

Code + Output

Part 1

Answer for question 3:

- a) To change the data type, you can typecast to an appropriate type. On the subscriber end, you must decode the received message before typecasting the data..
- b) Assuming the proper data type is being used and the message has been de-serialized, you certainly can perform arithmetic/logical operations on the received data
- c) You absolutely can. You must first de-serialize the message, and assuming the proper data type, you can select a subset of the received data.

Answer for question 4:

Please note that this answer is also found on line 11 of "publisher.py"

```
client.publish("DB_LEVEL", randNum, qos=0, retain=True) # To change the QoS level,  
change the "qos" argument to your desired QoS level. To set/clear the retain flag,  
change the "retain" argument to either True or False
```

Refer to the following files:

- vmr846-cme466-lab02/vmr846-cme466-lab02-part1/publisher.py
- vmr846-cme466-lab02/vmr846-cme466-lab02-part1/subscriber.py

Output:

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```
vinceruiz — vince@mcnaughton: ~/cme466/lab2/vmr846-lab02-part1 — ssh vince@192.168.2.2 — 107x...
>
(myvenv) vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part1 $ python publisher.py
Just published 77.06006710411799 to topic "DB_LEVEL"
Just published 64.34796558421615 to topic "DB_LEVEL"
Just published 84.94333557919363 to topic "DB_LEVEL"
Just published 66.94114223377726 to topic "DB_LEVEL"
Just published 34.11174572896761 to topic "DB_LEVEL"
Just published 86.20300248470136 to topic "DB_LEVEL"
Just published 96.65448081002103 to topic "DB_LEVEL"
Just published 10.762567031751225 to topic "DB_LEVEL"
Just published 65.06203378589997 to topic "DB_LEVEL"
Just published 38.23534992105498 to topic "DB_LEVEL"
Just published 94.17058776343795 to topic "DB_LEVEL"
Just published 66.2641939141166 to topic "DB_LEVEL"
Just published 70.79152703979109 to topic "DB_LEVEL"
Just published 81.05652368413476 to topic "DB_LEVEL"
Just published 46.93512404817655 to topic "DB_LEVEL"
Just published 52.27312717371596 to topic "DB_LEVEL"
Just published 41.73606811983694 to topic "DB_LEVEL"
Just published 64.14347070328061 to topic "DB_LEVEL"
Just published 15.36870994162719 to topic "DB_LEVEL"
Just published 78.80144694450027 to topic "DB_LEVEL"
Just published 67.24191273347596 to topic "DB_LEVEL"
Just published 47.52318605444936 to topic "DB_LEVEL"
Just published 30.69987545548585 to topic "DB_LEVEL"
Just published 67.6742716491416 to topic "DB_LEVEL"
Just published 23.56007008374049 to topic "DB_LEVEL"
Just published 67.64602618801422 to topic "DB_LEVEL"
^CTraceback (most recent call last):
  File "/home/vince/cme466/lab2/vmr846-lab02-part1/publisher.py", line 13, in <module>
    time.sleep(30)
KeyboardInterrupt

vinceruiz — vince@mcnaughton: ~/cme466/lab2/vmr846-lab02-part1 — ssh vince@192.168.2.2 — 107x...
(myvenv) vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part1 $ python subscriber.py
Received message: 71.80768380016055
Received message: 77.06006710411799
Received message: 64.34796558421615
Received message: 84.94333557919363
Received message: 66.94114223377726
Received message: 34.11174572896761
Received message: 86.20300248470136
Received message: 96.65448081002103
Received message: 10.762567031751225
Received message: 65.06203378589997
Received message: 38.23534992105498
Received message: 94.17058776343795
Received message: 66.2641939141166
Received message: 70.79152703979109
Received message: 81.05652368413476
Received message: 46.93512404817655
Received message: 52.27312717371596
Received message: 41.73606811983694
Received message: 64.14347070328061
Received message: 15.36870994162719
^CTraceback (most recent call last):
  File "/home/vince/cme466/lab2/vmr846-lab02-part1/subscriber.py", line 14, in <module>
    time.sleep(30)
KeyboardInterrupt

