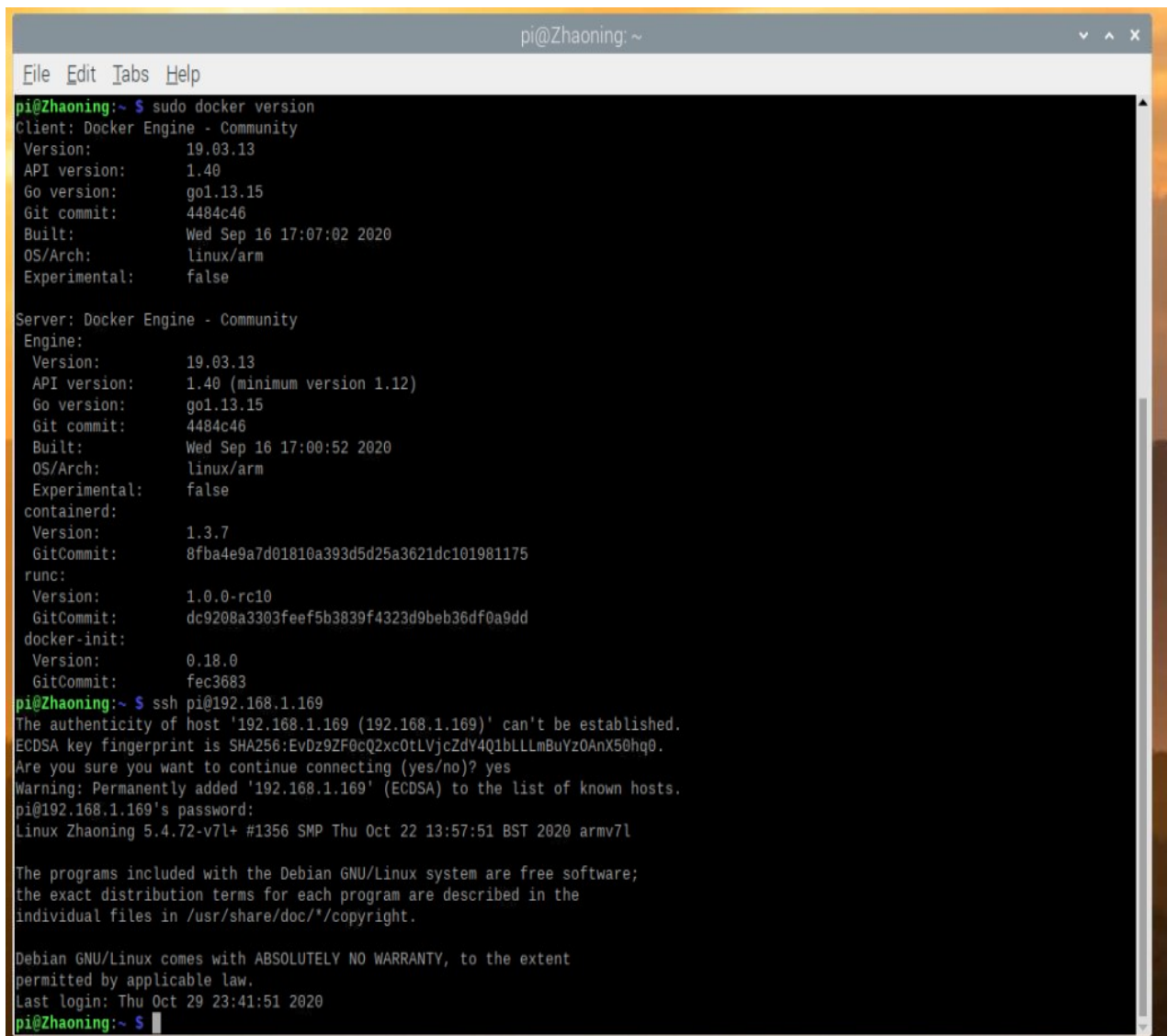


Lab 5A: Crossbar.io

Install Docker on a Raspberry Pi

Add pi to the Docker Group as a non-root user (Control-d to logout and reconnect via SSH for this to take effect)

