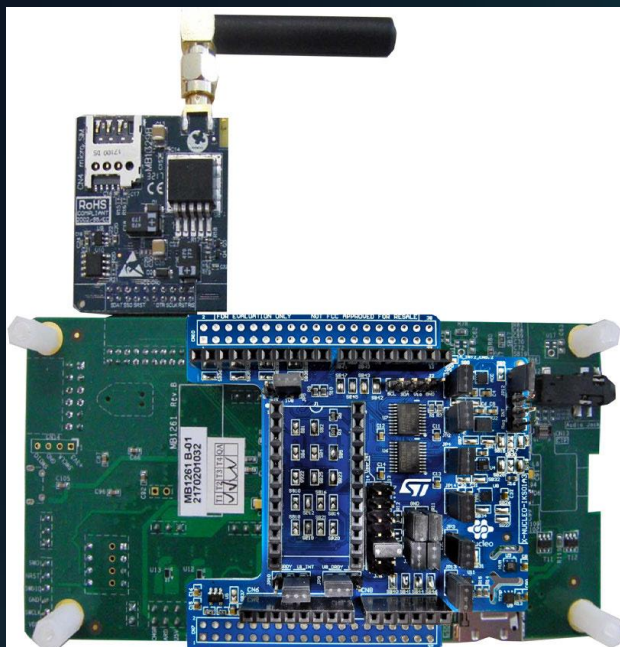




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Quick Start Guide

STM32Cube function pack for IoT sensor node
with cellular connectivity enabling IOTA
Distributed Ledger Technology (DLT) functions
(FP-SNS-IOTA1)

Version 1.1 (November 30, 2020)

Agenda

1 Hardware and Software overview

2 Setup & Demo Examples

3 Documents & Related Resources

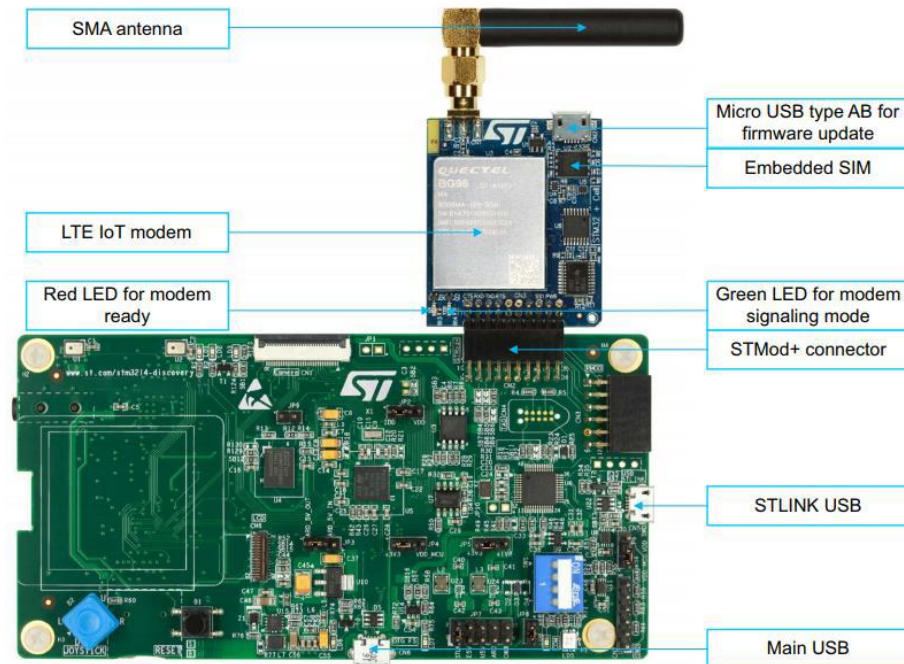
4 STM32 Open Development Environment: Overview

