lab2 LoRaWAN通訊模組

物聯網概論

黃能富特聘教授
國立清華大學資訊工程系
E-mail: nfhuang@cs.nthu.edu.tw

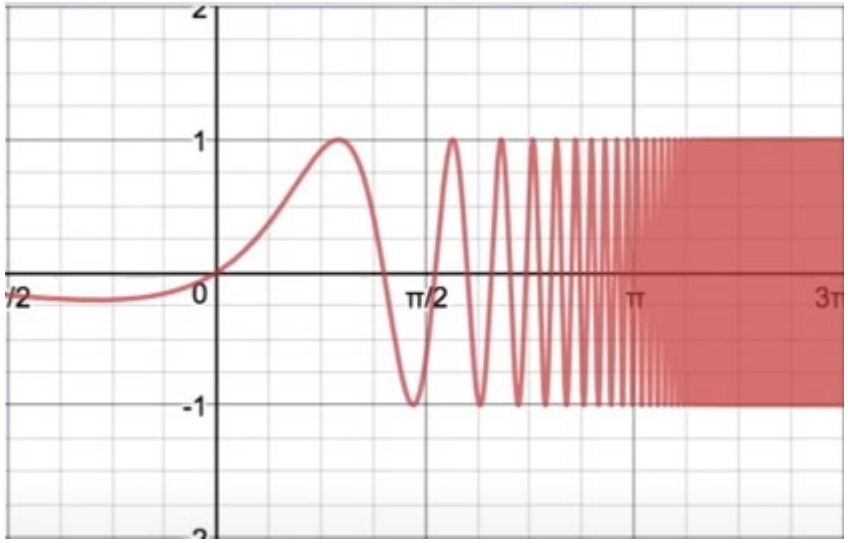
© (Verdana，14號字，粗體)

