From Sensors to Cloud: The Case for a Complete Ecosystem for IoT Development

Ernesto Manuel CANTONE

AME IoT Promotion and Enablement

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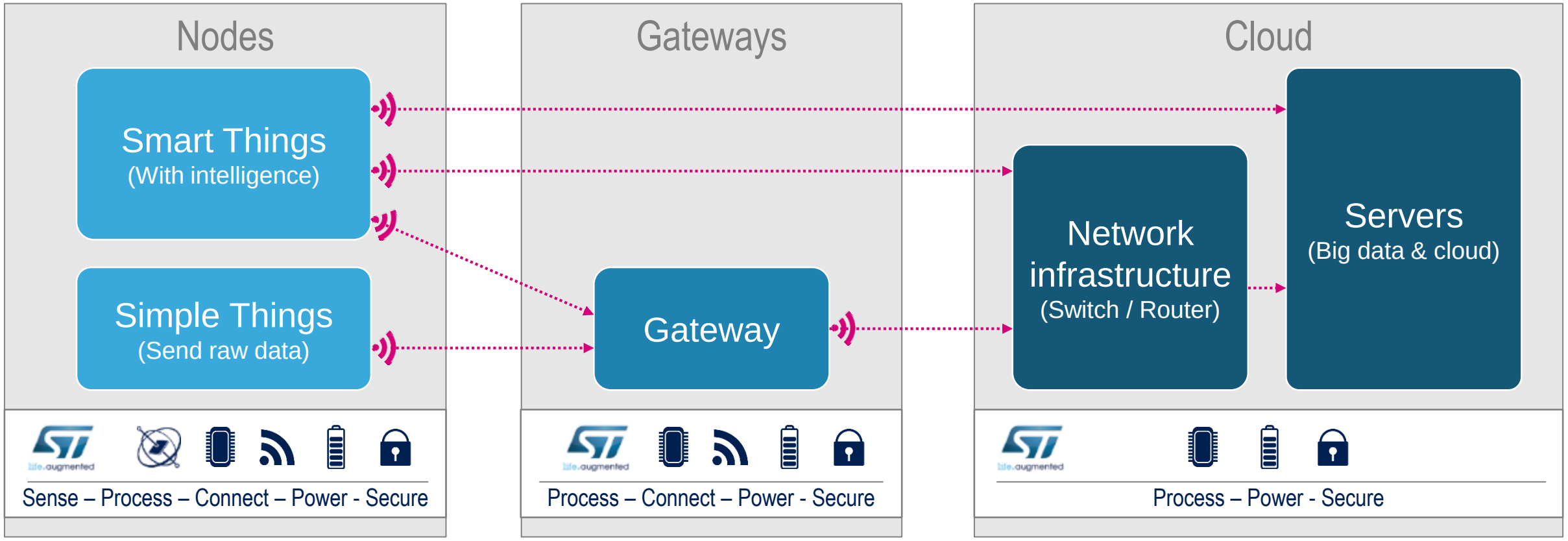
The IoT Movement

IoT is a movement where any system is able to leverage the Internet and its eco-system

Cloud computing – Low cost embedded computers – Explosion of reliable wireless connectivity – Rapid innovation of low cost sensors



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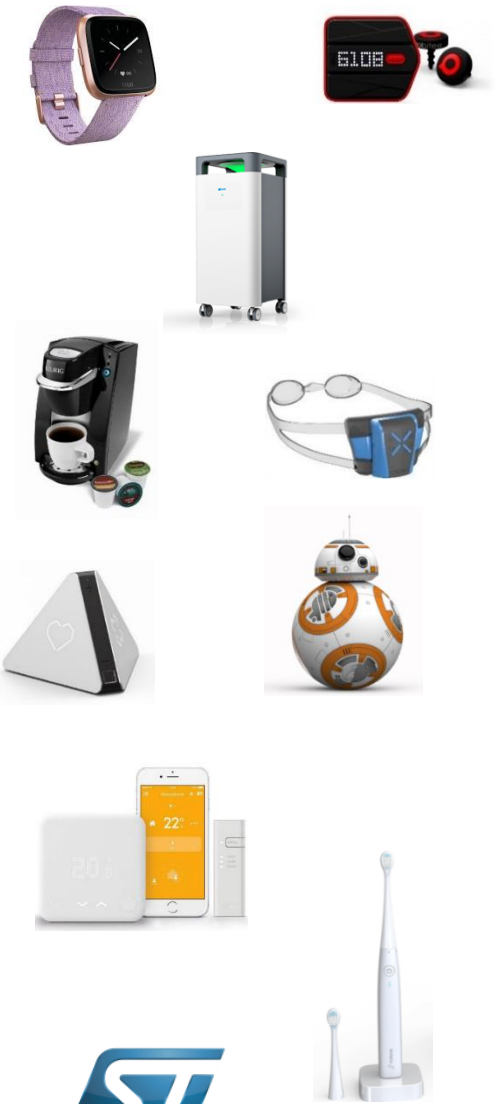
IoT Devices Come in Many Form Factors



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…but Their Needs are the Same

	Processing & Security	Sensing & Actuating	Connectivity	Signal Conditioning & Protection	Power & Energy Management
Smart Things	Ultra-Low Power to High Performance Scalable Security solutions	Full range of sensors and actuators	10 cm to 10 km	Nano Amps to Kilo Amps	Nano Watt to Mega Watt
Smart Home					
Smart City					
Smart Industry					

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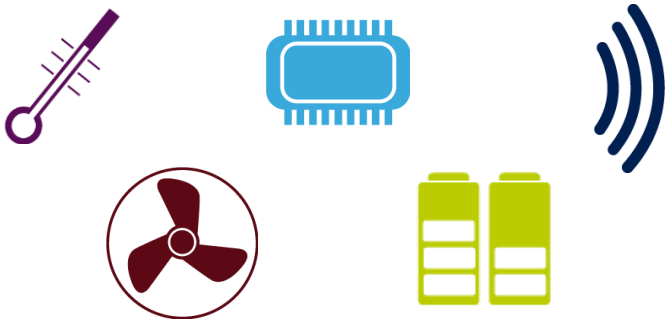
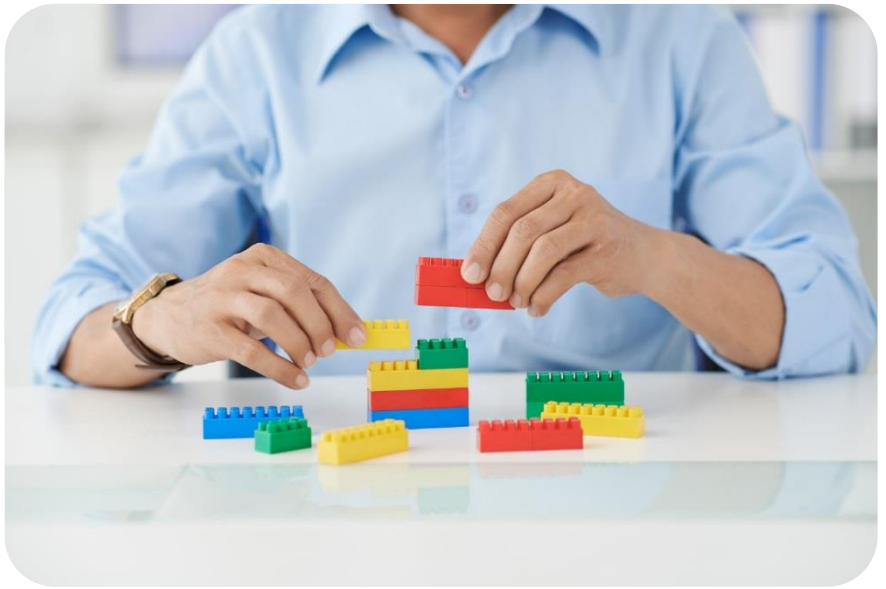
ST has all the building Blocks for the IoT

“Thing” you know how to build.

