

# Acsip

# LoRaWAN (S76S)

# Training Course



**An IoT Solution Company**

**2017/11/**

# Agenda

- **Gemtek Gateway Setup**
- **Mosquitto Setup**
- **NodeRed Setup**
- **SmartBlocks Introduction**
- **How Smart**
- **LoRaWAN Architecture**
- **S76S Setup**
- **Sensor Board Firmware**
- **Q & A**

# 範例系統及軟體版本規格

PC OS:Windows 7 x64

Node-Red:v9.0.0 x64

Arduino:1.6.11 x32

Sensor Board FW:1.1.4

Mosquitto:1.4.14 x32

# Gemtek Gateway Setup

# Login : 192.168.88.1

192.168.88.1/cgi-bin/luci;stok=053a5405e0fe638498b28a87eb4906c0/admin/network/diagnostics

Gateway IP

## Authorization Required

Please enter your username and password.

Username

Password

**admin**

# Gemtek Gateway Setup

## # Network Server :

Status

System

GloT

LoraWan

OTAA Status

OTAA

ABP

Network Server

Network

Logout

## Network Server

The description for the Network Server.

Forwarder

Protocol: MQTT ▾  
Hostname: 192.168.88.173  
Username: test  
Password: test  
Publish topic: GIOT-GW/DL/  
Subscribe topic: GIOT-GW/UL/  
Downlink ACK: GIOT-GW/DL-report/  
Port: 1883

# Mosquitto Setup

# Install Mosquitto :

- ◆ **Download pthreads-w32-2-9-1-release.zip**

<ftp://sourceware.org/pub/pthreads-win32/builds/win32/pthreads-w32-2-9-1-release.zip>

- ◆ **Download Win32 OpenSSL v1.0.2k Light Install Win32 OpenSSL**  
**Copy libeay32.dll & ssleay32.dll**

<https://slproweb.com/products/Win32OpenSSL.html>

# Mosquitto Setup

## # Install Mosquitto :

### ◆ Download and Install :

mosquitto-1.4.11-install-win32.exe


<https://mosquitto.org/download/>

◆ Copy libeay32.dll & ssleay32.dll & pthreadVC2.dll  
& pthreadVCE2.dll to c:\mosquitto

# Mosquitto Setup

## # Mosquitto .Conf Setup :

```
# =====  
# Default listener  
# =====  
# IP address/hostname to bind the default listener to. If not  
# given, the default listener will not be bound to a specific  
# address and so will be accessible to all network interfaces.  
# bind_address ip-address/host name  
bind_address 192.168.88.1  
              73  
# Port to use for the default listener.  
port 1883
```





# Mosquitto Setup

## # Start Mosquitto :

```
C:\mosquitto>mosquitto --help
```

```
mosquitto version 1.4.11 (build date 20/02/2017 23:24:29.40)
```

```
mosquitto is an MQTT v3.1.1/v3.1 broker.
```

```
Usage: mosquitto [-c config_file] [-d] [-h] [-p port]
```

-c : specify the broker config file.

-d : put the broker into the background after starting.

-h : display this help.

-p : start the broker listening on the specified port.

Not recommended in conjunction with the -c option.

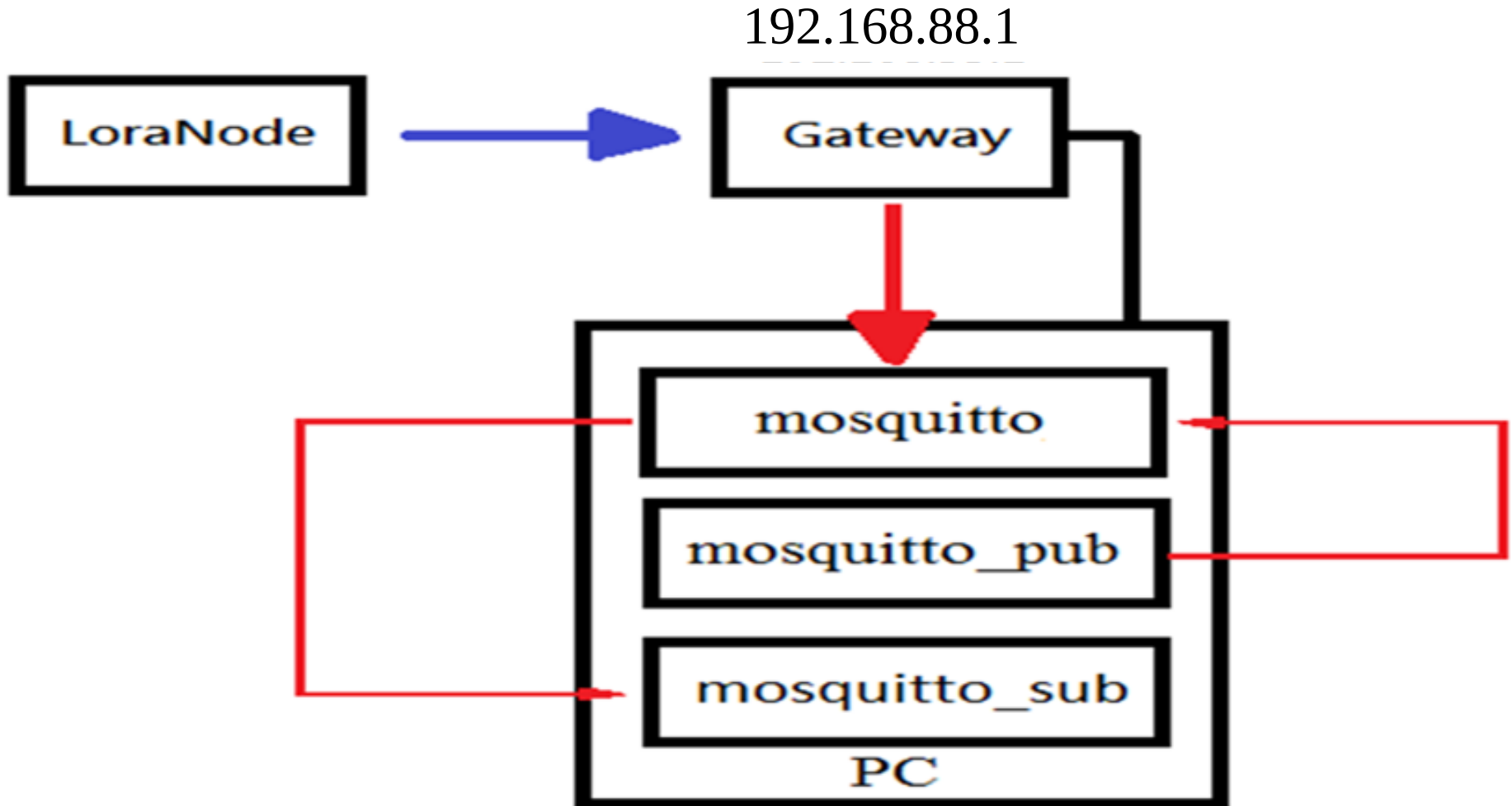
-v : verbose mode - enable all logging types. This overrides any logging options given in the config file.

See <http://mosquitto.org/> for more information.

```
C:\mosquitto>mosquitto
```

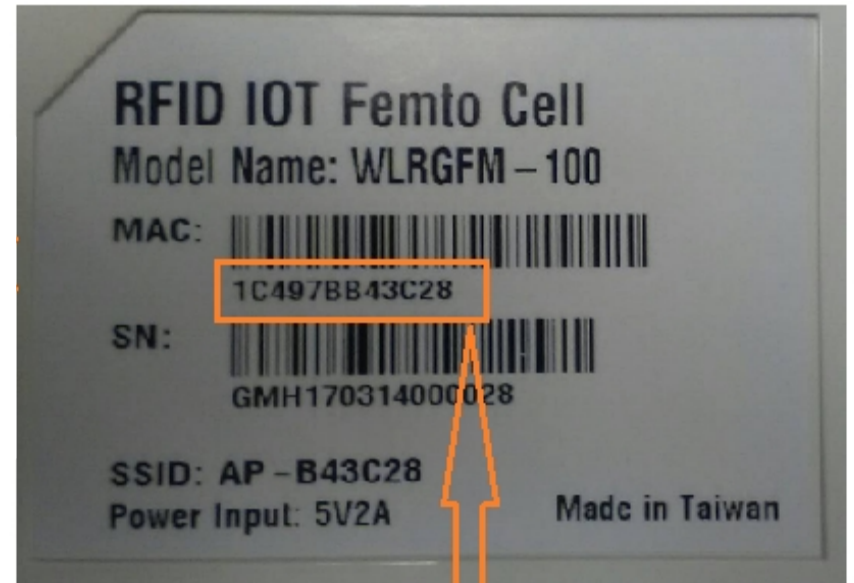
# Mosquitto Setup

## # Data Workflow :



# Mosquito Subscriber

# Uplink (UL) Command :

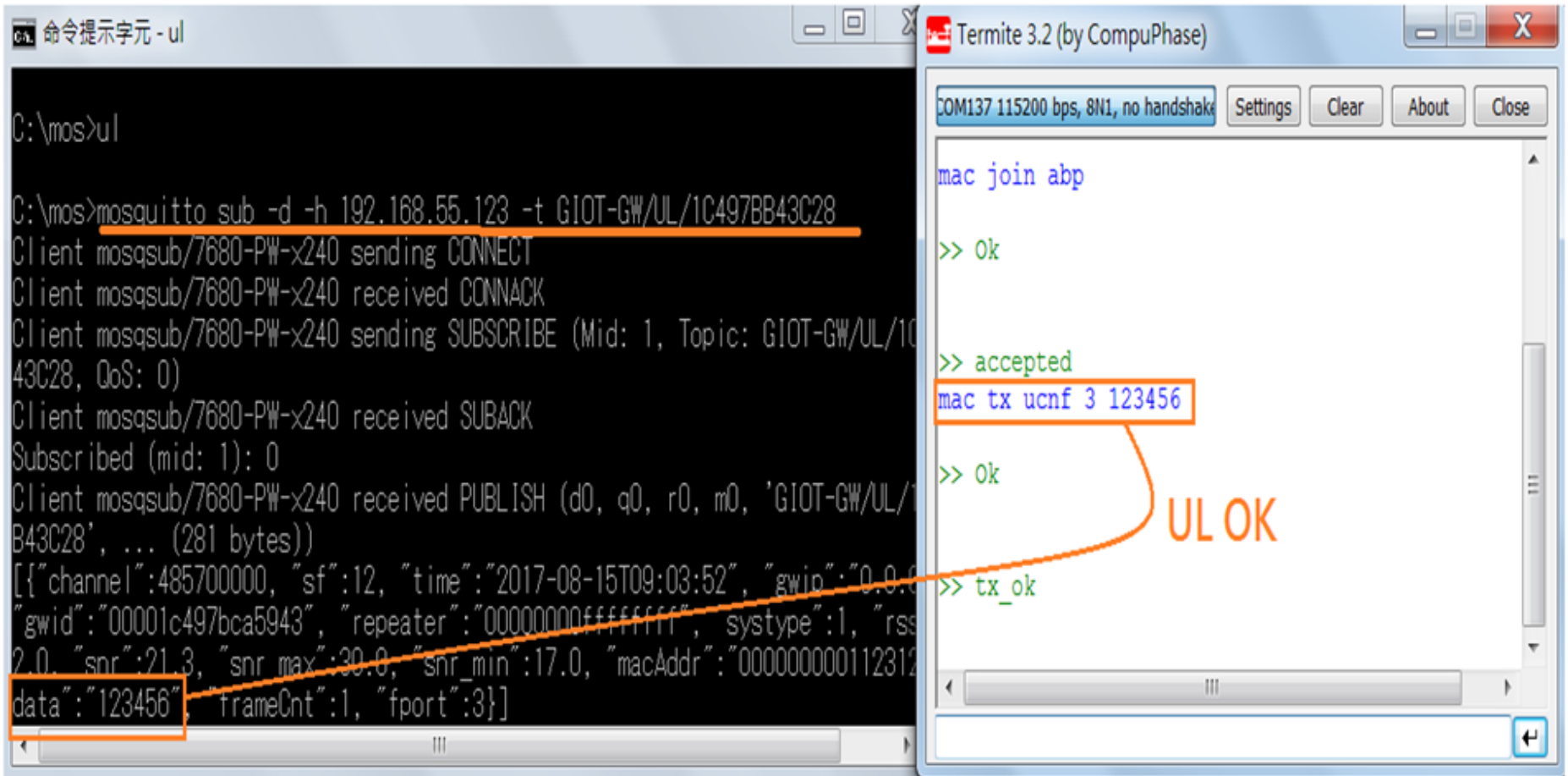


```
mosquitto_sub -d -h 192.168.55.123 -t GIOT-GW/UL/1C497BB43C28
```