1- Hardware and Software overview

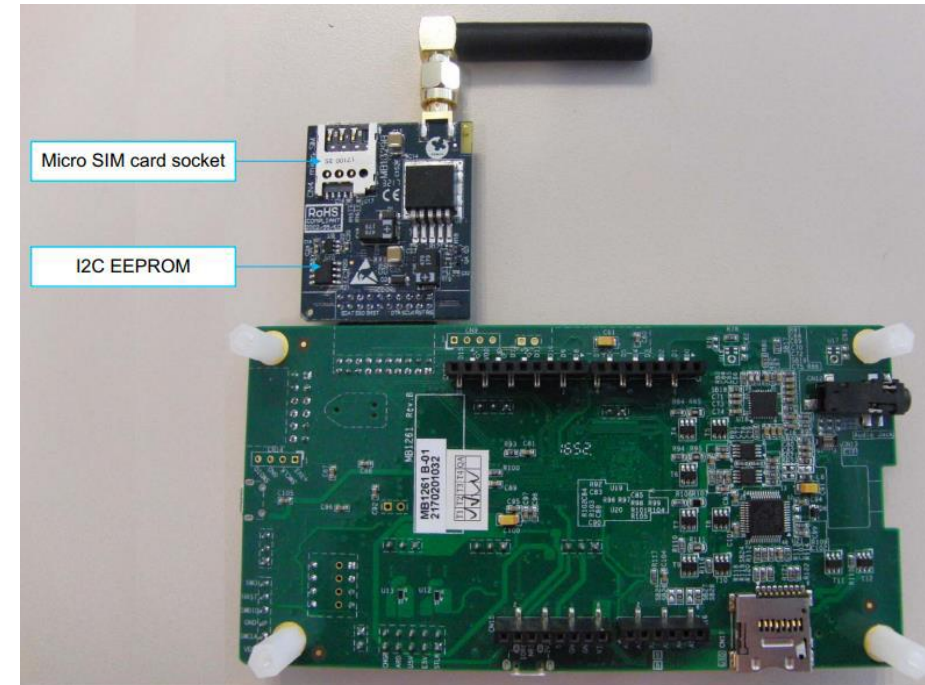
P-L496G-CELL02 Hardware Overview

P-L496G-CELL02 Hardware Description

- The P-L496-CELL02 STM32 discovery pack for LTE IoT cellular to cloud (STM32-C2C/LTE IoT) is a turnkey development platform for cellular and cloud technology based solutions.
- The pack is composed of an STM32L496AGI6-based low-power discovery mother board with preloaded firmware, and an STMod+ cellular expansion board with antenna.
- It features STM32L496AGI6Arm®-based microcontroller featuring 1Mbyte of Flash memory and 320Kbytes of RAM in a UFBGA169 package.
- Board expansion features QuectelBG96 worldwide cellular modem LTECatM1/CatNB1/EGPRS module, 300kbps downlink, 375kbps uplink.



Top view



Bottom view

Latest info available at www.st.com
P-L496G-CELL02

Motion MEMS and environmental sensors expansion board

Hardware Overview

X-NUCLEO-IKS01A3 Hardware Description

- The X-NUCLEO-IKS01A3 is a motion MEMS and environmental sensor evaluation board system.
- It is compatible with the Arduino UNO R3 connector layout, and is designed around ST's latest sensors.

Key Product on board

LSM6DSO

MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g) + 3D gyroscope ($\pm 125/\pm 250/\pm 500/\pm 1000/\pm 2000$ dps)

LIS2DW12

MEMS 3D accelerometer ($\pm 2/\pm 4/\pm 8/\pm 16$ g)

LIS2MDL MEMS 3D

MEMS 3D magnetometer (± 50 gauss)

LPS22HH

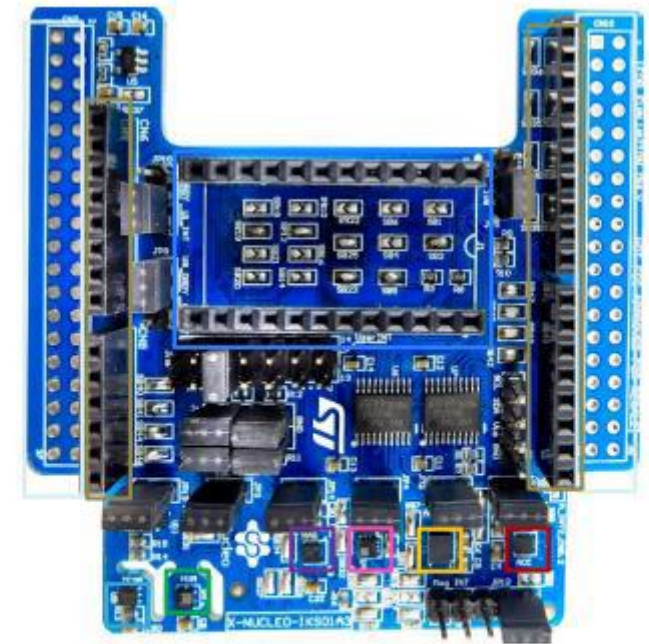
MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

HTS221

Capacitive digital relative humidity and temperature

STTS751

Digital Temperature sensor DIL 24-pin Socket available for additional MEMS adapters and other sensors (UV index)



 HTS221	 LSM6DSO	 ST morpho connector**
 LPS22HH	 LIS2DW12	 Arduino UNO R3 connector
 LIS2MDL	 STTS751	 DIL 24-pin

** Connector for the STM32 Nucleo board

Latest info available at www.st.com
X-NUCLEO-IKS01A3

FP-SNS-IOTA1

Software Overview

FP-SNS-IOTA1 Software Description

FP-SNS-IOTA1 is an STM32Cube Function Pack. Thanks to this package the user can enable IOTA DLT functions for an IoT sensor node with cellular connectivity. The application aims to implement and demonstrate IOTA DLT use cases for the STM32 MCU.

