



Presenter's name

IoT - Remote your Sensors

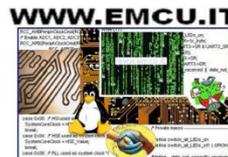
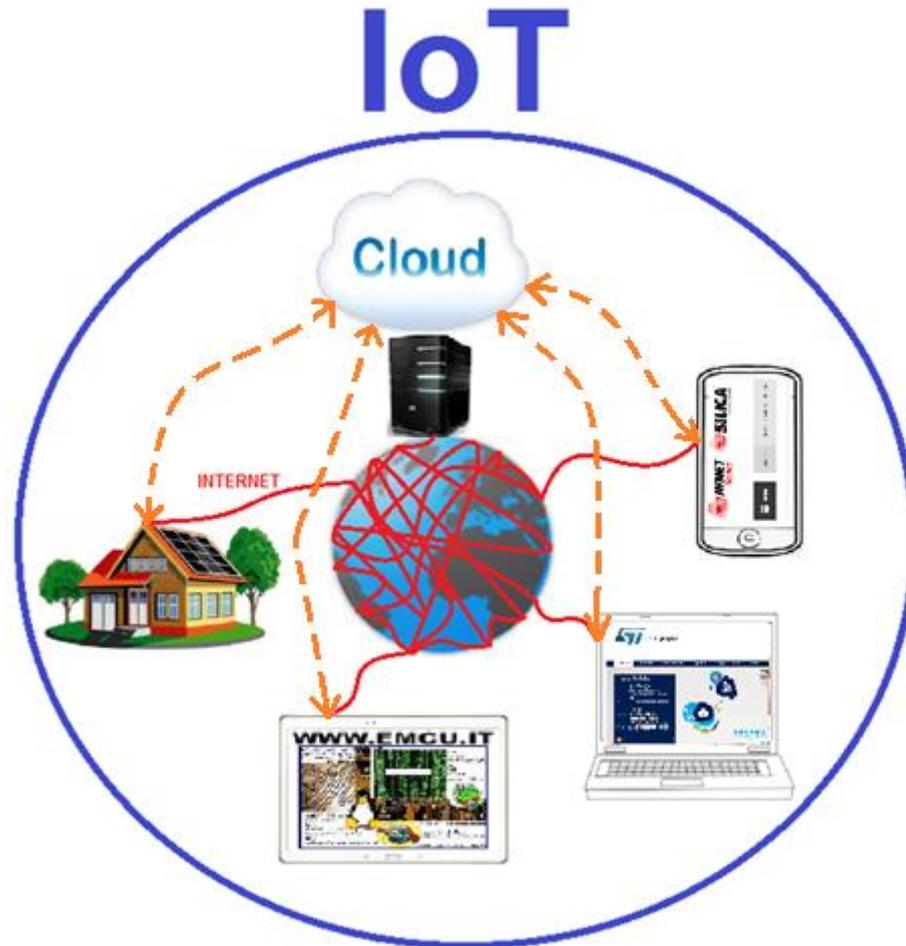
via WiFi and IBM BlueMix

Introduction

IoT - Remote your Sensors via WiFi and IBM BlueMix (Cloud)

HW: Nucleo-F401RE +
Sensors Board + WiFi
Board

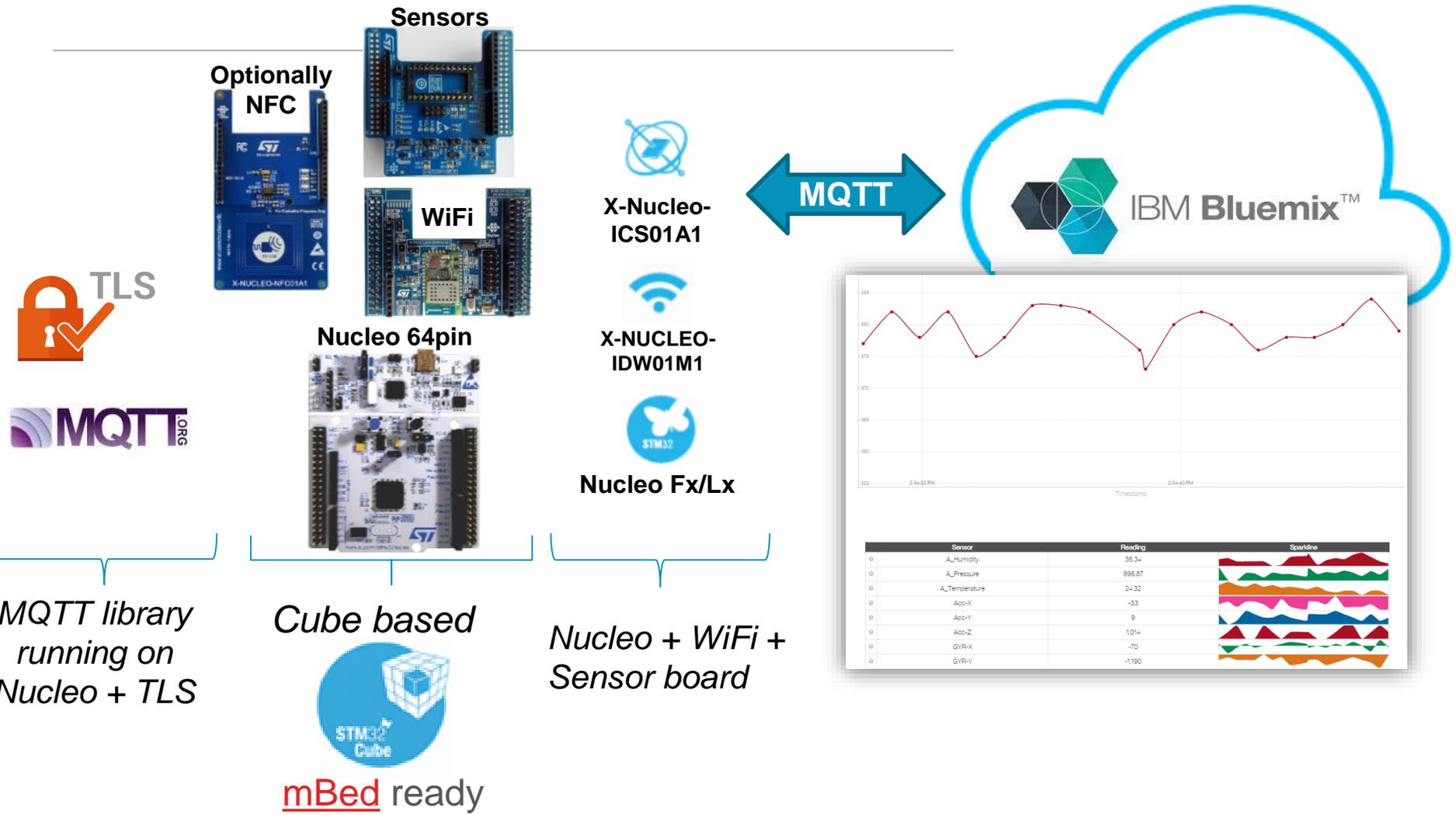
SW: IBM Bluemix
MQTT over TLS



Introduction

- **End-to-end** application to publish environmental data on a web service based on **IBM Bluemix**
- **Nucleo based application**
 - HW : **Nucleo Board** + **Sensors Board** + **WiFi Board**
 - SW : application reading and transmitting in real time environmental data (*temperature, pressure, humidity, inertial*) to IBM Bluemix. **MQTT** over **TLS** is used as application protocol for secure data communication with Bluemix.
- **IBM Bluemix application**
 - For the moment, only data visualization is supported (no analytics/commands back to Nucleo; they will be supported in later versions).

Introduction

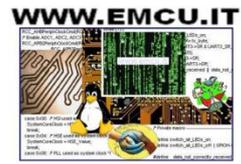


MQTT library running on Nucleo + TLS

Cube based

 mBed ready

Nucleo + WiFi + Sensor board



KIT HW

- **NUCLEO-F401RE**

- Low cost STM32 evaboard based on **STM32F401RE**

- **X-NUCLEO-IKS01A1** - **MEMS and Sensors**

- expansion board for STM32 Nucleo, it's include:
 - **LSM6DS0**: MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8$ g) + 3D gyroscope ($\pm 245/\pm 500/\pm 2000$ dps)
 - **LIS3MDL**: MEMS 3D magnetometer ($\pm 4/\pm 8/\pm 12/16$ gauss)
 - **LPS25H**: MEMS pressure sensor, 260-1260 hPa absolute digital output barometer
 - **HTS221**: capacitive digital relative humidity and temperature
 - **DIL 24-pin socket** available for additional MEMS adapters and other sensors (UV index) X-NUCLEO-IDW01M1

- **X-NUCLEO-IDW01M1** - **WiFi expansion board**

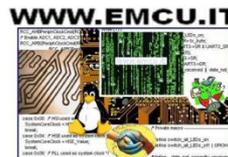
- based on **SWPF01SA.11** module

- **X-NUCLEO-NFC01A1** - **Dynamic NFC tag** (*optional*)

