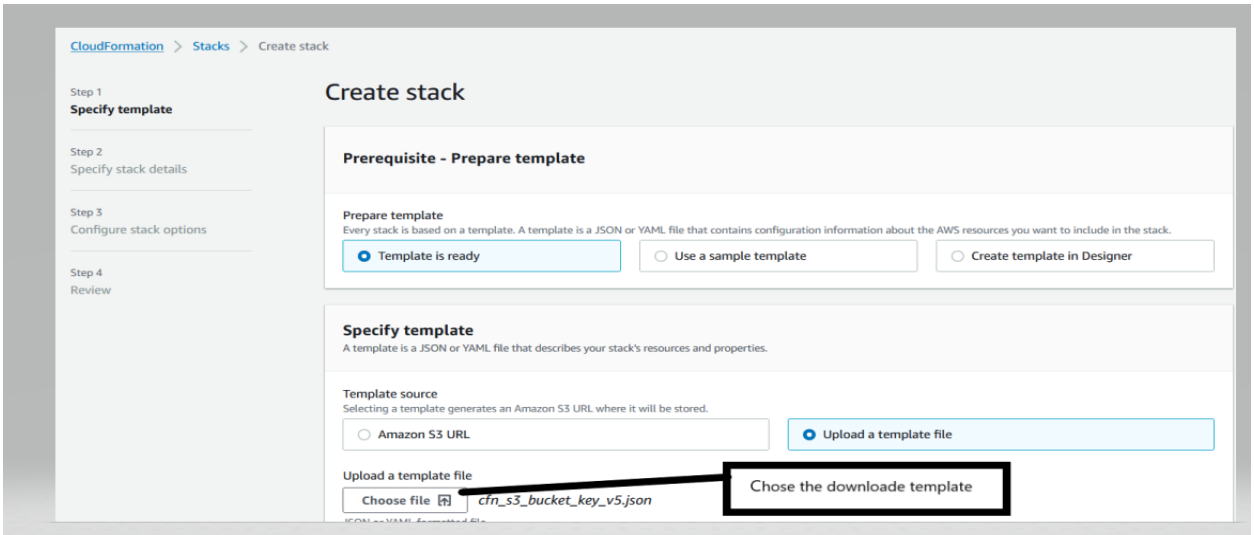
Phase 1: Create the Infrastructure Using CloudFormation CFN template

Step 1: Download the Cloud formation (CFN) template on your local Machine

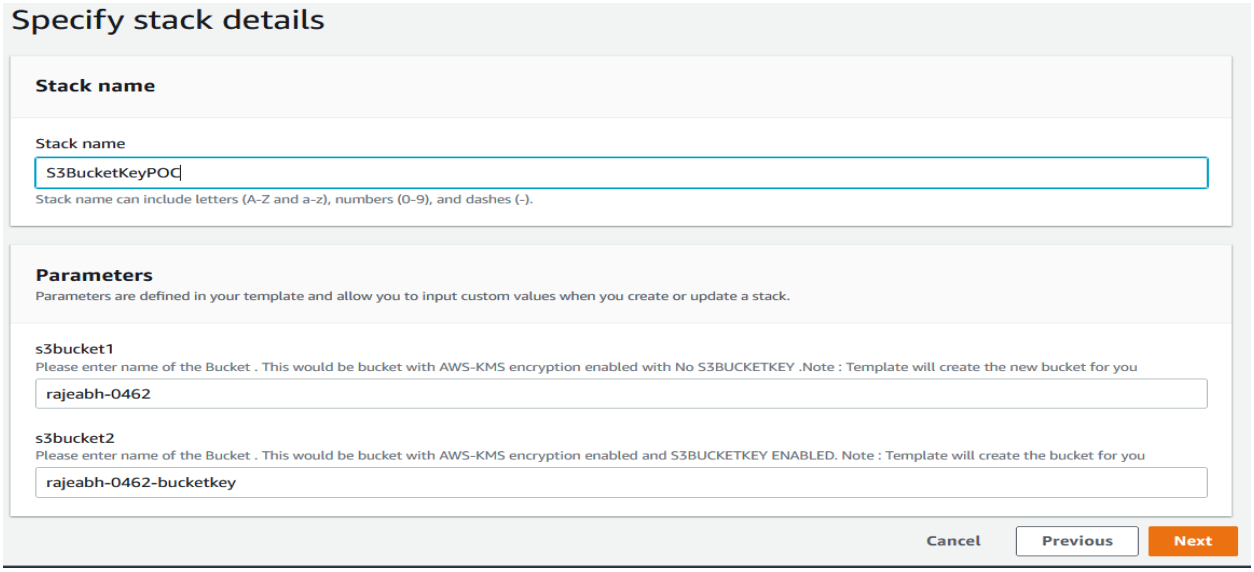
https://gitlab.aws.dev/rajeabh/s3bucketkey-poc/-/blob/main/cfn/cfn_s3_bucket_key_poc.json