The IOTA DLT is a transaction settlement and data transfer layer for the Internet of Things (IoT). IOTA allows people and machines to transfer money and/or data without any transaction fees in a trustless, permissionless and decentralized environment.

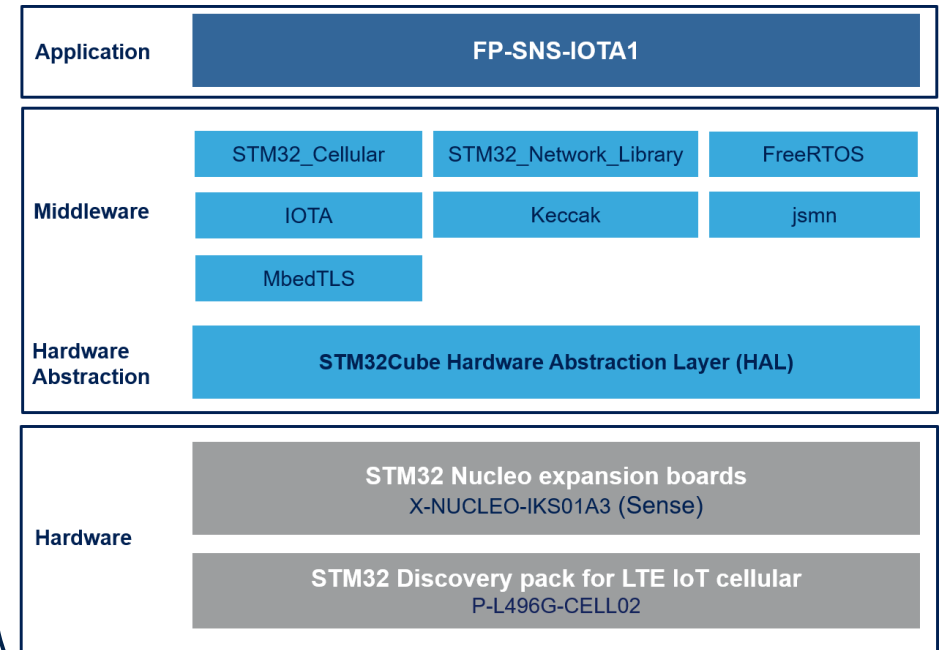
The featured use cases acquire sensor data and send them to the IOTA Ledger (also called Tangle) via LTE cellular connectivity.

Key features

- Complete firmware to build IOTA DLT applications for STM32-based boards
- Middleware libraries featuring FreeRTOS, cellular management, transport-level security (MbedTLS), and IOTA cryptography management
- Ready-to-use binary to build IOTA transactions including sensor data and send them to the Tangle via LTE connectivity
- Sample implementation available for STM32L496GI6-based low-power Discovery board equipped with the STMod+ cellular expansion board with antenna (P-L496G-CELL02), and the sensor expansion board (X-NUCLEO-IKS01A3)
- Easy portability across different MCU families, thanks to STM32Cube
- Free, user-friendly license terms



Overall Software Architecture



Latest info available at www.st.com
FP-SNS-IOTA1

2- Setup & Demo Example

Setup & Application Examples

HW prerequisites for P-L496G-CELL02 and X-NUCLEO-IKS01A3

- 1x X-NUCLEO-IKS01A3 Motion MEMS and Environmental Sensor expansion board
- 1x P-L496G-CELL02 discovery pack, which contains:
 - 1x STM32 Discovery development board **32L496GDISCOVERY**
 - 1x expansion board with QuectelBG96 LTE IoT modem, compatible with STMod+ connector
- Laptop/PC with Windows 7, 8 or 10
- 1 x microUSB cable
- Cellular network access point



X-NUCLEO-IKS01A3



P-L496G-CELL02

MicroUSB Cable



Setup & Application Examples

Software and Other prerequisites

- **STM32 ST-Link Utility**

- Download and install [STSW-LINK004](#) from www.st.com

- **FP-SNS-IOTA1**

- Download the [FP-SNS-IOTA1](#) package from www.st.com, copy the .zip file contents into a folder on your PC. The package contains binaries and source code with project files ([Keil](#), [IAR](#), STM32CubeIDE) based on P-L496G-CELL02.

- **Serial line monitor**, e.g. TeraTerm (<https://ttssh2.osdn.jp/>)

- Before flashing the FP-SNS-IOTA1 firmware it is necessary to register the embedded SIM card in the P-L496G-CELL02 as described in document [UM2567](#), Getting started with the X-CUBE-CELLULAR cellular connectivity Expansion Package for STM32Cube.

