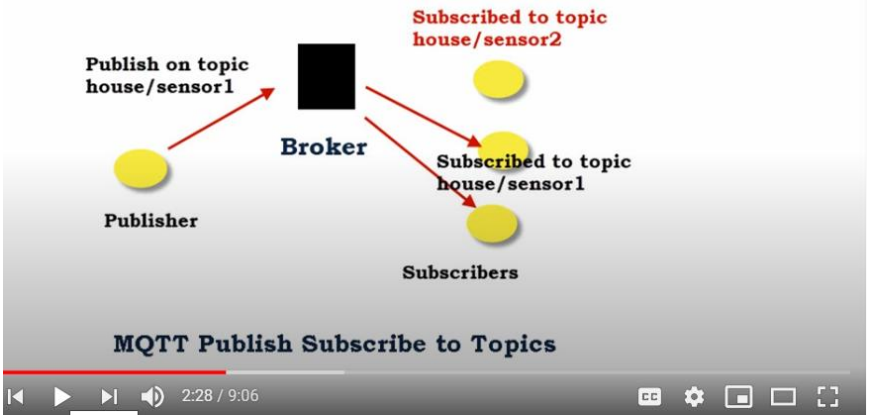
251 wk2 notes

MQTT Basics -How MQTT Works

MQTT uses a publish /subscribe model which **requires the use of a central Broker** as shown in the diagram below:



The model is similar to broadcast radio and TV were a TV or radio station broadcasts on a channel and listeners/viewers tune in to that channel.

In this model there is **no direct connection** between a publisher and subscriber.

However unlike the broadcast TV/radio model in MQTT all clients can publish (broadcast) and subscribe (receive).

Instead of Channels MQTT uses Topics

MQTT Topics

These are like channels in the TV radio model. Topics are what connects the publisher and subscriber.

In MQTT there is no **formal structure** and a publisher is free to choose it's own topic names and structure.

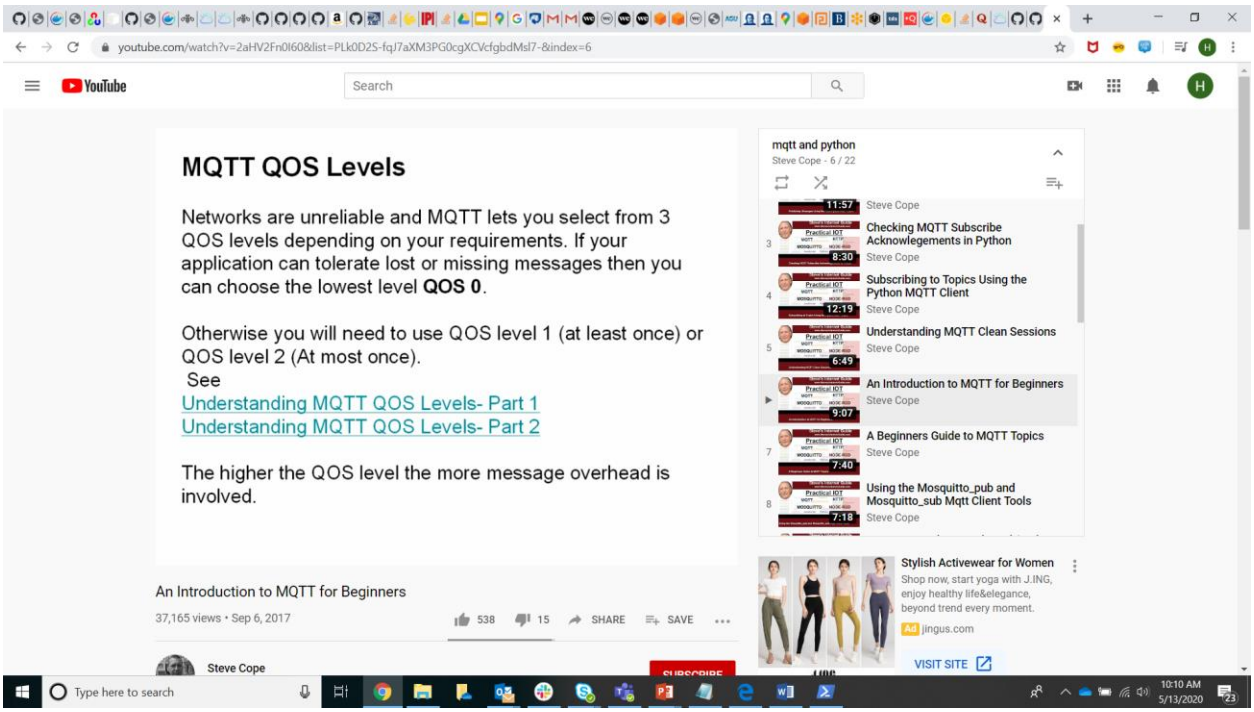
What Happens to Published Messages?

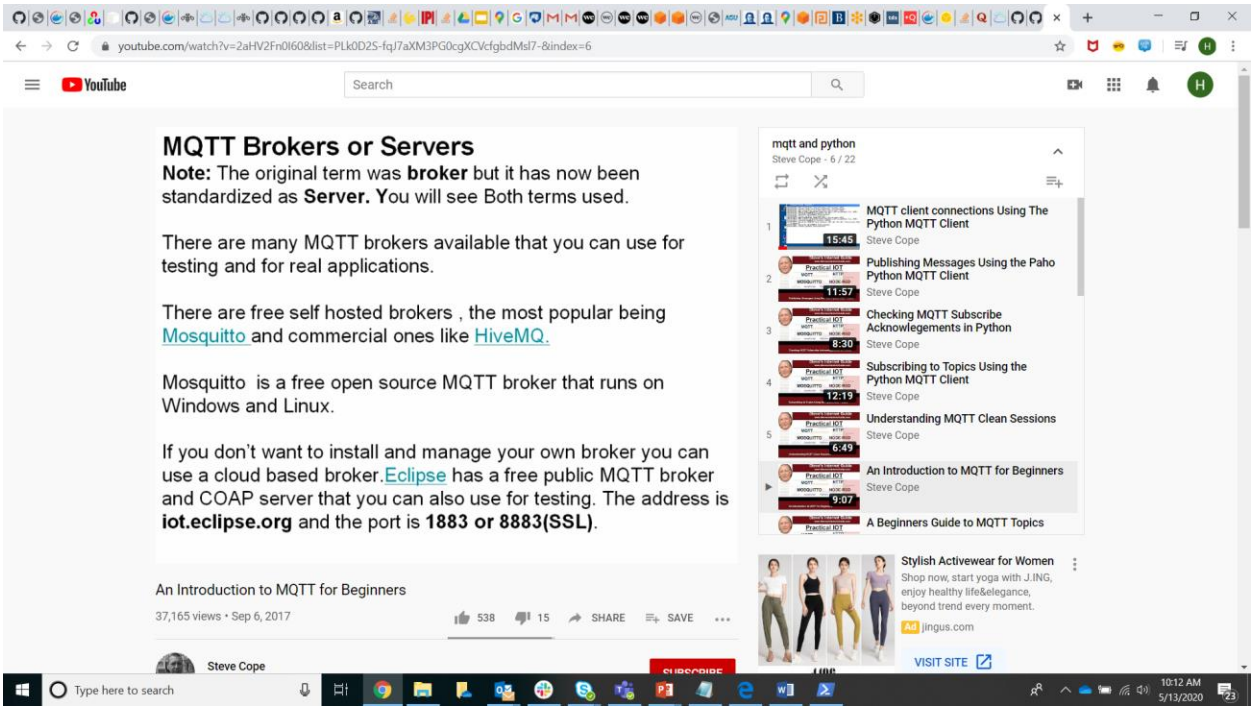
When a client publishes a message on a topic then the broker will distribute that message to any connected clients that have subscribed to that topic.

Once the message has been sent to those clients it is removed from the broker (see note).