- based on **M24SR**

- **WiFi Router** or access to WiFi network

- **1 x mini USB cable**



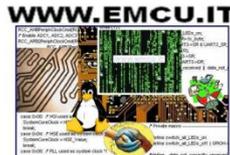
KIT SW 1/5

- **STM32 Software for this demo is [here](#)** (FP-CLD-BLUEMIX1).
UnZip it on C:\

Get Software Top			
Part Number	Version	Marketing Status	Order From ST
FP-CLD-BLUEMIX1	1.0.0	Active	Download

- **STM Virtual COM Port Driver that is [here](#).**

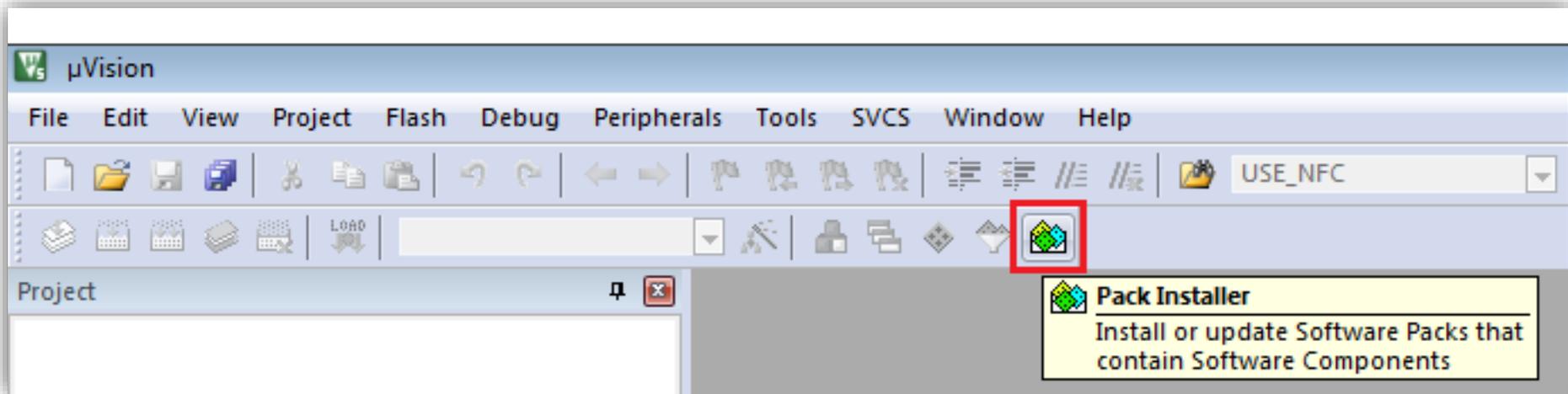
Part Number	Version	Marketing Status	Order From ST
STSW-STM32102	1.4.0	Active	Download



KIT SW 2/5

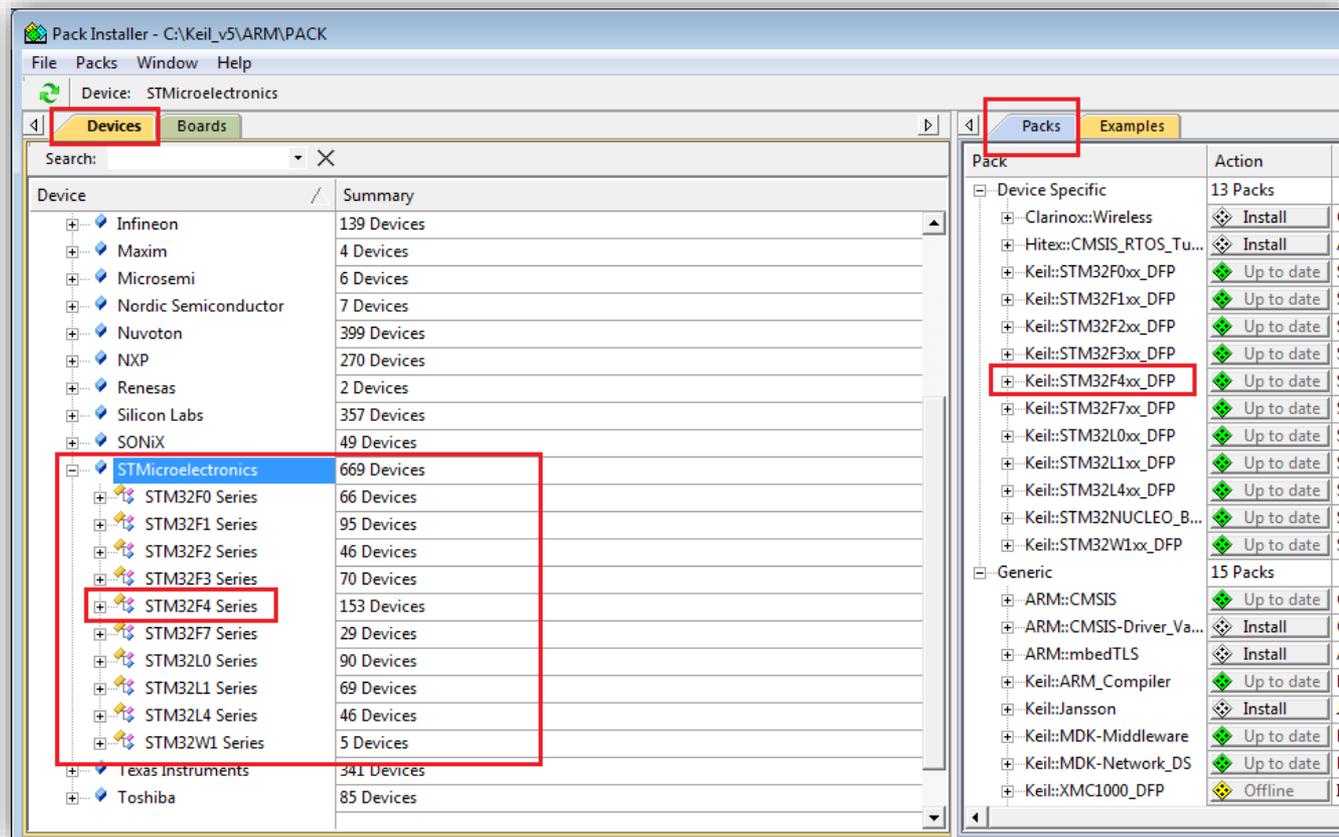
- **KEIL compiler.**

DownLoad and install it. After the installation run KEIL and select the: **Pack Installer** (see below).



KIT SW 3/5

- From the window that appears select and install: **STM32F4 Series** see below.

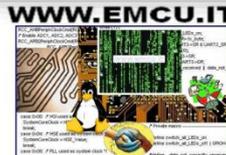
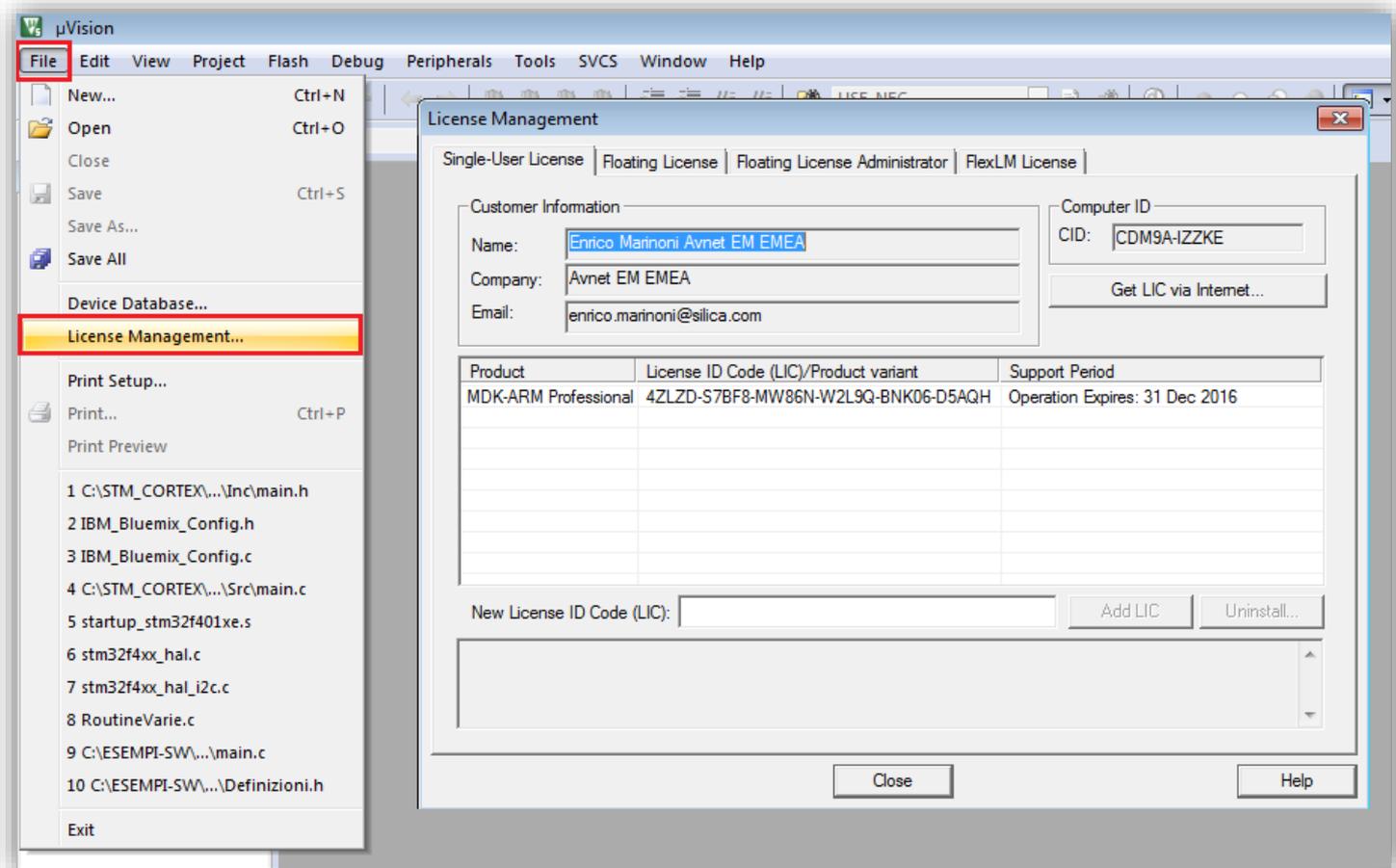


