

NBLoT與MQTT的完美組合

兼顧功能與流量的NBLoT感測器

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About Me

- Felix Lin (林士允)
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- 創客閣樓社群 召集人
- 各級大專院校 講師
- 研究領域
 - MCU
 - Embedded System
 - IoT、AIoT





情境說明

NB-IoT 資料傳輸量直接反應於費用上，
使用 MQTT 傳送感測器與控制 DS12598
可以降低傳輸量並且提高傳輸效率。



材料

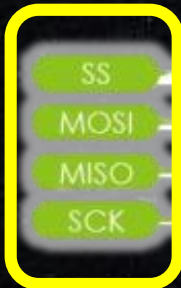
- DSI2598
- DHT11/DHT22
- NeoPixel LED模組
- 3D 列印外殼
- M3 皿頭螺絲 x4





DSI2598

SPI Bus



GPIO



Power



GPIO



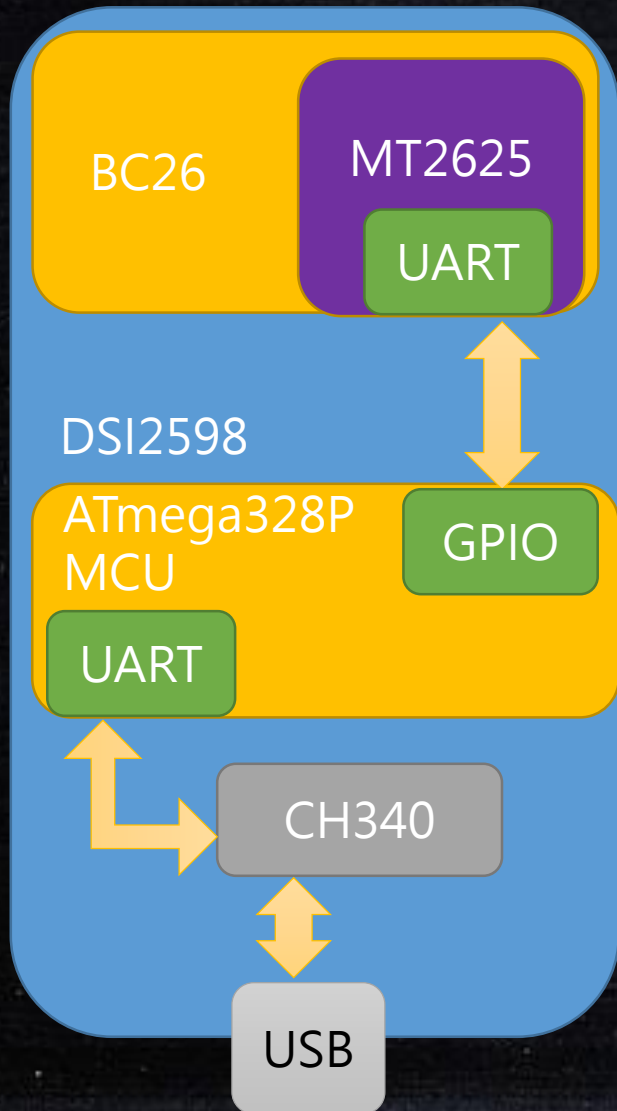
Power



I²C Bus



DSI2598 Block Diagram



- Microchip ATmega328p
 - AVR MCU
 - Arduino Nano like
 - P8(RX) P9(TX) connect to BC26
- Quectel BC26
 - MT2625 NBloT module
- WCH CH340
 - UART to USB



DHT11 / DHT22

	DHT11	DHT22
工作電壓(V)	3~5.5	3.3~6
耗電量(mA)	0.5~2.5	1~1.5
溫度量程	0~50 °C	-40~80 °C
濕度量程	20~90 %RH	0~100 %RH
溫度解析度Resolution	0.1 °C	0.1 °C
濕度解析度Resolution	1 %RH	0.1 %RH
溫度精確度Accuracy	±2 °C	± 0.5 °C
濕度精確度Accuracy	±5 %RH	±2 %RH
響應時間(s)	2	2



關於量測的規格術語

- Measurement Range 量程
- Resolution 解析度
- Accuracy 精確度
- Repeatability 重現性
- Response Time 響應時間



Accuracy vs Repeatability

Repeatability



Accuracy



Case Study: SHT3x

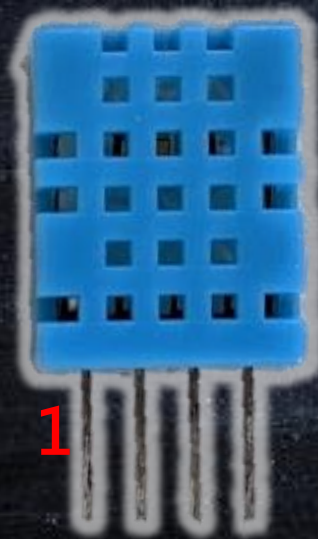
Temperature Sensor Specification

Parameter	Condition	Value	Units
SHT30 Accuracy tolerance ¹	typ., 0°C to 65°C	±0.3	°C
SHT31 Accuracy tolerance ¹	typ., -40°C to 90°C	±0.3	°C
SHT35 Accuracy tolerance ¹	typ., -40°C to 90°C	±0.2	°C
Repeatability ²	Low	0.24	°C
	Medium	0.12	°C
	High	0.06	°C
Resolution	Typ.	0.015	°C
Specified Range	-	-40 to 125	°C
Response time ⁸	$\tau_{63\%}$	>2	s
Long Term Drift	max	<0.03	°C/yr



DHT11 / DHT22 Pin Definition

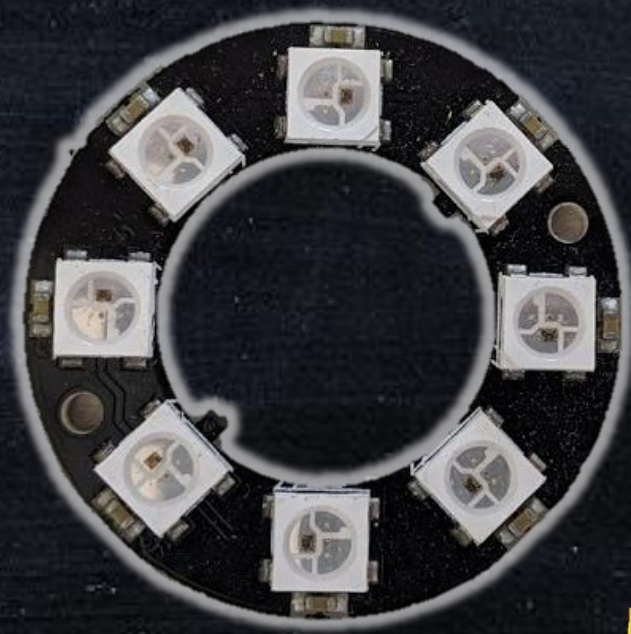
1. VCC 正電
2. Data 資料
3. NC 空接
4. GND 負電





NeoPixel (WS2812B)

- 24bit全彩LED (Red8 、 Green8 、 Blue8)
- 可程式化，透過訊號控制色彩
- 僅需要透過一個訊號腳位即可傳輸資料
- 最多可以串接到1024個燈珠





