Smart Meeting Room

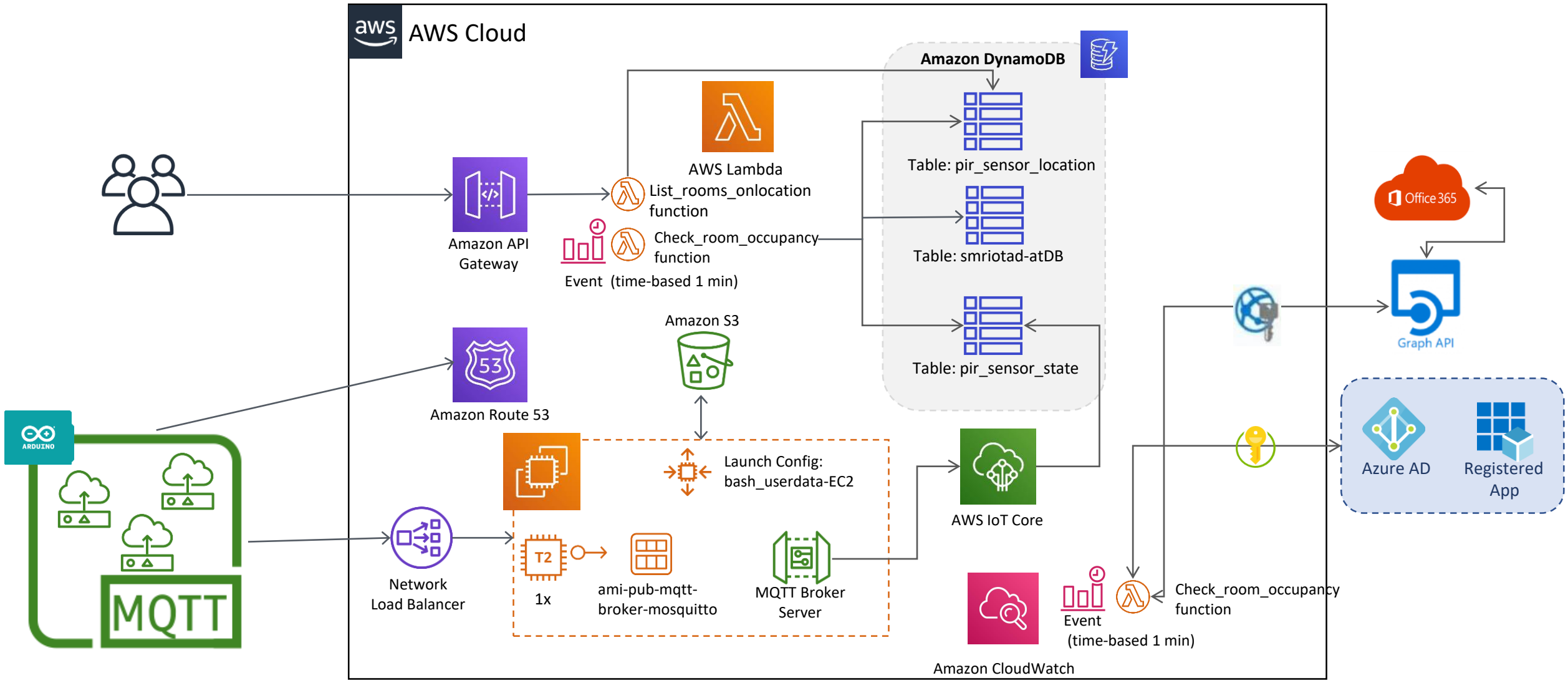
Bringing efficiency to space utilization at most end-user location convenience

Background and Goal

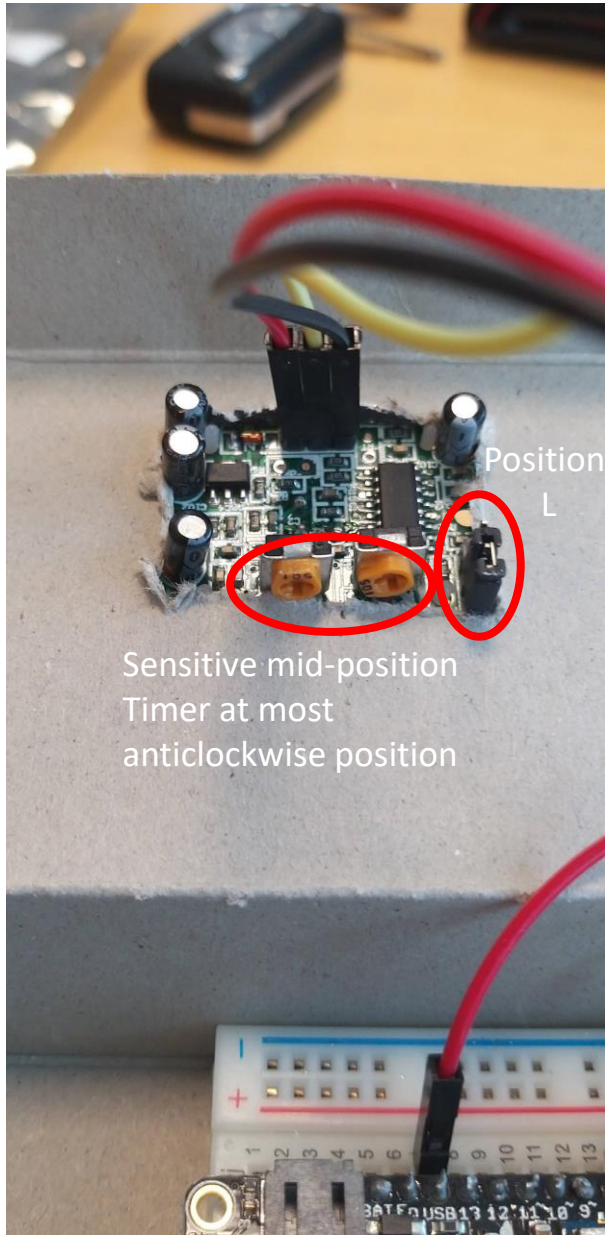
- Meeting rooms within companies and offices premises are often under utilization at an expensive building cost;
- Majority of companies utilizes MS Azure AD as company Active Directory for corporate user identities handlings, MS Outlook as email and calendar platforms, and where meeting rooms are seen as resources type of users, owning mailboxes and been handled/booked via MS Outlook (administrated via o365 admin console);
- To improve meeting rooms utilization and provide enhanced location based meeting rooms availability, this project integrates motion sensors into meeting rooms, where motion detection (PIR) and location (Google Wi-Fi Geolocation API) telemetric info is provided to backend non-SQL database (AWS DynamoDB) and applications (AWS Lambda), where this info is transformed into meaningful data for automatic meeting rooms reservation released due no activity/usage and provide to end-users closest available meeting rooms for utilization, based or their location.
- Sensors telemetry data is sent using MQTT (Message Queuing Telemetry Transport) protocol towards a MQTT broker (Mosquitto Server deployed in a AWS EC2 and S3), which in turns is integrated with AWS IoT (using TLS authentication) and backend non-SQL DB as mentioned above.
- For prototyping purposes, client app is developed using Python, making using of Google Wi-Fi based Geolocation and AWS API Gateway, also integrated with backend AWS Lambada applications for meeting room lookup purposes.

This is a work in progress with final goal to have a full programmatically “one-click” server-side architecture using AWS Cloud Formation for MQTT Broker / IoT Core / Cloud Watch and back-end Lambda functions. I will update this project continuously. Please check the last page for Project Roadmap.