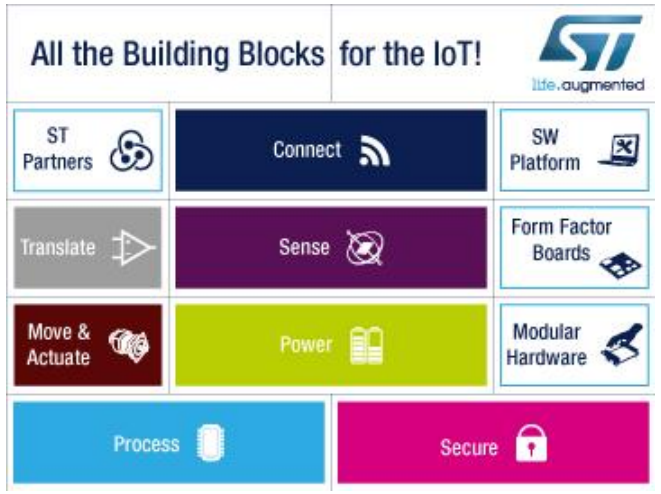
Plus what “Smart”?





Pieces from different sources and and no building instructions…

...or



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Supporting the IoT Movement

Connect

Sense

Translate

Move
Actuate

Power

Secure

Process

SensorTile

BlueCoin

SmarTAG

Discovery Kit IoT Node

STM32 Nucleo Development
& Expansion boards

Pre-integrated SW for vertical applications

Smart Things

Smart Home

Smart City

Smart Industry

Development Ecosystem

Code generators

Prototyping software

IDE
Development environments

Debug solutions

Simulation and analysis tools

On-line design tools

ST Community

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Partner Program

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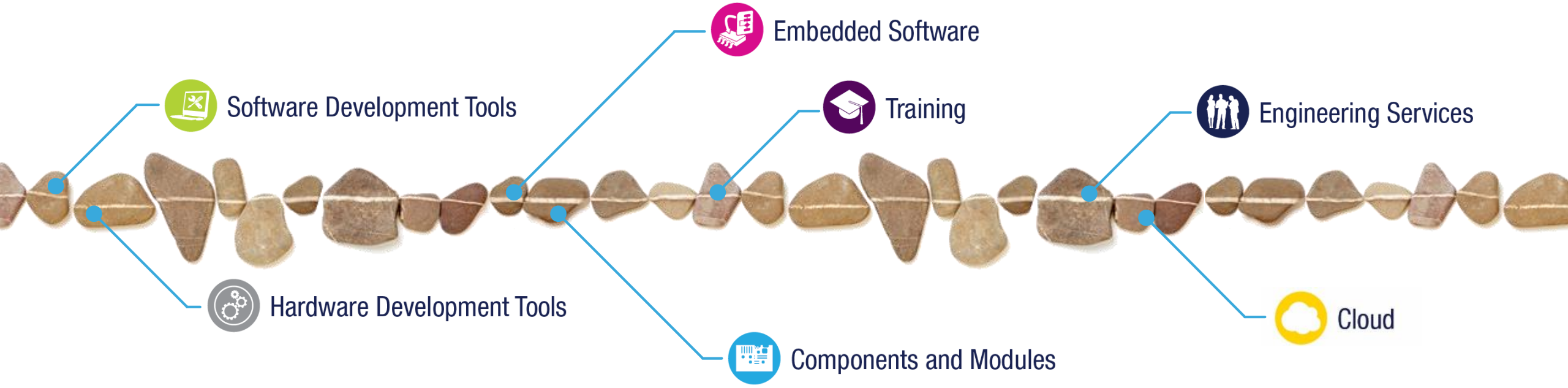
ST Partner Program

Building greater solutions together



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Partner Program

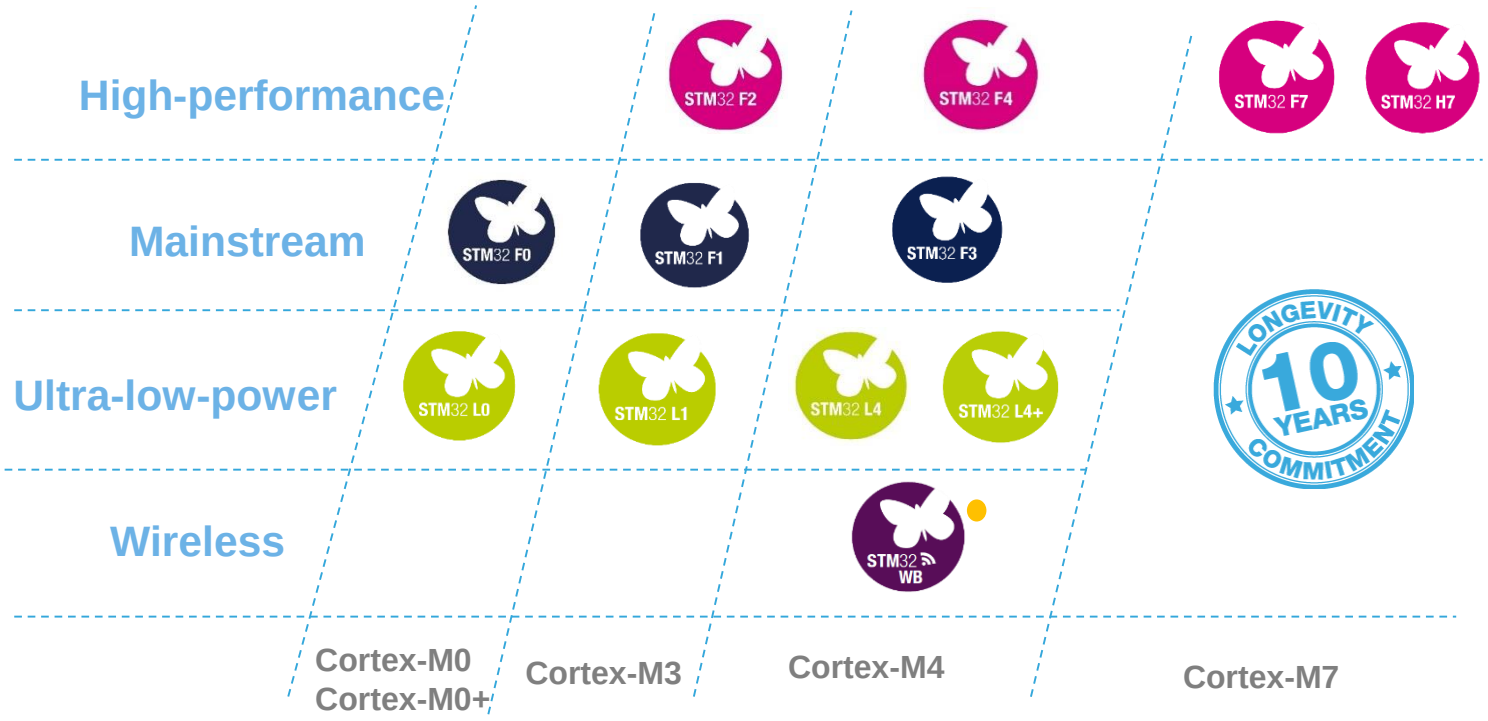
www.st.com/partners

>130 Partners… and Counting

Cloud | Components and Modules | Embedded Software | Engineering Services | Hardware Development Tools | Software Development Tools | Training

