Lab 3: Sending data using WiFi and low power mode. Configuring RaspBerryPi as a local middleware.

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Step Zero

Clean up your desks! :)

Goals of this Lab

- Learn how to send sensor data via WiFi.
- Configure RPi as a local Middleware
- Go into sleep and low power mode

- Excercises about:
  - sending WiFi data to ThingSpeak online
  - Using RPi as middleware and sending data using GPRS
  - Going into sleep mode and switching off grove

Start!

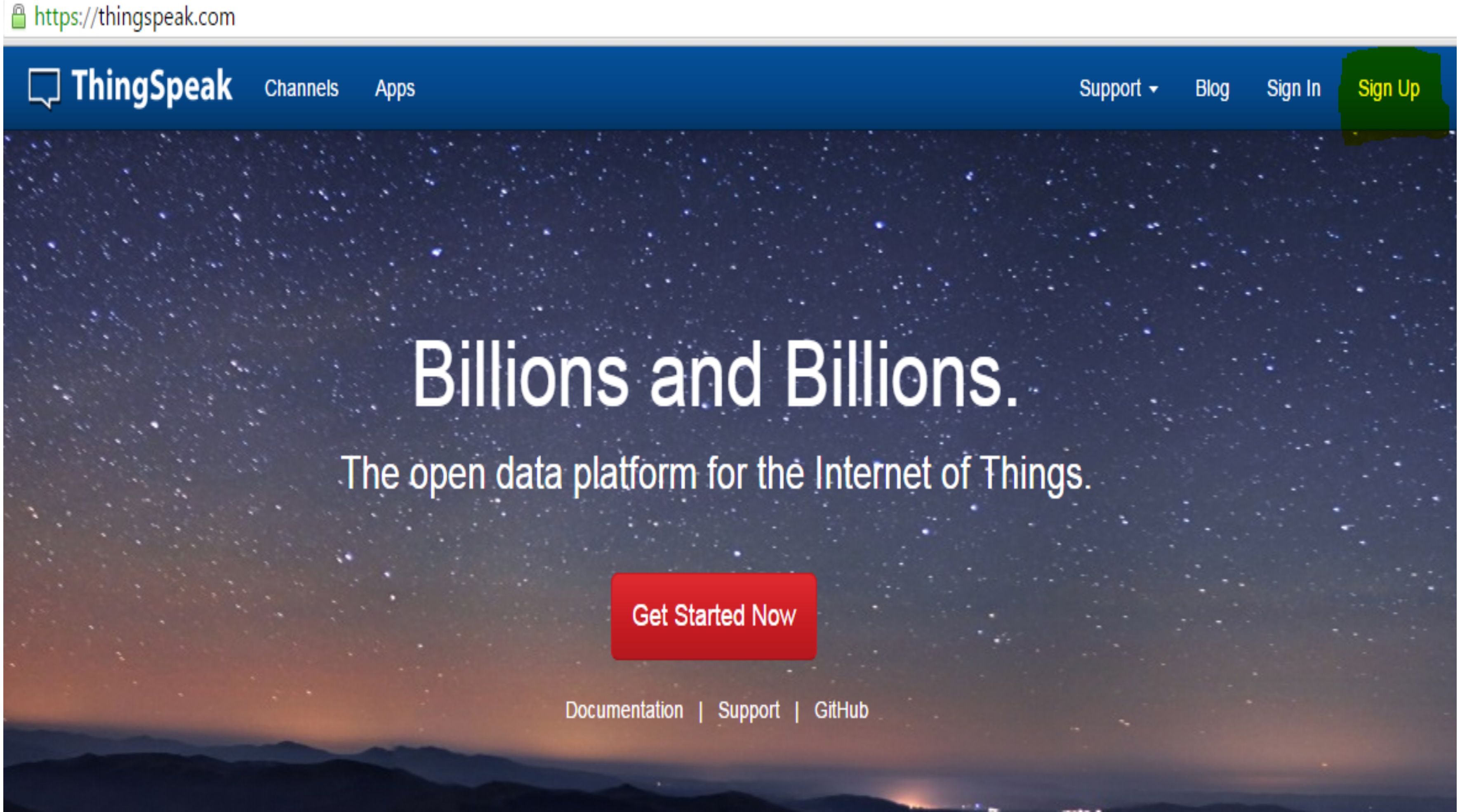
Example 1

This example will connect Mbili board using Wee board to an Ap router. It will create a TCP connection with ThingSpeak to post TPH data online.

