

STM32duino Workshop

Carlo Parata

2 December 2017



- Meet ST and STM32 ODE
- Meet Nucleo-F401RE
- STM32duino
- Examples
 - Blinking LED
 - Motion and Environmental Sensors Expansion Board
 - Proximity and Gesture Detection Sensor Expansion Board

Who We Are

- A global semiconductor leader
- 2014 revenues of **\$7.40B**
- Listed: NYSE, Euronext Paris and Borsa Italiana, Milan

- Research & Development
- Front-End
- Main Sales & Marketing
- Back-End

- Approximately **43,600** employees worldwide
- Approximately **8,700** people working in R&D
- **11** manufacturing sites
- Over **75** sales & marketing offices



Where you find us



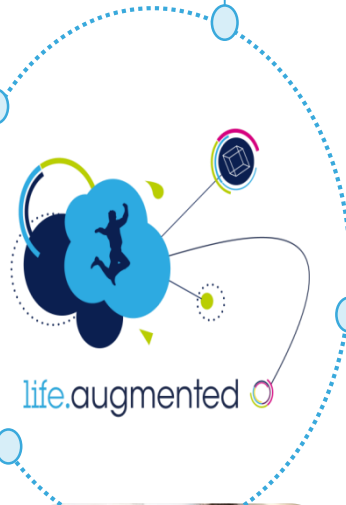
Our MEMS & Sensors are augmenting the consumer experience



Our digital consumer products are powering the augmented digital lifestyle



Our automotive products are making driving safer, greener and more entertaining



Our Microcontrollers are everywhere making everything smarter and more secure



Our smart power products are allowing our mobile products to operate longer and making more of our energy resources

Common SW platform

3 Cloud provider SDKs supported, enabling sensor-to-cloud platforms



131 SW packages from drivers to full application examples and mobile applications



STM32 Open Development Environment



Wearable



IoT Smart Things



Smart Home



Building automation



27 STM32 Nucleo development boards
Covering the broad portfolio of STM32 MCU families

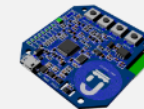
35 STM32 Nucleo expansion boards (X-NUCLEO)
Offering peripheral functions