E2E Architecture



Adafruit Feather M0 Wi-Fi (atwinc1500) and PIR Pinout

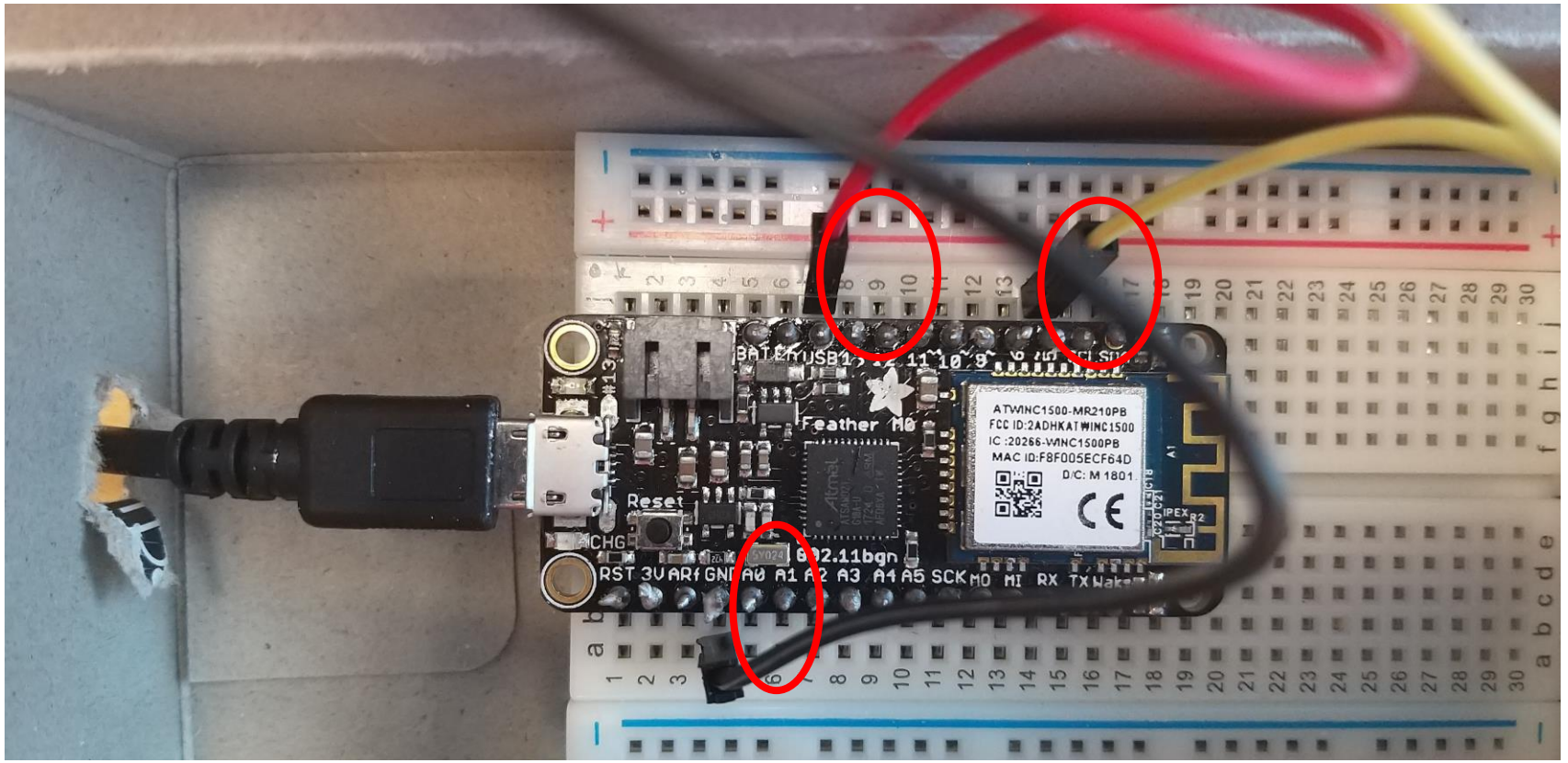


PIR motion has to be set up using jumper to L position where the sensor will 'toggle' (change state) every time motion is detected - providing the on-board timer has timed out. This is unlikely to be of much use in some applications, but not this one. At this IoT project we need to have a timely manner to track last presence state in a certain meeting room in order to determine occupancy from last state change and current time. Also for future purposes, the ambition is to optimize the solution in order to roughly determine the amount of people with a meeting room. The sensor (or sensors) shall be placed in a position (i.e: center of the room/table) where motion can be determined frequently based on peoples natural behavior (i.e.: body movements).

Cabling / Pin sets: Red cable at USB/5V pin, black at GND (ground) and yellow at pin 5 (GPIO).

Feather M0 has to be well stacked at the bread board using socket headers and **properly soldered,** to avoid motion detection misbehavior.

Adobe Acrobat Document



IoT Sensor configuration using IDE Arduino

Microcontroller has to be uploaded with the attached Arduino code and be provided with the following data:

```
const char* googleApiKey = "xxxxxxxxxxxxxxxxxxxx";
char ssid[] = "xxxxxx";
char pass[] = "xxxxxx";
```

googleApiKey has to be acquired from https://developers.google.com/maps/documentation/geolocation/intro, where billing details has to be provided. In case do you exceed the free tier credit, this will not incur in any charge. Note that the code request Geolocation of the microcontroller once at power-on, so it is unlikely that you exceed the free tier credit, even you decide to use for dozens of rooms.
SSID from closest access point is required, along with password. pass is optional and is required when WPA/WPA2 auth method is used instead of open access.

MQTT Broker details:

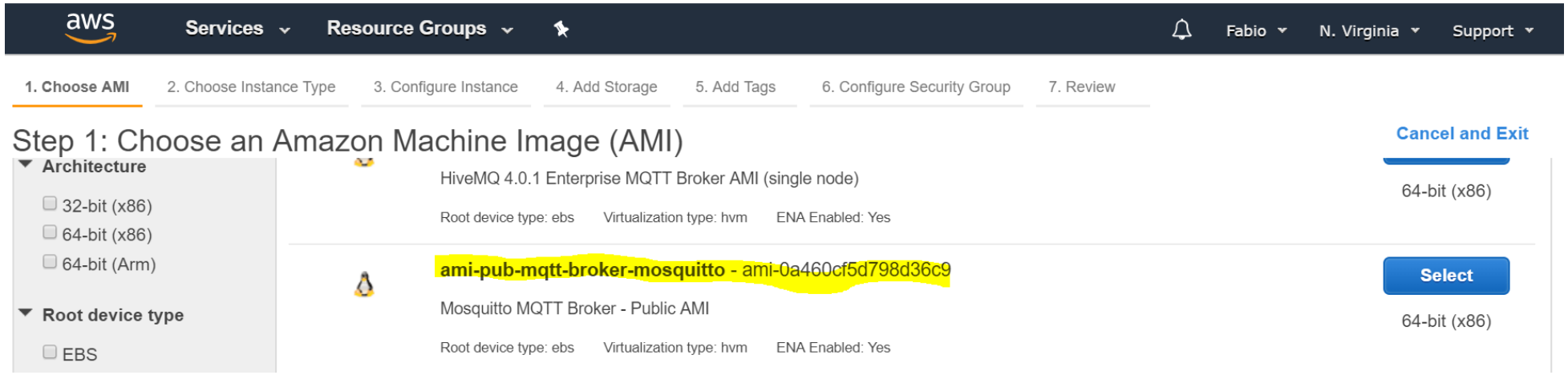
```
#define host      “<MQTT Broker IP address or FQDN if DNS is used: i.e.: AWS Route53>“
#define clientid  "<prefix>-meetingroom1“
//Common prefix is used to implement some level of access control at MQTT Broker Server
//clientid also must match user-part of room mailbox address, configured via o365 admin
#define username  "sensor1“
#define password  "sensor123“
//username and password is used for ACL purposes too at MQTT Broker side. More details will be provided MQTT Server side.
```

Mosquitto MQTT Broker Server Setup

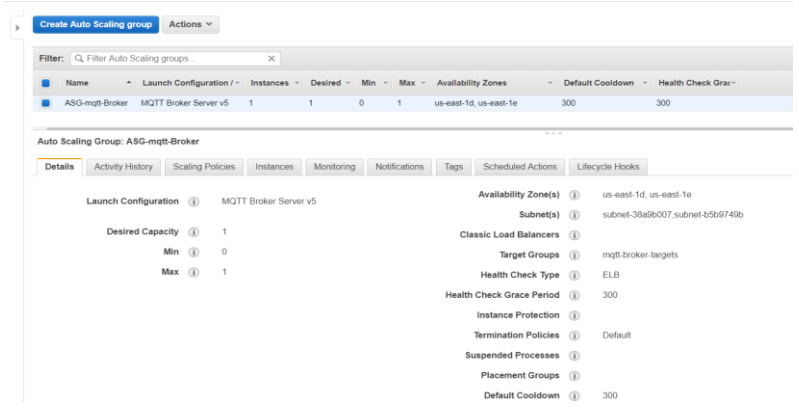
Mosquitto is the choice of MQTT Broker, placed between MQTT clients (publisher sensors) and AWS IoT Core (IoT Connectivity Manager). The broker is responsible for receiving all messages, filtering the messages (on #topic basis), determining who is subscribed to each message, and sending the message to these subscribed clients. The broker also holds the sessions of all persisted clients, including subscriptions and missed messages. Another responsibility of the broker is the authorization of clients done on MQTT Broker and initiate TLS authentication procedure towards the AWS IoT Core.