Wee is a WIFI module based on ESP8266

Create a free account in ThingSpeak.com

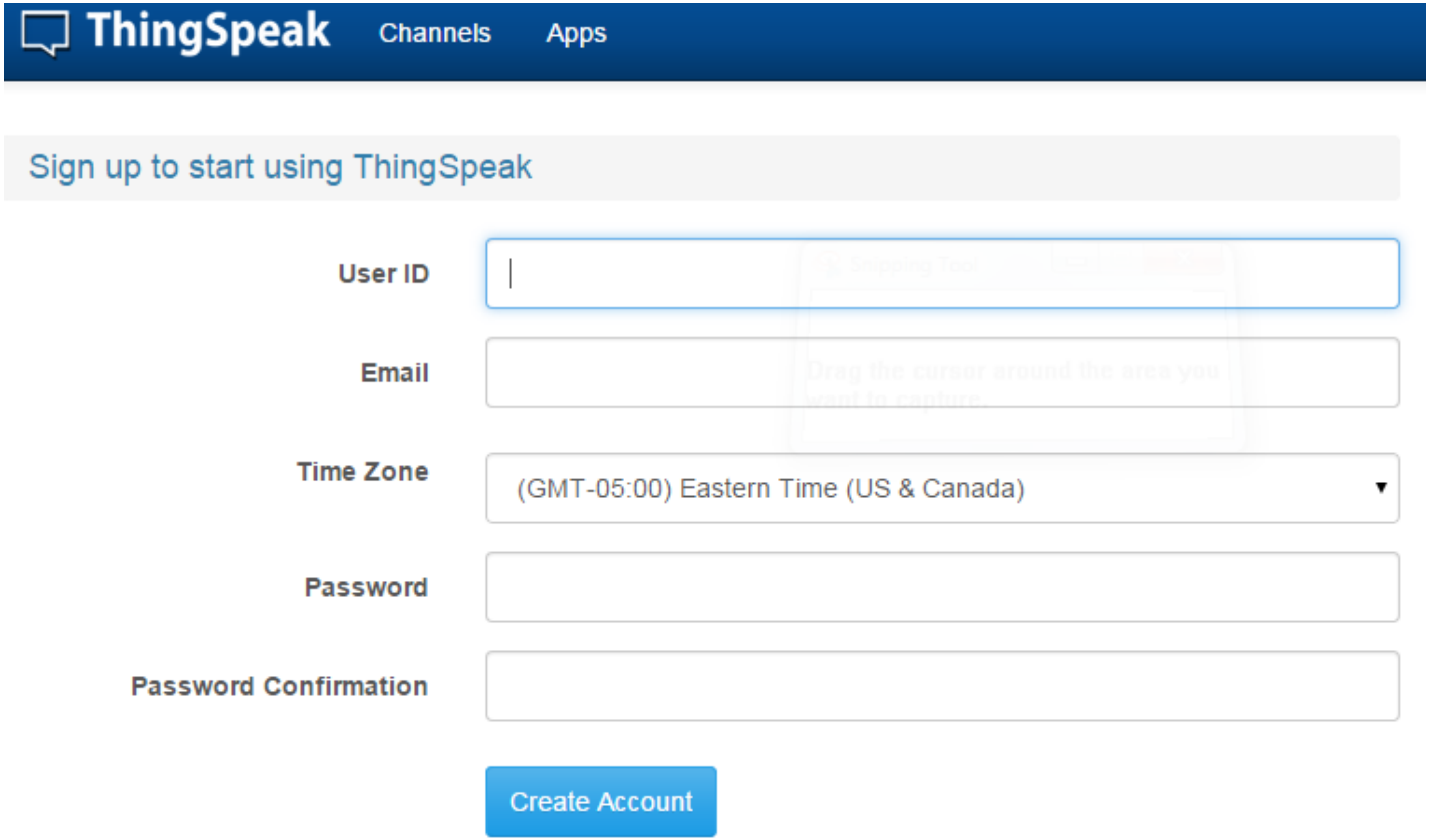
- Sign up



https://thingspeak.com

Billions and Billions.

The open data platform for the Internet of Things.



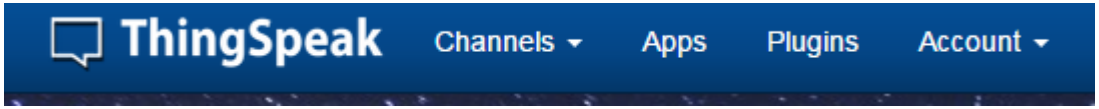
Sign up to start using ThingSpeak

User ID	
Email	
Time Zone	(GMT-05:00) Eastern Time (US & Canada) ▾
Password	
Password Confirmation	

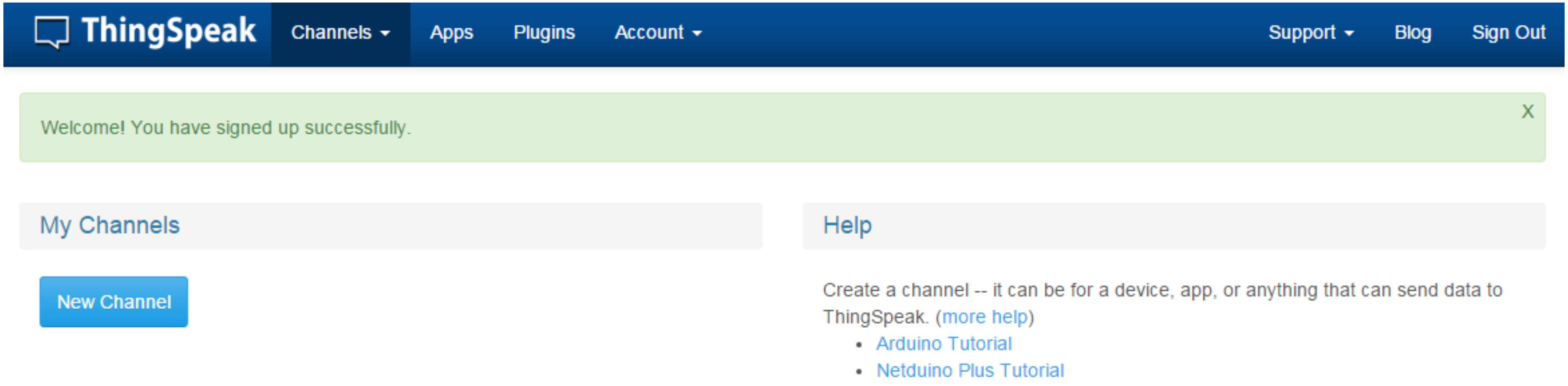
Drag the cursor around the area you want to capture.

ThingSpeak

- In TS menu you will have



Create a new channel in Channel option



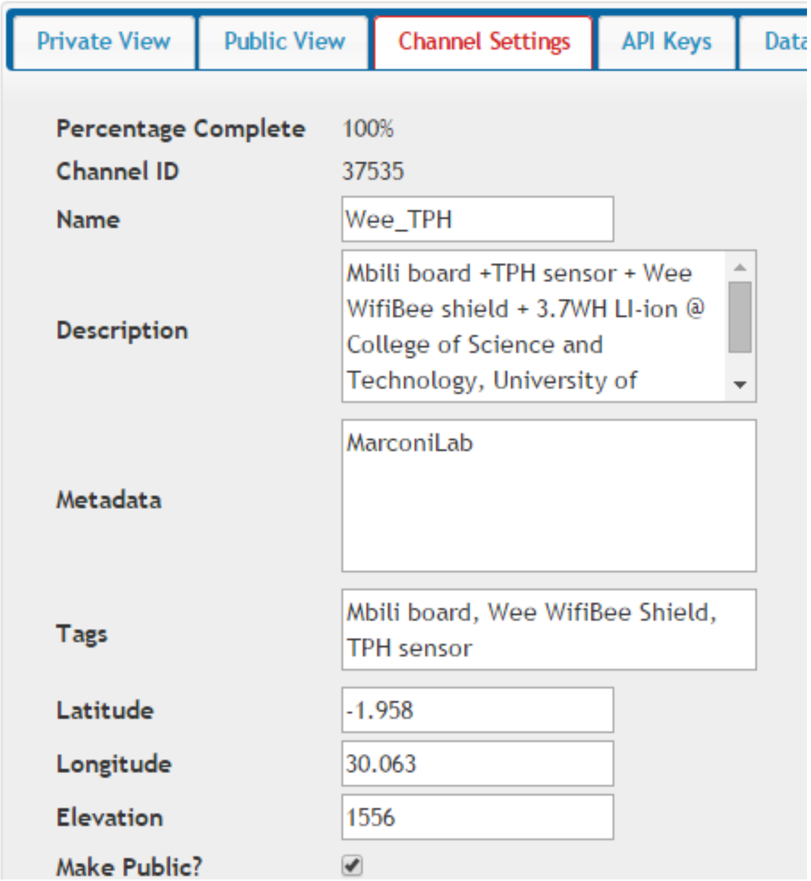
Welcome! You have signed up successfully.