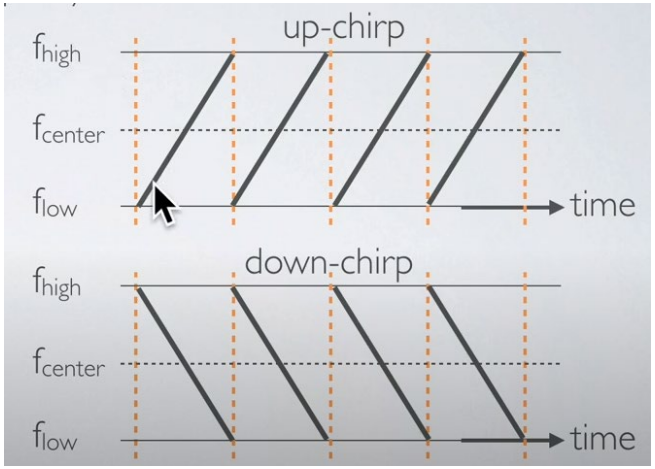
大綱

- LoRa & LoRaWAN review
- lab2-1:GL6509 通訊模組 AT command
- lab2-2: GL6509 uplink

LoRa

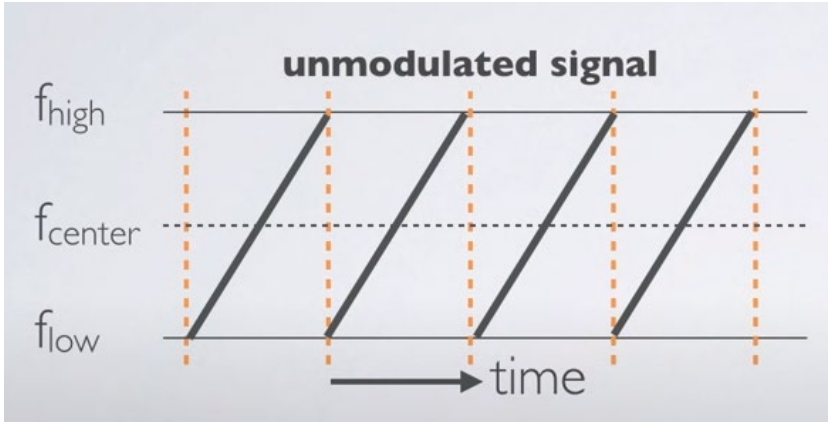
- 物理層通訊協議
- 使用chirp spread spectrum技術

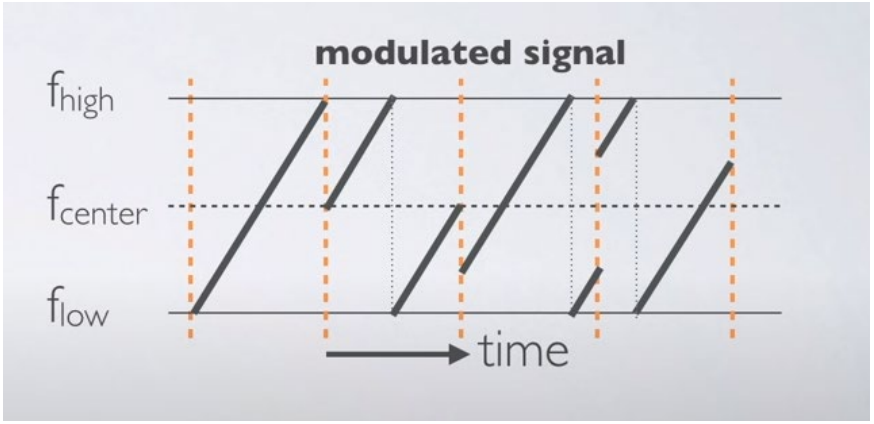




Chirp

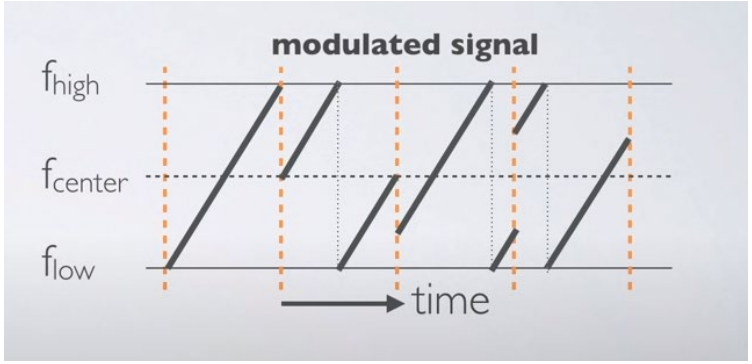
LoRa modulation





LoRa

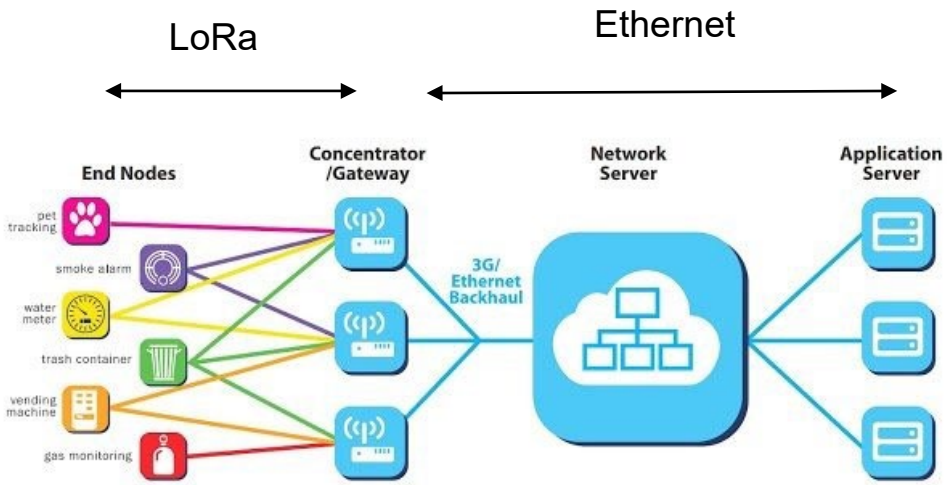
- 低功耗物理層通訊協議
- 使用chirp spread spectrum技術
- 重要參數:
  - frequency
  - bandwidth
  - spreading factor(SF)
  - coding rate(CR):傳輸來的資料中有多少是真正有用的



- Data rate(bit rate) = $SF * CR * \frac{BW}{2^{SF}}$
- SF越大,傳送的速度越慢
- SF越大,可以傳得越遠

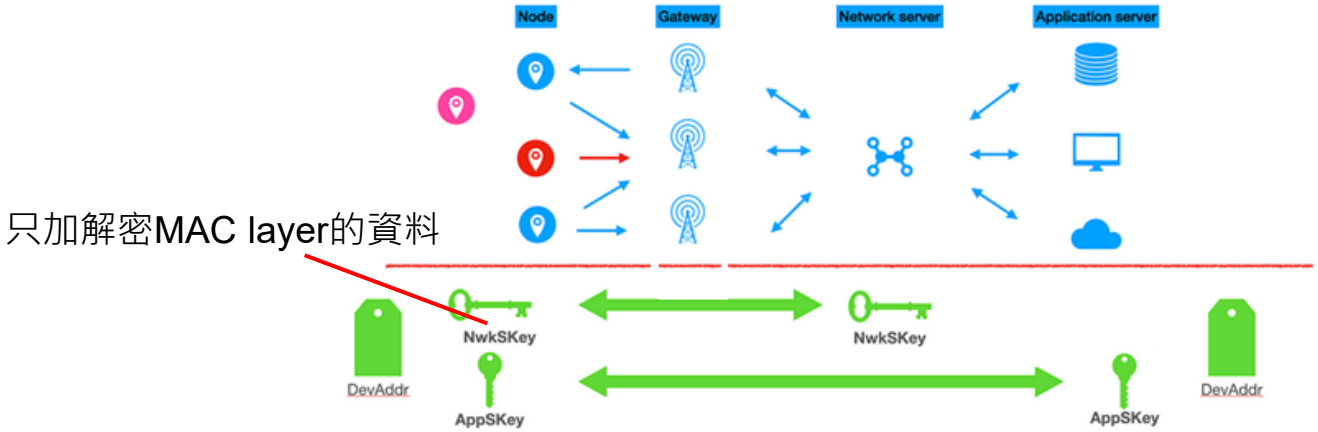
LoRaWAN

- 基於LoRa的LPWAN
- 由4個角色組成:
  - end node:透過LoRa傳送/接收訊息
  - gateway:同時具有Ethernet跟LoRa的連線功能
  - network server:處理重複上傳的數據、決定下行要由哪個gateway發送
  - application server



LoRaWAN 入網

- 在LoRaWAN中,需要DevAddr、 NwkSKey、 AppSKey來進行安全的通訊
  - DevAddr:每個end node的唯一識別符號
  - NwkSKey:與network server通訊的金鑰
  - AppSKey:與application server通訊的金鑰
- 通常用AES來加密