A terminal window titled 'pi@Zhaoning: ~' with a menu bar (File, Edit, Tabs, Help). The user runs 'sudo docker version', displaying client and server information for Docker Engine - Community. Then, the user runs 'ssh pi@192.168.1.169', showing a warning about the host's authenticity and a successful login to a Raspberry Pi running Linux Zhaoning 5.4.72-v7l+.

```
pi@Zhaoning:~ $ sudo docker version
Client: Docker Engine - Community
 Version:           19.03.13
 API version:       1.40
 Go version:        go1.13.15
 Git commit:        4484c46
 Built:             Wed Sep 16 17:07:02 2020
 OS/Arch:           linux/arm
 Experimental:      false

Server: Docker Engine - Community
 Engine:
  Version:           19.03.13
  API version:       1.40 (minimum version 1.12)
  Go version:        go1.13.15
  Git commit:        4484c46
  Built:             Wed Sep 16 17:00:52 2020
  OS/Arch:           linux/arm
  Experimental:      false
 containerd:
  Version:           1.3.7
  GitCommit:         8fba4e9a7d01810a393d5d25a3621dc101981175
 runc:
  Version:           1.0.0-rc10
  GitCommit:         dc9208a3303feef5b3839f4323d9beb36df0a9dd
 docker-init:
  Version:           0.18.0
  GitCommit:         fec3683
pi@Zhaoning:~ $ ssh pi@192.168.1.169
The authenticity of host '192.168.1.169 (192.168.1.169)' can't be established.
ECDSA key fingerprint is SHA256:EvDz9ZF0cQ2xc0tLVjcZdY4Q1bLLLmBuYz0AnX50hq0.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '192.168.1.169' (ECDSA) to the list of known hosts.
pi@192.168.1.169's password:
Linux Zhaoning 5.4.72-v7l+ #1356 SMP Thu Oct 22 13:57:51 BST 2020 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Thu Oct 29 23:41:51 2020
pi@Zhaoning:~ $
```

Run Docker images designed to work on ARM under the prefix armhf

```
pi@Zhaoning: ~  
File Edit Tabs Help  
11 12 13 14 15 16 17 15 16 17 18 19 20 21 13 14 15 16 17 18 19  
18 19 20 21 22 23 24 22 23 24 25 26 27 28 20 21 22 23 24 25 26  
25 26 27 28 29 30 31 29 30 27 28 29 30 31  
  
/ # busybox  
BusyBox v1.25.1 (2016-10-25 18:12:18 GMT) multi-call binary.  
BusyBox is copyrighted by many authors between 1998-2015.  
Licensed under GPLv2. See source distribution for detailed  
copyright notices.  
  
Usage: busybox [function [arguments]...]  
or: busybox --list[-full]  
or: busybox --install [-s] [DIR]  
or: function [arguments]...  
  
BusyBox is a multi-call binary that combines many common Unix  
utilities into a single executable. Most people will create a  
link to busybox for each function they wish to use and BusyBox  
will act like whatever it was invoked as.  
  
Currently defined functions:  
[, [[, acpid, add-shell, addgroup, adduser, adjtimex, arp, arping, ash, awk, base64, basename, bbconfig, beep, blkdiscard,  
blkid, blockdev, brctl, bunzip2, bzip2, cal, cat, catv, chgrp, chmod, chown, chpasswd, chroot, chvt, cksu, clear,  
cmp, comm, conspy, cp, cpio, crond, crontab, cryptpw, cut, date, dc, dd, deallocvt, delgroup, deluser, depmod, df, diff,  
dirname, dmesg, dnsd, dnsdomainname, dos2unix, du, dumpkmap, dumpleases, echo, ed, egrep, eject, env, ether-wake, expand,  
expr, fakeidentd, false, fatattr, fbset, fbsplash, fdflush, fdformat, fdisk, fgrep, find, findfs, flock, fold, free, fsck,  
fstirm, fsync, ftpd, ftpget, ftpput, fuser, getopt, getty, grep, groups, gunzip, gzip, halt, hd, hdparm, head, hexdump,  
hostid, hostname, httpd, hwclock, id, ifconfig, ifdown, ifenslave, ifup, inetd, init, inotifyd, insmod, install, ionice,  
iostat, ip, ipaddr, ipcalc, ipcrm, ipcs, iplink, iproute, iprule, iptunnel, kbd_mode, kill, killall, killall5, klogd,  
less, ln, loadfont, loadkmap, logger, login, logread, losetup, ls, lsmod, lsof, lspci, lsusb, lzcat, lzma, lzop, lzopcat,  
makemime, md5sum, mdev, msg, microcom, mkdir, mkdosfs, mkfifo, mkfs.vfat, mknod, mkpasswd, mkswap, mktemp, modinfo,  
modprobe, more, mount, mountpoint, mpstat, mv, nameif, nanddump, nandwrite, nbd-client, nc, netstat, nice, nmeter, nohup,  
nologin, nsenter, nslookup, ntpd, od, openvt, passwd, patch, pgrep, pidof, ping, ping6, pipe_progress, pkill, pmap,  
poweroff, powertop, printenv, printf, ps, pscan, pstree, pwd, pwdx, raidautorun, rdate, rdev, readahead, readlink,  
readprofile, realpath, reboot, reformime, remove-shell, renice, reset, resize, rev, rfcill, rm, rmdir, rmmid, route,  
run-parts, sed, sendmail, seq, setconsole, setfont, setkeycodes, setlogcons, setserial, setsid, sh, shasum, sha256sum,  
sha3sum, sha512sum, showkey, shuf, slattach, sleep, smemcap, sort, split, stat, strings, stty, su, sum, swapoff, swapon,  
switch_root, sync, sysctl, syslogd, tac, tail, tar, tee, telnet, test, tftp, time, timeout, top, touch, tr, traceroute,  
traceroute6, true, truncate, tty, ttysize, tuncctl, udhcpc, udhcpc6, udhcpd, umount, uname, unexpand, uniq, unix2dos,  
unlink, unlzma, unlzop, unshare, unxz, unzip, uptime, usleep, uuencode, vconfig, vi, vlock, volname, watch,  
watchdog, wc, wget, which, whoami, whois, xargs, xzcat, yes, zcat  
  
/ # exit  
pi@Zhaoning:~ $
```

