Amazon Web Services
Data Engineering Immersion Day

Database Migration Services Instructor Setup Instructions
March 2020

Table of Contents

Limit Instruction:

This immersion day required each student to have their own account. If you are sharing single account with multiple students by creating a multiple IAM users, Account can hit following default service limit:

- VPC – VPCs per Region 5
- Glue - Number of crawlers per account 50
- Glue - Number of concurrent jobs runs per account 50
- Glue - Maximum DPUs used by a role at one time 300
- S3 – Number of buckets per account 100
- Athena - Number of DDL queries you can submit at the same time 20
- Athena - Number of DML queries you can submit at the same time 20
- RDS – Make sure you have enough disk space available in your RDS instance, if want to run DMS Change Data Capture (CDC) as generating large amount of data can exhaust RDS disk space.
- DMS - Make sure you have enough disk space available in your DMS replication instance, if want to run DMS Change Data Capture (CDC) as transferring large amount of CDC data can exhaust disk space.

Introduction

*****Make sure you select the us-east-1 (Virginia) region*****

The Database Migration Services (DMS) hands-on lab provide a scenario, where participant learns to hydrate Amazon S3 data lake with a relation database. To achieve that, participants need a source endpoint and this guide helps instructors set up a PostgreSQL database with public endpoint as the source database.

In this lab, you will complete the following tasks:

1. Create the source database environment.
2. Hydrate the source database environment.
3. Update the source database environment to demonstrate CDC replication within DMS.

Relevant information about this lab:

• Expected setup time:	45 minutes
• Source database name:	sportstickets
• Source schema name:	dms_sample

Instructor will provide source database details to participants during main lab to configure source endpoint.

Create the Instructor Environment

In this section, you are going to create a PostgreSQL RDS instance as data source for AWS Data Migration Service to consume by lab attendees for data migration to Amazon S3 data lake.

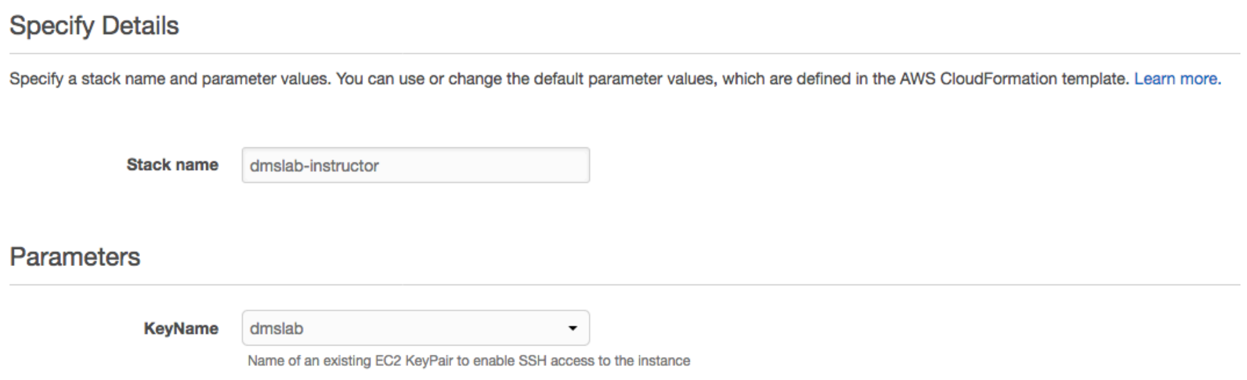
1. Sign in to the Console where you will host the source database environment.

2. Navigate to the AWS CloudFormation page.

3. Launch a new stack with the AWS CloudFormation template DMSLab_instructor_CFN.json provided with your lab package. Make sure to select us-east-1 (Virginia) region.

   Alternatively, You can follow instruction in Appendix : AWS CloudFormation Template to create your AWS CloudFormation template for this lab.

4. Give stack name and Enter the Key Pair to use. Please make sure to create an Amazon EC2 Key pair if don't have one in select us-east-1 (Virginia) region. Follow User guide Amazon EC2 key pairs to create a key pair.



Specify Details

Specify a stack name and parameter values. You can use or change the default parameter values, which are defined in the AWS CloudFormation template. Learn more.