- External SIM – You can use your local telecom service SIM and insert it to Micro SIM card socket. The SW will detect it and connect it to your local telecom service provider.



FP-SNS-IOTA1. Sample application

Start coding in just a few minutes



1 www.st.com/stm32code

2 Select Function Pack:
FP-SNS-IOTA1

3 Download & unpack

FP-SNS-IOTA1 package structure

- _htmresc
- Documentation
- Drivers
- Middlewares
- Projects
- Utilities
- Release_Notes.html

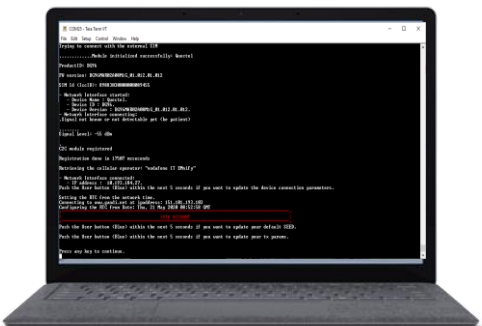
Docs

BSP, HAL drivers

IOTA, Cellular,
FreeRTOS,
MbedTLS libs

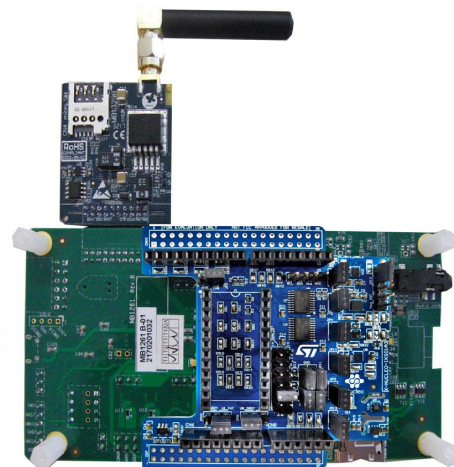
4 IOTA Sensor Node
application, binary

6 Evaluate using serial line terminal



5

Build/Flash and run the project



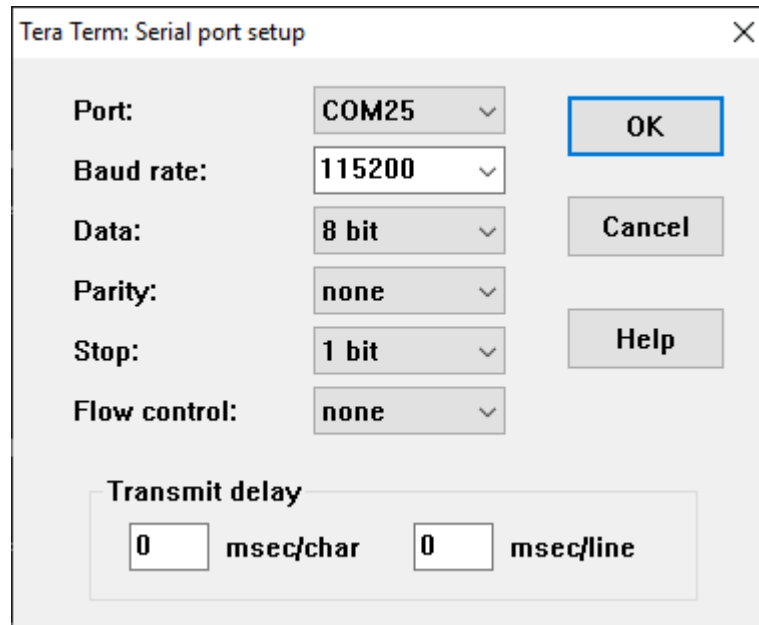
2.1- Test FP-SNS-IOTA1 with IOTA Tangle explorer



FP-SNS-IOTA1. Step by step setup

Launch sample application. Configure Serial Terminal

- The serial terminal (**Setup** → **Terminal** in TeraTerm) New-line receive configuration must be set to AUTO and the New-line transmit configuration must be set to LineFeed (\n or LF) in order to allow copy-paste from UNIX type text files. The Local echo option makes copy-paste visible on the console.
- The serial port (**Setup** → **Serial port** in TeraTerm) must be configured with:
 - COM port number
 - 115200 baud rate
 - 8-bit data
 - Parity none
 - 1 stop bit
 - No flow control