If no clients have subscribed to the topic or they aren't currently connected then the message is immediately removed from the broker. (see note)

In general **the broker doesn't store messages**.
Note: Retained messages, persistent connections and QOS levels can result in messages being temporarily stored on the broker/server.




youtube.com/watch?v=2aHV2Fn0I60&list=PLk0D2S-fqJ7aXM3PG0cgXCVcfgbdMsl7-&index=6
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MQTT Brokers or Servers
Note: The original term was broker but it has now been standardized as Server. You will see Both terms used.
There are many MQTT brokers available that you can use for testing and for real applications.
There are free self hosted brokers , the most popular being Mosquitto and commercial ones like HiveMQ.
Mosquitto is a free open source MQTT broker that runs on Windows and Linux.
If you don't want to install and manage your own broker you can use a cloud based broker.Eclipse has a free public MQTT broker and COAP server that you can also use for testing. The address is iot.eclipse.org and the port is 1883 or 8883(SSL).
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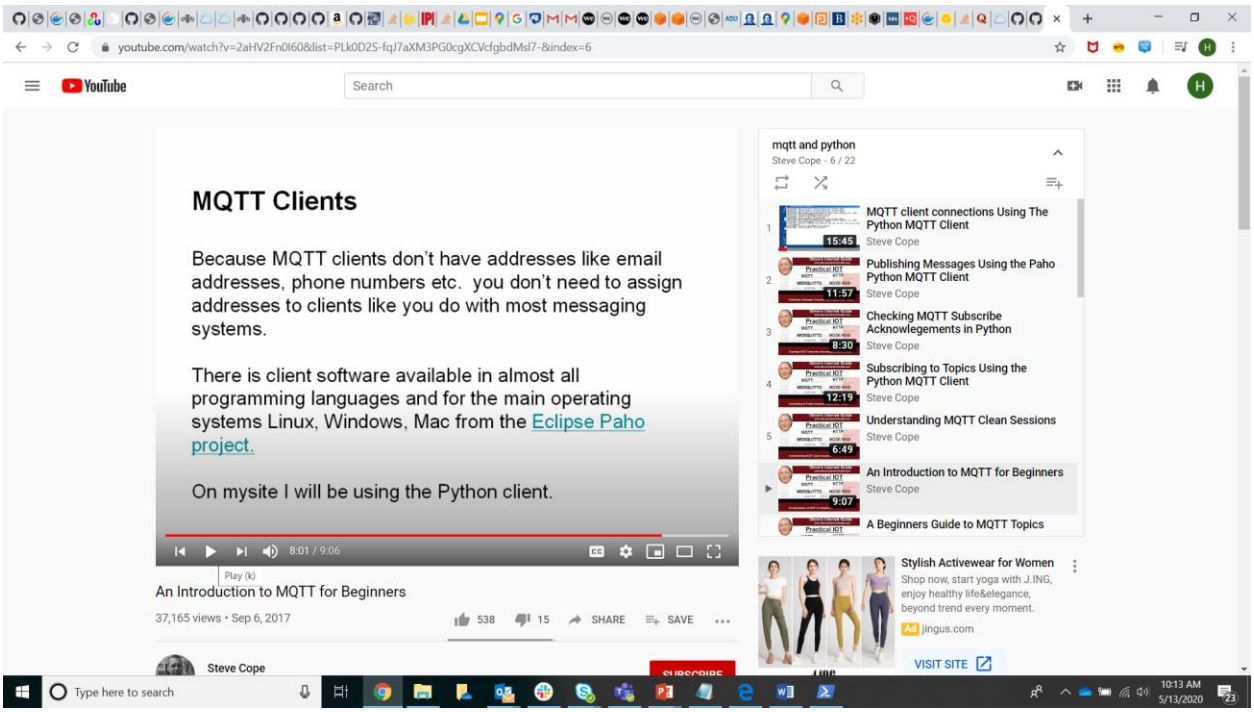
youtube.com/watch?v=2aHV2Fn0I60&list=PLk0D2S-fqJ7aXM3PG0cgXCVcfgbdMsl7-&index=6
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MQTT Clients
Because MQTT clients don't have addresses like email addresses, phone numbers etc. you don't need to assign addresses to clients like you do with most messaging systems.
There is client software available in almost all programming languages and for the main operating systems Linux, Windows, Mac from the Eclipse Paho project.
On mysite I will be using the Python client.
8:01 / 9:06
Play (k)
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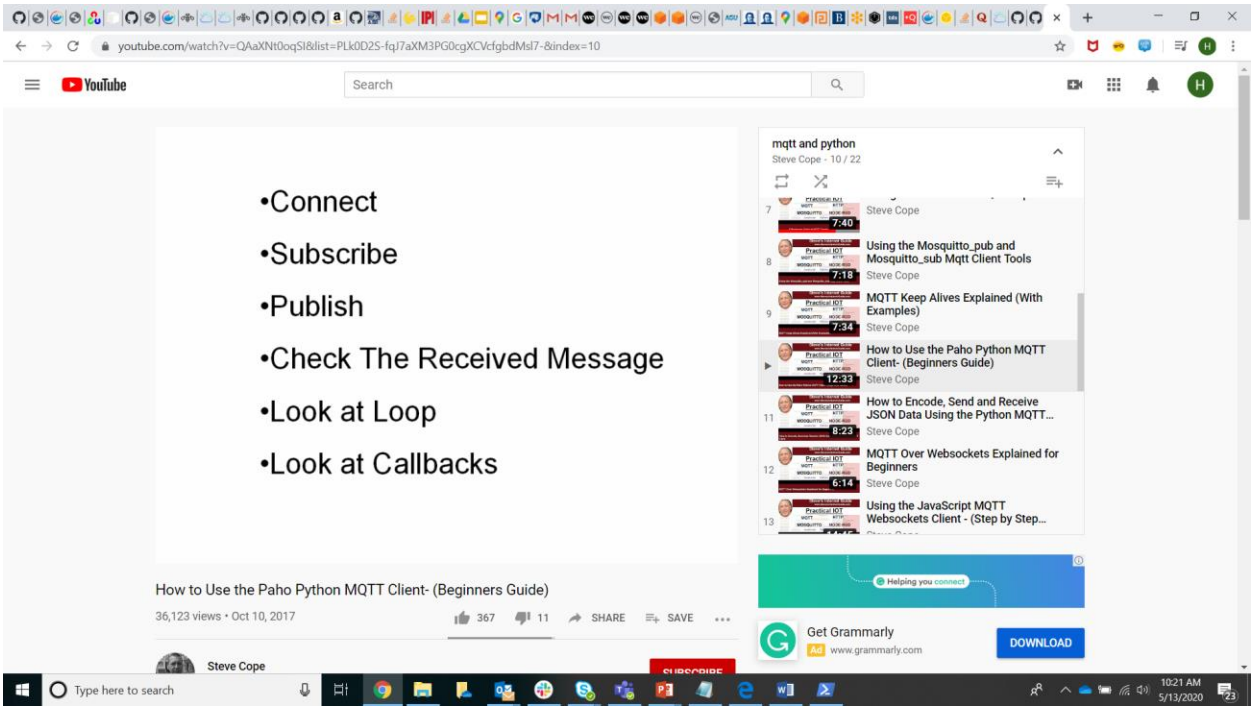
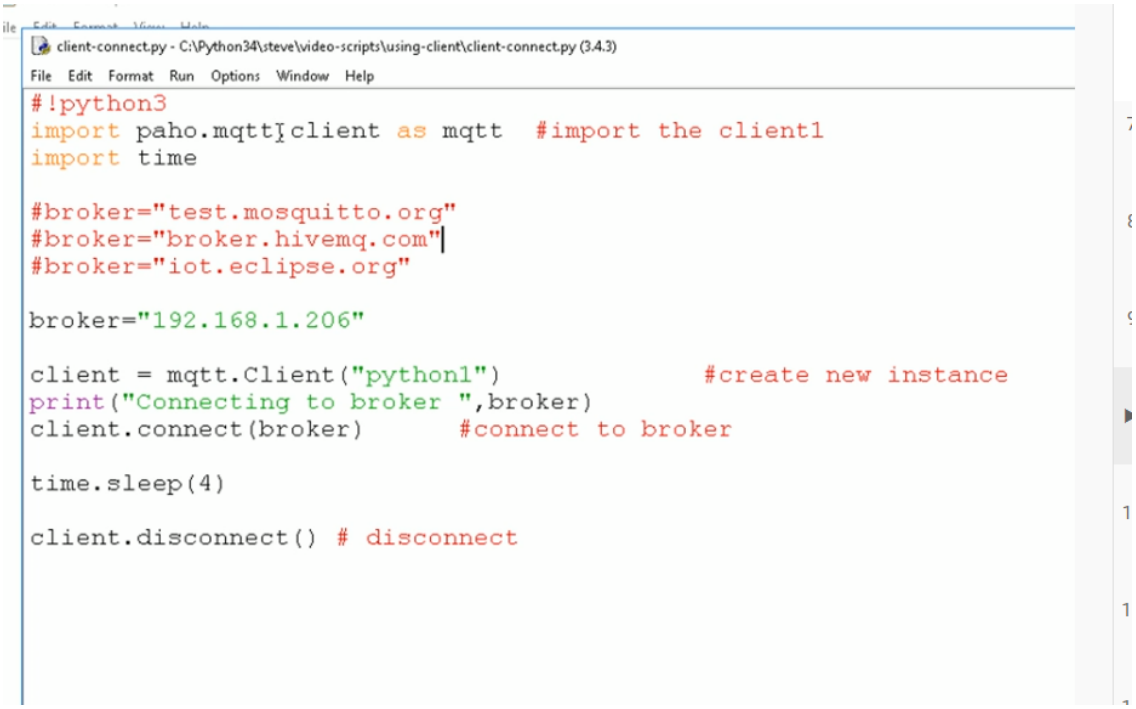
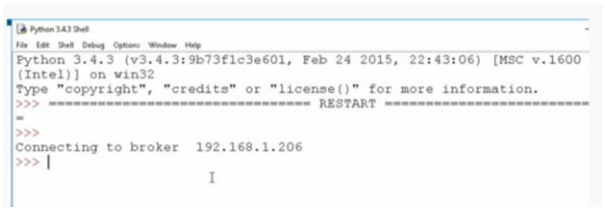
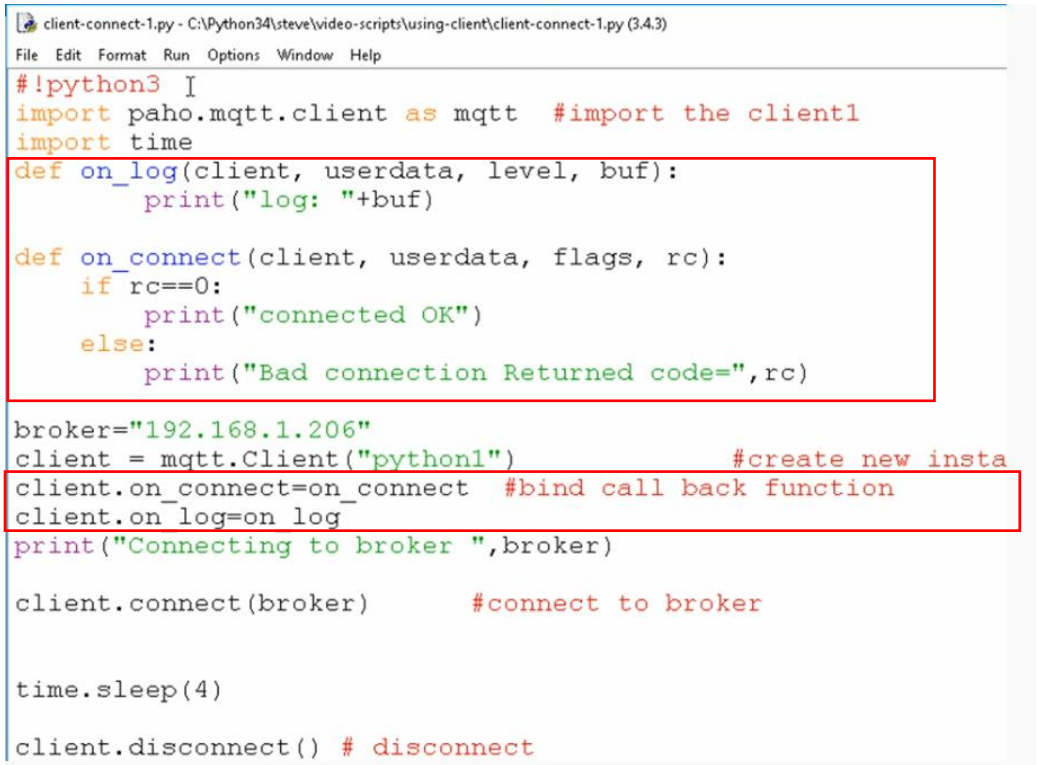