Modular hardware

ST & 3rd-party form-factor boards

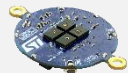
Cloud JAM



SensiBLE



Bluecoin



Sensor Tile



IoT Discovery



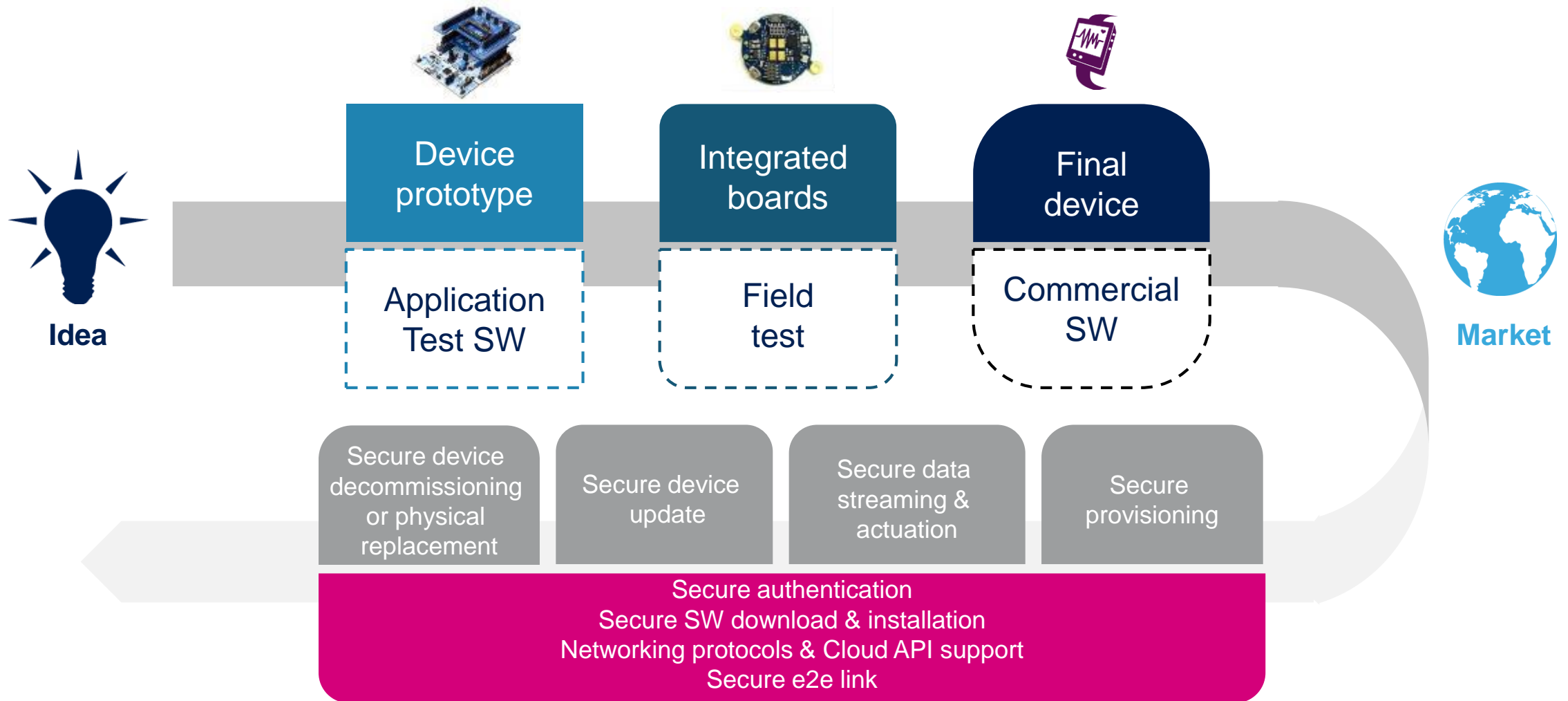
Form factor boards

How to address developers' needs

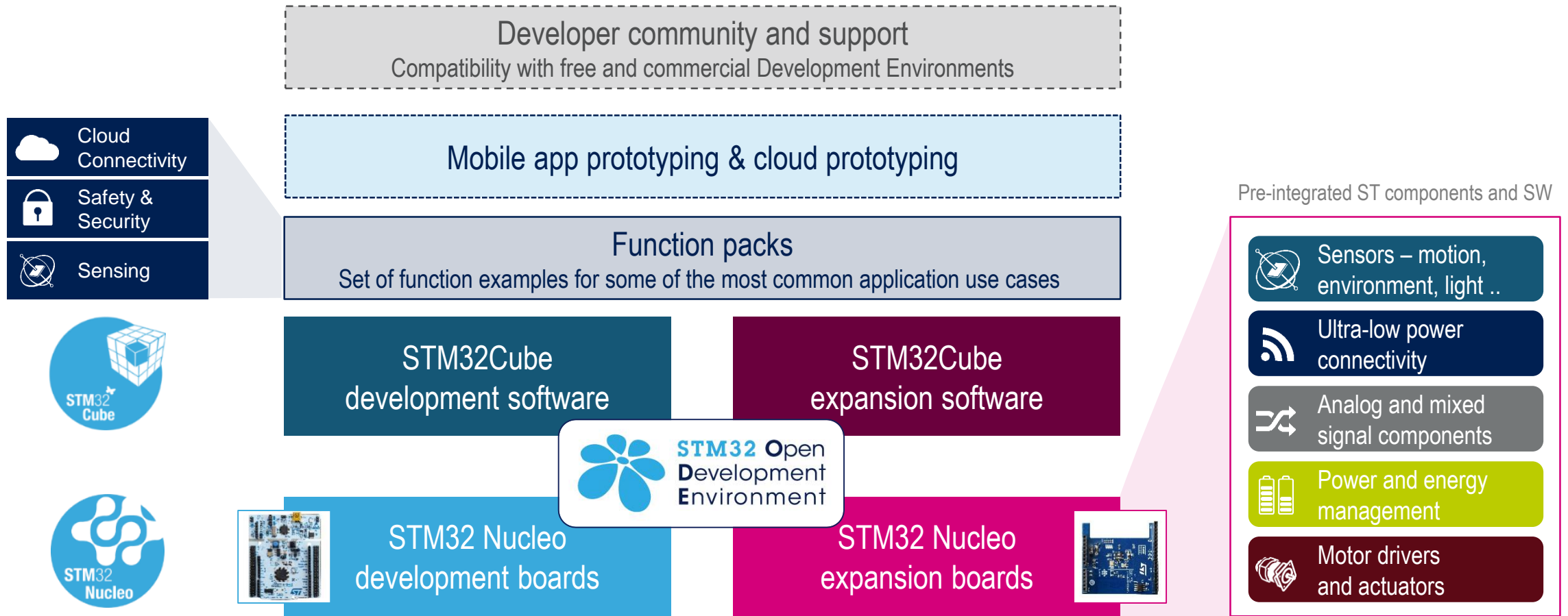
- Offer a large range of microcontrollers from low power to high performance to meet application needs
- Ensure that extra functions are covered in the main domains
 - Sensing, connectivity, power management, motor control and audio
- Ease the Development Environment to allow fast development and production
 - Support of multiple IDEs
 - Free-of-charge tools and embedded software to enable fast and easy development



The real IoT lifecycle



Fast, affordable prototyping & development



An application-oriented approach

Your need

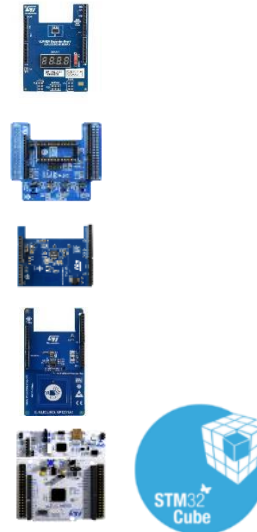
- Sensors
- Connectivity
- Translate
- Motor drivers
- Power
- Processing

Application software and development tools

The building blocks

Processor boards (Nucleo 64)
Expansion boards (X-Nucleo)

- Motion
- Environmental
- Bluetooth LE
- Sub-GHz
- NFC
- OpAmp
- Motor controller
- Power manager
- Microcontroller



Integrated Development Environment and middleware

Our answer

Function Packs (FP)



Ready-to-use application-oriented package

STM32 Nucleo development boards

27 development boards and growing... in two flavors (Processing & Security)

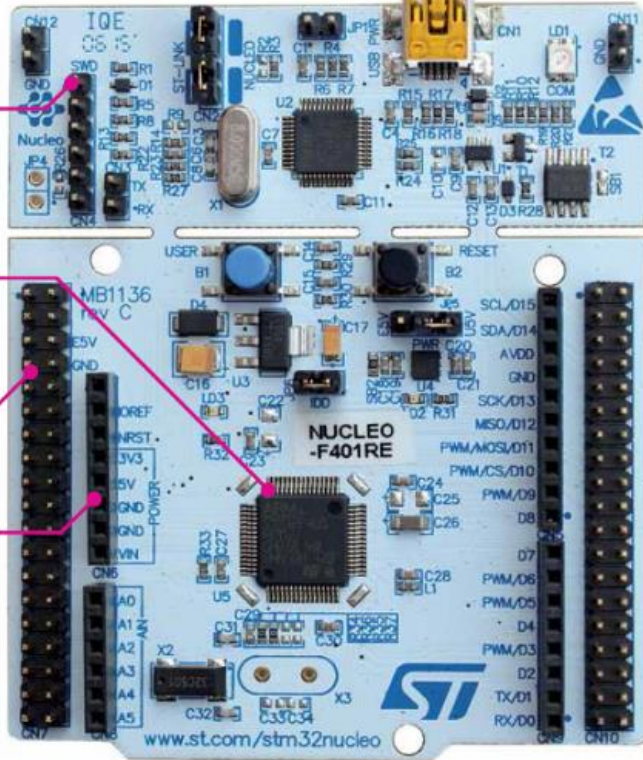
Board power supply through USB or external source

Integrated debugging and programming ST-LINK probe

STM32 microcontroller

Morpho extension header

Arduino™ extension header



STM32 complete product range from ultra-low power to high performance



STM32 Nucleo expansion boards

35 expansion boards and growing... covering all the key functions

5 Sense

- Motion & environmental sensors
- Proximity sensor
- Microphone

11 Connect

- BLE
- Wi-Fi
- Sub-GHz
- NFC

3 Power Drive

- Power management
- LED boost

12 Move Actuate

- Motor drive
- Actuator

4 Translate

- Audio amplifier
- OpAmp



STM32L4 Discovery IoT features

Multi-link communication, multiway sensing

BLE module

Audio mics

Power supply through USB

Gyro/Accelero/Magnetometer,
Proximity, Pressure, Humidity,
Temperature sensors

WiFi module

SubGHz module

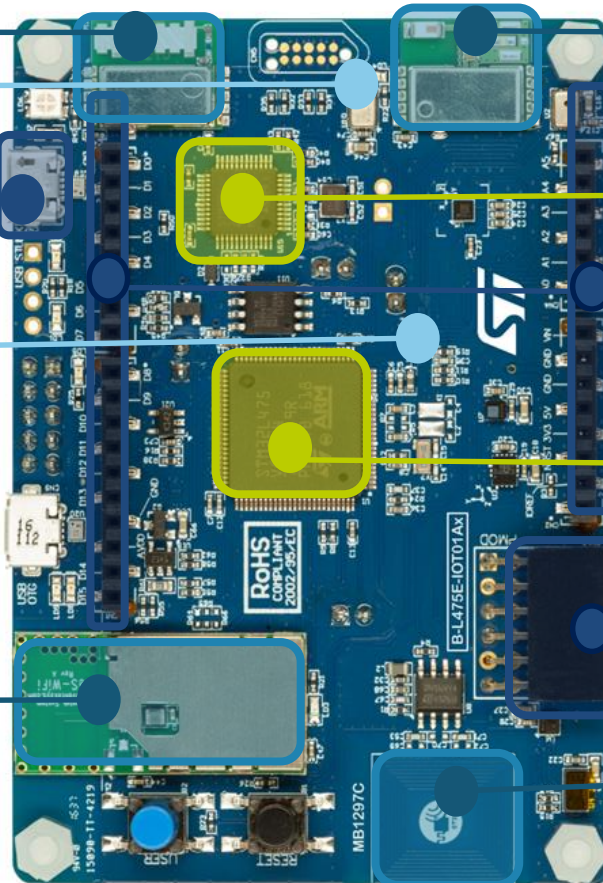
Integrated ST-Link/V2-1:
drag & drop flash programming