STM32 portfolio positioning

12 product series / More than 800 Parts



More than
40,000 customers

Note ● : Cortex-M0+ Radio Co-processor

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Secure Solutions

Certified secure MCU – Turnkey solutions

Mobile Security

Secure SIM and eSIM

Secure NFC

Solutions for wearable

Authentication

Trusted Platform Module

Brand protection

Home automation

SmartCard ICs

Banking

Identification

Transport

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Sensors and Actuators

ST is the only company to offer the full range of Sensors & Micro-actuators

Motion

Gyroscope

Accelerometer

Magnetometer

6 & 9-axis inertial module

Optical image stabilization

Environment

Temperature

Humidity

Pressure

VOC (Volatile Organic Compound)

Interactivity

MEMS microphone

Touchscreen controllers

Micro-Actuators

Micro-mirrors

Thin-film Piezo-electric MEMS

Optical

FlightSense™ Time-of-Flight ranging sensors

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Connectivity

Low-power wireless connectivity solutions

NFC and RFID

NFC/RFID tags

Dynamic NFC/RFID tags

NFC transceivers

Bluetooth

Bluetooth 4.x single core Network Processors and SoCs

Multiprotocol, multi core (Bluetooth 5.0/802.15.4) Wireless SoC

SubGHz

Transceivers

Modules

LoRa and SigFox compatibility

Wi-Fi Module

Plug & Play Wi-Fi module

Pre-certified solutions

Cellular

LTE CatM
LTE NB-IoT

Partner Radio
Partner Modules

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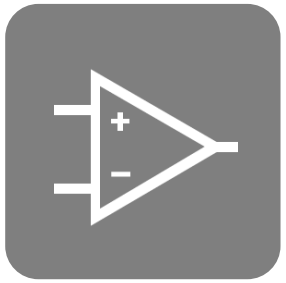
Analog Products

A broad selection of analog products to complete every design



Op amp

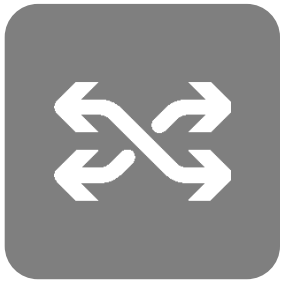
Large portfolio of highly power-efficient op amps in tiny packages

Current Sensors

High accuracy current measurement for contactless battery chargers

Audio Amplifiers

High-efficiency Class D and G amplifiers for headsets and speakers



Analog switches

Compact single and dual switches for audio and USB

Protections / filters

Balun for Wi-Fi and Bluetooth Low Energy
ESD Protections
EMI Filters

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Power & Energy Management

LED & OLED
power management

USB Type-C

Wireless
charging

Energy
harvesting

DC/DC regulators
& LDO

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Motor Control and Automation

Motor Drivers

Stepper Motor Drivers

Brushed DC Motor Drivers

Brushless DC Motor Drivers

Gate Driver

Single & Three Phase Driver

Galvanic Isolated Driver

Industrial Automation

Intelligent Power Switch

IO-Link Solutions
(Master & Device)

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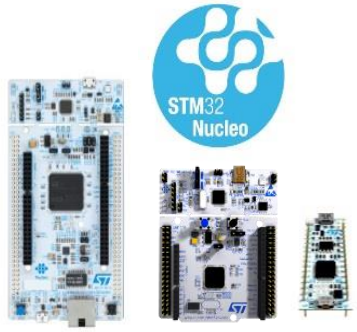
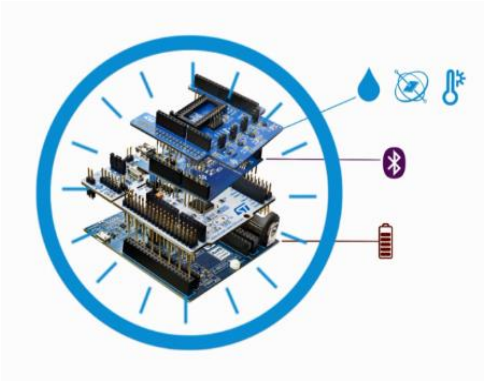
HW Development Tools

Development Tools adapted to your needs





STM32 Nucleo	Discovery kits	Evaluation boards	STM32 Nucleo expansion	Third-party boards
Flexible prototyping	Key feature prototyping	Full feature evaluation	Functionality add-on	From full evaluation to open hardware
www.st.com/stm32nucleo	www.st.com/stm32discovery	www.st.com/stm32evaltools	www.st.com/x-nucleo	

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ST's Solutions for IoT

INTEGRATION

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 Cube

Smart Things | Smart Home | Smart City | Smart Industry

STM32 Open Development Environment

Modular hardware

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

>30 STM32 Nucleo expansion boards (X-NUCLEO)
Offering peripheral functions

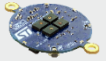
STM32 Nucleo

Form factor boards

ST & 3rd-party form-factor boards

SensiBLE

Discovery Kit IoT Node



Bluecoin

SensorTile

SmarTAG

An Application-Oriented Approach

Your need

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

The building blocks

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

- Motion
- Environmental
- Bluetooth LE
- Sub-1GHz
- NFC
- Op Amp
- Motor controller
- Power manager
- Microcontroller





STM32 Cube

Our answer

Function Packs (FP)