NeoPixel Pin Definition

1. DI: MCU訊號輸入，也可由前一級串接
2. 5V: 直流正電
3. GND: 直流負電
4. DO: 訊號輸出，可串接至後一級





步驟流程

1. MQTT與HTTP的差異
2. 雲端設定
3. 程式開發
4. 上傳測試
5. 組裝展示



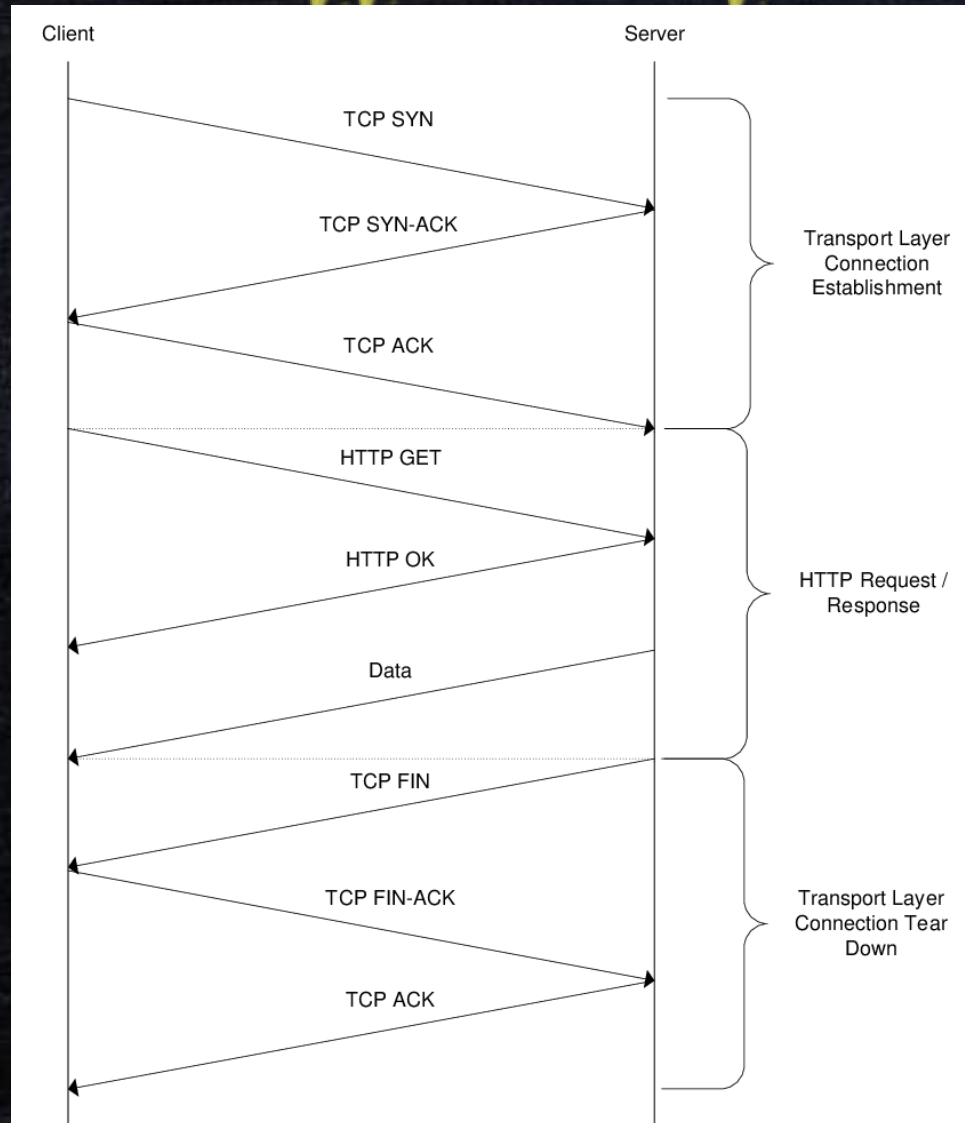


MQTT





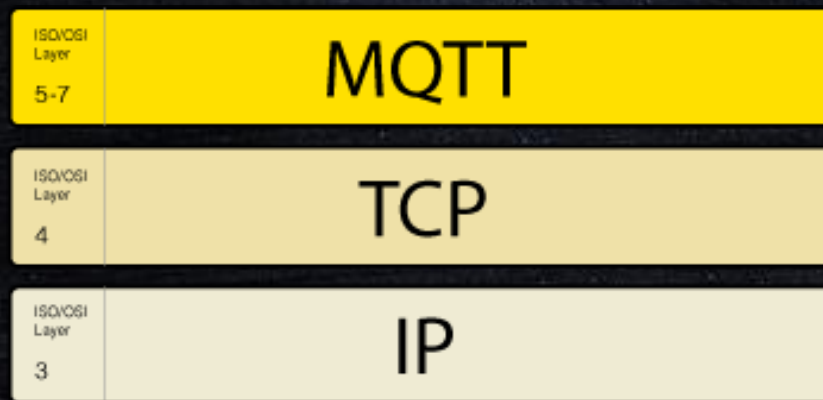
HTTP Connection Review





MQTT

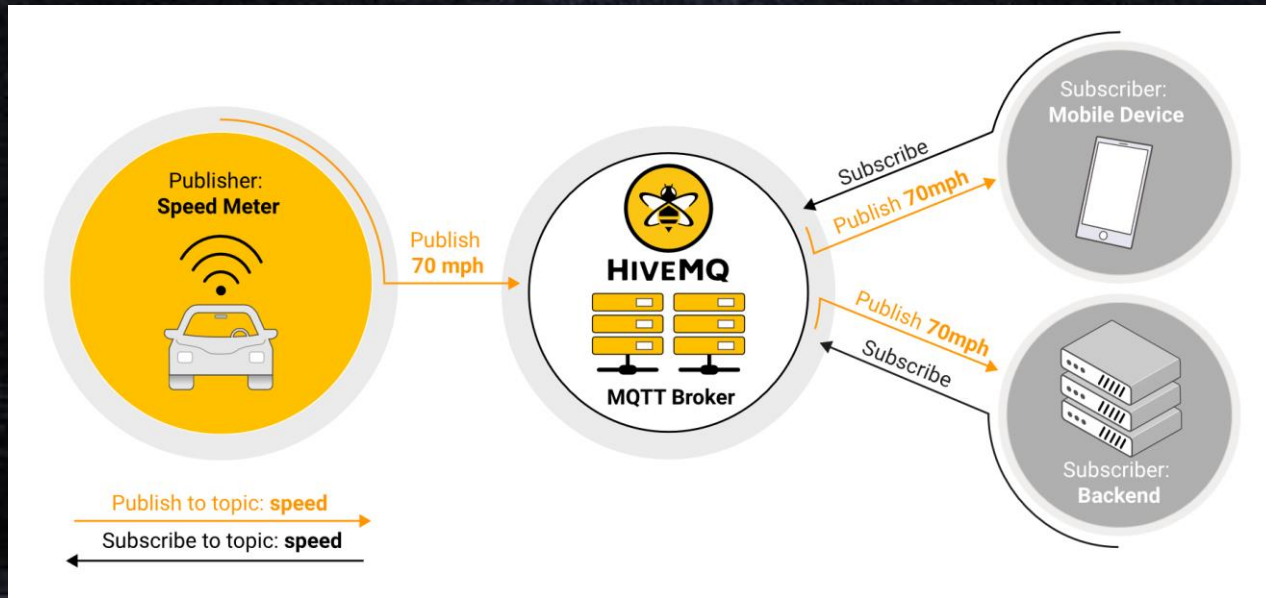
- MQTT (Message Queuing Telemetry Transport)
- 訊息佇列遙測傳輸
- 專為物聯網、M2M設計的公開標準
- 基於 TCP/IP 協定
- 輕量發布 (Publish)/訂閱 (Subscribe) 訊息式協議