Build and run new image from Dockerfile

```
pi@Zhaoning: ~/iot
File Edit Tabs Help
Reading state information...
ca-certificates is already the newest version (20200601-deb10u1).
curl is already the newest version (7.64.0-4+deb10u1).
0 upgraded, 0 newly installed, 0 to remove and 6 not upgraded.
Removing intermediate container 744a4c439e9e
--> 1ce4f7c297dd
Step 4/4 : CMD ["curl", "https://docker.com"]
--> Running in 4e2d54ccb094
Removing intermediate container 4e2d54ccb094
--> 3ca8c66935c0
Successfully built 3ca8c66935c0
Successfully tagged curl_docker:latest
pi@Zhaoning:~/iot $ docker run curl_docker
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           %             %             Dload  Upload   Total   Spent    Left   Speed
0          0          0     0      0      0     0      0      0      0  --:--:-- --:--:-- --:--:--    0
curl: (60) SSL certificate problem: unable to get local issuer certificate
More details here: https://curl.haxx.se/docs/sslcerts.html

curl failed to verify the legitimacy of the server and therefore could not
establish a secure connection to it. To learn more about this situation and
how to fix it, please visit the web page mentioned above.
pi@Zhaoning:~/iot $ docker images
REPOSITORY          TAG             IMAGE ID        CREATED         SIZE
curl_docker         latest          3ca8c66935c0   24 seconds ago  141MB
balenalib/rpi-raspbian  latest         bf0dbae8619b   3 days ago     111MB
armhf/alpine        latest         15ed6d4bf10d   3 years ago     3.6MB
pi@Zhaoning:~/iot $ docker run -it balenalib/rpi-raspbian /bin/sh
# cat /etc/os-release
PRETTY_NAME="Raspbian GNU/Linux 10 (buster)"
NAME="Raspbian GNU/Linux"
VERSION_ID="10"
VERSION="10 (buster)"
VERSION_CODENAME=buster
ID=raspbian
ID_LIKE=debian
HOME_URL="http://www.raspbian.org/"
SUPPORT_URL="http://www.raspbian.org/RaspbianForums"
BUG_REPORT_URL="http://www.raspbian.org/RaspbianBugs"
# pwd
/
# ls
bin boot dev etc home lib media mnt opt proc root run sbin srv sys tmp usr var
#
```

