```
user@box:~$ sudo apt update
[sudo] password for user:
Hit:1 http://us.archive.ubuntu.com/ubuntu focal InRelease
Get:2 http://us.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease [108 kB]
Get:4 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Get:5 http://us.archive.ubuntu.com/ubuntu focal-updates/main i386 Packages [6
10 kB]
Get:6 http://us.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [
1,608 kB]
Get:7 http://security.ubuntu.com/ubuntu focal-security/main amd64 Packages [1
,275 kB]
Get:8 http://us.archive.ubuntu.com/ubuntu focal-updates/main Translation-en [
308 kB]
Get:9 http://us.archive.ubuntu.com/ubuntu focal-updates/main amd64 DEP-11 Met
adata [280 kB]
Get:10 http://us.archive.ubuntu.com/ubuntu focal-updates/main amd64 c-n-f Met
adata [14.8 kB]
Get:11 http://us.archive.ubuntu.com/ubuntu focal-updates/restricted amd64 Pac
kages [827 kB]
Get:12 http://us.archive.ubuntu.com/ubuntu focal-updates/restricted Translati
on-en [118 kB]
Get:13 http://us.archive.ubuntu.com/ubuntu focal-updates/universe i386 Packag
es [671 kB]
Get:14 http://us.archive.ubuntu.com/ubuntu focal-updates/universe amd64 Packa
ges [908 kB]
```

```
user@box:~$ sudo apt install mosquitto mosquitto-clients
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer required:
  libllvm9
Use 'sudo apt autoremove' to remove it.
The following additional packages will be installed:
  libdlt2 libev4 libmosquitto1 libwebsockets15
The following NEW packages will be installed:
  libdlt2 libev4 libmosquitto1 libwebsockets15 mosquitto mosquitto-clients
0 upgraded, 6 newly installed, 0 to remove and 38 not upgraded.
Need to get 498 kB of archives.
After this operation, 1,589 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 libdlt2 amd64
2.18.4-0.1 [50.4 kB]
Get:2 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 libmosquitto1
amd64 1.6.9-1 [45.9 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 libev4 amd64 1
:4.31-1 [31.2 kB]
Get:4 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 libwebsockets1
5 amd64 3.2.1-3 [152 kB]
Get:5 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 mosquitto amd6
4 1.6.9-1 [160 kB]
Get:6 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 mosquitto-clie
```

```
user@box:~$ mosquitto_sub -h localhost -v -t "\$SYS/#"
$SYS/broker/version mosquitto version 1.6.9
$SYS/broker/uptime 11 seconds
$SYS/broker/clients/total 0
$SYS/broker/clients/inactive 0
$SYS/broker/clients/disconnected 0
$SYS/broker/clients/active 0
$SYS/broker/clients/connected 0
$SYS/broker/clients/expired 0
$SYS/broker/load/messages/received/1min 0.00
$SYS/broker/load/messages/received/5min 0.00
$SYS/broker/load/messages/received/15min 0.00
$SYS/broker/load/messages/sent/1min 0.00
$SYS/broker/load/messages/sent/5min 0.00
$SYS/broker/load/messages/sent/15min 0.00
$SYS/broker/load/publish/dropped/1min 0.00
$SYS/broker/load/publish/dropped/5min 0.00
$SYS/broker/load/publish/dropped/15min 0.00
$SYS/broker/load/publish/received/1min 0.00
$SYS/broker/load/publish/received/5min 0.00
$SYS/broker/load/publish/received/15min 0.00
$SYS/broker/load/publish/sent/1min 0.00
$SYS/broker/load/publish/sent/5min 0.00
```

```
● mosquitto.service - Mosquitto MQTT v3.1/v3.1.1 Broker
     Loaded: loaded (/lib/systemd/system/mosquitto.service; enabled; vendor preset: en>
     Active: active (running) since Mon 2022-03-07 12:07:53 EST; 1min 17s ago
       Docs: man:mosquitto.conf(5)
             man:mosquitto(8)
   Main PID: 2099 (mosquitto)
      Tasks: 3 (limit: 2269)
     Memory: 1.4M
     CGroup: /system.slice/mosquitto.service
             └─2099 /usr/sbin/mosquitto -c /etc/mosquitto/mosquitto.conf

Mar 07 12:07:53 box systemd[1]: Starting Mosquitto MQTT v3.1/v3.1.1 Broker...
Mar 07 12:07:53 box mosquitto[2099]: [  182.661748]~DLT~ 2099~INFO     ~FIFO /tmp/dlt >
Mar 07 12:07:53 box systemd[1]: Started Mosquitto MQTT v3.1/v3.1.1 Broker.
~
~
```

```
user@box:~$ netstat -tln
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 127.0.0.1:3306          0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.53:53           0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:631           0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:1883            0.0.0.0:*               LISTEN
tcp6       0      0 ::1:631                 :::*                    LISTEN
tcp6       0      0 :::1883                 :::*                    LISTEN
```