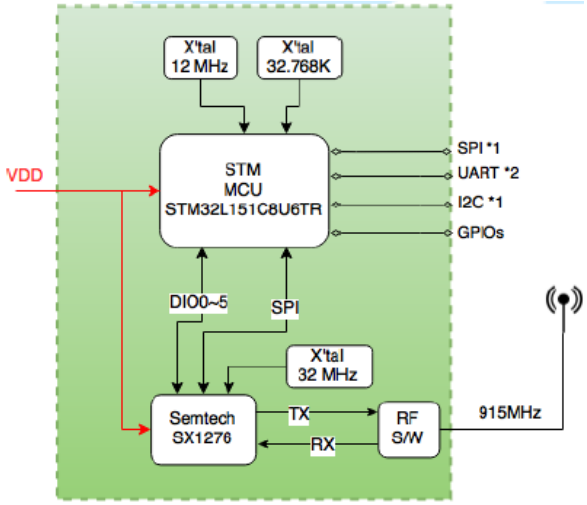


LoRaWAN 入網方式

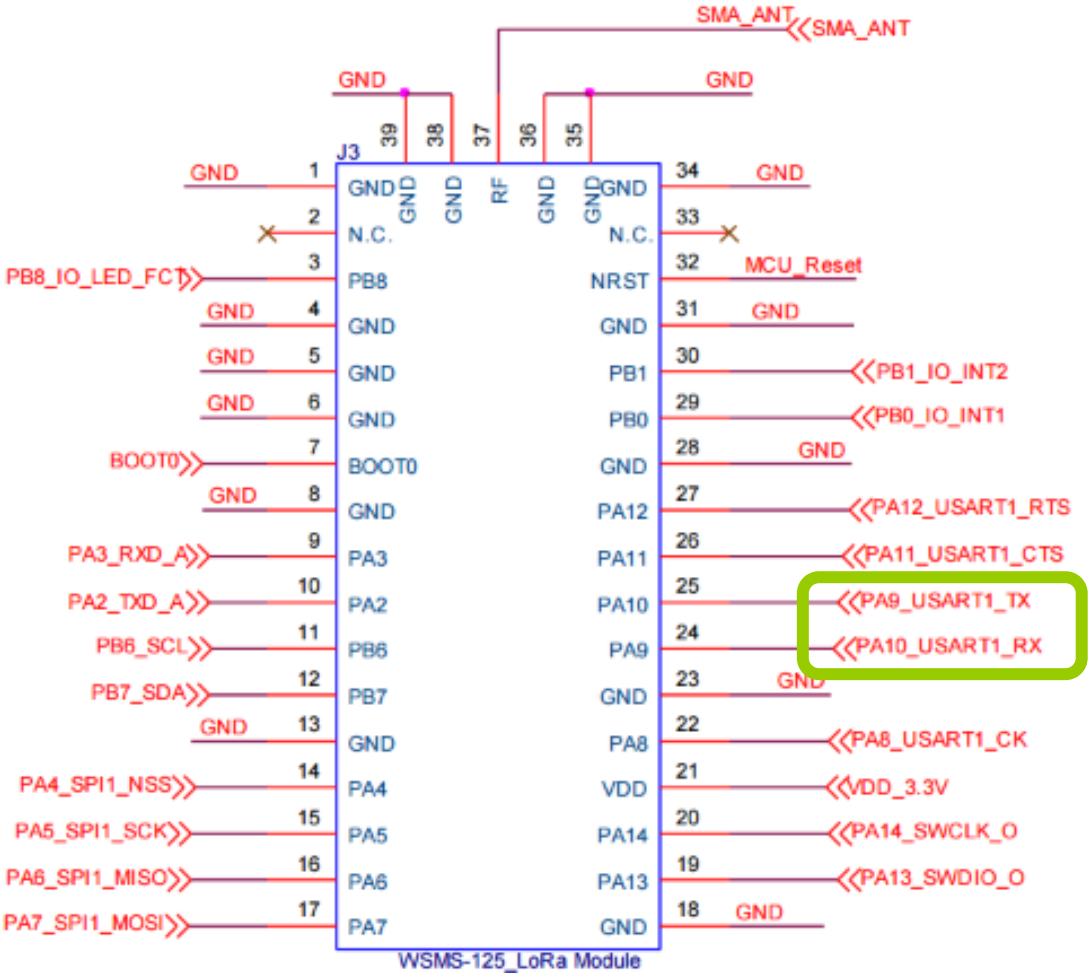
- Activation by personalized(ABP)
  - 寫死DevAddr、 NwkSKey、 AppSKey
- Over-The-Air Activation(OTAA)
  - 寫死DevEUI, APPEUI, APPKEY
  - 每次要連線前須先進行join動作, 動態產生此次連線的DevAddr、 NwkSKey、 AppSKey
  - 可以加入不同的LoRaWAN中
  - 安全性較高,可以每個sessio都使用不一樣的key

LoRa module-GL6509

- 操作環境
  - 3.3V 單電源供電
  - 操作溫度範圍: -40°C - 85°C
- 特性
  - 提供AT指令集配置
  - 可透過AT指令直接傳送資料進LoRaWAN
  - 介面:UART (reserve for UART*1, I2C*1, SPI*1)



LoRa 通訊模組 GL6509



觀看方向

腳位圖是將6509針腳朝下後從上面看下來!

AT command

- 一系列以AT開頭的命令
  - ？ 代表查詢指令
  - ＝ 代表設定相關指令
  - =？ 指令說明
- 若是有效指令且執行成功,會回傳OK及結果,反之會回傳ERROR
- 範例:
  - AT+CCLASS? 查詢class
  - AT+CCLASS=A 把class設定為A
  - AT+CCLASS=? 查詢這條指令可以接收的參數

command	AT+CCLASS?	AT+CCLASS=A	AT+CCLASS=?
result	+CCLASS:A OK	OK	+CCLASS=<A,B,C> OK

下達AT command

- 透過UART連接6509後,可以透過傳輸帶有AT開頭的字串給6509來對其下達指令

```
Serial1.println("AT&H");
```

- 6509收到命令後運行的結果也會透過UART傳送回來,可以透過UART read相關的程式碼來接收

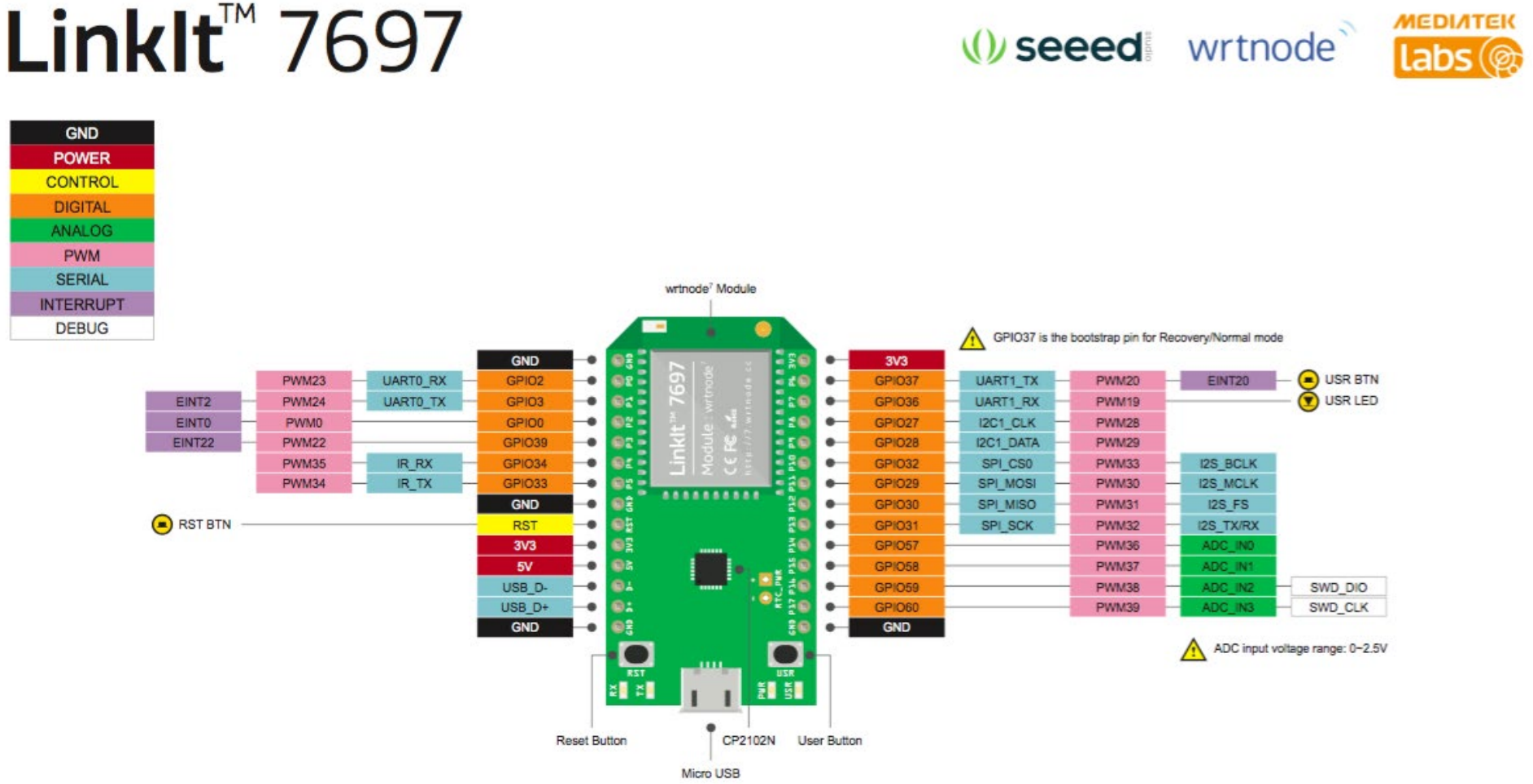
```
while(Serial1.available()){
  result+=(char) Serial.read();
}
```