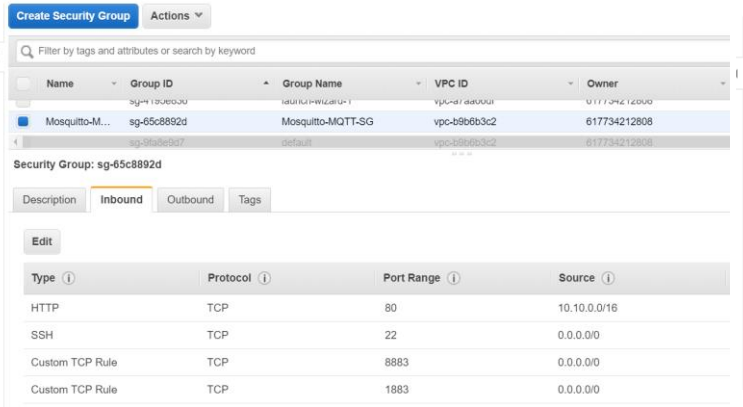
MQTT Broker AMI based on Mosquitto 1.4.5 is available at UE-EAST-1 region (N. Virginia), as found below. Just select Community AMIs at left frame and search by “mqtt” string.

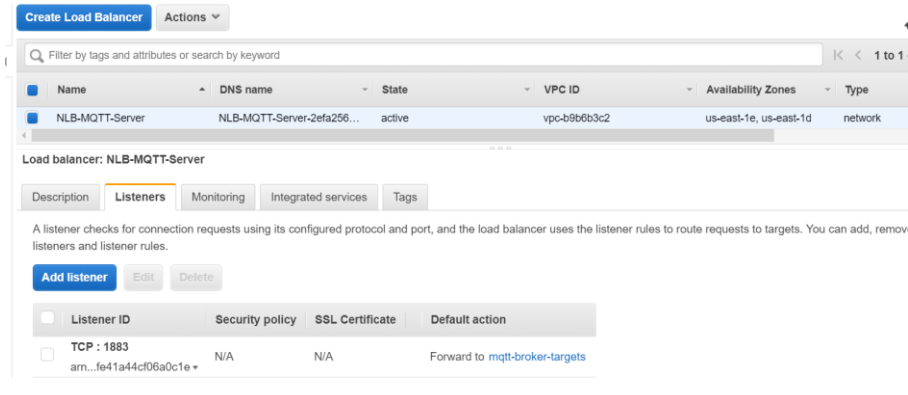
Launch Configuration for ASG can be created using indicated AMI and attached “user-data” in order to automate a couple tasks, such as “MQTT broker thing” creation at IoT Core, configuration of Mosquitto broker, etc. Zip file contains Broker configuration files, http index file (for http server used for Network Load Balancing monitoring) and customized init.d/mosquitto service file (stored in a S3 bucket and downloaded via VPC endpoint to avoid public access). In order to run under AWS free tier, ASG is made of 1 desired/max EC2 VM.

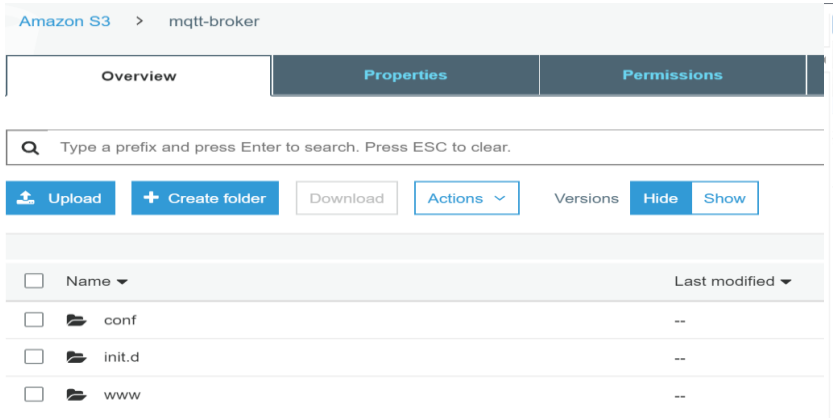


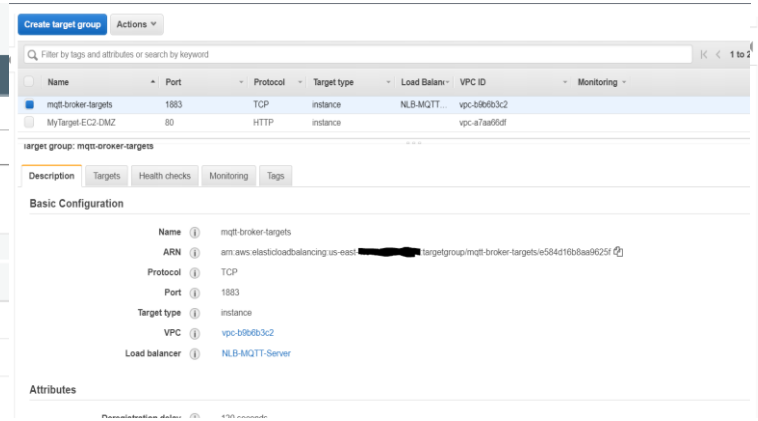
AWS EC2/NLB/ASG-LaunchConfig/S3/SG/VPC-EP screenshots configuration of MQTT Broker