Stack name: dmslab-instructor

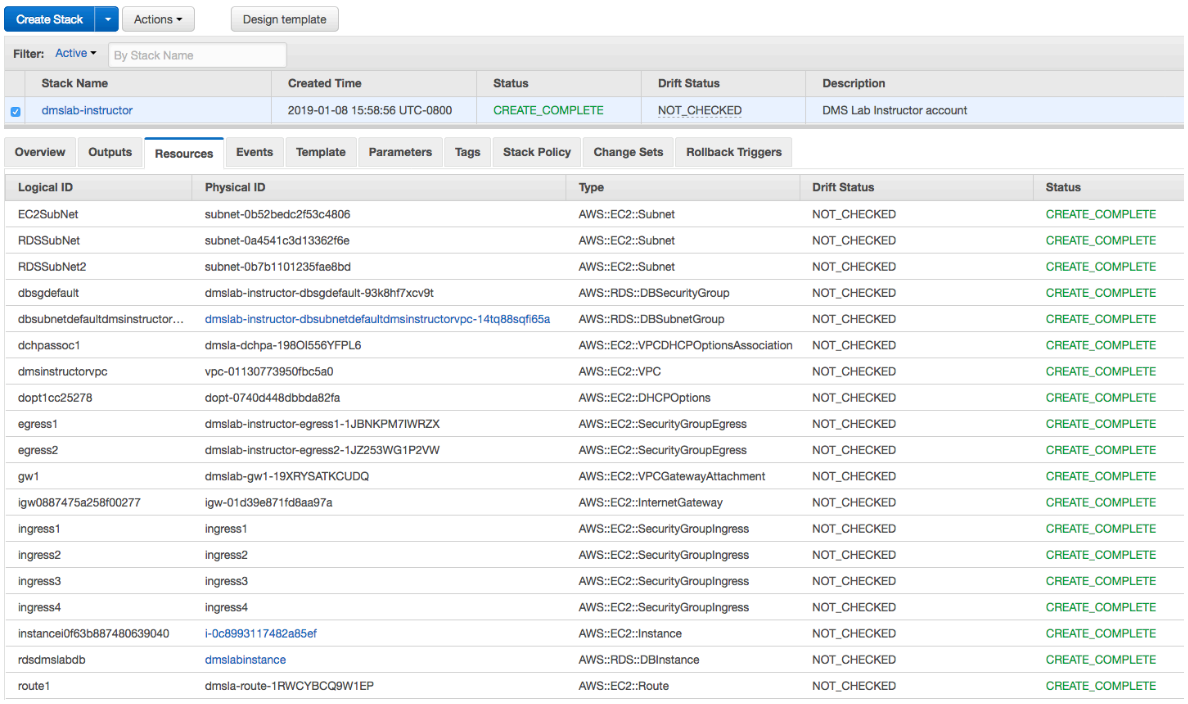
Parameters

KeyName: dmslab

Name of an existing EC2 KeyPair to enable SSH access to the instance

5. Enter a tag for the Name that identifies the resources as part of this lab.

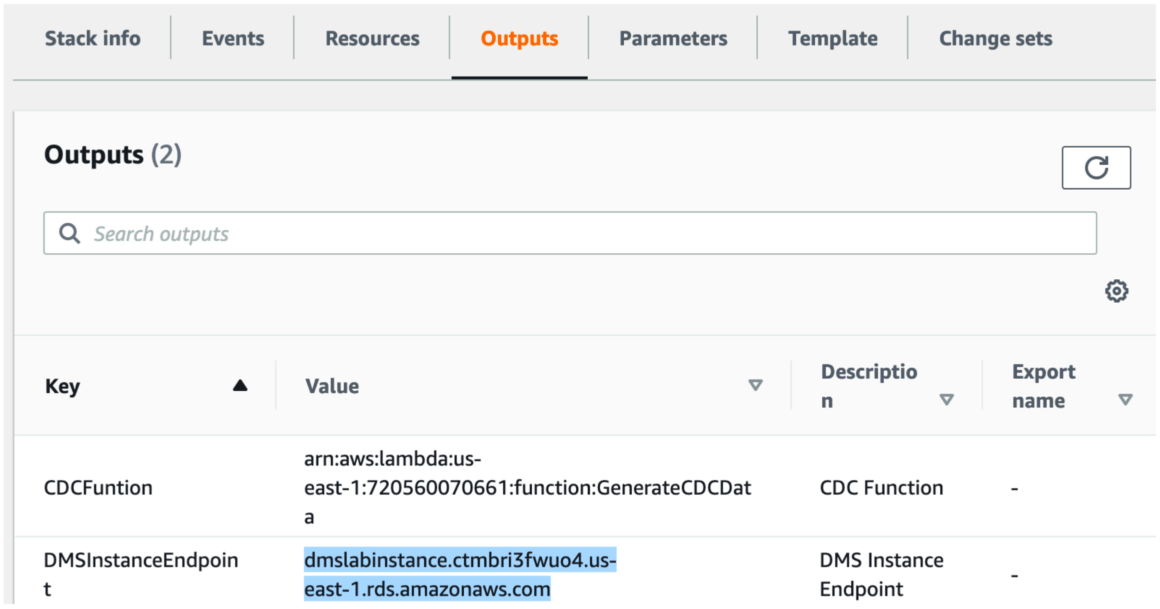
6. Launch the stack. It may take 15 minutes for the stack to launch.
   This stack creates a new VPC, Subnets, Security groups, EC2 instance, Route table, Routes, and an RDS Postgres instance. You can see all resources listed below:



	Stack Name	Created Time	Status	Drift Status	Description
✓	dmslab-instructor	2019-01-08 15:58:56 UTC-0800	CREATE_COMPLETE	NOT_CHECKED	DMS Lab Instructor account

Logical ID	Physical ID	Type	Drift Status	Status
EC2SubNet	subnet-0b52bedc2f53c4806	AWS::EC2::Subnet	NOT_CHECKED	CREATE_COMPLETE
RDSSubNet	subnet-0a4541c3d13362f6e	AWS::EC2::Subnet	NOT_CHECKED	CREATE_COMPLETE
RDSSubNet2	subnet-0b7b1101235fae8bd	AWS::EC2::Subnet	NOT_CHECKED	CREATE_COMPLETE
dbsgdefault	dmslab-instructor-dbsgdefault-93k8hf7xcv9t	AWS::RDS::DBSecurityGroup	NOT_CHECKED	CREATE_COMPLETE
dbsubnetdefaultdmsinstructor…	dmslab-instructor-dbsubnetdefaultdmsinstructorvpc-14tq88sqfi65a	AWS::RDS::DBSubnetGroup	NOT_CHECKED	CREATE_COMPLETE
dchpassoc1	dmsla-dchpa-198OI556YFPL6	AWS::EC2::VPCDHCPOptionsAssociation	NOT_CHECKED	CREATE_COMPLETE
dmsinstructorvpc	vpc-01130773950fbc5a0	AWS::EC2::VPC	NOT_CHECKED	CREATE_COMPLETE
dopt1cc25278	dopt-0740d448dbbda82fa	AWS::EC2::DHCPOptions	NOT_CHECKED	CREATE_COMPLETE
egress1	dmslab-instructor-egress1-1JBNKPM7IWRZX	AWS::EC2::SecurityGroupEgress	NOT_CHECKED	CREATE_COMPLETE
egress2	dmslab-instructor-egress2-1JZ253WG1P2VW	AWS::EC2::SecurityGroupEgress	NOT_CHECKED	CREATE_COMPLETE
gw1	dmslab-gw1-19XRYSATKCUDQ	AWS::EC2::VPCGatewayAttachment	NOT_CHECKED	CREATE_COMPLETE
igw0887475a258f00277	igw-01d39e871fd8aa97a	AWS::EC2::InternetGateway	NOT_CHECKED	CREATE_COMPLETE
ingress1	ingress1	AWS::EC2::SecurityGroupIngress	NOT_CHECKED	CREATE_COMPLETE
ingress2	ingress2	AWS::EC2::SecurityGroupIngress	NOT_CHECKED	CREATE_COMPLETE
ingress3	ingress3	AWS::EC2::SecurityGroupIngress	NOT_CHECKED	CREATE_COMPLETE
ingress4	ingress4	AWS::EC2::SecurityGroupIngress	NOT_CHECKED	CREATE_COMPLETE
instancei0f63b887480639040	i-0c8993117482a85ef	AWS::EC2::Instance	NOT_CHECKED	CREATE_COMPLETE
rdsdmslabdb	dmslabinstance	AWS::RDS::DBInstance	NOT_CHECKED	CREATE_COMPLETE
route1	dmsla-route-1RWCYBCQ9W1EP	AWS::EC2::Route	NOT_CHECKED	CREATE_COMPLETE

7. Once the stack is launched, navigate to the Outputs tab, copy the instance Endpoint information as shown in below screenshot

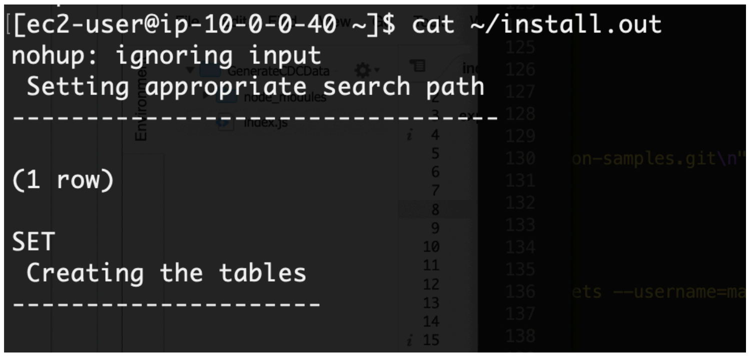


Key	Value	Description	Export name
CDCFuntion	arn:aws:lambda:us-east-1:720560070661:function:GenerateCDCData	CDC Function	-
DMSInstanceEndpoint	dmslabinstance.ctmbri3fwuo4.us-east-1.rds.amazonaws.com	DMS Instance Endpoint	-

8. SSH to the ec2 instance created by this template.

9. To see the database creation progress, you can observe install.out file by giving command:

```
cat ~/install.out
```



```
[ec2-user@ip-10-0-0-40 ~]$ cat ~/install.out
nohup: ignoring input
 Setting appropriate search path
--------------------------------

(1 row)

SET
 Creating the tables
--------------------
```

Note:

   i. It may include messages about non-existing table, but you should not see any errors and the background process will end when complete. You can check whether the process is still running with the following command.

```
ps -aef | grep psql
```

Wait 5 to 10 minutes for the database creation to complete.