Create a new instance, python1 is the name of the instance

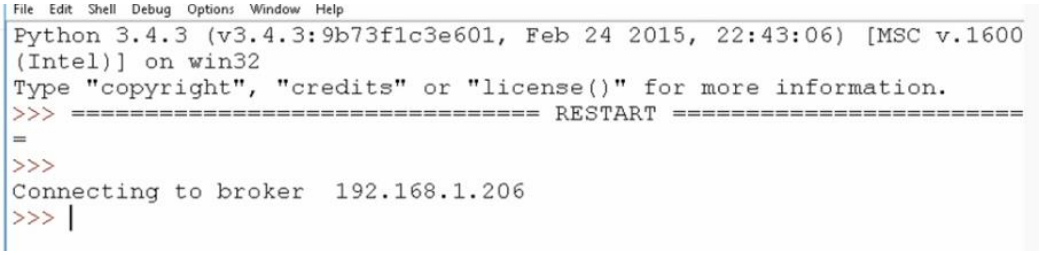




How to Use the Paho Python MQTT Client- (Beginners Guide)

Red box is call-back functions

Second red box is to create link to call-back function



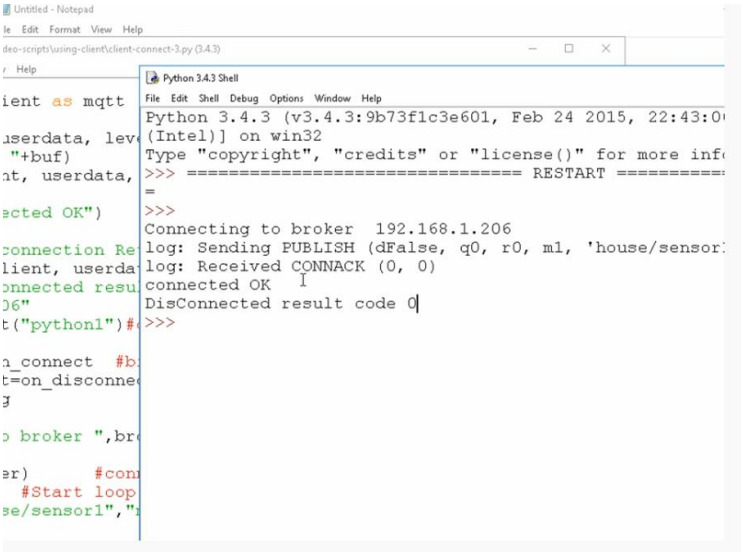
Looks the same as the first script, since we don't have loop

```
File  Edit  Format  Run  Options  Window  Help
#!python3
import paho.mqtt.client as mqtt  #import the client1
import time
def on_log(client, userdata, level, buf):
        print("log: "+buf)
def on_connect(client, userdata, flags, rc):
    if rc==0:
        print("connected OK")
    else:
        print("Bad connection Returned code=",rc)

broker="192.168.1.206"
client = mqtt.Client("python1")#create new instance

client.on_connect=on_connect  #bind call back function
client.on_log=on_log

print("Connecting to broker ",broker)

client.connect(broker)      #connect to broker
client.loop_start()  #Start loop

time.sleep(4)
client.loop_stop()    #Stop loop
client.disconnect() # disconnect
```

