AWS re:Invent

DAT303

Data security best practices on Amazon DynamoDB

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aws

Agenda

Protecting your data at rest

Monitoring access to your data

Controlling access to your data

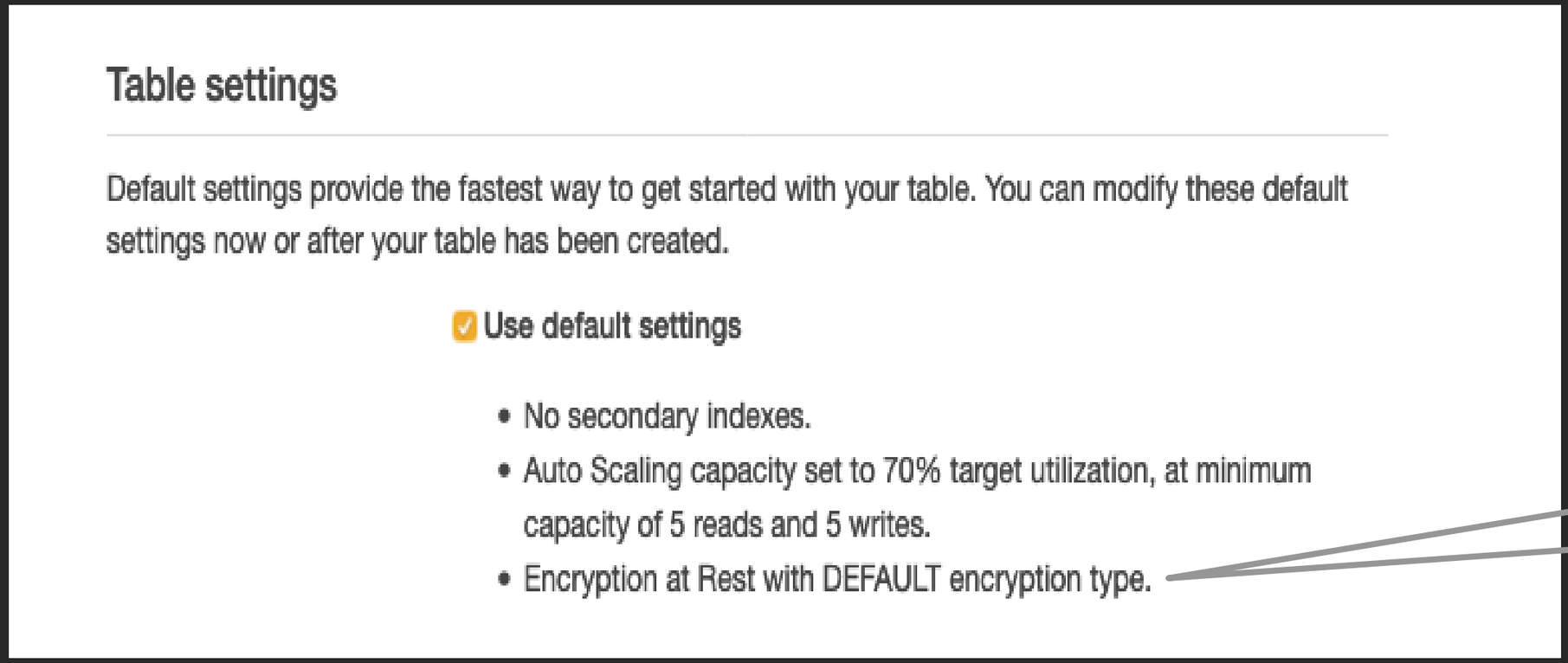
Limiting network access while using Amazon DynamoDB

Protecting your data at rest

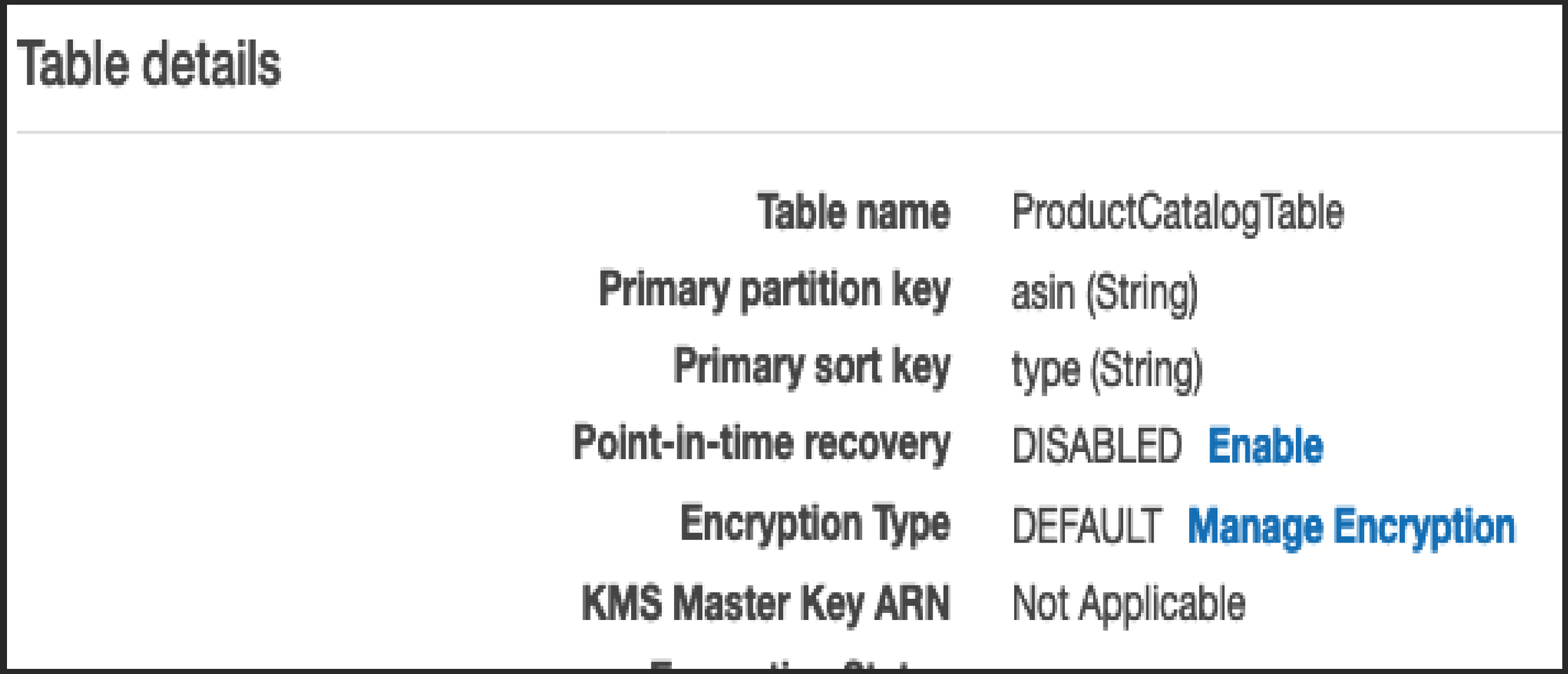
All Data Encrypted @ Rest with AWS KMS

- **AWS-owned CMK – default encryption type**
- **AWS-managed CMK**
- **Customer Managed CMK**
- **Table Level Encryption Settings**
- **GSI, Streams, and backups**