Run Crossbar.io router on Terminal 1

```
pi@Zhaoning: ~/iot/crossbar-examples/getting-started
File Edit Tabs Help
2020-11-07T00:02:05+0000 [control:145] 2 New node key pair generated! Public key is 0x00b0b05001d5523a4070127a50e7ff60373ba470eccc42007c142b3e2a6093
2020-11-07T00:02:05+0000 [control:145] 2 File permissions on node private key fixed
2020-11-07T00:02:05+0000 [control:145] 2 Node key loaded from /node/.crossbar/key.priv
2020-11-07T00:02:05+0000 [control:145] 2 Node configuration loaded [config_source=localfile, config_path=/node/.crossbar/config.json]
2020-11-07T00:02:05+0000 [control:145] 2 Entering event reactor ...
2020-11-07T00:02:05+0000 [control:145] 2 Starting node ... [crossbar node node Node.start]
2020-11-07T00:02:05+0000 [control:145] 2 Node ID 20207002232cf-1 set from hostname/pid
2020-11-07T00:02:05+0000 [control:145] 2 RouterFactory.start_realm: router created for realm "crossbar"
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar node node Node.add_global_role> node-wide role "controller" added on node management router realm "crossbar"
2020-11-07T00:02:05+0000 [control:145] 2 attached session 4939532251345341 to realm "crossbar" [authid="serviceagent", authrole="trusted"] <crossbar.router.router.Router.attach>
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar router.service.RouterServiceAgent.onJoin>: realm service session attached to realm "crossbar" [session_id=4939532251345341, authid="serviceagent", authrole="trusted", on_ready
None]
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar node node Node.start> router service agent session attached [crossbar.router.service.RouterServiceAgent]
2020-11-07T00:02:05+0000 [control:145] 2 attached session 001402074702049 to realm "crossbar" [authid="nodecontroller", authrole="controller"] <crossbar.router.router.Router.attach>
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar node controller.NodeController.onJoin>: joined realm="crossbar" on local node management router [authid="nodecontroller", authrole="controller"]
2020-11-07T00:02:05+0000 [control:145] 2 Signal handler installed on process 1 thread 3069382672
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar node node Node.start> node controller session attached [crossbar node controller.NodeController]
2020-11-07T00:02:05+0000 [control:145] 2 Using default node shutdown triggers ['shutdown_on_worker_exit']
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar node node Node.boot>: NODE_BOOT_BEGIN
2020-11-07T00:02:05+0000 [control:145] 2 Booting node <crossbar node node Node.boot>
2020-11-07T00:02:05+0000 [control:145] 2 Will start 1 worker ...
2020-11-07T00:02:05+0000 [control:145] 2 Order mode to start "Router worker001" ...
2020-11-07T00:02:05+0000 [control:145] 2 Starting router-worker "worker001" ... <crossbar node controller.NodeController.start_worker>
2020-11-07T00:02:05+0000 [control:145] 2 worker-specific role "crossbar.worker.worker001" added on node management router realm "crossbar" <crossbar node node Node._add_worker_role>
2020-11-07T00:02:05+0000 [control:145] 2 Starting router-worker "worker001" on node "20207002232cf-1" (personality "standalone") and local node management realm "crossbar" ... <crossbar.worker.router.RouterController>
2020-11-07T00:02:05+0000 [control:145] 2 Running as PID 9 on CPython/EpollReactor
2020-11-07T00:02:05+0000 [control:145] 2 Entering event reactor ...
2020-11-07T00:02:05+0000 [control:145] 2 attached session 11622204022045 to realm "crossbar" [authid="crossbar.process.9", authrole="crossbar.worker.worker001"] <crossbar.router.router.Router.attach>
2020-11-07T00:02:05+0000 [control:145] 2 Router worker session for "worker001" joined realm "crossbar" on node router <crossbar.worker.router.RouterController.onJoin>
2020-11-07T00:02:05+0000 [control:145] 2 Router worker session for "worker001" ready