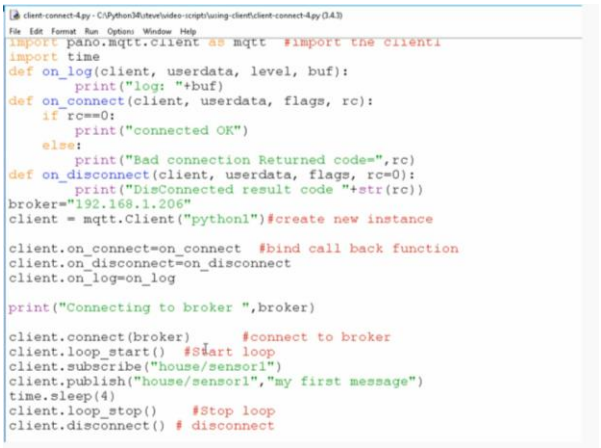
Purpose the loop is to process callback functions

```
File  Edit  Shell  Debug  Options  Window  Help
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600
(Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
=
>>>
Connecting to broker  192.168.1.206
log: Received CONNACK (0, 0)
connected OK
```

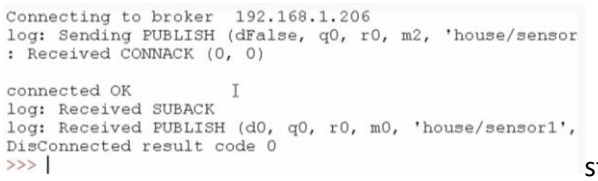
```
File  Edit  Format  Run  Options  Window  Help
#!python3
import paho.mqtt.client as mqtt  #import the client1
import time
def on_log(client, userdata, level, buf):
        print("log: "+buf)
def on_connect(client, userdata, flags, rc):
    if rc==0:
        print("connected OK")
    else:
        print("Bad connection Returned code=",rc)
def on_disconnect(client, userdata, flags, rc=0):
        print("DisConnected result code "+str(rc))
broker="192.168.1.206"
client = mqtt.Client("python1")#create new instance

client.on_connect=on_connect  #bind call back function
client.on_disconnect=on_disconnect
client.on_log=on_log

print("Connecting to broker ",broker)

client.connect(broker)      #connect to broker
client.loop_start()  #Start loop
client.publish("house/sensor1","my first message")
time.sleep(4)
client.loop_stop()    #Stop loop
client.disconnect() # disconnect
```



Subscribe the same message, then I can see the topic I published, here the topic is 'hour/sensor1'

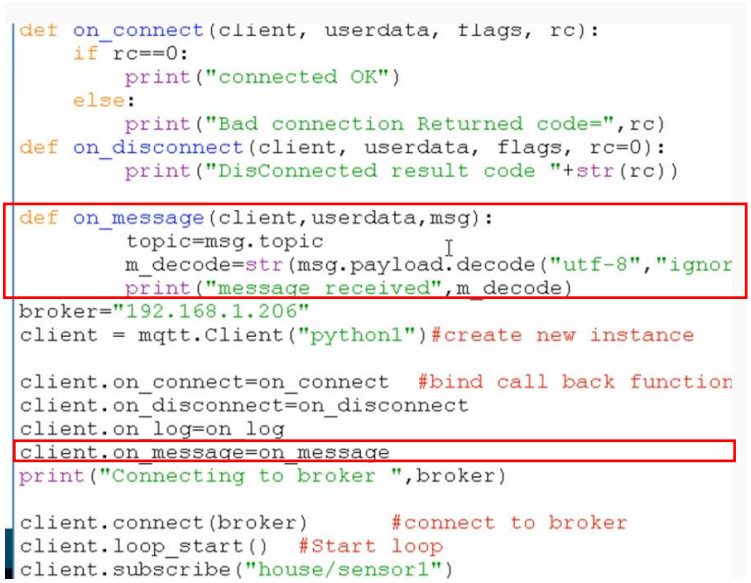


```
import paho.mqtt.client as mqtt  #import the client1
import time
def on_log(client, userdata, level, buf):
    print("log: "+buf)
def on_connect(client, userdata, flags, rc):
    if rc==0:
        print("connected OK")
    else:
        print("Bad connection Returned code=",rc)
def on_disconnect(client, userdata, flags, rc=0):
    print("DisConnected result code "+str(rc))
broker="192.168.1.206"
client = mqtt.Client("python1")#create new instance

client.on_connect=on_connect  #bind call back function
client.on_disconnect=on_disconnect
client.on_log=on_log

print("Connecting to broker ",broker)

client.connect(broker)      #connect to broker
client.loop_start()  #Start loop
client.subscribe("house/sensor1")
client.publish("house/sensor1","my first message")
time.sleep(4)
client.loop_stop()    #Stop loop
client.disconnect() # disconnect
```



```
Connecting to broker  192.168.1.206
log: Sending PUBLISH (dFalse, q0, r0, m2, 'house/sensor
: Received CONNACK (0, 0)

connected OK
log: Received SUBACK
log: Received PUBLISH (d0, q0, r0, m0, 'house/sensor1',
DisConnected result code 0
>>>
```

still have not seen the message, since the message need to be processed. Add more command



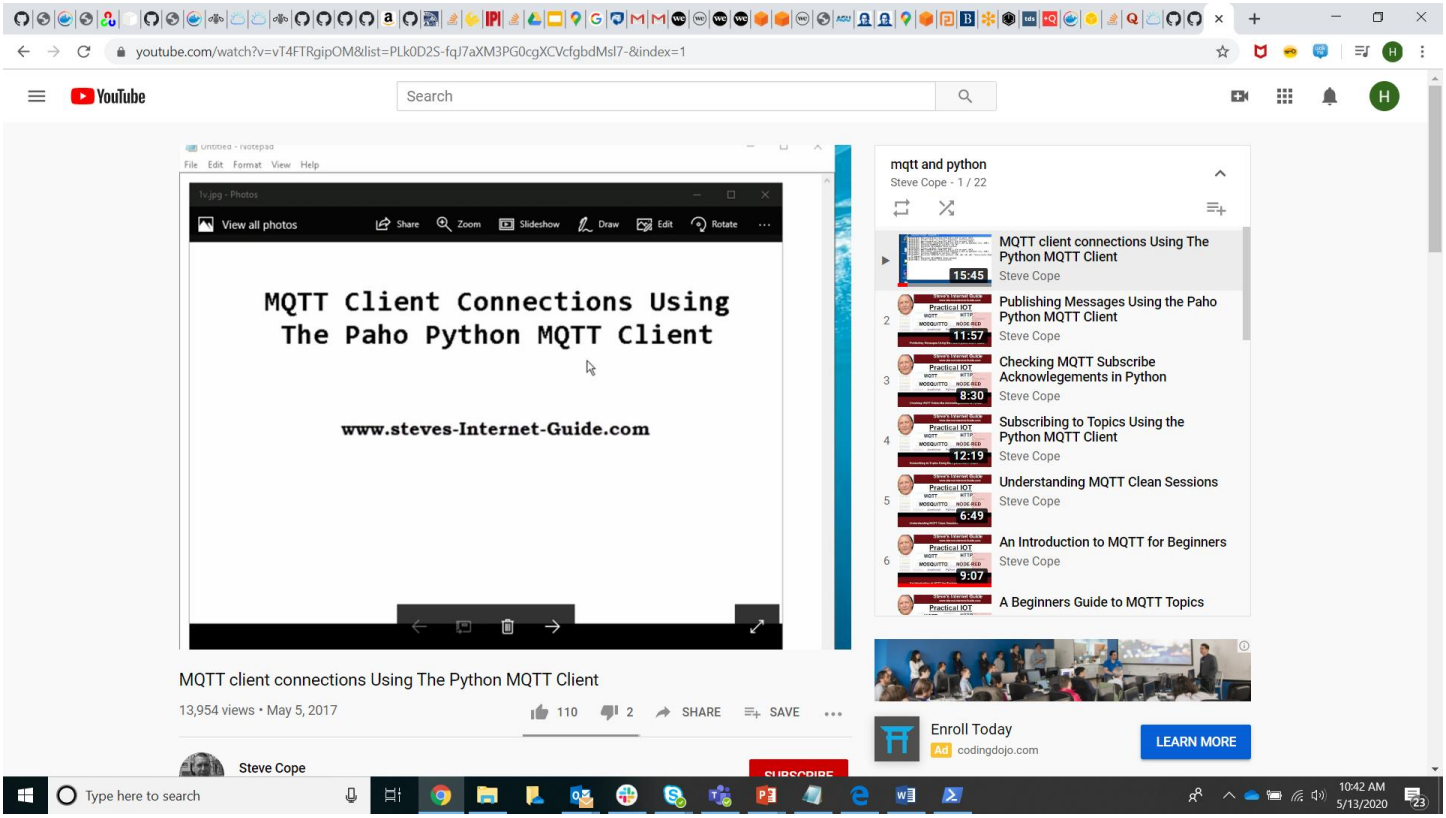
```
def on_connect(client, userdata, flags, rc):
    if rc==0:
        print("connected OK")
    else:
        print("Bad connection Returned code=",rc)
def on_disconnect(client, userdata, flags, rc=0):
        print("DisConnected result code "+str(rc))

def on_message(client,userdata,msg):
        topic=msg.topic
        m_decode=str(msg.payload.decode("utf-8","ignor
        print("message received",m_decode)
broker="192.168.1.206"
client = mqtt.Client("python1")#create new instance

client.on_connect=on_connect  #bind call back function
client.on_disconnect=on_disconnect
client.on_log=on_log
client.on_message=on_message
print("Connecting to broker ",broker)

client.connect(broker)      #connect to broker
client.loop_start()  #Start loop
client.subscribe("house/sensor1")
```