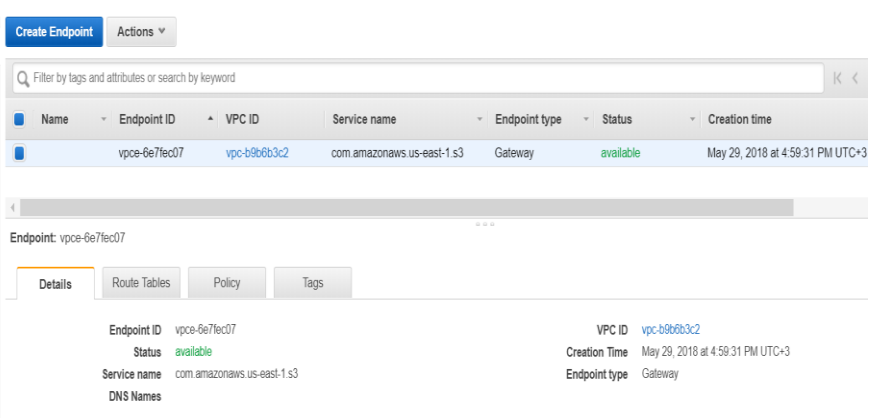


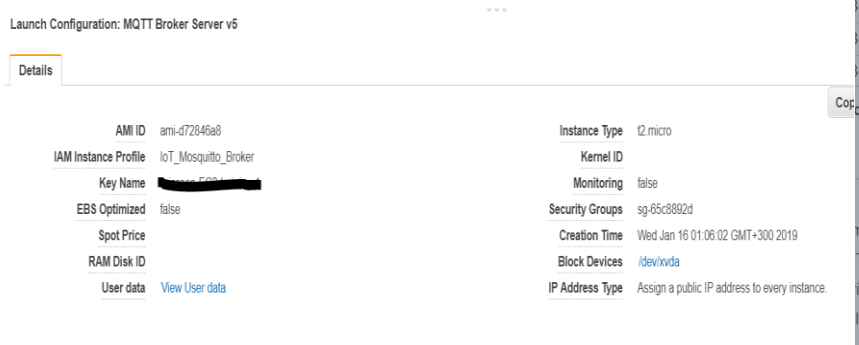


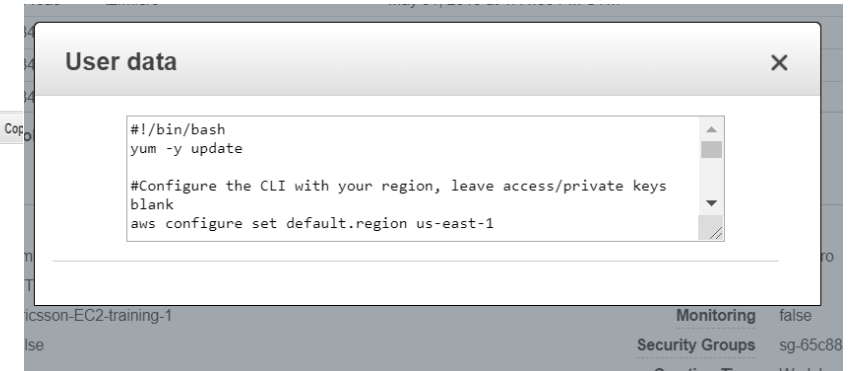








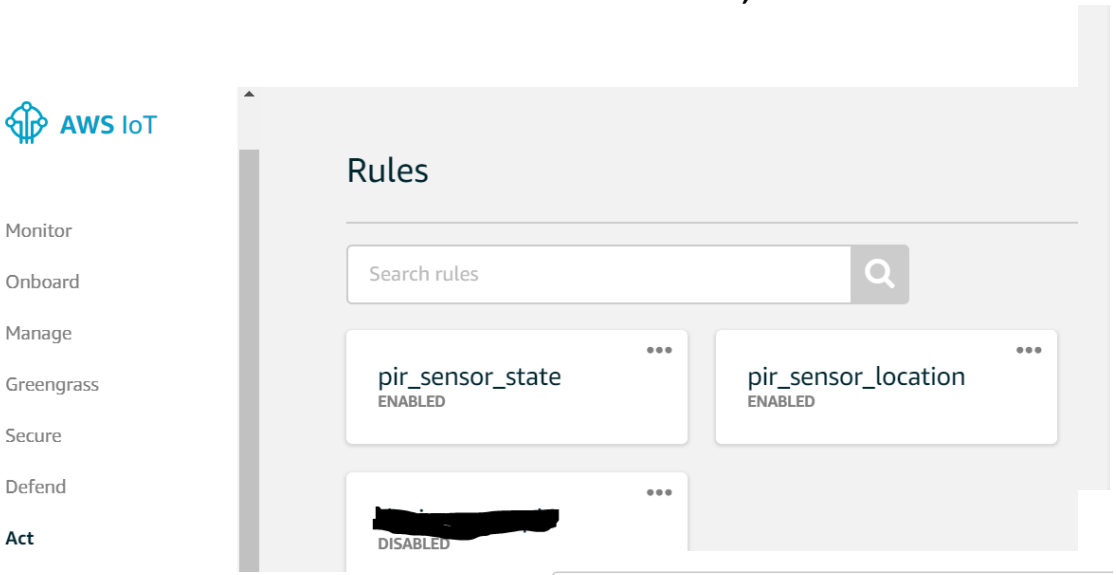


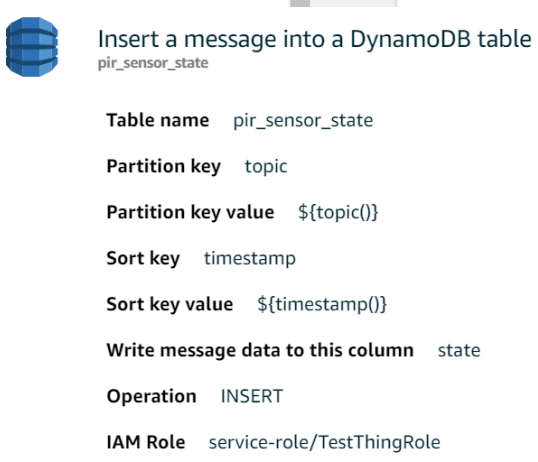


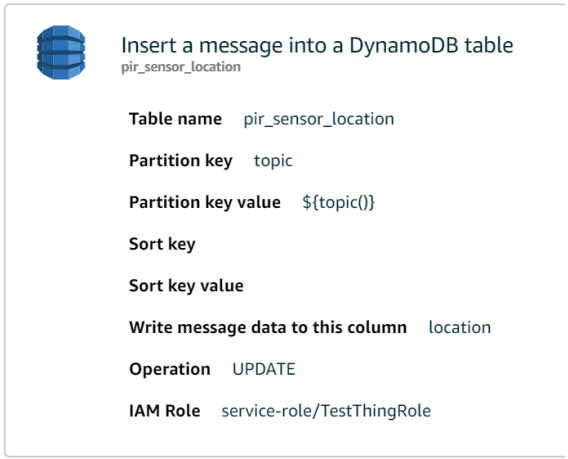
bash_userdata-EC2 - pub.bash

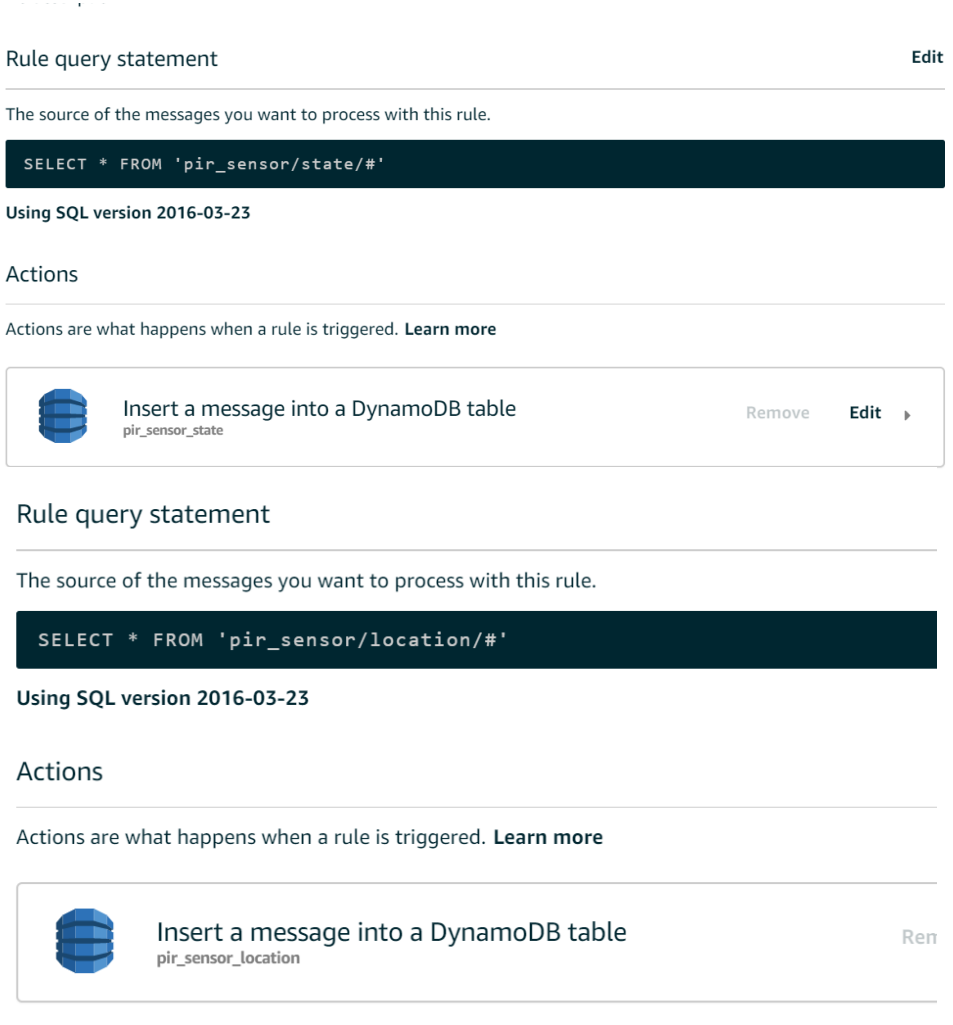
AWS IoT Core Configuration

NOTE that Mosquitto Broker once instantiated, will trigger broker thing creation, IAM policy for the bridge creation, certificates and keys creation and download, attach the policy to the certificate and finally attach the policy to your thing automatically, via EC2 user-data bash scripting. Please check slide 7 for details.
Rules creation are still not automated, not thus shared here.