- 6509常用指令:
  - AT&H :查看所有指令
  - ATZ :還原原廠設定
  - AT+CCLASS:class相關
  - AT+CAPPSKEY:appskey相關
  - AT+CNWKSKEY:nwkskey相關

lab 2-1

- task 1:將7697透過UART連接6509後,下AT command查看6509裡面的NwkSKey、 AppSKey
- task2:兩兩一組,使用6509的ping pong test功能(AT+CPT指令)來互相傳送測試訊息(其中一方當master,另一方當slave)
- Hint:
  - 可參考spec的15頁
  - master跟slave雙方要設定好相同的frequency,bandwidth,SF, code rate
  - 可使用的頻段(AS2)為
  - 使用完此指令請重新啟動6509(用ATZ指令)

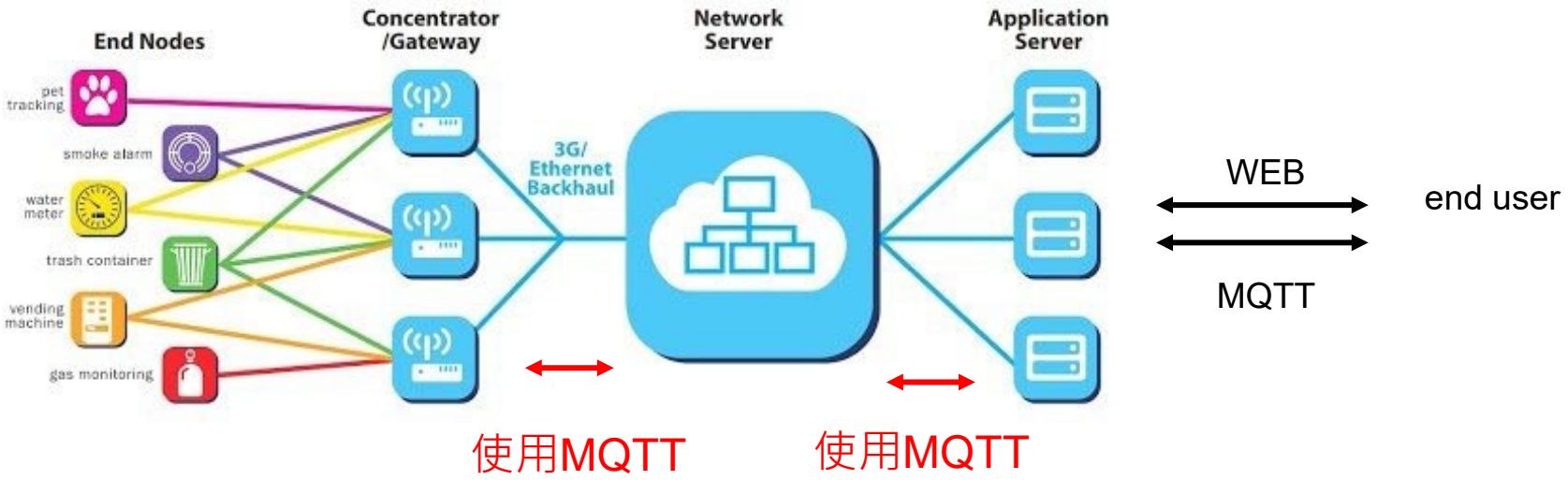
LinkIt 7697 腳位圖



lab2-1 result

```
RSSI =  -98, SNR=    8
RSSI =  -98, SNR=    7
RSSI =  -98, SNR=    6
RSSI =  -97, SNR=    8
RSSI =  -97, SNR=    6
RSSI =  -97, SNR=    7
RSSI =  -98, SNR=    7
100 packets including DONE message received in 3 seconds, now leaving TXPP mode.
```