WWW.EMCU.IT



KIT SW 4/5

- Install the KEIL license

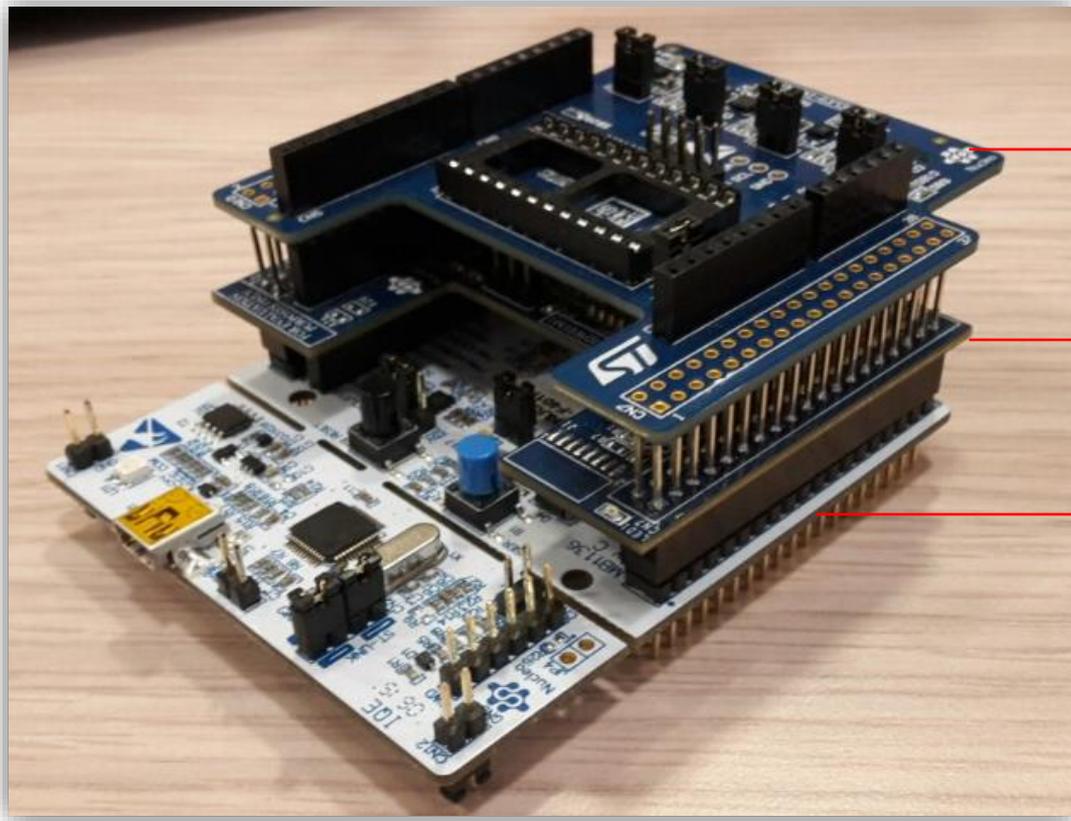


KIT SW 5/5

- **Serial line monitor** (e.g. [Termite](#) or [TeraTerm](#)).
DownLoad and install it.
- **Modern web browser** (e.g. [Chrome](#)).
DownLoad and install it.
- [ST-LINK-UTILITY](#), DownLoad and install it.

Part Number	Version	Marketing Status	Order From ST
STSW-LINK004	3.8.0	Active	Download