PC DHCP Address

# Mosquitto Subscriber

## # Uplink (UL) Done :



The image shows two overlapping windows. The left window is a Windows command prompt titled '命令提示字元 - ul'. It displays the following output:

```
C:\mos>ul  
C:\mos>mosquitto sub -d -h 192.168.55.123 -t GIOT-GW/UL/1C497BB43C28  
Client mosqsub/7680-PW-x240 sending CONNECT  
Client mosqsub/7680-PW-x240 received CONNACK  
Client mosqsub/7680-PW-x240 sending SUBSCRIBE (Mid: 1, Topic: GIOT-GW/UL/1C497BB43C28, QoS: 0)  
Client mosqsub/7680-PW-x240 received SUBACK  
Subscribed (mid: 1): 0  
Client mosqsub/7680-PW-x240 received PUBLISH (d0, q0, r0, m0, 'GIOT-GW/UL/1C497BB43C28', ... (281 bytes))  
[{"channel":485700000,"sf":12,"time":"2017-08-15T09:03:52","gwid":"0.0.0.0","gwid":"00001c497bca5943","repeater":"00000000ffffffff","systype":1,"rsn":2.0,"snr":21.3,"snr_max":30.0,"snr_min":17.0,"macAddr":"0000000001123123","data":"123456","frameCnt":1,"fport":3}]
```

The right window is a Termitte 3.2 terminal window titled 'Termitte 3.2 (by CompuPhase)'. It shows the following output:

```
COM137 115200 bps, 8N1, no handshake Settings Clear About Close  
mac join abp  
>> Ok  
  
>> accepted  
mac tx ucnf 3 123456  
>> Ok  
  
>> tx_ok
```

An orange arrow points from the 'data' field in the left window to the 'mac tx ucnf 3 123456' command in the right window. The text 'UL OK' is written in orange next to the arrow.

# Mosquitto Publisher

## # Downlink (DL) Command :

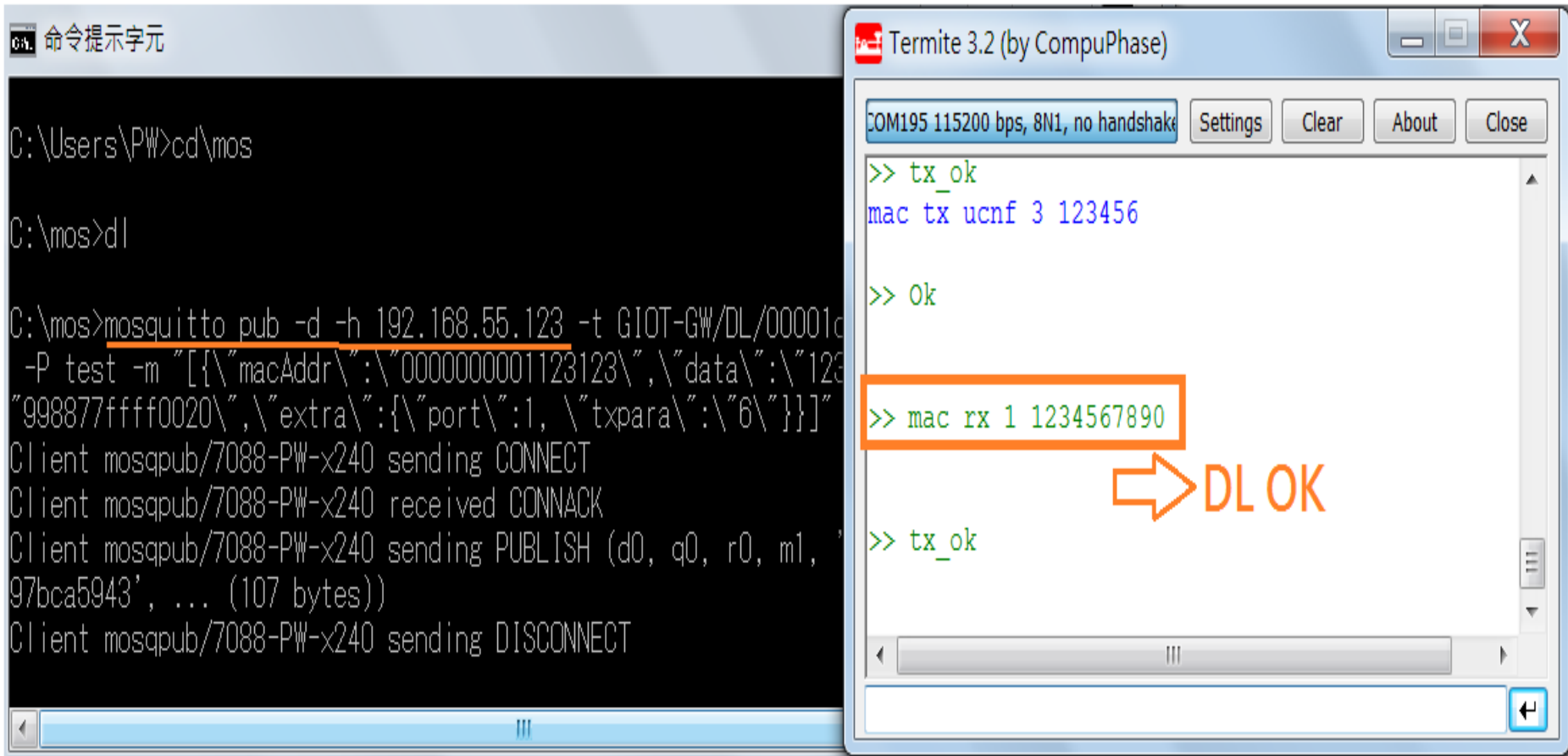
GloT Info	
Provisioning Code	B200A156 (Provision)
Area Code	B200A156
Gateway Type	Femto
LoRa Module	ON
Gateway ID	1c497bca5943

```
mosquitto_pub -d -h 192.168.55.123 -t GIOT-GW/DL/00001c497bca5943 -u test -P test -m  
"[{"macAddr\":"0000000001123123\"}, {"data\":"1234567890\"}, {"id\":"998877ffff0020\"}, {"ext  
ra\":"{\"port\":1, \"txpara\":\"6\"}}]"
```

DevAddr

# Mosquitto Publisher

## # Downlink (DL) Done :



The image shows two overlapping terminal windows. The left window is a Windows command prompt titled '命令提示字元' (Command Prompt) showing the execution of a Mosquitto publisher command. The right window is Termiter 3.2 (by CompuPhase) connected to a serial port (COM195) at 115200 bps, 8N1, no handshake. It displays the received data from the publisher.

```
C:\Users\PW>cd\mos
C:\mos>dl
C:\mos>mosquitto pub -d -h 192.168.55.123 -t GIOT-GW/DL/00001c
-P test -m "[{"macAddr":"0000000001123123","data":"123
"998877ffff0020","extra":{"port":1, "txpara":"6"}}]"
Client mosqpub/7088-PW-x240 sending CONNECT
Client mosqpub/7088-PW-x240 received CONNACK
Client mosqpub/7088-PW-x240 sending PUBLISH (d0, q0, r0, m1,
97bca5943', ... (107 bytes))
Client mosqpub/7088-PW-x240 sending DISCONNECT
```

```
Termiter 3.2 (by CompuPhase)
COM195 115200 bps, 8N1, no handshake
>> tx_ok
mac tx ucnf 3 123456
>> Ok
>> mac rx 1 1234567890
>> tx_ok
```

An orange arrow points from the text 'DL OK' to the received data line '>> mac rx 1 1234567890' in the Termiter window.

# Node-Red Setup

## # NodeRed Setup : Install

### Install node.js

We recommend the use of node.js LTS 6.x or 6.x . Node-RED no longer supports node.js 0.10.x or 0.12.x.

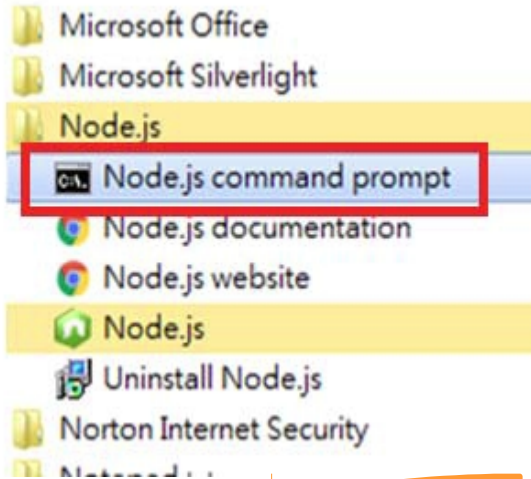
*Note:* Node.js 7.x is under active development and is not recommended for a stable base. Many 3rd party node packages may not yet fully support Node 7.x and later, especially if they contain a binary component. Check with the author of the package if you are not sure.

You can get the latest Long Term Support (LTS) version of Node **6.x** from:

- Max OS X Installer: Universal
- Windows Installer: 32-bit or **64-bit**
- Linux Binaries: 32-bit or 64-bit

# Node-Red Setup

# NodeRed Setup : Run Node.js command prompt  
npm install -g --unsafe-perm node-red



```
Node.js command prompt
Your environment has been set up for using Node.js 6.10.0 (x64) and npm.

C:\Users\Gino-E420> npm install -g --unsafe-perm node-red
npm WARN deprecated i18next-client@1.10.3: you can use npm install i18next from
version 2.0.0
npm WARN deprecated node-uuid@1.4.7: use uuid module instead
C:\Users\Gino-E420\AppData\Roaming\npm\node-red-pi -> C:\Users\Gino-E420\AppData\
Roaming\npm\node_modules\node-red\bin\node-red-pi
C:\Users\Gino-E420\AppData\Roaming\npm\node-red -> C:\Users\Gino-E420\AppData\Ro
aming\npm\node_modules\node-red\red.js
C:\Users\Gino-E420\AppData\Roaming\npm
`-- node-red@0.16.2
   +-- mqtt@2.2.1
      | +-- mqtt-packet@5.2.2
      | `-- readable-stream@2.2.6
      `-- node-red-node-twitter@0.1.10

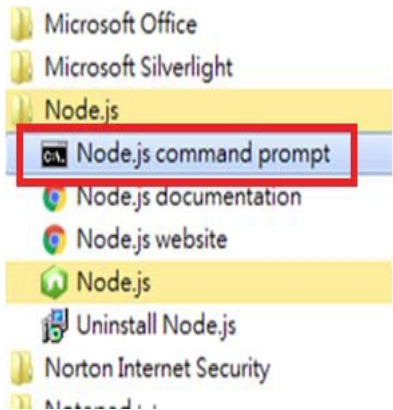
C:\Users\Gino-E420>
```