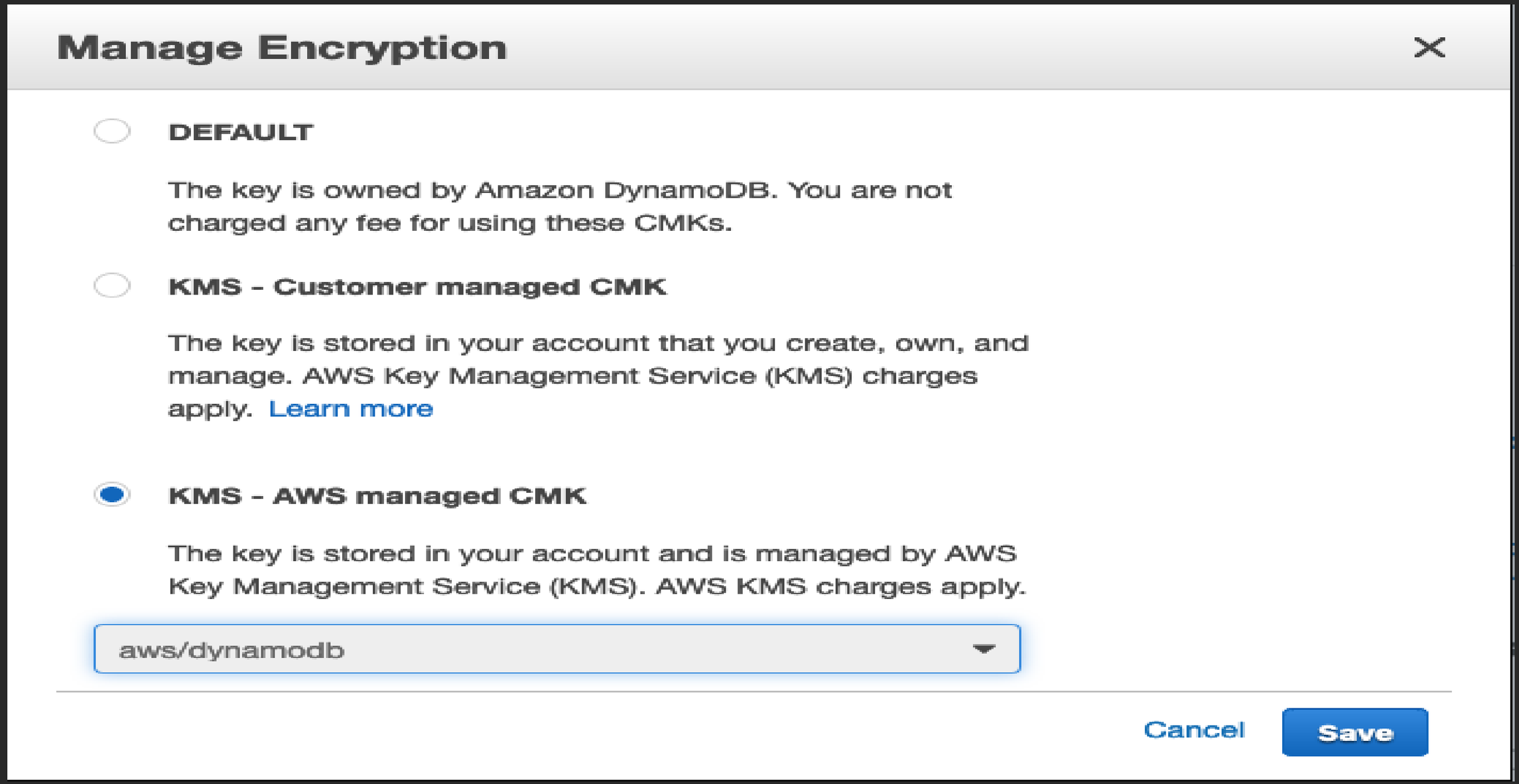
Encryption Enabled By Default



Encryption state of the table



Managing Encryption Type



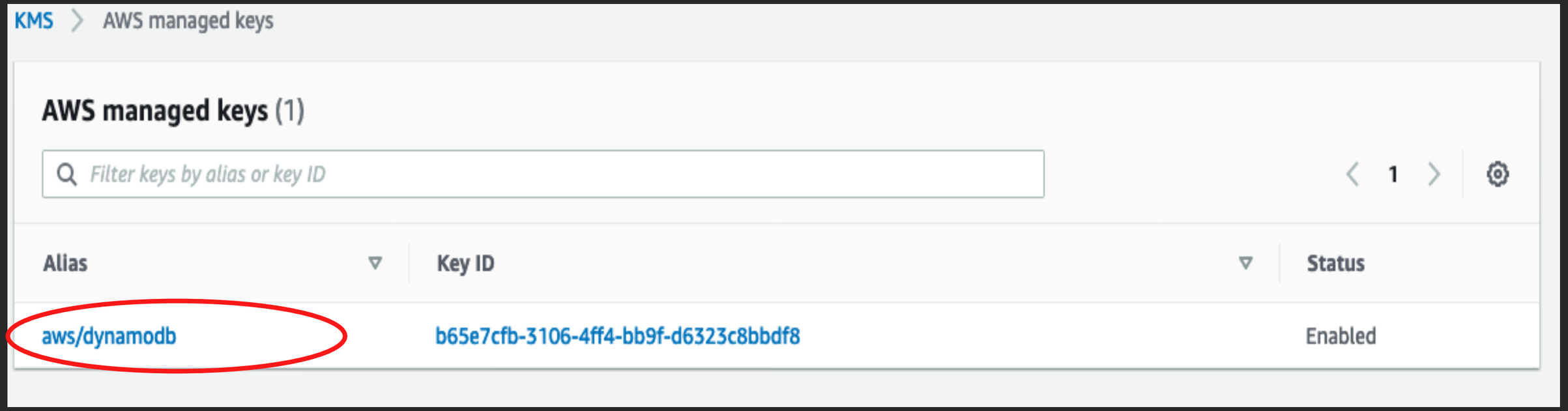
Encryption state of the table

Table name	ProductCatalogTable
Primary partition key	asin (String)
Primary sort key	type (String)
Point-in-time recovery	DISABLED **Enable**
Encryption Type	KMS **Manage Encryption**
KMS Master Key ARN	arn:aws:kms:us-east-2:784361292956:key/b65e7cfb-3106-4ff4-bb9f-d6323c8bbdf8

% aws dynamodb describe-table --table-name ProductCatalogTable

```
…
   "SSEDescription": {
         "Status": "ENABLED",
         "SSEType": "KMS",
         "KMSMasterKeyArn": "arn:aws:kms:us-east-1:111122223333:key/[KMS_KEY_ID]"
    }
```

AWS-managed CMK for DynamoDB



AWS KMS key grants for DynamoDB table

```
% aws kms list-grants --key-id [KMS_KEY_ID]
…
    "KeyId": "arn:aws:kms:us-east-1:111122223333:key/[KMS_KEY_ID]",
    …,
    "GranteePrincipal": "dynamodb.us-east-1.amazonaws.com",
    …,
    "Constraints": {
        "EncryptionContextSubset": {
            "aws:dynamodb:subscriberId": "111122223333",
            "aws:dynamodb:tableName": "ProductCatalog"
        }
    }
```

AWS KMS key AWS CloudTrail event: who

```
{
    "eventVersion": "1.05",
    "userIdentity": {
        ...
        "arn": "arn:aws:sts::111122223333:assumed-role/ApplicationRole/Worker70",
        ...
    },
```

AWS KMS key AWS CloudTrail event: what

```
"resources": [
    {
        "ARN": "arn:aws:kms:us-east-1:111122223333:key/[KMS_KEY_ID]",
        "accountId": "111122223333",
        "type": "AWS::KMS::Key"
    }
],
```

AWS KMS key AWS CloudTrail event: from where

```
...
"eventSource": "kms.amazonaws.com",
"eventName": "Decrypt",
...
"sourceIPAddress": "dynamodb.amazonaws.com",
...
```

AWS KMS key AWS CloudTrail event: from where

```
"requestParameters": {
    "encryptionContext": {
        "aws:dynamodb:tableName": "ProductCatalog",
        "aws:dynamodb:subscriberId": "111122223333"
    }
},
```

AWS KMS & DynamoDB permissions

User must have permissions to

- Create grants and encrypt data when creating a table with CMK encryption
- Use the CMK to decrypt when accessing data in the table (including via DynamoDB streams)

AWS-managed CMK has these permissions by default

- But a user/role policy can deny these permissions

Jane's IAM user permissions

```
{
    "Effect": "Allow",
    "Action": "dynamodb:*",
    "Resource": "*"
},
{
    "Effect": "Deny",
    "NotAction": "dynamodb:*",
    "Resource": "*"
}
```

Allows all DynamoDB actions on all DynamoDB resources

Denies everything other than DynamoDB

Jane's table creation

```
% aws dynamodb create-table --table-name JanesTable \
                           --provisioned-throughput ReadCapacityUnits=5,…\
                           …
…
|| CreationDateTime | ItemCount  |                      TableArn                          |               TableId                |  TableName  | …
|+------------------+------------+--------------------------------------------------------+--------------------------------------+-------------+-…
||  1541875075.012  |  0         |  arn:aws:dynamodb:us-east-1:676190956703:table/JanesTable  |  9f3370a2-4126-40fa-9e6b-9c759a76f477 |  JanesTable | …
…

% aws dynamodb create-table --table-name JanesTableEncrypted \
                           --sse-specification Enabled=true  \
                           --provisioned-throughput ReadCapacityUnits=5,…\
                           …
An error occurred (AccessDeniedException) when calling the CreateTable operation: KMS key access denied error: … User: …:user/Jane is not authorized to perform: kms:DescribeKey on resource: …:key/[KMS_KEY_ID] with an explicit deny …
```

Jane's access to the table

```
% aws dynamodb get-item --table-name ProductCatalogNoEncrypt \
                        --key '{"Id" : { "N" : "101" } }'
…
"Title": {
            "S": "Book 101 Title"
        },
…
```

```
% aws dynamodb get-item --table-name ProductCatalog \
                        --key '{"Id" : { "N" : "101" } }'
```

```
An error occurred (AccessDeniedException) when calling the GetItem operation: KMS key access denied error: com.amazonaws.services.kms.model.AWSKMSException: The ciphertext refers to a customer master key that does not exist, does not exist in this region, or you are not allowed to access. (Service: AWSKMS; …)
```

Fixing Jane's IAM user permissions

```
{
    "Effect": "Allow",
    "Action": "dynamodb:*",
    "Resource": "*"
},
{
    "Effect": "Deny",
    "NotAction": [ "dynamodb:*", "kms:*" ],
    "Resource": "*"
}
```

Monitoring access to your data

DynamoDB and CloudTrail

Control plane operations

- CreateTable, UpdateTable, etc.
- Always enabled
- Identifies who did what from where

Data plane operations

- PutItem, GetItem, QueryItem, etc.
- Not currently logged
- Modifications (PutItem, UpdateItem, etc.) can be monitored via DynamoDB streams

Amazon CloudWatch Events

Near real-time tracking of service actions

Customer-defined rules associated with events

Example use case

- Notification message when a table deletion is attempted

Troublesome Bob…

```
% date -u; aws --profile bob dynamodb delete-table --table-name MyTestTable

Sat Nov 10 20:15:43 UTC 2018

An error occurred (AccessDeniedException) when calling the DeleteTable operation:
User: …:user/Bob is not authorized to perform: dynamodb:DeleteTable on resource:
…:table/MyTestTable
```

From	Subject	Date Received	Size
AWS Notifications	Attempted delete of DynamoDB table in account 676190956703 by user/Bob	Sat 11/10/18, 3:16 PM	24.3 KB

Event processed at 2018-11-10 20:15:45.867169

It appears that user/Bob attempted to delete a table which failed with the error message:

User: …:user/Bob is not authorized to perform: dynamodb:DeleteTable on resource: …:table/MyTestTable