2020-11-07T00:02:05+0000 [control:145] 2 OK, node has started Router worker001
2020-11-07T00:02:05+0000 [control:145] 2 Configuring Router worker001
2020-11-07T00:02:05+0000 [control:145] 2 Order Router worker001 to start Realm realm001
2020-11-07T00:02:05+0000 [control:145] 2 Starting router realm realm001 <crossbar.worker.router.RouterController.start_router_realm>
2020-11-07T00:02:05+0000 [control:145] 2 RouterFactory.start_realm: router created for realm "realm1"
2020-11-07T00:02:05+0000 [control:145] 2 attached session 700184700062723 to realm "realm1" [authid="routerworker-worker001-realm.realm001-serviceagent", authrole="trusted"] <crossbar.router.router.Router.attach>
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar router.service.RouterServiceAgent.onJoin>: realm service session attached to realm "realm1" [session_id=700184700062723, authid="routerworker-worker001-realm.realm001-service
agent", authrole="trusted", on_ready=Deferred at 0xb3bc730b]
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar worker.router.RouterController.set_service_session>(session=crossbar.router.service.RouterServiceAgent object at 0xb3bc730b, realm="realm1", authrole="trusted")
2020-11-07T00:02:05+0000 [control:145] 2 RouterServiceAgent started on realm="realm1" with authrole="trusted", authid="routerworker-worker001-realm.realm001-serviceagent"
2020-11-07T00:02:05+0000 [control:145] 2 Realm "realm001" (name="realm1", authrole="trusted", authid="routerworker-worker001-realm.realm001-serviceagent") started
2020-11-07T00:02:05+0000 [control:145] 2 OK, Router worker001 has started Realm realm001
2020-11-07T00:02:05+0000 [control:145] 2 Order Realm realm001 to start Role role001
2020-11-07T00:02:05+0000 [control:145] 2 Role role001 named "anonymous" started on realm "realm1"
2020-11-07T00:02:05+0000 [control:145] 2 OK, Realm realm001 has started Role role001
2020-11-07T00:02:05+0000 [control:145] 2 Order Router worker001 to start Transport transport001
2020-11-07T00:02:05+0000 [control:145] 2 Starting router transport transport001 <crossbar.worker.router.RouterController.start_router_transport>
2020-11-07T00:02:05+0000 [control:145] 2 Creating router transport for "transport001"
2020-11-07T00:02:05+0000 [control:145] 2 Router transport created for "transport001" [transport_class=crossbar.worker.transport.RouterWebTransport]
2020-11-07T00:02:05+0000 [control:145] 2 Created "static" Web service on root path "/" of Web transport "transport001"
2020-11-07T00:02:05+0000 [control:145] 2 Site starting on 8080
2020-11-07T00:02:05+0000 [control:145] 2 Router TCP/8080 transport started as transport "transport001" and listening on TCP port 8080
2020-11-07T00:02:05+0000 [control:145] 2 OK, Router worker001 has started Transport transport001
2020-11-07T00:02:05+0000 [control:145] 2 Order Transport transport001 to start Web Service webservice001
2020-11-07T00:02:05+0000 [control:145] 2 Starting "nodeinfo" Web service on path "/info" of transport "transport001" <crossbar.worker.transport.TransportController.start_web_transport_service>
2020-11-07T00:02:05+0000 [control:145] 2 OK, Transport transport001 has started Web Service webservice001
2020-11-07T00:02:05+0000 [control:145] 2 Order Transport transport001 to start Web Service webservice002
2020-11-07T00:02:05+0000 [control:145] 2 Starting "websocket" Web service on path "/ws" of transport "transport001" <crossbar.worker.transport.TransportController.start_web_transport_service>
2020-11-07T00:02:05+0000 [control:145] 2 OK, Transport transport001 has started Web Service webservice002
2020-11-07T00:02:05+0000 [control:145] 2 OK, worker "Router worker001" configured and ready!
2020-11-07T00:02:05+0000 [control:145] 2 OK, local node configuration ran successfully
2020-11-07T00:02:05+0000 [control:145] 2 <crossbar node node Node.boot>: NODE_BOOT_COMPLETE
```