Arduino Uno extension connectors

STM32L475 MCU

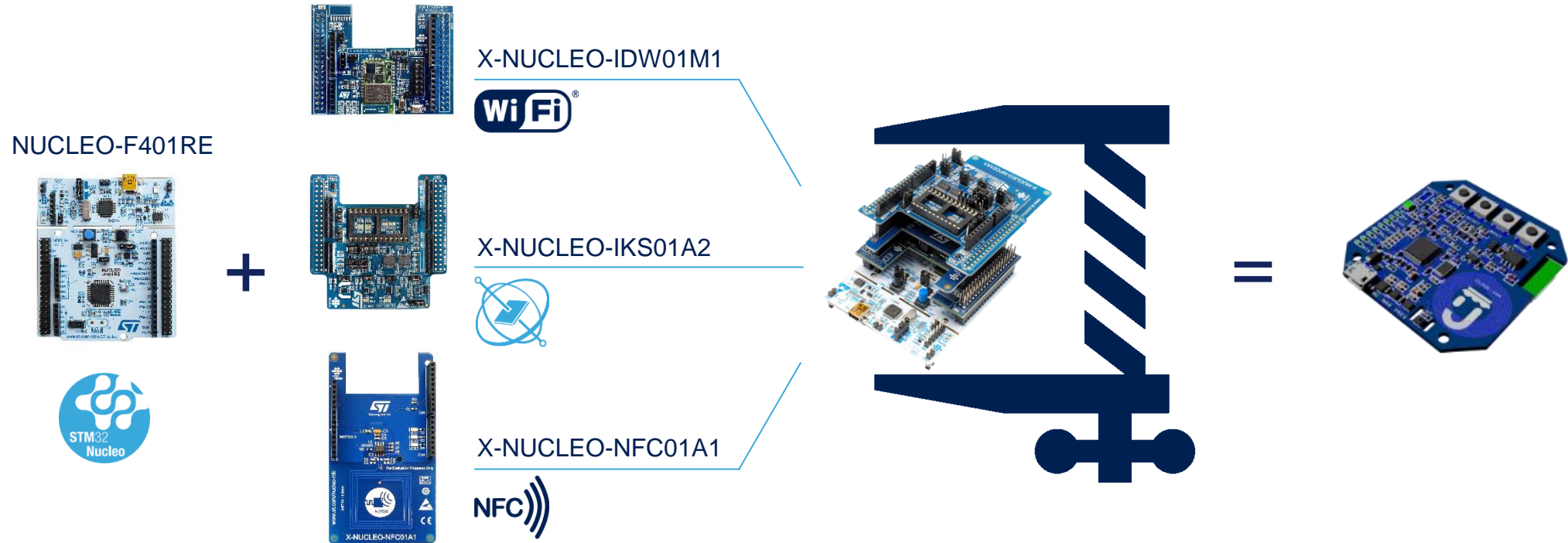
PMOD extension connector

NFC : intuitive configuration



STM32 ODE product accelerators

A fast track from idea to production



Idea

Prototype



Engineering sample

Product

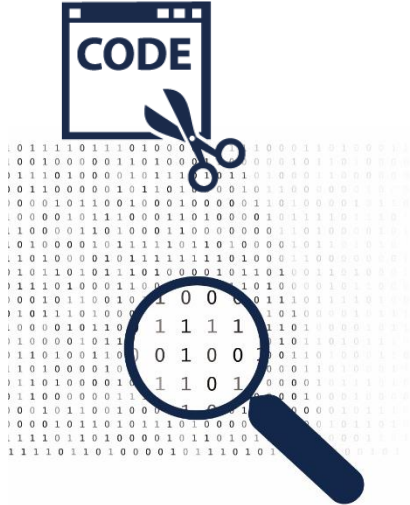
Embedded Software offer

STM32Snippets,
Cube LL

STM32Cube HAL

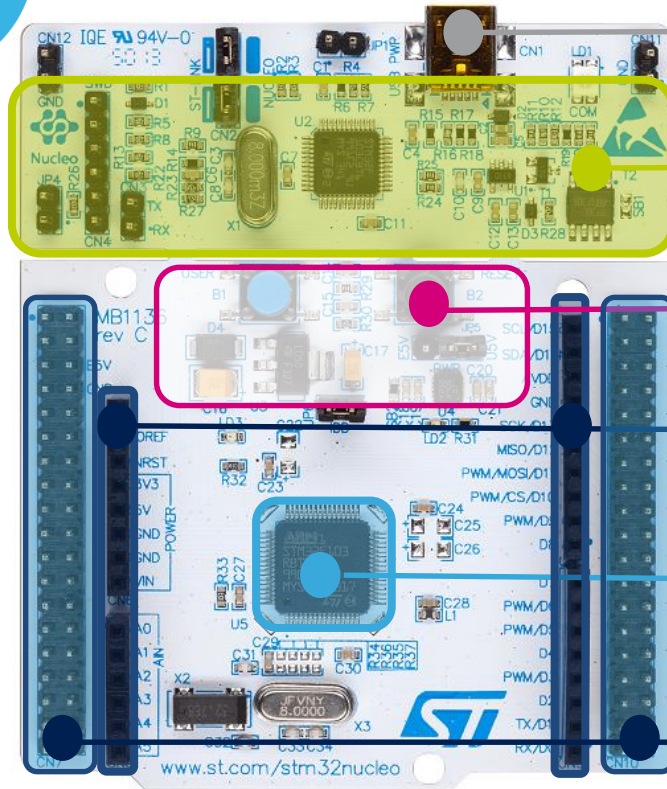
Arduino and mbed

MicroPython,
Espruino



ARMmbed





Flexible board power supply :
through USB or external source

Integrated ST-Link/V2-1:
mass storage device flash programming

2 push buttons, 2 color Leds

Arduino extension connectors :
easy access to add-ons

One STM32 MCU flavor with 64 pins

Morpho extension headers :
direct access to all MCU I/Os

- Freely available Arduino support for STM32 MCUs
- Run your sketches on STM32!
- Active online community

The screenshot shows the 'Arduino for STM32' forum interface. At the top, there's a navigation bar with the forum logo, a search bar, and links for 'Quick links', 'FAQ', 'Register', and 'Login'. Below this is a 'Board index' section with a timestamp: 'It is currently Tue Oct 25, 2016 11:27 am'.

The main content area is divided into two sections: 'ARDUINO FOR STM32' and 'BOARDS'. Each section contains a table with columns for 'TOPICS', 'POSTS', and 'LAST POST'.