Check_room_occupancy Lambda Function, environment variables used and execution timer (1/2)

Check_room_occupancy

Throttle | Qualifiers ▼ | Actions ▼

Environment variables

You can define environment variables as key-value pairs that are accessible from your function code. These are useful to store configuration settings without the need to change function code.

DB_SMRIOTAD_AT	smriotad-atDB	Remove
DB_TABLE_LOCATION	pir_sensor_location	Remove
DB_TABLE_STATE	pir_sensor_state	Remove
authorityHostUrl	https://login.microsoftonline.com	Remove
clientId	[Azure AD Application ID]	Remove
clientSecret	[Azure AD Application Secret]	Remove
resource	https://graph.microsoft.com	Remove
tenant	[tenant name].onmicrosoft.com	Remove
topic_location	pir_sensor/location	Remove
topic_state	pir_sensor/state	Remove
aad_domain	[custom domain]	Remove
Key	*Value*	

Check_room_occupancy.zip

Deployment package (Python 3.7) found above. Please note that it is greater than 3MB and and it is not possible to edit the code at lambda GUI directly. Azure AD related variables values (**where to locate?**), are found at slide 15.

Execution timer of 10 secs is suggested for 3 meeting rooms made available at same time, due MS Graph API callbacks execution to check and release rooms. This timer shall be increase if more rooms are added. Cost Analysis shall be carried between lambda services and dedicated EC2 instances if intended for commercial purposes.

Execution role

Choose a role that defines the permissions of your function. To create a custom role, go to the IAM console.

Use an existing role ▼

Existing role

Choose an existing role that you've created to be used with this Lambda function. The role must have permission to upload logs to Amazon CloudWatch Logs.

service-role/Smart_room_IoT ▼

View the Smart_room_IoT role on the IAM console.

Basic settings

Description

Check Smart Room occupancy. Default non-occupancy

Memory (MB) Info

Your function is allocated CPU proportional to the memory configured.

128 MB

Timeout Info

0 min 10 sec

Event (time-based 1 min)

Rules > job_check_room_occupancy

Actions

Summary

ARN arn:aws:events:us-east-1:[redacted]rule/job_check_room_occupancy

Schedule Fixed rate of 1 minutes

Status Disabled

Description This event job execute Check_room_occupancy Lambda function every minute and provides fixed JSON constant data to the function

Monitoring Show metrics for the rule

Targets

Filter:

Viewing 1 to 1 of 1 Targets

Type	Name	Input	Role	Additional parameters
Lambda function	Check_room_occupancy	**Constant:** {"occupancy_timer": 600}		

An event-driven Lambda function (Check_room_occupancy) is triggered every 1 minute, in order check reported presence/motion by IoT sensors installed at each meeting room, against current timestamp and configured “occupancy_timer”, this last to used determine the pre-booked meeting rooms in idle state and entitled for auto-cancellation.

Check_room_occupancy Lambda Function, environment variables used and execution timer (2/2)

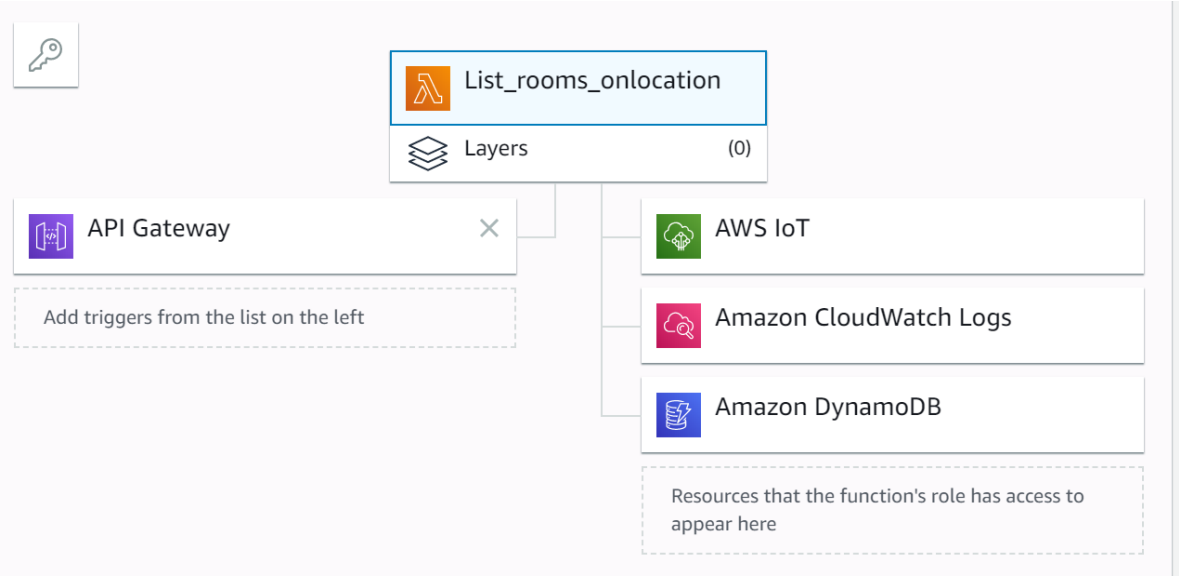
```
PS C:\Users\[redacted]\AWS\MQTT Broker & IoT\Check_room_occupancy> dir


    Directory: C:\Users\[redacted]\AWS\MQTT Broker & IoT\Check_room_occupancy


Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
d-----         5/18/2019  11:18 PM                adal
d-----         5/18/2019  11:18 PM                adal-1.2.1.dist-info
d-----         5/18/2019  11:18 PM                asn1crypto
d-----         5/18/2019  11:18 PM                asn1crypto-0.24.0.dist-info
d-----         5/18/2019  11:18 PM                bin
d-----         5/18/2019  11:18 PM                certifi
d-----         5/18/2019  11:18 PM                certifi-2019.3.9.dist-info
d-----         5/18/2019  11:18 PM                cffi
d-----         5/18/2019  11:18 PM                cffi-1.12.3.dist-info
d-----         5/18/2019  11:18 PM                chardet
d-----         5/18/2019  11:18 PM                chardet-3.0.4.dist-info
d-----         5/18/2019  11:18 PM                cryptography
d-----         5/18/2019  11:18 PM                cryptography-2.6.1.dist-info
d-----         5/18/2019  11:18 PM                dateutil
d-----         5/18/2019  11:18 PM                idna
d-----         5/18/2019  11:18 PM                idna-2.8.dist-info
d-----         5/18/2019  11:18 PM                jwt
d-----         5/18/2019  11:18 PM                pycparser
d-----         5/18/2019  11:18 PM                pycparser-2.19-py3.7.egg-info
d-----         5/18/2019  11:18 PM                PyJWT-1.7.1.dist-info
d-----         5/18/2019  11:18 PM                python_dateutil-2.8.0.dist-info
d-----         5/18/2019  11:18 PM                requests
d-----         5/18/2019  11:18 PM                requests-2.22.0.dist-info
d-----         5/18/2019  11:18 PM                six-1.12.0.dist-info
d-----         5/18/2019  11:18 PM                urllib3
d-----         5/18/2019  11:18 PM                urllib3-1.25.2.dist-info
d-----         5/18/2019  11:18 PM                __pycache__
-a----         5/29/2019  12:47 PM           4482 lambda_function.py
-a----         5/18/2019  11:18 PM          32452 six.py
-a----         5/18/2019  11:18 PM         174592 _cffi_backend.cp37-win_amd64.pyd
```

aws lambda update-function-code --function-name Check_room_occupancy --zip-file fileb://Check_room_occupancy.zip

List_rooms_onlocation Lambda Function and environment variables



Deployment package written in Python 3.7 and environment variables used below.