Create a channel -- it can be for a device, app, or anything that can send data to ThingSpeak. (more help)

- Arduino Tutorial
- Netduino Plus Tutorial

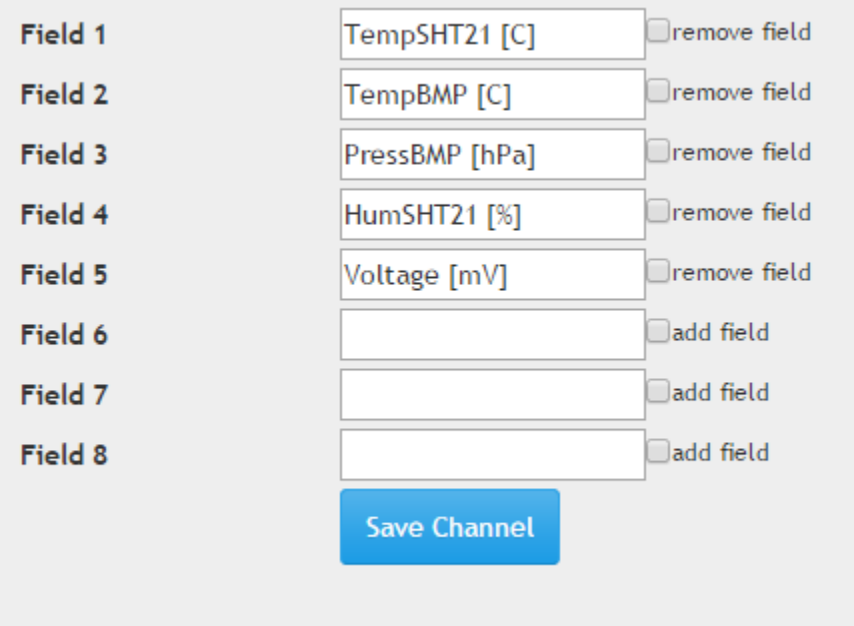
Example 1

- Channel with 5 fields and copy your API KEY



Percentage Complete	100%
Channel ID	37535
Name	Wee_TPH
Description	Mbili board +TPH sensor + Wee WifiBee shield + 3.7WH LI-ion @ College of Science and Technology, University of
Metadata	MarconiLab
Tags	Mbili board, Wee WifiBee Shield, TPH sensor
Latitude	-1.958
Longitude	30.063
Elevation	1556
Make Public?	☑

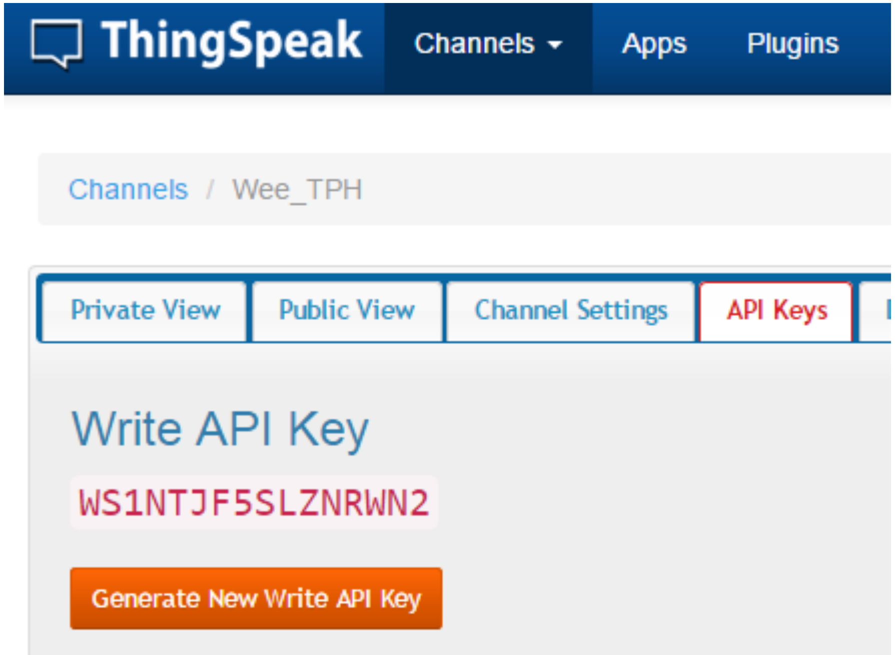
Example 1



Field 1	TempSHT21 [C]	□remove field
Field 2	TempBMP [C]	□remove field
Field 3	PressBMP [hPa]	□remove field
Field 4	HumSHT21 [%]	□remove field
Field 5	Voltage [mV]	□remove field
Field 6		□add field
Field 7		□add field
Field 8		□add field

