

MQTT Broker Creation:

For this project, we decided to use a Docker-based broker infrastructure, which allows us to easily run and manage our MQTT broker in a containerized environment.

```
mehmet [ ~ ]$ RESOURCE_GROUP="Smart_home_rg"
mehmet [ ~ ]$ LOCATION="switzerlandnorth"
mehmet [ ~ ]$ VM_NAME="Sm-mqtt-docker"
mehmet [ ~ ]$ IMAGE="Ubuntu2204"
mehmet [ ~ ]$ SIZE="Standard_B1s"
mehmet [ ~ ]$ az group create --name $RESOURCE_GROUP --location $LOCATION
{
  "id": "/subscriptions/dfb690e9-8142-4be3-a449-086ec0dde2e8/resourceGroups/Smart_home_rg",
  "location": "switzerlandnorth",
  "managedBy": null,
  "name": "Smart_home_rg",
  "properties": {
    "provisioningState": "Succeeded"
  },
  "tags": null,
  "type": "Microsoft.Resources/resourceGroups"
}

mehmet [ ~ ]$ az vm create \
--resource-group $RESOURCE_GROUP \
--name $VM_NAME \
--image $IMAGE \
--size $SIZE \
--admin-user-name azureuser \
--generate-ssh-keys
The default value of '--size' will be changed to 'Standard_D2s_v5' from 'Standard_DS1_v2' in a future release.
SSH key files '/home/mehmet/.ssh/id_rsa' and '/home/mehmet/.ssh/id_rsa.pub' have been generated under ~/.ssh to allow SSH access to the VM. If using machines without permanent storage, back up your keys to a safe location.
{
  "fqdns": "",
  "id": "/subscriptions/dfb690e9-8142-4be3-a449-086ec0dde2e8/resourceGroups/Smart_home_rg/providers/Microsoft.Compute/virtualMachines/Sm-mqtt-docker",
  "location": "switzerlandnorth",
  "macAddress": "00-22-48-12-75-38",
  "powerState": "VM running",
  "privateIpAddress": "10.0.0.4",
  "publicIpAddress": "172.161.154.169",
  "resourceGroup": "Smart_home_rg"
}
mehmet [ ~ ]$ 

mehmet [ ~ ]$ az vm extension set \
--resource-group $RESOURCE_GROUP \
--vm-name $VM_NAME \
--name DockerExtension \
--publisher Microsoft.Azure.Extensions \
--version 1.0 \
--settings '{"docker": {"port": "2375"}}'
{
  "autoUpgradeMinorVersion": true,
  "id": "/subscriptions/dfb690e9-8142-4be3-a449-086ec0dde2e8/resourceGroups/Smart_home_rg/providers/Microsoft.Compute/virtualMachines/Sm-mqtt-docker/extensions/DockerExtension",
  "location": "switzerlandnorth",
  "name": "DockerExtension",
  "provisioningState": "Succeeded",
  "publisher": "Microsoft.Azure.Extensions",
  "resourceGroup": "Smart_home_rg",
  "settings": {
    "docker": {
      "port": "2375"
    }
  },
  "type": "Microsoft.Compute/virtualMachines/extensions",
  "typeHandlerVersion": "1.0",
  "typePropertiesType": "DockerExtension"
}
mehmet [ ~ ]$
```

```
mehmet [ ~ ]$ az network nsg rule create \
--resource-group $RESOURCE_GROUP \
--nsg-name ${VM_NAME}NSG \
--name allow-mqtt \
--protocol tcp \
--priority 1020 \
--destination-port-range 1883 \
--access allow

{
  "access": "Allow",
  "destinationAddressPrefix": "*",
  "destinationAddressPrefixes": [],
  "destinationPortRange": "1883",
  "destinationPortRanges": [],
  "direction": "Inbound",
  "etag": "W/\"ce2bab14-adc2-4256-9c25-6f3d38c10614\"",
  "id": "/subscriptions/dfb690e9-8142-4be3-a449-086ec0dde2e8/resourceGroups/Smart_home_rg/providers/Microsoft.Network/networkSecurityGroups/Sm-mqtt-dockerNSG/securityRules/allow-mqtt",
  "name": "allow-mqtt",
  "priority": 1020,
  "protocol": "Tcp",
  "provisioningState": "Succeeded",
  "resourceGroup": "Smart_home_rg",
  "sourceAddressPrefix": "*",
  "sourceAddressPrefixes": [],
  "sourcePortRange": "*",
  "sourcePortRanges": [],
  "type": "Microsoft.Network/networkSecurityGroups/securityRules"
}
```

