Athena**, and **SNS**, the system efficiently captures data from the frontend, processes it through Lambda, stores structured records in S3, and enables instant querying through Athena. Glue provides automated schema detection, while SNS enhances the solution with immediate alerting through email notifications.

This architecture highlights the power of cloud-native, event-driven design — requiring no servers, automatically scaling with demand, and operating at very low cost. The project proves how real-time data streams can be collected, stored, analyzed, and notified with minimal configuration and maximum reliability. Overall, this system forms a strong foundation for modern analytics workflows and can be extended further with dashboards, AI models, or additional AWS integrations.