Terminals 1 and 2 (Mosquitto Commands):

```
user@box:~/iot$ mosquitto_sub -h localhost -v -t test/topic &
[2] 2595
user@box:~/iot$ test/topic Hello
test/topic Hello
```

```
user@box:~$ mosquitto_pub -h localhost -t test/topic -m "Hello"
```

```
user@box:~$ sudo pip3 install -U paho-mqtt
/usr/local/lib/python3.8/dist-packages/pkg_resources/__init__.py:122: PkgResourcesDepre
cationWarning: 0.23ubuntu1 is an invalid version and will not be supported in a future
release
  warnings.warn(
/usr/local/lib/python3.8/dist-packages/pkg_resources/__init__.py:122: PkgResourcesDepre
cationWarning: 0.1.36ubuntu1 is an invalid version and will not be supported in a futur
e release
  warnings.warn(
Collecting paho-mqtt
  Downloading paho-mqtt-1.6.1.tar.gz (99 kB)
     |████████████████████████████████| 99 kB 2.2 MB/s
Building wheels for collected packages: paho-mqtt
  Building wheel for paho-mqtt (setup.py) ... done
  Created wheel for paho-mqtt: filename=paho_mqtt-1.6.1-py3-none-any.whl size=62133 sha
256=7ae20fdcaa7040d193c8ff3e26bc44ce2ccafbf3ac3186a35d359504fbb50894
  Stored in directory: /root/.cache/pip/wheels/6a/48/01/c895c027e9b9367ec5470fbf371ee56
e795a49ac6a19aa4c9f
Successfully built paho-mqtt
Installing collected packages: paho-mqtt
Successfully installed paho-mqtt-1.6.1
```

```
user@box:~$ netstat -tln
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 127.0.0.1:3306          0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.53:53           0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:631           0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:1883            0.0.0.0:*               LISTEN
tcp6       0      0 ::1:631                 :::*                    LISTEN
tcp6       0      0 :::1883                 :::*                    LISTEN
user@box:~$ mosquitto_sub -h localhost -v -t test/topic &
[1] 2445
user@box:~$ mosquitto_pub -h localhost -t test/topic -m "Hello"
test/topic Hello
user@box:~$ sudo pip3 install -U paho-mqtt
/usr/local/lib/python3.8/dist-packages/pkg_resources/__init__.py:122: PkgResourcesDepre
cationWarning: 0.23ubuntu1 is an invalid version and will not be supported in a future
release
  warnings.warn(
/usr/local/lib/python3.8/dist-packages/pkg_resources/__init__.py:122: PkgResourcesDepre
cationWarning: 0.1.36ubuntu1 is an invalid version and will not be supported in a futur
e release
  warnings.warn(
Collecting paho-mqtt
  Downloading paho-mqtt-1.6.1.tar.gz (99 kB)
     |████████████████████████████████| 99 kB 2.2 MB/s
Building wheels for collected packages: paho-mqtt
```

```
Successfully installed paho-mqtt-1.6.1
user@box:~$ git clone https://github.com/eclipse/paho.mqtt.python.git
Cloning into 'paho.mqtt.python'...
remote: Enumerating objects: 4491, done.
remote: Counting objects: 100% (929/929), done.
remote: Compressing objects: 100% (369/369), done.
remote: Total 4491 (delta 547), reused 826 (delta 490), pack-reused 3562
Receiving objects: 100% (4491/4491), 1.37 MiB | 7.52 MiB/s, done.
Resolving deltas: 100% (2395/2395), done.
user@box:~$ cd ~/iot/lesson5
user@box:~/iot/lesson5$ python3 client.py
Connected with result code 0
$SYS/broker/publish/messages/dropped 10911527
$SYS/broker/publish/messages/received 76950567
$SYS/broker/publish/messages/sent 127555427
$SYS/broker/publish/bytes/received 13456085190
$SYS/broker/publish/bytes/sent 15001401900
$SYS/broker/publish/messages/dropped 10911747
$SYS/broker/publish/messages/received 76951115
$SYS/broker/publish/messages/sent 127555558
$SYS/broker/publish/bytes/received 13456150093
$SYS/broker/publish/bytes/sent 15001416366
$SYS/broker/publish/messages/dropped 10912007
$SYS/broker/publish/messages/received 76951690
$SYS/broker/publish/messages/sent 127555732
$SYS/broker/publish/bytes/received 13456218838
```