Run publish-client on Terminal 2

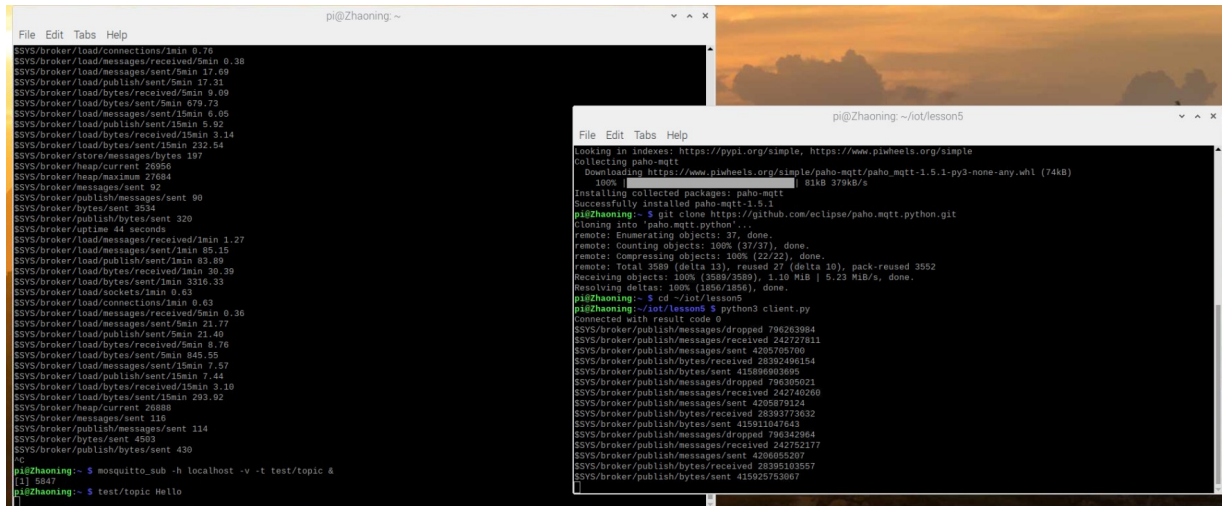
```
pi@Zhaoning: ~/crossbar-examples/getting-started/1.hello-world
File Edit Tabs Help
pi@Zhaoning:~ $ cd crossbar-examples/getting-started/1.hello-world/
pi@Zhaoning:~/crossbar-examples/getting-started/1.hello-world $ python3 client_component_publish.py
ws://localhost:8080/ws realm1
2020-11-07T19:20:28-0500 Starting factory <autobahn.twisted.websocket.WampWebSocketClientFactory object at 0xb5326c30>
2020-11-07T19:20:28-0500 session ready
```

Run subscribe-client on Terminal 3

```
pi@Zhaoning: ~/crossbar-examples/getting-started/1.hello-world
File Edit Tabs Help
pi@Zhaoning:~ $ cd crossbar-examples/getting-started/1.hello-world/
pi@Zhaoning:~/crossbar-examples/getting-started/1.hello-world $ python3 client_component_subscribe.py
2020-11-07T19:22:05-0500 Starting factory <autobahn.twisted.websocket.WampWebSocketClientFactory object at 0xb5f226f0>
2020-11-07T19:22:06-0500 session ready
2020-11-07T19:22:06-0500 subscribed to topic
```