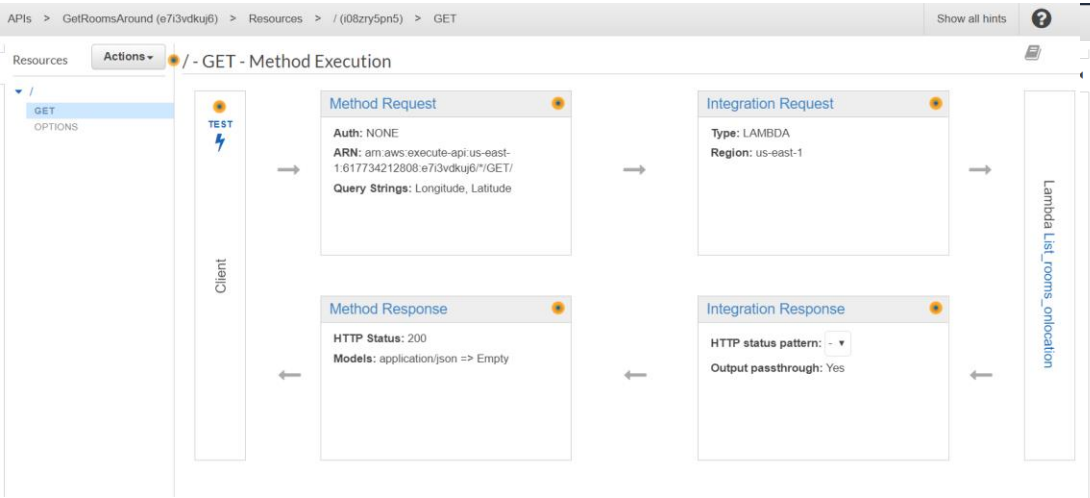
API Gateway configuration found in the next page.

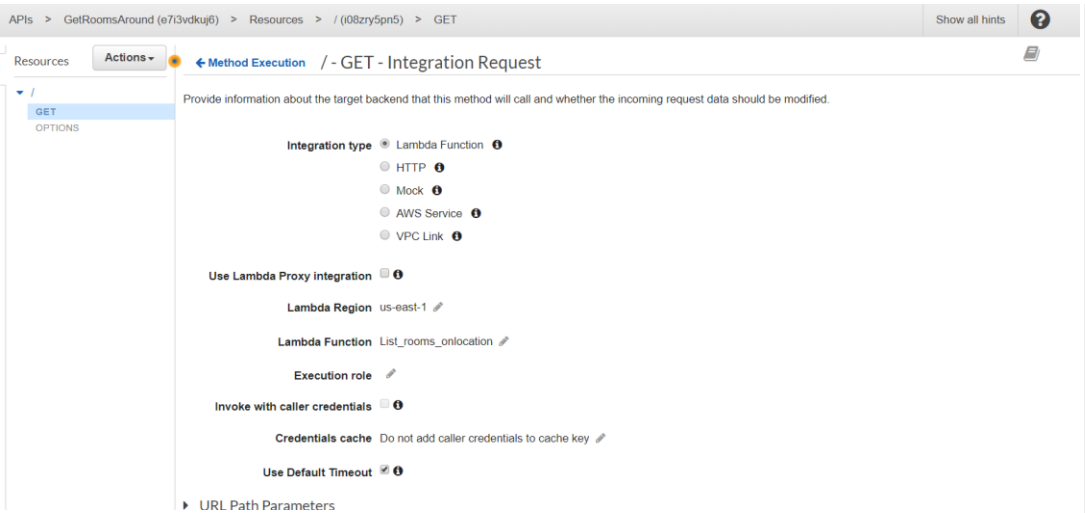
Environment variables

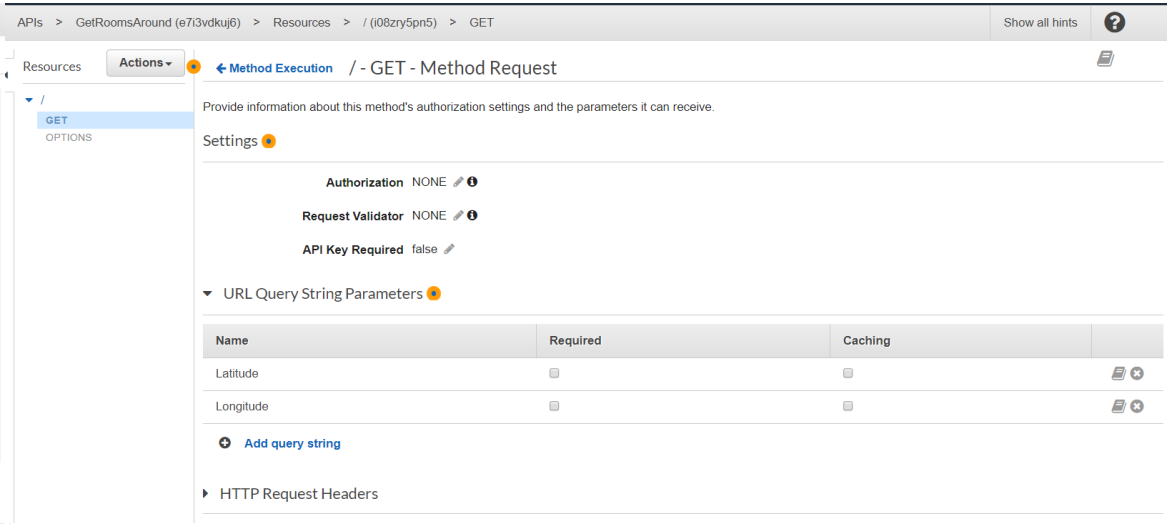
You can define environment variables as key-value pairs that are accessible from your function code. These are useful to store configuration settings without the need to change function code.
Learn more

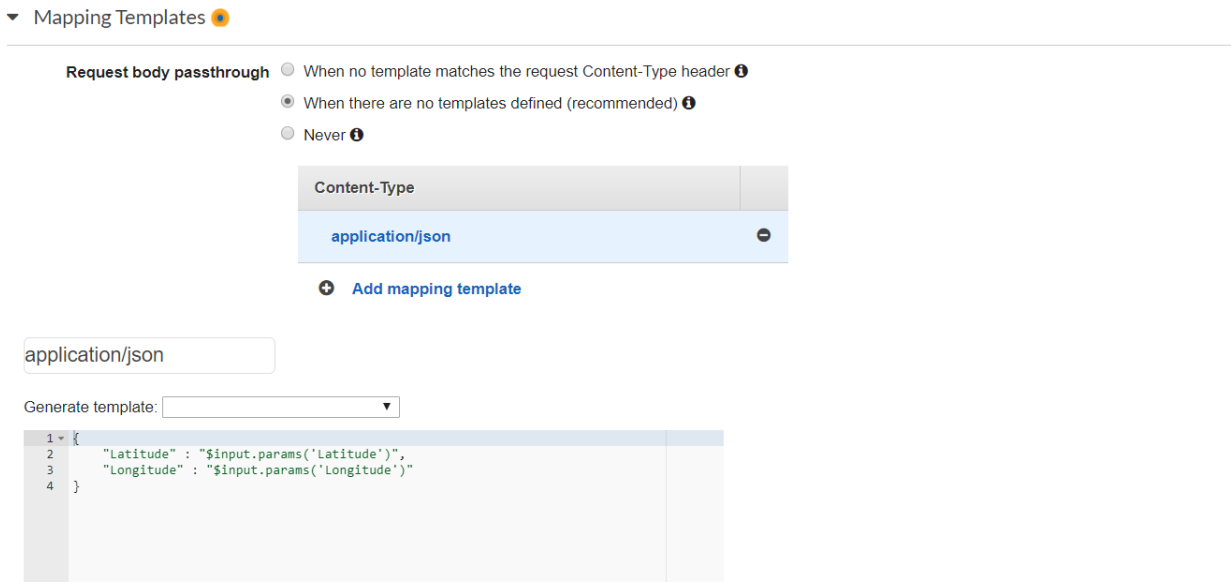
DB_TABLE_LOCATION	pir_sensor_location	Remove
DB_TABLE_STATE	pir_sensor_state	Remove
topic_location	pir_sensor/location	Remove
Key	*Value*	Remove