Terminal 1:

```
user@box:~/iot/lesson5$ python3 sub.py
Connected with result code 0
paho/test Hello
```

Terminal 2:

```
user@box:~/iot/lesson5$ python3 pub.py
```

Terminals 1 and 2:

```
user@box:~/iot/lesson5$ python3 sub-multiple.py
Connected with result code 0
paho/test/multiple multiple 1
paho/test/multiple multiple 2
```

```
user@box:~/iot/lesson5$ python3 pub-multiple.py
```

Terminals 1 and 2 (subcpu and pubcpu):

```
user@box:~/iot/lesson5$ python3 subcpu.py
Connected with result code 0
MyCPU 2022-03-07 12:32:43
MyCPU CPU Usage:    30.0 %
MyCPU 2022-03-07 12:32:51
MyCPU CPU Usage:    6.3 %
MyCPU 2022-03-07 12:32:53
MyCPU CPU Usage:    0.2 %
MyCPU 2022-03-07 12:33:01
MyCPU CPU Usage:    1.8 %
MyCPU 2022-03-07 12:33:03
MyCPU CPU Usage:    0.1 %
```

```
user@box:~/iot/lesson5$ python3 pubcpu.py
2022-03-07 12:32:43
CPU Usage:    30.0 %
2022-03-07 12:32:53
CPU Usage:    0.2 %
2022-03-07 12:33:03
CPU Usage:    0.1 %
2022-03-07 12:33:13
CPU Usage:    0.8 %
2022-03-07 12:33:23
CPU Usage:    0.7 %
```

Terminals 1 and 2 (subraspi and pubraspi):

```
user@box:~/demo$ cp ~/iot/lesson5/subraspi.py .
user@box:~/demo$ nano subraspi.py
user@box:~/demo$ python3 subraspi.py
Connected with result code 0
Raspberry Pi 2022-03-07 12:42:15
Raspberry Pi Temperature: 0.0 C
Raspberry Pi CPU Usage:    41.7 %
```

```
user@box:~$ cd  ~/demo
user@box:~/demo$ cp ~/iot/lesson5/system_info.py .
user@box:~/demo$ cp ~/iot/lesson5/pubraspi.py .
user@box:~/demo$ nano pubraspi.py
user@box:~/demo$ python3 pubraspi.py
Free RAM: 0 (1983)
Number of processes: 157
Up time: 37 min
Number of connections: 6
Temperature in C: 0
IP-address: 10.0.2.15
/bin/sh: 1: /opt/vc/bin/vcgencmd: not found
CPU speed in MHz:
2022-03-07 12:42:15
Temperature: 0.0 C
CPU Usage:    41.7 %
2022-03-07 12:42:25
Temperature: 0.0 C
CPU Usage:     1.1 %
```

```
GNU nano 4.8                    subraspi.py
import paho.mqtt.client as mqtt
def on_connect(client, userdata, flags, rc):
    print("Connected with result code "+str(rc))
    client.subscribe("Raspberry Pi")
def on_message(client, userdata, msg):
    print(msg.topic+" "+str(msg.payload.decode()))
client = mqtt.Client()
client.on_connect = on_connect
client.on_message = on_message
client.connect("mqtt.eclipseprojects.io", 1883, 60)
client.loop_forever()
```

```
GNU nano 4.8                    pubraspi.py
import time
import datetime
from system_info import get_temperature
import psutil
import paho.mqtt.client as mqtt
mqttc = mqtt.Client()
mqttc.connect("mqtt.eclipseprojects.io", 1883, 60)
mqttc.loop_start()
while True:
    try:
        cpu = psutil.cpu_percent()
        tmp = get_temperature()
        if cpu is None or tmp is None:
            time.sleep(2)
            continue
        now = datetime.datetime.now()
        dt = now.replace(microsecond=0)
        print(dt)
        print('Temperature: {0:0.1f} C'.format(tmp))
```