Tera Term: Serial port setup

Port: COM25

Baud rate: 115200

Data: 8 bit

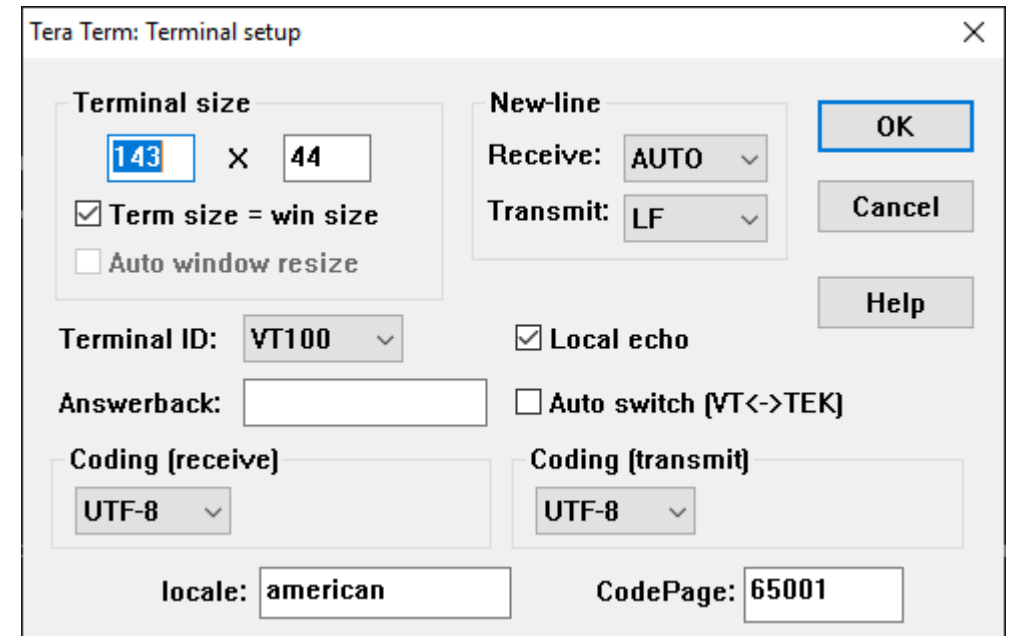
Parity: none

Stop: 1 bit

Flow control: none

Transmit delay: 0 msec/char 0 msec/line

Buttons: OK, Cancel, Help



Tera Term: Terminal setup

Terminal size: 143 X 44

Term size = win size

Auto window resize

New-line: Receive: AUTO, Transmit: LF

Terminal ID: VT100

Local echo

Answerback:

Auto switch [VT<->TEK]