Step 2: CFN Stack

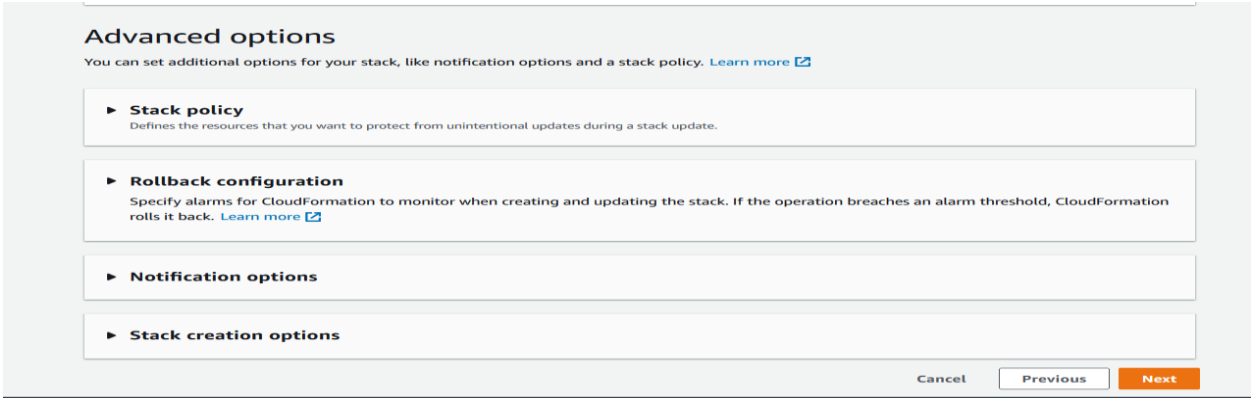
Login to AWS console and go to CloudFormation→ Create Stack → Chose the downloaded cfn_s3_bucket_key_poc file as shown in diagram below.



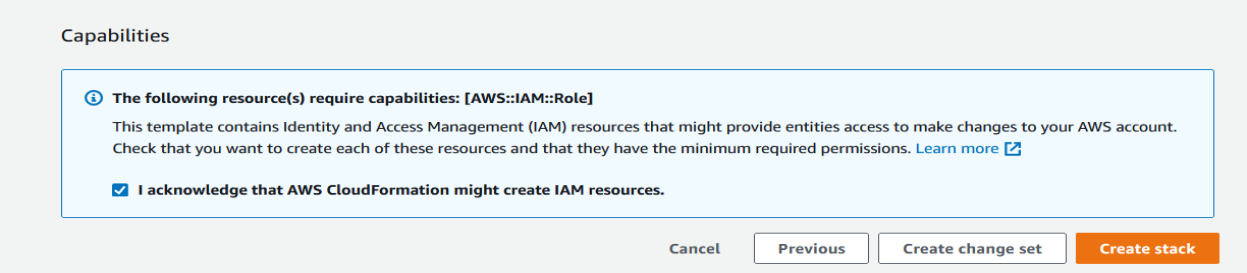
Step 3: Specify Stack Details: Enter the Stack Name and Bucket Names and click Next. Please note: CFN template will create two buckets. First bucket with S3 Bucket Keys DISABLED and Second Bucket with S3 Bucket Keys ENABLED.



Step 4: Configure Stack Option, you don't need to change anything, just need to click Next