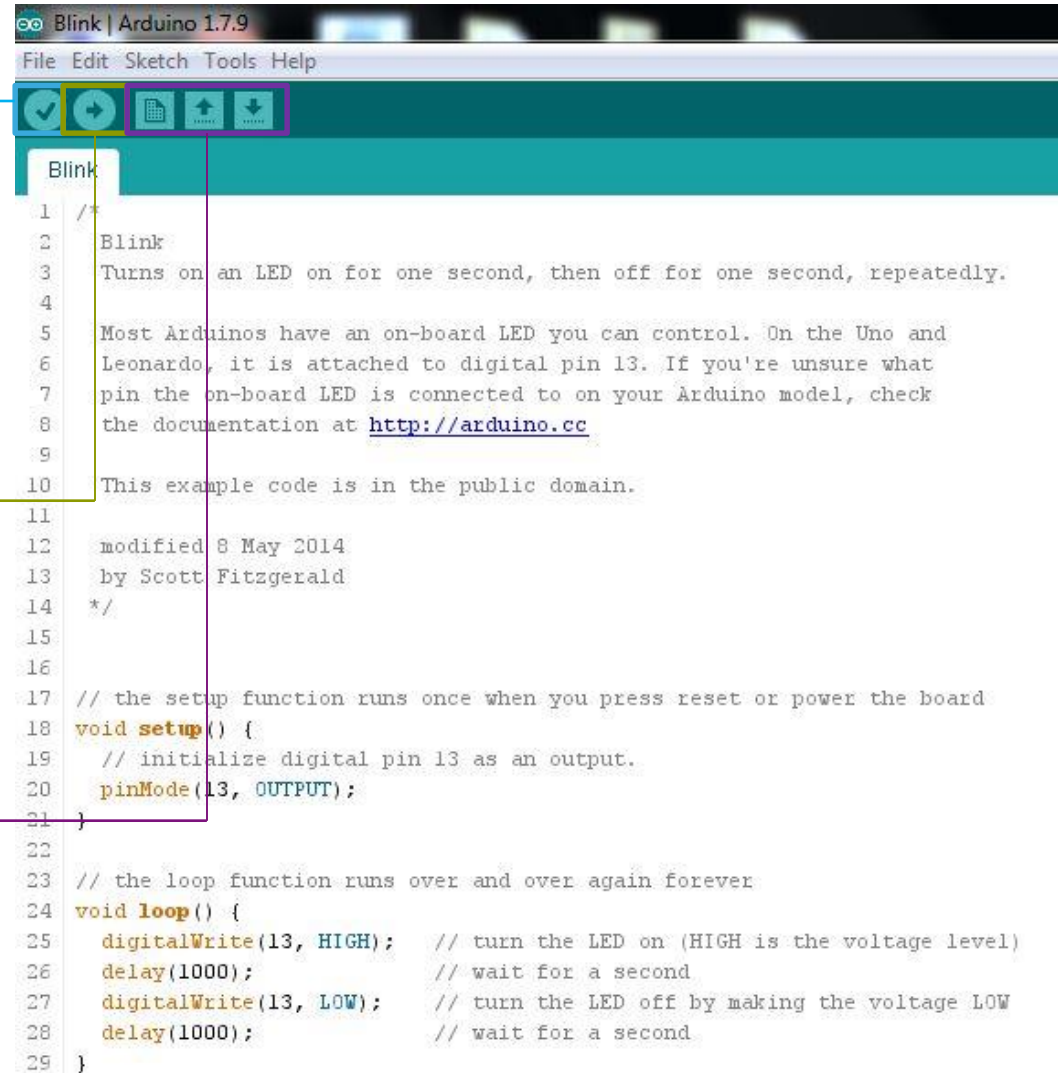
ARDUINO FOR STM32			
	TOPICS	POSTS	LAST POST
Welcome & FAQs Please read this if you are new to the STM32	29	347	Re: Hello everyone! A little ... by RogerClark Sat Oct 22, 2016 8:04 pm
Builds and Announcements Information on the latest releases	75	737	Re: Partial support for JLink... by VK3TY Tue Oct 18, 2016 10:57 pm
General discussion Post here first, or if you can't find a relevant section!	302	4069	Re: Using J-Link with STM32F1... by VK3TY Tue Oct 25, 2016 10:45 am
Libraries & Hardware Working libraries, libraries being ported and related hardware	202	2873	Re: SST26VF064B Library... he... by rexnanet Tue Oct 25, 2016 10:38 am
Projects What are you developing?	66	1504	Re: \$10 O-Scope revisited by ag123 Sat Oct 22, 2016 7:28 pm
Ideas & suggestions What could be included in further releases, or for the forum.	26	264	Re: RTC library by GrumpyOldPizza Sun Oct 23, 2016 2:01 pm
Code snippets Post your cool example code here.	42	499	Re: Super Simple RTC by mrburnette Sat Oct 01, 2016 6:08 pm
Installation and OS related How to install STM32 Arduino into the Arduino IDE, and any OS specific issues	45	443	1.7.11 ST-LINK/V2 and Blue pi... by x0a Sat Oct 08, 2016 1:47 pm
IDE's Development environment specific, Arduino, Eclipse, VS2013, Em::Blocks etc	45	741	Re: Board Manager again by ahull Tue Oct 25, 2016 10:29 am
Off topic Anything not related to STM32	194	2360	Re: ESP32 in Pre-Order by Ollie Sun Oct 23, 2016 1:48 am

BOARDS			
	TOPICS	POSTS	LAST POST
Maple mini	49	634	Re: Extended Code Size while ... by Rick Kimball Tue Oct 25, 2016 12:17 am
Generic STM32F103 Generic boards that are not Maple or Maple mini clones, and don't contain the additional USB reset hardware	92	1282	Re: Thoughts on the: mini STM... by keypunch Tue Oct 25, 2016 1:27 am
STM Nucleo boards STM32F103 Nucleo boards e.g. STM Nucleo F103RB	10	106	Re: Anyone playing with these... by zmemw16 Tue Oct 25, 2016 1:27 am