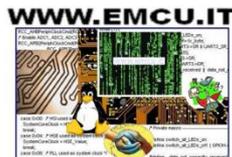
Compose the kit 1/4



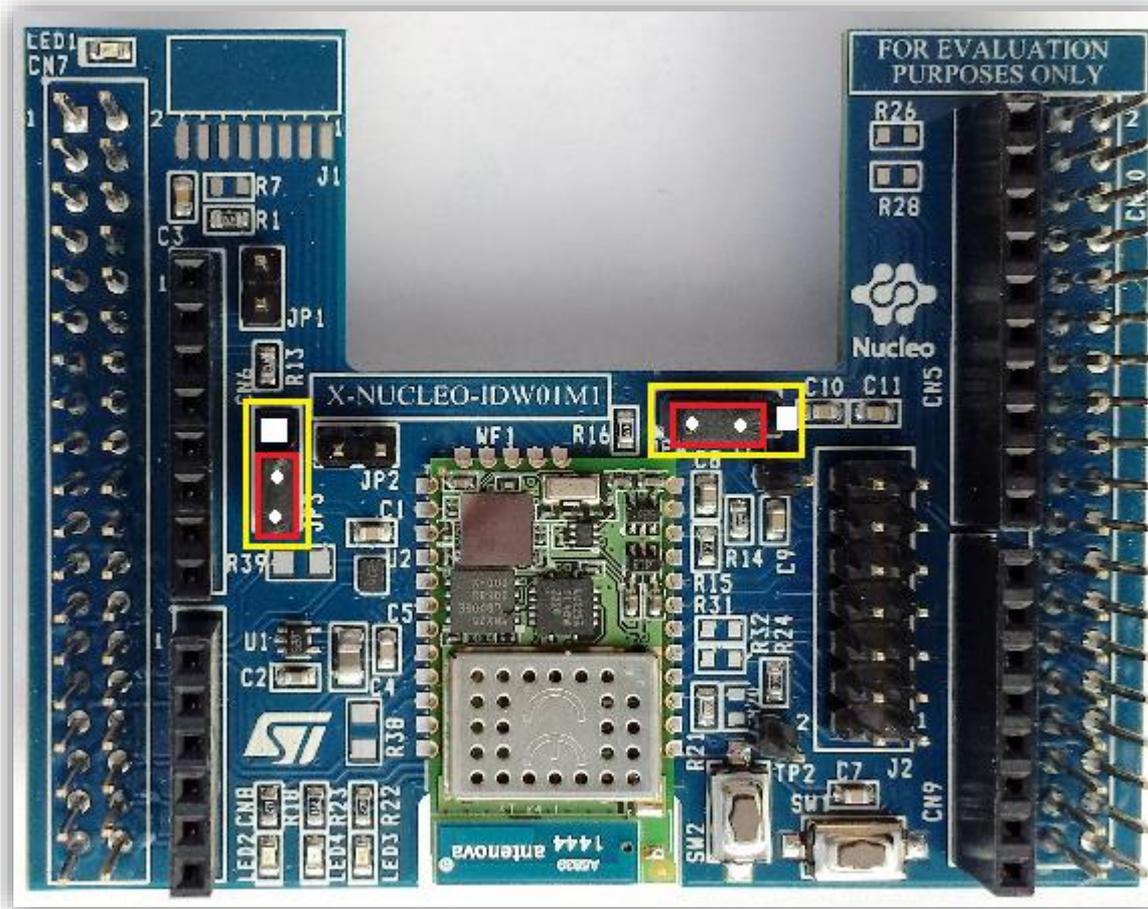
X-NUCLEO-IKS01A1
Sensor module

X-NUCLEO-IDW01M1
WiFi module

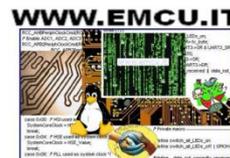
Nucleo-F401RE



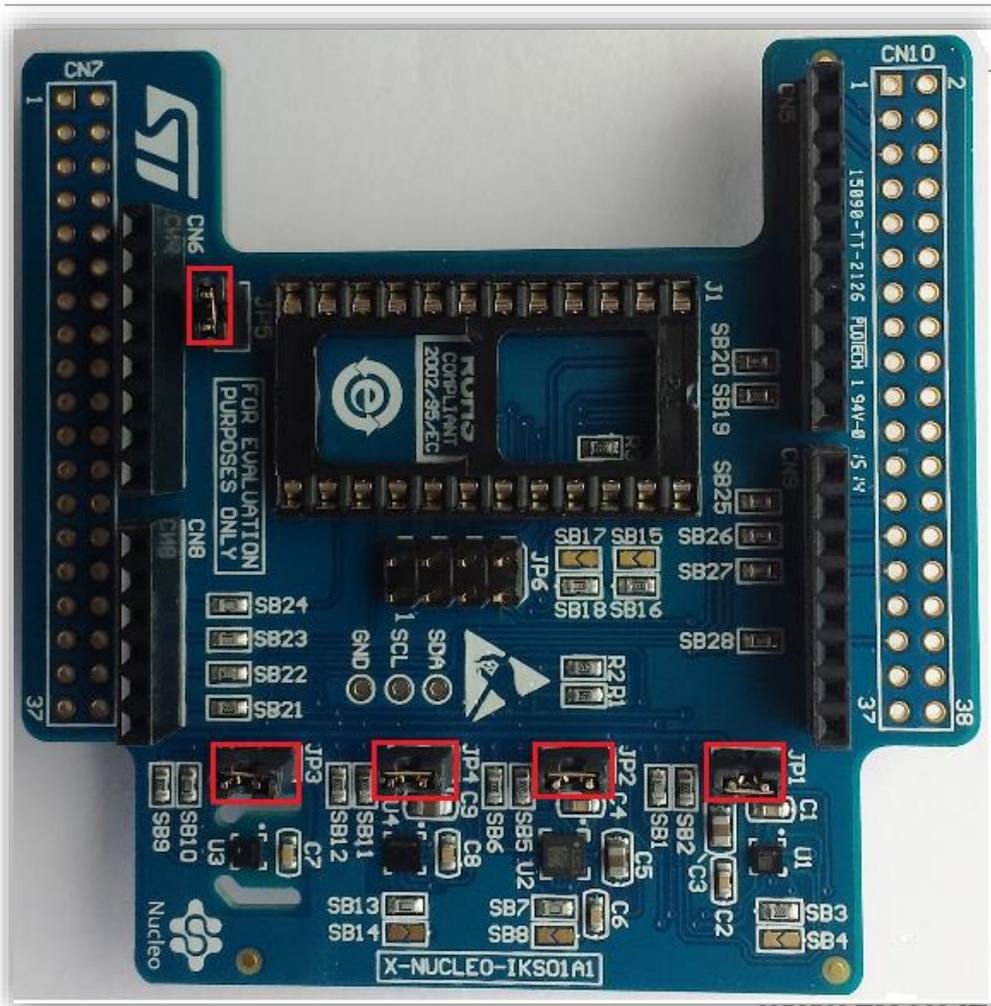
Compose the kit 2/4



Jumper configuration on X-NUCLEO-IDW01M1 (WiFi Module)



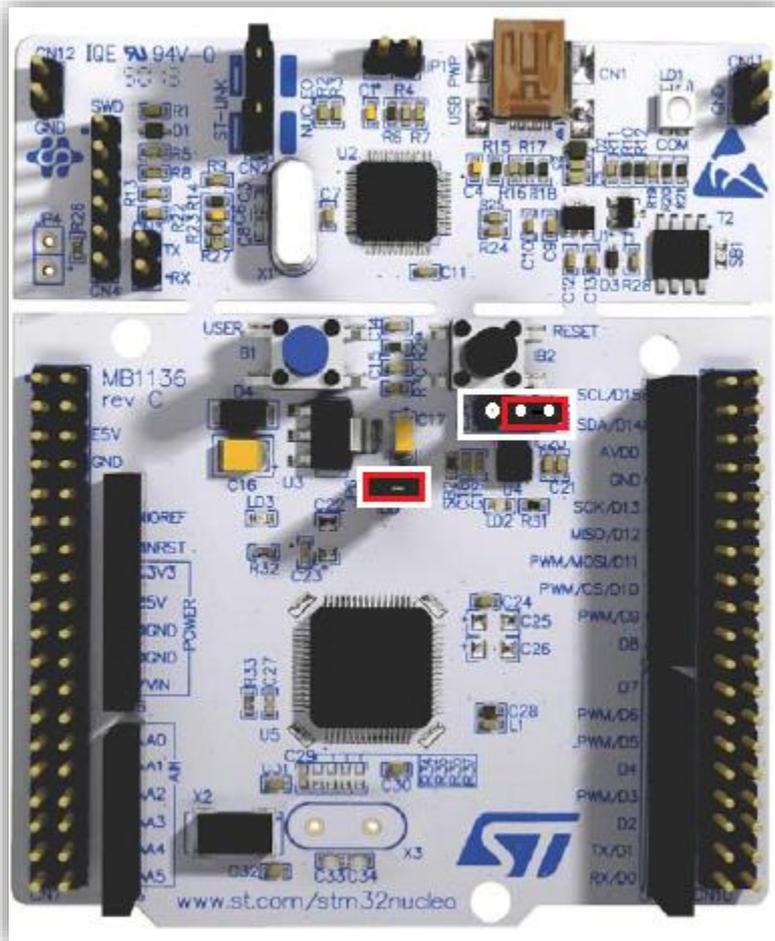
Compose the kit 3/4



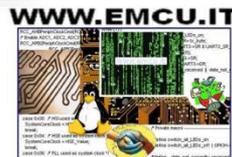
Jumper configuration on
X-NUCLEO-IKS01A1
Sensor module



Compose the kit 4/4

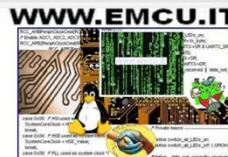
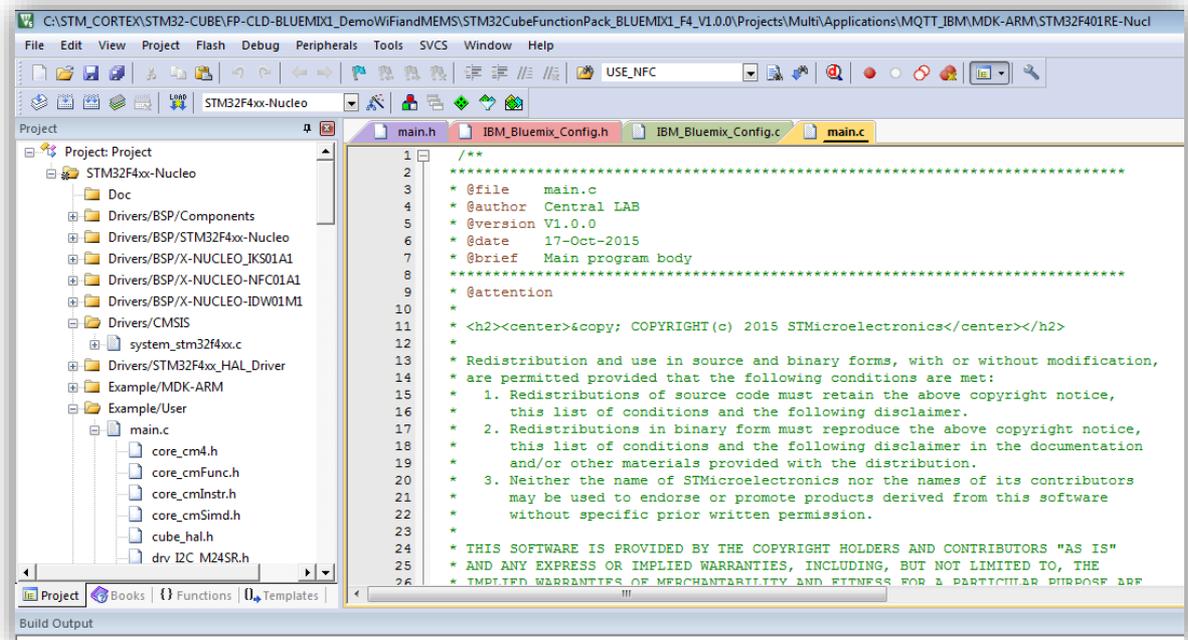