LoRaWAN

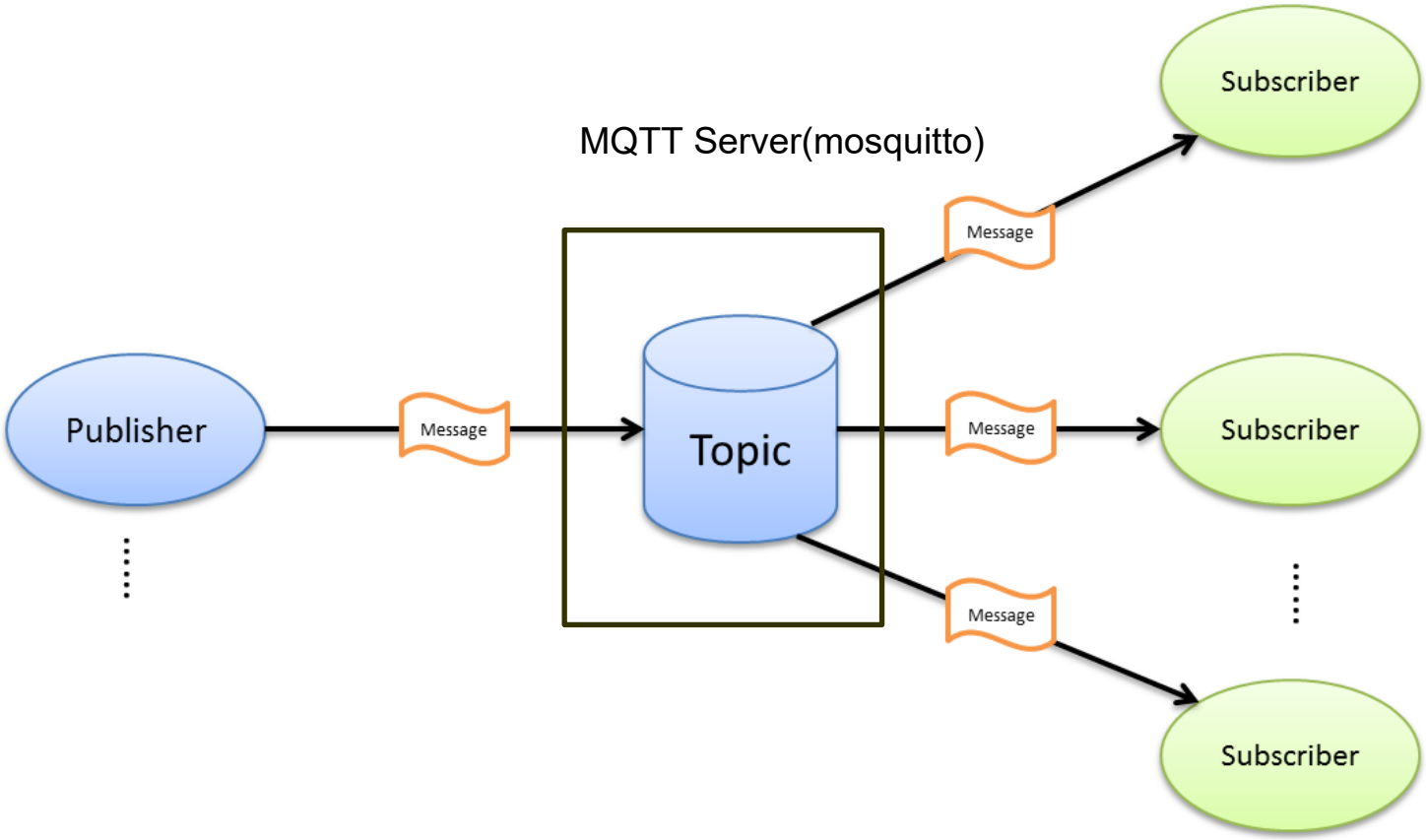

End Nodes
Concentrator /Gateway
Network Server
Application Server
pet tracking
smoke alarm
water meter
trash container
vending machine
gas monitoring
3G/ Ethernet Backhaul
WEB
MQTT
end user
使用MQTT
使用MQTT

MQTT

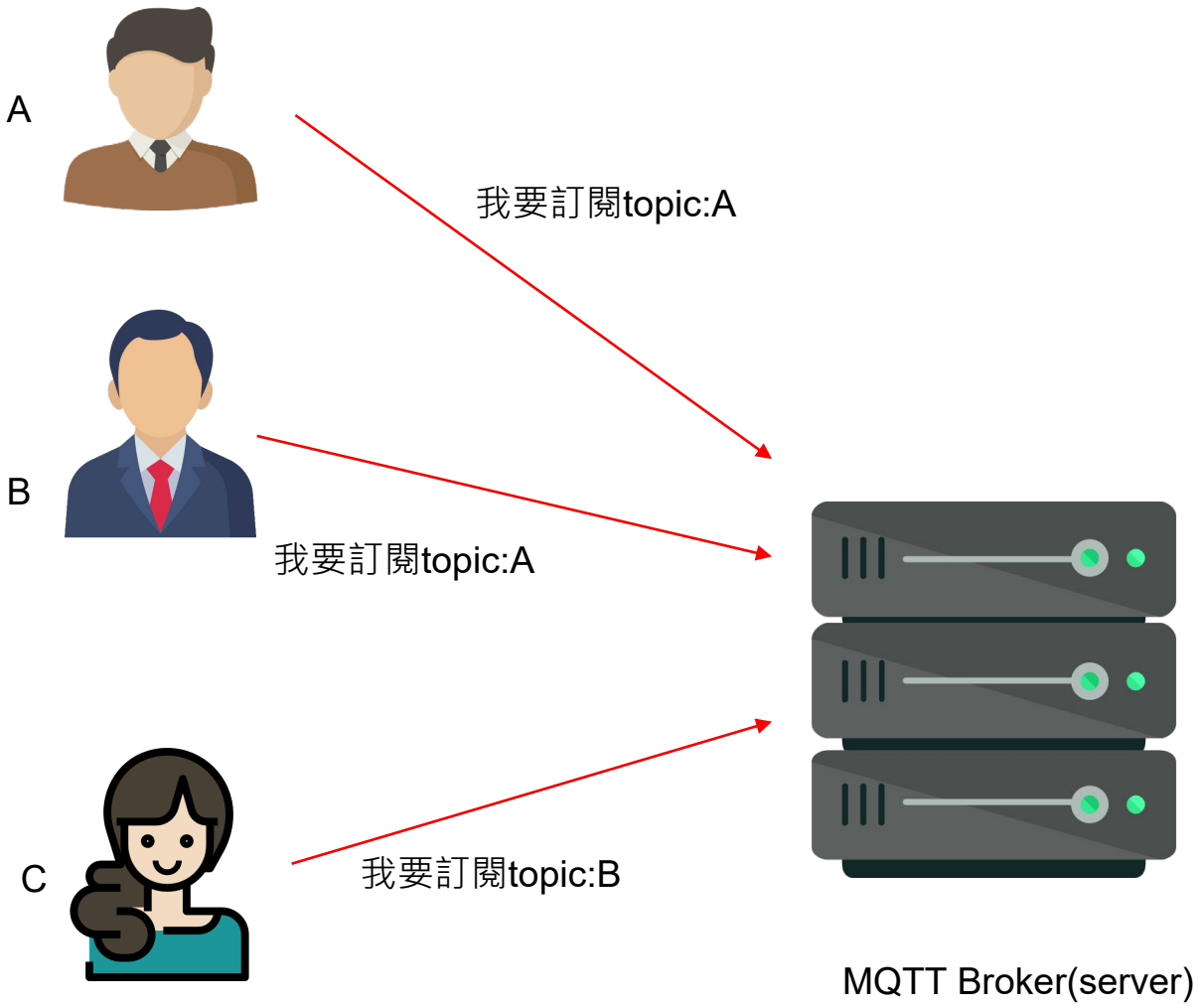
- MQTT(Message Queue Telemetry Transport)
- application layer protocol.
- 建立在TCP/IP 上的一種輕量化的
- 相較於 HTTP ，MQTT 的特色是可以快速回應、低耗電量、以及使用的heade較小(僅2 byte)

MQTT

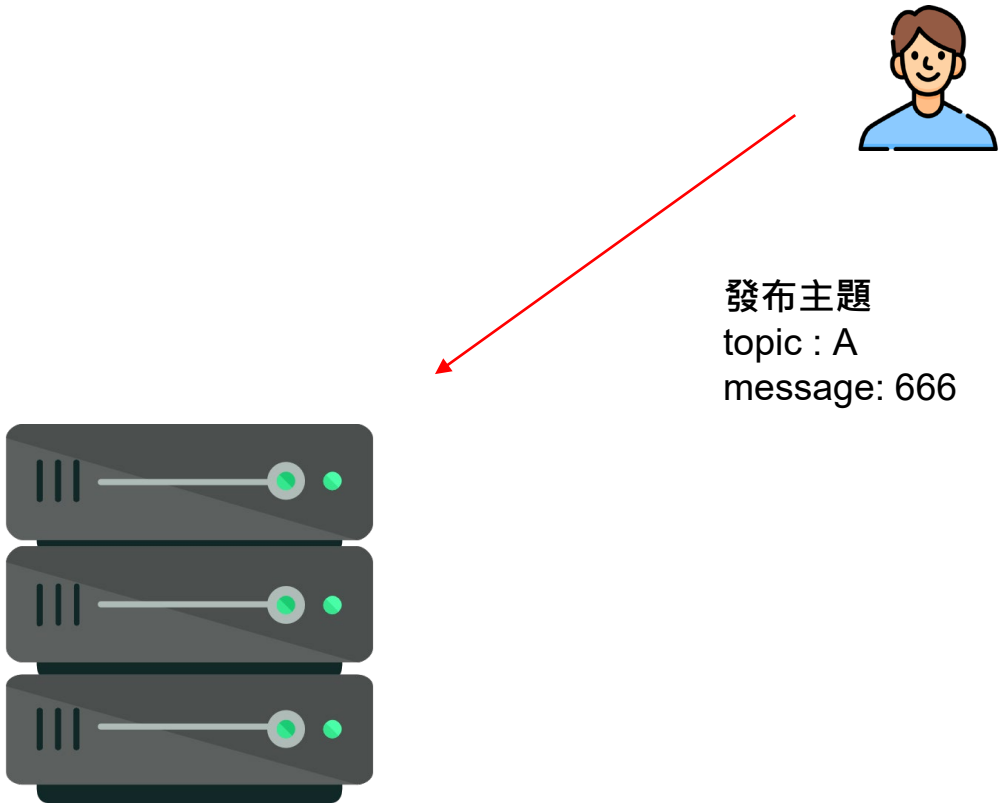
- 發佈者將訊息送至 Topic 平台，而 Topic 會將這個訊息送到所註冊的訂閱者