Application software
and development tools

Integrated Development Environment
and middleware

Ready-to-use
application-oriented package

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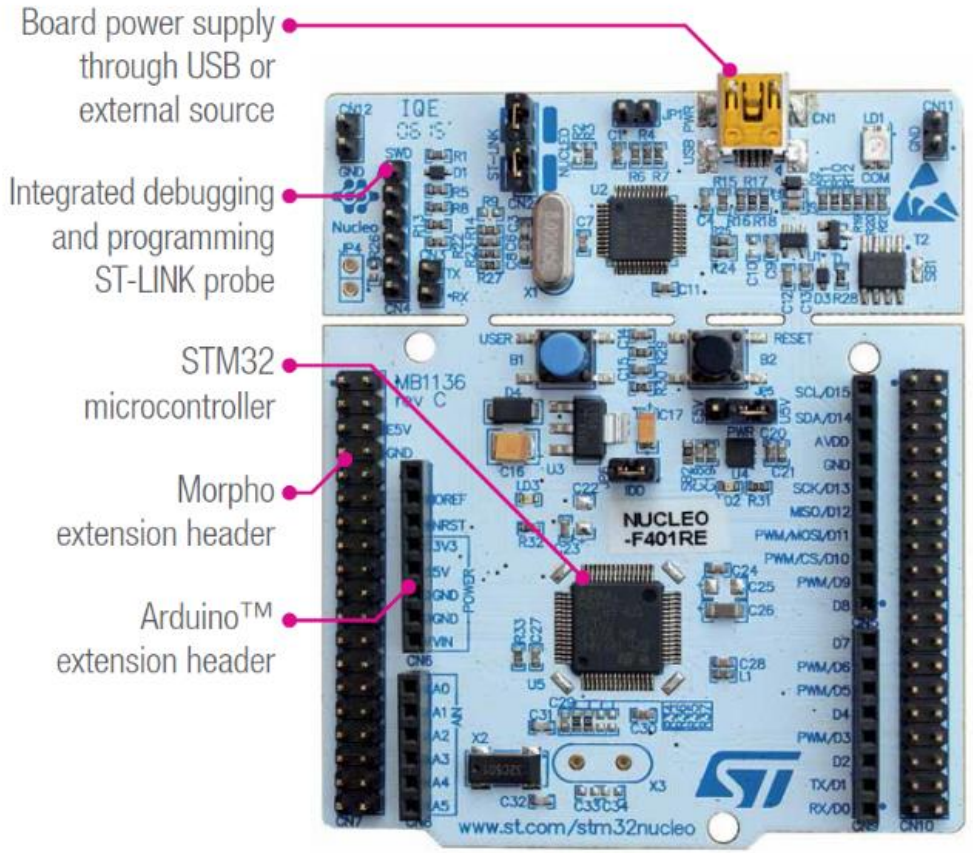
STM32 Nucleo Development Boards

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



STM32 Nucleo

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

STM32 F0 STM32 F1 STM32 F2 STM32 F3 STM32 F4 STM32 F7

STM32 L0 STM32 L1 STM32 L4 STM32 H7

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STM32 Nucleo Expansion Boards

>30 expansion boards and growing… covering all the key functions

Sense (5)	Connect (11)	Power Drive (3)	Move Actuate (13)	Translate (4)
Motion & environmental sensors	BLE	Power management	Motor drive	Audio amplifier
Proximity sensor	Wi-Fi	LED boost	Actuator	OpAmp
Microphone	Sub-GHz			
	NFC			

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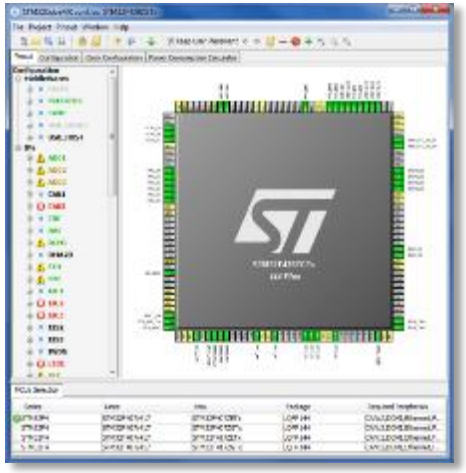
Software Development Tools

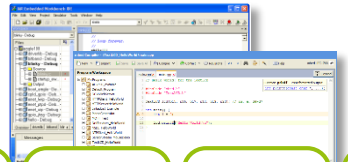
C/C++ Focus

A complete flow, from configuration up to monitoring

STM32 CubeMX



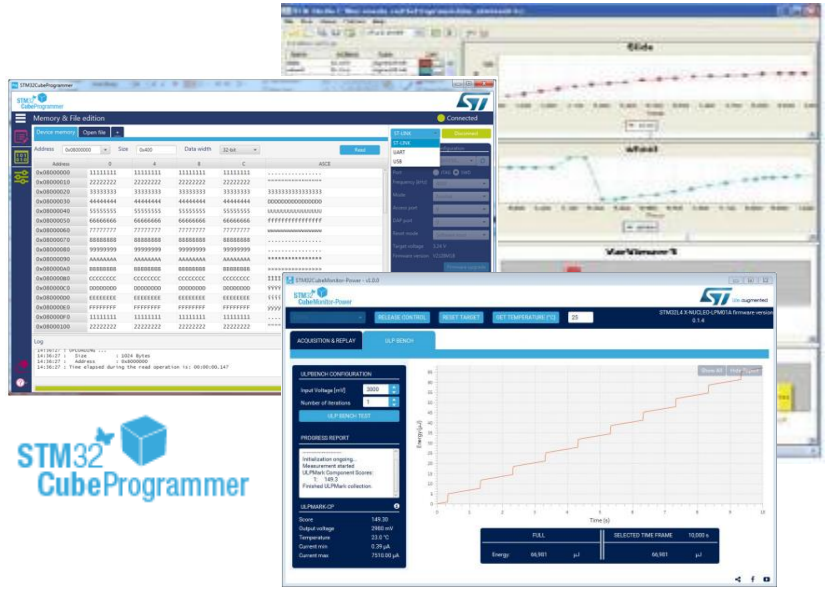
FREE IDE's



IAR SYSTEMS · arm KEIL · ac6 Assistance Conseil Systemes · atollic · ARDUINO

arm MBED · TASKING AN ALTIUM BRAND · SEGGER · SysProgs

RAISONANCE · CooCox · iSYSTEM · EMPROG "Where Software Meets Hardware"