The github repository for aws-database-migration-samples is located here:

https://github.com/aws-samples/aws-database-migration-samples/tree/master/PostgreSQL/sampledb/v1

You can read though the documentation to better understand the source database environment.

Access Database from SQL Client (Optional)

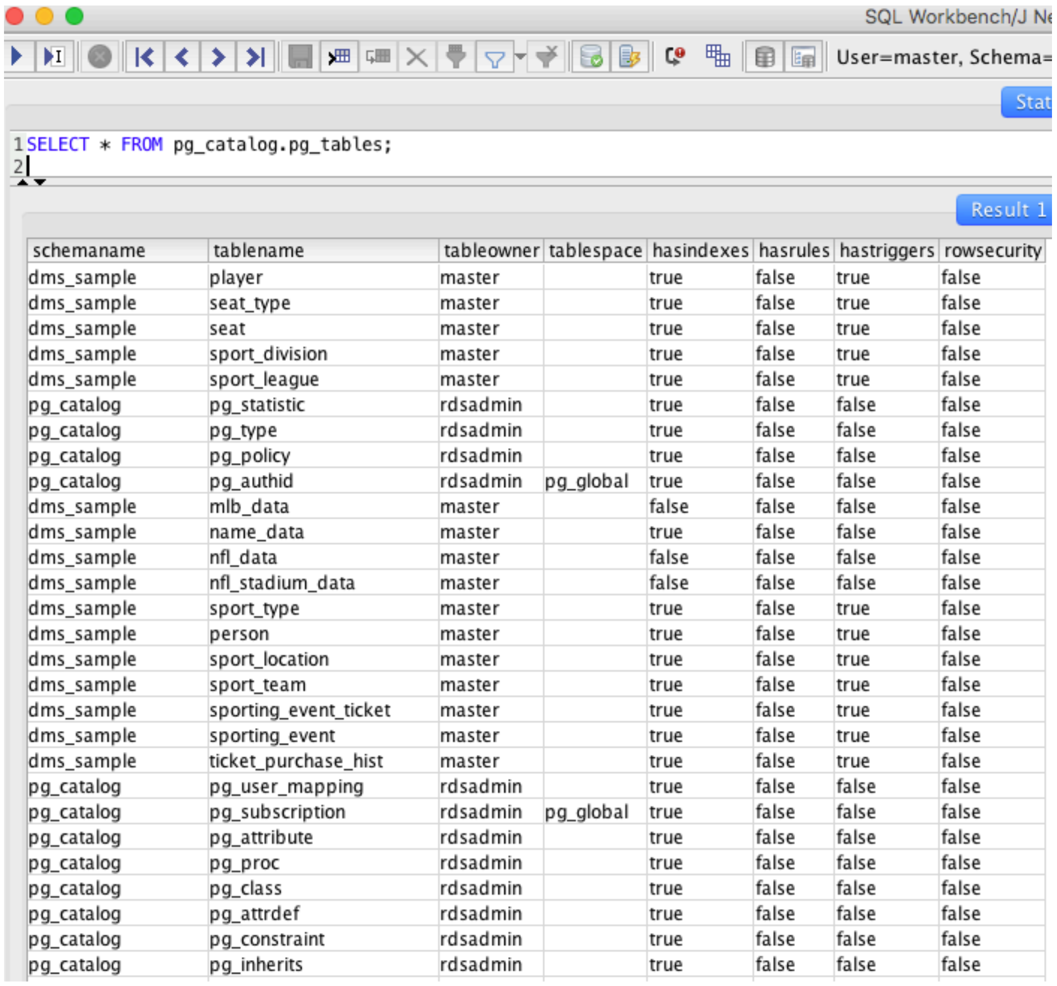
You can follow below instruction to setup SQL Workbench to access your Postgre Database from SQL client:

https://aws.amazon.com/getting-started/tutorials/create-connect-postgresql-db/

In SQL Workbench:

Run following query to find out all Schema and table created.

```
SELECT * FROM pg_catalog.pg_tables;
```



```
SELECT * FROM pg_catalog.pg_tables;
```

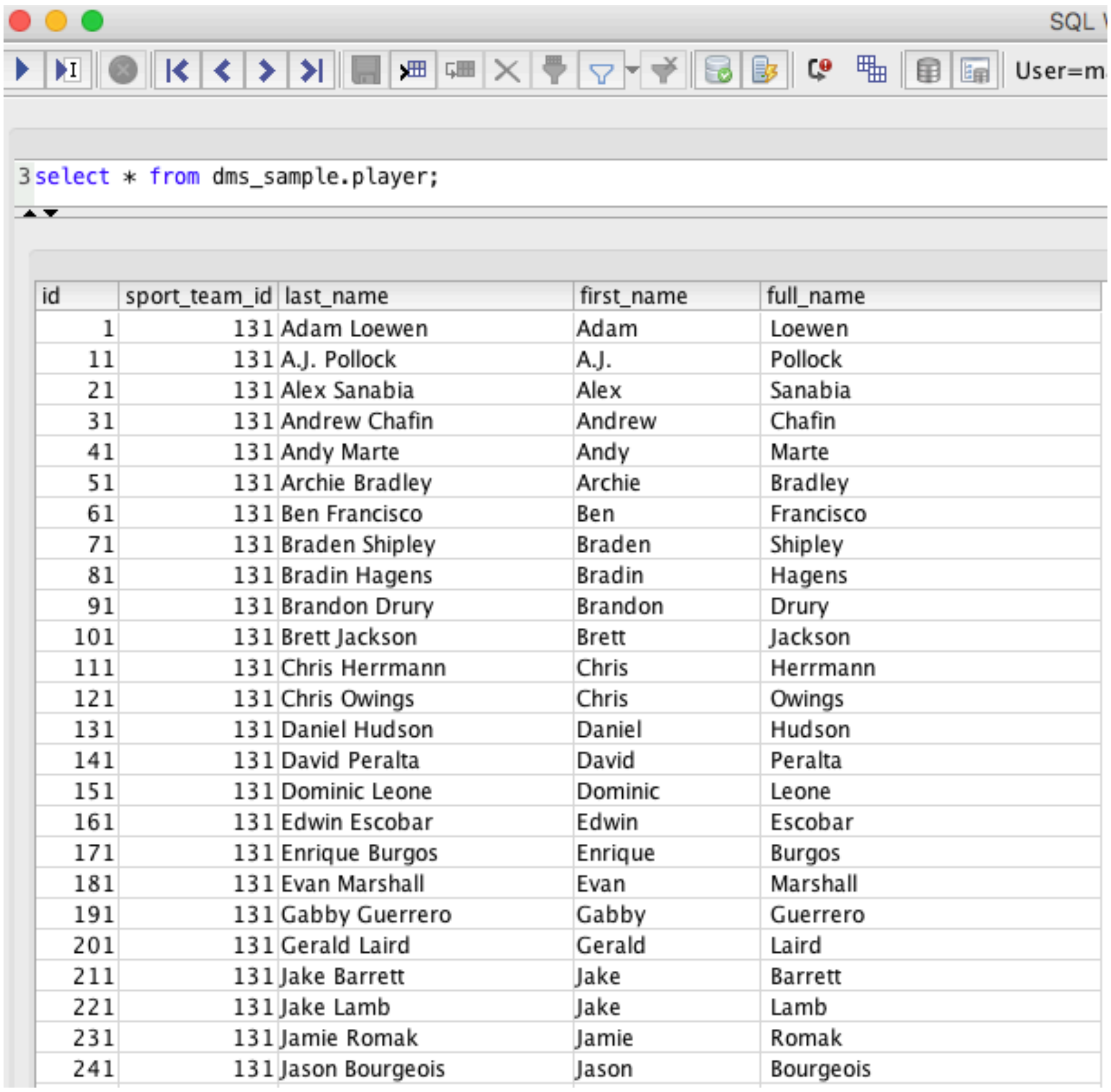
schemaname	tablename	tableowner	tablespace	hasindexes	hasrules	hastriggers	rowsecurity
dms_sample	player	master		true	false	true	false
dms_sample	seat_type	master		true	false	true	false
dms_sample	seat	master		true	false	true	false
dms_sample	sport_division	master		true	false	true	false
dms_sample	sport_league	master		true	false	true	false
pg_catalog	pg_statistic	rdsadmin		true	false	false	false
pg_catalog	pg_type	rdsadmin		true	false	false	false
pg_catalog	pg_policy	rdsadmin		true	false	false	false
pg_catalog	pg_authid	rdsadmin	pg_global	true	false	false	false
dms_sample	mlb_data	master		false	false	false	false
dms_sample	name_data	master		true	false	false	false
dms_sample	nfl_data	master		false	false	false	false
dms_sample	nfl_stadium_data	master		false	false	false	false
dms_sample	sport_type	master		true	false	true	false
dms_sample	person	master		true	false	true	false
dms_sample	sport_location	master		true	false	true	false
dms_sample	sport_team	master		true	false	true	false
dms_sample	sporting_event_ticket	master		true	false	true	false
dms_sample	sporting_event	master		true	false	true	false
dms_sample	ticket_purchase_hist	master		true	false	true	false
pg_catalog	pg_user_mapping	rdsadmin		true	false	false	false
pg_catalog	pg_subscription	rdsadmin	pg_global	true	false	false	false
pg_catalog	pg_attribute	rdsadmin		true	false	false	false
pg_catalog	pg_proc	rdsadmin		true	false	false	false
pg_catalog	pg_class	rdsadmin		true	false	false	false
pg_catalog	pg_attrdef	rdsadmin		true	false	false	false
pg_catalog	pg_constraint	rdsadmin		true	false	false	false
pg_catalog	pg_inherits	rdsadmin		true	false	false	false