MQTT-subscribe



MQTT-publish



MQTT

A

訂閱topic:A

B

訂閱topic:A

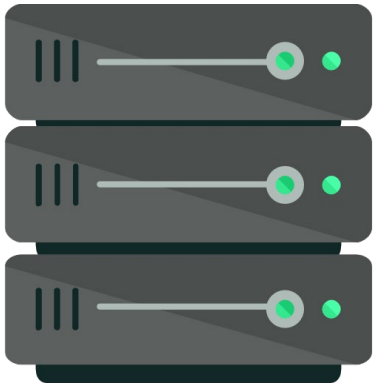
C

訂閱topic:B

有人發布主題
topic : A
message: 666

有人發布主題
topic : A
message: 666

發布主題
topic : A
message: 666



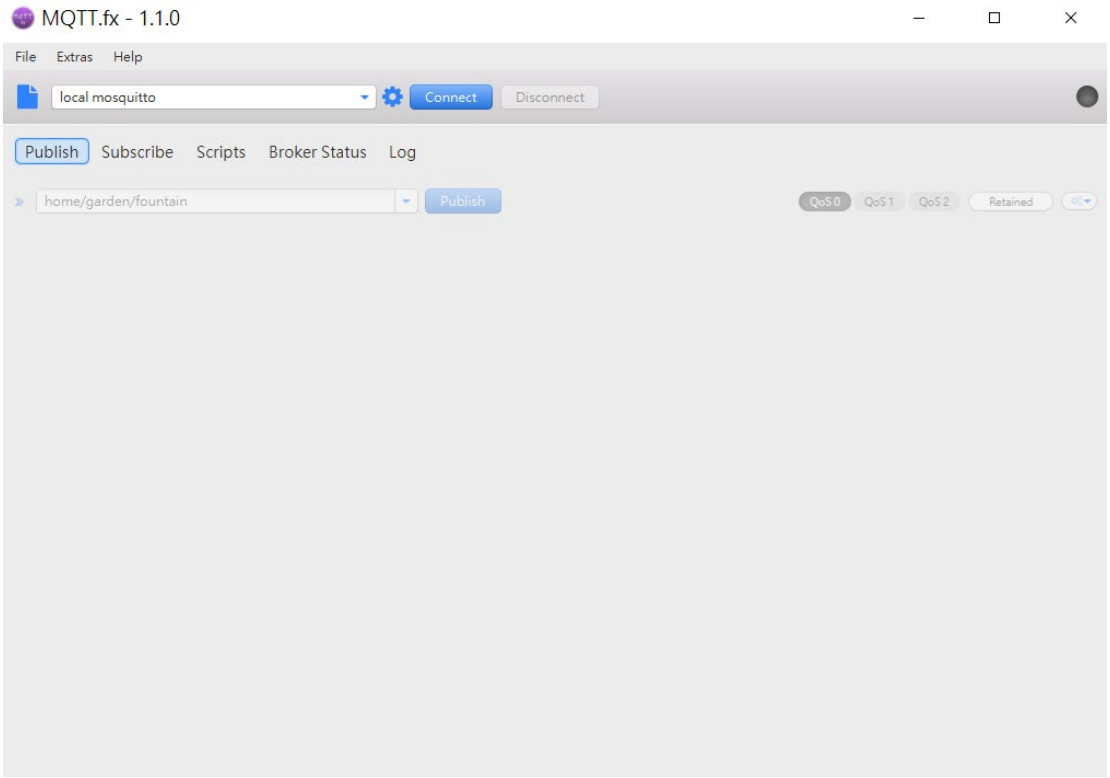
MQTT Broker(server)

MQTT-fx

- 可以連線至MQTT server的工具
- 下載 MQTT.fx

  Windows(雲端中"mqttfx-1.7.1-windows-x64.exe")

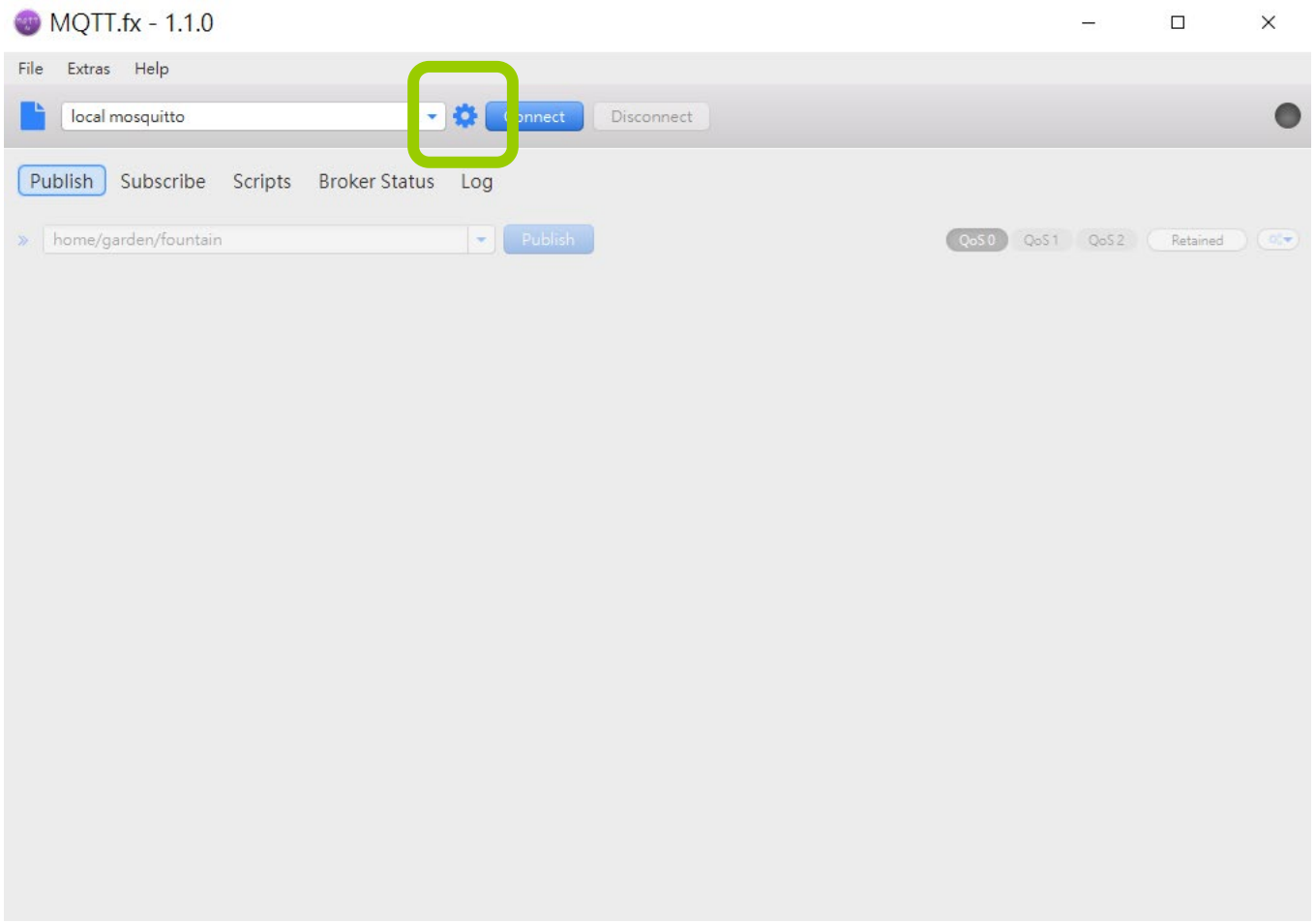
  MacOS(雲端中"MQTT-MacOS.fx.zip")