AWS API Gateway for HTTP/REST requests configuration and backend lambda function integration



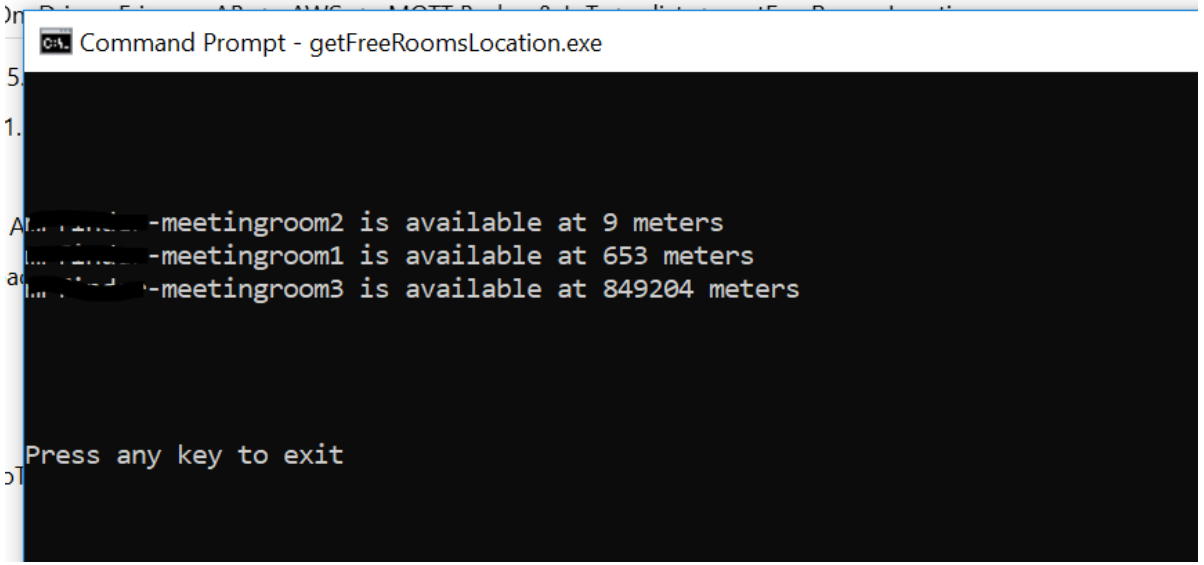






Client Desktop App

Client desktop App is coded in python 3.7 for simplicity and prototyping purposes.



Run it using c:\python .\getFreeRoomsLocation.py

Or use pyinstaller for executable creation and easy distribution. Suggest to pack it one directly instead of one file due performance purposes:

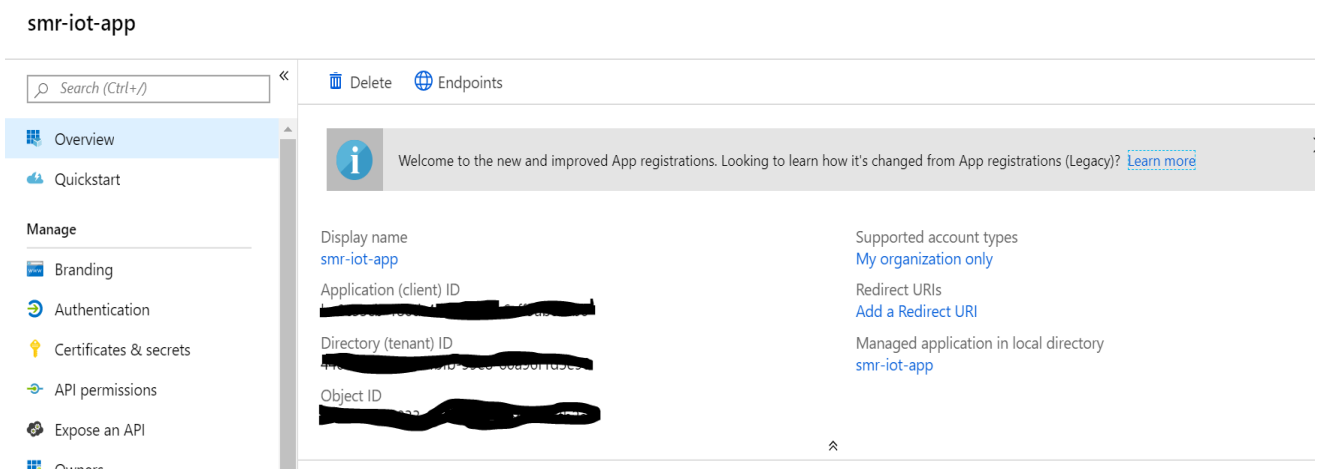
What to configure/customize?

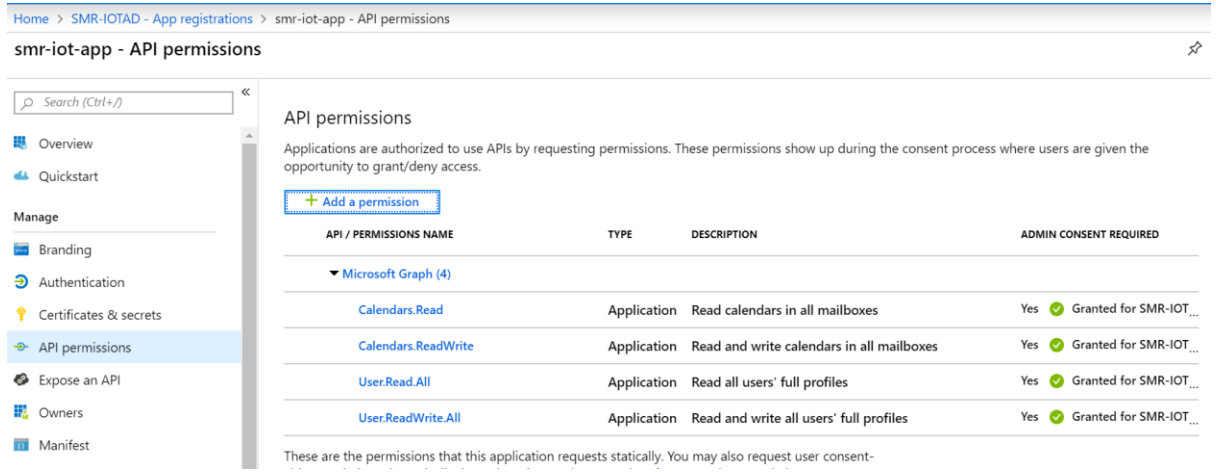
# Google Geoloction api-endpoint + Key
URL = https://www.googleapis.com/geolocation/v1/geolocate?key=xxxxxxxxxxxxxxxxxxxxxxxxxx