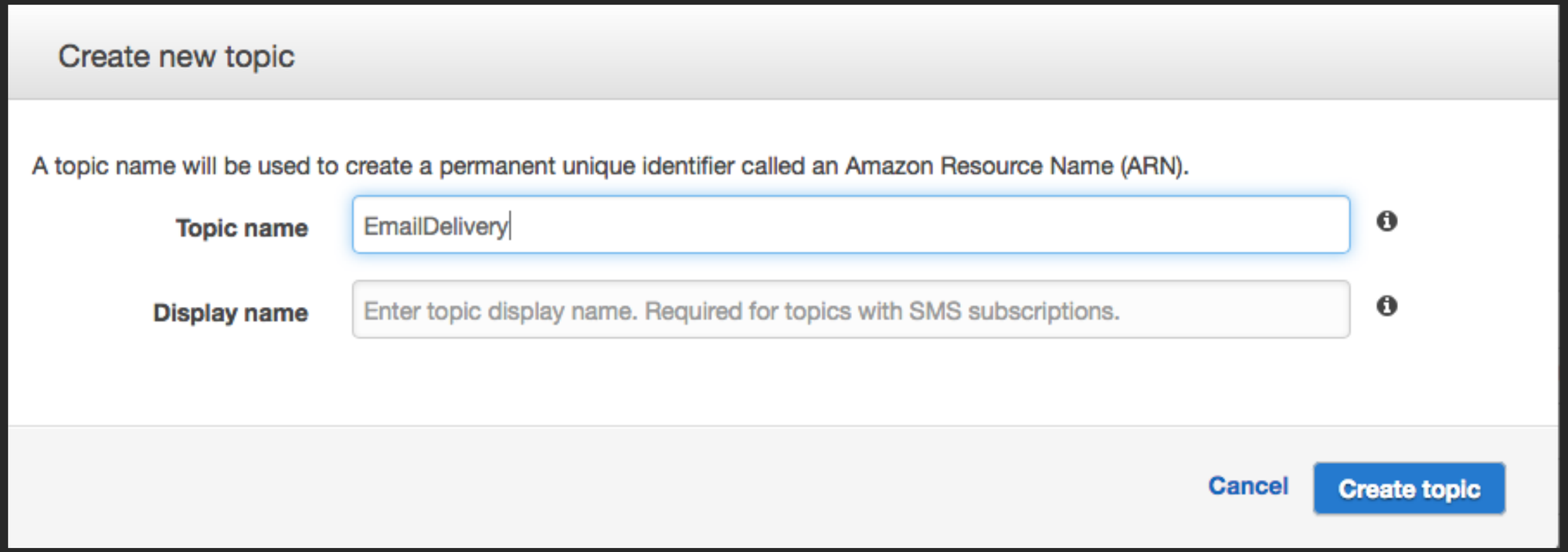
Configuring DynamoDB delete event notifications

1. Configure CloudWatch Events rule to invoke AWS Lambda function
2. Configure Lambda function for processing event notification
3. Set up Amazon Simple Notification Service (Amazon SNS) topic for email notification

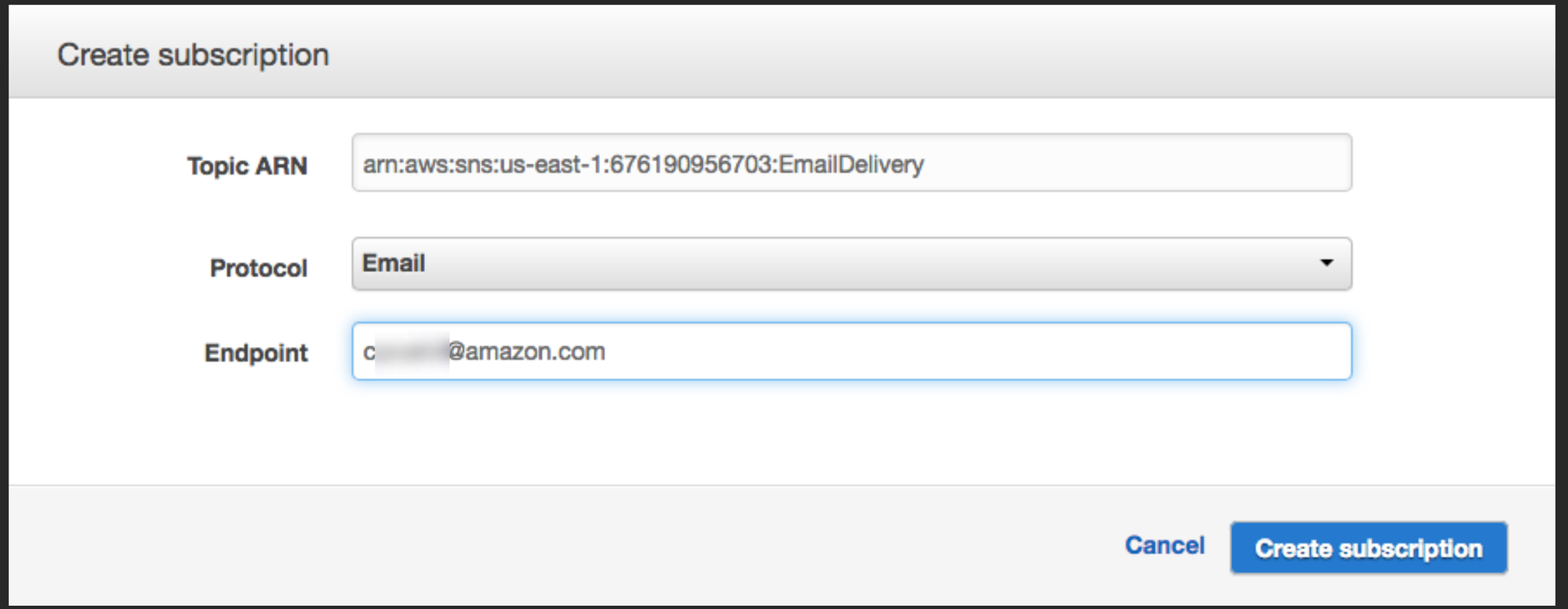
Configuring DynamoDB delete event notifications

1. Configure CloudWatch Events rule to invoke AWS Lambda function
2. Configure Lambda function for processing event notification
3. **Set up Amazon SNS topic for email notification**

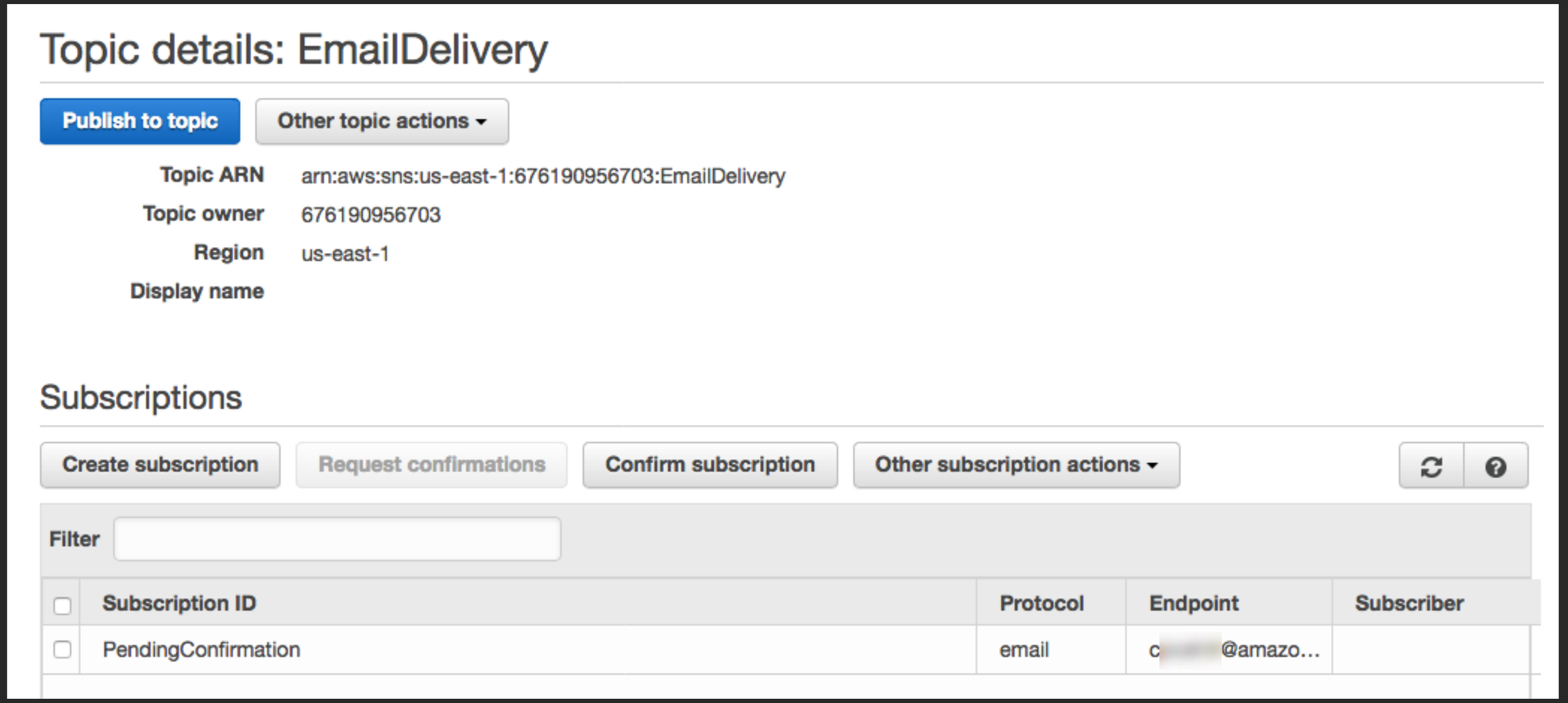
Configure Amazon SNS topic for email delivery



Configure Amazon SNS topic for email delivery



Configure Amazon SNS topic for email delivery



Configure Amazon SNS topic for email delivery

You have chosen to subscribe to the topic:
arn:aws:sns:us-east-1:676190956703:EmailDelivery

To confirm this subscription, click or visit the link below (If this was in error no action is necessary):
Confirm subscription