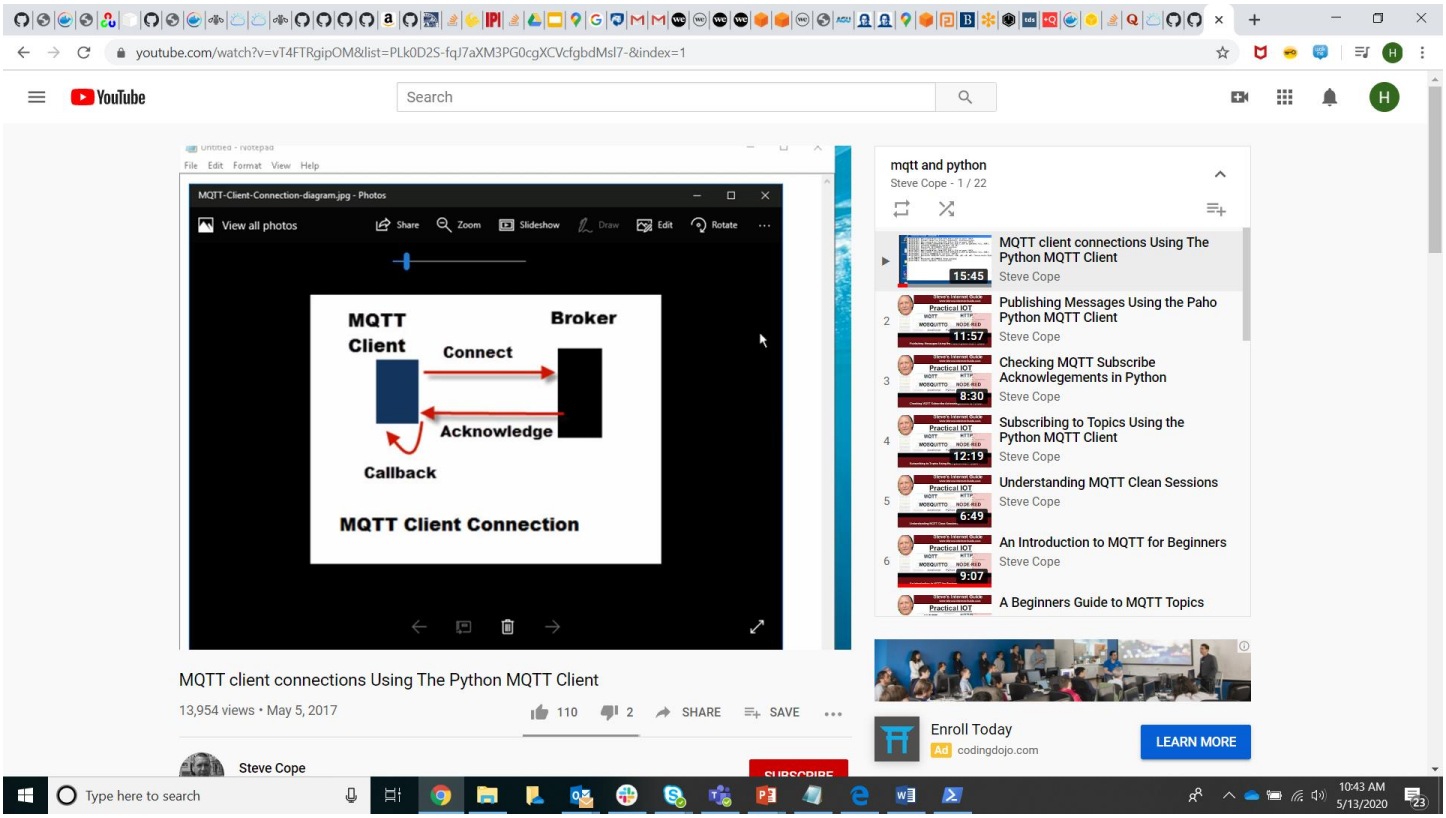
```
Connecting to broker  192.168.1.206
log: Sending PUBLISH (dFalse, q0, r0, m2, 'hous
log: Received CONNACK (0, 0)
connected OK
log: Received SUBACK
log: Received PUBLISH (d0, q0, r0, m0, 'house/s
message received my first message
DisConnected result code 0
>>>
```

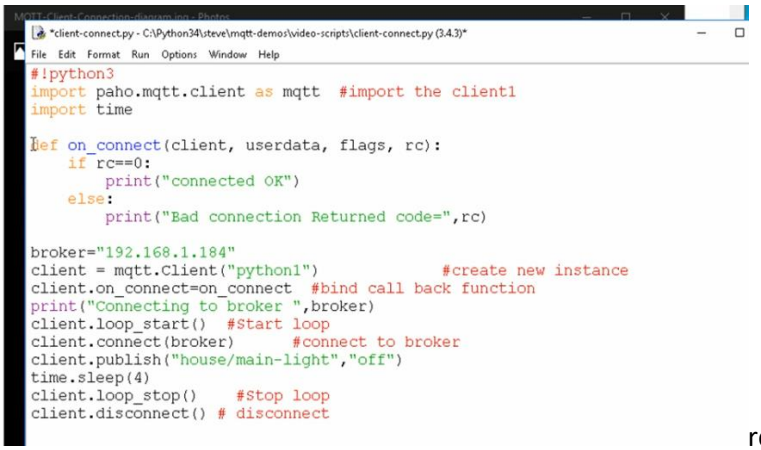
now we can see the message here, my first message

```
>>>
Connecting to broker  192.168.1.206
log: Sending PUBLISH (dFalse, q0, r0, r
log: Received CONNACK (0, 0)
connected OK
log: Received SUBACK
log: Received PUBLISH (d0, q0, r0, m0,
message received my first message
DisConnected result code 0
>>> ================================ RE
=
>>>
Connecting to broker  192.168.1.206
connected OK
message received my first message
DisConnected result code 0
>>>
```