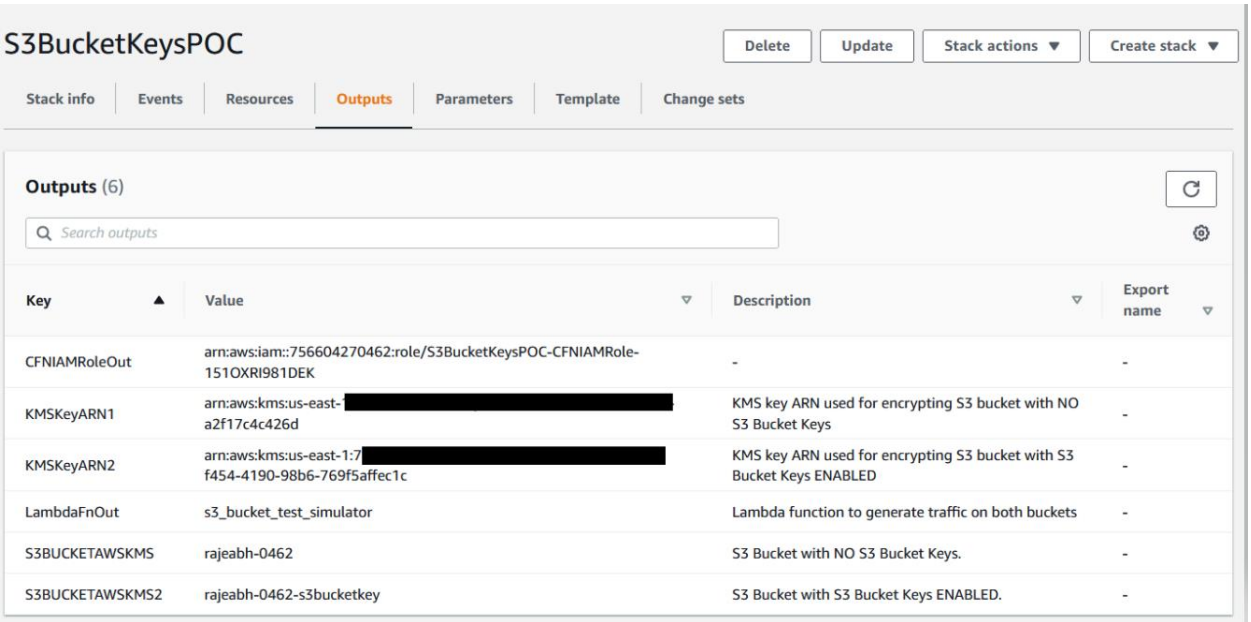


Step 5: Review the stack and acknowledge that CFN template is creating IAM role.



Step 6: Note down the stack output values

Please note that **values** for KMSKeyARN1 and KMSKeyARN2 these values required in Athena query to analyze the KMS traffic

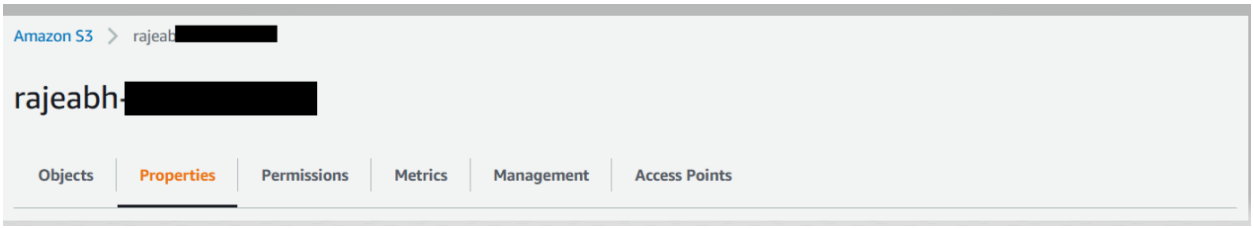


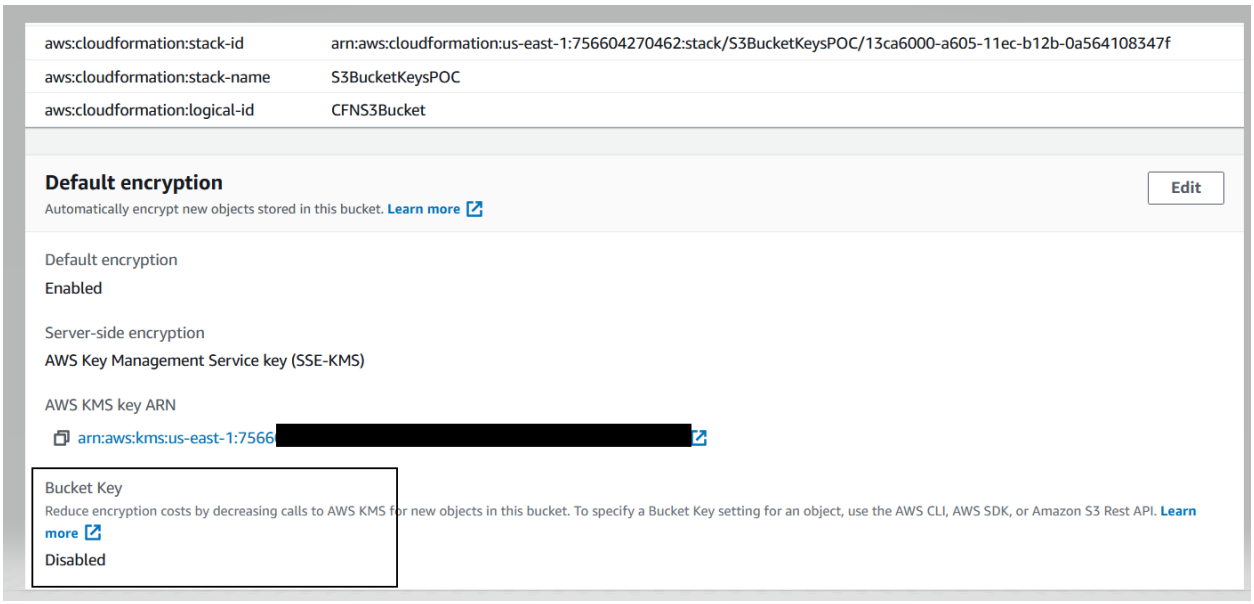
Key	Value	Description	Export name
CFNIAMRoleOut	arn:aws:iam::756604270462:role/S3BucketKeysPOC-CFNIAMRole-151OXRI981DEK	-	-
KMSKeyARN1	arn:aws:kms:us-east-[redacted]a2f17c4c426d	KMS key ARN used for encrypting S3 bucket with NO S3 Bucket Keys	-
KMSKeyARN2	arn:aws:kms:us-east-1:7[redacted]f454-4190-98b6-769f5affec1c	KMS key ARN used for encrypting S3 bucket with S3 Bucket Keys ENABLED	-
LambdaFnOut	s3_bucket_test_simulator	Lambda function to generate traffic on both buckets	-
S3BUCKETAWSKMS	rajeabh-0462	S3 Bucket with NO S3 Bucket Keys.	-
S3BUCKETAWSKMS2	rajeabh-0462-s3bucketkey	S3 Bucket with S3 Bucket Keys ENABLED.	-