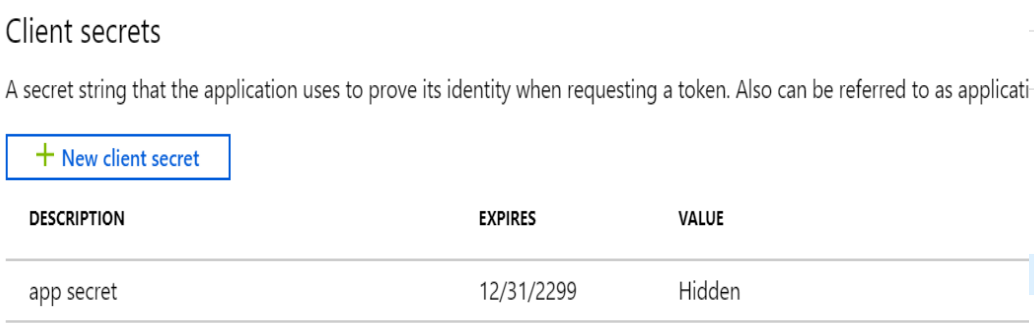
# api-gateway endpoint, found at AWS API Gateway GUI, left frame menu "Dashboard" of concerned API
URL_APIG = https://xxxxxxxxxxxxxxxxxxxxxxxxx

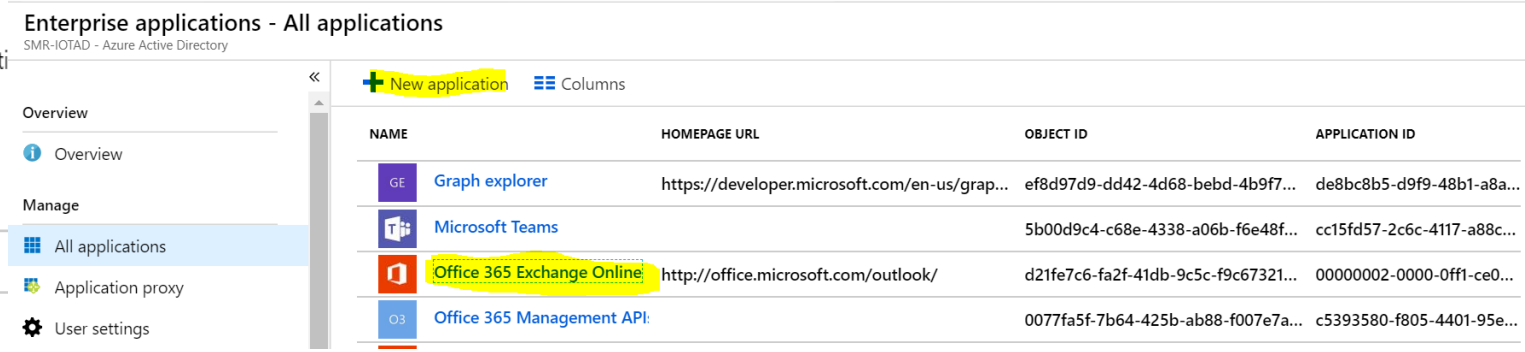
MS Azure AD App registration, Client secrets and API permissions

Add Enterprise application o365 Exchange Online for test environment purposes



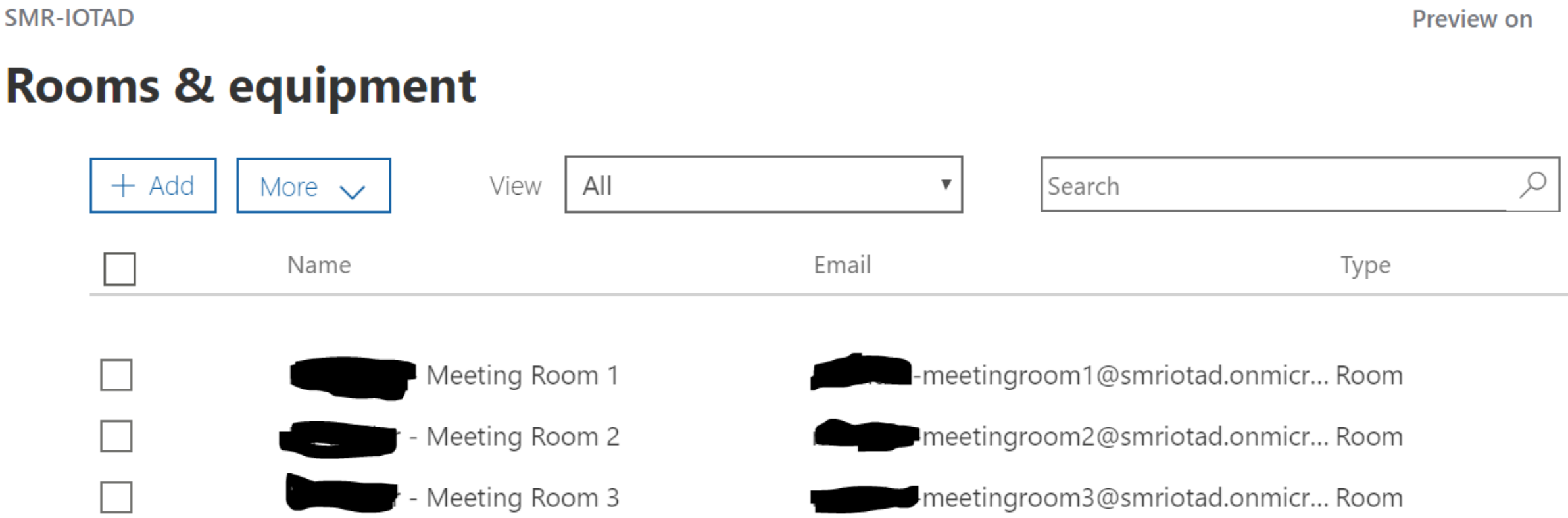






Microsoft o365 Resource Rooms configuration

Access to admin console is required. Create an user with admin privileges for the respective tenant in the Azure AD, and associate it to the Enterprise Application o365 Exchange Online



clientid used in the sensor side to identify the room must match user-part of room mailbox address, configured via o365 admin. @domain.com is configured inside the Lambda functions.

AWS DynamoDB tables

Filter by table name | Choose a table group | Actions | Viewing 3 of 3 Ta

Name	Status	Partition key	Sort key	Indexes	Total read capacity	Total write capacity
pir_sensor_location	Active	topic (String)	-	0	5	5
pir_sensor_state	Active	topic (String)	timestamp (Number)	0	5	5
smriotad-atDB	Active	record_type (String)	-	0	5	5

Table details

Table name	pir_sensor_location
Primary partition key	topic (String)
Primary sort key	-
Point-in-time recovery	DISABLED Enable
Encryption Type	DEFAULT Manage Encryption
KMS Master Key ARN	Not Applicable
Time to live attribute	DISABLED Manage TTL
Table status	Active
Creation date	March 10, 2019 at 1:25:36 PM UTC+3
Read/write capacity mode	Provisioned
Last change to on-demand mode	-
Provisioned read capacity units	5(Auto Scaling Disabled)
Provisioned write capacity units	5(Auto Scaling Disabled)
Last decrease time	-
Last increase time	-

Table details

Table name	pir_sensor_state
Primary partition key	topic (String)
Primary sort key	timestamp (Number)
Point-in-time recovery	DISABLED Enable
Encryption Type	DEFAULT Manage Encryption
KMS Master Key ARN	Not Applicable
Time to live attribute	DISABLED Manage TTL
Table status	Active
Creation date	March 6, 2019 at 3:53:58 PM UTC+3
Read/write capacity mode	Provisioned
Last change to on-demand mode	-
Provisioned read capacity units	5(Auto Scaling Disabled)
Provisioned write capacity units	5(Auto Scaling Disabled)

Table details

Table name	smriotad-atDB
Primary partition key	record_type (String)
Primary sort key	-
Point-in-time recovery	DISABLED Enable
Encryption Type	DEFAULT Manage Encryption
KMS Master Key ARN	Not Applicable
Time to live attribute	DISABLED Manage TTL
Table status	Active
Creation date	May 26, 2019 at 2:01:07 PM UTC+3
Read/write capacity mode	Provisioned
Last change to on-demand mode	-
Provisioned read capacity units	5(Auto Scaling Disabled)
Provisioned write capacity units	5(Auto Scaling Disabled)
Last decrease time	-