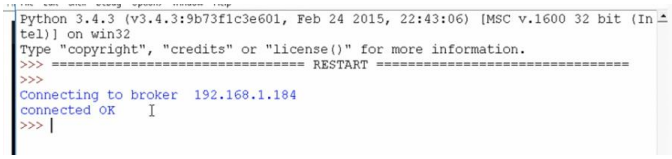
normally don't need to use log, #client.on_log.







rc=return code



```
File  Edit  Format  Run  Options  Window  Help
#!python3
import paho.mqtt.client as mqtt  #import the client1
import time

def on_connect(client, userdata, flags, rc):
    if rc==0:
        print("connected OK")
    else:
        print("Bad connection Returned code=",rc)

broker="192.168.1.184"
client = mqtt.Client("python1")             #create new ir
client.on_connect=on_connect  #bind call back function
print("Connecting to broker ",broker)
#client.loop_start()  #Start loop
client.connect(broker)      #connect to broker
client.loop_start()  #Start loop
client.publish("house/main-light","off")
time.sleep(4)
client.loop_stop()    #Stop loop
client.disconnect() # disconnect
```

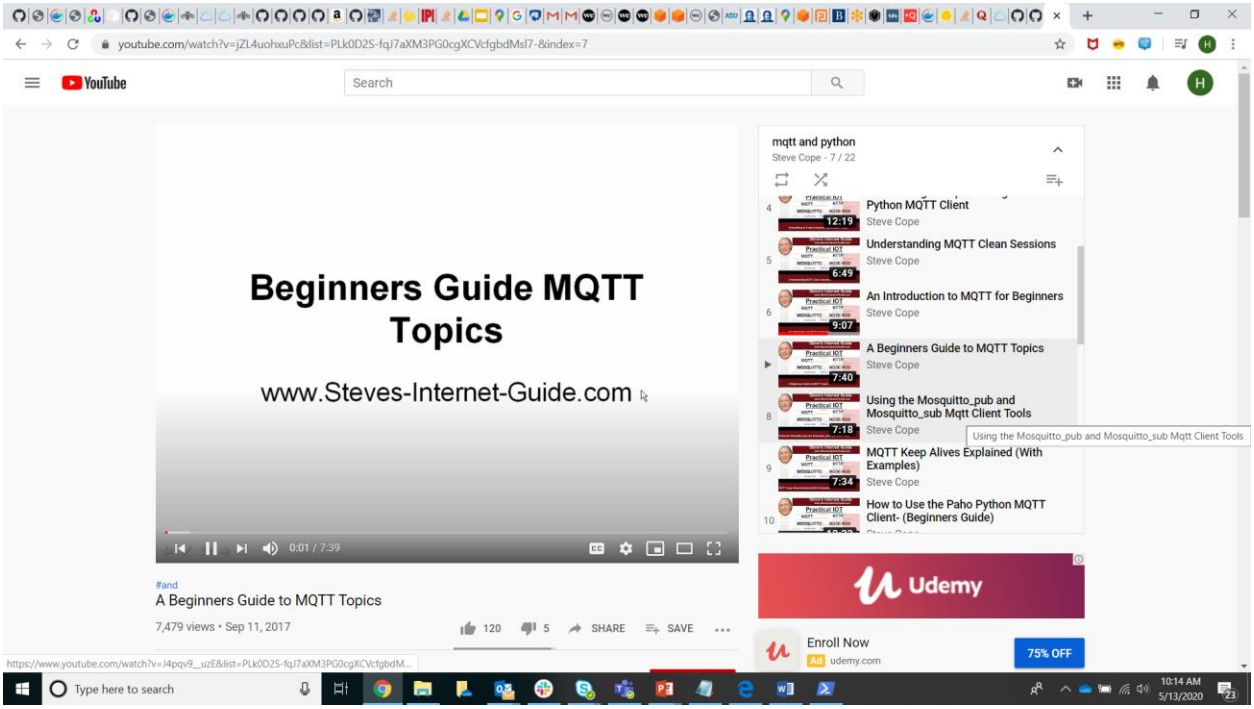
conncet first, than start the loop is correct

```
Command Prompt - mosquitto -v
1493976794: New connection from 192.168.1.154 on port 1883.
1493976795: Socket error on client <unknown>, disconnecting.
1493976795: New connection from 192.168.1.154 on port 1883.
1493976795: New client connected from 192.168.1.154 as python1 (c1, k60).
1493976795: Sending CONNACK to python1 (0, 0)
1493976798: Received DISCONNECT from python1
1493976798: Client python1 disconnected.
1493977077: New connection from 192.168.1.154 on port 1883.
1493977077: New client connected from 192.168.1.154 as python1 (c1, k60).
1493977077: Sending CONNACK to python1 (0, 0)
1493977077: Received PUBLISH from python1 (d0, q0, r0, m0, 'house/main-ligh
.. (3 bytes))
1493977081: Received DISCONNECT from python1
1493977081: Client python1 disconnected.
```

these are the mosqitoo console message for the first script and second script, only connect first then start the loop. We can publish the message.

```
File  Edit  Format  Run  Options  Window  Help
#!python3
import paho.mqtt.client as mqtt  #import the client1
import time

def on_connect(client, userdata, flags, rc):
    if rc==0:
        client.connected_flag=True #set flag
        print("connected OK")
    else:
        print("Bad connection Returned code=",rc)

mqtt.Client.connected_flag=False#create flag in class
broker="192.168.1.184"
client = mqtt.Client("python1")             #create new instance
client.on_connect=on_connect  #bind call back function
print("Connecting to broker ",broker)
client.connect(broker)      #connect to broker
client.loop_start()  #Start loop
while not client.connected_flag: #wait in loop
    print("In wait loop")
    time.sleep(1)
print("in Main Loop")
client.publish("house/main-light","off")
time.sleep(4)
client.loop_stop()    #Stop loop
client.disconnect() # disconnect
```

```
File  Edit  Shell  Debug  Options  Window  Help
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32
tel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ================================ RESTART ================================
>>>
Connecting to broker  192.168.1.184
In wait loop
connected OK
in Main Loop
>>>
```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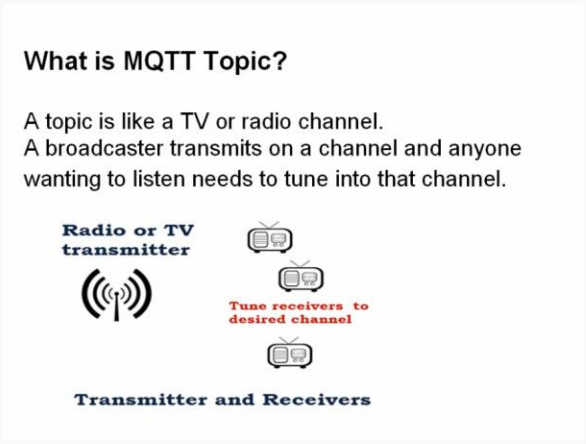

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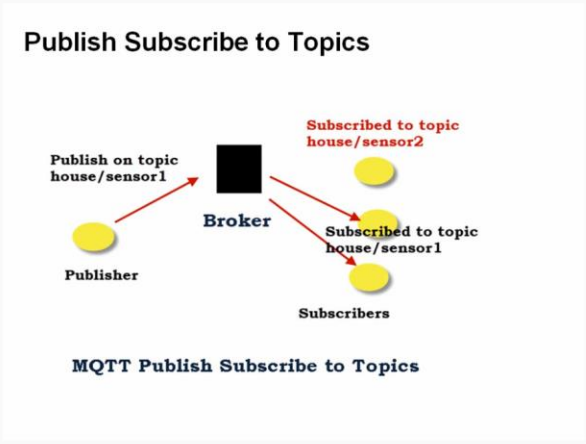