Use following query to analyze a table

select * from schemaname.tablename;

For example:

select * from dms_sample.player;



```
3 select * from dms_sample.player;
```

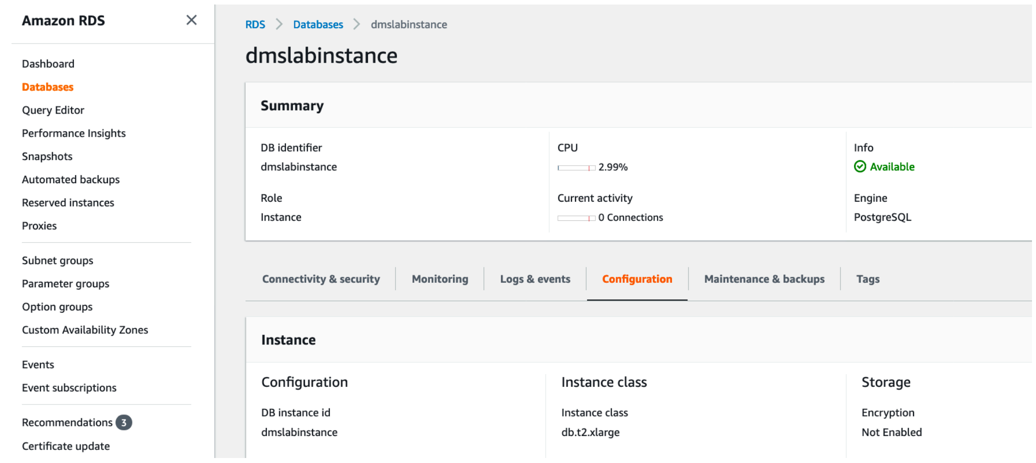
id	sport_team_id	last_name	first_name	full_name
1	131	Adam Loewen	Adam	Loewen
11	131	A.J. Pollock	A.J.	Pollock
21	131	Alex Sanabia	Alex	Sanabia
31	131	Andrew Chafin	Andrew	Chafin
41	131	Andy Marte	Andy	Marte
51	131	Archie Bradley	Archie	Bradley
61	131	Ben Francisco	Ben	Francisco
71	131	Braden Shipley	Braden	Shipley
81	131	Bradin Hagens	Bradin	Hagens
91	131	Brandon Drury	Brandon	Drury
101	131	Brett Jackson	Brett	Jackson
111	131	Chris Herrmann	Chris	Herrmann
121	131	Chris Owings	Chris	Owings
131	131	Daniel Hudson	Daniel	Hudson
141	131	David Peralta	David	Peralta
151	131	Dominic Leone	Dominic	Leone
161	131	Edwin Escobar	Edwin	Escobar
171	131	Enrique Burgos	Enrique	Burgos
181	131	Evan Marshall	Evan	Marshall
191	131	Gabby Guerrero	Gabby	Guerrero
201	131	Gerald Laird	Gerald	Laird
211	131	Jake Barrett	Jake	Barrett
221	131	Jake Lamb	Jake	Lamb
231	131	Jamie Romak	Jamie	Romak
241	131	Jason Bourgeois	Jason	Bourgeois

Following sections are optional you only need to execute, if you want to show change data capture replication with DMS.

Create the Change Data Capture Environment (Optional)

If you are planning to show ongoing CDC capability you should also set the following attributes:

1. Locate the custom DB parameter group for postgres10. Go to your RDS database instance, click on Configuration tab. Go to the Parameter Group link. as shown below:



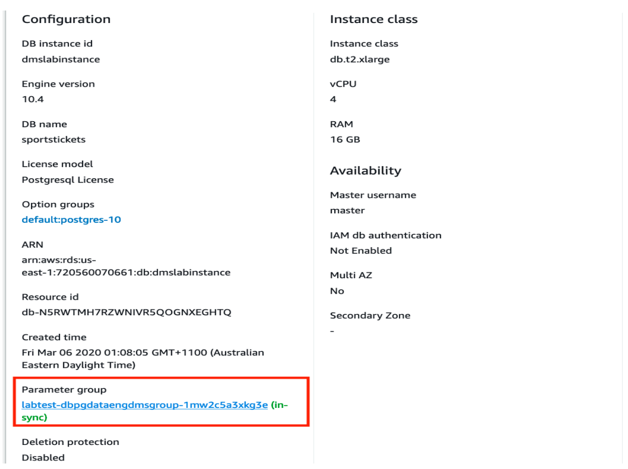
dmslabinstance

Summary

DB identifier: dmslabinstance	CPU: 2.99%	Info: Available
Role: Instance	Current activity: 0 Connections	Engine: PostgreSQL

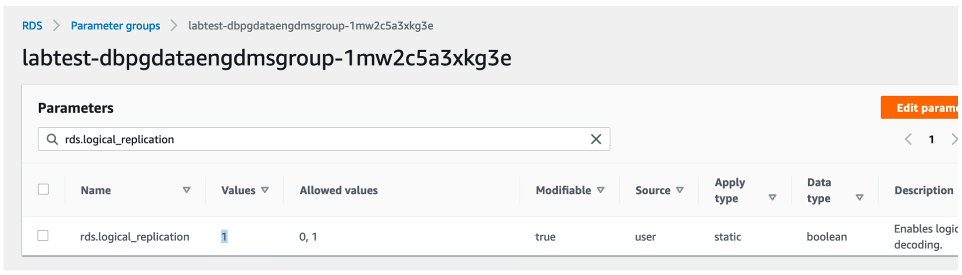
Instance

Configuration	Instance class	Storage
DB instance id: dmslabinstance	Instance class: db.t2.xlarge	Encryption: Not Enabled