MQTT

- Broker 代理人、伺服器。訊息交換中心
- Client 用戶端、裝置。可以為 Publisher 或 Subscriber
- Topic 訊息主題。
- Publish 訊息發布 / Subscribe 訊息訂閱。
- Retain 訊息保留（最後一筆）





MQTT QoS

- MQTT定義了 0, 1和2 三個層級的 QoS (Quality of Service) 服務品質
- 實際支援情況依 Broker 主機而定 (如 Adafruit.io 只支援0、1)
- 0 : 最多傳送一次 (at most once)
- 1 : 至少傳送一次 (at least once)
- 2 : 確實傳送一次 (exactly once)





MQTT QoS 0: at most once



MQTT Client



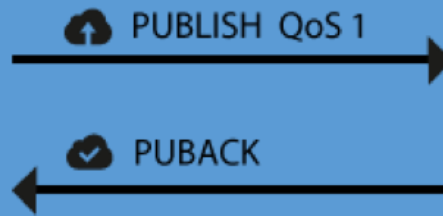
MQTT Broker



MQTT QoS 1: at least once



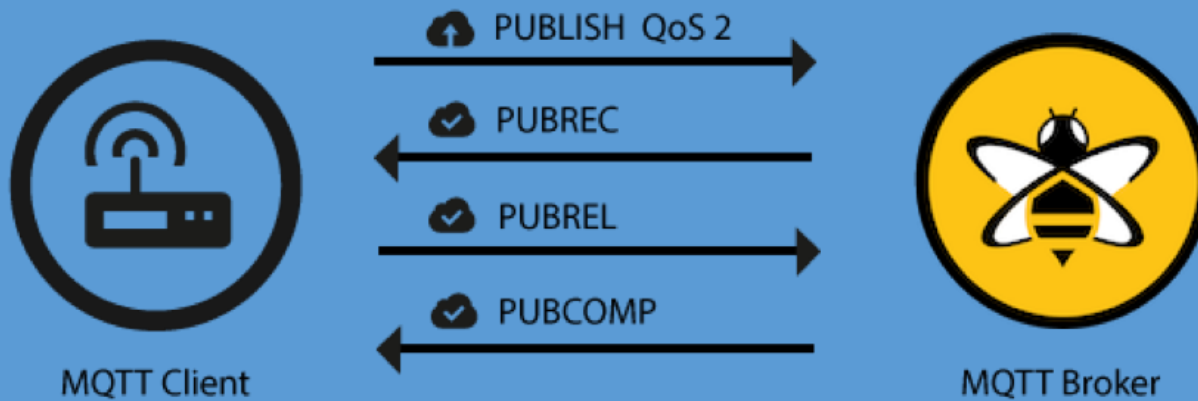
MQTT Client



MQTT Broker



MQTT QoS 2: exactly once





Free Public MQTT Broker

- HiveMQ
 - broker.hivemq.com
 - **TCP Port: 1883**
 - **Websocket Port: 8000**
- Mosquitto
 - test.mosquitto.org
 - **TCP Port: 1883/8883(TLS)**
 - **Websocket Port: 8080/8081(TLS)**
- EMQX
 - broker.emqx.io
 - **TCP Port: 1883/8883(TLS)**
 - **Websocket Port: 8083/8084(TLS)**

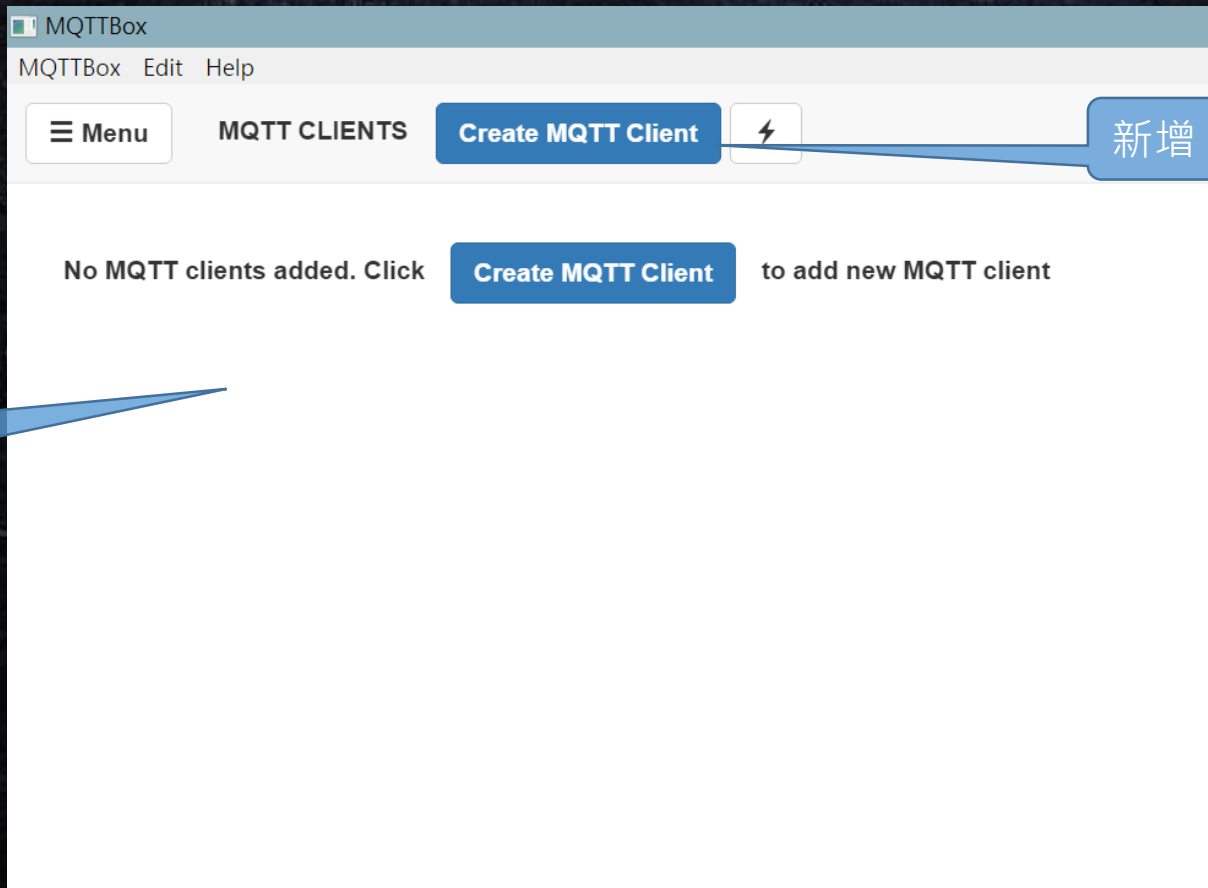


測試專用
所有人都看得到



測試工具(MQTTBox)

- MQTTBox [官方網站](#) , [下載連結](#)