Jumper configuration on Nucleo-F401RE

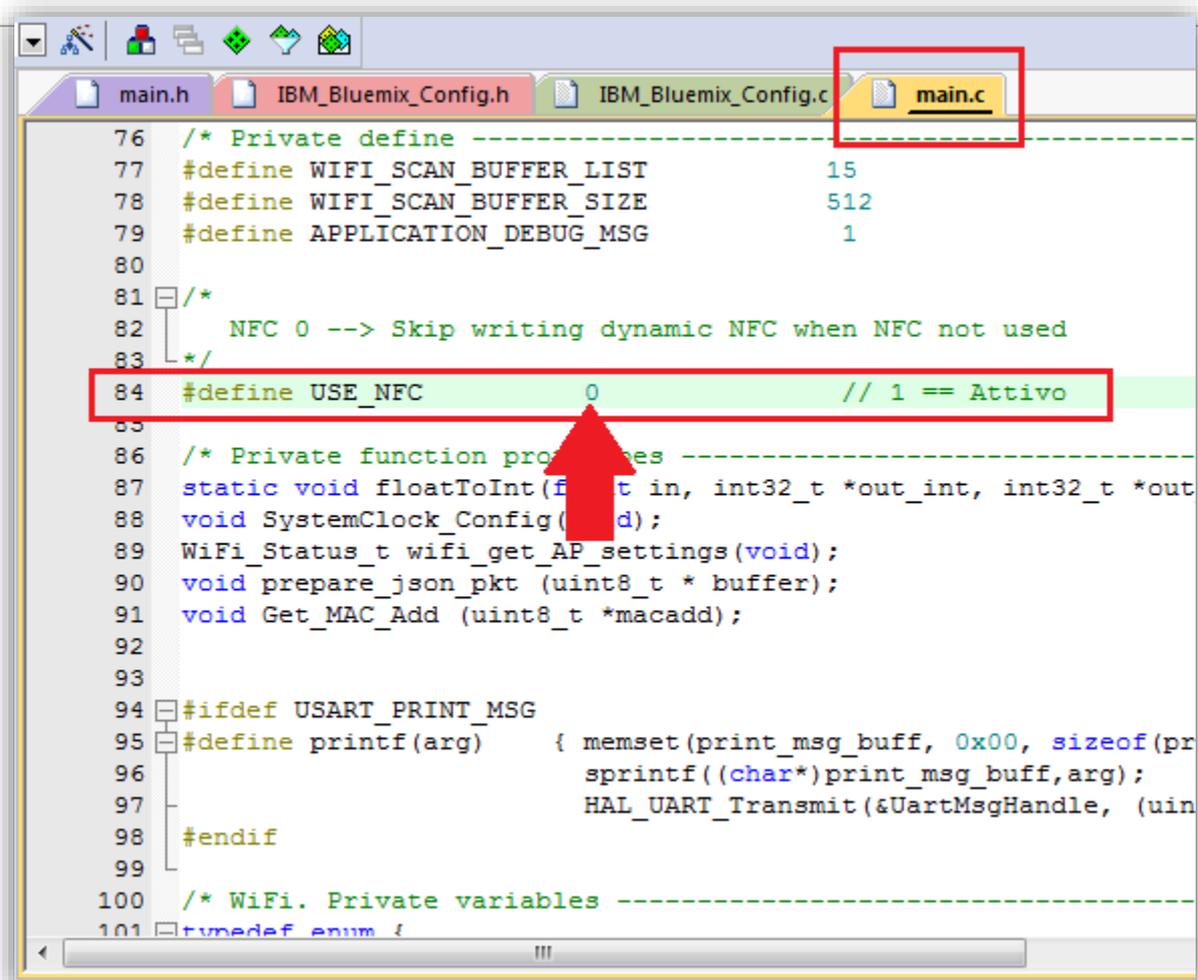


Configure and run the SW

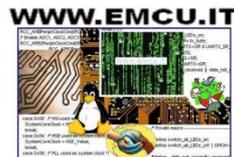
- Launch KEIL project
- C:\...\FP-CLD-BLUEMIX1_DemoWiFiandMEMS
\STM32CubeFunctionPack_BLUEMIX1_F4_V1.0.0
\Projects\Multi\Applications\MQTT_IBM\MDK-ARM\STM32F401RE-Nucleo
\Project.uvprojx



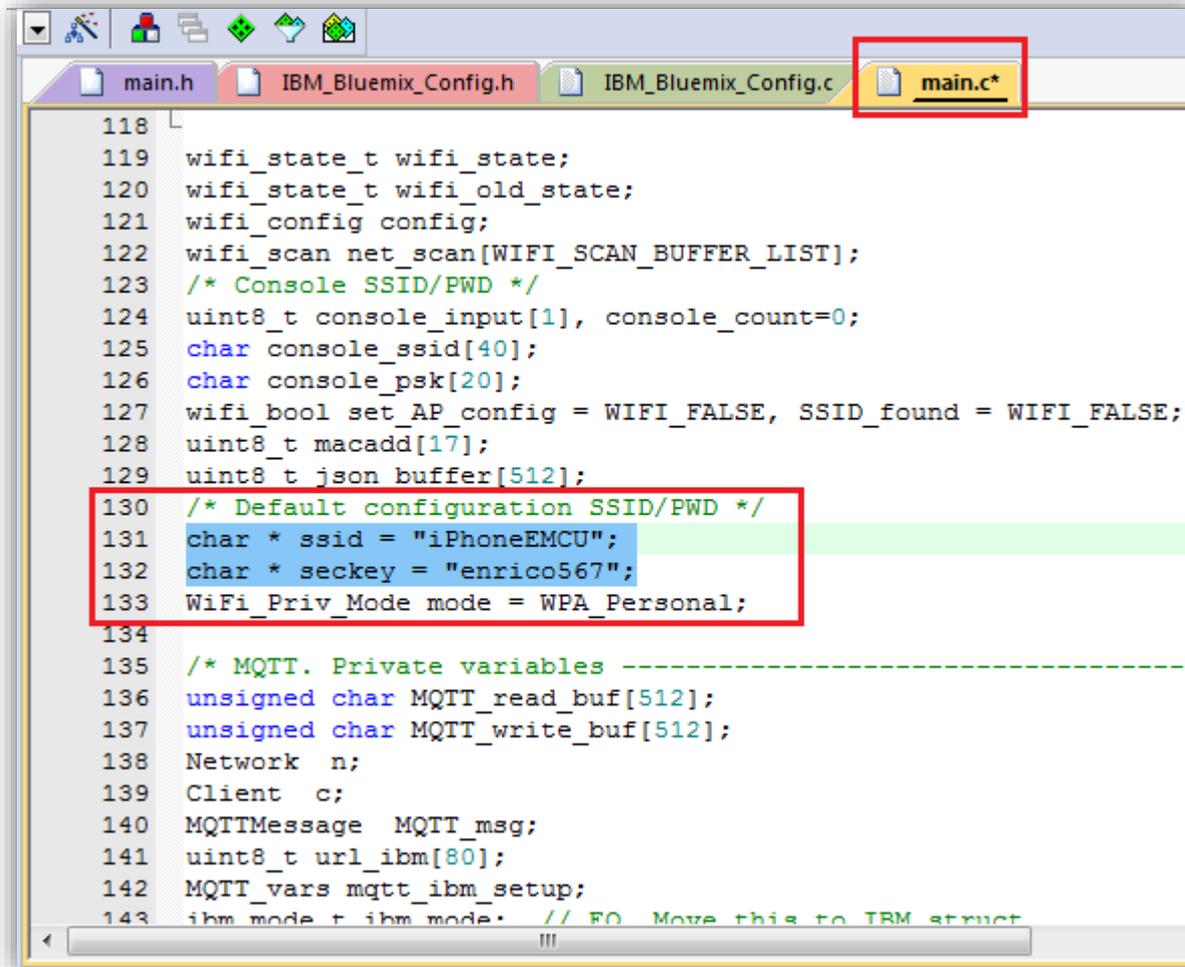
Disable the NFC board in main.c line 84



```
76  /* Private define -----
77  #define WIFI_SCAN_BUFFER_LIST          15
78  #define WIFI_SCAN_BUFFER_SIZE         512
79  #define APPLICATION_DEBUG_MSG         1
80
81  /*
82   * NFC 0 --> Skip writing dynamic NFC when NFC not used
83  */
84  #define USE_NFC 0 // 1 == Attivo
85
86  /* Private function prototypes -----
87  static void floatToInt(float in, int32_t *out_int, int32_t *out
88  void SystemClock_Config(void);
89  WiFi_Status_t wifi_get_AP_settings(void);
90  void prepare_json_pkt (uint8_t * buffer);
91  void Get_MAC_Add (uint8_t *macadd);
92
93
94  #ifndef USART_PRINT_MSG
95  #define printf(arg) { memset(print_msg_buff, 0x00, sizeof(pr
96                      sprintf((char*)print_msg_buff,arg);
97                      HAL_UART_Transmit(&UartMsgHandle, (uin
98  #endif
99
100 /* WiFi. Private variables -----
101 #typedef enum {
```

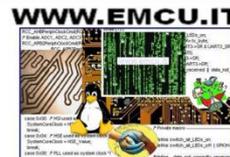


Configure SSID e PWD for WiFi AP in main.c



```
118
119 wifi_state_t wifi_state;
120 wifi_state_t wifi_old_state;
121 wifi_config config;
122 wifi_scan net_scan[WIFI_SCAN_BUFFER_LIST];
123 /* Console SSID/PWD */
124 uint8_t console_input[1], console_count=0;
125 char console_ssid[40];
126 char console_psk[20];
127 wifi_bool set_AP_config = WIFI_FALSE, SSID_found = WIFI_FALSE;
128 uint8_t macadd[17];
129 uint8_t json_buffer[512];
130 /* Default configuration SSID/PWD */
131 char * ssid = "iPhoneEMCU";
132 char * seckey = "enrico567";
133 WiFi_Priv_Mode mode = WPA_Personal;
134
135 /* MQTT. Private variables -----
136 unsigned char MQTT_read_buf[512];
137 unsigned char MQTT_write_buf[512];
138 Network n;
139 Client c;
140 MQTTMessage MQTT_msg;
141 uint8_t url_ibm[80];
142 MQTT_vars mqtt_ibm_setup;
143 ibm_mode_t ibm_mode; // EQ Move this to IBM struct
```