MQTT-fx

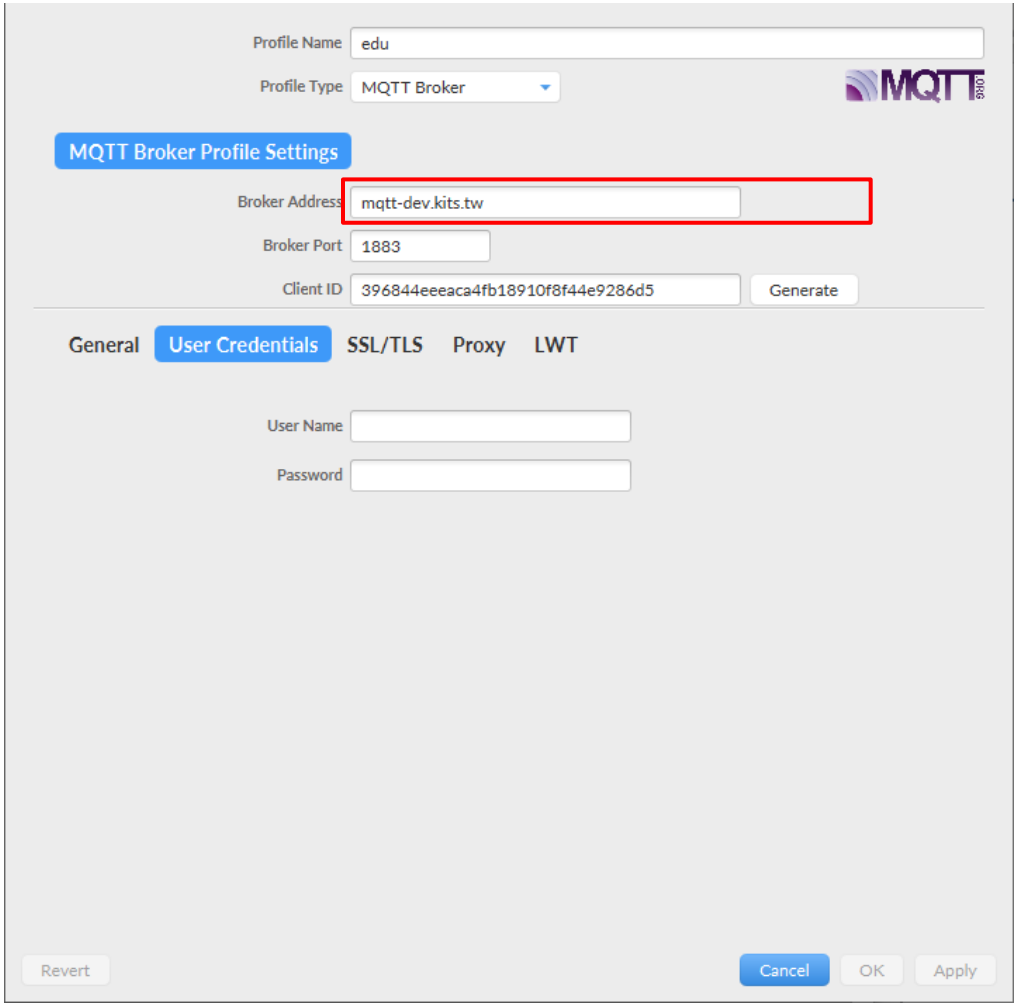
- 將 MQTT-MacOS.fx.zip 解壓縮
- 前往「安全性與隱私權」。在「一般」面板上按一下「強制打開」