Lab 5B: Eclipse Mosquitto and Eclipse Paho

Publish "Hello" on another terminal

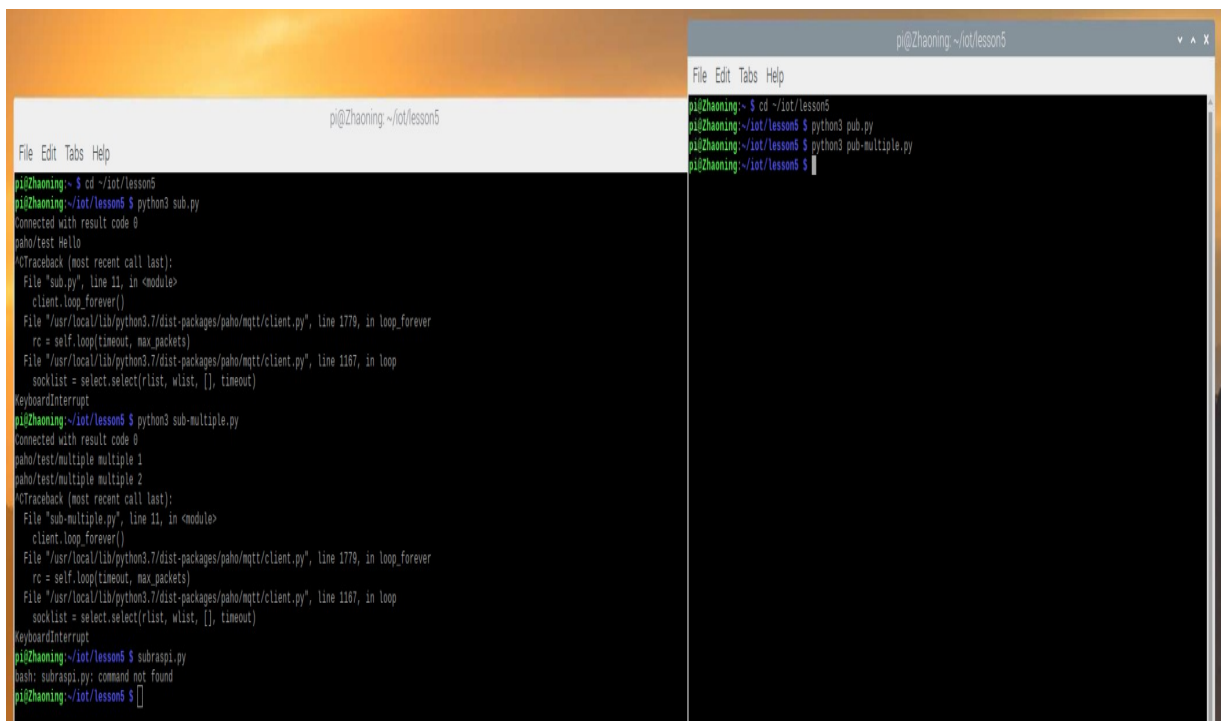


The image shows two terminal windows. The left window, titled 'pi@Zhaoning: ~', displays real-time statistics for an MQTT broker. The right window, titled 'pi@Zhaoning: ~/iot/lesson5', shows the process of installing the Eclipse Paho MQTT Python client. It includes commands to clone the GitHub repository, install dependencies, and run a test script.

```
pi@Zhaoning: ~  
SSYS/broker/load/connections/1min 0.76  
SSYS/broker/load/messages/received/5min 0.38  
SSYS/broker/load/messages/sent/5min 17.69  
SSYS/broker/load/publish/sent/5min 17.51  
SSYS/broker/load/bytes/received/5min 9.09  
SSYS/broker/load/bytes/sent/5min 679.73  
SSYS/broker/load/messages/received/15min 6.05  
SSYS/broker/load/publish/sent/15min 5.12  
SSYS/broker/load/bytes/received/15min 3.14  
SSYS/broker/load/bytes/sent/15min 232.54  
SSYS/broker/store/messages/bytes 197  
SSYS/broker/heap/current 26956  
SSYS/broker/heap/maximum 27684  
SSYS/broker/messages/sent 92  
SSYS/broker/publish/messages/sent 90  
SSYS/broker/bytes/sent 2534  
SSYS/broker/publish/bytes/sent 320  
SSYS/broker/uptime 44 seconds  
SSYS/broker/load/messages/received/1min 1.27  
SSYS/broker/load/messages/sent/1min 85.15  
SSYS/broker/load/publish/sent/1min 83.89  
SSYS/broker/load/bytes/received/1min 30.39  
SSYS/broker/load/bytes/sent/1min 3316.33  
SSYS/broker/load/sockets/1min 0.63  
SSYS/broker/load/connections/1min 0.63  
SSYS/broker/load/messages/received/5min 0.36  
SSYS/broker/load/messages/sent/5min 21.77  
SSYS/broker/load/publish/sent/5min 21.40  
SSYS/broker/load/bytes/received/5min 8.76  
SSYS/broker/load/bytes/sent/5min 845.56  
SSYS/broker/load/messages/sent/15min 7.57  
SSYS/broker/load/publish/sent/15min 7.44  
SSYS/broker/load/bytes/received/15min 3.10  
SSYS/broker/load/bytes/sent/15min 293.92  
SSYS/broker/heap/current 26888  
SSYS/broker/messages/sent 116  
SSYS/broker/publish/messages/sent 114  
SSYS/broker/bytes/sent 4593  
SSYS/broker/publish/bytes/sent 430  
^C  
pi@Zhaoning:~$ mosquitto_sub -h localhost -v -t test/topic &  
[1] test  
pi@Zhaoning:~$ test/topic Hello
```

```
pi@Zhaoning: ~/iot/lesson5  
Looking in indexes: https://pypi.org/simple, https://www.piwheels.org/simple  
Collecting paho-mqtt  
  Downloading https://www.piwheels.org/simple/paho-mqtt/paho-mqtt-1.5.1-py3-none-any.whl (74kB)  
    100% |#####| 81kB 379kB/s  
Installing collected packages: paho-mqtt  
Successfully installed paho-mqtt-1.5.1  
pi@Zhaoning:~$ git clone https://github.com/eclipse/paho.mqtt.python.git  
Cloning into 'paho-mqtt-python'...  
remote: Enumerating objects: 37, done.  
remote: Counting objects: 100% (37/37), done.  
remote: Compressing objects: 100% (22/22), done.  
remote: Total 3589 (delta 13), reused 27 (delta 10), pack-reused 3552  
Receiving objects: 100% (3589/3589), 1.10 MiB | 5.23 MiB/s, done.  
Resolving deltas: 100% (1866/1866), done.  
pi@Zhaoning:~$ cd ~/iot/lesson5  
pi@Zhaoning:~/iot/lesson5$ python3 client.py  
Connected with result code 0  
SSYS/broker/publish/messages/dropped 706263984  
SSYS/broker/publish/messages/received 242727811  
SSYS/broker/publish/messages/sent 4295705700  
SSYS/broker/publish/bytes/received 28302460154  
SSYS/broker/publish/bytes/sent 415896903695  
SSYS/broker/publish/messages/dropped 706305021  
SSYS/broker/publish/messages/received 242740260  
SSYS/broker/publish/messages/sent 4295879124  
SSYS/broker/publish/bytes/received 283372632  
SSYS/broker/publish/bytes/sent 415911047643  
SSYS/broker/publish/messages/dropped 706342964  
SSYS/broker/publish/messages/received 242752177  
SSYS/broker/publish/messages/sent 4296055207  
SSYS/broker/publish/bytes/received 28305103557  
SSYS/broker/publish/bytes/sent 415925753807
```