# Node-Red Setup

# NodeRed Setup : Run Node.js command prompt  
Execute dashboard Command



```
options@0.6.0
  -- ultron@1.0.2
  -- xml2js@0.4.17
  +-- sax@0.6.1
  -- xmlbuilder@4.2.1
  -- lodash@4.17.4

C:\Users\PW> npm install node-red-dashboard

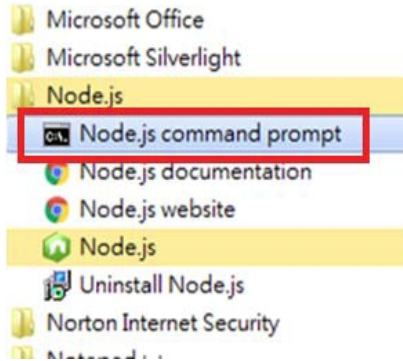
> node-red-dashboard@2.4.3 postinstall C:\Users\PW\node_modules\node-red-dashboard
> node fixfa.js

C:\Users\PW>
  -- node-red-dashboard@2.4.3
  +-- serve-static@1.12.4
  +-- encodeurl@1.0.1
  +-- escape-html@1.0.3
  +-- parseurl@1.3.1
  -- send@0.15.4
  +-- debug@2.6.8
  +-- depd@1.1.1
  +-- destroy@1.0.4
```



# Node-Red Setup

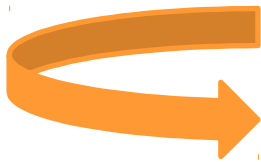
# NodeRed Setup : run Node.js command prompt  
Execute `node-red -v`



```
node-red
C:\Users\Gino-E420>node-red -v
17 Mar 14:56:44 - [info]

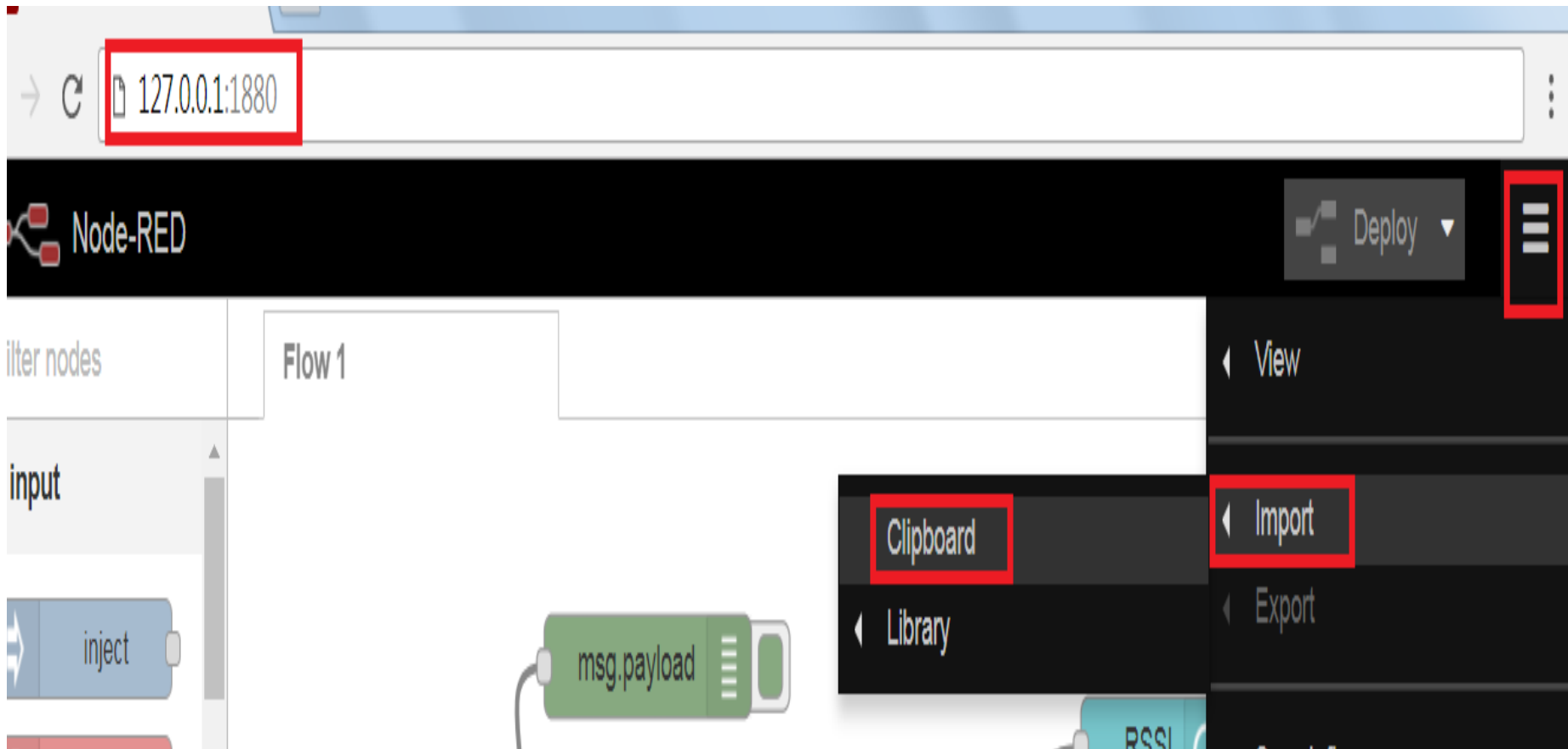
Welcome to Node-RED
=====

17 Mar 14:56:44 - [info] Node-RED version: v0.16.2
17 Mar 14:56:44 - [info] Node.js version: v6.10.0
17 Mar 14:56:44 - [info] Windows_NT 6.1.7601 x64 LE
17 Mar 14:56:45 - [info] Loading palette nodes
17 Mar 14:56:47 - [info] Dashboard version 2.3.5 started at /ui
17 Mar 14:56:47 - [warn] -----
17 Mar 14:56:47 - [warn] [rpi-gpio] Info : Ignoring Raspberry Pi specific node
17 Mar 14:56:47 - [warn] [tail] Not currently supported on Windows.
17 Mar 14:56:47 - [warn] -----
17 Mar 14:56:47 - [info] Settings file : \Users\Gino-E420\.node-red\settings.js
17 Mar 14:56:47 - [info] User directory : \Users\Gino-E420\.node-red
17 Mar 14:56:47 - [info] Flows file : \Users\Gino-E420\.node-red\flows_Leo-E420-THINK.json
17 Mar 14:56:47 - [info] Server now running at http://127.0.0.1:1880/
17 Mar 14:56:47 - [info] Starting flows
17 Mar 14:56:47 - [info] Started flows
17 Mar 14:56:48 - [info] [ttn app:33675034.1007a] Connected to TTN application 12314249
```



# Node-Red Setup

# NodeRed Setup : Import Node-Red sample code



# Node-Red Setup

## # NodeRed Setup : Import Node-Red sample code

Node-RED interface showing the 'Import nodes' dialog box. The dialog contains a text area with sample code for importing nodes into the current flow. The code defines a tab and a group for an ACSIP Sensor Dashboard.

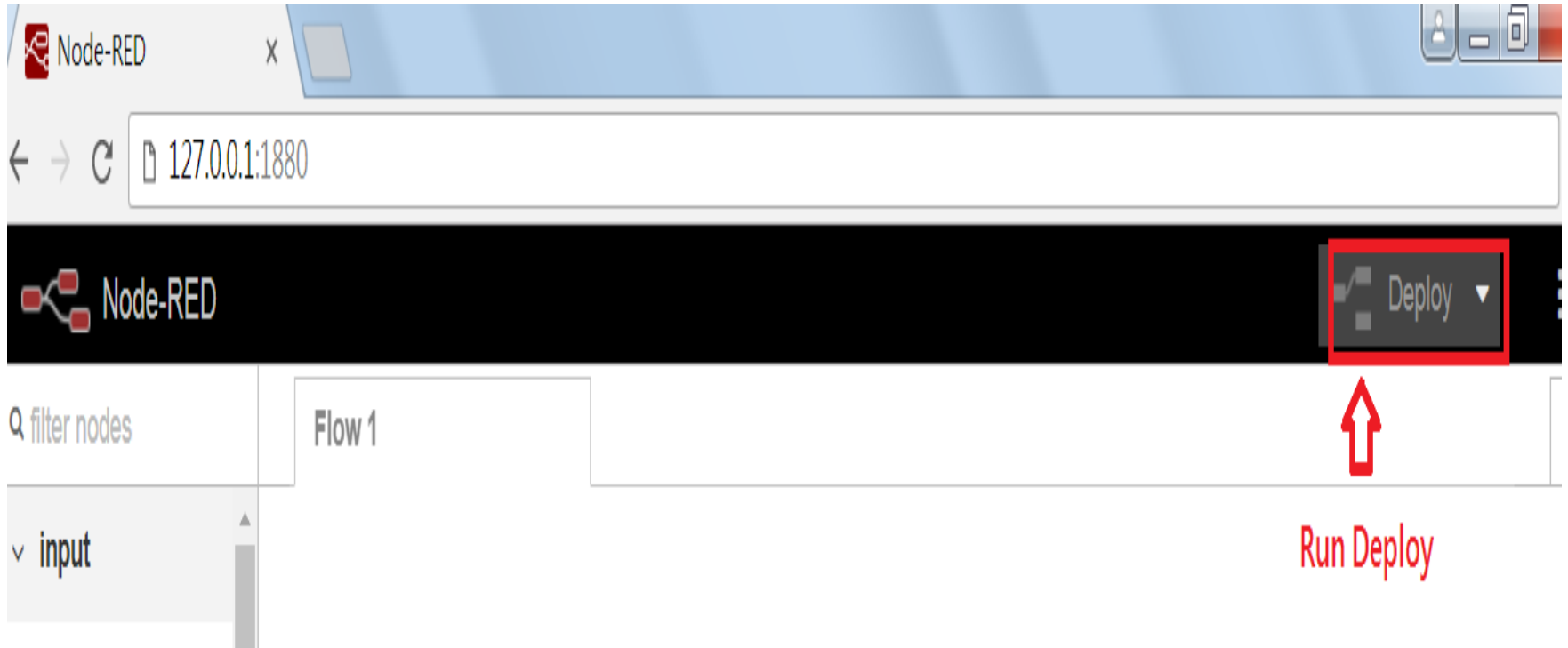
```
re", "tab": "4c57e140.a6d73", "order": 1, "disp": true, "width": "6"},  
{ "id": "bea9045e.d41338", "type": "ui_group", "z": "", "name": "RSSI", "ta  
b": "4c57e140.a6d73", "order": 3, "disp": true, "width": "6"},  
{ "id": "4c57e140.a6d73", "type": "ui_tab", "z": "", "name": "ACSIP  
Sensor Dashboard", "icon": "dashboard" }
```