連線至MQTT server



連線至MQTT server

- 你的mqtt.fx設定參數應該長這樣



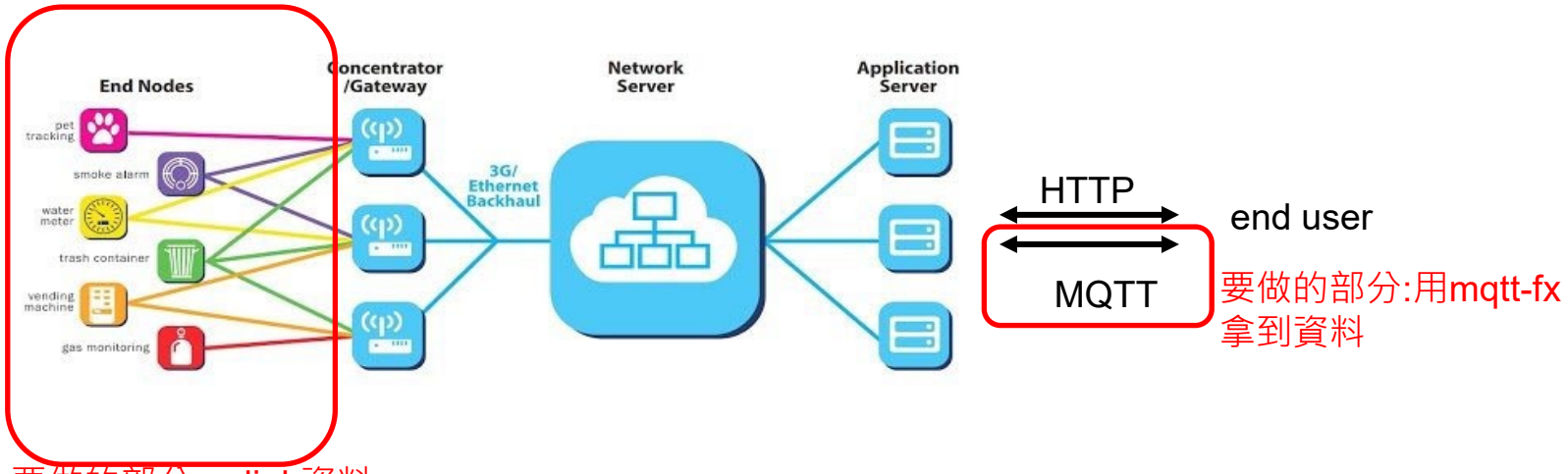
MQTT subscribe

從這邊輸入想要訂閱的topic後按下subscrib就能訂閱該topic

lab2-2

- 透過6509上傳資料到gateway,然後去清大的mqtt server中訂閱GIOT-GW/UL/1C497BFA2FC8這個topic,並查看是否有在該topic中收到自己上傳的資料
- hint:
  - 當資料上傳到gateway後,我們的gateway會幫忙處理資料解密的動作後,再幫你們送去上述的topic中
  - 使用AT+DTX=<想傳的資料長度>,<要傳的字串>,指令在spec的第9頁

```
AT+DTX=5,"ABCDE"
```



lab2-2 result

GIOT-GW/UL/1C497BFA2FC8

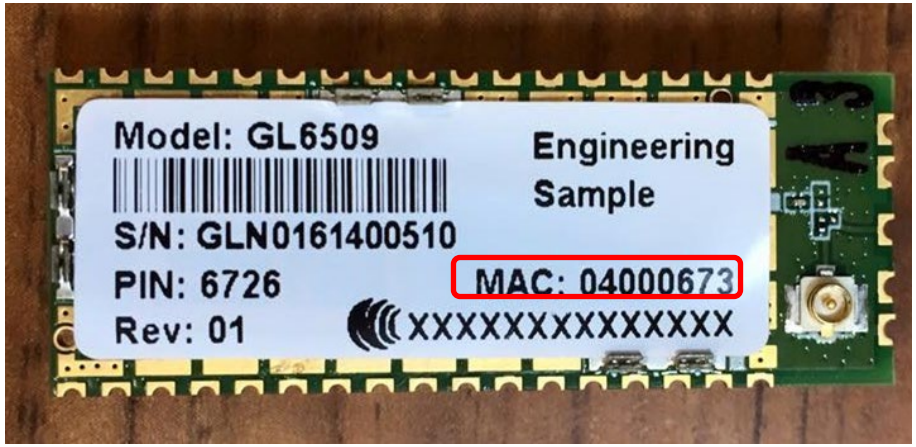
#

4

02-11-2023 04:01:15.14475953

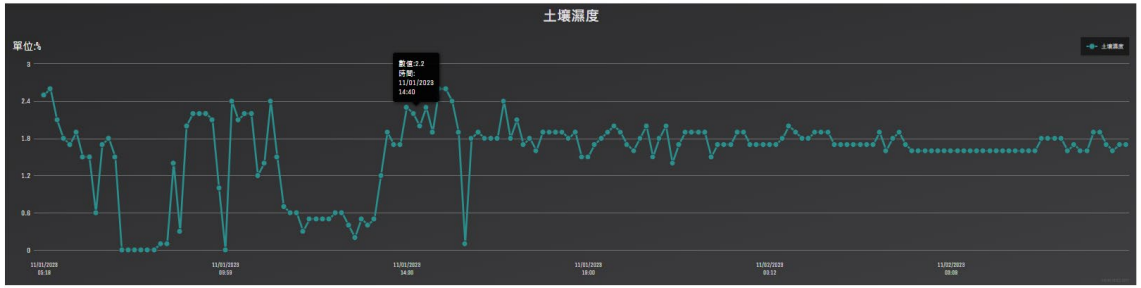
QoS 0

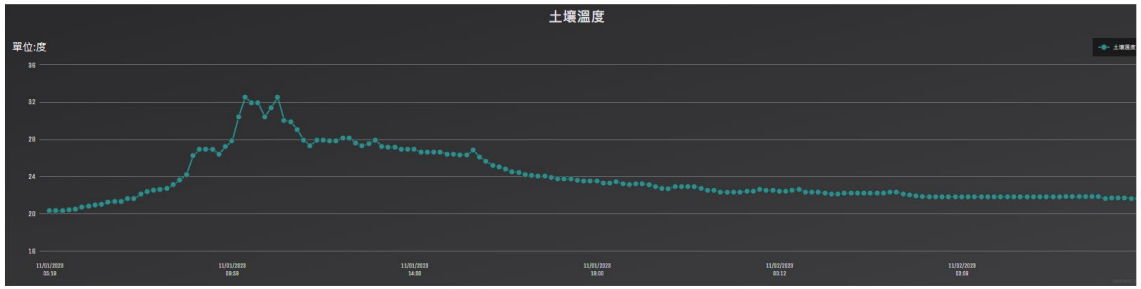

```
[{"channel":924375000, "sf":10, "time":"2023-11-02T04:01:16+08:00",
"gwip":"192.168.0.101", "gwid":"00001c497bf883bf", "repeater":"00000000ffffffff",
"systype":7, "rssi":-72.0, "snr":33.3, "snr_max":42.5, "snr_min":28.8,
"macAddr":"0000000007000061", "data":"75686b6665", "frameCnt":2, "fport":1}]
```

後續應用

- 數據的分析、呈現






thank you
danke
謝謝
ngiyabonga
teşekkür ederim
gracias
merci
obrigado
dziękuję
bedankt
sukriya
kop khun krap
go raibh maith agat
terima kasih
grazie
arigatô
dakujem
takk
tapadh leat
mauruuru
hvala
sagolun
спасибо
рахмат
Баярлалаа
dank je
misaotra
matondo
paldies
grazzi
mahalo
faafetai lava
vinaka
спасибі
blagodaram
kiitos
dankie
dhanyavad
nanni
nandri
köszönöm
gràcie
bayarlalaa
enkosi
akun
dankon
ačiū
djiere dieuf
tau
mochchakkeram
дякую
mamnun
хвала
asante
manana
obrigada
tenki
murakoze
chokrane
chnorakaloutioun
gratias ago
gràcies
sulpáy
ţaiku
sobodi
dēkuji
mèsi
didi madloba
kam sah hamnida
najis tuke
rahmat
ありがとう
tanemirt
rahmet
diolch
dhanyavadagalu
shukriya
mercé
мерси
trugarez
তোমাকে ধন্যবাদ
감사합니다
xièxie
ευχαριστώ