STM32 CubeProgrammer

STM32 CubeMonitor-Power

STM32CubeMX
Configure & Generate Code

IDEs
Compile and Debug

STM32CubeProgrammer
STM32CubeMonitor
Program & Monitor

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ST Acquires Atollic

and enriches its STM32 ecosystem

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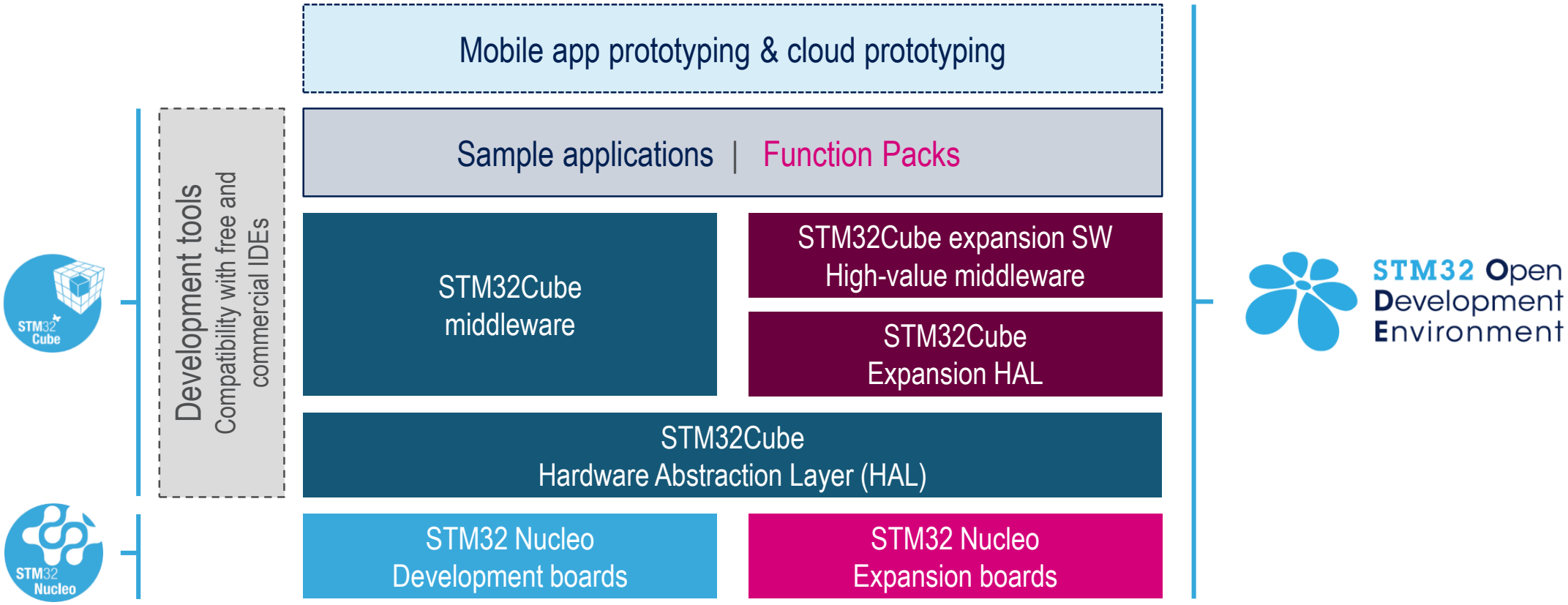
Development Software Architecture

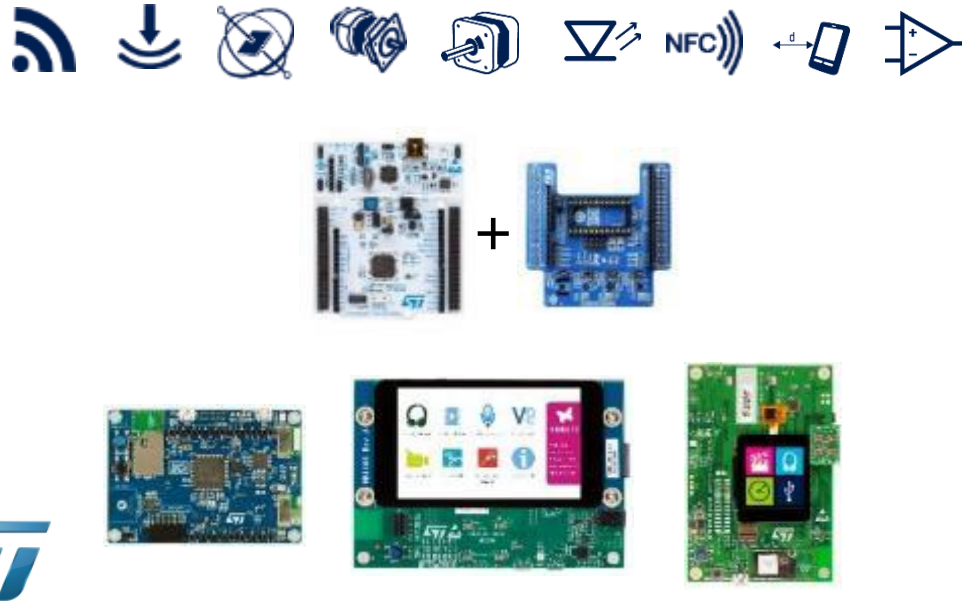


Simple vs Advanced Use Cases

Expansion SW (X-Cube) vs Function Pack

- Prototype with a single expansion board
- Expanded Functionality (e.g. Cloud Connectivity)

Sample applications



- Create advanced use cases based on multiple expansion boards (e.g. Device Management, Predictive Maintenance)

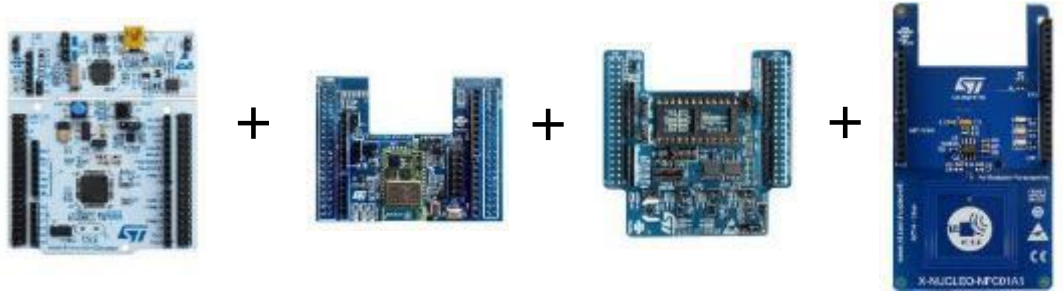
Pre-integrated application example

Wearables

IoT
Smart Things

Home
applications

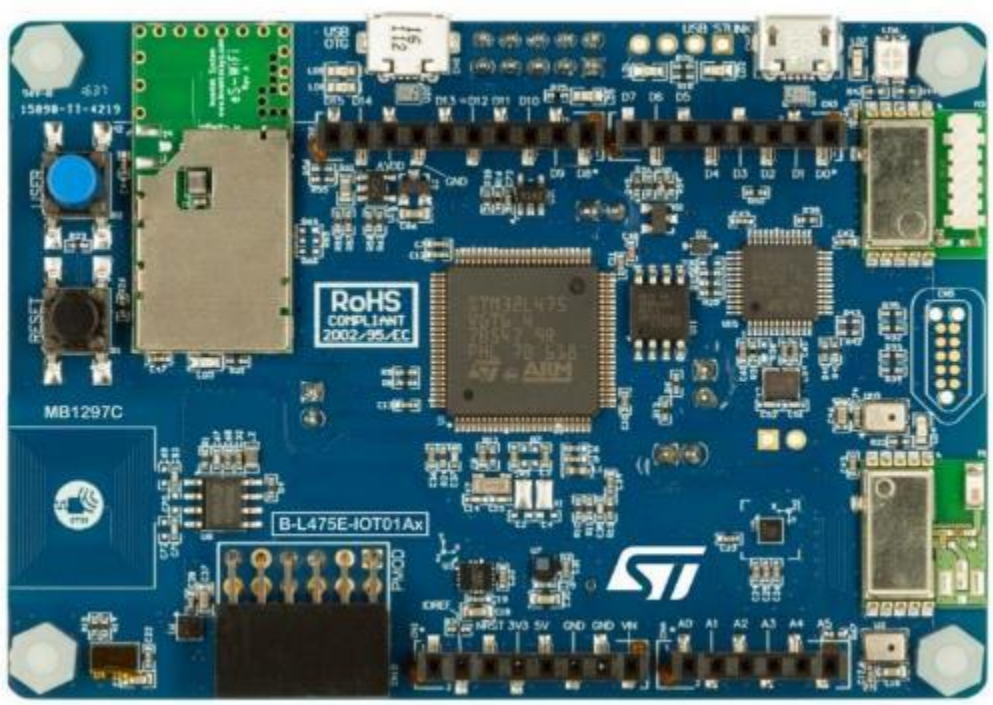
Building
automation



STM32L475 Discovery Kit IoT Node

B-L475E-IOT01A

- SW Libraries for STM32L4 MCU & Sensors
- Low-power long-range communication (SubGHz)
- Direct Wi-Fi connection to cloud servers
- Environmental awareness: humidity, pressure, temp
- Detection hub: motion, proximity, audio