Import to:  current flow  new flow

Buttons: Cancel, Import

# Node-Red Setup

## # NodeRed Setup : Import Node-Red sample code



# Node-Red Setup

## # NodeRed Setup : Modify Node Properties

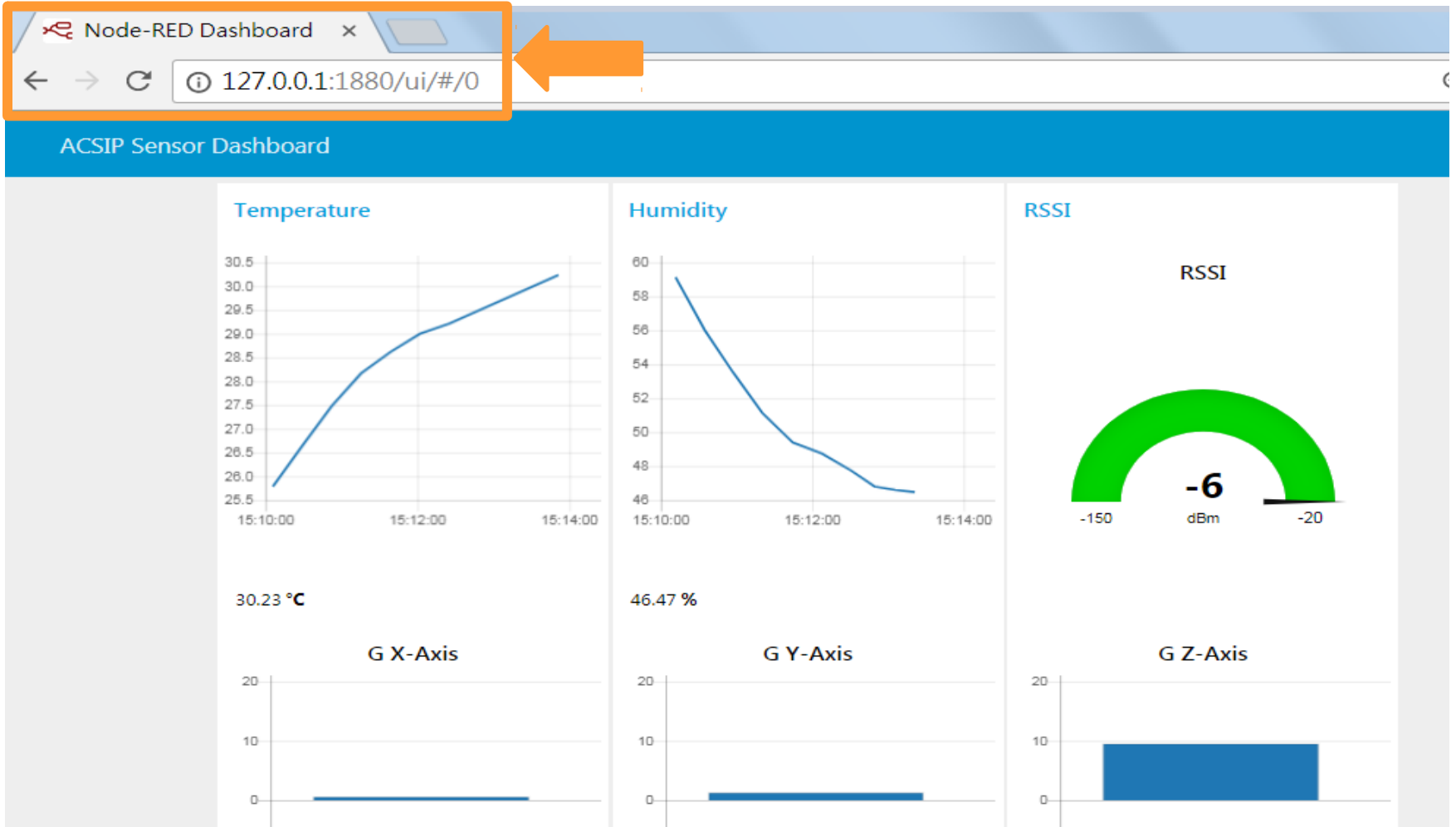
The screenshot shows the Node-RED interface with a flow named 'Flow 1'. A 'TEST' node (MQTT client) is highlighted with a red box. The 'Edit mqtt in node' dialog is open, showing the following properties:

- Server: 192.168.88.137:1883 (Annotated: Modify to your DHCP Address)
- Topic: GIOT-GW/UL/1C497B498C90 (Annotated: Modify to your Gateway MAC (See Gateway Label))
- QoS: 2
- Name: TEST

The 'Done' button is highlighted with a blue box and an arrow pointing to it.

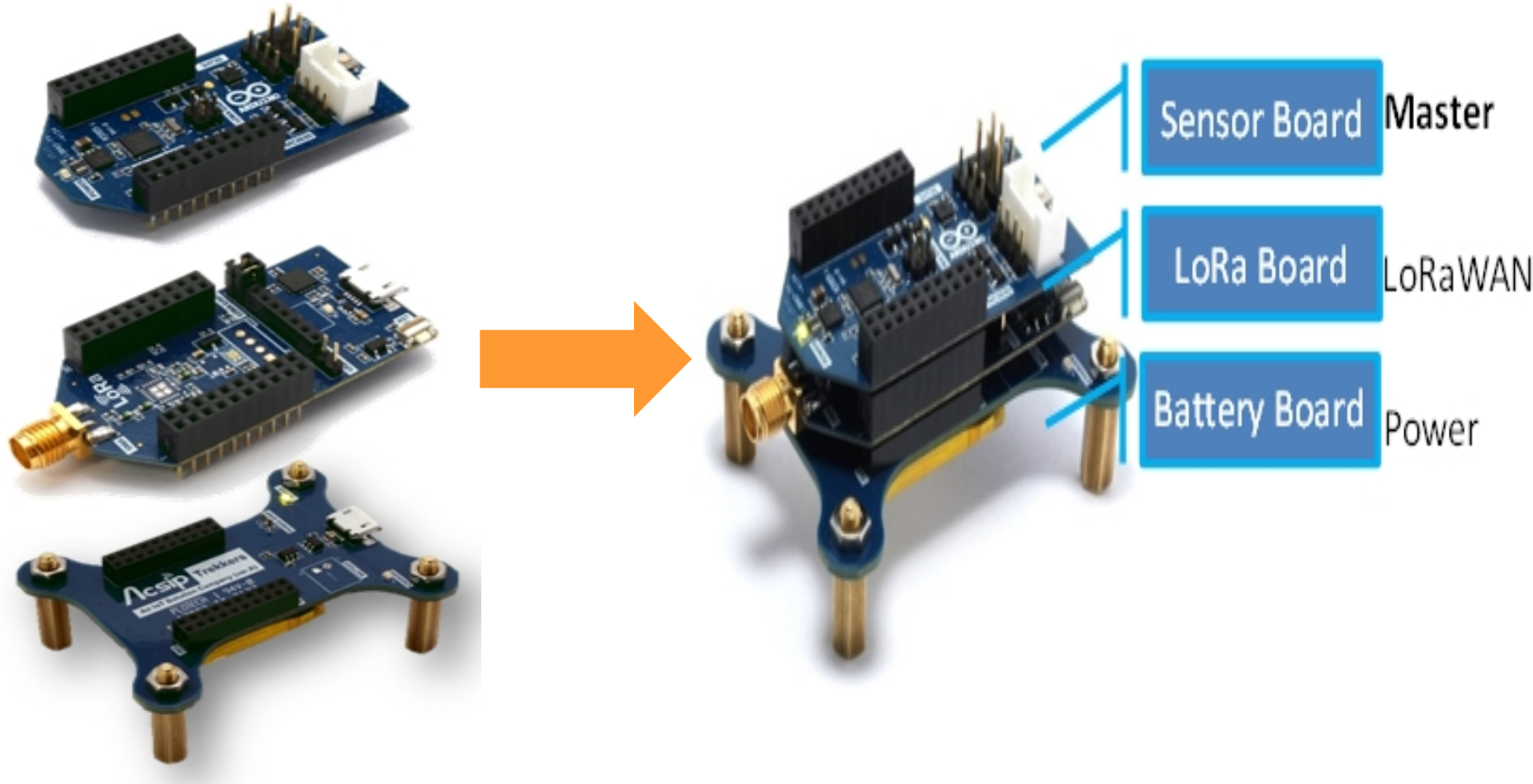
# Node-Red Setup

# Dashboard Demo : [127.0.0.1:1880/ui/#/0](http://127.0.0.1:1880/ui/#/0)



# SmartBlocks Introduction

## # Hardware Combination : Board Stack





# SmartBlocks Introduction

## # Hardware Combination : Board Communication

S76S Lora

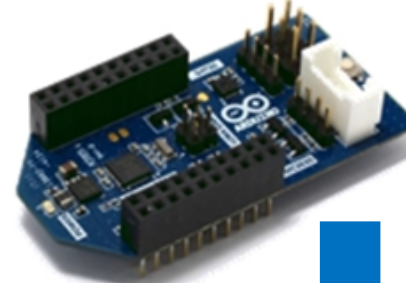


UART 1



Sensor Board

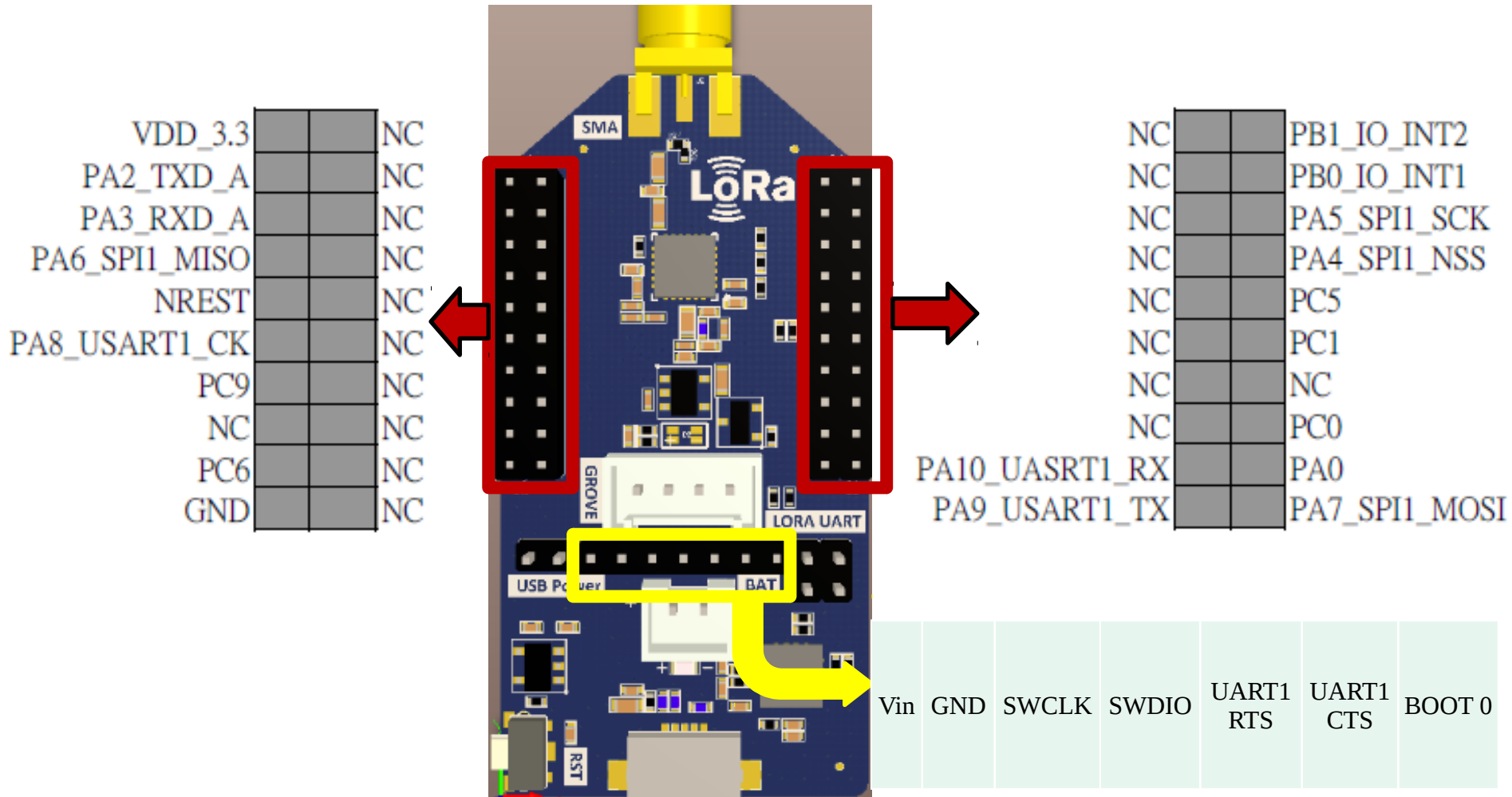
MCU:ATmega328p



Model Name	Function description	Interface	address
SHT30	Humidity and Temperature Sensor	I <sup>2</sup> C	0x45
MC3060	3-Axis Accelerometer	I <sup>2</sup> C	0x6C