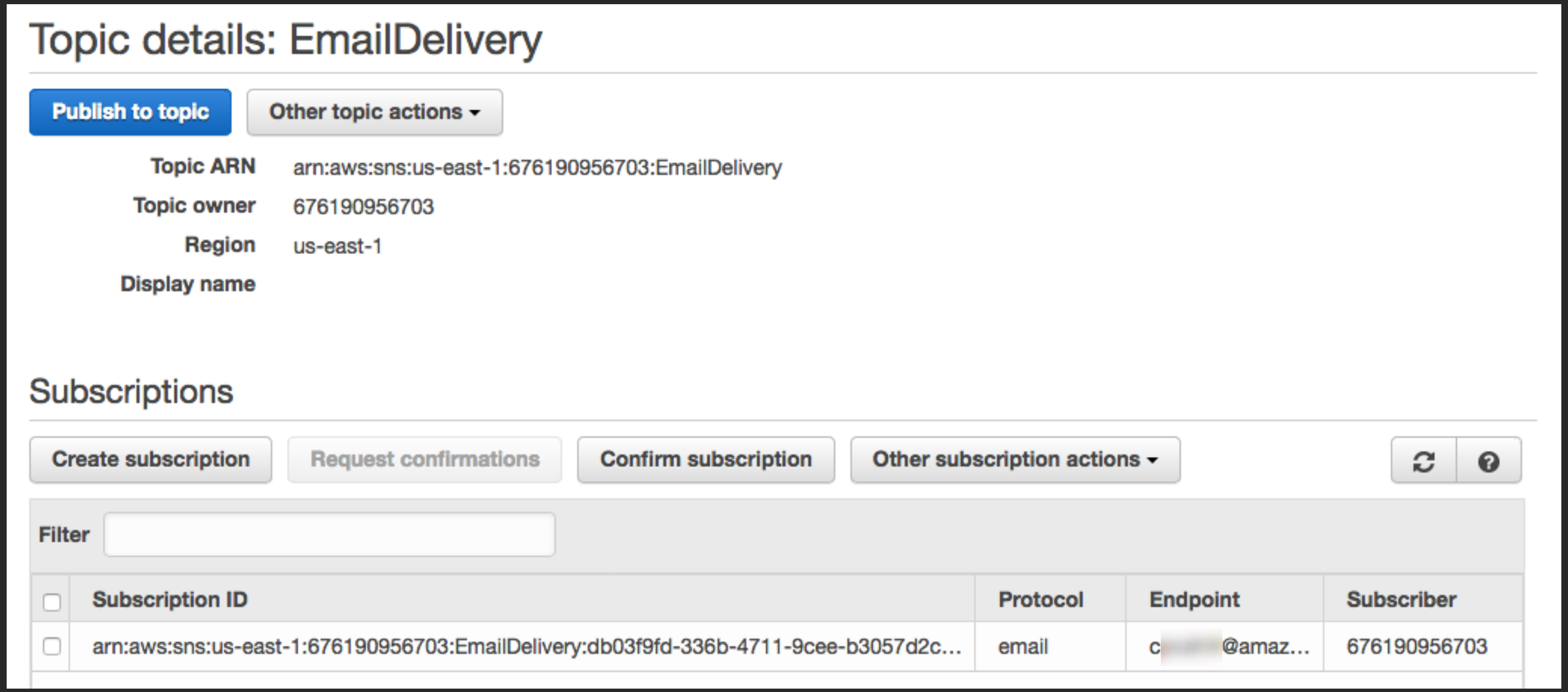
Subscription confirmed!

You have subscribed c[redacted]@amazon.com to the topic:
EmailDelivery.

Your subscription's id is:
`arn:aws:sns:us-east-1:676190956703:EmailDelivery:db03f9fd-336b-4711-9cee-b3057d2c76f5`

If it was not your intention to subscribe, click here to unsubscribe.

Configure Amazon SNS topic for email delivery



Configuring DynamoDB delete event notifications

1. Configure CloudWatch Events rule to invoke Lambda function
2. Configure Lambda function for processing event notification
3. Set up Amazon SNS topic for email notification

Configure Lambda function

Configure Lambda function

Configure Lambda function

Role

Defines the permissions of your function. Note that new roles may not be available for a few minutes after creation. **Learn more** about Lambda execution roles.

Create a new role from one or more templates.

Lambda automatically creates a role with permissions from the selected policy templates. Basic Lambda permissions (such as logging to Amazon CloudWatch) are automatically added. If your function accesses a VPC, the required permissions are also added.

Role name

Enter a name for your new role.

DynamoDBAlertsMailDelivery

This new role will be scoped to the current function. To use it with other functions, you can modify it in the IAM console.

Policy templates

Choose one or more policy templates. A role will be generated for you before your function is created. **Learn more** about the permissions that each policy template will add to your role.

Amazon SNS publish policy

Sample CloudWatch Event


```
"detail": {
    "eventVersion": "1.06",
    "eventID": "c7650985-8f79-4b8f-a09d-8966247554ad",
    "eventTime": "2018-11-07T15:28:10Z",
    "requestParameters": {
        "tableName": "TestDelTable"
    },
    "eventType": "AwsApiCall",
    "responseElements": {
        "tableDescription": {
            "tableArn": "arn:aws:dynamodb:us-east-1:111122223333:table/TestDelTable",
            "provisionedThroughput": {
                "writeCapacityUnits": 5.0,
                "numberOfDecreasesToday": 0.0,
                "readCapacityUnits": 5.0
            },
            "tableSizeBytes": 0.0,
            "tableName": "TestDelTable",
            "tableStatus": "DELETING",
            "tableId": "1903977f-1d73-4c7c-9768-6f6b6f437a36",
            "itemCount": 0.0
        }
    },
```

Sample CloudWatch Event


```
        "awsRegion": "us-east-1",
        "eventName": "DeleteTable",
        "readOnly": "False",
        "userIdentity": {
            "userName": "Bob",
            "principalId": "AIDAIDJA…",
            "accessKeyId": "AKIA…",
            "type": "IAMUser",
            "arn": "arn:aws:iam::111122223333:user/Bob",
            "accountId": "111122223333"
        },
        "eventSource": "dynamodb.amazonaws.com",
        "requestID": "84C8DULU0OHN3U8ACKFUH7EH9BVV4KQNSO5AEMVJF66Q9ASUAAJG",
        "apiVersion": "2012-08-10",
        "userAgent": "aws-cli/1.15.83 Python/3.7.0 Darwin/17.7.0 botocore/1.10.82",
        "sourceIPAddress": "72…",
        "managementEvent": "True",
        "recipientAccountId": "111122223333"
    },
```

Configure Lambda function

lambda_function

```
1  import json
2  import boto3
3  import datetime
4  def lambda_handler(event, context):
5
6      detail = event['detail']
7      action = detail['eventName']
8      identity = detail['userIdentity']
9      source = detail['eventSource']
10     invokerARN = identity['arn']
11     invokerID = invokerARN.split(":")[5]
12     account = identity['accountId']
13
```

Configure Lambda function

```
14      message = 'Event processed at %s\n\n' % str(datetime.datetime.now())
15
16      if 'errorMessage' in detail:
17          message += 'It appears that %s attempted to delete a table which failed ' % invokerID
18          message += 'with the error message:\n\n'
19          message += '    %s\n' % detail['errorMessage']
20
21          subject = 'Attempted delete of DynamoDB table in account %s by %s' % (account, invokerID)
22      else:
23          tableName = detail['requestParameters']['tableName']
24          message += '%s deleted the table %s in account %s\n' % (invokerID,tableName,account )
25
26          subject = 'Table %s in account %s deleted by %s' % (tableName, account, invokerID )
27
```

Configure Lambda function

```
28      message += '\n\nAPI Invocation details:\n'
29      message += '    DynamoDB API:     ' + action + '\n'
30      message += '    Invoked by: ' + invokerARN + '\n'
31      message += '    Parameters: \n'
32
33      requestParms = detail['requestParameters']
34      if requestParms is None or requestParms == "None" or len(requestParms) == 0:
35          message += '        None\n'
36      else:
37          for k, v in requestParms.items():
38              message += '       %s: %s\n' % (k, v)
39
```

Configure Lambda function

```
40      client = boto3.client('sns')
41      response = client.publish(
42          TargetArn="arn:aws:sns:us-east-1:676190956703:EmailDelivery",
43          Message=message,
44          MessageStructure='string',
45          Subject=subject
46      )
47
48      return 'Done'
```