The following are the logs from our broker after sending messages from our simulator:

```
mehmet [ ~ ]$ docker compose up
[warn] [0000] /home/mkurnaz/docker-compose.yml: the attribute 'version' is obsolete, it will be ignored, please remove it to avoid potential confusion
Attaching to mqtt-broker
mqtt-broker 1765475628: mosquitto version 2.0.22 starting
mqtt-broker 1765475628: Config loaded from /mosquitto/config/mosquitto.conf.
mqtt-broker 1765475628: Opening ipv4 listen socket on port 1883.
mqtt-broker 1765475628: Opening ipv6 listen socket on port 1883.
mqtt-broker 1765475628: mosquitto version 2.0.22 running
mqtt-broker 1765475628: New connection from 83.8.169.134:51190 on port 1883.
mqtt-broker 1765475628: New client connected from 83.8.169.134:51190 as Thermostat_device_01 (p2, c1, k60).
mkurnaz@du.edu.p18Sm-mqtt-docker:~$ docker exec -it mqtt-broker mosquitto_sub -h localhost -t "devices/thermostat_device_01/messages/events/"
{"device_id": "Thermostat_device_01", "current_temperature": 23.02, "target_temperature": 24.0, "humidity": 47.56, "pressure": 1013.07, "heating_on": false, "cooling_on": false, "timestamp": 1765475717.12328}
{"device_id": "Thermostat_device_01", "current_temperature": 23.52, "target_temperature": 24.0, "humidity": 48.07, "pressure": 1013.16, "heating_on": true, "cooling_on": false, "timestamp": 1765475717.12321}
{"device_id": "Thermostat_device_01", "current_temperature": 22.66, "target_temperature": 24.0, "humidity": 47.97, "pressure": 1012.29, "heating_on": false, "cooling_on": false, "timestamp": 1765475722.1235}
{"device_id": "Thermostat_device_01", "current_temperature": 23.16, "target_temperature": 24.0, "humidity": 48.13, "pressure": 1012.68, "heating_on": true, "cooling_on": false, "timestamp": 1765475727.12417}
{"device_id": "Thermostat_device_01", "current_temperature": 23.66, "target_temperature": 24.0, "humidity": 48.3, "pressure": 1011.88, "heating_on": true, "cooling_on": false, "timestamp": 1765475732.124654}
{"device_id": "Thermostat_device_01", "current_temperature": 22.8, "target_temperature": 24.0, "humidity": 48.46, "pressure": 1012.38, "heating_on": false, "cooling_on": false, "timestamp": 1765475737.12506}
{"device_id": "Thermostat_device_01", "current_temperature": 23.3, "target_temperature": 24.0, "humidity": 48.18, "pressure": 1012.22, "heating_on": true, "cooling_on": false, "timestamp": 1765475742.125303}
{"device_id": "Thermostat_device_01", "current_temperature": 23.8, "target_temperature": 24.0, "humidity": 47.77, "pressure": 1011.49, "heating_on": true, "cooling_on": false, "timestamp": 1765475747.126152}
{"device_id": "Thermostat_device_01", "current_temperature": 22.92, "target_temperature": 24.0, "humidity": 47.5, "pressure": 1011.19, "heating_on": false, "cooling_on": false, "timestamp": 1765475752.12644}
{"device_id": "Thermostat_device_01", "current_temperature": 23.42, "target_temperature": 24.0, "humidity": 47.77, "pressure": 1011.19, "heating_on": true, "cooling_on": false, "timestamp": 1765475757.12720}
```