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SensorTile

www.st.com/sensortile

Ultra Low Power Connectivity

Low-Power MCU

Sensors

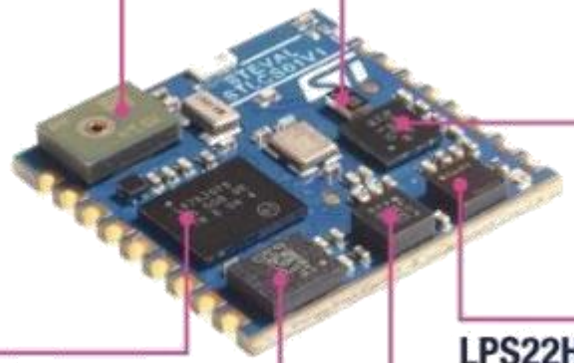
Balun Filter

MEMS microphone

MP34DT04: Microphone

Bluetooth 4.1

BlueNRG-MS: Bluetooth low-energy



STM32L476: Cortex-M4

Low-power brain
Sensor fusion

LPS22HB: Barometer

Environmental sensors

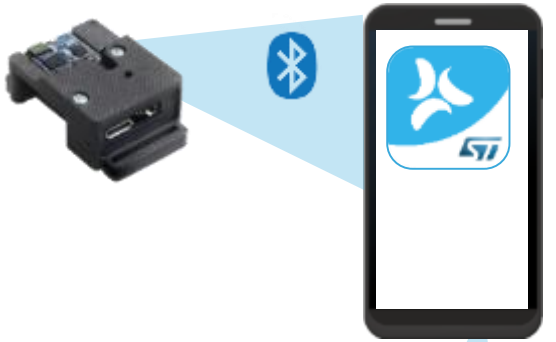
LSM6DSM: 3DAcc+3DGyro

Motion MEMS

LSM303AGR: 3DAcc+3DMag

Motion MEMS

BLE to Smartphone app



MQTT, HTTP

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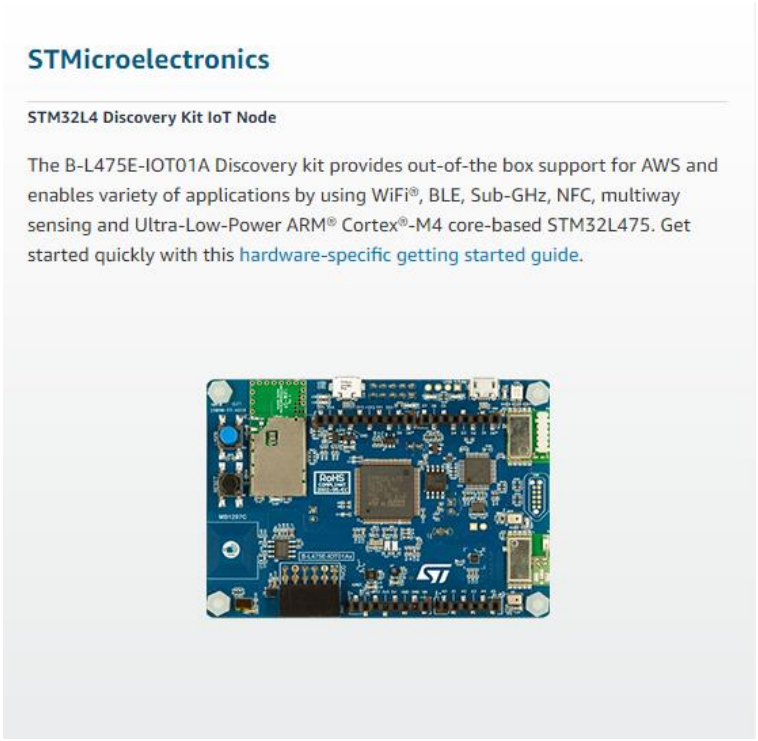
Sensor To Cloud

AWS IoT

- The **AWS IoT Device SDK** helps you to easily and quickly connect your hardware device or your mobile device to AWS IoT Core. IoT Discovery Kit Node is listed on https://aws.amazon.com/iot-core/getting-started/
- ST implementations of AWS IoT Device SDK
  - X-CUBE-AWS on B-L475E-IOT01A, 32F413HDISCOVERY, 32F769IDISCOVERY (Ethernet)
    - One board starter kit on amazon website
    - **Training available on Udemy Mooc Upon request**

- **Amazon FreeRTOS** console to get a custom download of the OS by choosing the libraries relevant to use case and HW.
- Alternatively GitHub, SourceForge, or FreeRTOS.org containing all libraries and hardware-specific porting layers.



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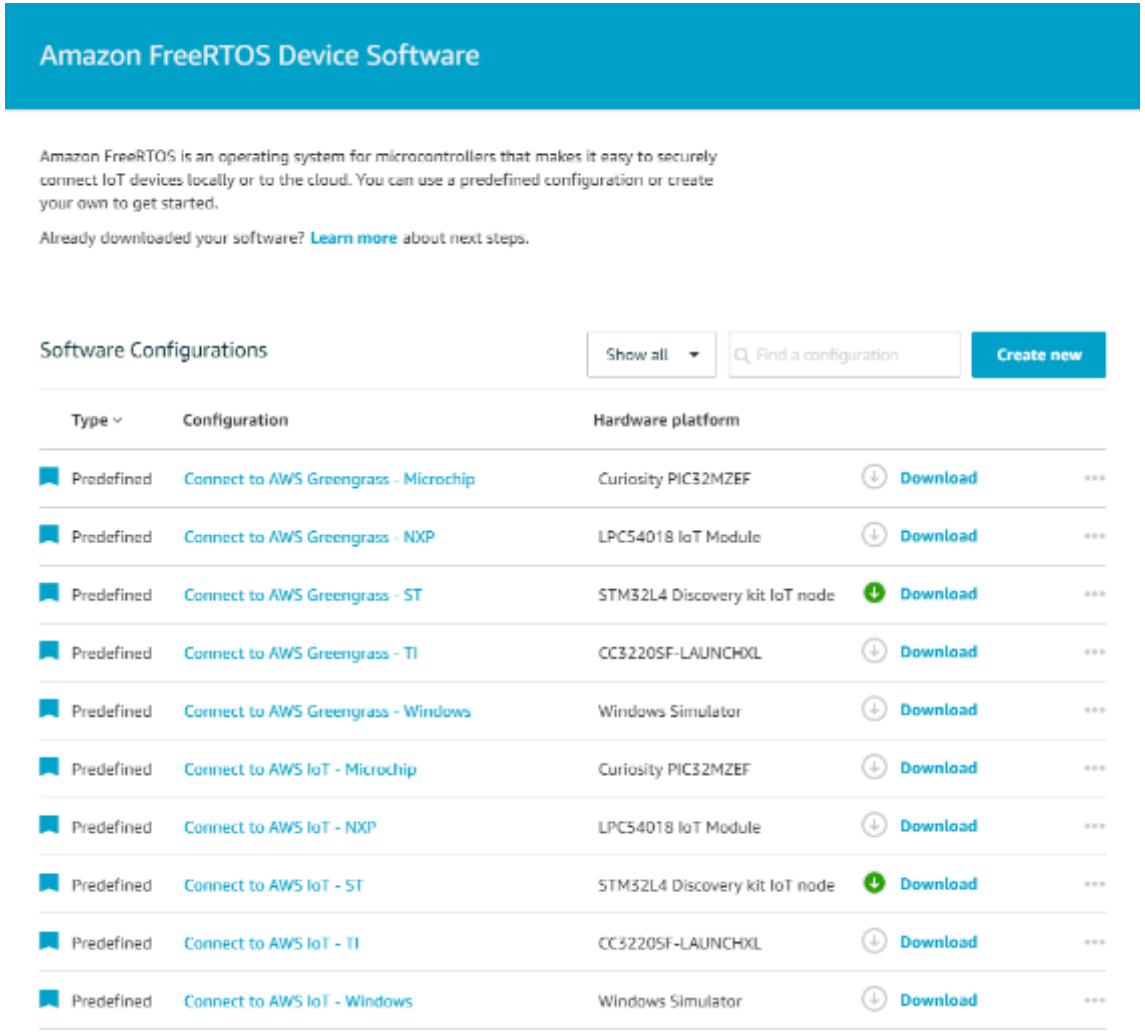
Amazon FreeRTOS Console