Configuring DynamoDB delete event notifications

1. Configure CloudWatch Events rule to invoke Lambda function
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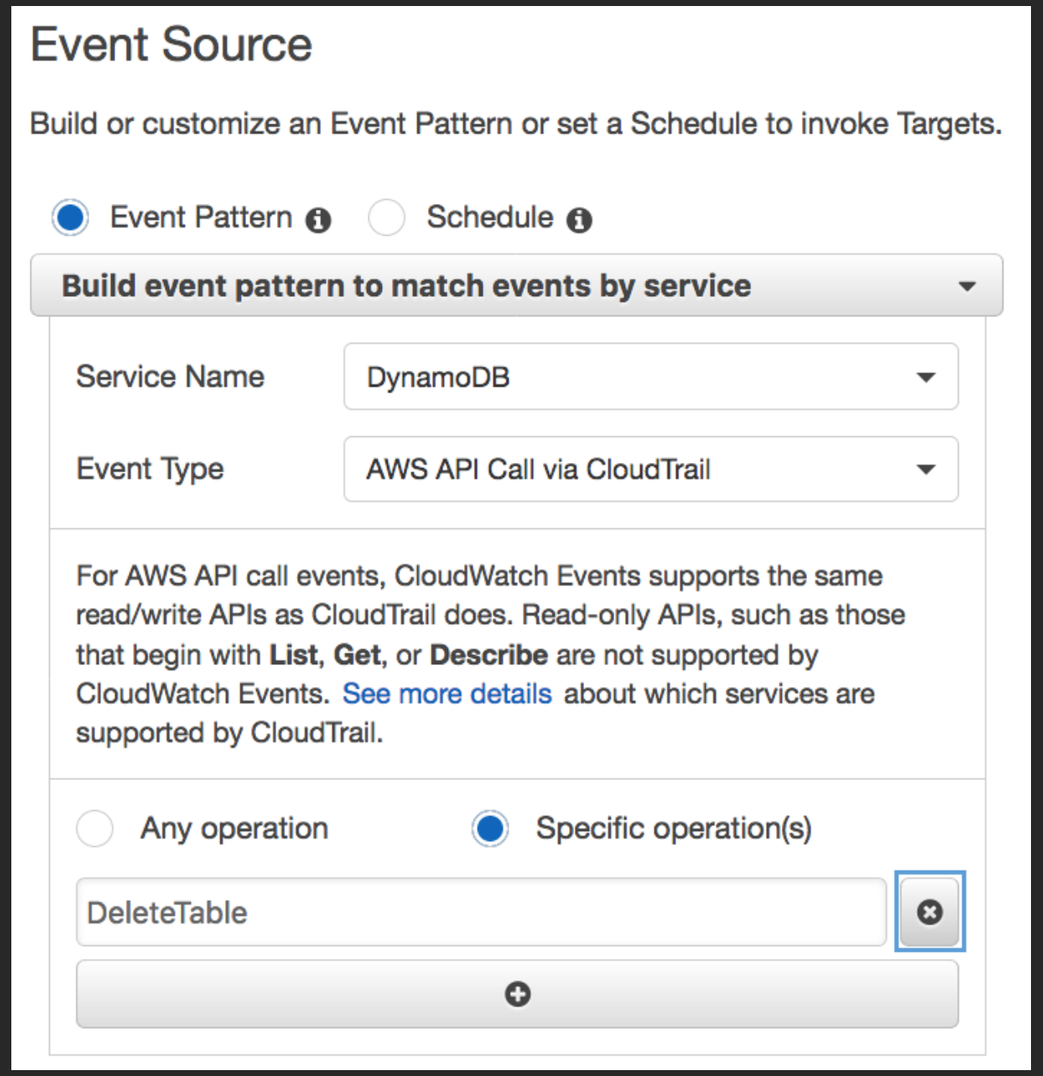
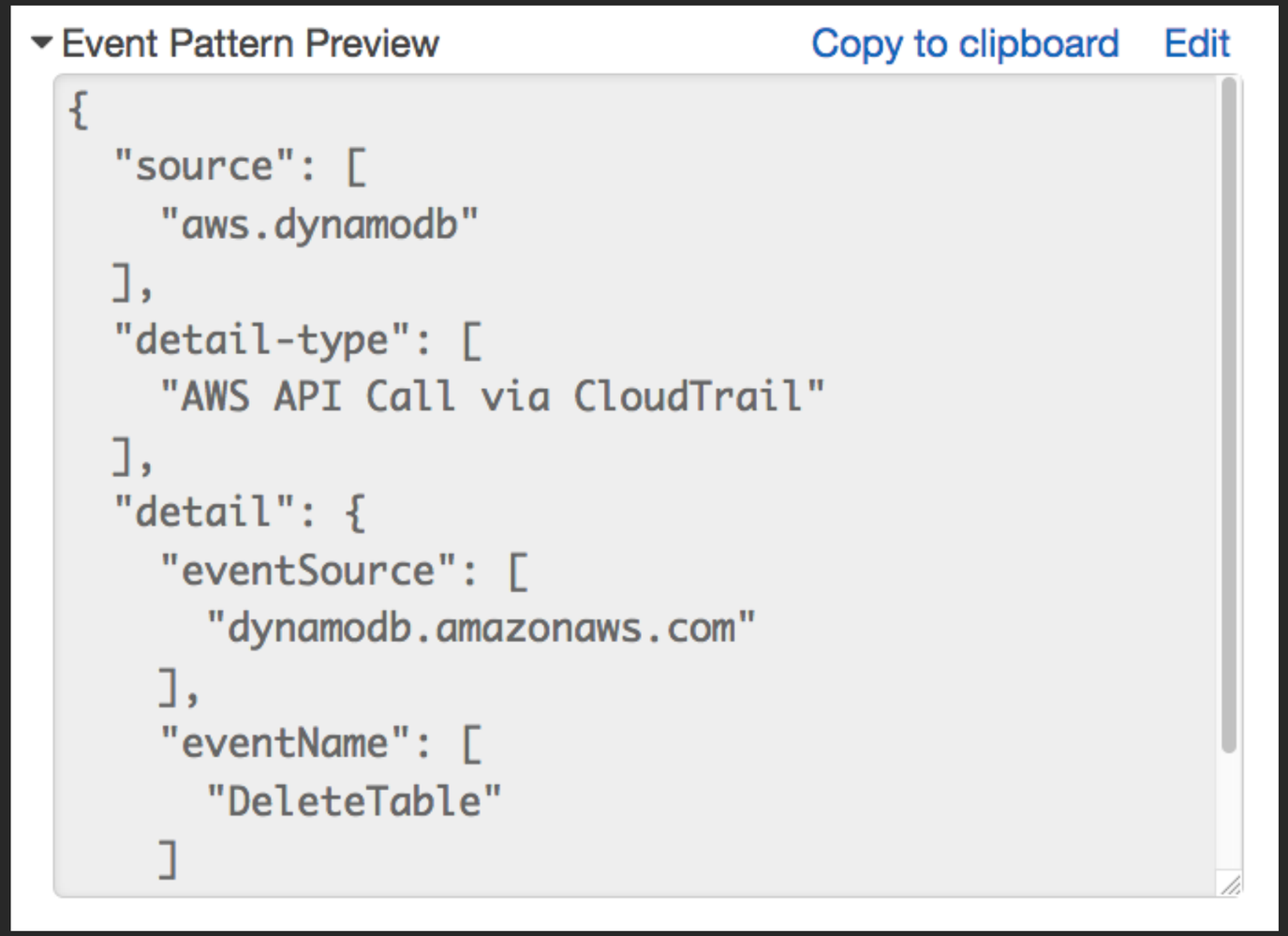
3. Setup Amazon SNS topic for email notification

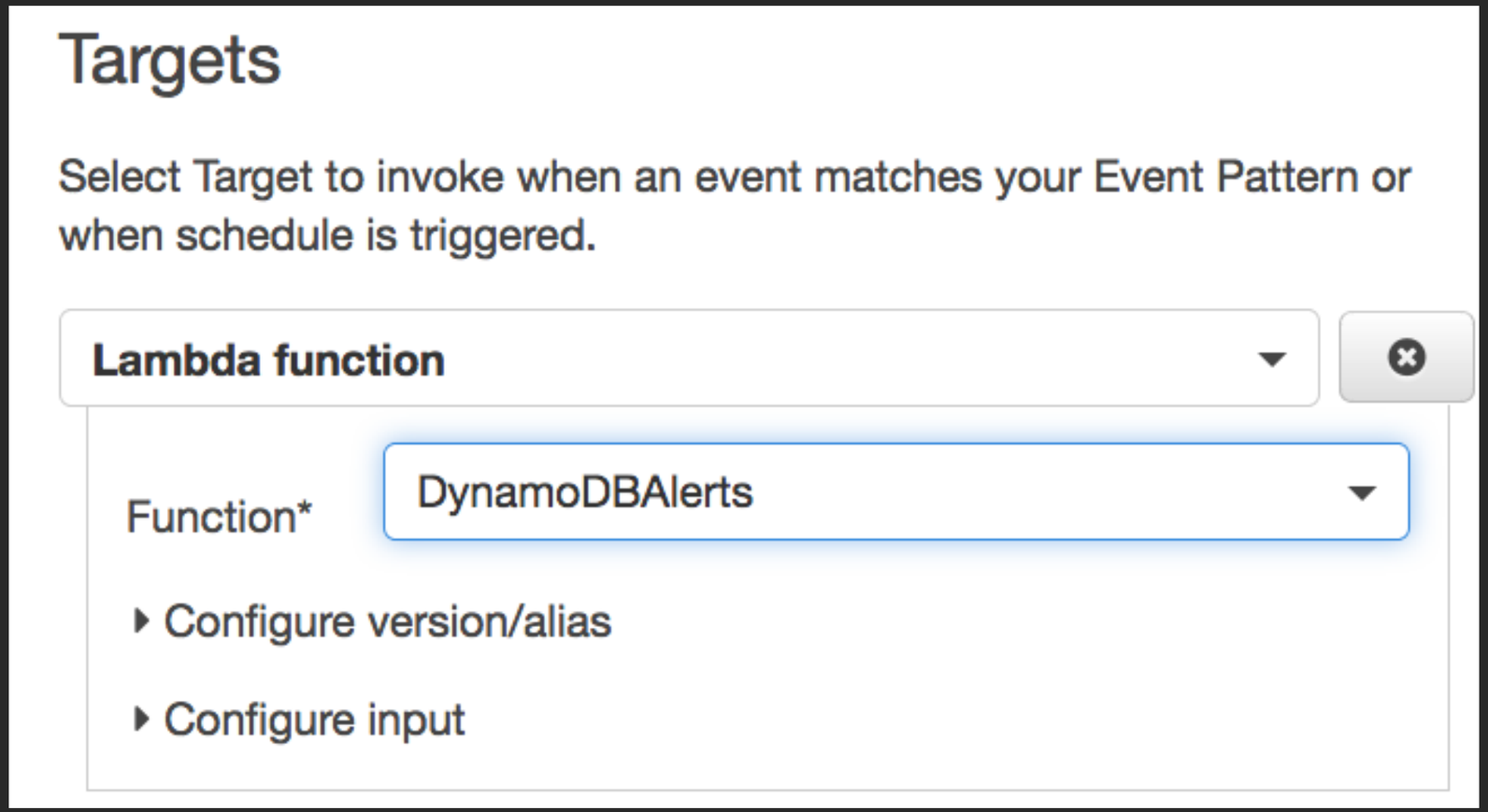
Configure CloudWatch Events rule



Configure CloudWatch Events rule

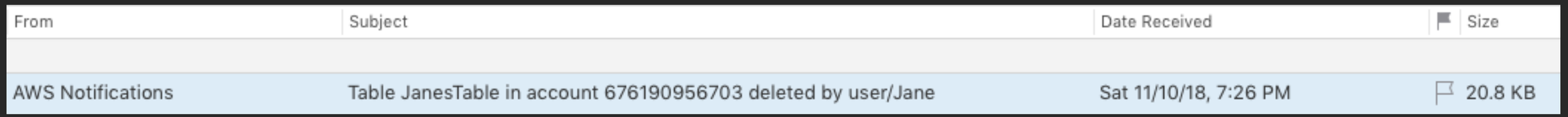


Configure CloudWatch Events rule



Jane deletes her table

```
% date -u; aws --profile jane dynamodb delete-table --table-name JanesTable
Sun Nov 11 00:25:37 UTC 2018
{
    "TableDescription": {
        "TableName": "JanesTable",
…
```