Step 7: Verify S3 Buckets

Go to S3 Bucket → First Bucket → Click on Properties → Default Encryption

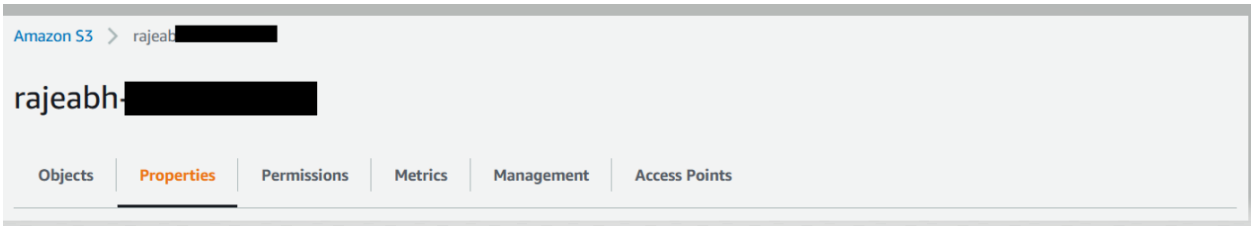
Observe S3 Bucket Key is Disabled

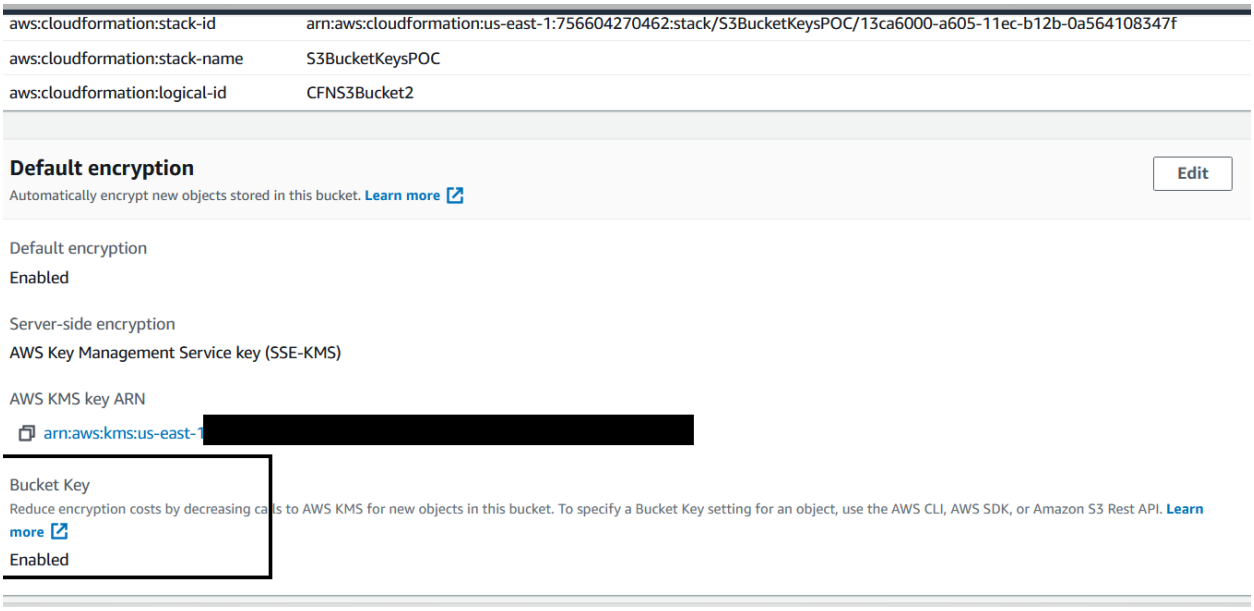




Go to S3 Bucket → Second Bucket → Click on Properties → Default Encryption

Observe S3 Bucket Key is Enabled





Phase 2: Generate and analyze the KMS traffic

Now we have created all the Infrastructure we will enable the CloudTrail and Amazon Athena. Generate the traffic to both the S3 Buckets using Lambda function and Analyze the KMS API calls using Athena.

Step 8: Enable AWS CloudTrail account

AWS CloudTrail is a service that enables governance, compliance, operational auditing, and risk auditing of your AWS account. With AWS CloudTrail, you can log, continuously monitor, and retain account activity related to actions across your AWS. If you have already enabled CloudTrail, you can reuse the same. If CloudTrail is not enabled, you can enable CloudTrail as mentioned in the tutorial link below.
Please note, for the proposed solution you need to enable CloudTrail for management events only. You don't need to enable CloudTrail for data events or insight events. Also, please note that we need only single cloud trail and creating duplicate cloud trails can increase the cost. Please see the pricing page.
Tutorial:https://docs.aws.amazon.com/awsCloudTrail/latest/userguide/CloudTrail-tutorial.html#tutorial-step2
CloudTrail pricing: https://aws.amazon.com/CloudTrail/pricing/
Please note that you can analyze the data in Athena only when the Cloudtrail data is available. it takes up to 15 minutes for events to get to CloudTrail, and up to 5 minutes for CloudTrail to write to S3

Step 9: Create Amazon Athena table to query the CloudTrail data

Amazon Athena is an interactive query service that makes it easy to analyze data in Amazon S3 using standard SQL. Amazon Athena is Serverless, so there is no infrastructure to manage, and you pay only for the queries that you run.