- ST predefined configurations for STM32L4 Discovery Kit IoT Node include a project for System Workbench for STM32

(coming soon)

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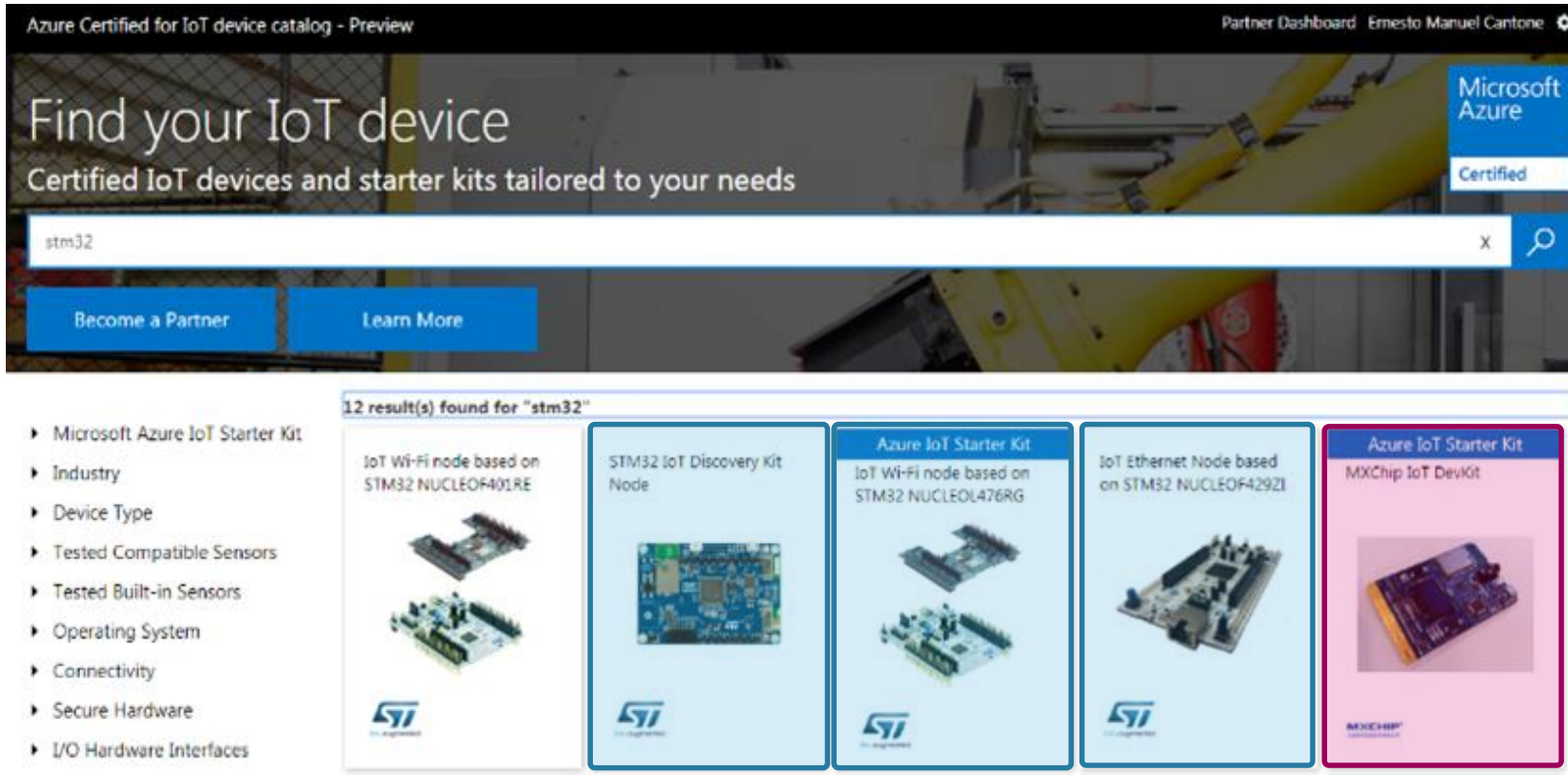
Microsoft

Azure Device Catalog

Azure IoT Starter Kits with ST

- P-NUCLEO-AZURE1
  - MCU STM32F429 / Ethernet
  - MCU STM32L476 / WiFi
  - Compatible with Professional IDE (IAR, Keil)
- B-L475E-IOT01A
  - MCU STM32L475
  - WIFI Inventek ISM43362-M3G-L44
  - Compatible with Professional IDE (IAR, Keil)
- MXCHIP AZ1366 (3rd party)
  - “Microsoft IoT Starter Kit”
  - EMW3166 Module with STM32F412RG + BCM43362
  - HW Design MXCHIP
  - SW Design Microsoft
  - Visual Studio Code Extension for Arduino

https://catalog.azureiotsuite.com



Firmware Packages and Features

- FP-CLD-AZURE1 with Device Management and STM32ODE IoT Web Dashboard support (B-L475E-IOT01A, NucleoL476, NucleoF429)
- X-CUBE-AZURE on B-L475E-IOT01A, 32F413HDISCOVERY, 32F769IDISCOVERY (Ethernet)