起始
頁面

新增 MQTT Client



測試工具(MQTTBox)

MQTTBox Edit Help

Menu MQTT CLIENT SETTINGS

MQTT Client Name Adafruit	MQTT Client Id 32f3fdc-49be-4cf0-a3e7-3e202de'	Append timestamp to MQTT client id? <input checked="" type="checkbox"/> Yes
Protocol mqtt / tcp	Host io.adafruit.com	Clean Session? <input checked="" type="checkbox"/> Yes
Username Zack_Huang	Password	Reschedule Pings? <input checked="" type="checkbox"/> Yes
Reconnect Period (milliseconds) 1000	Connect Timeout (milliseconds) 30000	KeepAlive (seconds) 10
Will - Topic Will - Topic	Will - QoS 0 - Almost Once	Will - Retain <input type="checkbox"/> No

Save Delete

自訂
Client
name

MQTT / TCP

Username

Password

存檔



測試工具(MQTTBox)

新增
發布

新增
訂閱

連線
狀態

主題
名稱

Qos
品質

發布
格式

發布
內容

發布

發布
資訊

The screenshot shows the MQTTBox web interface. At the top, there's a status bar with 'MQTTBox', 'MQTTBox Edit Help', and a 'Connected' indicator. Below this are buttons for 'Add publisher' and 'Add subscriber'. The main area is split into two panels. The left panel is for publishing, with fields for 'Topic to publish' (Zack_Huang/feeds/pi-data), 'QoS' (0 - Almost Once), 'Retain' (unchecked), 'Payload Type' (Strings / JSON / XML / Characters), and 'Payload' ({"value": "99.9"}). A 'Publish' button is at the bottom. The right panel is for subscribing, with a 'Topic to subscribe' (Zack_Huang/feeds/pi-data), 'QoS' (0 - Almost Once), and a 'Subscribe' button. Below the subscribe button, it shows the received message: '99.9' and its details: 'qos : 0, retain : false, cmd : publish, dup : false, topic : Zack_Huang/feeds/pi-data, messageid : , length : 30, Raw payload : 57574657'.