5 channels

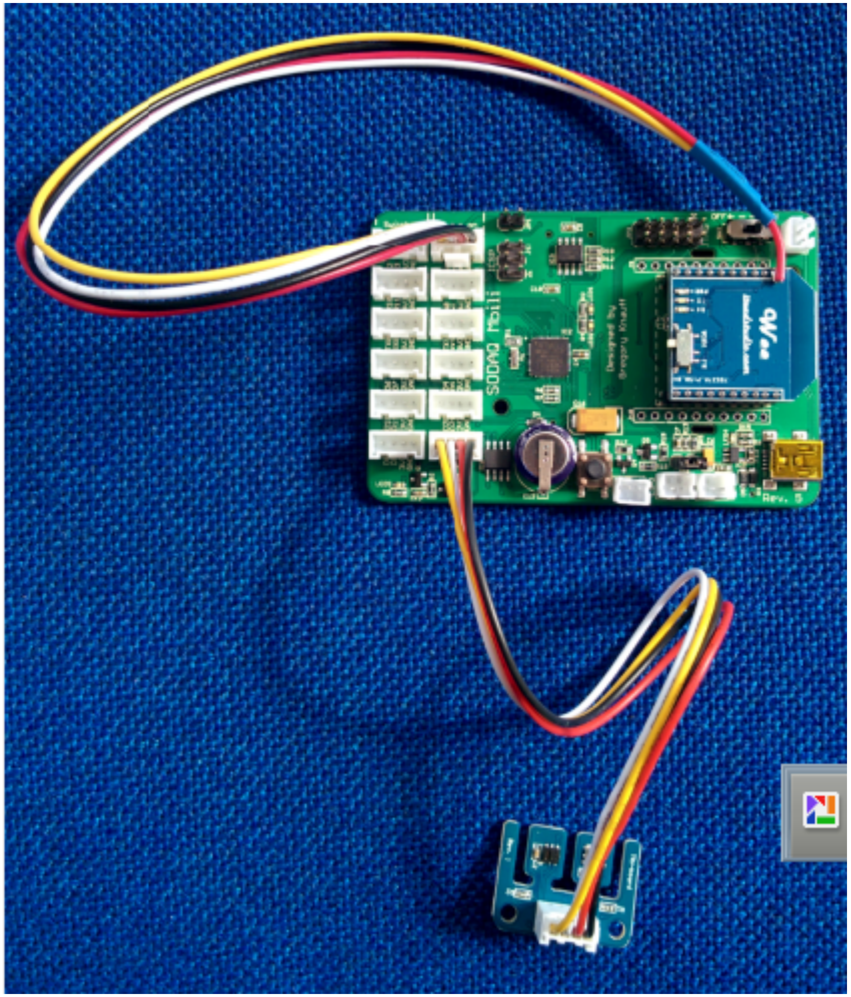
- Get Api key



Write API Key

WS1NTJF5SLZNRWN2

Example 1



Example 1

- Open Wee_TPH_ThingSpeak.ino
- We need to use WeeESP8266 library. Copy it into libraries folder.

In Windows it is located in: C:\Users \yourusername\Documents\Arduino\

- Plug Wee shield into Bee port and connect cable as follow.

Example 1

Check that you include library

```
#include "ESP8266.h"
```

And change SSID and Password from your AP router

```
#define SSID “SSID_NAME"
#define PASSWORD   “SSID_PASS"
```

Here we define the TCP address and port

```
#define HOST_NAME   "api.thingspeak.com"
#define HOST_PORT   (80)
```

Change your API Key

```
//Add your apikey (THINGSPEAK_KEY) from your channel
// GET /update?key=[THINGSPEAK_KEY]&field1=[data 1]&field2=[data 2]...;
String GET = "GET /update?key=WS1NTJF5SLZNRWN2";
```

Example 1

Setup Wee to send data, connect to SSID and disable multiple connections using:

```
if (wifi.setOprToStationSoftAP()) {
        Serial.print("to station + softap ok\r\n");
    } else {
        Serial.print("to station + softap err\r\n");
    }

    if (wifi.joinAP(SSID, PASSWORD)) {
        Serial.print("Join AP success\r\n");
        Serial.print("IP:");
        Serial.println( wifi.getLocalIP().c_str());
    } else {
        Serial.print("Join AP failure\r\n");
    }

    if (wifi.disableMUX()) {
        Serial.print("single ok\r\n");
    } else {
        Serial.print("single err\r\n");
    }
```

Example 1

In the loop you have to create TCP connection to the server, measure and prepare data and send it.

Here you have to use your key from ThingSpeak

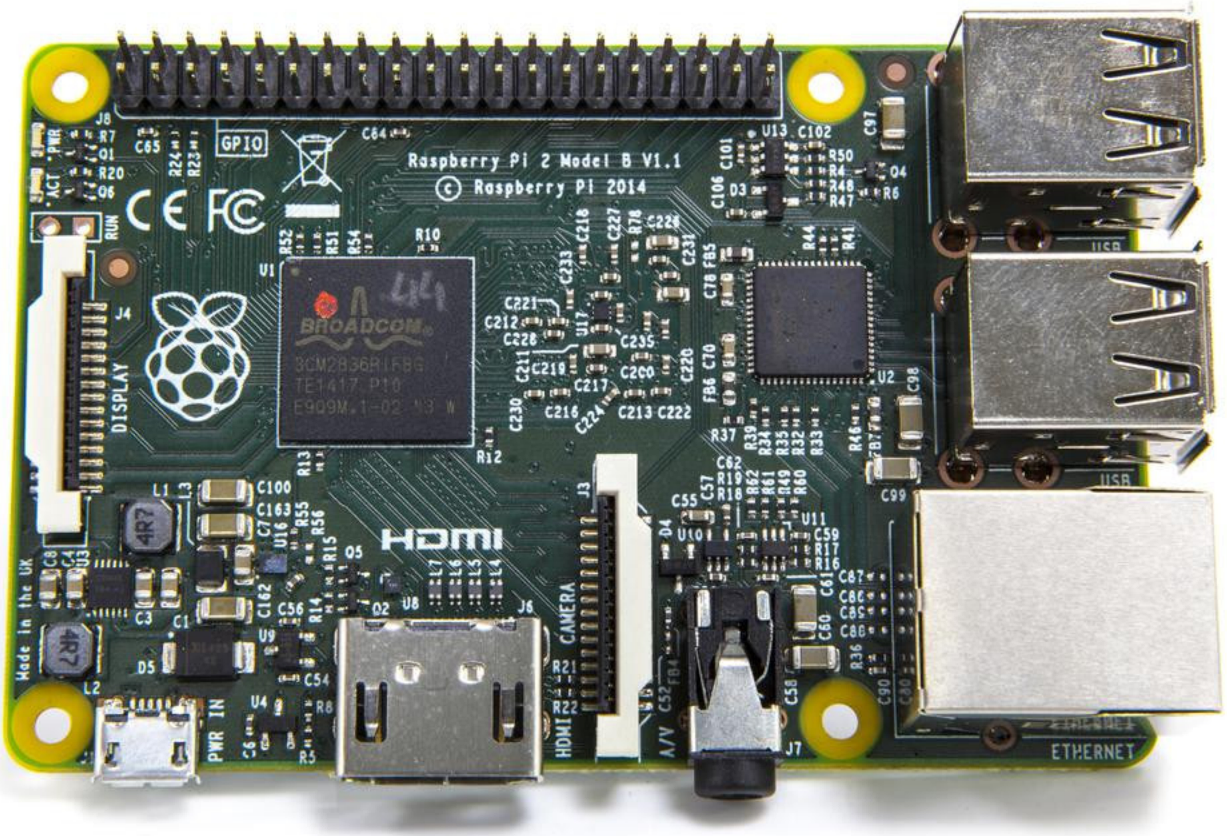
```
//----- update the  Thingspeak string with 3 values
void updateTS( String T1, String T2 , String P, String H, String V)
{
  //create GET message
  String cmd = GET + "&field1=" + T1 +"&field2="+ T2 + "&field3=" + P +"&field4=" + H +"&field5=" + V+"\r\n";

   //convert String to char
   char buf[150]; //make buffer large enough for 7 digits
   cmd.toCharArray(buf, sizeof(buf));

    wifi.send((const uint8_t*)buf, strlen(buf));
    uint32_t len = wifi.recv(buffer, sizeof(buffer), 10000);
    if (len > 0) {
        Serial.print("Received:[");
        for(uint32_t i = 0; i < len; i++) {
            Serial.print((char)buffer[i]);
        }
        Serial.print("]\r\n");
    }
```

