QEMU networking for MQTT on virtual RPis

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Instructions for QEMU networking for MQTT serving two RPis guests on Ubuntu

Prerequisites:

1. QEMU installed on an Ubuntu machine – this can be a real or virtual Ubuntu system
2. Two separate 64-bit Raspberry Pi OS Lite VMs, expanded size +10G
   a. Ensure Python3 are installed
   b. Use a Python venv on the RPis and use pip3 in the venv
3. Install Paho Mosquitto on both Raspberry Pis
4. On the RPis, clone Python libraries from
   a. https://github.com/wonder-phil/ChainsThatBindUs/tree/main/ch4
   b. https://github.com/wonder-phil/ChainsThatBindUs/blob/main/ch8/

Set up a user to start via the following QEMU commands on Ubuntu.

rpi1:

```
qemu-system-aarch64  -kernel Kernel64 -M virt  -cpu cortex-a72  \
-append "root=/dev/vda2 panic=1 rootfstype=ext4 rw" \
-drive "format=raw,file=RPILite-2024-07.img,if=none,index=0,media=disk,id=disk0" \
-device "virtio-blk-pci,drive=disk0"  \
-device "virtio-net-pci,netdev=net0" \
-netdev "user,id=net0,dhcpstart=10.0.2.15,hostfwd=tcp::5015-:22" \
-no-reboot
```

rpi2:

```
qemu-system-aarch64  -kernel Kernel64 -M virt  -cpu cortex-a72   \
-append "root=/dev/vda2 panic=1 rootfstype=ext4 rw" \
-drive "format=raw,file=RPILite-2024-07.img,if=none,index=0,media=disk,id=disk0" \
-device "virtio-blk-pci,drive=disk0"  \
-device "virtio-net-pci,netdev=net0" \
-netdev "user,id=net0,dhcpstart=10.0.2.16,hostfwd=tcp::5016-:22" \
-no-reboot
```

Note that we provide the starting addresses in the above commands instead of providing port mappings for SSH. rpi1 is running on 10.0.2.15 and rpi2 is running on 10.0.2.16 on their local private network. These RPIs interact with Ubuntu, the host OS, via the gateway IP address 10.0.2.2. This can be seen in the below diagram, pulled from QEMU's networking documentation:
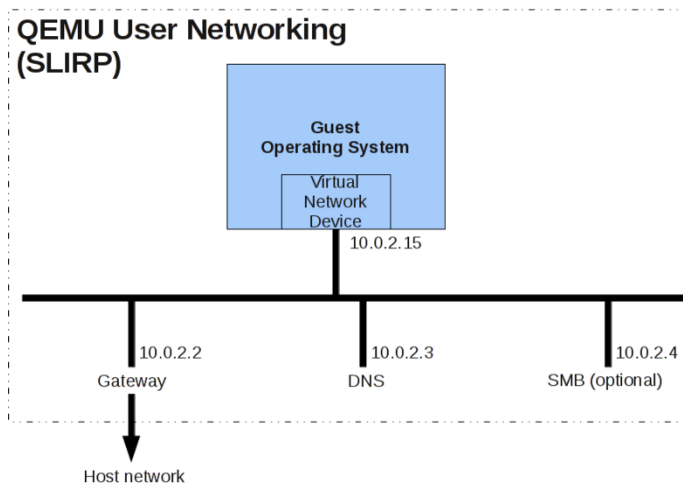

Image from https://wiki.qemu.org/Documentation/Networking

1. Install Mosquitto on both Ubuntu and within each Raspberry Pi. Run these two commands in each environment (total 3 times: on Ubuntu, on rpi1, on rp2). This may take a while on the RPIs.

   sudo apt update

   sudo apt install mosquitto mosquitto-clients

2. Verify that Mosquitto was successfully installed on each machine by trying the below command and verifying that an error, along with a typical 'help' output, is generated:

   mosquitto_sub

3. Test out pub/sub by in both directions. First, from rpi1 and/or rpi2, subscribe to the "test" topic, listening on IP 10.0.2.2 (the gateway IP to the host):

   mosquitto_sub -h 10.0.2.2 -t "test"

4. Publish a message from Ubuntu to the "test" topic on its own IP (localhost):

   mosquitto_pub -h localhost -t "test" -m "Hello World!"

   This should cause the message "Hello World" to appear in the RPI/s.

5. To test this in the other direction, cancel listening on one/both the RPIs with ^C. Begin listening on the host OS, Ubuntu's own IP (localhost), with the below command:

   mosquitto_sub -h localhost -t "test"

6. Publish a message from rpi1, to the "test" topic, to the host's IP (the 10.0.2.2 gateway):

   mosquitto_pub -h 10.0.2.2 -t "test" -m "Hello from rpi1

   This should cause the message "Hello from rpi1" to appear in the Ubuntu terminal.

7. Publish a message from rpi2, to the "test" topic, to the host's IP (the 10.0.2.2 gateway):

   mosquitto_pub -h 10.0.2.2 -t "test" -m "Hello from rpi2

   This should cause the message "Hello from rpi2" to appear in the Ubuntu terminal.