Verify
button:
compile
a sketch

Upload
button:
flash a
sketch

New/
Open/
Save
buttons:
edit a
sketch



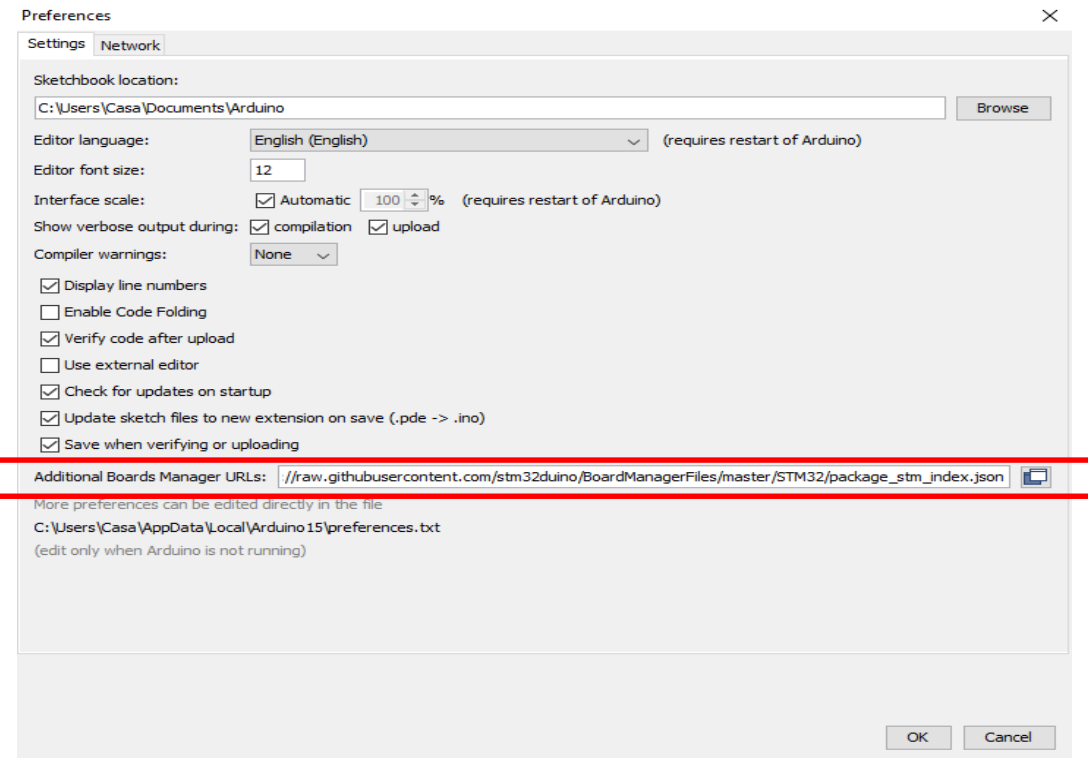
```
Blink | Arduino 1.7.9
File Edit Sketch Tools Help

1 /*
2  * Blink
3  * Turns on an LED on for one second, then off for one second, repeatedly.
4  *
5  * Most Arduinos have an on-board LED you can control. On the Uno and
6  * Leonardo, it is attached to digital pin 13. If you're unsure what
7  * pin the on-board LED is connected to on your Arduino model, check
8  * the documentation at http://arduino.cc
9  *
10 * This example code is in the public domain.
11 *
12 * modified 8 May 2014
13 * by Scott Fitzgerald
14 */
15
16
17 // the setup function runs once when you press reset or power the board
18 void setup() {
19   // initialize digital pin 13 as an output.
20   pinMode(13, OUTPUT);
21 }
22
23 // the loop function runs over and over again forever
24 void loop() {
25   digitalWrite(13, HIGH); // turn the LED on (HIGH is the voltage level)
26   delay(1000);           // wait for a second
27   digitalWrite(13, LOW); // turn the LED off by making the voltage LOW
28   delay(1000);          // wait for a second
29 }
```

Install STM32 support files (1)

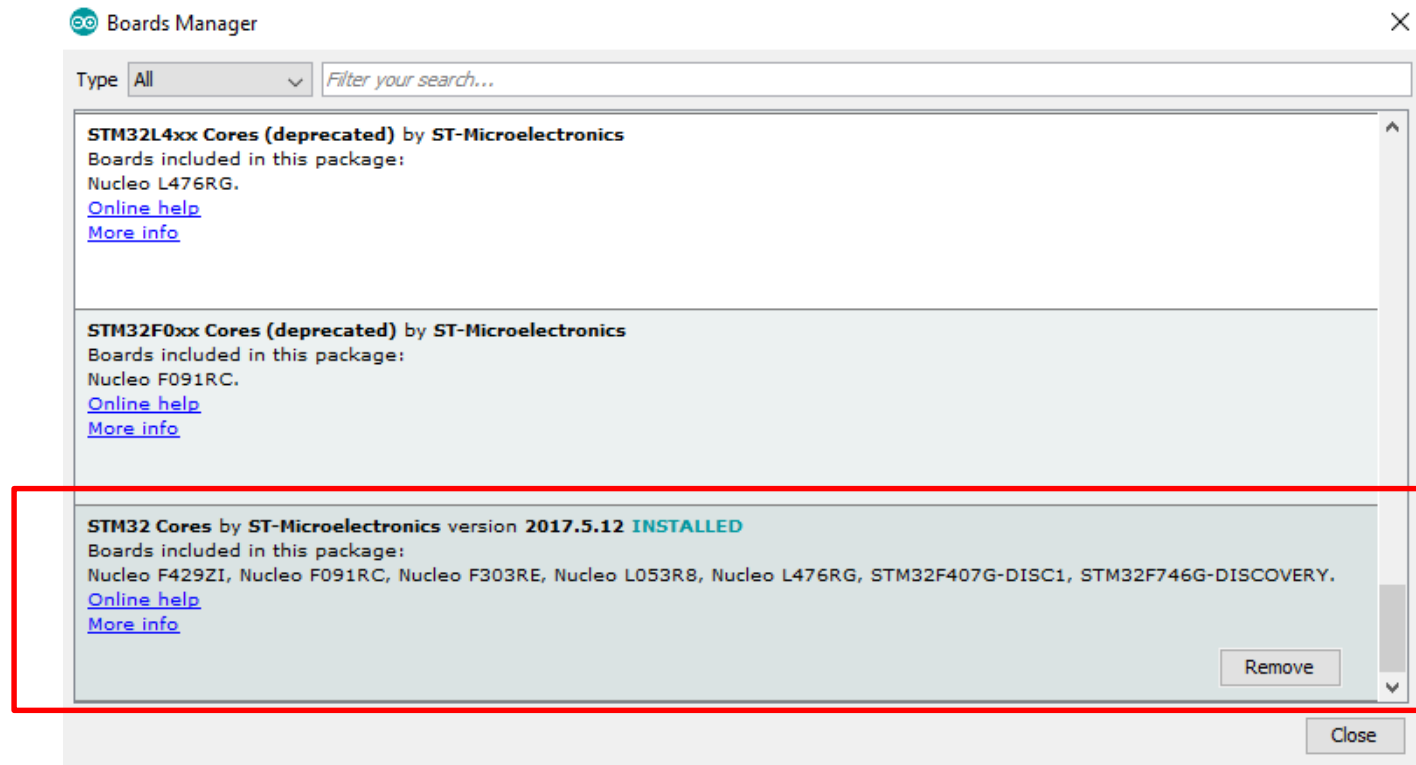
- Copy

https://raw.githubusercontent.com/stm32duino/BoardManagerFiles/master/STM32/package_stm_index.json
inside “Additional Boards Manager URLs”



Install STM32 support files (2)

- Go to “Boards Manager” and install the “STM32 Cores”