Create Amazon Athena table in any database or default database in a region where your hub account S3 Data Lake bucket resides.
If you are using Athena first time follow the steps below to create database.
https://docs.aws.amazon.com/athena/latest/ug/getting-started.html

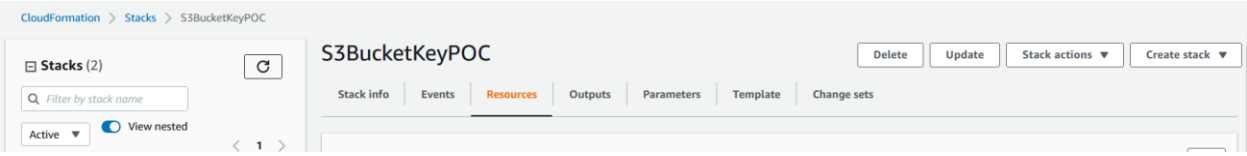
Open the Athena built-in query editor, copy below query, modify as suggested below, and run the query.
In the LOCATION and storage.location.template clauses, replace the bucket with CloudTrail Bucket, account-id with your account's account ID, and aws-region with region where CloudTrail bucket is located. For projection.timestamp.range, replace 2020/01/01 with the starting date that you want to use .
After successful execution of the query, you will see the CloudTrail_logs table created in Athena.

```
CREATE EXTERNAL TABLE cloudtrail_logs_region(
   eventVersion STRING,
   userIdentity STRUCT<
      type: STRING,
      principalId: STRING,
      arn: STRING,
      accountId: STRING,
      invokedBy: STRING,
      accessKeyId: STRING,
      userName: STRING,
      sessionContext: STRUCT<
         attributes: STRUCT<
            mfaAuthenticated: STRING,
            creationDate: STRING>,
         sessionIssuer: STRUCT<
            type: STRING,
            principalId: STRING,
            arn: STRING,
            accountId: STRING,
            userName: STRING>>>,
   eventTime STRING,
   eventSource STRING,
   eventName STRING,
   awsRegion STRING,
   sourceIpAddress STRING,
   userAgent STRING,
   errorCode STRING,
   errorMessage STRING,
   requestParameters STRING,
   responseElements STRING,
   additionalEventData STRING,
   requestId STRING,
   eventId STRING,
   readOnly STRING,
   resources ARRAY<STRUCT<
      arn: STRING,
      accountId: STRING,
      type: STRING>>,
   eventType STRING,
```