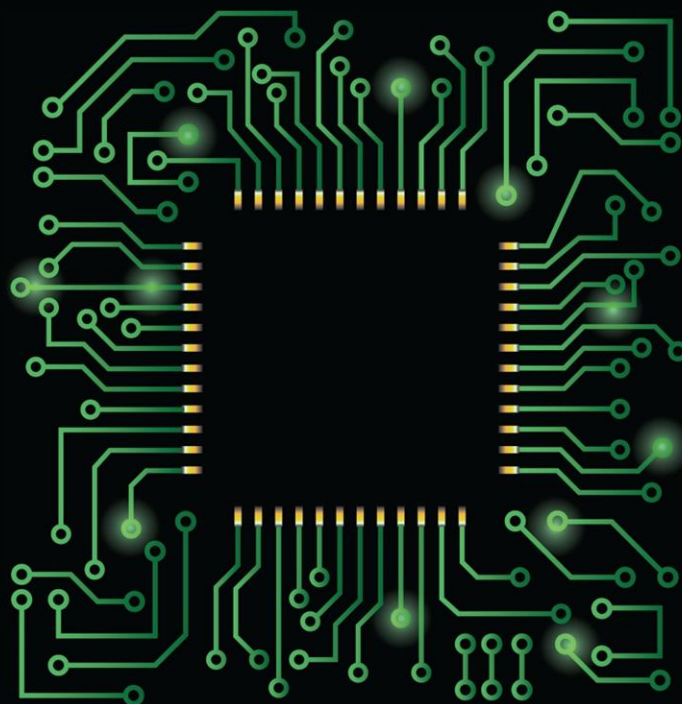
主題
名稱

Qos
品質

訂閱

接收到
新數據

數據
內容

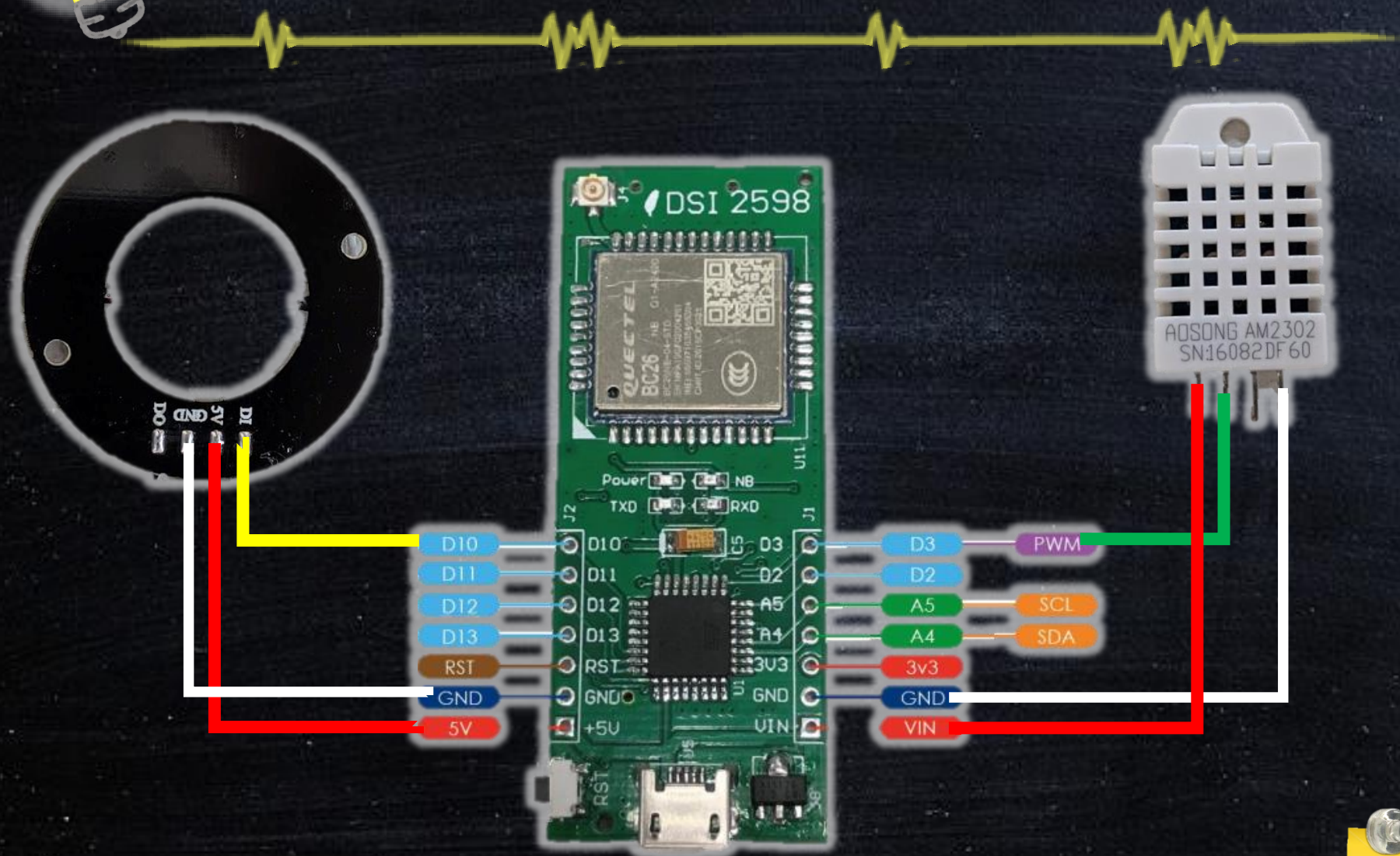


線路連接



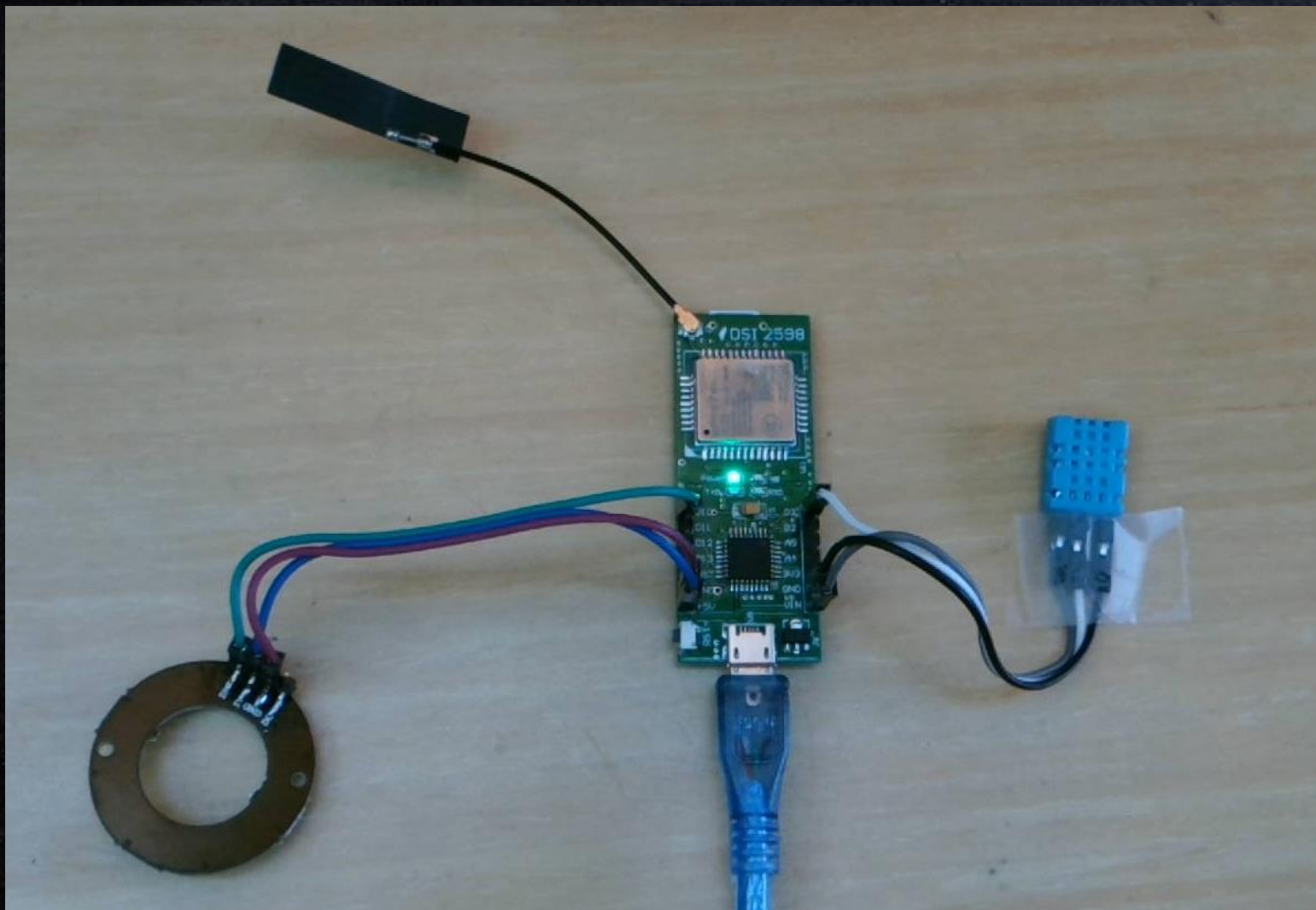


硬體接線圖





實體接線





ideaschain雲端設定

1. 創建專案 Project
2. 創建裝置 Device
3. 建立專案與裝置關聯
4. 上傳資料
5. 創建儀表板 Dashboard



Ideaschain – 創建專案

The screenshot displays the IDEASChain web interface. On the left is a navigation sidebar with icons for Home, Rule Library, Customers, Projects, Devices, Component Library, Dashboard, and Audit Log. The main content area shows a project named 'myProject' with a 'Test' button. A modal dialog titled '添加專案' (Add Project) is open, containing the following fields:

- 名稱* (Name): DSI2598_MobileSensor
- 專案類型* (Project Type): Sensor
- 描述 (Description): NBIOT 感測器

At the bottom of the dialog are two buttons: '添加' (Add) and '取消' (Cancel). The background interface is dimmed, and a red '+' button is visible in the bottom right corner of the main area.



Ideaschain – 創建裝置

The screenshot displays the IDEASChain user interface. On the left is a navigation menu with options: 首頁, 規則庫, 客戶, 專案, 裝置, 部件庫, 儀表板庫, and 稽核日誌. The main content area is titled '裝置' and shows a '測試裝置' section with a 'Data Count' field. A modal dialog box titled '添加裝置' is open in the center, containing the following fields and options:

- 名稱*: DSI2598_MS01
- 裝置類型*: Sensor
- 是閘道
- 說明: 走到哪量到哪

At the bottom of the dialog are '添加' and '取消' buttons. A red '+' button is visible in the bottom right corner of the application interface.



Ideaschain – 建立關聯

The screenshot displays the IDEASChain web interface. A modal dialog titled "添加關聯" (Add Relationship) is open in the center. The dialog contains the following fields:

- 關聯類型*** (Relationship Type): Contains
- 到實體類型** (Target Entity Type): 裝置*
- 裝置** (Device): DSI2598_MS01
- 附加信息 (JSON)** (Additional Information): An empty text area for entering JSON data.

At the bottom of the dialog, there are two buttons: "添加" (Add) and "取消" (Cancel). The background shows a sidebar with navigation options like "首頁", "規則鏈庫", "客戶", "專案", "裝置", "部件庫", "儀表板庫", and "稽核日誌". The main content area shows a project named "myProj" with a "測試" (Test) button.