Coding (receive): UTF-8

Coding (transmit): UTF-8

locale: american

CodePage: 65001

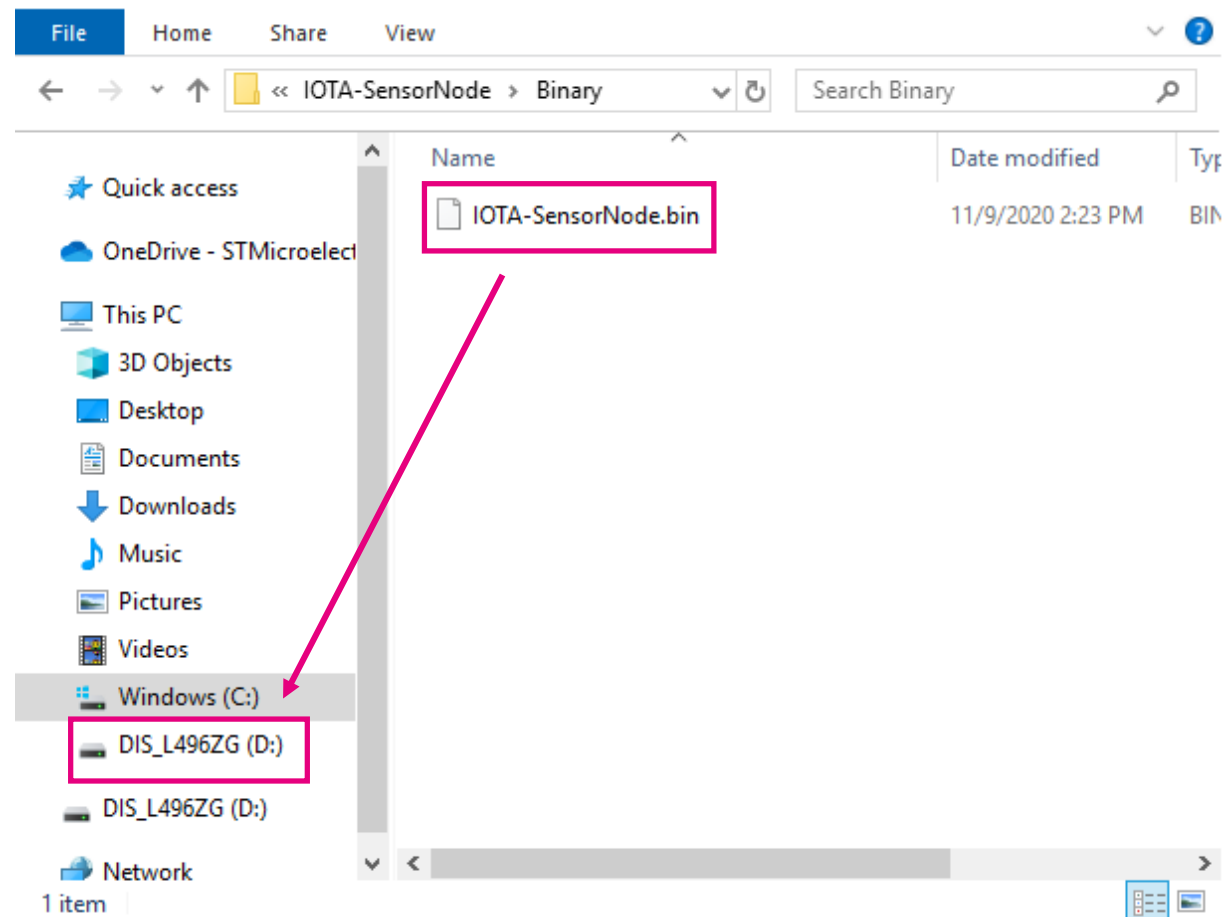
Buttons: OK, Cancel, Help

FP-SNS-IOTA1. Step by step setup

Launch sample application. Use pre-compiled binary

- The pre-compiled binary is in folder:
 - `Projects\STM32L496G_Discovery\Applications\DLT\IOTA-SensorNode\Binary\IOTA-SensorNode.bin`

- To start the application:
 - Connect your board to your PC
 - Using Explorer, drag the binary to the board's USB storage



FP-SNS-IOTA1. Step by step setup

Configure Cellular network parameters

- Open a serial terminal to visualize the log of messages
- Enter your C2C network configuration (SIM operator access point code, username and password)
 - Example with Emnify SIM:
access point: "EM", username: "", password: ""
- Set the TLS root CA certificates:
 - Copy-paste the contents of
Projects\STM32L496G_Discovery\Applications\DLT\IOTA-SensorNode\usertrust_thetangle.pem
 - The device uses them to authenticate the remote hosts through TLS
- After the parameters are configured, it is possible to change them by restarting the board and pushing the User button (blue button) within 5 seconds
- This data will be saved in flash

```
COM25 - Tera Term VT
File Edit Setup Control Window Help

Starting Main Thread...
*****
*** STM32 IOTA Light Node for STM32L496 MCU
*** FP-SNS-IOTA1 Demonstration
*** FW version: 1.0.0 - DAY-MONTH-YEAR HH:MM:SS PM
*****
*** Board personalization ***
BG96 UART config: BaudRate=115200 / HW flow ctrl=1
Push the User button (Blue) within the next 5 seconds if you want to update the Cellular network configuration.
- Network interface starting:
*** C2C connection ***

Trying to connect with the external SIM
.....Module initialized successfully: Quectel
ProductID: BG96
FW version: BG96MAR02A08M1G_01.012.01.012
SIM Id (IccID): 89883030000000089455
- Network Interface started:
- Device Name : Quectel.
- Device ID : BG96.
- Device Version : BG96MAR02A08M1G_01.012.01.012.
- Network Interface connecting:
Signal not known or not detectable yet (be patient)

Signal Level: -51 dBm

C2C module registered
Registration done in 17635 msseconds
Retrieving the cellular operator: "vodafone IT Emnify"

Network interface connected.
- IP address : 10.193.184.27.
Push the User button (Blue) within the next 5 seconds if you want to update the device connection parameters.

Setting the NIC from the network time.
Connecting to www.gandi.net at ipaddress: 151.101.193.103
```