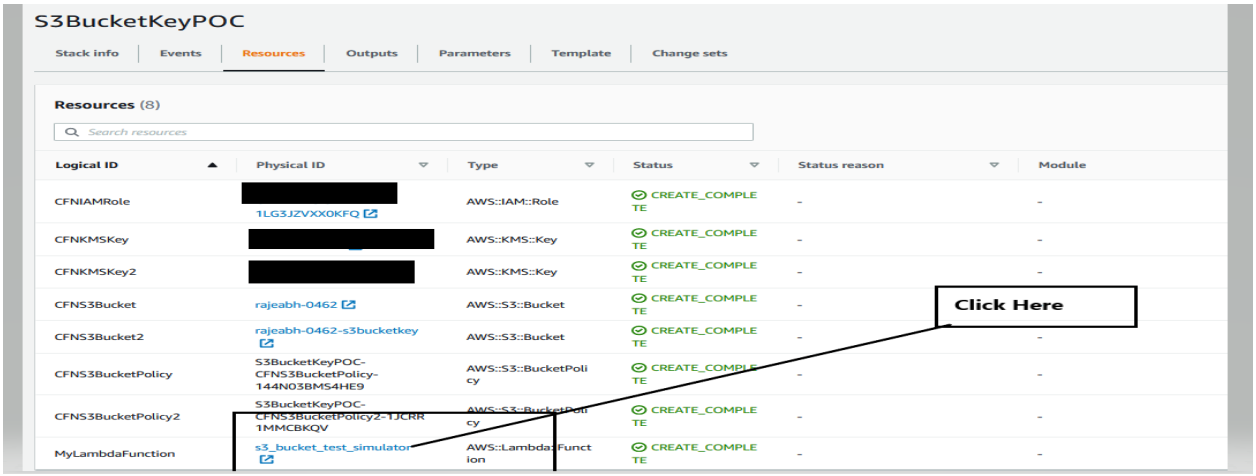
```
    apiVersion STRING,
    recipientAccountId STRING,
    serviceEventDetails STRING,
    sharedEventID STRING,
    vpcEndpointId STRING
  )
PARTITIONED BY (
   `timestamp` string)
ROW FORMAT SERDE 'com.amazon.emr.hive.serde.CloudTrailSerde'
STORED AS INPUTFORMAT 'com.amazon.emr.cloudtrail.CloudTrailInputFormat'
OUTPUTFORMAT 'org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat'
LOCATION
  's3://bucket/AWSLogs/account-id/CloudTrail/aws-region'
TBLPROPERTIES (
  'projection.enabled'='true',
  'projection.timestamp.format'='yyyy/MM/dd',
  'projection.timestamp.interval'='1',
  'projection.timestamp.interval.unit'='DAYS',
  'projection.timestamp.range'='2020/01/01,NOW',
  'projection.timestamp.type'='date',
  'storage.location.template'='s3://bucket/AWSLogs/account-id/CloudTrail/aws-
region/${timestamp}')
```

Step 10: Run the Lambda function to generate the traffic to S3 Bucket which intern will generate KMS API calls.

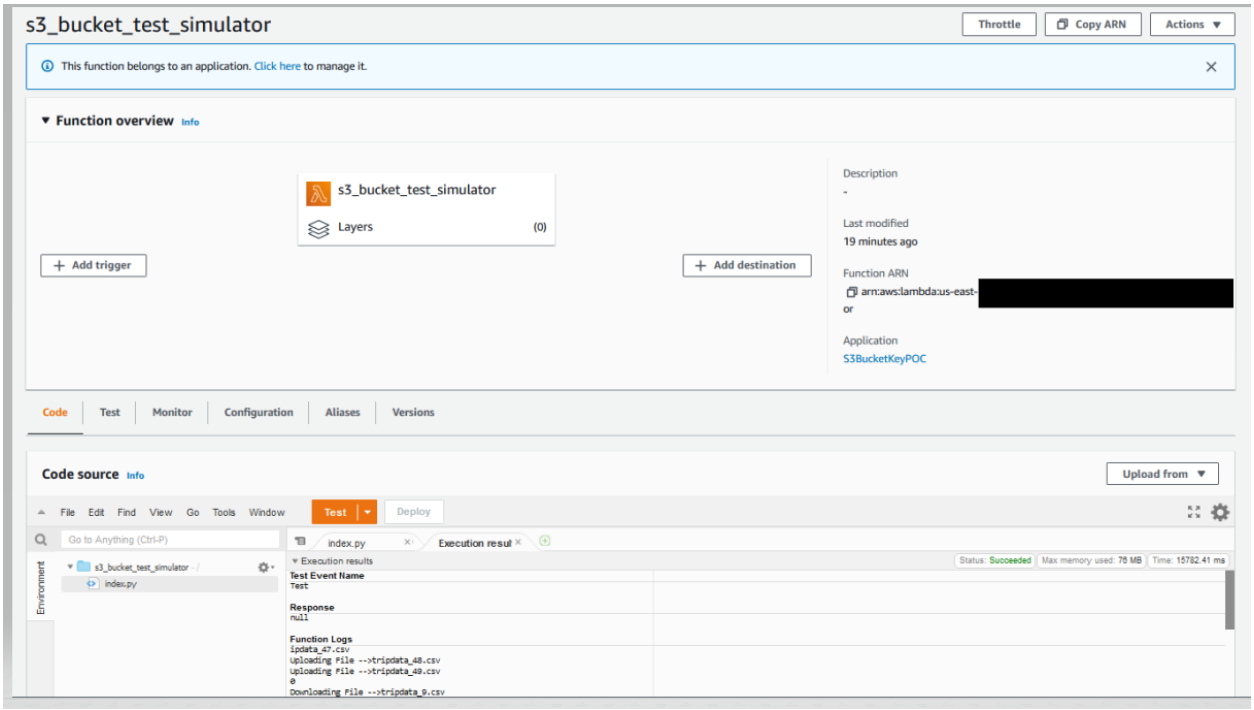
- Go to Cloudformation → Stacks → Select S3 Bucket Key POC stack→ Resource