程式開發





程式說明

- Dependent Libraries 相依函式庫
 - DHT sensor library
 - Adafruit NeoPixel
 - 以上皆從 Arduino IDE 安裝
 - 較新版的 IDE (1.8.10) 安裝時會提醒相依 Library
- Main Program 主程式
 - DSI2598 TemperatureBox Ideaschain (github)
 - <https://bit.ly/3kqzmPq>



程式說明

- bc26.cpp
 - BC26 專用函式庫
- bc26.h
 - 函式庫標頭檔
- DSI2598_TemperatureBox_Ideaschain
 - 主程式
 - 取得感測資料
 - 定時上傳雲端



上傳測試

- 左側選單**裝置** → 選擇對應**裝置** → **最新遙測**頁籤

The screenshot displays the IDEASChain web application interface. On the left is a navigation sidebar with the following menu items: 首頁 (Home), 規則總庫 (Rule Library), 客戶 (Customers), 專案 (Projects), 裝置 (Devices), 部件庫 (Component Library), 儀表板庫 (Dashboard Library), and 稽核日誌 (Audit Log). The main content area is titled '裝置' (Devices) and shows a list of devices. Two device cards are visible: '測試裝置' (Test Device) with a 'Data Count: 39298' and 'DSI2598_MS01' with a 'Data Count: 2804'. The 'DSI2598_MS01' card is selected, and its details are shown on the right. The details page for 'DSI2598_MS01' includes a '裝置詳細信息' (Device Details) section with tabs for '詳細信息' (Details), '屬性' (Attributes), '最新遙測' (Latest Telemetry), '警告' (Warnings), '事件' (Events), '關聯' (Associations), and '稽核日誌' (Audit Log). The '最新遙測' tab is active, displaying a table of telemetry data. The table has columns for '最後更新時間' (Last Update Time), '鍵' (Key), and '值' (Value). The data rows are as follows:

最後更新時間	鍵	值
2020-07-14 15:44:34	humidity	25.75
2020-07-14 15:44:34	lux	48
2020-07-14 15:44:34	temperature	43.21
2020-07-14 15:44:34	uv	0

At the bottom of the table, there is a pagination control showing 'Page: 1', 'Rows per page: 5', and '1 - 4 of 4'.



Ideaschain – 創建儀表板

The dashboard displays the following components:

- MobileSensor 溫濕度趨勢圖** (Temperature and Humidity Trend Chart): A line chart showing humidity (blue) and temperature (green) over time. The x-axis ranges from 11:30 to 11:55. The y-axis ranges from 30 to 50. A summary table below the chart provides the following data:

	最小值	最大值	平均值
humidity	44.9	46.09	45.45
temperature	31.64	32	31.83

- Lux Gauge**: A circular gauge showing light intensity in Lux, with a needle pointing to 318.00.
- UV Bar Chart**: A vertical bar chart showing UV intensity, with a value of 2.00.

New Timeseries table (即時 - 最後 15 分):

Timestamp ↓	humidity	temperature	lux	uv
2020-07-14 11:55:25	44.96	31.95	318	2
2020-07-14 11:55:05	44.9	31.97	318	2
2020-07-14 11:54:45	44.92	31.99	318	2
2020-07-14 11:54:25	45.06	31.99	318	2

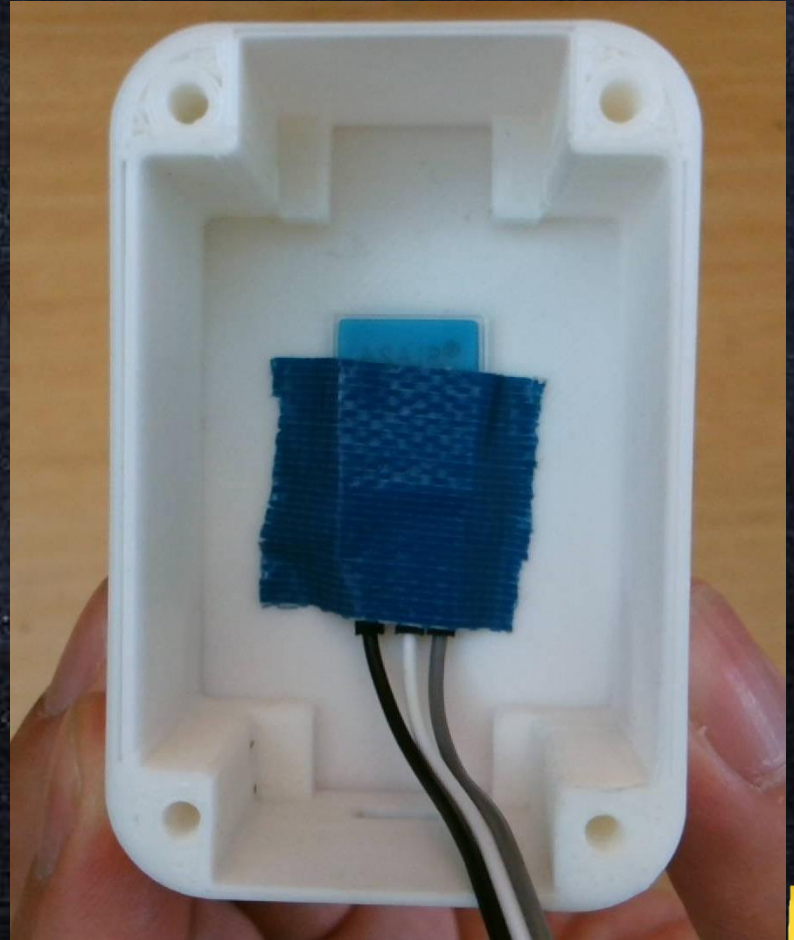
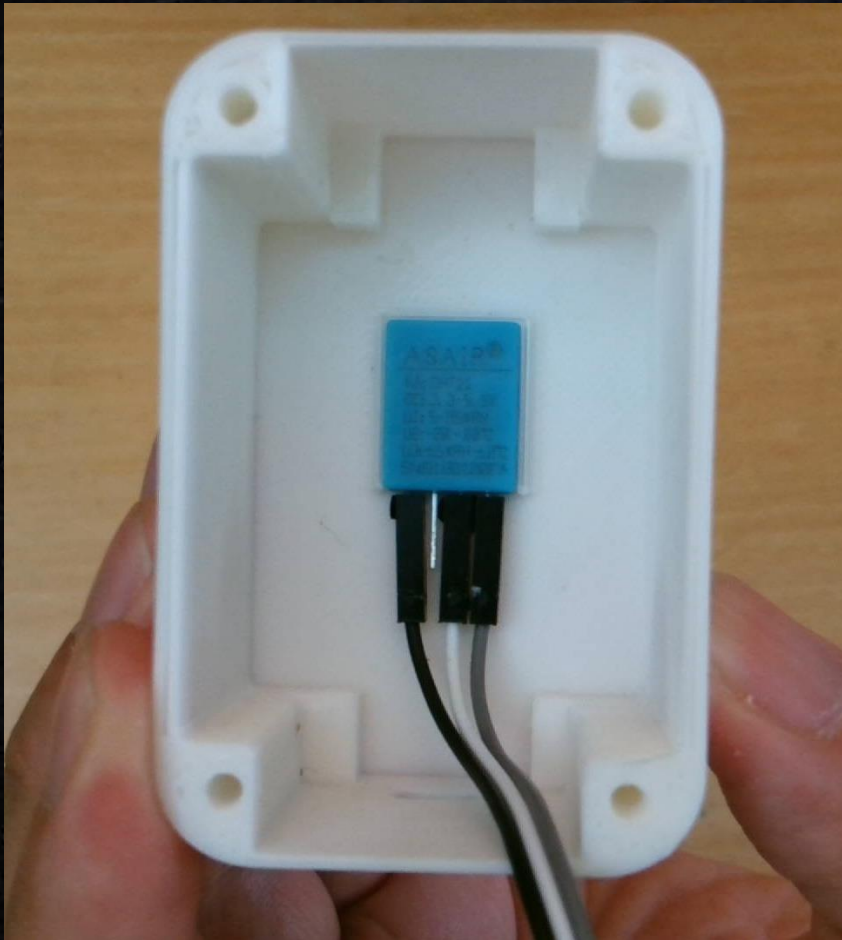