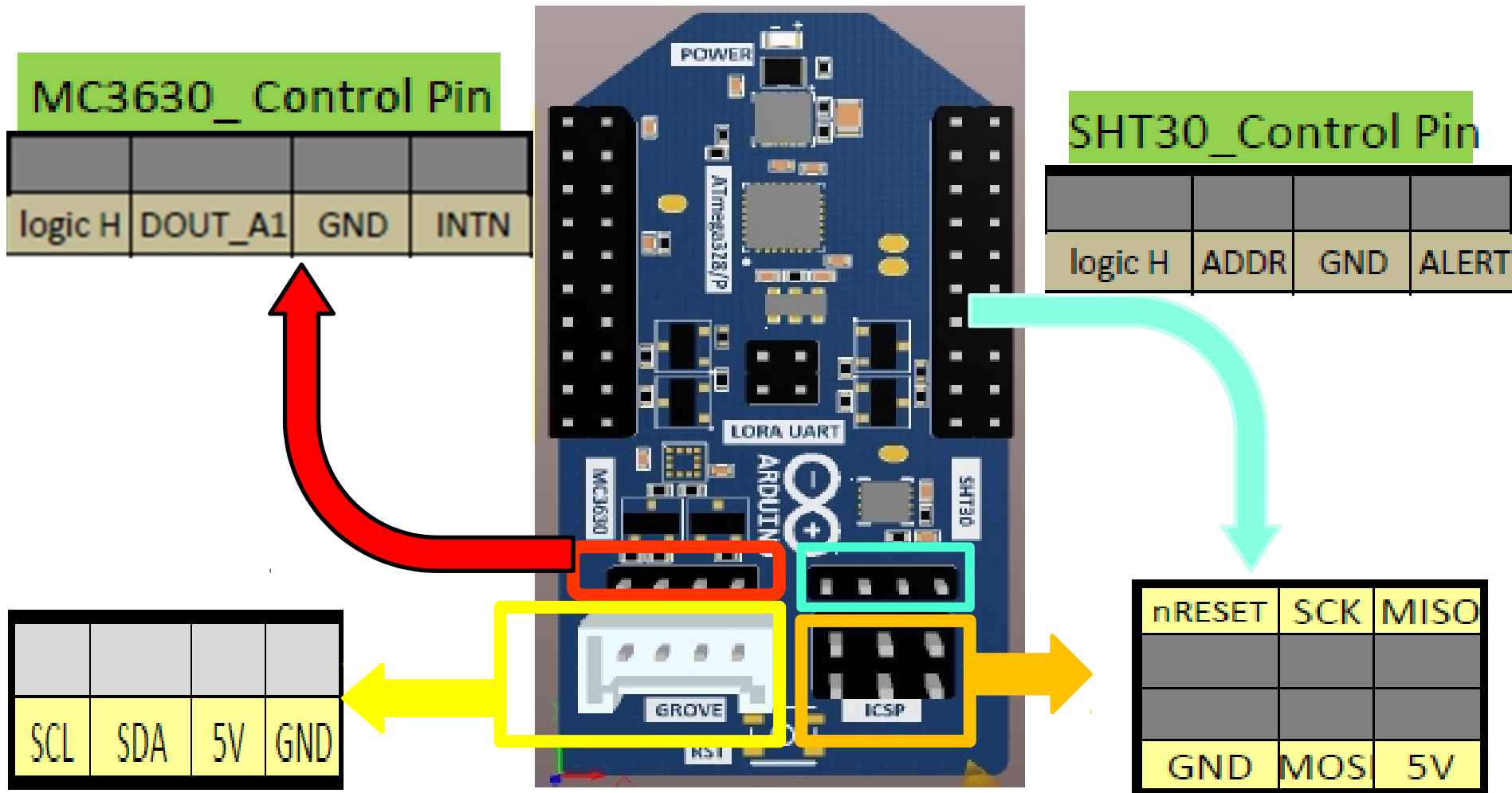
# SmartBlocks Introduction

## # Hardware Combination : LoRa Board Pinout



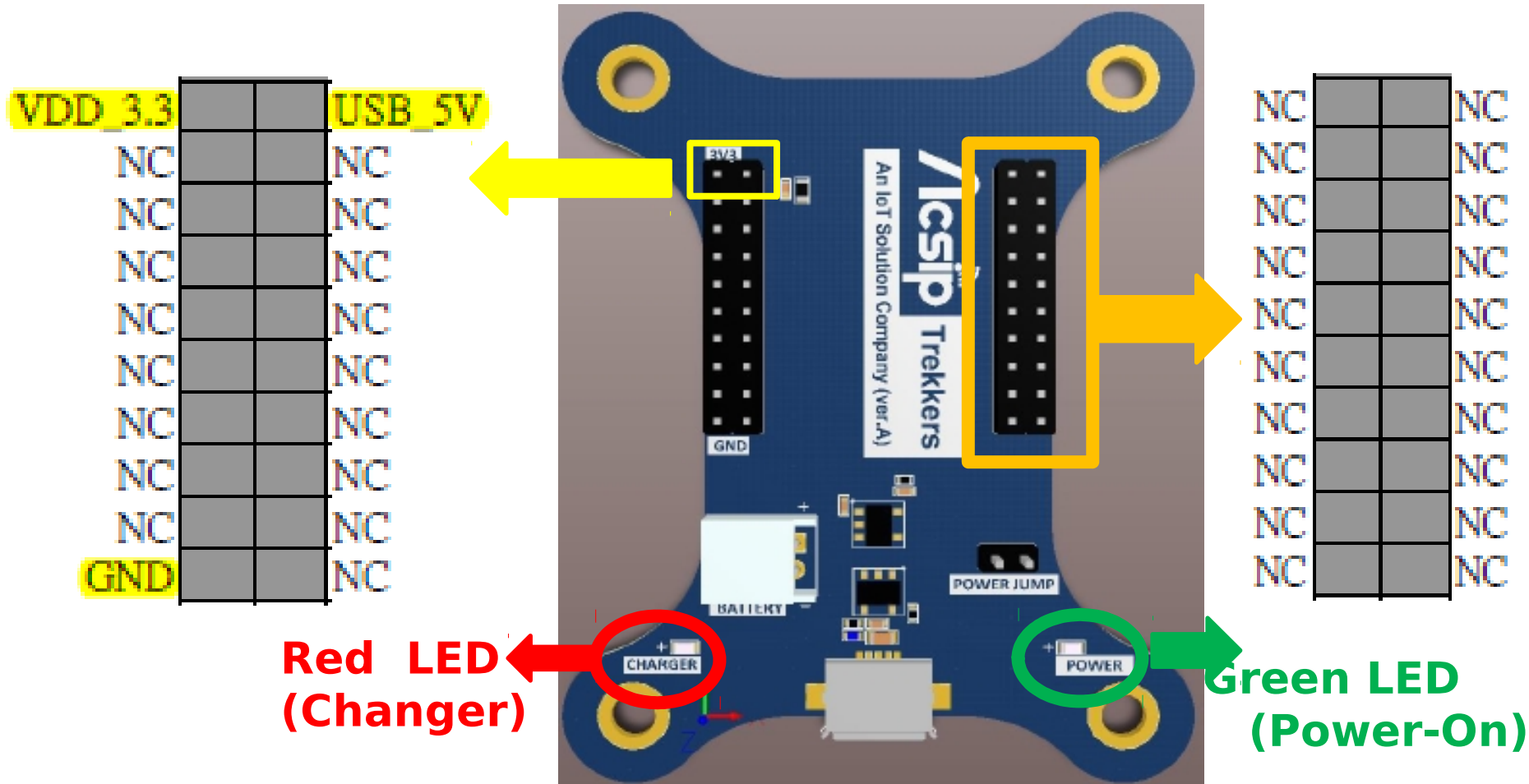
# SmartBlock Introduction

## # Hardware Combination : Sensor Board Pinout



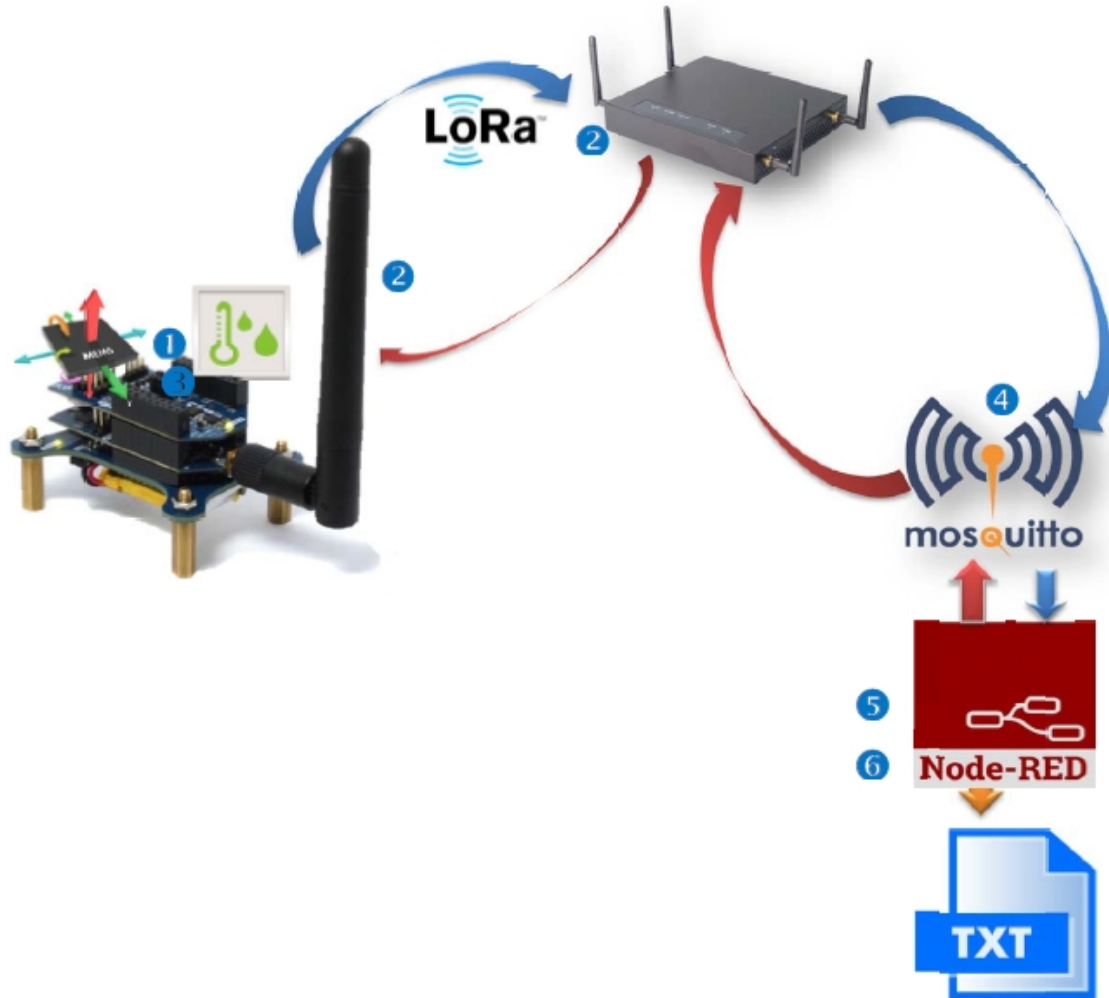
# SmartBlocks Introduction

## # Hardware Combination : Power Board Pinout



# SmartBlocks Introduction

## # Software Setup : Data Flow

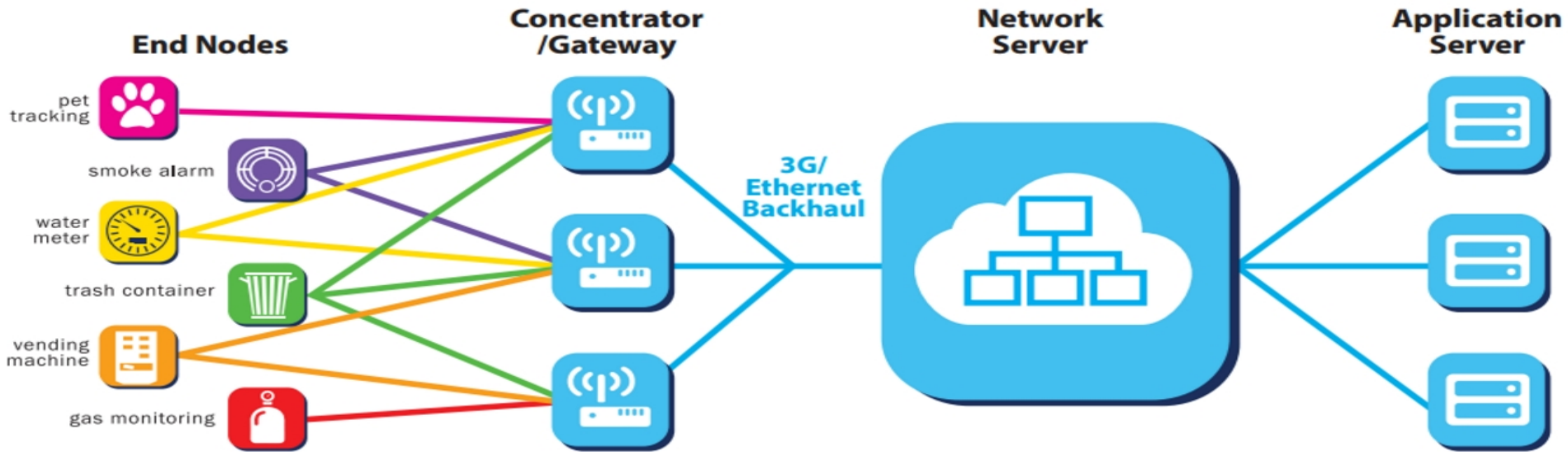


# How Smart

1. 節省 RF 開發的時間
2. 軟體彈性
3. 硬體延伸性

# LoRaWAN Architecture

## # Ecosystem :



# LoRaWAN Architecture

## # End-Device Activation :

- **Over-The-Air Activation (OTAA)**
- **Activation By Personalization (ABP)**

Refer the table below about relationship of key, ID, EUI and mode:

Mode	ID/EUI	Key
ABP	DevAddr	NwkSKey, AppSKey
OTAA	AppEUI, DevEUI	AppKey



# S76S Setup – Command Set

## # Set CH0 ~ CH15 Frequency

=> Must be the same as Gateway Frequency Plan

```
Termite 3.2 (by CompuPhase)
DM188 115200 bps, 8N1, no handshak Settings Clear About Close
LoRaWAN v1.0.2 F
(Class A & C)
>> S76S - v1.4.2 - AS923 - Apr 19 2017 - 09:46:
mac set_ch_freq 0 922625000
>> Ok
mac set_ch_freq 1 922875000
>> Ok
mac set_ch_freq 2 923125000
>> Ok
mac set_ch_freq 3 923375000
>> Ok
mac set_ch_freq 4 923625000
>> Ok
mac set_ch_freq 5 923875000
>> Ok
mac set_ch_freq 6 924125000
>> Ok
mac set_ch_freq 7 924375000
>> Ok
```

```
Termite 3.2 (by CompuPhase)
DM188 115200 bps, 8N1, no handshak Settings Clear About Close
mac set_ch_freq 8 925125000
>> Ok
mac set_ch_freq 9 925375000
>> Ok
mac set_ch_freq 10 925625000
>> Ok
mac set_ch_freq 11 925875000
>> Ok
mac set_ch_freq 12 926125000
>> Ok
mac set_ch_freq 13 926375000
>> Ok
mac set_ch_freq 14 926625000
>> Ok
mac set_ch_freq 15 926875000
>> Ok
mac save
>> Ok
```

# S76S Setup – Command Set

## # Get Gateway Frequency Plan :

Status

GloT

Status

Provision

Configuration

Network Server

Channel Scan

Channel Setting

GPS MAP

System

Network

Logout

## GloT Status

### GloT Info

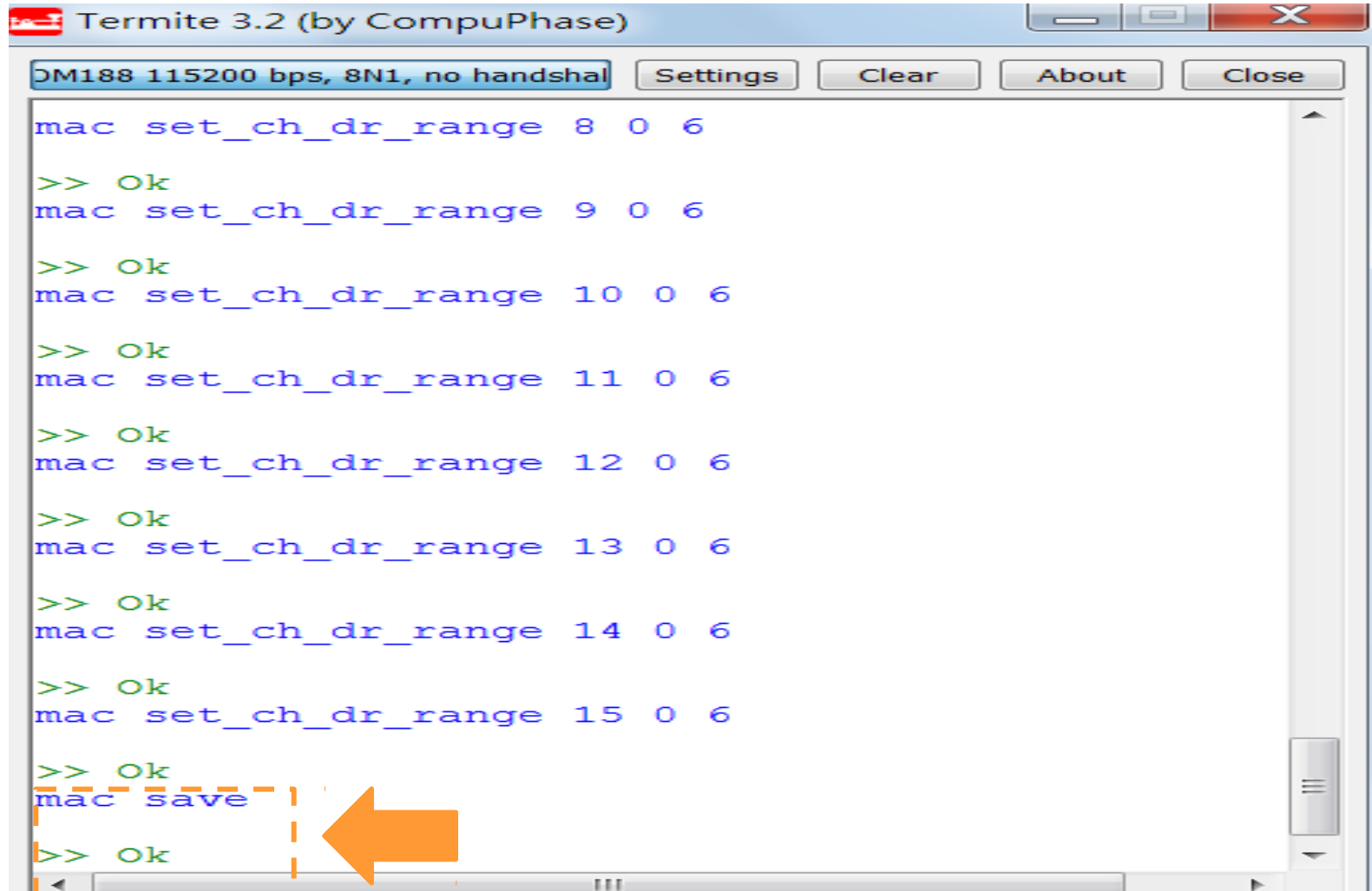
Provisioning Code	B200A156 (Provision)
Area Code	B200A156
Gateway Type	Femto
LoRa Module	ON
Gateway ID	1c497bca5a09

Channel List

Radio 0	Ch0: ON 485.7MHz
	Ch1: ON 485.9MHz
	Ch2: ON 486.1MHz
	Ch3: ON 486.3MHz
Radio 1	Ch4: ON 486.5MHz
	Ch5: ON 486.7MHz
	Ch6: ON 486.9MHz
	Ch7: ON 487.1MHz

# S76S Setup – Command Set

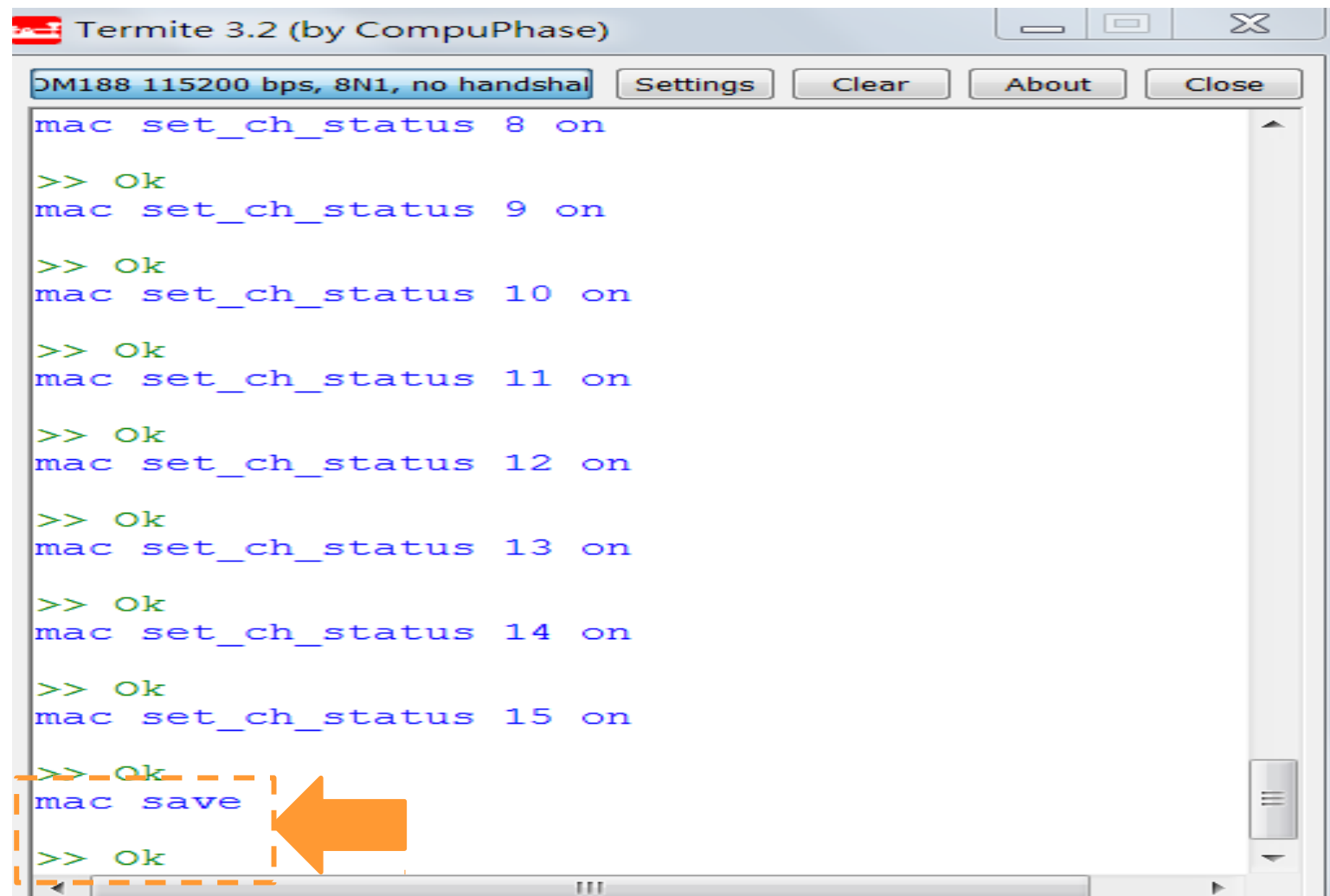
## # Set CH8 ~ CH15 DR Range



```
DM188 115200 bps, 8N1, no handshak Settings Clear About Close
mac set_ch_dr_range 8 0 6
>> Ok
mac set_ch_dr_range 9 0 6
>> Ok
mac set_ch_dr_range 10 0 6
>> Ok
mac set_ch_dr_range 11 0 6
>> Ok
mac set_ch_dr_range 12 0 6
>> Ok
mac set_ch_dr_range 13 0 6
>> Ok
mac set_ch_dr_range 14 0 6
>> Ok
mac set_ch_dr_range 15 0 6
>> Ok
mac save
>> Ok
```