From	Subject	Date Received	Size
AWS Notifications	Table JanesTable in account 676190956703 deleted by user/Jane	Sat 11/10/18, 7:26 PM	20.8 KB

Event processed at 2018-11-11 00:25:38.814578

user/Jane deleted the table JanesTable in account 676190956703

API Invocation details:
DynamoDB API: DeleteTable
…

Controlling access to your data

Amazon DynamoDB access control

Base authorization

- Action—the API that is being used
- Resource—the table/index/backup/stream that is being accessed

Fine-grained controls

- **LeadingKeys**—the key of the record being accessed
- **Attributes**—the attributes (fields) of the records being accessed
- **Select**—the select parameter of a query or scan request
- **ReturnValues**—whether the requestor asked for values to be returned
- **ReturnConsumeCapacity**—whether the requestor asked for the consumed capacity

Fine-grained access control example scenario

ProductCatalog table, Partition Key = id

- Books
  - Ids in the 100s
  - Attributes: Title, ISBN, Authors, Price, Dimensions, PageCount, inPublication, ProductCategory
- Bicycles
  - Ids in the 200s
  - Attributes: Title, Description, BicycleType, Brand, Price, Color, ProductCategory

Users

- Alice (works on books)
- Bob (works on bicycles)

Alice's permissions (Books only)

```
{
    "Effect": "Allow",
    "Action": "dynamodb:ListTables",
    "Resource": "*"
},
{
    "Sid": "FineGrainedTableAccess",
    "Effect": "Allow",
    "Action": [
        "dynamodb:PutItem",
        "dynamodb:GetItem",
        "dynamodb:UpdateItem",
        "dynamodb:Query"
    ],
    "Resource": "arn:aws:dynamodb:us-east-1:676190956703:table/ProductCatalogTable",
```

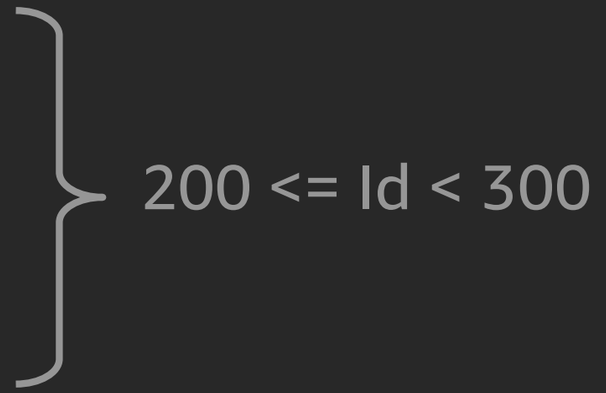
Alice's permissions (Books only), part 2

```
"Condition": {
    "ForAllValues:NumericGreaterThanEquals": {
        "dynamodb:LeadingKeys": "100"
    },
    "ForAllValues:NumericLessThan": {
        "dynamodb:LeadingKeys": "200"
    },
    "ForAllValues:StringLike": {
        "dynamodb:Attributes": [
            "Id",  "Title", "ISBN", "Authors", "Price",
            "Dimensions", "PageCount", "inPublication", "ProductCategory"
        ]
    }
}
```

100 <= Id < 200

Bob's permissions (Bikes only) , part 2 (skipped part 1)

```
"Condition": {
    "ForAllValues:NumericGreaterThanEquals": {
        "dynamodb:LeadingKeys": "200"
    },
    "ForAllValues:NumericLessThan": {
        "dynamodb:LeadingKeys": "300"
    },
    "ForAllValues:StringLike": {
        "dynamodb:Attributes": [
            "Id", "Title", "Description", "BicycleType",
            "Brand", "Price", "Color", "ProductCategory"
        ]
    }
}
```



Permission impacts with Alice

```
% aws --profile Alice dynamodb get-item --table-name ProductCatalogTable \
                                        --key '{ "Id" : { "N" : "99" } }' \
                                        --projection-expression 'Id, Title'

An error occurred (AccessDeniedException) when calling the GetItem
operation: User: arn:aws:iam::676190956703:user/Alice is not authorized
to perform: dynamodb:GetItem on resource:
arn:aws:dynamodb:us-east-1:676190956703:table/ProductCatalog
```

More permission impacts with Alice

```
% aws --profile Alice dynamodb get-item --table-name ProductCatalogTable \
                                        --key '{ "Id" : { "N" : "101" } }' \
                                        --projection-expression 'Id, Title'
{
    "Item": {
        "Id": {
            "N": "101"
        },
        "Title": {
            "S": "Book 101 Title"
        }
    }
}
```

More permission impacts with Alice

```
% aws --profile Alice dynamodb get-item --table-name ProductCatalogTable \
                                        --key '{ "Id" : { "N" : "101" } }' \
                                        --projection-expression 'Id, Brand'
```

```
An error occurred (AccessDeniedException) when calling the GetItem
operation: User: arn:aws:iam::676190956703:user/Alice is not authorized
to perform: dynamodb:GetItem on resource:
arn:aws:dynamodb:us-east-1:676190956703:table/ProductCatalogTable
```

Permission impacts with Bob

```
% aws --profile Bob dynamodb get-item --table-name ProductCatalogTable \
                                      --key '{ "Id" : { "N" : "199" } }' \
                                      --projection-expression 'Id, Title, Brand'

An error occurred (AccessDeniedException) when calling the GetItem
operation: User: arn:aws:iam::676190956703:user/Bob is not authorized
to perform: dynamodb:GetItem on resource:
arn:aws:dynamodb:us-east-1:676190956703:table/ProductCatalogTable
```

More permission impacts with Bob

```
% aws --profile Bob dynamodb get-item --table-name ProductCatalog \
                                      --key '{ "Id" : { "N" : "201" } }' \
                                      --projection-expression 'Id, Title, Brand'
{
    "Item": {
        "Id": {
            "N": "201"
        },
        "Title": {
            "S": "18-Bike-201"
        },
        "Brand": {
            "S": "Mountain A"
        }
    }
}
```