Configuration	Instance class	Storage
DB instance id: dmslabinstance	Instance class: db.t2.xlarge	Encryption: Not Enabled
Engine version: 10.4	vCPU: 4	Storage type: General Purpose (SSD)
DB name: sportstickets	RAM: 16 GB	IOPS: -
License model: Postgresql License	**Availability**	Storage: 20 GiB
Option groups: default:postgres-10	Master username: master	Storage autoscaling: Disabled
ARN: arn:aws:rds:us-east-1:720560070661:db:dmslabinstance	IAM db authentication: Not Enabled	
Resource id: db-N5RWTMH7RZWNIVR5QOGNXEGHTQ	Multi AZ: No	
Created time: Fri Mar 06 2020 01:08:05 GMT+1100 (Australian Eastern Daylight Time)	Secondary Zone: -	
Parameter group: labtest-dbpgdataengdmsgroup-1mw2c5a3xkg3e (in-sync)		
Deletion protection: Disabled		

2. In your custom parameter group, make sure 3 parameters are set as below:
   a. rds.logical_replication is 1. This is a static parameter that requires a reboot of the DB instance for the parameter to take effect.

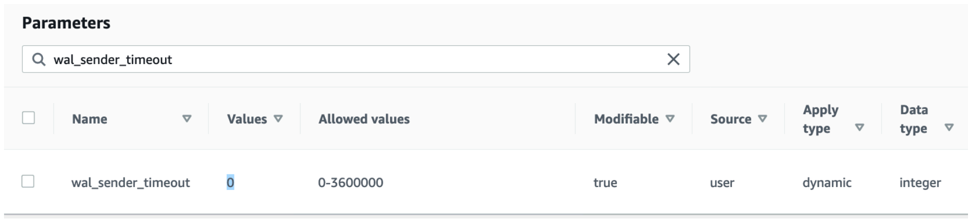

RDS > Parameter groups > labtest-dbpgdataengdmsgroup-1mw2c5a3xkg3e
Edit param
rds.logical_replication
1

labtest-dbpgdataengdmsgroup-1mw2c5a3xkg3e

Parameters

Name	Values	Allowed values	Modifiable	Source	Apply type	Data type	Description
rds.logical_replication	1	0, 1	true	user	static	boolean	Enables logic decoding.

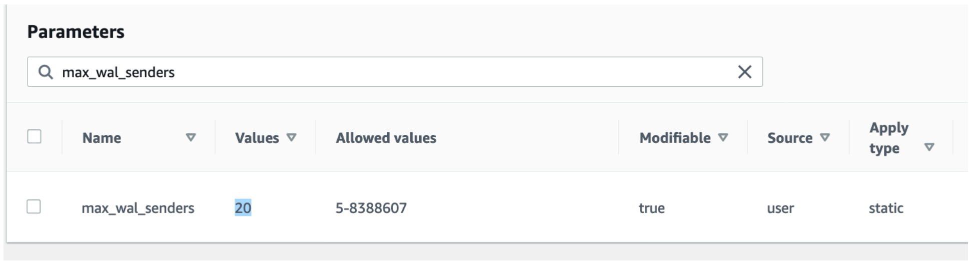
b. wal_sender_timeout is 0. Setting this parameter to 0 prevents PostgreSQL from terminating replication connections that are inactive longer than the specified timeout.


Parameters

wal_sender_timeout

	Name	Values	Allowed values	Modifiable	Source	Apply type	Data type
☐	wal_sender_timeout	0	0-3600000	true	user	dynamic	integer

c. max_wal_senders is increased to 20 to accommodate for Data Migration Service.


Parameters

max_wal_senders

	Name	Values	Allowed values	Modifiable	Source	Apply type
☐	max_wal_senders	20	5-8388607	true	user	static

3. Now SSH to your ec2 instance and run following:

```
export PGPASSWORD=master123

psql --host=<instanceaddress> --port=5432 --dbname=sportstickets --
username=master
```

For example : nohup psql --host=dmslabinstance.ccla1oozkrry.us-east-1.rds.amazonaws.com --port=5432 --dbname=sportstickets --username=master

run the following SQL script to create the wrappers needed for DMS CDC replication:

```
   BEGIN;
   CREATE SCHEMA IF NOT EXISTS fnRenames;
   CREATE OR REPLACE FUNCTION fnRenames.pg_switch_xlog()
RETURNS pg_lsn AS $$
      SELECT pg_switch_wal(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION fnRenames.pg_xlog_replay_pause()
RETURNS VOID AS $$
      SELECT pg_wal_replay_pause(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_xlog_replay_resume() RETURNS VOID AS $$
      SELECT pg_wal_replay_resume(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_current_xlog_location() RETURNS pg_lsn AS $$
      SELECT pg_current_wal_lsn(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_is_xlog_replay_paused() RETURNS boolean AS $$
      SELECT pg_is_wal_replay_paused(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION fnRenames.pg_xlogfile_name(lsn
pg_lsn) RETURNS TEXT AS $$
      SELECT pg_walfile_name(lsn); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_last_xlog_replay_location() RETURNS pg_lsn AS $$
      SELECT pg_last_wal_replay_lsn(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_last_xlog_receive_location() RETURNS pg_lsn AS $$
      SELECT pg_last_wal_receive_lsn(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_current_xlog_flush_location() RETURNS pg_lsn AS
$$
      SELECT pg_current_wal_flush_lsn(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_current_xlog_insert_location() RETURNS pg_lsn AS
$$
      SELECT pg_current_wal_insert_lsn(); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_xlog_location_diff(lsn1 pg_lsn, lsn2 pg_lsn)
RETURNS NUMERIC AS $$
      SELECT pg_wal_lsn_diff(lsn1, lsn2); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_xlogfile_name_offset(lsn pg_lsn, OUT TEXT, OUT
INTEGER) AS $$
      SELECT pg_walfile_name_offset(lsn); $$ LANGUAGE SQL;
   CREATE OR REPLACE FUNCTION
fnRenames.pg_create_logical_replication_slot(slot_name name,
plugin name,
      temporary BOOLEAN DEFAULT FALSE, OUT slot_name name, OUT
xlog_position pg_lsn) RETURNS RECORD AS $$
      SELECT slot_name::NAME, lsn::pg_lsn FROM
pg_catalog.pg_create_logical_replication_slot(slot_name,
plugin,
      temporary); $$ LANGUAGE SQL;

   ALTER user master SET search_path to fnRenames, pg_catalog,
"$user", public;
   COMMIT;
```

Details on the above script can be found here , You can also copy from below docs and change user name :

https://docs.aws.amazon.com/dms/latest/userguide/CHAP_Source.PostgreSQL.html#CHAP_Source.PostgreSQL.v10)