# S76S Setup – Command Set

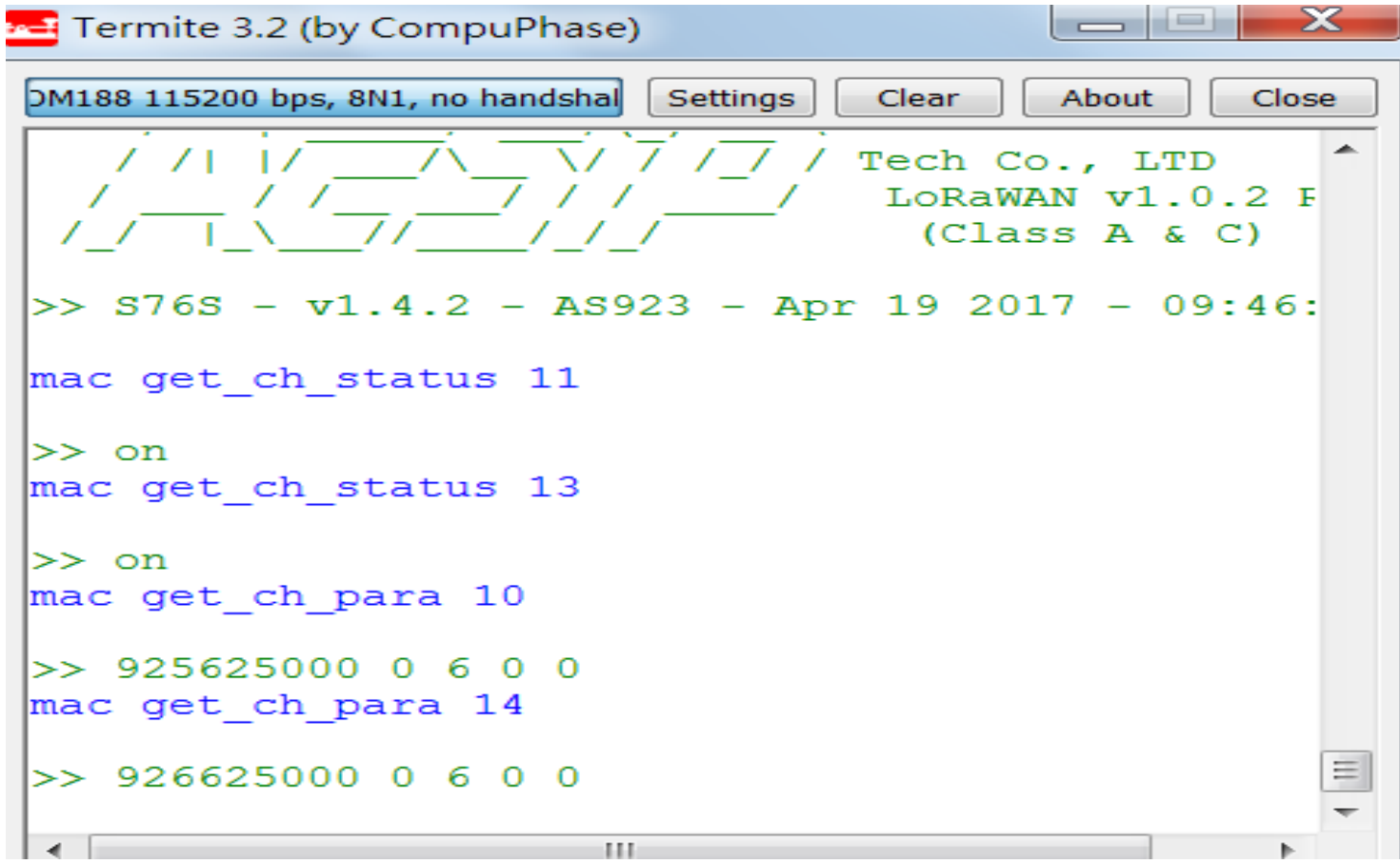
## # Set CH8 ~ CH15 Status ON



```
DM188 115200 bps, 8N1, no handshal Settings Clear About Close
mac set_ch_status 8 on
>> Ok
mac set_ch_status 9 on
>> Ok
mac set_ch_status 10 on
>> Ok
mac set_ch_status 11 on
>> Ok
mac set_ch_status 12 on
>> Ok
mac set_ch_status 13 on
>> Ok
mac set_ch_status 14 on
>> Ok
mac set_ch_status 15 on
>> Ok
mac save ←
>> Ok
```

# S76S Setup – Command Set

# Check CH0 ~ Ch15 Status Command :  
mac get\_ch\_status X & mac get\_ch\_para X



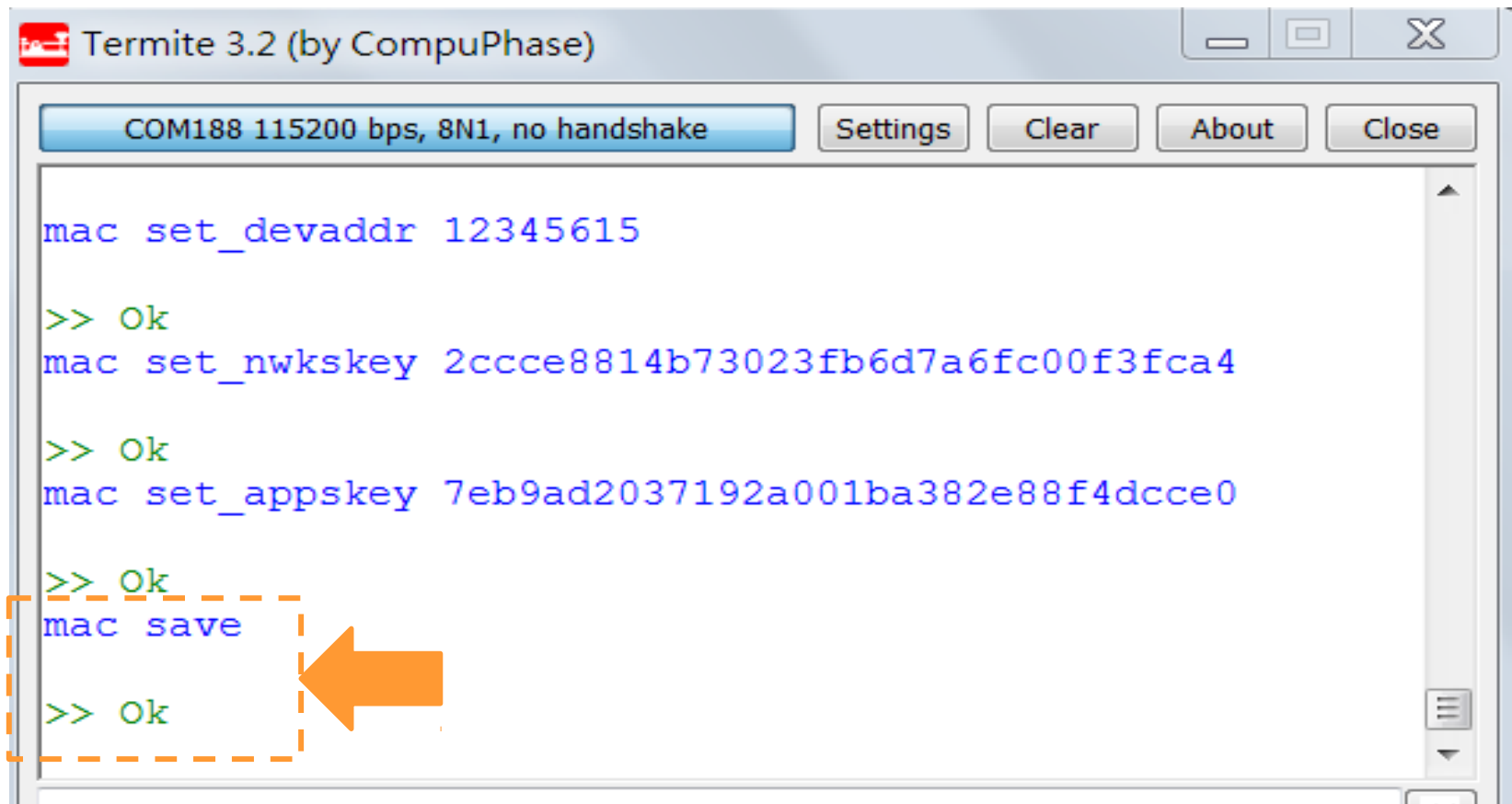
The screenshot shows a terminal window titled "Termite 3.2 (by CompuPhase)". The window displays the following text:

```
DM188 115200 bps, 8N1, no handshal Settings Clear About Close
Tech Co., LTD
LoRaWAN v1.0.2 F
(Class A & C)
>> S76S - v1.4.2 - AS923 - Apr 19 2017 - 09:46:
mac get_ch_status 11
>> on
mac get_ch_status 13
>> on
mac get_ch_para 10
>> 925625000 0 6 0 0
mac get_ch_para 14
>> 926625000 0 6 0 0
```

# S76S Setup – Command Set

# ABP Setup ( DevAddr 、 NwkSKey 、 AppSKey )

=> Must be the same as Gateway ABP Table



The screenshot shows a terminal window titled "Termit 3.2 (by CompuPhase)". The window has a status bar at the top that reads "COM188 115200 bps, 8N1, no handshake" and buttons for "Settings", "Clear", "About", and "Close". The terminal content shows the following sequence of commands and responses:

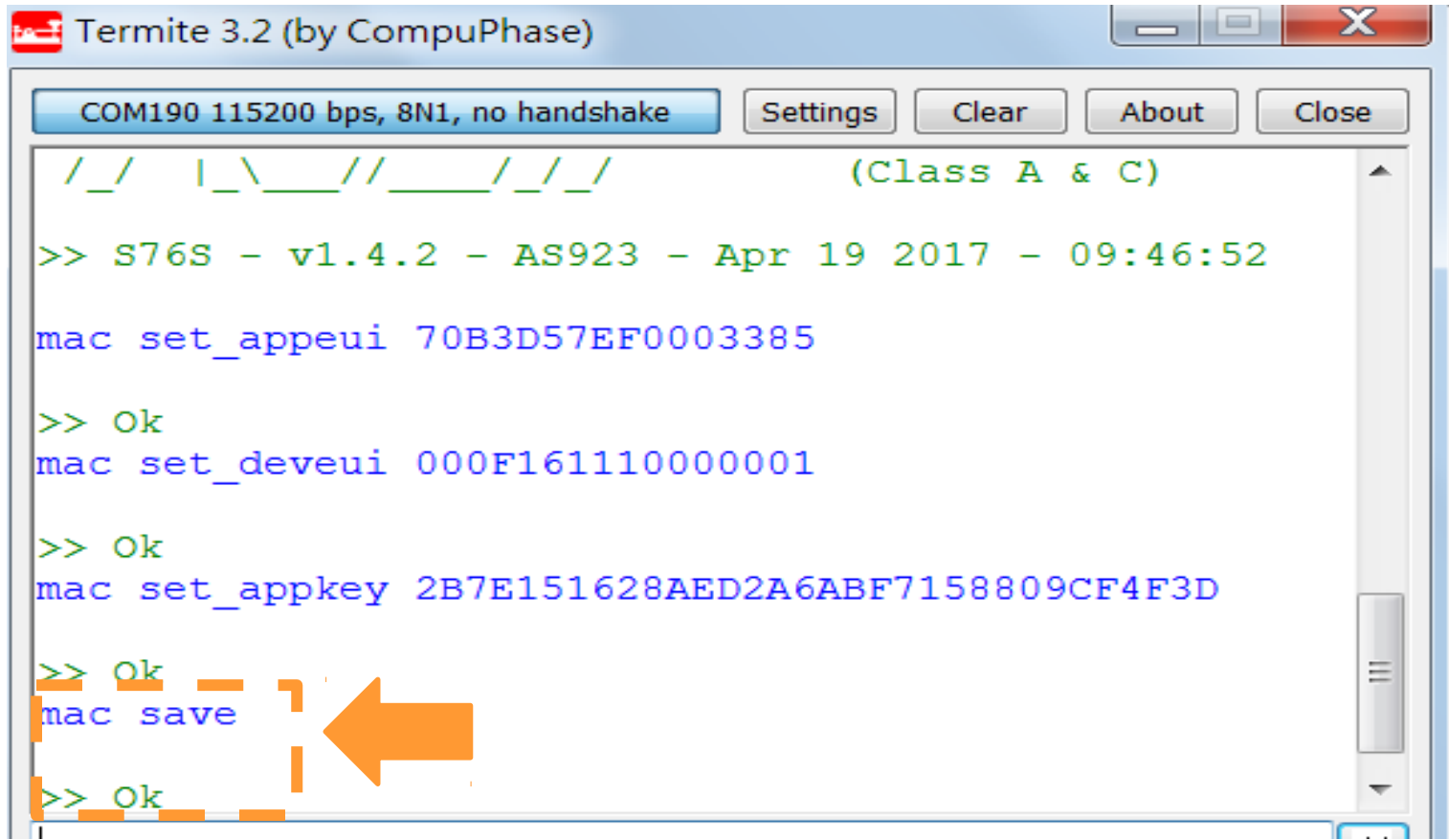
```
mac set_devaddr 12345615
>> Ok
mac set_nwkskey 2ccce8814b73023fb6d7a6fc00f3fca4
>> Ok
mac set_appskey 7eb9ad2037192a001ba382e88f4dcce0
>> Ok
mac save
>> Ok
```

An orange dashed box highlights the "mac save" command and its response ">> Ok". A large orange arrow points from the right towards the "mac save" command.