Example 1

- Open ThingSpeak and check if data is being sent.

- Extended
- Try changing delay time. Be careful because a free ThingSpeak account let a maximum update rate of 15 seconds.
- Try adding Battery value in a new field.

Raspberry Pi 2 model B



What is Rpi?

- **Raspberry Pi** is a **small**, single-board computer developed for computer science education.
- Because it has an *ARMv7* processor, it can run the full range of ARM GNU/Linux distributions, including Snappy **Ubuntu** Core, as well as Microsoft **Windows 10**
- Single board computer for $35

RPi 2 model B. Features

- A 900MHz quad-core ARM Cortex-A7 CPU
- 1GB RAM
- 4 USB ports
- 40 GPIO pins
- Full HDMI port
- Ethernet port
- Combined 3.5mm audio jack and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot
- VideoCore IV 3D graphics core

Why?

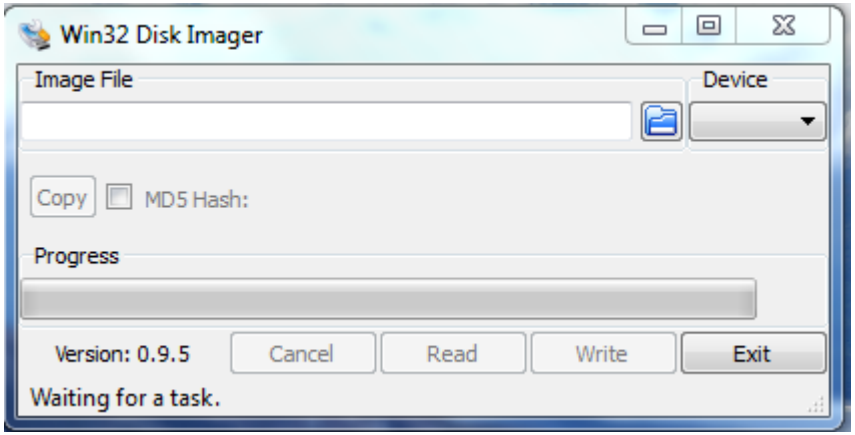
- Run a private ThingSpeak server on a Rapberry Pi:
    - Private data
    - Free
    - Safe, no time changes
    - No limitations, storing and refreshing.
    - No internet needed

Steps to follow

1. Install operating system image in a SD card
    1. Ej. Raspbian (https://www.raspberrypi.org/documentation/installation/installing-images/README.md)
2. Install ThinkSpeak server
    1. IoTBrindge has steps to follow on his GitHub account
    2. https://github.com/iobridge/thingspeak
    3. But Angryelectron made an script which install TS by itself
    4. http://angryelectron.com/how-to-install-a-thingspeak-server/

This steps take time and sometimes are hard to make them work.

So, in a 8GB SD card we can put an image from a OS with TS running.
Use Win32DiskImager program to upload the image.



Version: 0.9.5

Waiting for a task.

When it is ready plug sd card and chech if ThingSpeak is running on
http://<ip-address>:3000

Example 2

TPH_Volt_GPRS_TS.ino. Send TPH data to ThingSpeak running on a Raspberry pi using a GPRS connection.

APN, APN_USERNAME, and *APN_PASSWORD* need to be set to the correct values for your particular network

```
//Network constants
#define APN "internet.mtn"
#define APN_USERNAME ""
#define APN_PASSWORD ""
```

Setup GPRSBee

```
//Setup GPRSbee
 setupComms();
```

Example 2

Use your API KEY from ThingSpeak

```
//SpeakThings constants
#define URL "api.thingspeak.com/update"
//#define URL "184.106.153.149/update"
#define WRITE_API_KEY "45BJ3YEW8W8SB09M" //Change to your channel's key
```

SendURLData() sends data using GPRSBee

```
void sendURLData(String url)
{
  Serial.println("Sending data to Server");
  char result[20] = "";
  gprsbee.doHTTPGET(APN, APN_USERNAME, APN_PASSWORD, url.c_str(), result, sizeof(result));

  Serial.println("Received: " + String(result));
}
```

Low Power mode

- Mbili boards uses 40mA during normal operation.
- A rechargeable Li-ion battery will have a typical capacity of 1000 mAh. If used to power Mbili board, it will last for about *25 hours* under normal operation (1000mAh/40mA)

Solutions

- Use a battery with a bigger capacity, or use a battery pack, made up of several batteries.