Terminal 1 & 2



The image shows two terminal windows. The left window, titled 'pi@Zhaoning: ~/iot/lesson5', shows a subscriber script that receives the 'Hello' message. The right window, titled 'pi@Zhaoning: ~/iot/lesson5', shows a publisher script that sends the 'Hello' message.

```
pi@Zhaoning: ~/iot/lesson5  
File Edit Tabs Help  
pi@Zhaoning:~$ cd ~/iot/lesson5  
pi@Zhaoning:~/iot/lesson5$ python3 sub.py  
Connected with result code 0  
paho/test Hello  
^C  
Traceback (most recent call last):  
  File "sub.py", line 11, in <module>  
    client.loop_forever()  
  File "/usr/local/lib/python3.7/dist-packages/paho/mqtt/client.py", line 1779, in loop_forever  
    rc = self.loop(timeout, max_packets)  
  File "/usr/local/lib/python3.7/dist-packages/paho/mqtt/client.py", line 1167, in loop  
    socklist = select.select(rlist, wlist, [], timeout)  
KeyboardInterrupt  
pi@Zhaoning:~/iot/lesson5$ python3 sub-multiple.py  
Connected with result code 0  
paho/test/multiple multiple 1  
paho/test/multiple multiple 2  
^C  
Traceback (most recent call last):  
  File "sub-multiple.py", line 11, in <module>  
    client.loop_forever()  
  File "/usr/local/lib/python3.7/dist-packages/paho/mqtt/client.py", line 1779, in loop_forever  
    rc = self.loop(timeout, max_packets)  
  File "/usr/local/lib/python3.7/dist-packages/paho/mqtt/client.py", line 1167, in loop  
    socklist = select.select(rlist, wlist, [], timeout)  
KeyboardInterrupt  
pi@Zhaoning:~/iot/lesson5$ subraspi.py  
bash: subraspi.py: command not found  
pi@Zhaoning:~/iot/lesson5$
```

```
pi@Zhaoning: ~/iot/lesson5  
File Edit Tabs Help  
pi@Zhaoning:~$ cd ~/iot/lesson5  
pi@Zhaoning:~/iot/lesson5$ python3 pub.py  
pi@Zhaoning:~/iot/lesson5$ python3 pub-multiple.py  
pi@Zhaoning:~/iot/lesson5$
```