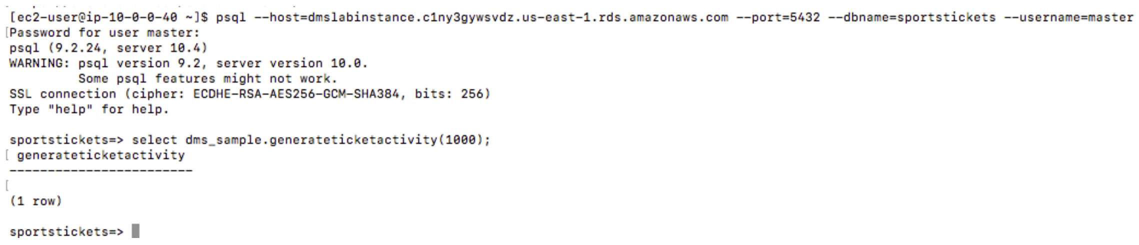
Generate the CDC Data (Optional)

When you want to generate transactions to demonstrate DMS CDC (Change Data Capture) functionality, you can execute the following commands:

```
psql --host=<instanceaddress> --port=5432 --dbname=sportstickets --username=master
```

enter the password "master123" when prompted, then you can execute the following within the psql command prompt (sportstickets=>) .

```
select dms_sample.generateticketactivity(1000);
```



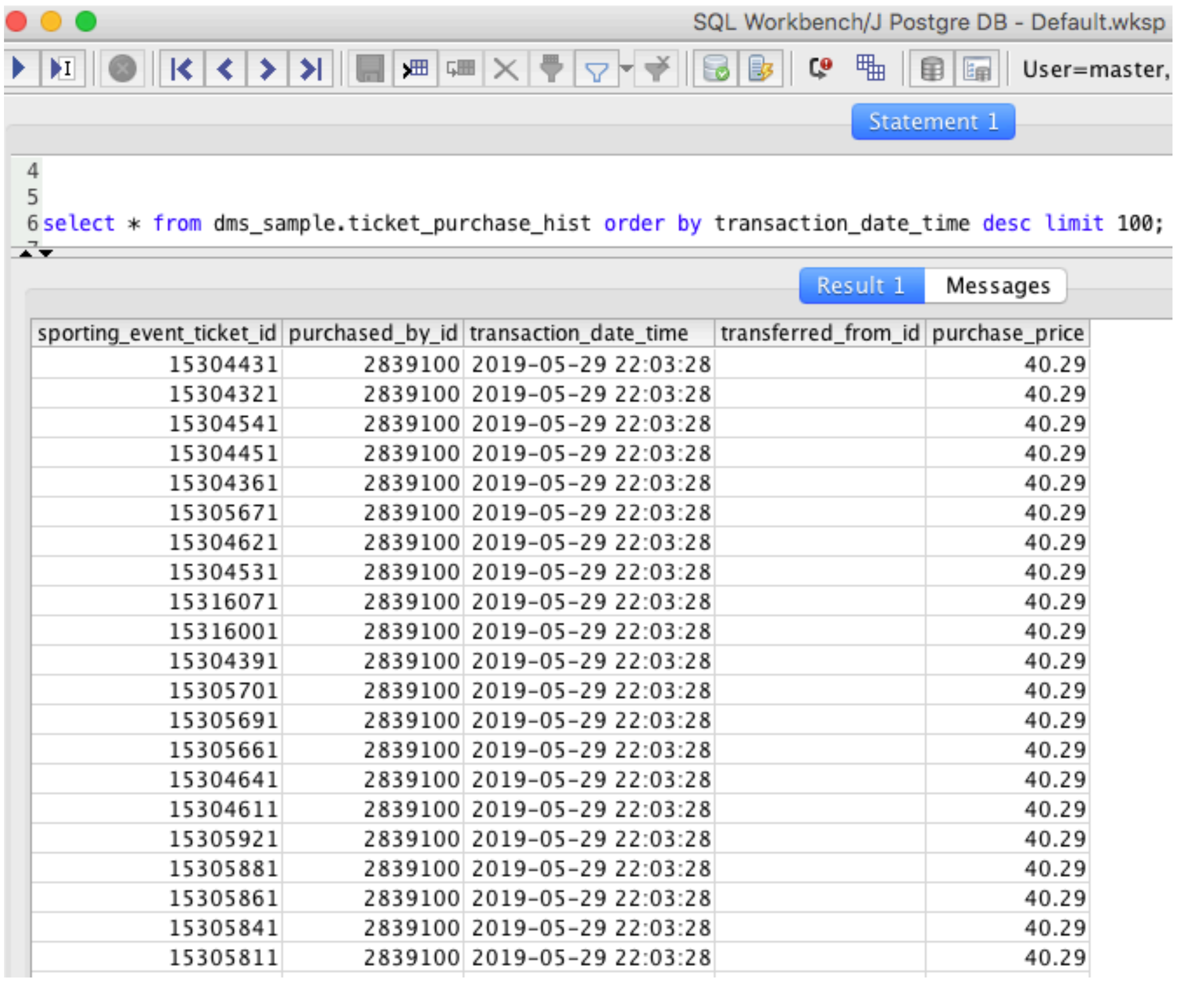
```
[ec2-user@ip-10-0-0-40 ~]$ psql --host=dmslabinstance.c1ny3gywsvdz.us-east-1.rds.amazonaws.com --port=5432 --dbname=sportstickets --username=master
Password for user master:
psql (9.2.24, server 10.4)
WARNING: psql version 9.2, server version 10.0.
         Some psql features might not work.
SSL connection (cipher: ECDHE-RSA-AES256-GCM-SHA384, bits: 256)
Type "help" for help.

sportstickets=> select dms_sample.generateticketactivity(1000);
 generateticketactivity
------------------------

(1 row)

sportstickets=> 
```

Above query will generate 1000 ticket sales in batches of 1-6 tickets to randomly selected people for a random price (within a range.) A record of each transaction is recorded in the ticket_purchase_hist table. See more details in below SQL code:

https://github.com/aws-samples/aws-database-migration-samples/blob/master/PostgreSQL/sampledb/v1/schema/functions/generateticketactivity.sql

Run following query in SQL Workbench to see changes in table:

select * from dms_sample.ticket_purchase_hist order by transaction_date_time desc limit 100;



```
select * from dms_sample.ticket_purchase_hist order by transaction_date_time desc limit 100;
```

sporting_event_ticket_id	purchased_by_id	transaction_date_time	transferred_from_id	purchase_price
15304431	2839100	2019-05-29 22:03:28		40.29
15304321	2839100	2019-05-29 22:03:28		40.29
15304541	2839100	2019-05-29 22:03:28		40.29
15304451	2839100	2019-05-29 22:03:28		40.29
15304361	2839100	2019-05-29 22:03:28		40.29
15305671	2839100	2019-05-29 22:03:28		40.29
15304621	2839100	2019-05-29 22:03:28		40.29
15304531	2839100	2019-05-29 22:03:28		40.29
15316071	2839100	2019-05-29 22:03:28		40.29
15316001	2839100	2019-05-29 22:03:28		40.29
15304391	2839100	2019-05-29 22:03:28		40.29
15305701	2839100	2019-05-29 22:03:28		40.29
15305691	2839100	2019-05-29 22:03:28		40.29
15305661	2839100	2019-05-29 22:03:28		40.29
15304641	2839100	2019-05-29 22:03:28		40.29
15304611	2839100	2019-05-29 22:03:28		40.29
15305921	2839100	2019-05-29 22:03:28		40.29
15305881	2839100	2019-05-29 22:03:28		40.29
15305861	2839100	2019-05-29 22:03:28		40.29
15305841	2839100	2019-05-29 22:03:28		40.29
15305811	2839100	2019-05-29 22:03:28		40.29

Once you've sold some tickets you can run the generateTransferActivity procedure. The following will transfer tickets from the owner to another person. The whole "batch" of tickets purchased is transferred 80% of the time and 20% of the time an individual ticket is transferred.

```
select dms_sample.generatetransferactivity(100);
```

Note:

When enabling CDC functionality in DMS, only one DMS instance/task should activate “Ongoing replication” to avoid conflicts.