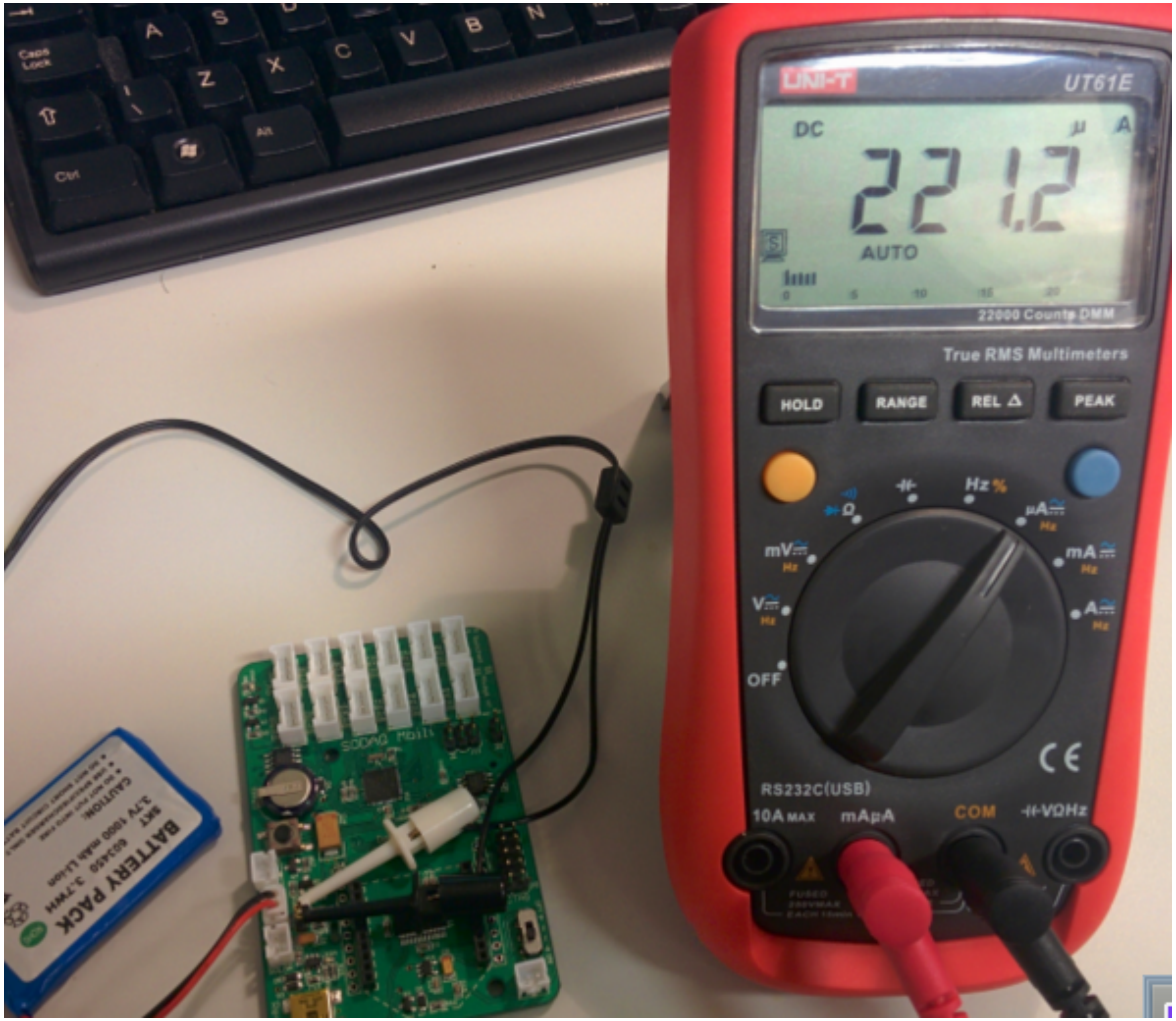
- Use a solar panel with a battery pack to be charged during daylight.

- Put microcontroller into sleep mode cycling the operation.

The ATmega1284 micro-controller in our Mbili board supports several modes of sleep!!!

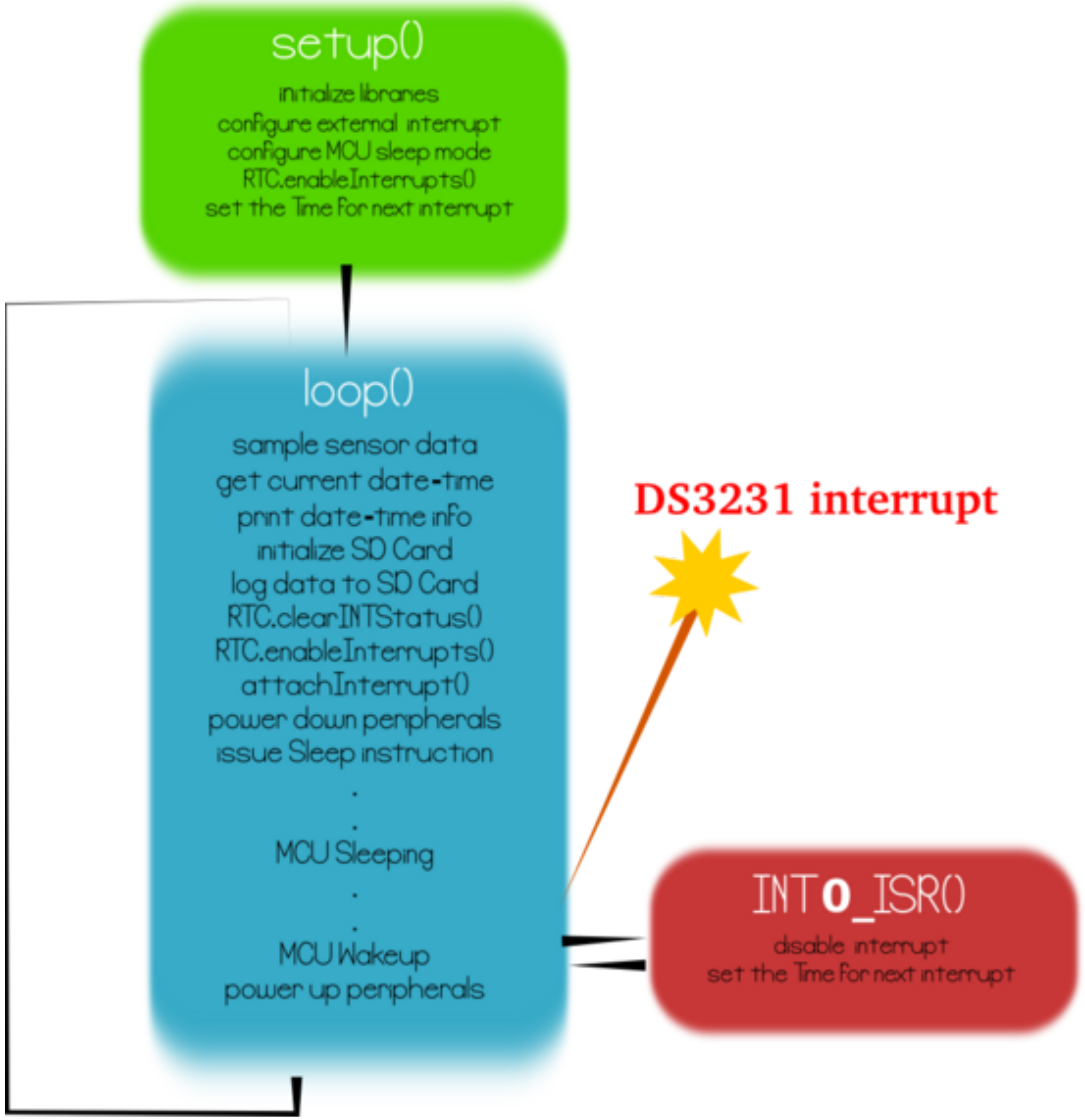
But…..Is it enough?