SSID – iPhoneEMCU
SECKEY – enrico567



Configure Compiler

Options for Target 'STM32F4xx-Nucleo'

Device | Target | Output | Listing | User | C/C++ | Asm | Linker | **Debug** | Utilities | 3 | 4

Use Simulator *with restrictions* Settings

Limit Speed to Real-Time

Use: **ST-Link Debugger** Settings

Load Application at Startup Run to main0 Load Application at Startup

Cortex-M Target Driver Setup

Debug | Trace | **Flash Download** | 7

Download Function

LOAD

Erase Full Chip

Erase Sectors

Do not Erase

Program

Verify

Reset and Run

RAM for Algorithm

Start: 0x20000000 Size: 0x1000

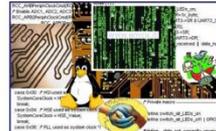
Description	Device Size	Device Type	Address Range
STM32F4xx 512kB Flash	512k	On-chip Flash	08000000H - 0807FFFFH

Start: Size:

Add Remove

OK Cancel Apply

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Compile & Program

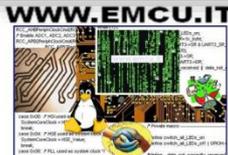
The screenshot shows the IDE interface for an STM32F4xx-Nucleo project. The menu bar includes File, Edit, View, Project, Flash, Debug, Peripherals, Tools, SVCS, Window, and Help. The toolbar contains various icons for file operations and debugging. The project tree on the left shows the project structure, including folders for Doc, Drivers/BSP/Components, Drivers/BSP/STM32F4xx-Nucleo, Drivers/BSP/X-NUCLEO_IKS01A1, Drivers/BSP/X-NUCLEO-NFC01A1, Drivers/BSP/X-NUCLEO-IDW01M1, and Drivers/CMSIS. The code editor displays the main.h file with the following code:

```
124 uint8_t console_input[1], console_count=0;
125 char console_ssid[40];
126 char console_psk[20];
127 wifi_bool set_AP_config = WIFI_FALSE, SSID_f
128 uint8_t macadd[17];
129 uint8_t json_buffer[512];
130 /* Default configuration SSID/PWD */
131 char * ssid = "iPhoneEMCU";
132 char * seckey = "enrico567";
133 WiFi_Priv_Mode mode = WPA_Personal;
134
135 /* MQTT. Private variables -----
136 unsigned char MQTT_read_buf[512];
```

The Build Output window at the bottom shows the following output:

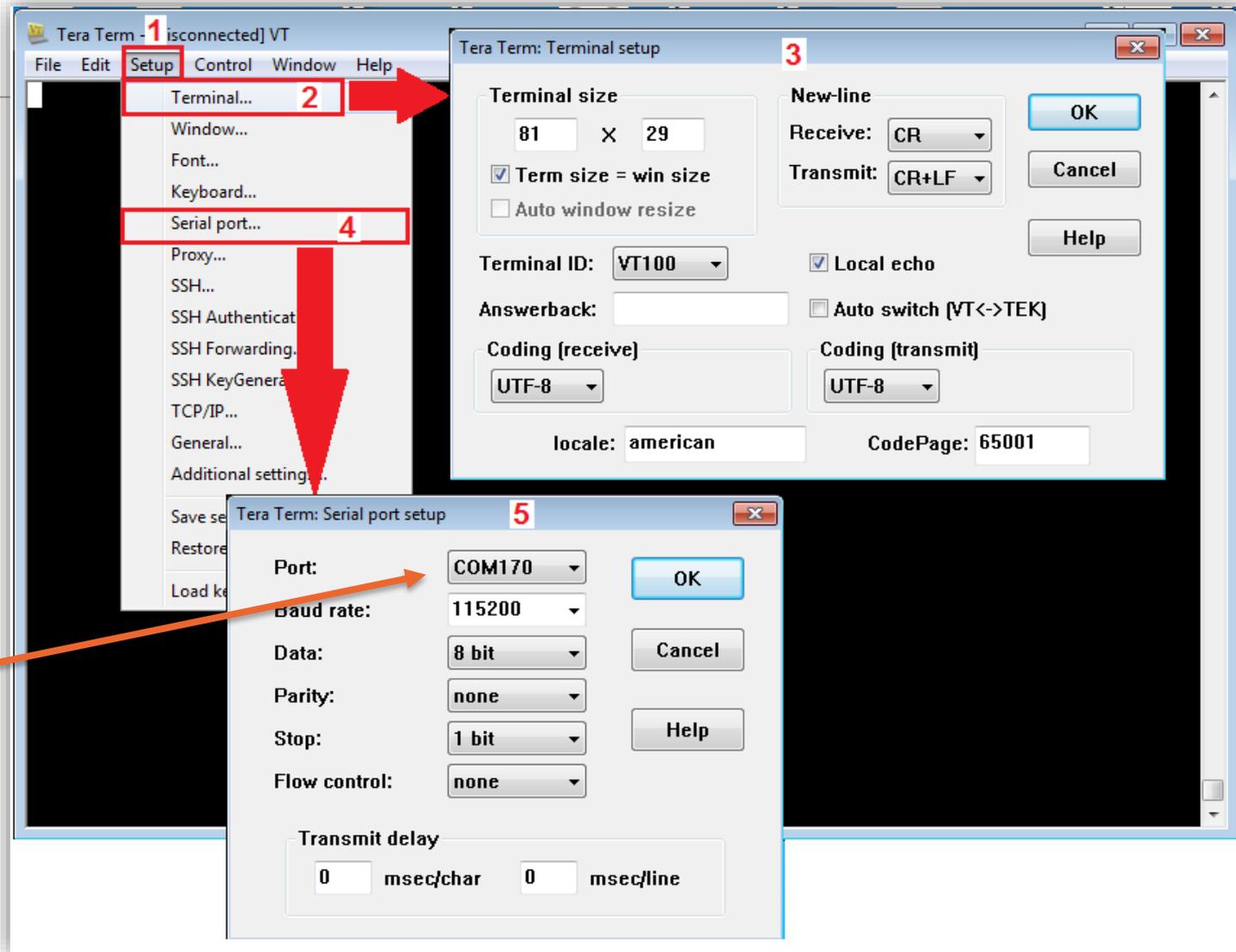
```
linking...
Program Size: Code=42124 RO-data=1968 RW-data=752 ZI-data=8952
FromELF: creating hex file...
".\Objects\Project.axf" - 0 Error(s), 0 Warning(s).
Build Time Elapsed: 00:00:58
```

The ST-Link Debugger is visible at the bottom right of the IDE.



Launch Serial Line Monitor 1/4

- Connect the KIT to the PC.
- Open the TeraTerm and configure it, steps 1...5
- Make sure to choose the right PORT.

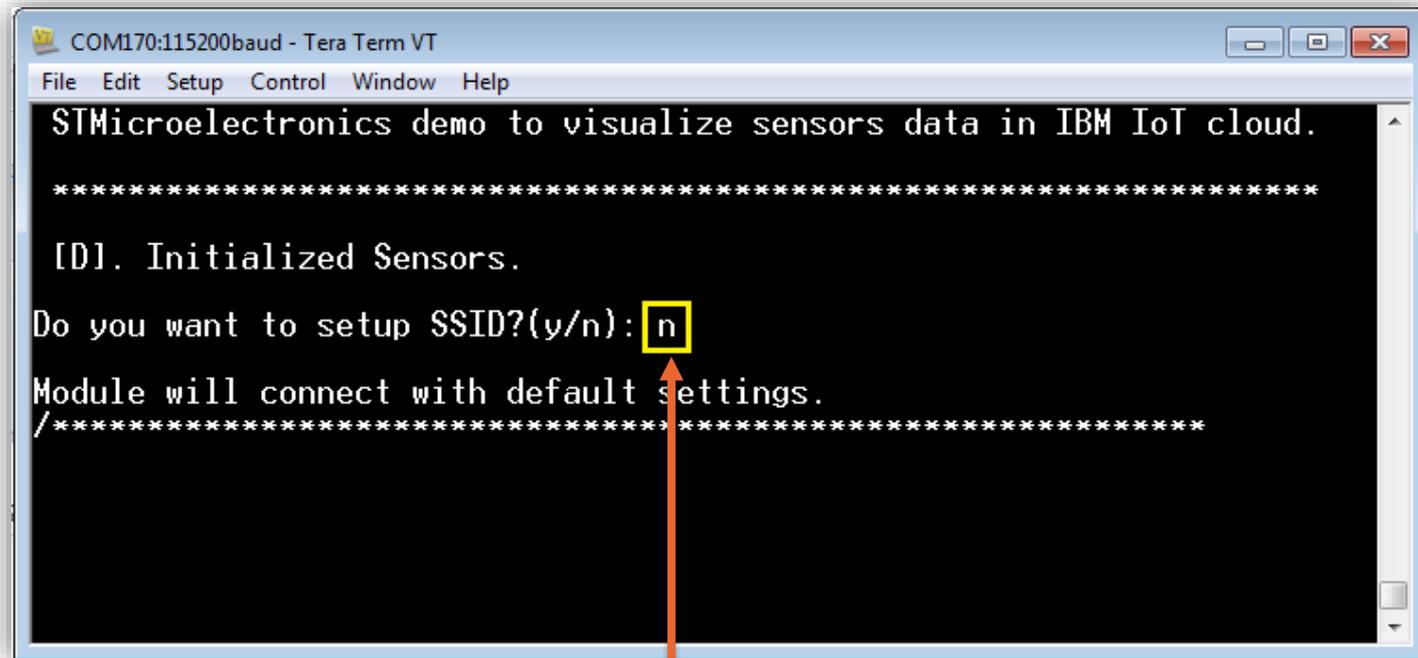


WWW.EMCU.IT



Launch Serial Line Monitor 2/4

- Press the **RESET** button on the **NUCLEO-F401RE** (it is the black button).
- You have to see something like below.