(myvenv) vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part1 $
```

Top: publisher || Bottom: subscriber

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Part 2

In this part, I have a non-encrypted publisher/subscriber set, and an encrypted publisher/subscriber set. To run the encrypted system, you must cd into the publisher_encrypted and the subscriber_encrypted folders to ensure the encryption key is being read. If the key.bin file is missing from either folder, run the keygen.py script.

Refer to the following files:

- vmr846-cme466-lab02/vmr846-cme466-lab02-part2/publisher.py
- vmr846-cme466-lab02/vmr846-cme466-lab02-part2/subscriber.py
- vmr846-cme466-lab02/vmr846-cme466-lab02-part2/keygen.py
- vmr846-cme466-lab02/vmr846-cme466-lab02-part2/subscriber_encrypted/subscriber_encrypted.py
- vmr846-cme466-lab02/vmr846-cme466-lab02-part2/publisher_encrypted/publisher_encrypted.py

Output:

Please note that for the following screenshots, the publishers and subscribers are connect to the mqtt.eclipseprojects.io broker

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```
vinceruiz — vince@mcnaughton: ~/cme466/lab2/vmr846-lab02-part2 — ssh vince@192.168.2.2 — 107...
[myvenv] vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part2 $ python publisher.py
[PUBLISHER] Just published {'data': 77.34848710007347, 'timestamp': 1706305091.4473004} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 12.958096731467194, 'timestamp': 1706305092.5084753} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 70.14235707935632, 'timestamp': 1706305093.5531898} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 32.09765939681347, 'timestamp': 1706305094.6213632} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 79.02329021018224, 'timestamp': 1706305095.6643658} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 58.918881807191546, 'timestamp': 1706305096.7005453} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 42.061577707545, 'timestamp': 1706305097.7561145} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 95.08095233428257, 'timestamp': 1706305098.7887912} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 59.7159514759661, 'timestamp': 1706305099.837772} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 18.667262989845625, 'timestamp': 1706305100.8749328} to topic "DB_LEVEL"
^C
Traceback (most recent call last):
  File "/home/vince/cme466/lab2/vmr846-lab02-part2/publisher.py", line 28, in <module>
    time.sleep(1)
    ^^^^^^^^^^^^^
KeyboardInterrupt

[myvenv] vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part2 $

vinceruiz — vince@mcnaughton: ~/cme466/lab2/vmr846-lab02-part2 — ssh vince@192.168.2.2 — 107...
[myvenv] vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part2 $ python subscriber.py
[SUBSCRIBER] Received message: 9.499578048726487
[SUBSCRIBER] Transmission latency: 25451.86424255371 ms
[SUBSCRIBER] Received message: 77.34848710007347
[SUBSCRIBER] Transmission latency: 127.69079208374023 ms
[SUBSCRIBER] Received message: 12.958096731467194
[SUBSCRIBER] Transmission latency: 113.39187622070312 ms
[SUBSCRIBER] Received message: 70.14235707935632
[SUBSCRIBER] Transmission latency: 117.34580993652344 ms
[SUBSCRIBER] Received message: 32.09765939681347
[SUBSCRIBER] Transmission latency: 102.68831253051758 ms
[SUBSCRIBER] Received message: 79.02329021018224
[SUBSCRIBER] Transmission latency: 95.13425827026367 ms
[SUBSCRIBER] Received message: 58.918881807191546
[SUBSCRIBER] Transmission latency: 103.93190383911133 ms
[SUBSCRIBER] Received message: 42.061577707545
[SUBSCRIBER] Transmission latency: 88.64021301269531 ms
[SUBSCRIBER] Received message: 95.08095233428257
[SUBSCRIBER] Transmission latency: 104.34246063232422 ms
[SUBSCRIBER] Received message: 59.7159514759661
[SUBSCRIBER] Transmission latency: 98.50072860717773 ms
[SUBSCRIBER] Received message: 18.667262989845625
[SUBSCRIBER] Transmission latency: 151.3824462890625 ms
^C
Traceback (most recent call last):
  File "/home/vince/cme466/lab2/vmr846-lab02-part2/subscriber.py", line 27, in <module>
    time.sleep(30)
KeyboardInterrupt

[myvenv] vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part2 $ ^C
```