FP-SNS-IOTA1. Step by step setup

Configure IOTA application parameters

- Enter a seed (a character string, 81 characters long, composed only by capital letters from 'A' to 'Z' and '9'), representing the IOTA account
- Enter the IOTA transaction parameters (Full Node URL, tx-interval, and temperature threshold).
- After the parameters are configured, it is possible to change them by restarting the board and pushing the User button (blue button) within 5 seconds
- This data will be saved in flash

```
COM25 - Tera Term VT
File Edit Setup Control Window Help
.Signal not known or not detectable yet <be patient>
Signal Level: -57 dBm
C2C module registered
Registration done in 15771 msseconds
Retrieving the cellular operator: "vodafone IT EMnify"
- Network Interface connected:
- IP address : 10.193.184.27.
Push the User button <Blue> within the next 5 seconds if you want to update the device connection parameters.
Setting the RIC from the network time.
Connecting to www.gandi.net at ipaddress: 151.101.193.103
Configuring the RIC from Date: Thu, 21 May 2020 14:43:40 GMT
IOTA ACCOUNT
Push the User button <Blue> within the next 5 seconds if you want to update your default SEED.
Your SEED needs to be entered to proceed.
Enter new seed <81 characters, allowed characters: 'A':'Z' and '9':>
DS9KURJREZSAZNI0QAREASQEOTHAKPNQE9GDDDLGXLMRUXCHQCTVHRDLCRGQY9MKCQSKAKWCOPM9FOUR
New entered:
DS9 KUR JRE ZSA ZNI OQA REA SQE OTH
AKP NQE 9GD DDU LCX LMR UXC HQC TYH
RDL CRG QY9 MKC QSK AKW COP M9F OUR
Proceed? <Y/N> y
Your default SEED:
DS9 KUR JRE ZSA ZNI OQA REA SQE OTH
AKP NQE 9GD DDU LCX LMR UXC HQC TYH
RDL CRG QY9 MKC QSK AKW COP M9F OUR
Push the User button <Blue> within the next 5 seconds if you want to update your tx params.
Your TX params need to be entered to proceed.
Enter Full Node URL <https://nodes.thetangle.org:443/>: https://nodes.thetangle.org:443/
You have entered https://nodes.thetangle.org:443/ as the Full Node URL.
Enter TX interval [min] <1>: 10
You have entered 10 as the TX interval.
Enter Temperature threshold [degC] <18.5>: 18.5
You have entered 18.5 as the TEMP THRESH.
full_node_url=https://nodes.thetangle.org:443/ tx_interval=10 temp_thresh=18.5
Press any key to continue.
```

FP-SNS-IOTA1. Step by step setup

IOTA Transaction

- A new 0-value transaction will be automatically generated and sent to the Tangle every *tx_interval* minutes
- The transaction data includes the following:
 - Pressure
 - Humidity
 - Temperature
 - FreeFall counter: number of FreeFall events occurred during a *tx_interval*
 - Temperature event: *true* if the measured temperature has overcome the configurable threshold during a *tx_interval*; *false* otherwise

```
COM25 - Tera Term VT
File Edit Setup Control Window Help
-----
SENSOR VALUE TRANSACTION
-----
Transaction recap
-----
[Address ]
BSIXFJENGUJSOWPUHUALMPOPO9PUKHXDQI9UDELCBJXN9TCNQPTFEDMPQCUBOJSZUHEOABVYYAT9IAHHY
[Message] <in trytes>
ECUAEADDGBUAUAUAABEAWCZBPCEAWCGB9BXAEAJAEAHDGBWABBEANFMBEAPBGBUAEACCGBHDFDIDTC
[Tag]
STSENSORNODE99999999999999999999
-----
```


FP-SNS-IOTA1. Step by step setup


Tangle explorer

- Check the status of the transaction on the Tangle Explorer website searching by IOTA address, transaction, bundle, tag

TheTangle.org Home Statistics Services ▾ Business

Search by IOTA address, transaction, bundle, tag

Transaction

YJHMQGLIJOAERBGLMKJDSFAJNKBWEDIF9YZH9XHYATMUYIYPNXAEXLWFPZROEKIXEAZTXQXGKJDP99999 </> 

April 9, 2020 16:38:11 - 1 month and 1 week ago

Value	0i	Confirmed	on 2020-04-09 at 16:39:36
Conversion ?	0 USD	Index in bundle	0 / 0
Tag	STSENSORNODE9999999999999999	Weight magnitude ?	15

Address	BSIXFJENGVJSOWPVHVALMPOPO9PUKHXDQI9VDELCEBJXN9TCNQPTFEDMPQCVBOJSZUHEOABYYYAT9IAHHYZLUURD9YW
Bundle ?	J99LH9TGFIVLWJNKGTQCPTIWTUAM9DJKBRITFFTJQIYQIJCQHI9RZVZXF9KOQELDBNLDXHBRPLNHBBJEW
Nonce ?	SJCXSAPF9CUIKDXECFWJGTJANER
Message	p=1015 hPa h=60 % t=24 °C F=2 T=1
	<input type="radio"/> Trytes
	<input checked="" type="radio"/> Text

3- Documents & Related Resources



Documents & Related Resources

All documents are available in the DESIGN tab of the related products webpage

FP-SNS-IOTA1:

- **DB4250:** STM32Cube function pack for IoT sensor node with cellular connectivity enabling IOTA Distributed Ledger Technology (DLT) functions – [databrief](#)
- **UM2744:** Getting started with the STM32Cube function pack for IoT sensor node with cellular connectivity enabling IOTA Distributed Ledger Technology (DLT) functions – [user manual](#)
- [Software setup file](#)

X-NUCLEO-IKS01A3:

- [Gerber files, BOM, Schematic](#)
- **DB3851:** Motion MEMS and environmental sensor expansion board for STM32 Nucleo – [databrief](#)
- **UM2559:** Getting started with the X-NUCLEO-IKS01A3 motion MEMS and environmental sensor expansion board for STM32 Nucleo – [user manual](#)

P-L496G-CELL02:

- [Gerber files, BOM, Schematic](#)
- **DB3530:** STM32 discovery pack for LTE IoT cellular to cloud – [databrief](#)
- **UM2052:** Getting started with STM32 MCU Discovery Kits software development tools – [user manual](#)
- **UM2365:** STM32 Discovery pack for LTE IoT cellular to cloud – [user manual](#)

X-CUBE-CELLULAR:

- **UM2567:** Getting started with the X-CUBE-CELLULAR cellular connectivity Expansion Package for STM32Cube – [user manual](#)
- **UM2426:** X-CUBE-CELLULAR cellular connectivity Expansion Package for STM32Cube – [user manual](#)

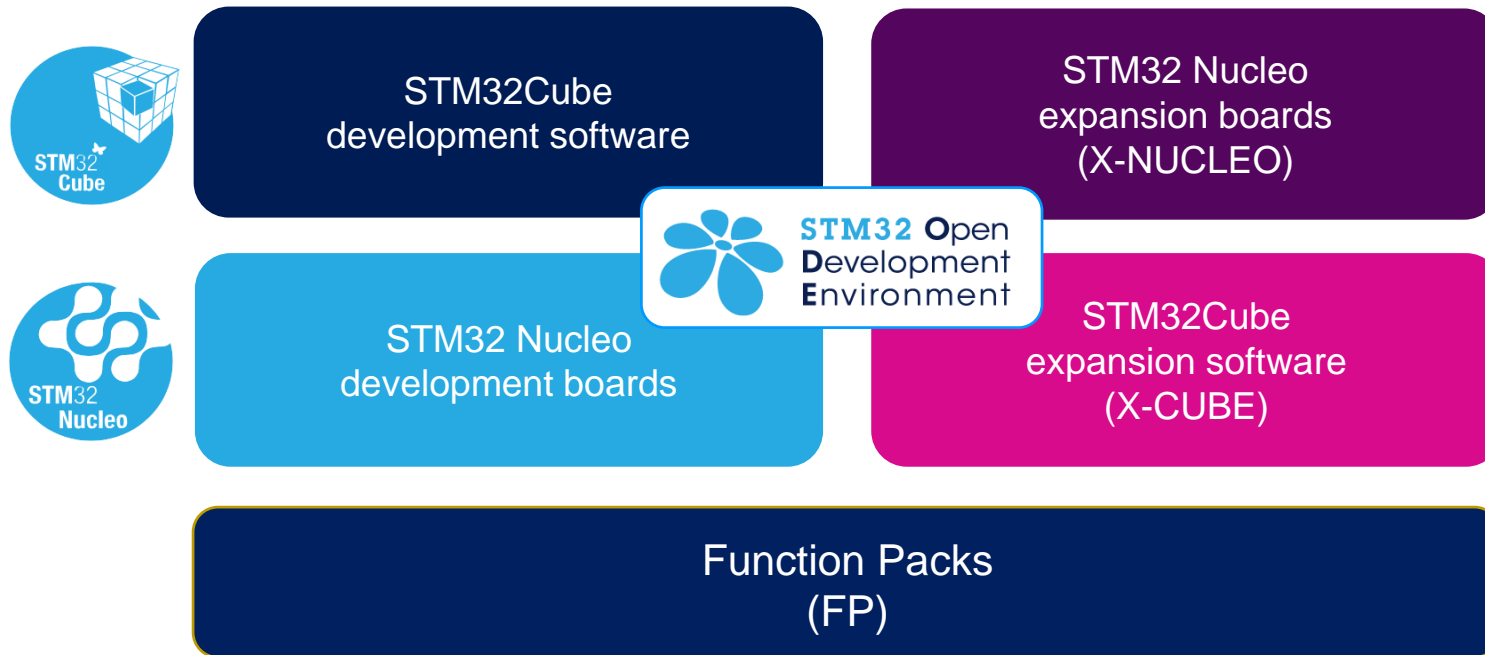
4- STM32 Open Development Environment: Overview



STM32 Open Development Environment

Fast, affordable Prototyping and Development

- The STM32 Open Development Environment (STM32 ODE) is an open, flexible, easy, and affordable way to develop innovative devices and applications based on the STM32 32-bit microcontroller family combined with other state-of-the-art ST components connected via expansion boards. It enables fast prototyping with leading-edge components that can quickly be transformed into final designs



For further information, please visit www.st.com/stm32ode

Thank you

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