When replicating to multiple targets, the processing to fan out the updates should begin with the Amazon S3 bucket, that is the target of the DMS task responsible for Ongoing replication. The process should not begin with the source database, as only one CDC process should be tracking and setting the last committed transaction that was replicated.

Appendix : AWS CloudFormation Template

```
{
   "AWSTemplateFormatVersion": "2010-09-09",
   "Parameters" : {
      "KeyName": {
         "Description" : "Name of an existing EC2 KeyPair to enable SSH access to the
instance",
         "Type": "AWS::EC2::KeyPair::KeyName",
         "ConstraintDescription" : "must be the name of an existing EC2 KeyPair in us-
east-1 only."
      }
   },
   "Resources": {
      "dmsinstructorvpc": {
         "Type": "AWS::EC2::VPC",
         "Properties": {
            "CidrBlock": "10.0.0.0/16",
            "InstanceTenancy": "default",
            "EnableDnsSupport": "true",
            "EnableDnsHostnames": "true",
            "Tags": [
               {
                  "Key": "Name",
                  "Value": "DMSLabSourceDB"
               }
            ]
         }
      },
      "RDSSubNet": {
         "Type": "AWS::EC2::Subnet",
         "Properties": {
            "CidrBlock": "10.0.1.0/24",
            "AvailabilityZone": "us-east-1d",
            "VpcId": {
               "Ref": "dmsinstructorvpc"
            },
            "Tags": [
               {
                  "Key": "Name",
                  "Value": "DMSLabRDS1"
               }
            ]
         }
      },
      "EC2SubNet": {
         "Type": "AWS::EC2::Subnet",
         "Properties": {
            "CidrBlock": "10.0.0.0/24",
            "AvailabilityZone": "us-east-1c",
            "VpcId": {
               "Ref": "dmsinstructorvpc"
            },
            "Tags": [
               {
                  "Key": "Name",
                  "Value": "DMSLabEC2"
               }
            ]
         }
      },
      "RDSSubNet2": {
         "Type": "AWS::EC2::Subnet",
         "Properties": {
            "CidrBlock": "10.0.2.0/24",
            "AvailabilityZone": "us-east-1b",
            "VpcId": {
            "Ref": "dmsinstructorvpc"
            },
            "Tags": [
               {
                  "Key": "Name",
                  "Value": "DMSLabRDS2"
               }
            ]
         }
      },
      "igw0887475a258f00277": {
         "Type": "AWS::EC2::InternetGateway",
         "Properties": {
            "Tags": [
               {
                  "Key": "Name",
                  "Value": "DMSLabIGW"
               }
            ]
         }
      },
      "dopt1cc25278": {
         "Type": "AWS::EC2::DHCPOptions",
        "Properties": {
          "DomainName": "ec2.internal",
          "DomainNameServers": [
            "AmazonProvidedDNS"
          ]
        }
      },
      "rtb0c3fae104a7b64456": {
        "Type": "AWS::EC2::RouteTable",
        "Properties": {
          "VpcId": {
            "Ref": "dmsinstructorvpc"
          },
          "Tags": [
            {
              "Key": "Name",
              "Value": "DMSLabRT"
            }
          ]
        }
      },
      "instancei0f63b887480639040": {
        "Type": "AWS::EC2::Instance",
        "DependsOn": "rdsdmslabdb",
        "Properties": {
          "DisableApiTermination": "false",
          "InstanceInitiatedShutdownBehavior": "stop",
          "EbsOptimized": "true",
          "ImageId": "ami-04681a1dbd79675a5",
          "InstanceType": "t3.2xlarge",
          "KeyName": {
            "Ref": "KeyName"
          },
          "UserData": {
            "Fn::Base64": {
              "Fn::Join": [
                "",
                [
                  "#!/bin/bash -xe\n",
                  "yum install -y postgresql\n",
                  "yum install -y git\n",
                  "yum update -y\n",
                  "cd /home/ec2-user\n",
                  "git clone https://github.com/aws-samples/aws-database-
migration-samples.git\n",
                        "cd aws-database-migration-
samples/PostgreSQL/sampledb/v1/\n",
                        "export PGPASSWORD=master123\n",
                        "export ENDPOINT=",
                        {"Fn::GetAtt":["rdsdmslabdb","Endpoint.Address"]},
                        "\n",
                        "nohup psql --host=${ENDPOINT} --port=5432 --
dbname=sportstickets --username=master -f install-postgresql.sql >& ~/install.out
&\n",
                        "\n"
                     ]
                  ]
               }
            },
            "Monitoring": "false",
            "Tags": [
               {
                  "Key": "Name",
                  "Value": "DMSLabEC2"
               }
            ],
            "NetworkInterfaces": [
               {
                  "DeleteOnTermination": "true",
                  "Description": "Primary network interface",
                  "DeviceIndex": 0,
                  "SubnetId": {
                     "Ref": "EC2SubNet"
                  },
                  "PrivateIpAddresses": [
                     {
                        "PrivateIpAddress": "10.0.0.40",
                        "Primary": "true"
                     }
                  ],
                  "GroupSet": [
                     {
                        "Ref": "sgDMSLabSG"
                     }
                  ],
                  "AssociatePublicIpAddress": "true"
               }
            ]
         }
      },
"rdsdmslabdb": {
  "Type": "AWS::RDS::DBInstance",
  "Properties": {
    "AllocatedStorage": "20",
    "AllowMajorVersionUpgrade": "false",
    "AutoMinorVersionUpgrade": "true",
    "DBInstanceClass": "db.t2.xlarge",
        "DBInstanceIdentifier": "dmslabinstance",
    "Port": "5432",
    "PubliclyAccessible": "true",
    "StorageType": "gp2",
    "BackupRetentionPeriod": "7",
    "MasterUsername": "master",
    "MasterUserPassword": "master123",
    "PreferredBackupWindow": "04:00-04:30",
    "PreferredMaintenanceWindow": "sun:05:20-sun:05:50",
    "DBName": "sportstickets",
    "Engine": "postgres",
    "EngineVersion": "10.4",
    "LicenseModel": "postgresql-license",
    "DBSubnetGroupName": {
      "Ref": "dbsubnetdefaultdmsinstructorvpc"
    },
    "DBParameterGroupName": {
      "Ref": "dbpgdataengdmsgroup"
    },
    "VPCSecurityGroups": [
      {
        "Ref": "sgrdslaunchwizard2"
      }
    ],
    "Tags": [
      {
        "Key": "workload-type",
        "Value": "other"
      }
    ]
  }
},
"dbsubnetdefaultdmsinstructorvpc": {
  "Type": "AWS::RDS::DBSubnetGroup",