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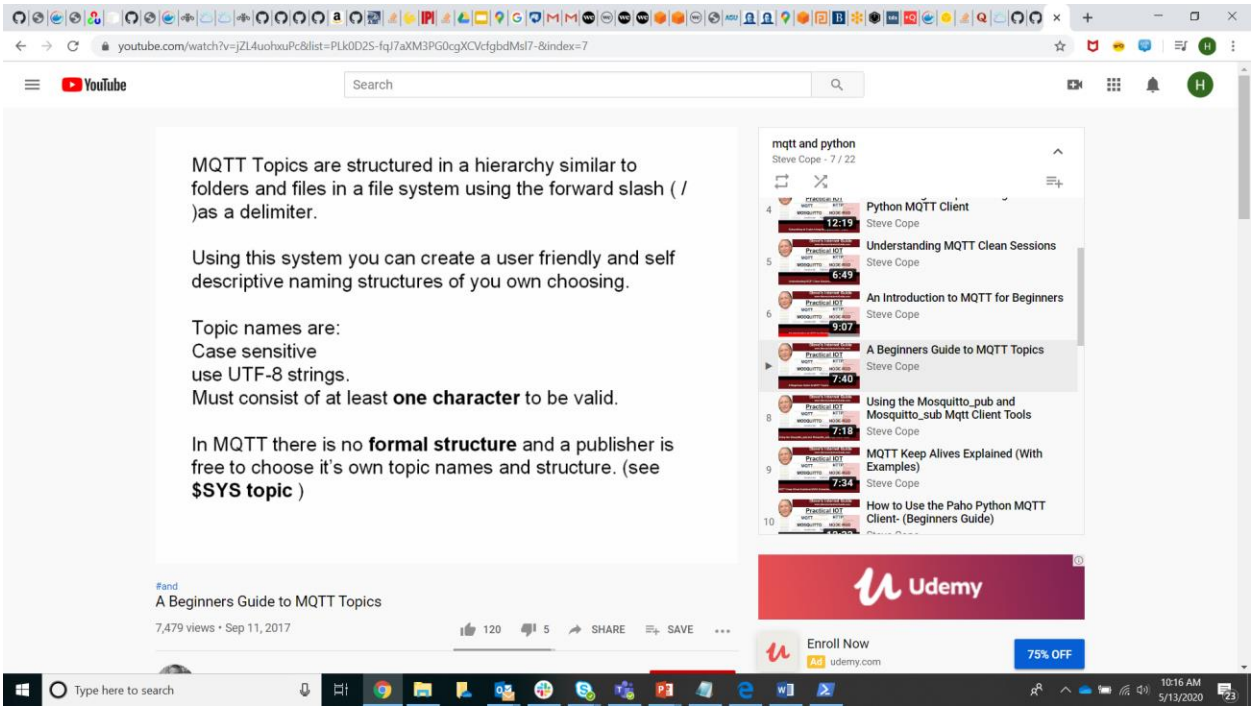
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MQTT Topics are structured in a hierarchy similar to folders and files in a file system using the forward slash (/)as a delimiter.
Using this system you can create a user friendly and self descriptive naming structures of you own choosing.
Topic names are:
Case sensitive
use UTF-8 strings.
Must consist of at least **one character** to be valid.
In MQTT there is no **formal structure** and a publisher is free to choose it's own topic names and structure. (see **$SYS topic**)
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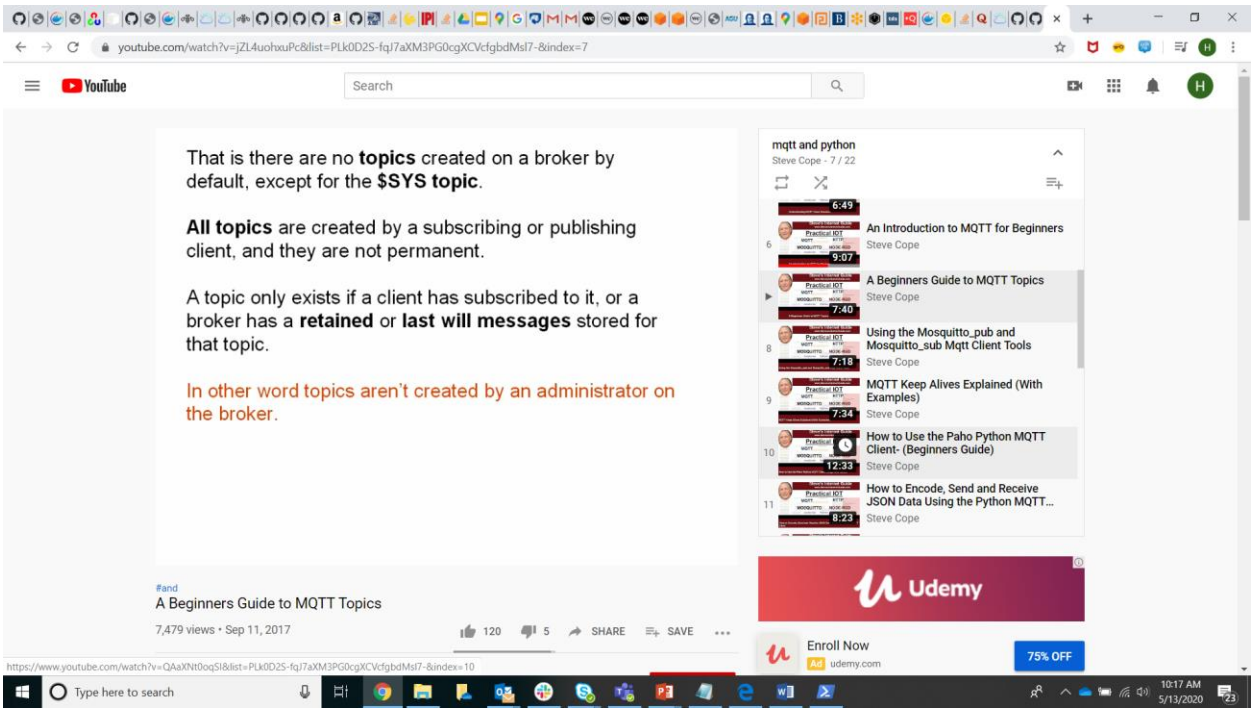
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That is there are no **topics** created on a broker by default, except for the **$SYS topic**.
All topics are created by a subscribing or publishing client, and they are not permanent.
A topic only exists if a client has subscribed to it, or a broker has a **retained** or **last will messages** stored for that topic.
In other word topics aren't created by an administrator on the broker.
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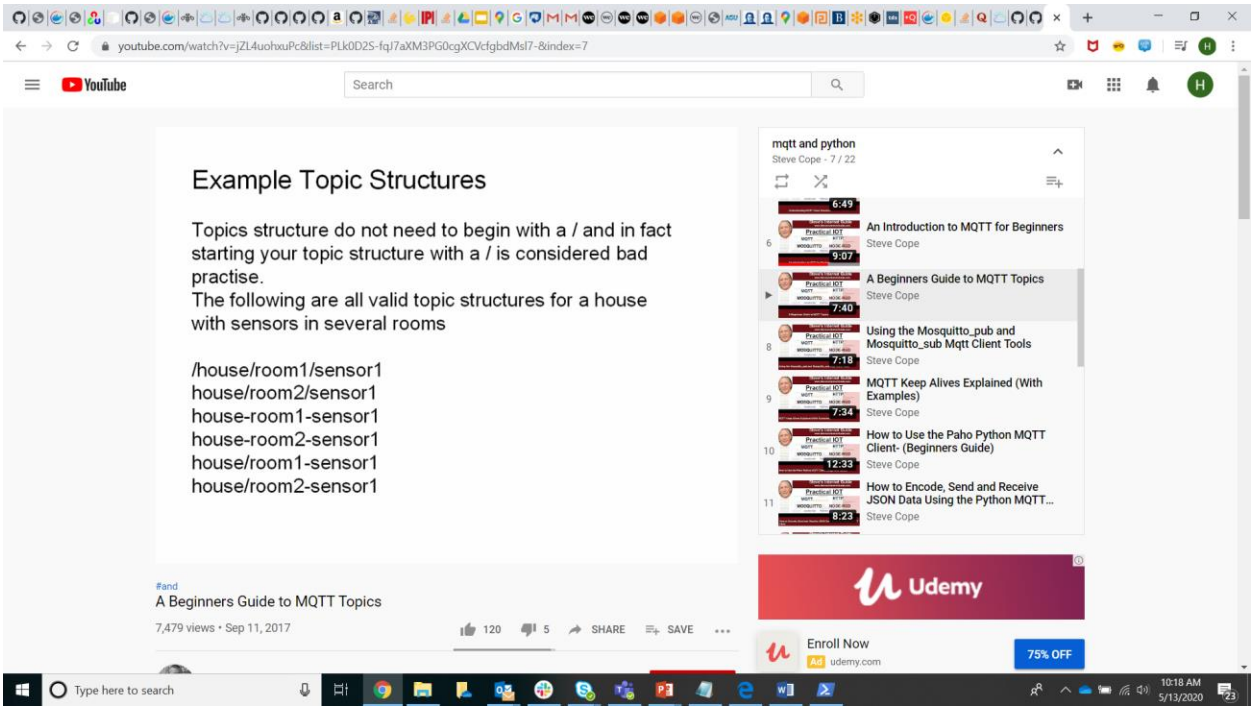
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Example Topic Structures