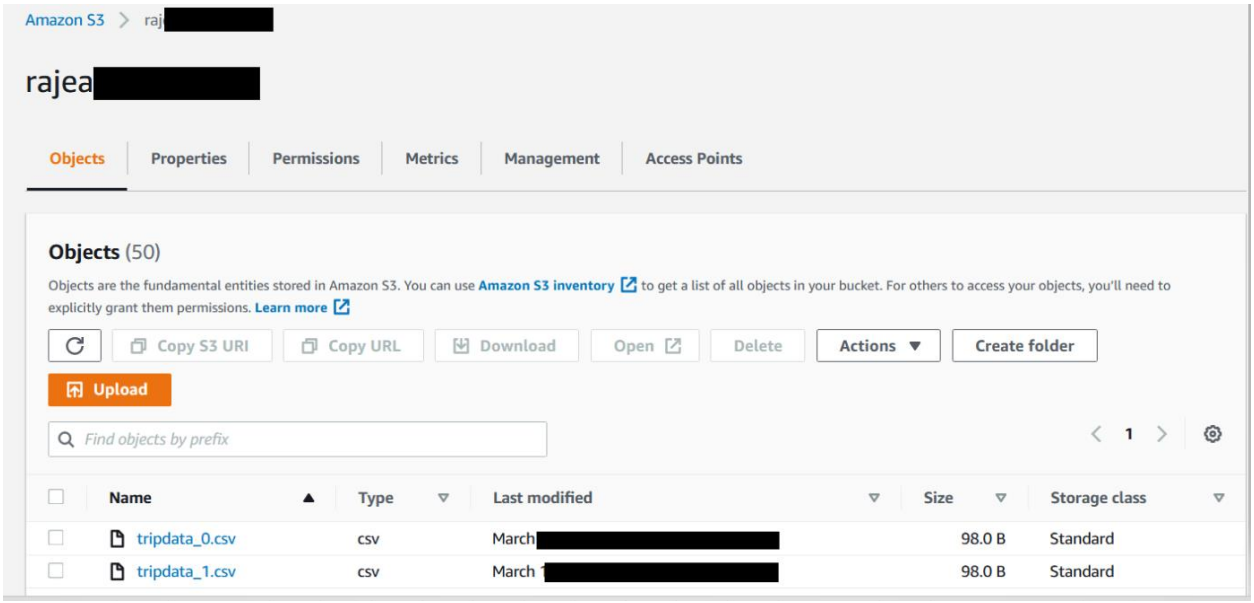
- **Click on Lambda function**



- **Run the s3_bucket_test_simulator Lambda function**



Once you run the lambda function you will see traffic generated on S3 Bucket. You will 50 test files are uploaded in both the S3 Buckets.



Step 11: See the difference of KMS API call reduction when S3 bucket Key is ENABLED.