Low power consumption



- 220uA
- 1000mAh/ 0.22mA
- More than 180 days

RTC interruption



setup()

initialize libraries
configure external interrupt
configure MCU sleep mode
RTC.enableInterrupts()
set the Time for next interrupt

loop()

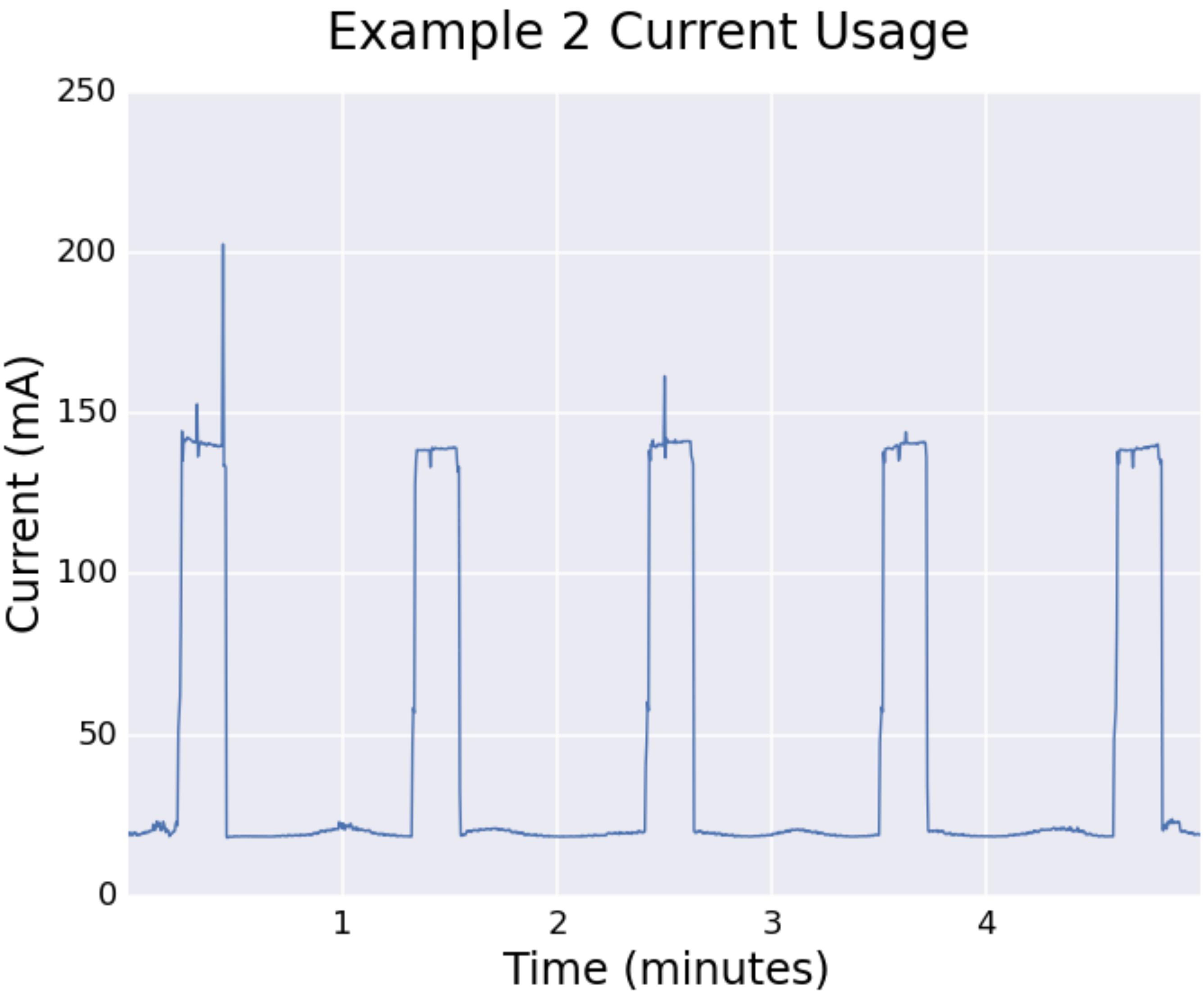
sample sensor data
get current date-time
print date-time info
initialize SD Card
log data to SD Card
RTC.clearINTStatus()
RTC.enableInterrupts()
attachInterrupt()
power down peripherals
issue Sleep instruction
.
.
MCU Sleeping
.
.
MCU Wakeup
power up peripherals

DS3231 interrupt

INT0_ISR()

disable interrupt
set the Time for next interrupt

Sleep mode operation



Example 3

Serial_TPH_LP.ino. To make Mbili go into sleep mode and wake it up using a RTC interruption we need 3 new libraries

```
#include <avr/sleep.h>
#include <avr/wdt.h>
#include <Sodaq_PcInt.h>
```

We define in which pin we will ercieve the interruption

```
//RTC Interrupt pin
#define RTC_PIN A7
```

In the setup we configure sleeping mode

```
//Setup sleep mode
  setupSleep();
```

Example 3

Use RTC interruption pin as input and attach interruption to this pin. Set sleep mode into SLEEP_MODE_PWR_DOWN

```
void setupSleep()
{
  pinMode(RTC_PIN, INPUT_PULLUP);
  PcInt::attachInterrupt(RTC_PIN, wakeISR);

  //Setup the RTC in interrupt mode
  rtc.begin();

  //Set the sleep mode
  set_sleep_mode(SLEEP_MODE_PWR_DOWN);
}
```

systemSleep()