# S76S Setup – Command Set

# OTAA Setup ( AppEUI 、 DevEUI 、 AppKey )

=> Must be the same as Gateway OTAA Table



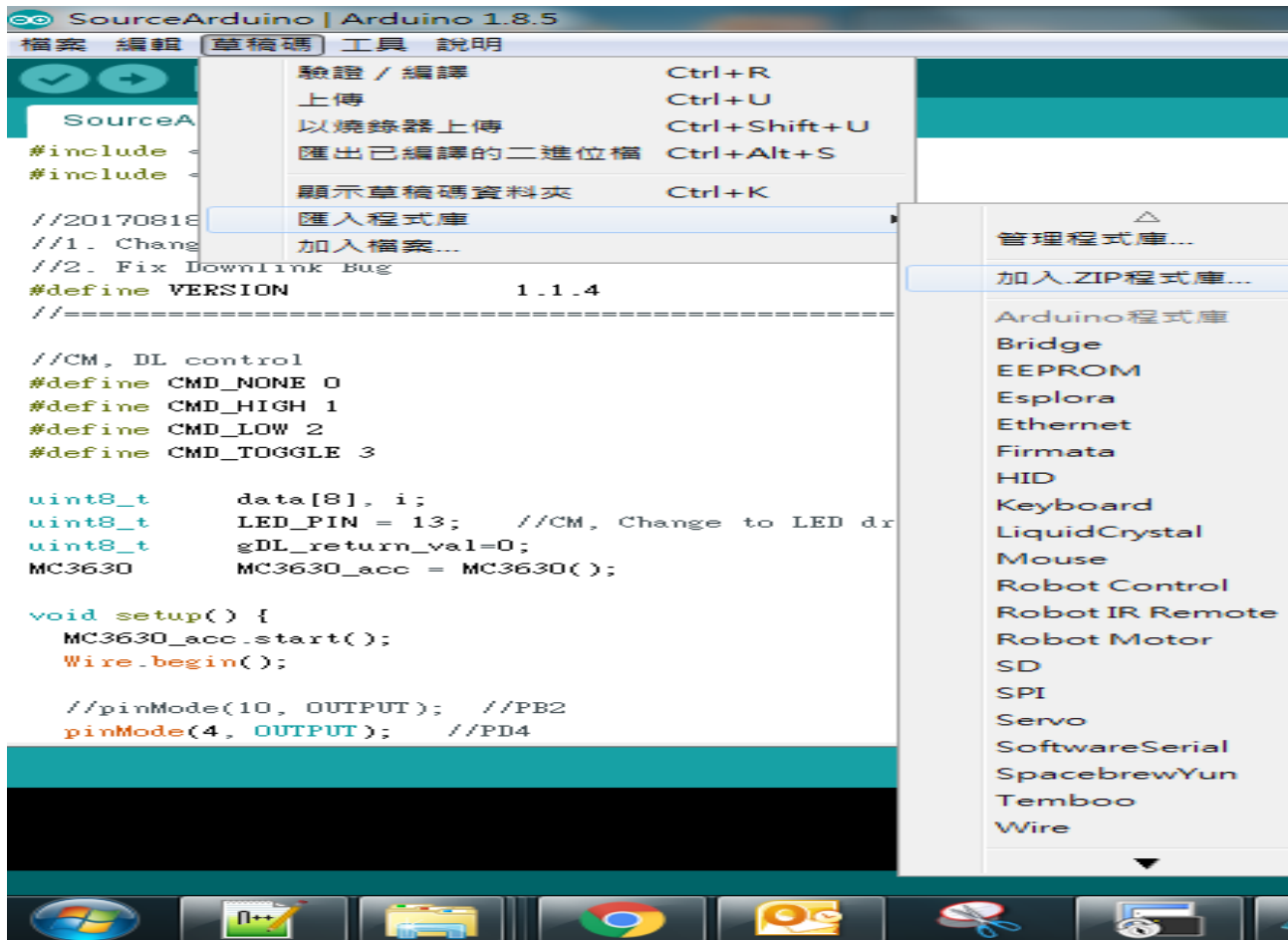
The screenshot shows a terminal window titled "Termitte 3.2 (by CompuPhase)" with a status bar indicating "COM190 115200 bps, 8N1, no handshake". The terminal output is as follows:

```
COM190 115200 bps, 8N1, no handshake  Settings  Clear  About  Close
/_/ |_\_//___//_/ (Class A & C)
>> S76S - v1.4.2 - AS923 - Apr 19 2017 - 09:46:52
mac set_appeui 70B3D57EF0003385
>> Ok
mac set_deveui 000F161110000001
>> Ok
mac set_appkey 2B7E151628AED2A6ABF7158809CF4F3D
>> Ok
mac save
>> Ok
```

An orange arrow points to the "mac save" command, which is highlighted with a dashed orange box.

# Sensor Board Firmware

Import library for fist time verify





# Sensor Board Firmware

## Arduino Firmware: Setup

```
void setup() {
  MC3630_acc.start();
  Wire.begin();

  //pinMode(10, OUTPUT); //PB2
  pinMode(4, OUTPUT); //PD4
  pinMode(LED_PIN, OUTPUT); //PB5
  digitalWrite(LED_PIN, HIGH);
  //digitalWrite(4, HIGH);

  Serial.begin(115200);
  delay(1000);

  /*
   * joining by otaa (or abp), you should be get a accepted message.
   */
  Serial.print("mac join abp");
  delay(5000);
}
```

# Sensor Board Firmware

## Arduino Firmware:Loop

```
void loop() {  
  
    static bool pin_status = false;  
    SensorSHT30();  
    SensorMC3630();  
    switch(gDL_return_val)  
    {  
        case CMD_HIGH:  
            pin_status=true;  
            digitalWrite(LED_PIN, HIGH);  
            break;  
  
        case CMD_LOW:
```

# Sensor Board Firmware

## Arduino Firmware: Send Tx Command

```
void LoRaPackageTx(String keyword, float data)
{
  String str1, str2;
  char test[64];
  int i;

  str1 = keyword+ data;
  for(i=0; i<str1.length(); i++)
  {
    test[(i<<1)] = str1[i]>>4;
    test[(i<<1)+1] = str1[i]&0xF;
    if(test[(i<<1)]<0xA) test[(i<<1)] = test[(i<<1)] +0x30;
    else test[(i<<1)] = test[(i<<1)] +0x57;
    if(test[(i<<1)+1]<0xA) test[(i<<1)+1] = test[(i<<1)+1] +0x30;
    else test[(i<<1)+1] = test[(i<<1)+1] +0x57;
  }
  test[(i<<1)] = 0x00;
  str2 = test;
  str1 = "mac tx ucnf 2 " + str2;
  Serial.print(str1);

  //digitalWrite(4, HIGH); //CM, For Debug
  //digitalWrite(13, HIGH);

  return;
}
```

# Sensor Board Firmware

## ## Software Setup : Firmware Update

WorkFlow:

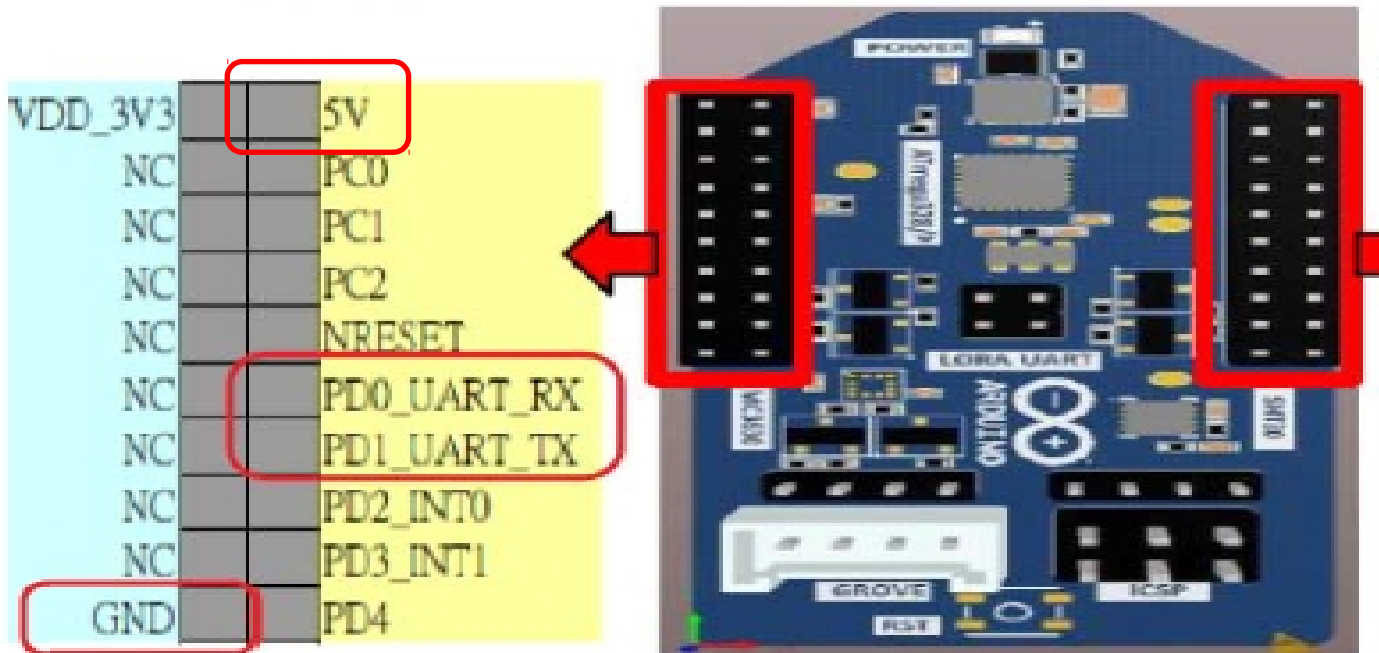
1. Setup ISP
2. Configuring as “Acsip UNO Board”
3. Configuring ISP with your Device(Sensor Board)
4. Programming
5. Verify your ino(Firmware)


詳細內容請參考：

[.\SmartBlocks\\_DevKit\\_Package\(S76S\)\\_V1.1.4\SmartBlocks\\_DevKit\\_Package\(S76S\)\\_V1.1.4\Docs\SensorBoard\Arduino\\_ICSP\\_Update\\_FW.pdf](#)

# Sensor Board Firmware

- # Open UART console tool to Verify Sensor Board Update F/W OK by ISP
- # Check output log





# Q & A