Top: non-encrypted publisher || Bottom: non-encrypted subscriber

CME466 Lab02

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```
vinceruiz — vince@mcnaughton: ~/cme466/lab2/vmr846-lab02-part2/publisher_encrypted — ssh vinc...
(myvenv) vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part2/publisher_encrypted $ python publisher_encrypted.py
[PUBLISHER] Just published {'data': 92.0901549899251, 'timestamp': 1706305267.2098088} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 51.38169428396676, 'timestamp': 1706305268.2329617} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 84.87372614223004, 'timestamp': 1706305269.2587938} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 28.609891459175827, 'timestamp': 1706305270.3212419} to topic "DB_LEVEL"
"
[PUBLISHER] Just published {'data': 57.59082323890464, 'timestamp': 1706305271.3444686} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 28.599281047703773, 'timestamp': 1706305272.4363608} to topic "DB_LEVEL"
"
[PUBLISHER] Just published {'data': 58.742755789505374, 'timestamp': 1706305273.5418477} to topic "DB_LEVEL"
"
[PUBLISHER] Just published {'data': 44.61266014956038, 'timestamp': 1706305274.5738587} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 37.40414806746762, 'timestamp': 1706305275.5991302} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 70.2704208027271, 'timestamp': 1706305276.6747193} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 93.55909204880511, 'timestamp': 1706305277.7793856} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 54.799661308292656, 'timestamp': 1706305279.000651} to topic "DB_LEVEL"
[PUBLISHER] Just published {'data': 23.701350506467346, 'timestamp': 1706305280.1265087} to topic "DB_LEVEL"
"
[PUBLISHER] Just published {'data': 61.191662536367645, 'timestamp': 1706305281.2362967} to topic "DB_LEVEL"
"
^CTraceback (most recent call last):
  File "/home/vince/cme466/lab2/vmr846-lab02-part2/publisher_encrypted/publisher_encrypted.py", line 38, in
    <module>
      time.sleep(1)
      ^^^^^^^^^^^^^
KeyboardInterrupt

(myvenv) vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part2/publisher_encrypted $ ^C

vinceruiz — vince@mcnaughton: ~/cme466/lab2/vmr846-lab02-part2/subscriber_encrypted — ssh vin...
(myvenv) vince@mcnaughton:~/cme466/lab2/vmr846-lab02-part2/subscriber_encrypted $ python subscriber_encrypted.py
[SUBSCRIBER] Received message: 51.38169428396676
[SUBSCRIBER] Transmission latency: 680.1948547363281 ms
[SUBSCRIBER] Received message: 84.87372614223004
[SUBSCRIBER] Transmission latency: 83.64105224609375 ms
[SUBSCRIBER] Received message: 28.609891459175827
[SUBSCRIBER] Transmission latency: 124.51171875 ms
[SUBSCRIBER] Received message: 57.59082323890464
[SUBSCRIBER] Transmission latency: 85.10112762451172 ms
[SUBSCRIBER] Received message: 28.599281047703773
[SUBSCRIBER] Transmission latency: 91.41969680786133 ms
[SUBSCRIBER] Received message: 58.742755789505374
[SUBSCRIBER] Transmission latency: 129.17566299438477 ms
[SUBSCRIBER] Received message: 44.61266014956038
[SUBSCRIBER] Transmission latency: 89.76221084594727 ms
[SUBSCRIBER] Received message: 37.40414806746762
[SUBSCRIBER] Transmission latency: 91.38965606689453 ms
[SUBSCRIBER] Received message: 70.2704208027271
[SUBSCRIBER] Transmission latency: 166.35799407958984 ms
[SUBSCRIBER] Received message: 93.55909204880511
[SUBSCRIBER] Transmission latency: 284.60693359375 ms
[SUBSCRIBER] Received message: 54.799661308292656
[SUBSCRIBER] Transmission latency: 123.53038787841797 ms
[SUBSCRIBER] Received message: 23.701350506467346
[SUBSCRIBER] Transmission latency: 169.3439483642578 ms
[SUBSCRIBER] Received message: 61.191662536367645
[SUBSCRIBER] Transmission latency: 135.6821060180664 ms
^CTraceback (most recent call last):
```

Top: Encrypted Publisher || Bottom: Encrypted Subscriber

Left: LED Controller Client || Top-Right: sound sensor publisher/LED control subscriber Client ||
Bottom-Right: Sound Sensor Client

Latency Tables

The average latency was calculated by taking the sum of the first 10 measurements and dividing by 10 for each broker. Please note that broker traffic influences the latency.

No Encryption

	Localhost Mosquitto Broker	broker.hivemq. com	test.mosquitto. org	broker.emqx.io	mqtt.eclipsepr jects.io
Average Latency (ms)	67.23	355.34	219.67	130.94	98.97

With Encryption

	Localhost Mosquitto Broker	broker.hivemq. com	test.mosquitto. org	broker.emqx.io	mqtt.eclipsepr jects.io
Average Latency (ms)	67.47	360.47	217.26	132.25	97.68

Libraries Used

- smbus - for I2C
- RPi.GPIO - for GPIO interaction
- time - for delay using time.sleep()
- threading - leveraging parallel computing to run both light, sound, and mqtt functions simultaneously
- math - to convert the adc value to dB using math.log() function
- paho.mqtt for mqtt communication across clients
- random to generate a random number as the payload
- pycryptodome for encryption
- json to format payload
- ntplib to get a synchronized time reading to calculate latency