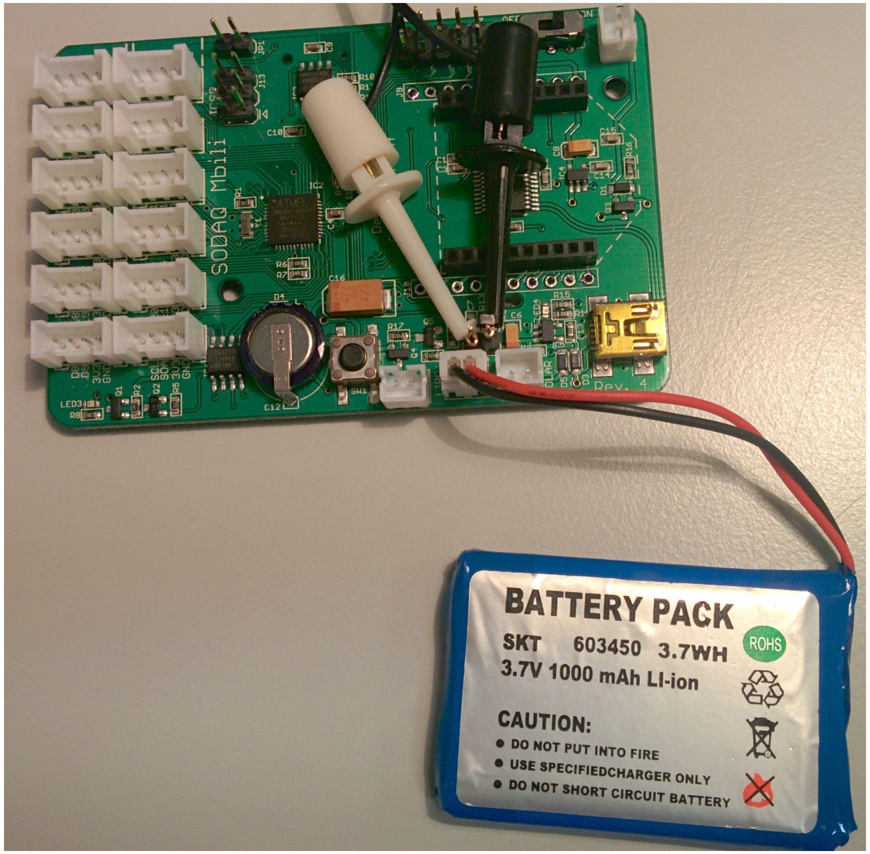
Here we schedule the next wake up pulse

Clear interruption and put Mbili into sleep mode disabling ADC. Wait for interruption to happen.

```
//Schedule the next wake up pulse timeStamp + SLEEP_PERIOD
  DateTime wakeTime(getNow() + SLEEP_PERIOD);
  rtc.enableInterrupts(wakeTime.hour(), wakeTime.minute(), wakeTime.second());

  //The next timed interrupt will not be sent until this is cleared
  rtc.clearINTStatus();

  //Disable ADC
  ADCSRA &= ~_BV(ADEN);
   //Sleep time
  noInterrupts();
  sleep_enable();
  interrupts();
  sleep_cpu();

  sleep_disable();
   //Enbale ADC
  ADCSRA |= _BV(ADEN);
  Serial.println("Waking-up");
  //This method handles any sensor specific wake setup
```

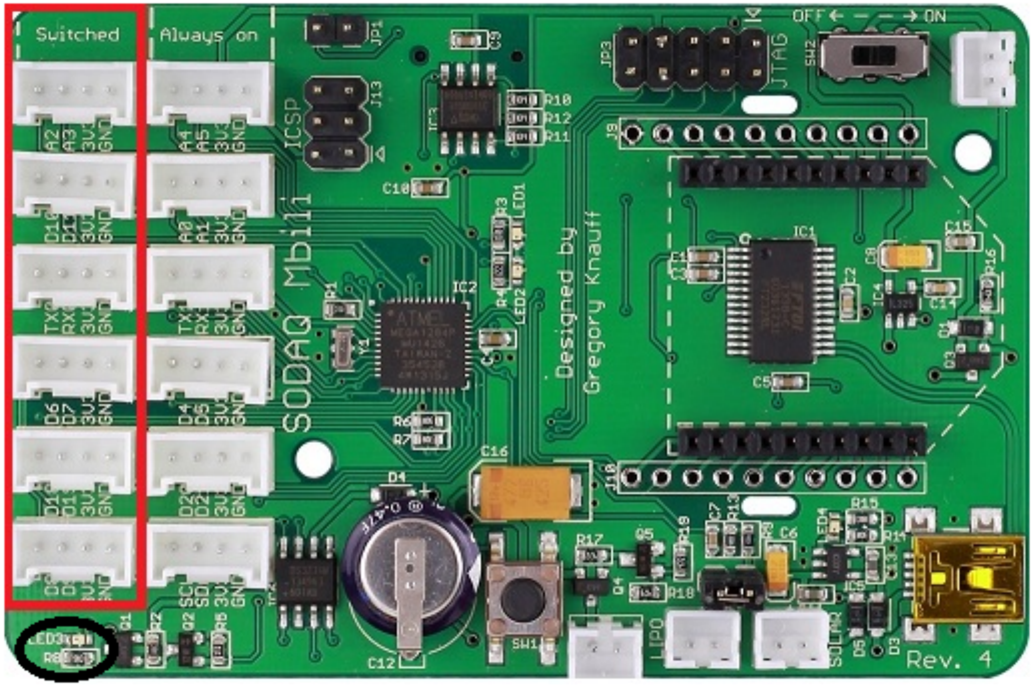
Example 3

- Upload the code and measure current when the device is in sleeping mode using a battery and Battery pin jumper using a multimeter.



Example 3 extended

Another way to save energy is switching off the Switched row grove to switch on and off sensors and radios. It has a Led associated the turns off when row is switched on



Note that Switched row is off in default mode

Example 3 extended

- Open OnOff_test.ino.

To switch on and off switched arrow we use digital pin number 23 which has a led associated.

- Check how Led3 blink

Real world example.
Tea Factory

- Use GPRSbee to send TPH data to ThingSpeak in low power mode.
- Send moisture sensor (switch on and off)

Thanks

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