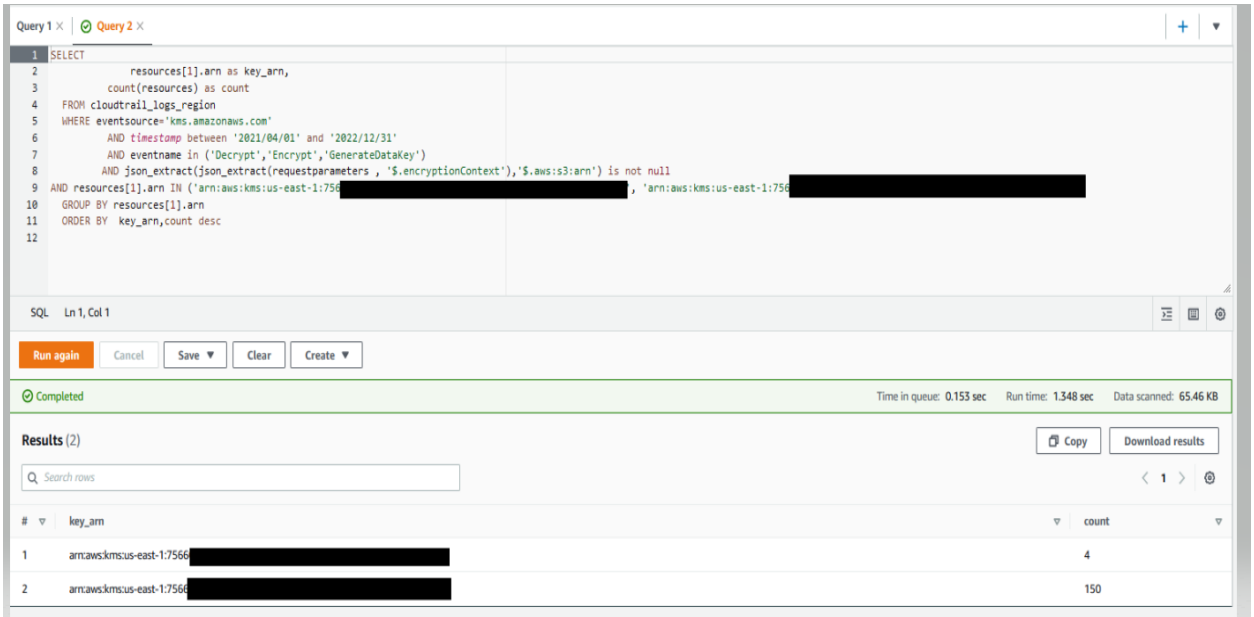
Go to Athena query Editor and run the following query. Replace “KMSKeyARN1-Value” and “KMSKeyARN2-value” generated from Cloud formation template. Change the timestamp between as appropriate

```
SELECT
          resources[1].arn as key_arn,
       count(resources) as count
 FROM cloudtrail_logs_region
 WHERE eventsource='kms.amazonaws.com'
       AND timestamp between '2021/04/01' and '2022/12/31'
       AND eventname in ('Decrypt','Encrypt','GenerateDataKey')
      AND json_extract(json_extract(requestparameters , '$.encryptionContext'),'$.aws:s3:arn') is not
null
AND resources[1].arn IN (KMSKeyARN1-Value ',' KMSKeyARN2-value')
 GROUP BY resources[1].arn
 ORDER BY  key_arn,count desc
```

Result Show demonstrate that by uploading 50 file objects and by downloading 100 files objects on both SSE-KMS encrypted bucket .

S3 Bucket with Bucket Key **Enabled** made 4 KMS API calls
S3 Bucket with Bucket Key **Disabled** has 150 KMS API calls

In this example there **is 97.33% reduction in KMS API calls**.



Phase 3: Clean Up

- **Step1: Empty S3 Buckets**

  Empty both the S3 buckets that were created as part of Step-3

  1. Sign in to the AWS Management Console and open the Amazon S3 console at https://console.aws.amazon.com/s3/
  2. In the Bucket name list, select the option next to bucket name (that you entered as part of **Step 3**) and then choose Empty.
  3. On the Empty bucket page, confirm that you want to empty the bucket by entering the bucket name into the text field, and then choose Empty.
  4. Monitor the progress of the bucket emptying process on the Empty bucket: Status page.
  5. Follow 1-4 for other S3 bucket

- **Step 2: Delete the Cloudformation Stack**

  6. Open the AWS CloudFormation console at https://console.aws.amazon.com/cloudformation
  7. On the Stacks page in the CloudFormation console, select the stack **S3BucketKeyPOC** to delete.
  8. In the stack details pane, choose Delete.
  9. Select Delete stack when prompted.

- **Step 3: Delete the CloudTrail created**

  If you have **created CloudTrail specifically for this solution**, you can delete the CloudTrail by following the instructions provided in link.
  https://docs.aws.amazon.com/awsCloudTrail/latest/userguide/CloudTrail-delete-trails-console.html

- **Step 4: Drop the Amazon Athena table**

  1. Log in to the Amazon Athena console and run the following drop table query:
  2. Drop table < CloudTrail_logs_aws_region>