Limiting network access while using DynamoDB

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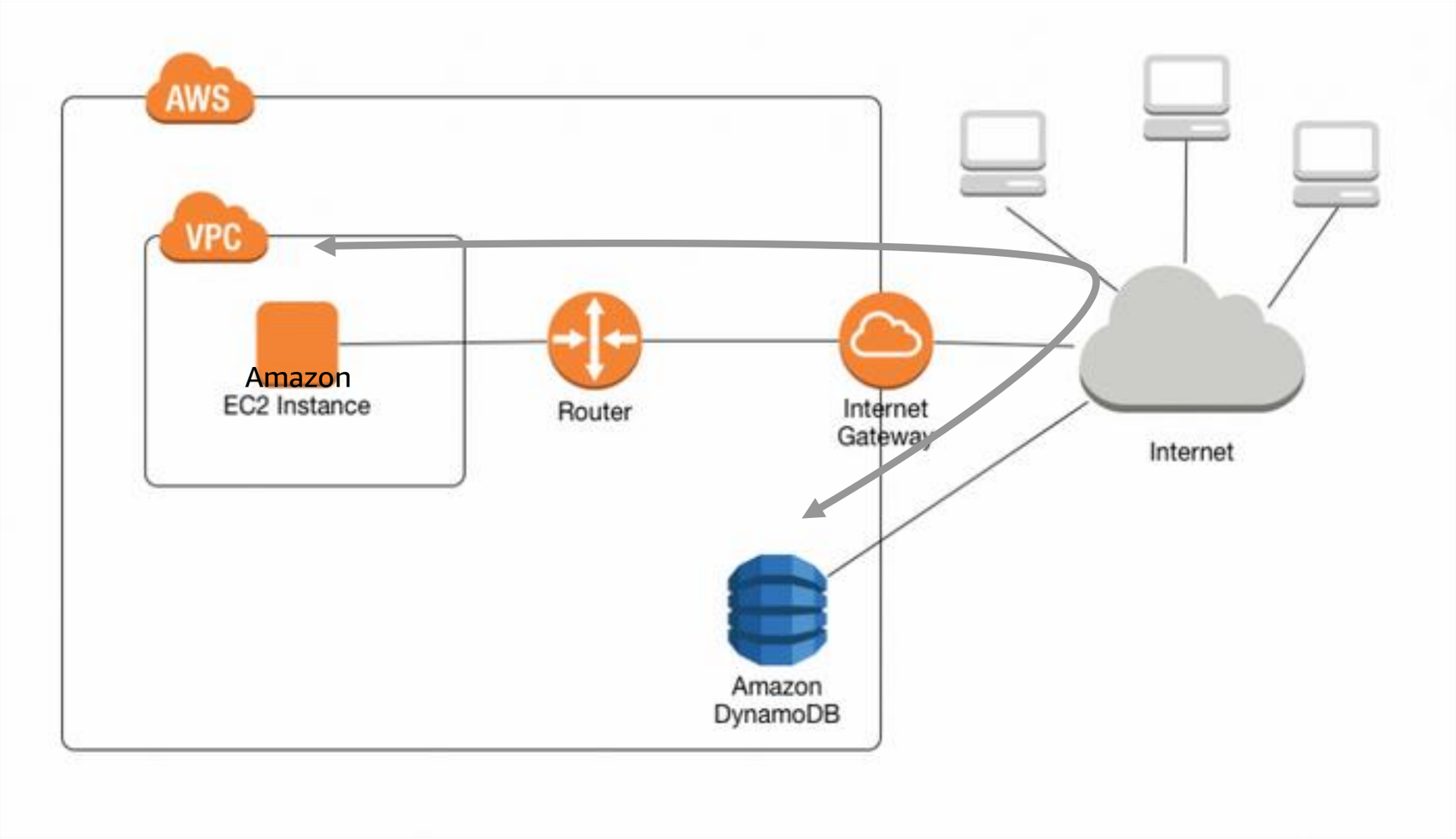
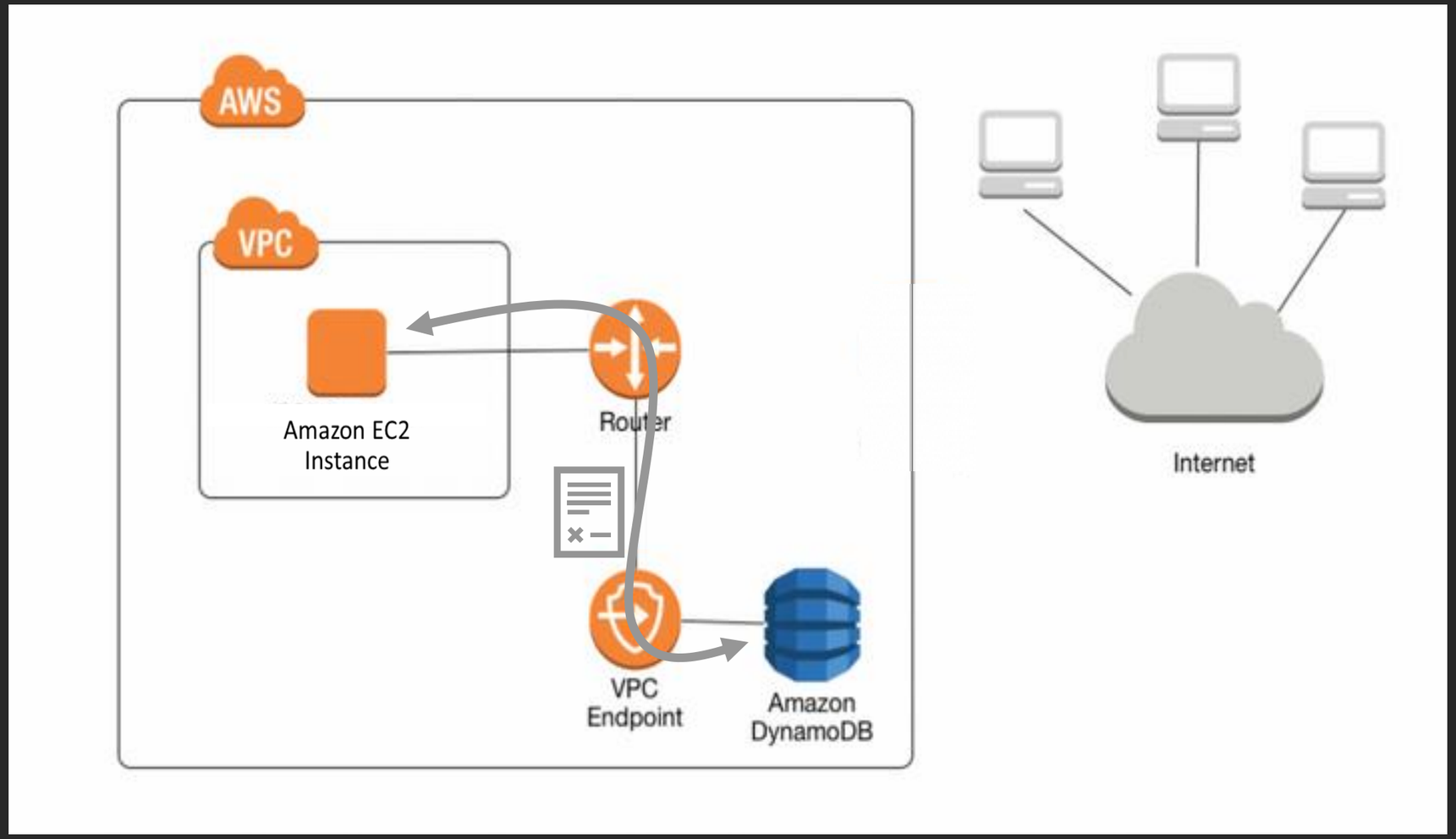
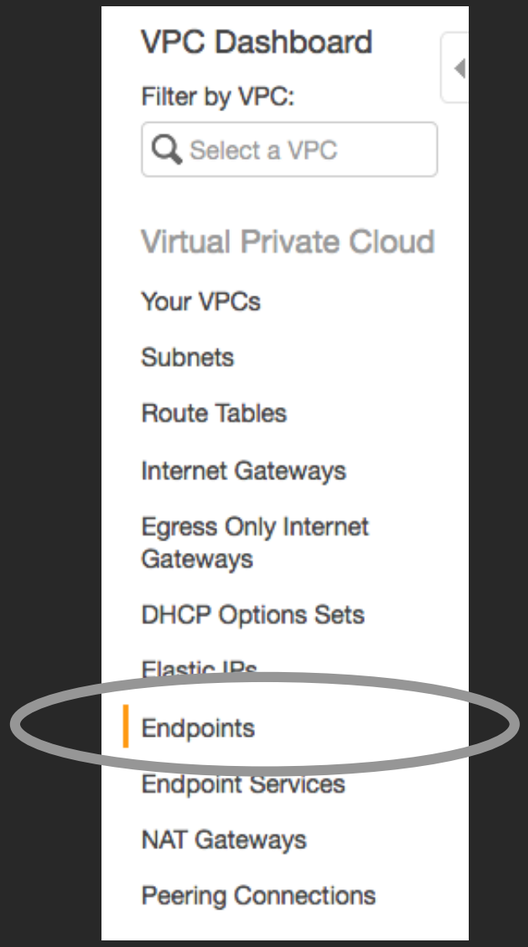
Traditional virtual private cloud (VPC) access to DynamoDB