Topics structure do not need to begin with a / and in fact starting your topic structure with a / is considered bad practise.
The following are all valid topic structures for a house with sensors in several rooms
/house/room1/sensor1
house/room2/sensor1
house-room1-sensor1
house-room2-sensor1
house/room1-sensor1
house/room2-sensor1
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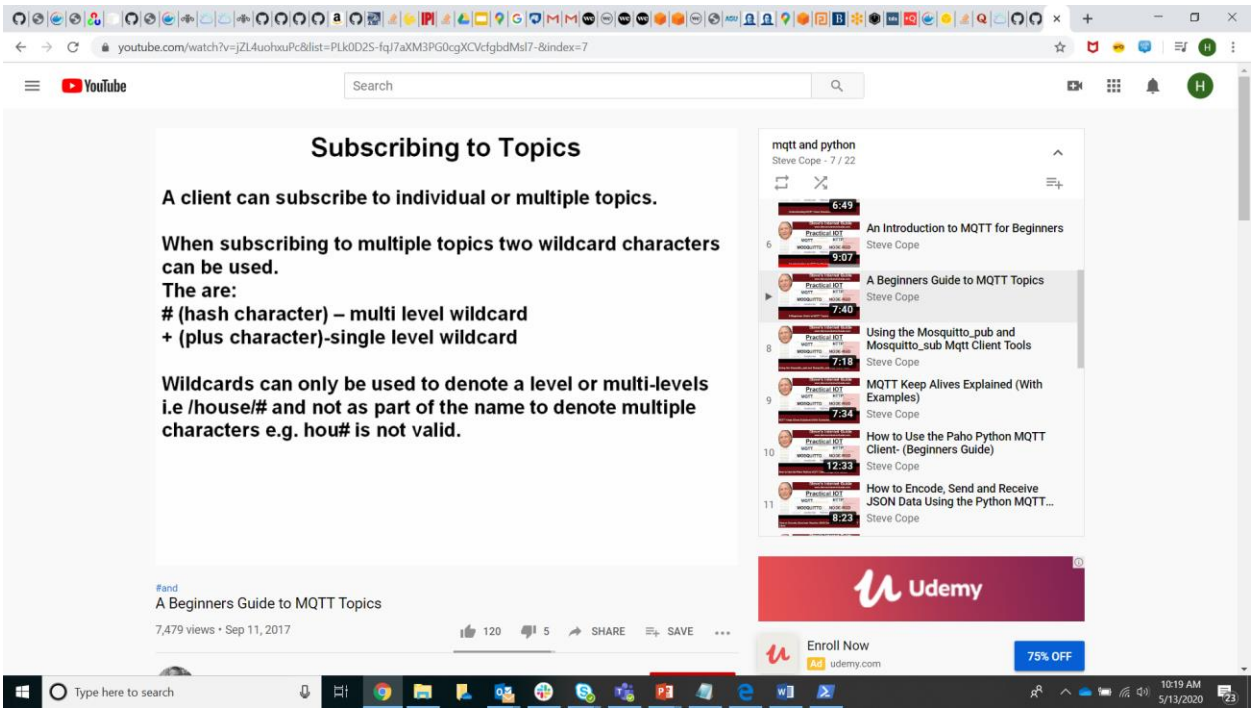
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Subscribing to Topics
A client can subscribe to individual or multiple topics.
When subscribing to multiple topics two wildcard characters can be used.
The are:
(hash character) – multi level wildcard
+ (plus character)-single level wildcard
Wildcards can only be used to denote a level or multi-levels i.e /house/# and not as part of the name to denote multiple characters e.g. hou# is not valid.
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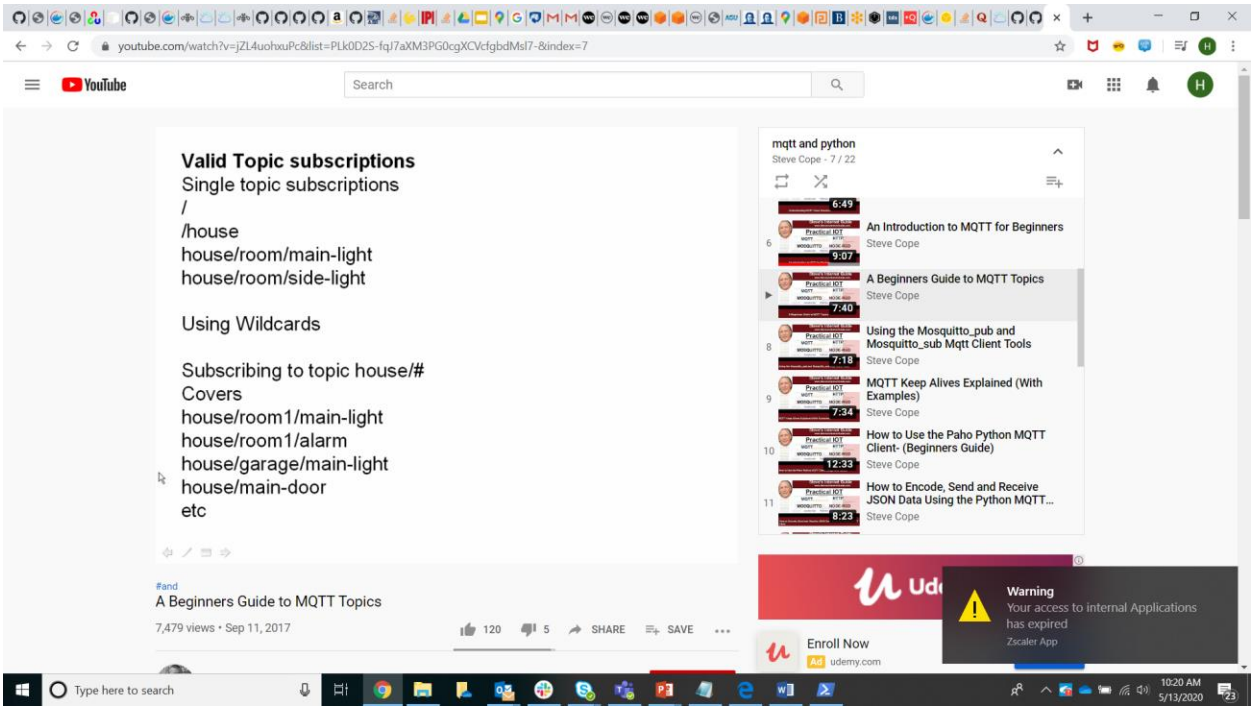
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Single topic subscriptions
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/house
house/room/main-light
house/room/side-light
Using Wildcards
Subscribing to topic house/#
Covers
house/room1/main-light
house/room1/alarm
house/garage/main-light
house/main-door
etc
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