  "Properties": {
    "DBSubnetGroupDescription": "Created from the RDS Management Console",
    "SubnetIds": [
      {
```

```
                "Ref": "RDSSubNet"
            },
            {
                "Ref": "EC2SubNet"
            },
            {
                "Ref": "RDSSubNet2"
            }
        ]
    }
},
"dbpgdataengdmsgroup": {
    "Type": "AWS::RDS::DBParameterGroup",
    "Properties": {
      "Description": "Parameter for Ticket Database",
      "Family": "postgres10",
      "Parameters": {
        "rds.logical_replication" : "1",
        "wal_sender_timeout" : "0",
        "max_wal_senders" : "20"

      }
    }
},
"sgDMSLabSG": {
    "Type": "AWS::EC2::SecurityGroup",
    "Properties": {
        "GroupDescription": "EC2 Security Group",
        "VpcId": {
            "Ref": "dmsinstructorvpc"
        }
    }
},
"sgrdslaunchwizard2": {
    "Type": "AWS::EC2::SecurityGroup",
    "Properties": {
        "GroupDescription": "RDS Security Group",
        "VpcId": {
            "Ref": "dmsinstructorvpc"
        },
        "Tags": [
            {
                "Key": "Name",
                "Value": "DMSLabRDS-SG"
            }
        ]
      }
    },
    "dbsgdefault": {
      "Type": "AWS::RDS::DBSecurityGroup",
      "Properties": {
        "GroupDescription": "default"
      }
    },
    "gw1": {
      "Type": "AWS::EC2::VPCGatewayAttachment",
      "Properties": {
        "VpcId": {
          "Ref": "dmsinstructorvpc"
        },
        "InternetGatewayId": {
          "Ref": "igw0887475a258f00277"
        }
      }
    },
    "subnetroute1": {
      "Type": "AWS::EC2::SubnetRouteTableAssociation",
      "Properties": {
        "RouteTableId": {
          "Ref": "rtb0c3fae104a7b64456"
        },
        "SubnetId": {
          "Ref": "RDSSubNet2"
        }
      }
    },
    "subnetroute2": {
      "Type": "AWS::EC2::SubnetRouteTableAssociation",
      "Properties": {
        "RouteTableId": {
          "Ref": "rtb0c3fae104a7b64456"
        },
        "SubnetId": {
          "Ref": "RDSSubNet"
        }
      }
    },
    "subnetroute3": {
      "Type": "AWS::EC2::SubnetRouteTableAssociation",
      "Properties": {
```

```
      "RouteTableId": {
        "Ref": "rtb0c3fae104a7b64456"
      },
      "SubnetId": {
        "Ref": "EC2SubNet"
      }
    }
  },
  "route1": {
    "Type": "AWS::EC2::Route",
    "Properties": {
      "DestinationCidrBlock": "0.0.0.0/0",
      "RouteTableId": {
        "Ref": "rtb0c3fae104a7b64456"
      },
      "GatewayId": {
        "Ref": "igw0887475a258f00277"
      }
    },
    "DependsOn": "gw1"
  },
  "dchpassoc1": {
    "Type": "AWS::EC2::VPCDHCPOptionsAssociation",
    "Properties": {
      "VpcId": {
        "Ref": "dmsinstructorvpc"
      },
      "DhcpOptionsId": {
        "Ref": "dopt1cc25278"
      }
    }
  },
  "ingress1": {
    "Type": "AWS::EC2::SecurityGroupIngress",
    "Properties": {
      "GroupId": {
        "Ref": "sgDMSLabSG"
      },
      "IpProtocol": "tcp",
      "FromPort": "22",
      "ToPort": "22",
      "CidrIp": "0.0.0.0/0"
    }
  },
  "ingress2": {
    "Type": "AWS::EC2::SecurityGroupIngress",
    "Properties": {
      "GroupId": {
        "Ref": "sgrdslaunchwizard2"
      },
      "IpProtocol": "tcp",
      "FromPort": "5432",
      "ToPort": "5432",
      "SourceSecurityGroupId": {
        "Ref": "sgDMSLabSG"
      },
      "SourceSecurityGroupOwnerId": "649225637812"
    }
  },
  "ingress3": {
    "Type": "AWS::EC2::SecurityGroupIngress",
    "Properties": {
      "GroupId": {
        "Ref": "sgrdslaunchwizard2"
      },
      "IpProtocol": "tcp",
      "FromPort": "5432",
      "ToPort": "5432",
      "CidrIp": "0.0.0.0/0"
    }
  },
  "egress1": {
    "Type": "AWS::EC2::SecurityGroupEgress",
    "Properties": {
      "GroupId": {
        "Ref": "sgDMSLabSG"
      },
      "IpProtocol": "-1",
      "CidrIp": "0.0.0.0/0"
    }
  },
  "egress2": {
    "Type": "AWS::EC2::SecurityGroupEgress",
    "Properties": {
      "GroupId": {
        "Ref": "sgrdslaunchwizard2"
      },
      "IpProtocol": "-1",
      "CidrIp": "0.0.0.0/0"
    }
```

```
},
"GenerateCDCData" : {
   "DependsOn": ["rdsdmslabdb", "LambdaExecutionRole"],
   "Type" : "AWS::Lambda::Function",
   "Properties" : {
     "Code" :  {
       "S3Bucket": "luis-guides",
       "S3Key": "dms-lab/function.zip"
     },
     "Description" : "Function to generate CDC data",
     "FunctionName" : "GenerateCDCData",
     "Handler" : "index.handler",
     "MemorySize" : 128,
     "Runtime" : "nodejs12.x",
     "Timeout" : 60,
     "Environment":{
       "Variables": {"HOST":{"Fn::GetAtt":["rdsdmslabdb","Endpoint.Address"]}}
     },
     "Role" :  { "Fn::GetAtt" : [ "LambdaExecutionRole", "Arn" ] } ,
     "VpcConfig" :
              {
                 "SecurityGroupIds" : [{"Fn::GetAtt" : [ "sgDMSLabSG","GroupId" ]}],
                 "SubnetIds" : [{"Ref" : "EC2SubNet"}]
              }
   }
},
"LambdaExecutionRole" : {
   "Type": "AWS::IAM::Role",
   "Properties": {
     "AssumeRolePolicyDocument": {
       "Version" : "2012-10-17",
       "Statement": [ {
         "Effect": "Allow",
         "Principal": {
           "Service": [ "lambda.amazonaws.com" ]
         },
           "Action": [ "sts:AssumeRole" ]
       } ]
     },
     "Policies": [ {
       "PolicyName": "DMSlabRDSAccess",
         "PolicyDocument": {
           "Version": "2012-10-17",
           "Statement": [{
             "Sid" : "RDSAccess",
              "Effect": "Allow",
              "Action": [
                "rds:*",
                "logs:CreateLogGroup",
                "logs:CreateLogStream",
                "logs:PutLogEvents",
                "ec2:CreateNetworkInterface",
                "ec2:DescribeNetworkInterfaces",
                "ec2:DeleteNetworkInterface"
              ],
              "Resource": "*"
            }]
          }
        }]
      }
    }
  },
  "Outputs":{
    "DMSInstanceEndpoint":{
       "Description": "DMS Instance Endpoint",
       "Value": {
           "Fn::GetAtt" : [ "rdsdmslabdb", "Endpoint.Address" ]
       }
    },
       "CDCFuntion" : {
       "Description": "CDC Function",
       "Value" : { "Fn::GetAtt" : [ "GenerateCDCData","Arn" ] }
    }
  },
  "Description": "DMS Lab Instructor account",
  "Metadata": {
    "AWS::CloudFormation::Designer": {
       "a79fb943-c167-4e59-8eda-911d4acc331f": {
          "size": {
             "width": 60,
             "height": 60
          },
          "position": {
             "x": 810,
             "y": 390
          },
          "z": 1,
          "embeds": []
       }
    }
    }
}
```