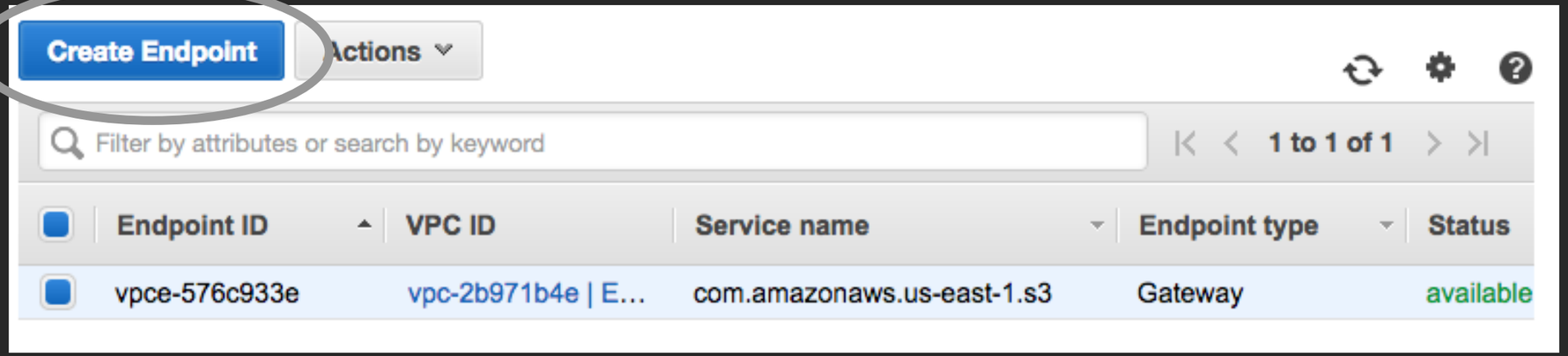
VPC endpoint access to DynamoDB



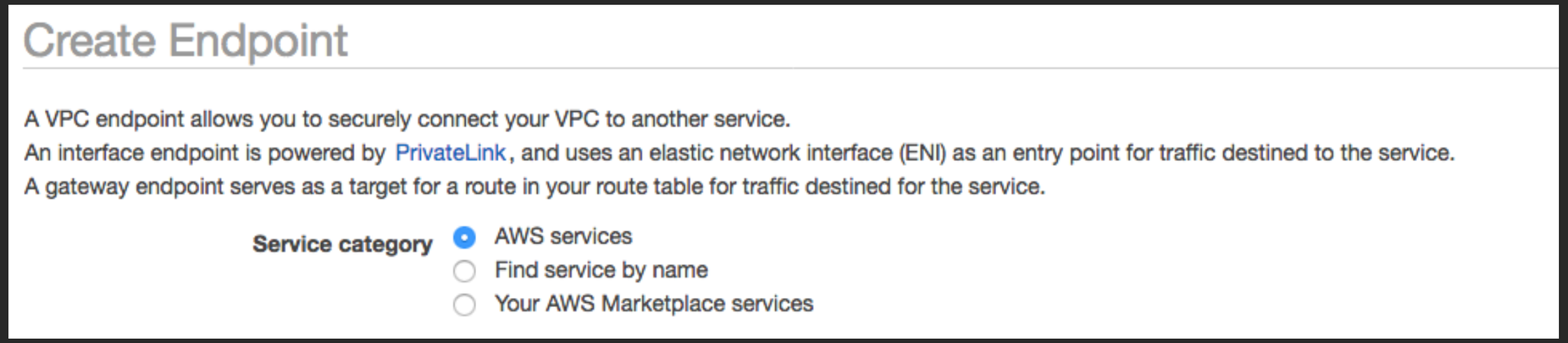
Setting up a VPC endpoint for DynamoDB

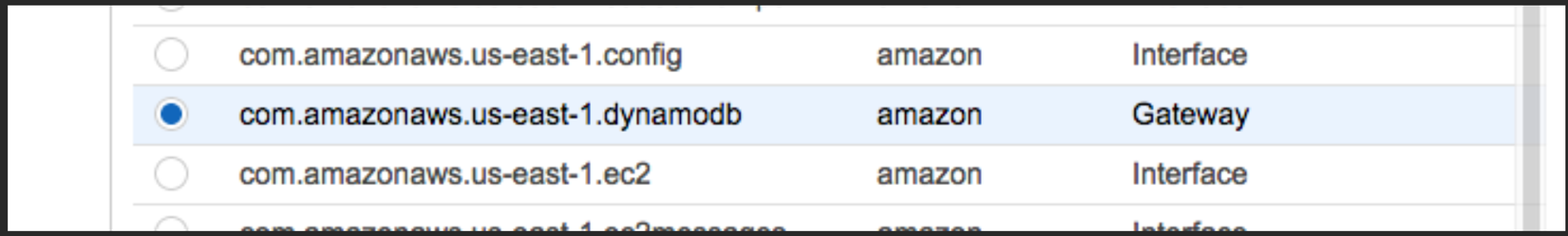


Viewing VPC endpoints



Selecting Amazon DynamoDB





Warning: source IP address will change

Warning

When you use an endpoint, the source IP addresses from your instances in your affected subnets for accessing the AWS service in the same region will be private IP addresses, not public IP addresses. Existing connections from your affected subnets to the AWS service that use public IP addresses may be dropped. Ensure that you don't have critical tasks running when you create or modify an endpoint.

Source IP address restriction policy for Bob

```
"Effect": "Allow",
"Action": [ "dynamodb:*"],
"Resource": [ "*" ],
"Condition": {
        "IpAddress": {
            "aws:SourceIp": [ "<CORP_IP_ADDRESS>" ]
        }
 }
```

Bob accesses his database from his VPC

```
% aws --profile Bob dynamodb list-tables

{  "TableNames": [  "MyTestTable" ] }


===== DynamoDB VPC endpoint is enabled in Bob's VPC =====


% aws --profile Bob dynamodb list-tables

An error occurred (AccessDeniedException) when calling the ListTables operation: User:
arn:aws:iam::676190956703:user/Bob is not authorized to perform: dynamodb:ListTables on
resource: *
```

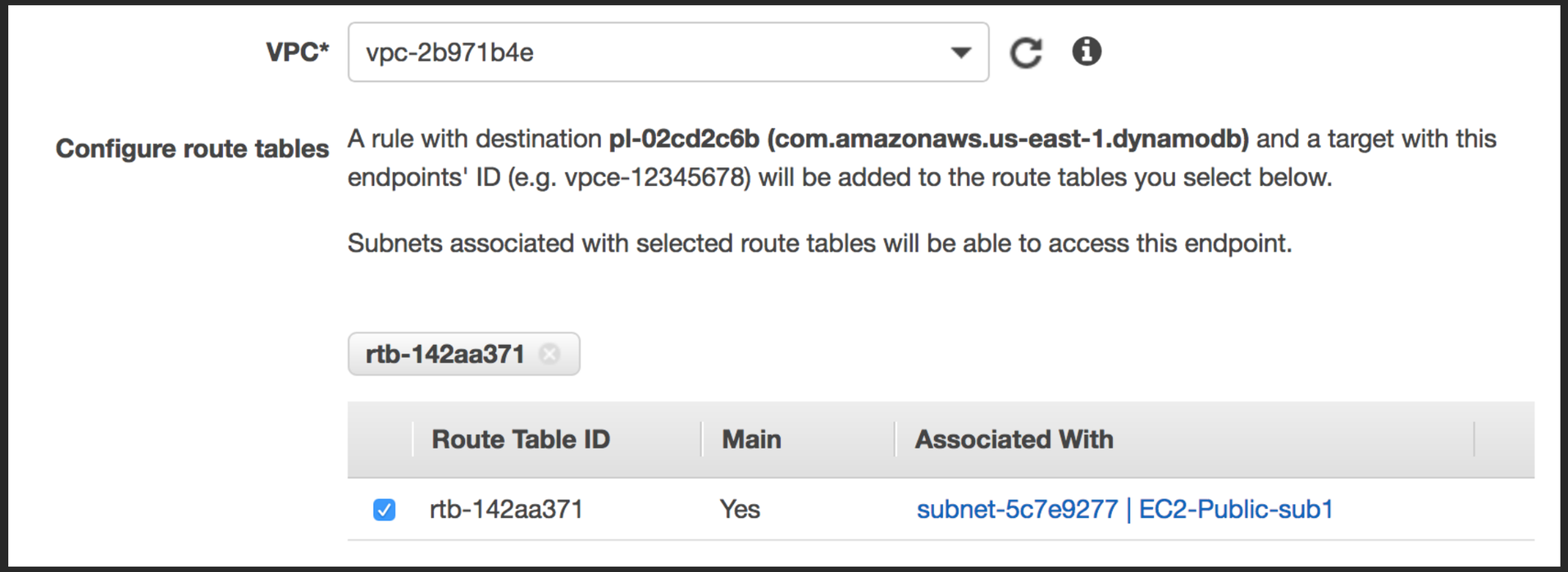
Source IP or VPC endpoint restriction policy

```
"Effect": "Allow",
"Action": [ "dynamodb:*"],
"Resource": [ "*" ],
"Condition": {
        "IpAddressIfExists": {
                "aws:SourceIp": [ "<CORP_IP_ADDRESS>" ]
        },
        "StringEqualsIfExists": {
                "aws:SourceVpce": [ "vpce-0a87fbf7ad21cd41f" ]
        }
 }
```

VPC endpoint-only restriction policy

```
"Effect": "Allow",
"Action": [ "dynamodb:*"],
"Resource": [ "*" ],
"Condition": {
        "StringEquals": {
                "aws:SourceVpce": [ "vpce-0a87fbf7ad21cd41f" ]
        }
 }
```

Select your VPC and route table for the VPC endpoint



VPC endpoint policy

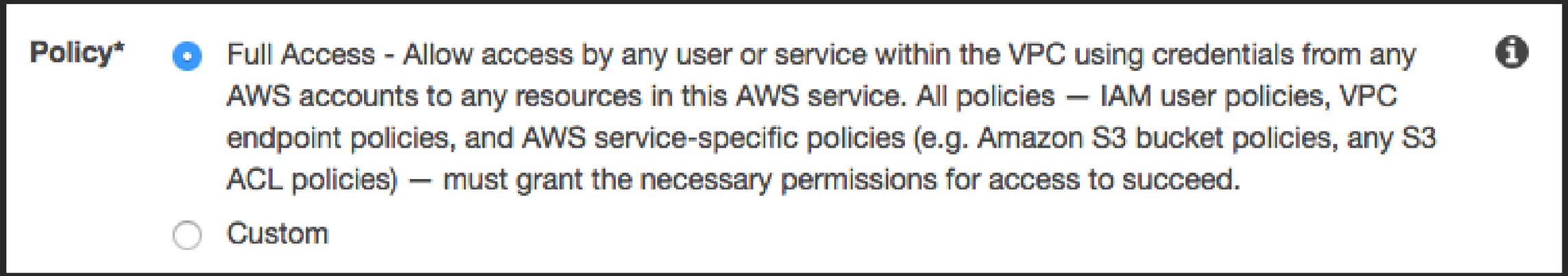
Limit policy

- Limits what the VPC endpoint can be used for
- Does not grant access—IAM policies grant access

Controls

- Principals—who can use the endpoint
- Actions—what DynamoDB APIs they can invoke
- Resources—what resources can be accessed

Set your VPC endpoint policy: full access



- Enables all DynamoDB access within and across AWS accounts
- Existing applications that use DynamoDB under the hood continue working

VPC endpoint policy: only my organization

```
"Statement": [ {
    "Effect": "Allow",
    "Principal": "*",
    "Action": "dynamodb:*",
    "Resource": "*",
    "Condition" : {
        "StringEquals" : { "aws:PrincipalOrgID" : "<MY-ORGANIZATION-ID" }
    }
} ]
```

Any resource

The principal's organization

DynamoDB Tagging

- Labels attached to AWS resources
- Tags make it easier to manage, search, filter
- View AWS bills broken down by tags
- Tag at creation time
- Allowed operations: Add, List, Edit, Delete

Further exploration

Continuous backup and point-in-time restore

https://aws.amazon.com/dynamodb/backup-restore/

Includes ability to restore deleted tables

Monitoring Amazon DynamoDB configuration with AWS Config

Automates service configuration monitoring tasks

https://docs.aws.amazon.com/config/latest/developerguide/WhatIsConfig.html

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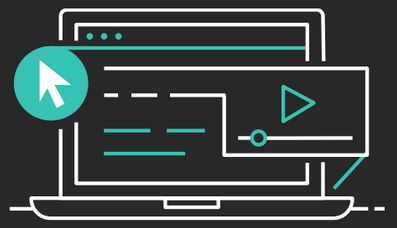

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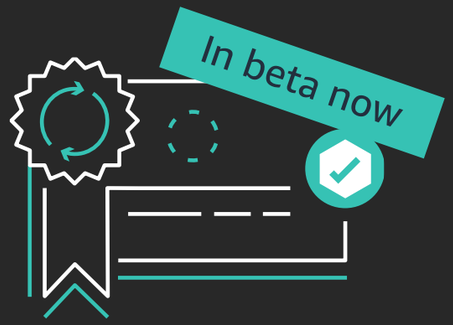

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