整合組裝



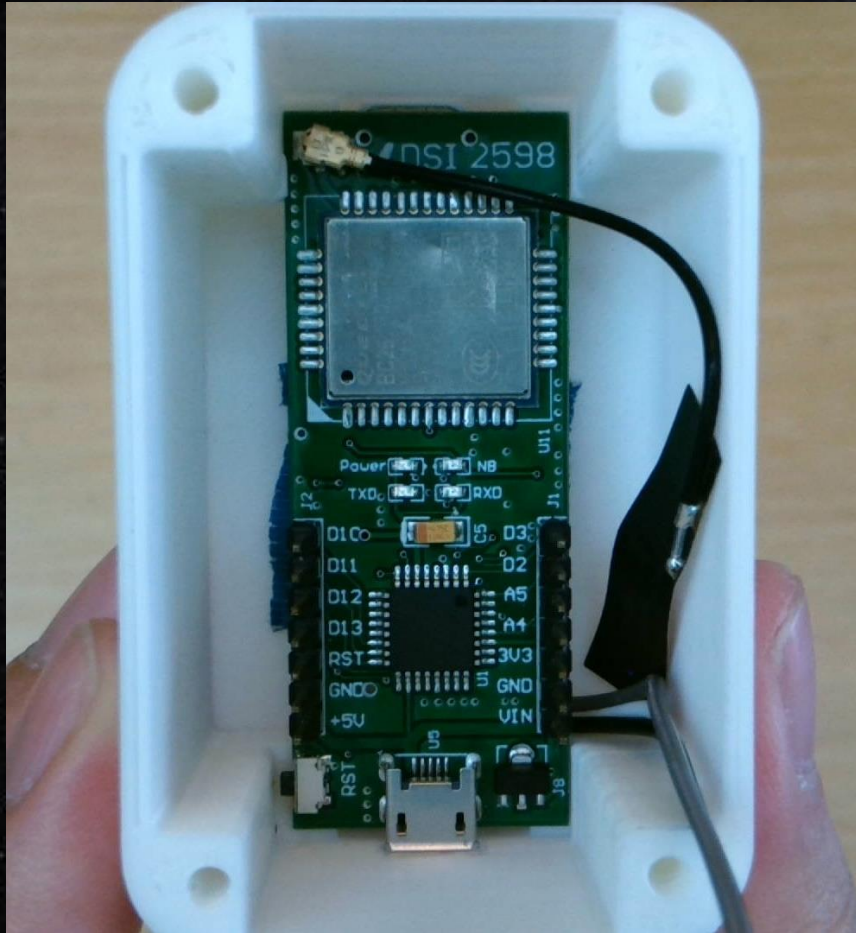


組裝DHT11



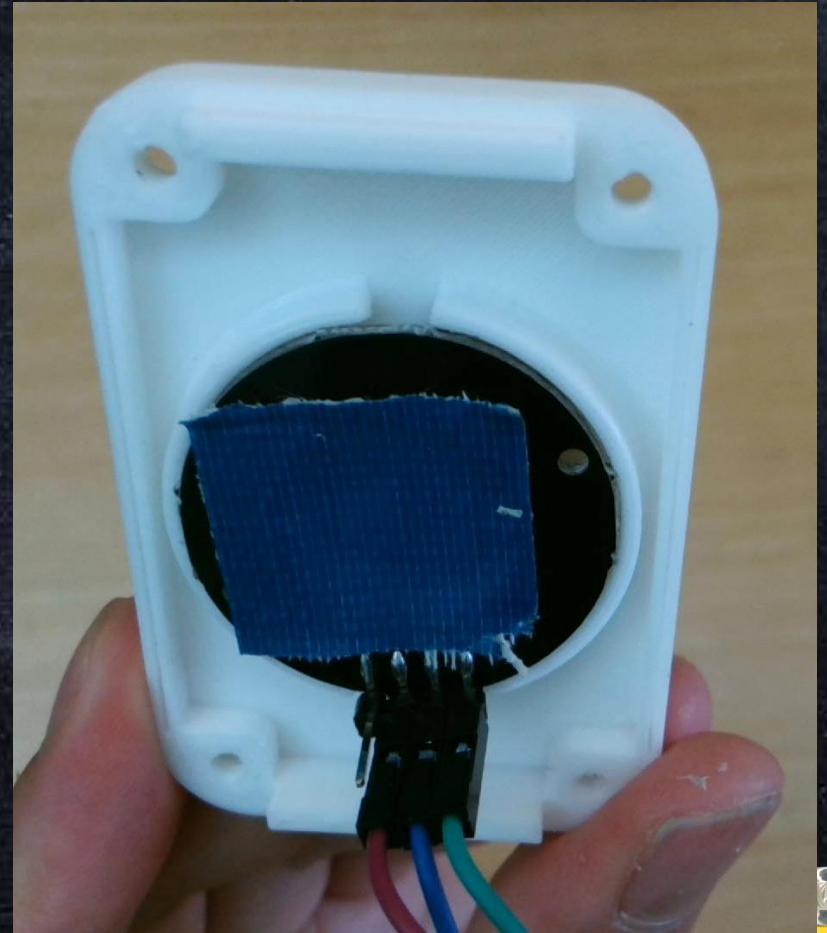
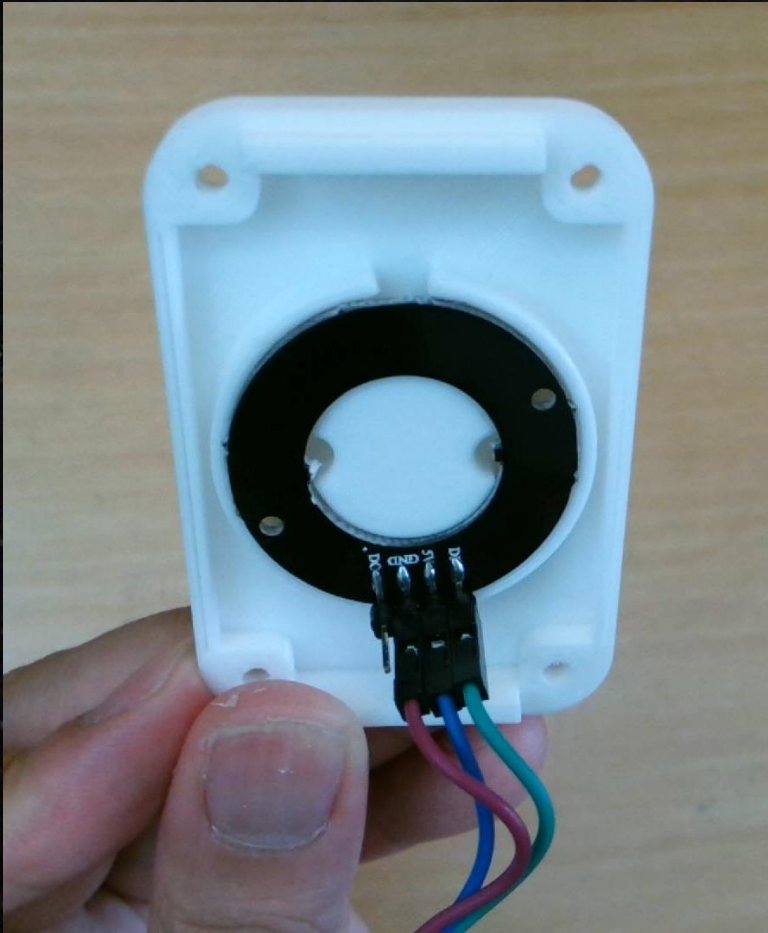