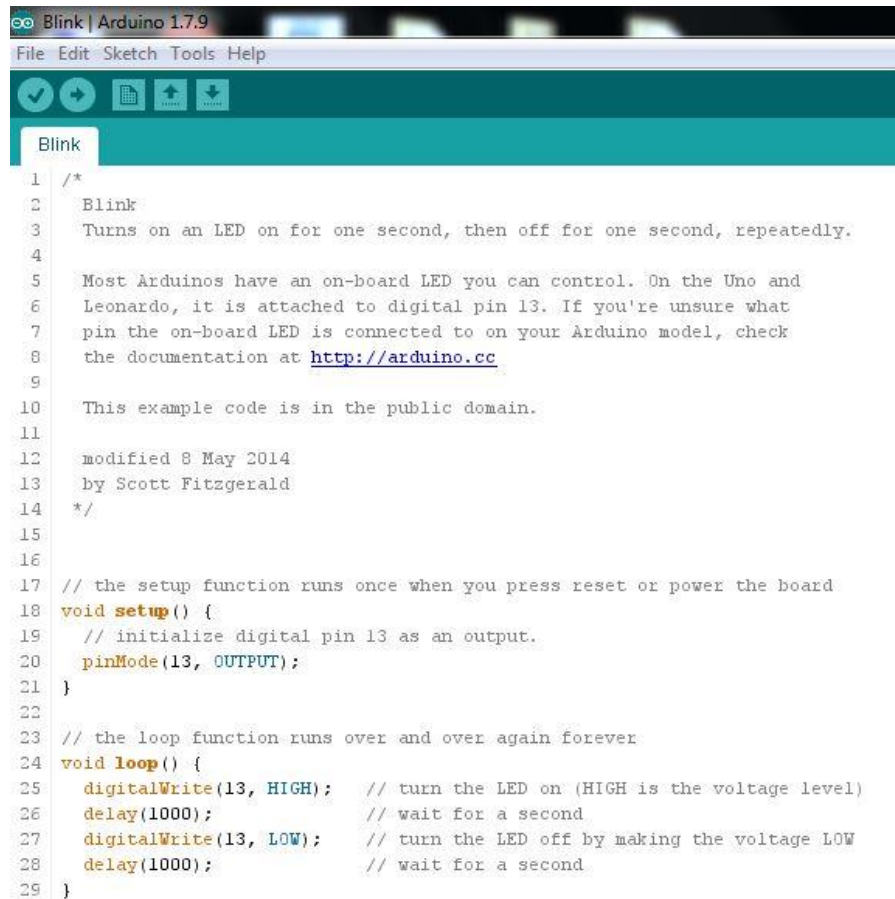

```
Blink | Arduino 1.7.9
File Edit Sketch Tools Help

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26   delay(1000);           // wait for a second
27   digitalWrite(13, LOW); // turn the LED off by making the voltage LOW
28   delay(1000);           // wait for a second
29 }
```

Setup routine: where all the initializations are done

Loop routine: it represents the core of the application and it is called in an infinite loop

Nucleo-F401RE: Blinking the LED



```
Blink | Arduino 1.7.9
File Edit Sketch Tools Help
Blink
1  /*
2   Blink
3   Turns on an LED on for one second, then off for one second, repeatedly.
4
5   Most Arduinos have an on-board LED you can control. On the Uno and
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27    digitalWrite(13, LOW); // turn the LED off by making the voltage LOW
28    delay(1000);           // wait for a second
29  }
```

- Compile the sketch
- Upload the binary on the Nucleo-F401RE
- See the led blinking

Motion MEMS and environmental sensors expansion board

X-NUCLEO-IKS01A2 Hardware description

The X-NUCLEO-IKS01A2 is a motion MEMS and environmental sensor expansion board for the STM32 Nucleo. It is compatible with the Arduino UNO R3 connector layout, and is designed around the LSM6DSL 3D accelerometer and 3D gyroscope, the LSM303AGR 3D accelerometer and 3D magnetometer, the HTS221 humidity and temperature sensor and the LPS22HB pressure sensor. The X-NUCLEO-IKS01A2 interfaces with the STM32 microcontroller via the I²C pin, and it is possible to change the default I²C port.

Key products on board

LSM6DSL

MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g) + 3D gyroscope ($\pm 125/\pm 245/\pm 500/\pm 1000/\pm 2000$ dps)

LSM303AGR

MEMS 3D magnetometer (± 50 gauss) + MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g)

LPS22HB

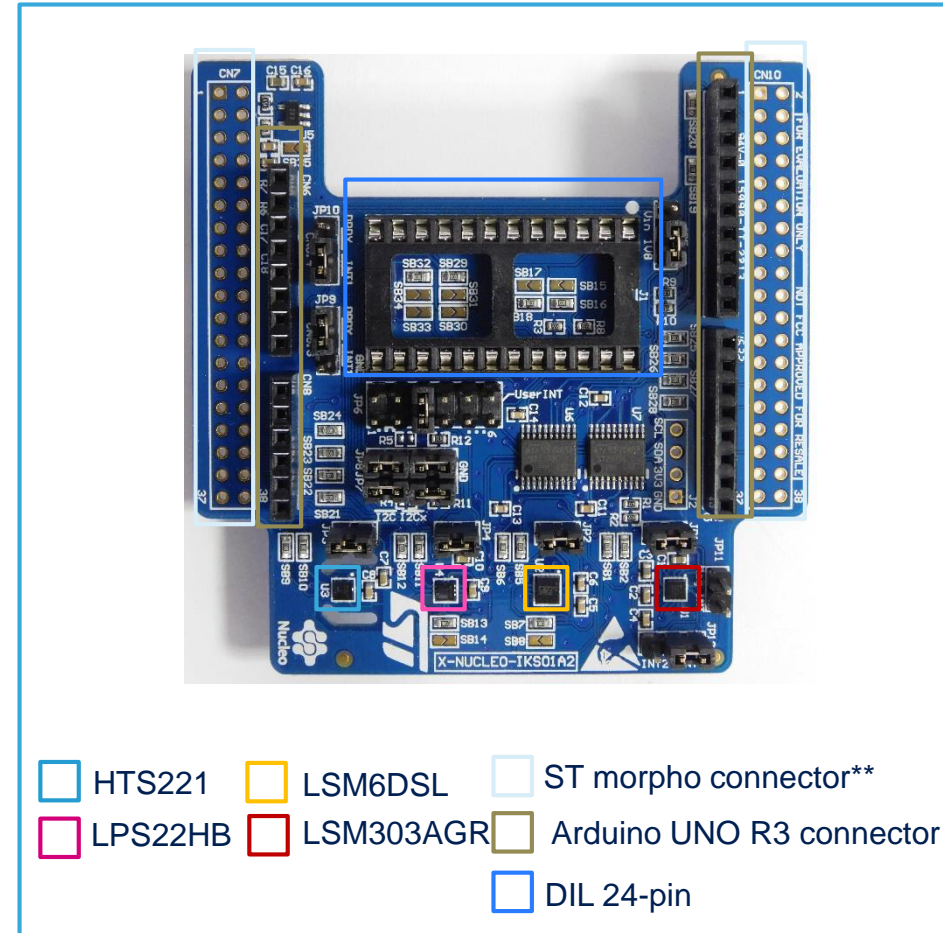
MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

HTS221

Capacitive digital relative humidity and temperature

DIL 24-pin

Socket available for additional MEMS adapters and other sensors (UV index)

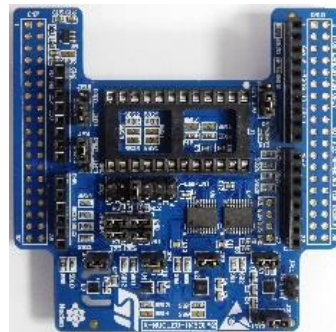


Latest info available at www.st.com
X-NUCLEO-IKS01A2

** Connector for the STM32 Nucleo Board

Combine Nucleo-F401RE with ST MEMS and environmental sensors shield (1)