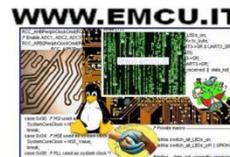


```
COM170:115200baud - Tera Term VT
File Edit Setup Control Window Help
STMicroelectronics demo to visualize sensors data in IBM IoT cloud.
*****
[D]. Initialized Sensors.
Do you want to setup SSID?(y/n): n
Module will connect with default settings.
/*****
```

At the question:

Do you want to setup SSID?(y/n):

answer: n

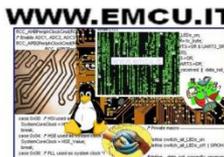


Launch Serial Line Monitor 3/4

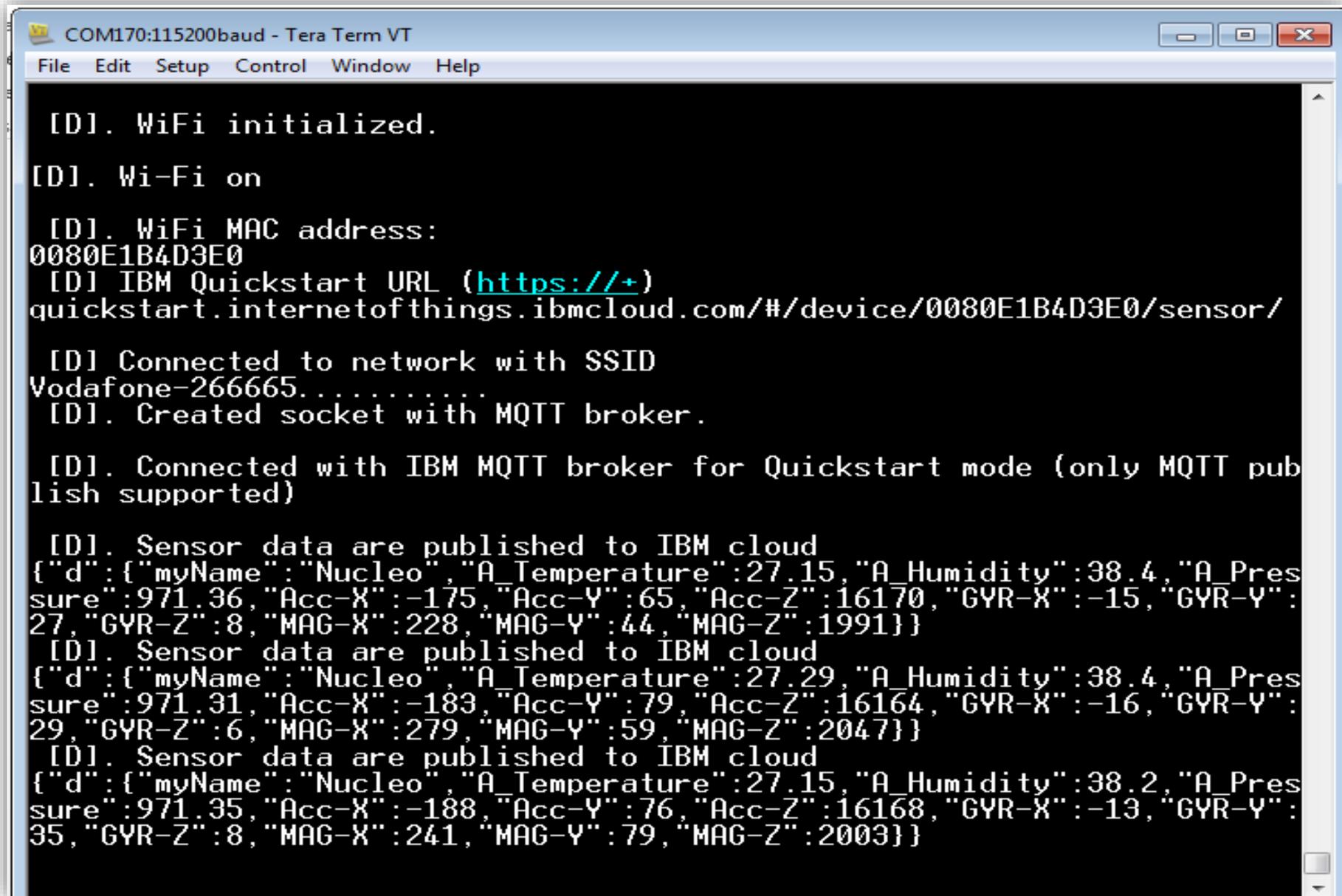
```
COM170:115200baud - Tera Term VT
File Edit Setup Control Window Help
*****
[D]. Initialized Sensors.
Do you want to setup SSID?(y/n): n
Module will connect with default settings.
/*****
* Configuration Complete
* Please make sure a server is listening at given hostname
*****
[D]. WiFi initialized.
[D]. Wi-Fi on
[D]. WiFi MAC address:
0080E1B4D3E0
[D] IBM Quickstart URL (https://+)
quickstart.internetofthings.ibmcloud.com/#/device/0080E1B4D3E0/sensor/
```

• Copy the URL 

- URL in this case is:
<https://quickstart.internetofthings.ibmcloud.com/#/device/0080E1B4D3E0/sensor/>



Launch Serial Line Monitor 4/4



The screenshot shows a Tera Term VT window titled "COM170:115200baud - Tera Term VT". The window has a menu bar with "File", "Edit", "Setup", "Control", "Window", and "Help". The main area displays the following text:

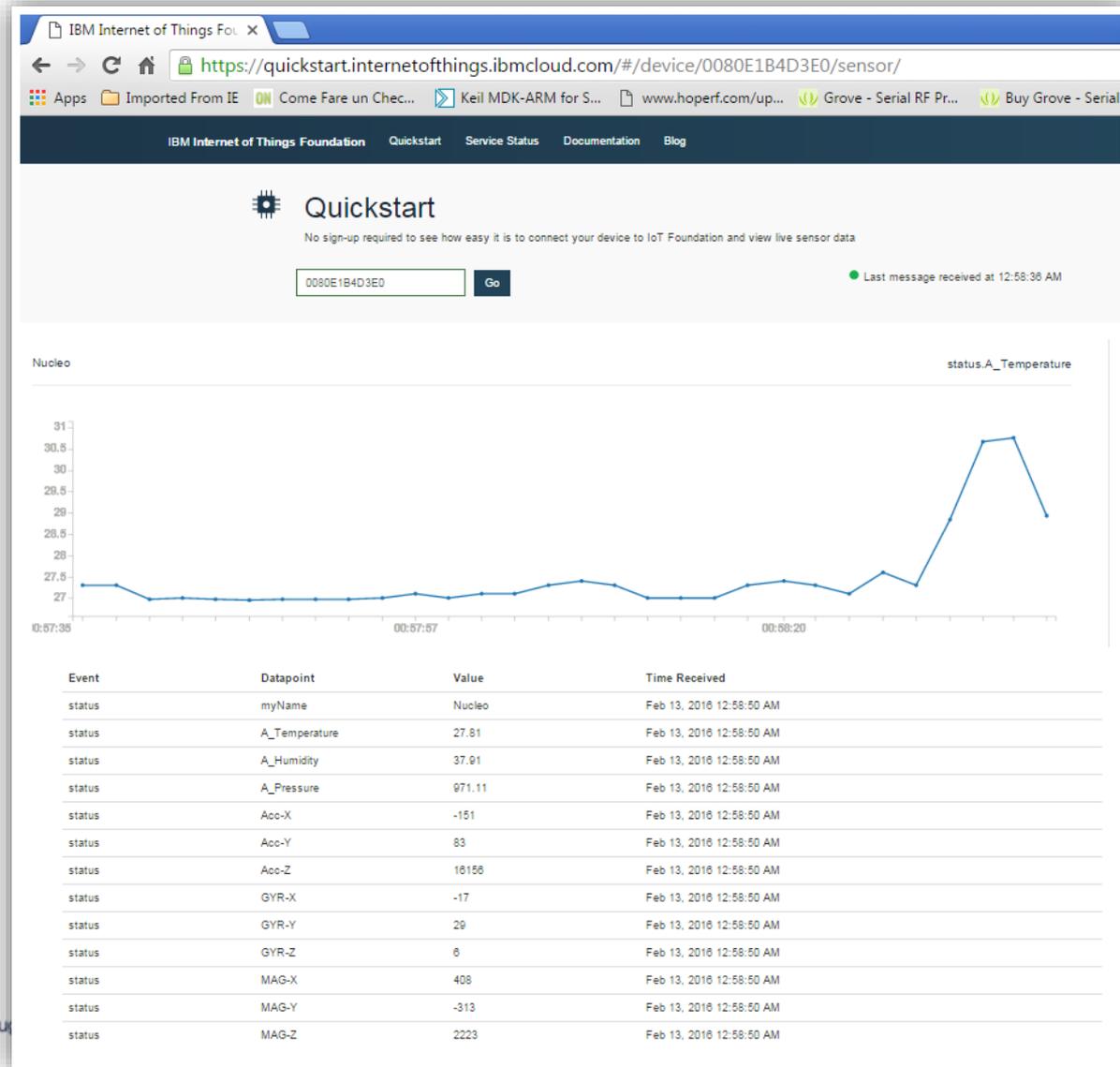
```
[D]. WiFi initialized.  
[D]. Wi-Fi on  
[D]. WiFi MAC address:  
0080E1B4D3E0  
[D] IBM Quickstart URL (https://+)  
quickstart.internetofthings.ibmcloud.com/#/device/0080E1B4D3E0/sensor/  
[D] Connected to network with SSID  
Vodafone-266665.....  
[D]. Created socket with MQTT broker.  
[D]. Connected with IBM MQTT broker for Quickstart mode (only MQTT pub  
lish supported)  
[D]. Sensor data are published to IBM cloud  
{"d":{"myName":"Nucleo","A_Temperature":27.15,"A_Humidity":38.4,"A_Pres  
sure":971.36,"Acc-X":-175,"Acc-Y":65,"Acc-Z":16170,"GYR-X":-15,"GYR-Y":  
27,"GYR-Z":8,"MAG-X":228,"MAG-Y":44,"MAG-Z":1991}}  
[D]. Sensor data are published to IBM cloud  
{"d":{"myName":"Nucleo","A_Temperature":27.29,"A_Humidity":38.4,"A_Pres  
sure":971.31,"Acc-X":-183,"Acc-Y":79,"Acc-Z":16164,"GYR-X":-16,"GYR-Y":  
29,"GYR-Z":6,"MAG-X":279,"MAG-Y":59,"MAG-Z":2047}}  
[D]. Sensor data are published to IBM cloud  
{"d":{"myName":"Nucleo","A_Temperature":27.15,"A_Humidity":38.2,"A_Pres  
sure":971.35,"Acc-X":-188,"Acc-Y":76,"Acc-Z":16168,"GYR-X":-13,"GYR-Y":  
35,"GYR-Z":8,"MAG-X":241,"MAG-Y":79,"MAG-Z":2003}}
```

Open the web browser, Chrome

Go to the URL that you are copied before (slide n.21).

In my case the URL is:
<https://quickstart.internetofthings.ibmcloud.com/#/device/0080E1B4D3E0/sensor/>

You must see the data of your sensors. 



The screenshot shows the IBM Internet of Things Foundation Quickstart web interface. The browser address bar displays the URL: <https://quickstart.internetofthings.ibmcloud.com/#/device/0080E1B4D3E0/sensor/>. The page title is "Quickstart" and it includes a navigation menu with "Quickstart", "Service Status", "Documentation", and "Blog". A "Go" button is present next to the device ID "0080E1B4D3E0". A green dot indicates "Last message received at 12:58:36 AM".

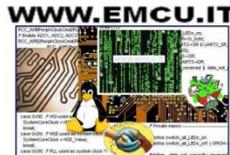
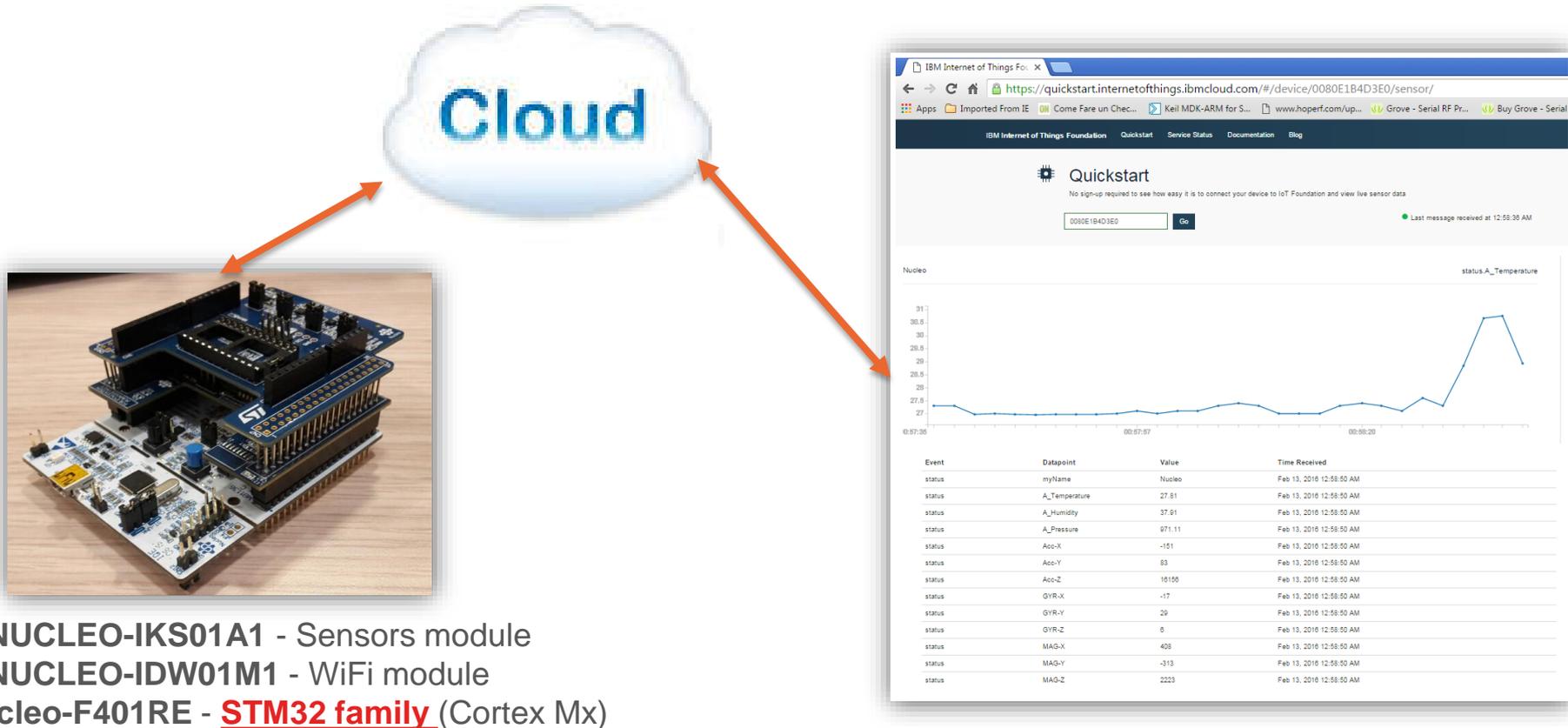
The main content area displays a line graph titled "Nucleo" showing "status.A_Temperature" data. The graph shows a temperature that remains relatively stable around 27.5 degrees Celsius until approximately 00:57:57, after which it rises sharply to a peak of about 30.5 degrees Celsius at 00:58:20, before decreasing to approximately 29.5 degrees Celsius.

Below the graph is a table of sensor data points:

Event	Datapoint	Value	Time Received
status	myName	Nucleo	Feb 13, 2016 12:58:50 AM
status	A_Temperature	27.81	Feb 13, 2016 12:58:50 AM
status	A_Humidity	37.91	Feb 13, 2016 12:58:50 AM
status	A_Pressure	971.11	Feb 13, 2016 12:58:50 AM
status	Acc-X	-151	Feb 13, 2016 12:58:50 AM
status	Acc-Y	83	Feb 13, 2016 12:58:50 AM
status	Acc-Z	16156	Feb 13, 2016 12:58:50 AM
status	GYR-X	-17	Feb 13, 2016 12:58:50 AM
status	GYR-Y	29	Feb 13, 2016 12:58:50 AM
status	GYR-Z	0	Feb 13, 2016 12:58:50 AM
status	MAG-X	408	Feb 13, 2016 12:58:50 AM
status	MAG-Y	-313	Feb 13, 2016 12:58:50 AM
status	MAG-Z	2223	Feb 13, 2016 12:58:50 AM

Summary

IBM Bluemix MQTT over TLS





Thank you.