組裝DSI2598



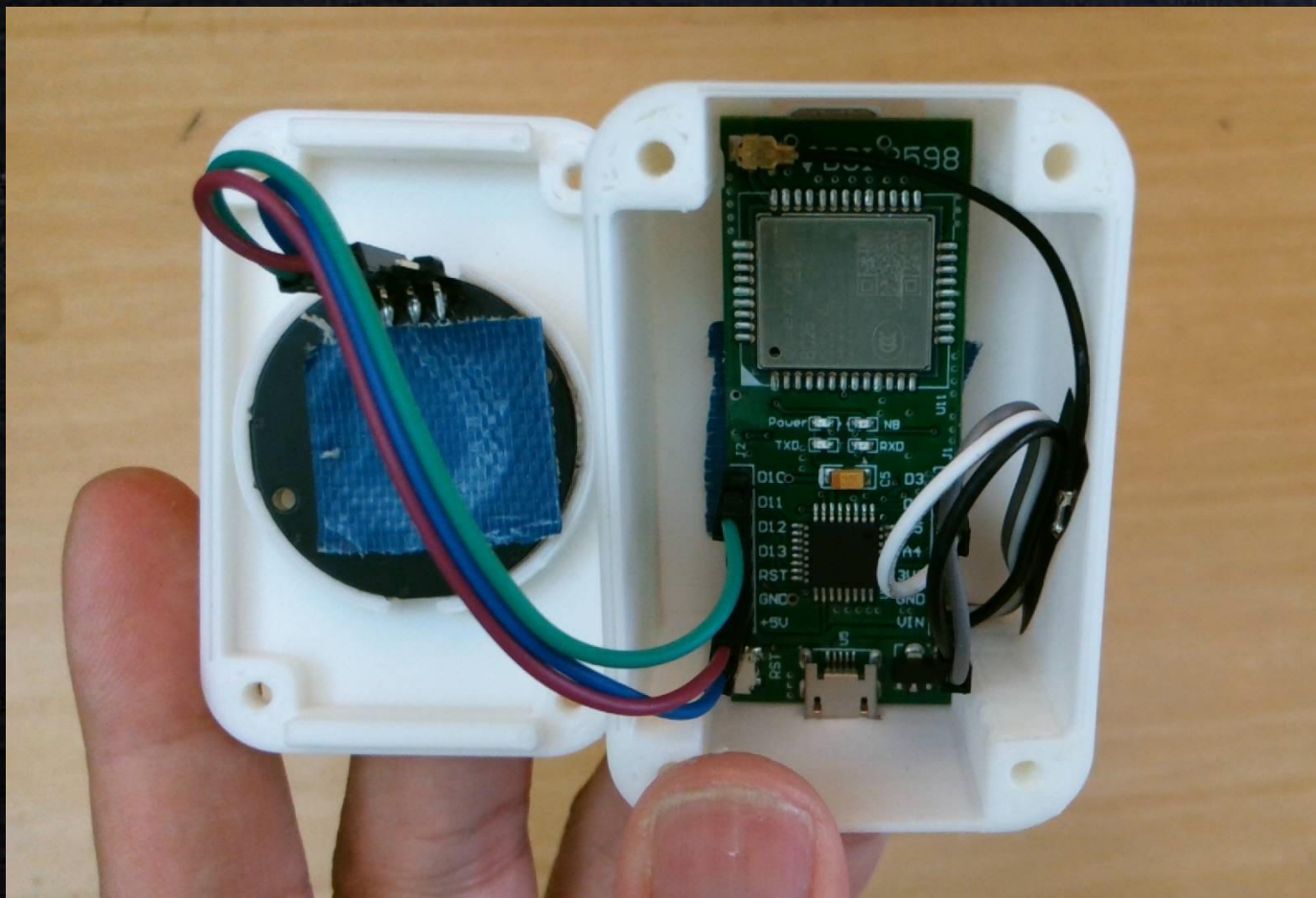


組裝NeoPixel





線路連接



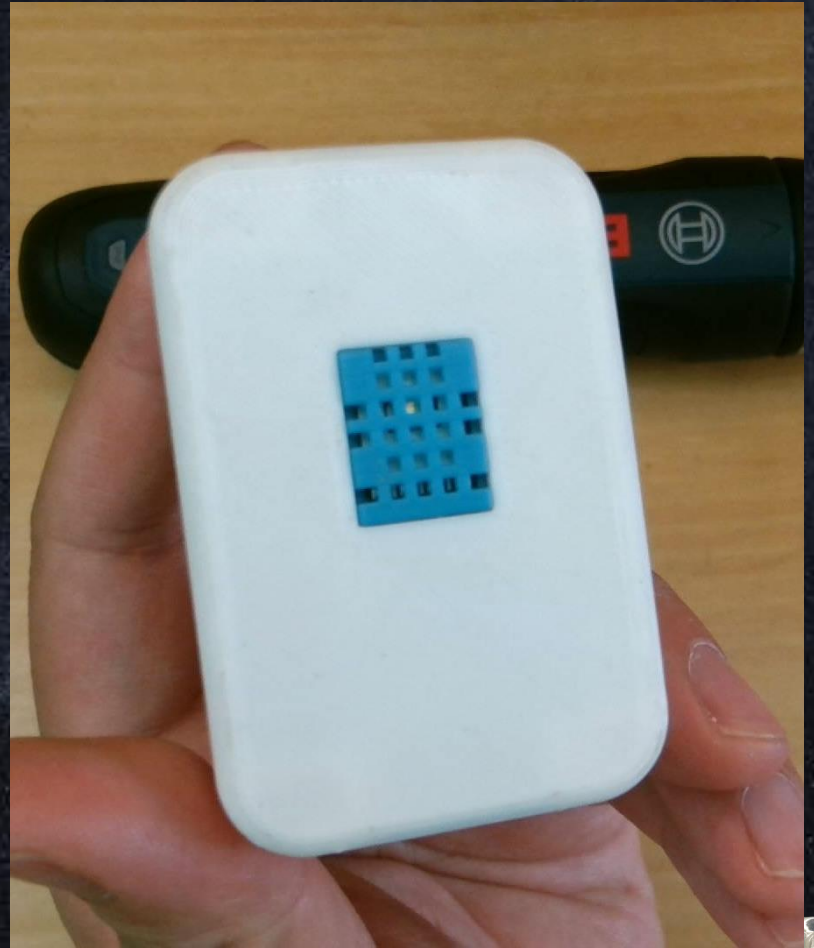


組裝上蓋





鎖上螺絲





完成





小結

- 本實驗以最簡單的感測器與元件，建構一個最小可行 NBloT 專案
- 運用 NBloT 的特性拓展物聯網應用更多的可能性
- MQTT 協定比 HTTP 更適合 NBloT 裝置
- 若想要更具省電特性，可以將 ATmega328p 設定休眠，BC26 也進入省電模式，在不傳送資料期間，耗能約是 μA 等級。





Thanks for your attention !