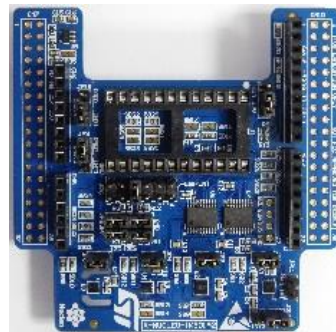
```
COM34
Hum[%]: 53.10 | Temp[C]: 25.30 | Pres[hPa]: 1004.51 | Temp2[C]: 26.50 | Acc[mg]: -21 2 1032 | Gyr[mdps]: 1610 -350 1330 | Acc2[mg]: 4 8 1006 | Mag[mGauss]: -102 -132 -516 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.53 | Temp2[C]: 26.50 | Acc[mg]: -21 1 1032 | Gyr[mdps]: 1610 -350 1330 | Acc2[mg]: 4 8 1010 | Mag[mGauss]: -106 -142 -523 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.51 | Temp2[C]: 26.50 | Acc[mg]: -20 1 1034 | Gyr[mdps]: 1540 -420 1330 | Acc2[mg]: 4 12 1006 | Mag[mGauss]: -103 -126 -511 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.53 | Temp2[C]: 26.60 | Acc[mg]: -20 2 1033 | Gyr[mdps]: 1610 -350 1330 | Acc2[mg]: 0 8 1002 | Mag[mGauss]: -105 -129 -514 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.48 | Temp2[C]: 26.60 | Acc[mg]: -20 2 1034 | Gyr[mdps]: 1610 -350 1330 | Acc2[mg]: -11 8 1006 | Mag[mGauss]: -103 -127 -510 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.57 | Temp2[C]: 26.60 | Acc[mg]: -20 1 1033 | Gyr[mdps]: 1540 -350 1330 | Acc2[mg]: 12 12 1037 | Mag[mGauss]: -111 -133 -513 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.60 | Temp2[C]: 26.60 | Acc[mg]: -21 0 1034 | Gyr[mdps]: 1540 -350 1330 | Acc2[mg]: 4 8 1006 | Mag[mGauss]: -103 -132 -514 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.55 | Temp2[C]: 26.60 | Acc[mg]: -20 1 1033 | Gyr[mdps]: 1540 -350 1330 | Acc2[mg]: 0 8 1006 | Mag[mGauss]: -118 -130 -517 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.59 | Temp2[C]: 26.60 | Acc[mg]: -20 2 1034 | Gyr[mdps]: 1540 -420 1330 | Acc2[mg]: 0 12 1002 | Mag[mGauss]: -111 -129 -513 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.56 | Temp2[C]: 26.60 | Acc[mg]: -20 1 1033 | Gyr[mdps]: 1540 -350 1330 | Acc2[mg]: 0 4 1010 | Mag[mGauss]: -111 -135 -517 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.41 | Temp2[C]: 26.60 | Acc[mg]: -20 1 1033 | Gyr[mdps]: 1610 -420 1330 | Acc2[mg]: 8 4 1006 | Mag[mGauss]: -103 -127 -516 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.60 | Temp2[C]: 26.60 | Acc[mg]: -20 2 1033 | Gyr[mdps]: 1540 -420 1330 | Acc2[mg]: 0 12 1010 | Mag[mGauss]: -105 -135 -516 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.59 | Temp2[C]: 26.60 | Acc[mg]: -20 2 1034 | Gyr[mdps]: 1540 -350 1330 | Acc2[mg]: -19 4 1018 | Mag[mGauss]: -105 -138 -511 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.59 | Temp2[C]: 26.60 | Acc[mg]: -20 2 1034 | Gyr[mdps]: 1540 -350 1330 | Acc2[mg]: 4 8 971 | Mag[mGauss]: -96 -123 -514 |
Hum[%]: 53.00 | Temp[C]: 25.40 | Pres[hPa]: 1004.57 | Temp2[C]: 26.60 | Acc[mg]: -19 1 1033 | Gyr[mdps]: 1610 -420 1330 | Acc2[mg]: 0 12 1010 | Mag[mGauss]: -111 -130 -514 |
```



- Plug ST MEMS and environmental sensor shield on Nucleo-F401RE board
- Compile and run the data logging demo
- Look at the source code to understand the usage of the sensor libraries

Combine Nucleo-F401RE with ST MEMS and environmental sensors shield (2)

```
COM34  
  
Free Fall Detected!  
Free Fall Detected!  
Free Fall Detected!  
Free Fall Detected!
```



- Plug ST MEMS and environmental sensors shield on Nucleo-F401RE board
- Compile and run the free fall detection demo
- Look at the source code to understand the usage of the sensor libraries for the hardware features of LSM6DSL

ST's FlightSense™ - ToF Sensors



VL6180X

- Proximity, Gesture & ALS sensor
- Up to 40cm Ranging

- 1st generation ST ToF sensor
 - Small 3-in-1 Optical LGA12 package, dimensions: 4.8 x 2.8 x 1.0 mm
- Proximity sensor & ALS
 - Up to 40 cm Proximity
 - 850nm IR emission (Vcsel)
- Major use cases:
 - Proximity detection
 - Ambient Light Sensing (ALS)
 - Basic gesture



VL53L0X

- Ranging sensor
- Up to 200cm ranging

- 2nd generation ST ToF sensor
 - Miniature Optical LGA12 package, dimensions: 4.4 x 2.4 x 1.0 mm
- Ranging sensor
 - Up to 2 meters distance measurement
 - 940nm IR emission (Vcsel)
- Major use cases:
 - User / object detection
 - Autofocus Laser Assist
 - Basic gesture

Ranging and gesture detection sensor expansion board

X-NUCLEO-53L0A1 Hardware Description

- The X-NUCLEO-53L0A1 is a ranging and gesture detection sensor evaluation and development board system, designed around VL53L0X, a device based on ST's FlightSense™, Time-of-Flight technology.
- The VL53L0X communicates with STM32 Nucleo developer board host microcontroller through an I²C link available on the Arduino UNO R3 connector.

Key Products on board

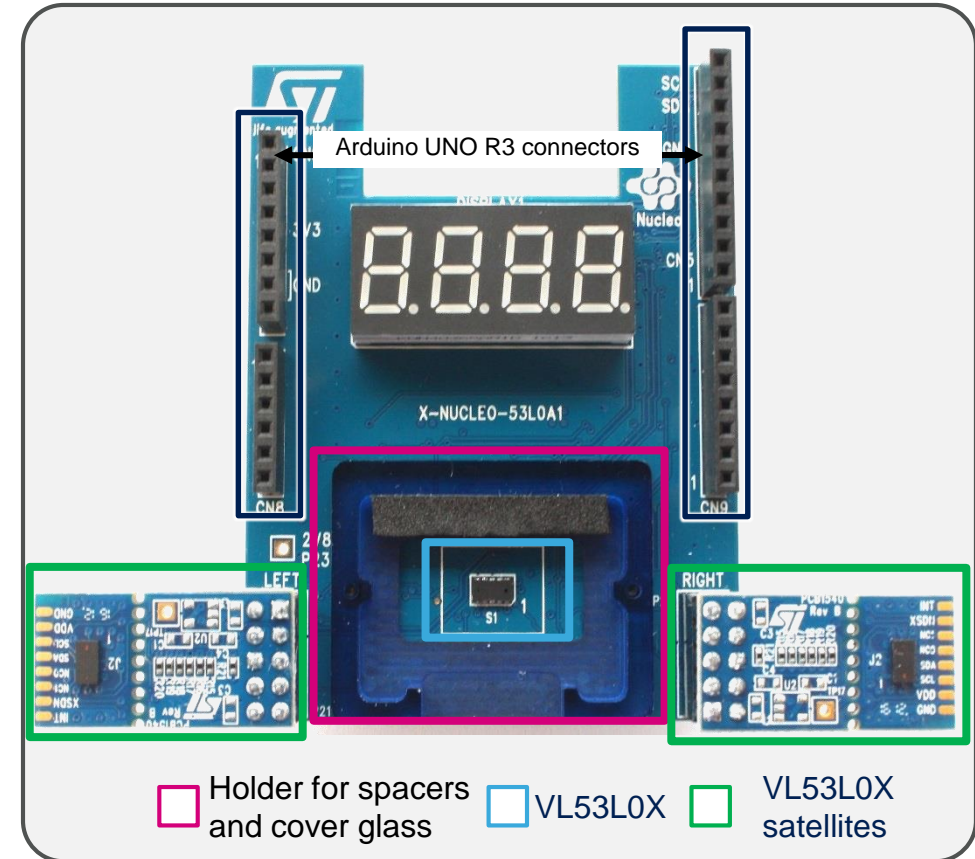
VL53L0X proximity and gesture detection sensor module.

4-digit display, displaying the distance of a target from the ranging sensor.

0.25, 0.5 and 1mm spacers to simulate air gaps.

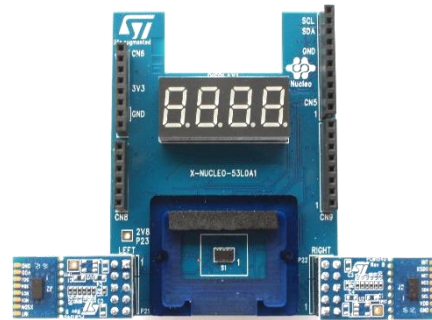
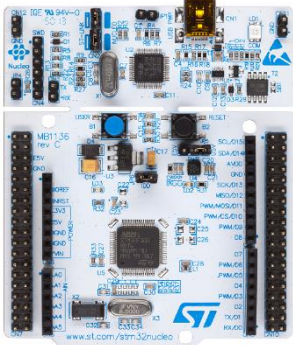
Cover glass

2x VL53L0X satellite boards



Combine Nucleo-F401RE with ST proximity and gesture detection sensor shield (1)

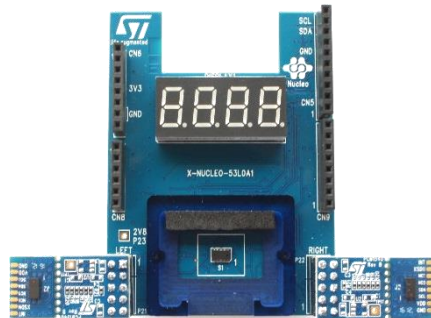
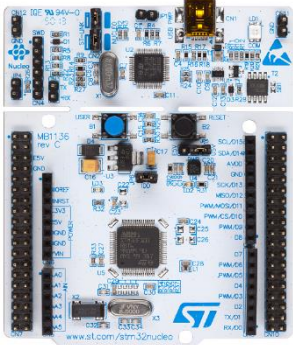
```
COM15
|
| Distance left [mm]: 2254 |
| Distance top [mm]: 574 |
| Distance left [mm]: 364 |
| Distance right [mm]: 338 |
| Distance top [mm]: 314 |
| Distance left [mm]: 289 |
| Distance right [mm]: 314 |
| Distance top [mm]: 309 |
| Distance left [mm]: 280 |
| Distance right [mm]: 303 |
| Distance top [mm]: 274 |
| Distance left [mm]: 258 |
| Distance right [mm]: 266 |
```



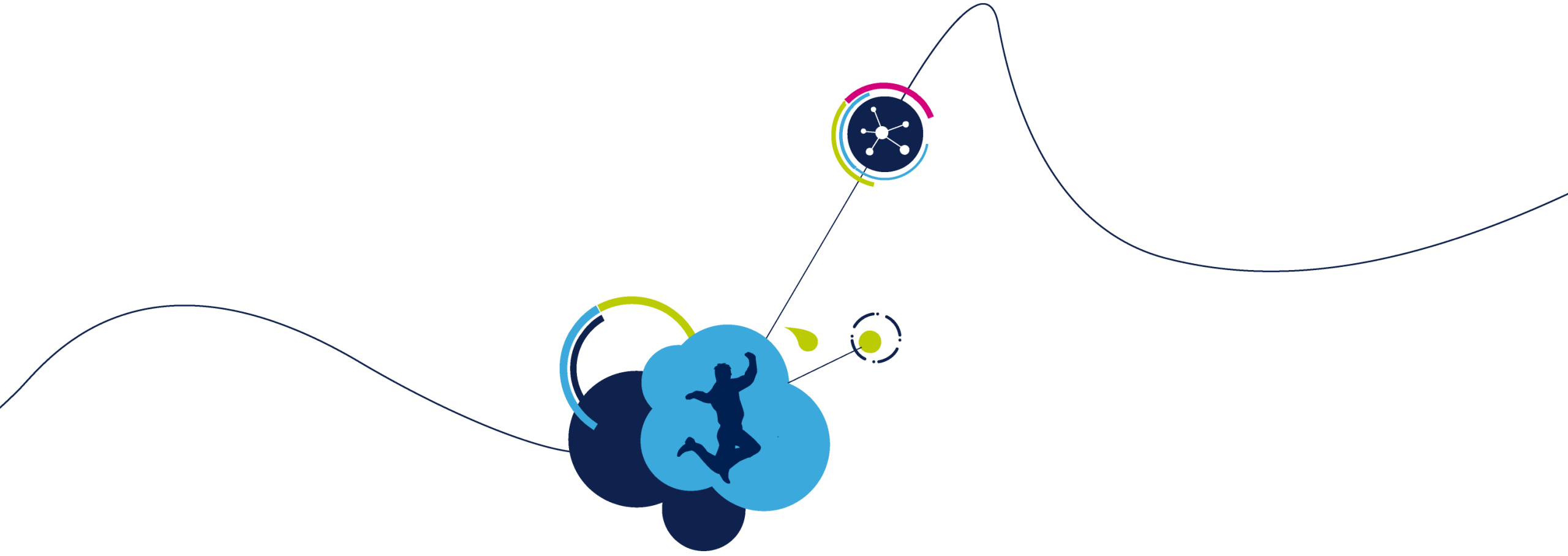
- Plug ST proximity and gesture detection sensor shield on Nucleo-F401RE board
- Compile and run the X_NUCLEO_53L0A1_HelloWorld sketch
- Look at the source code to understand the usage of the FlightSense libraries

Combine Nucleo-F401RE with ST proximity and gesture detection sensor shield (2)

```
COM34  
  
GESTURES_SINGLE_SWIPE DETECTED!!!  
GESTURES_SINGLE_SWIPE DETECTED!!!  
GESTURES_SINGLE_SWIPE DETECTED!!!  
GESTURES_SINGLE_SWIPE DETECTED!!!  
GESTURES_SINGLE_SWIPE DETECTED!!!
```



- Plug ST proximity and gesture detection sensor shield on Nucleo-F401RE board
- Compile and run the X_NUCLEO_53L0A1_Gesture_Swipe1 sketch
- Look at the source code to understand the usage of the FlightSense libraries



Thank you!