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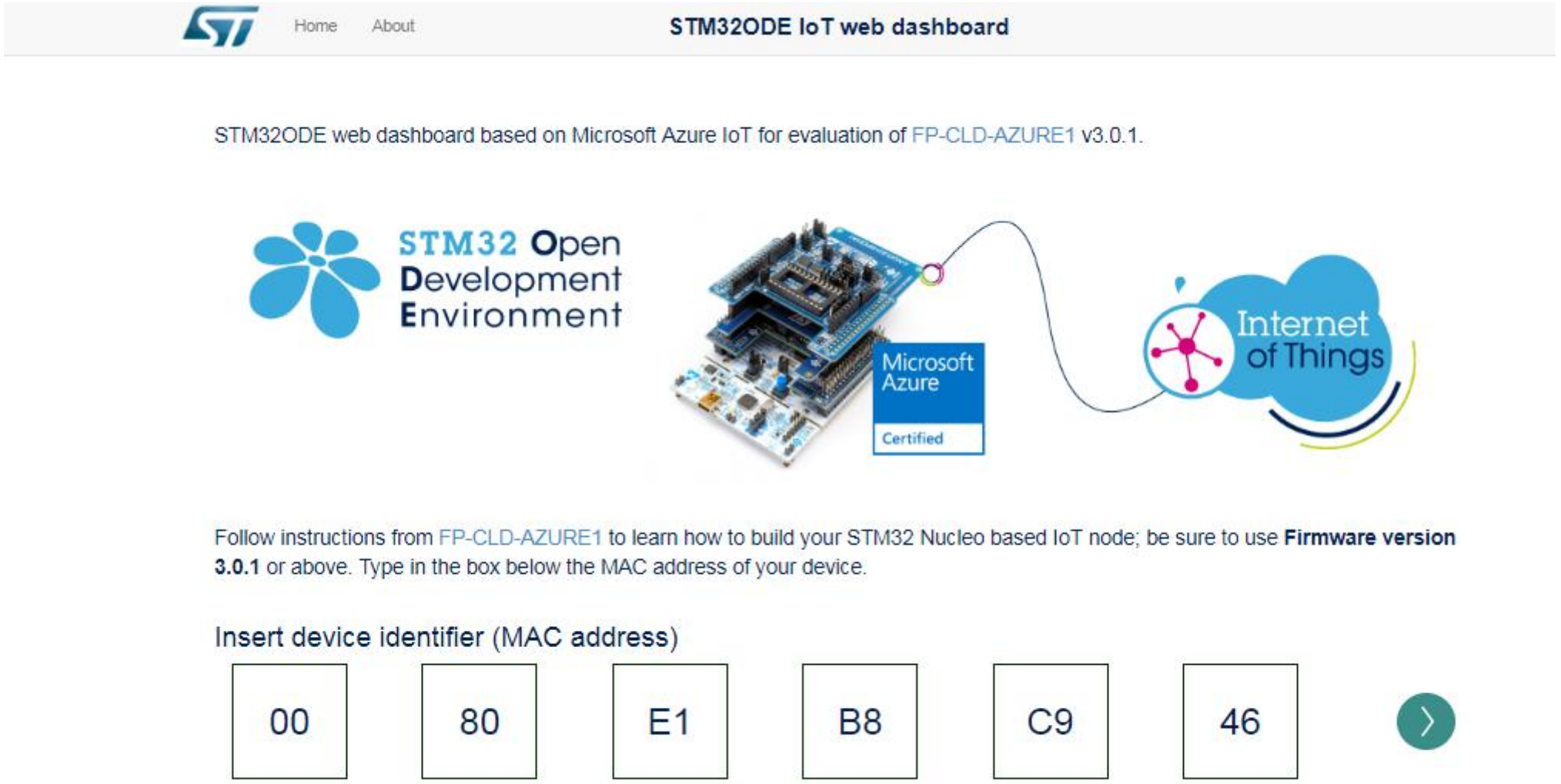
STM32ODE IoT Web Dashboard

https://stm32ode.azurewebsites.net/



Get MAC address from serial terminal (e.g. TeraTerm) at board boot

Microsoft

Home About

STM32ODE IoT web dashboard

Device name 0080E1B8C946

Board type Nucleo-L476RG

Device management

Device status

Connected

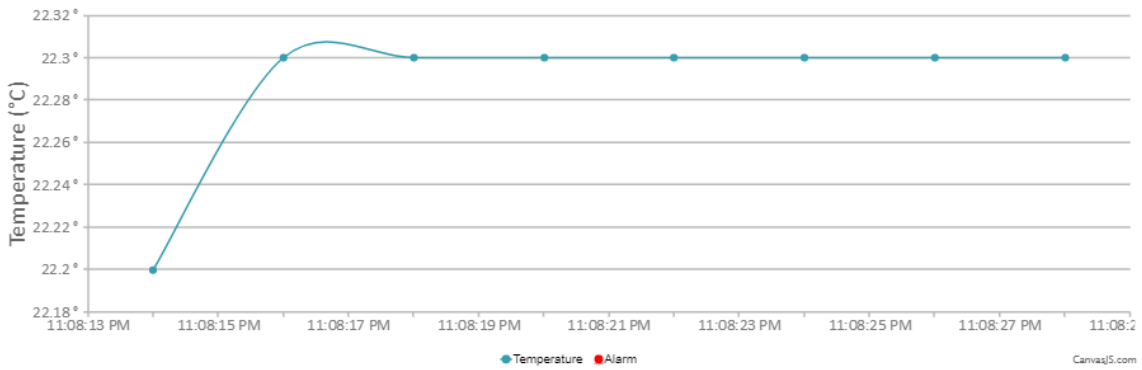
Enabled

Live sensor data from device

Temperature | Humidity | Accelerometer | Gyroscope

Temp Threshold 30

Save threshold



Alerts

Time	Device	Alert	Message

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Home About

STM32ODE IoT web dashboard

Device name 0080E1B8C946

Board type Nucleo-L476RG

Telemetry

Twin Properties

Device Id

0080E1B8C946

MAC address of this device

Tags Properties

Properties Properties

Desired Properties

Reported

Azure Fw Version

Azure_Sns_DM V3.1.0 SDK=1.1.16

Azure Status

Running

Telemetry Interval

2

Active HW Mode

2

Supported Methods

Supported Commands

Control device

LedOn

Send message to device

Call Method on Device

Reboot

Call Method

Firmware update

Azure_L476RG.bin

Force firmware update

FP-CLD-WATSON1 (1)

IBM developerWorks Marketplace

developerWorks Recipes Home All recipes My recipes

STM32 modular sensors node for vibration analysis connected with IBM Watson

STM32-ODE
Published on May 23, 2017 / *Updated on July 5, 2017*

1278 0 8

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For more information on community content, please refer to our Terms of Use.

Contents

Overview

Ingredients

Acquire all the HW boards

Connect HW boards to the PC using USB 2.0 port

Download and unzip the SW

Overview

Skill Level: Any Skill Level

All developers and system integrators

An STM32 modular sensor node integrates a combination of hardware boards and pre-built software to enable the fast prototyping of Internet of Things (IoT) applications.

Ingredients

STM32 Microcontroller: Nucleo-F401RE

Sensors board: X-NUCLEO-IKS01A2

WiFi: X-NUCLEO-IDW01M1

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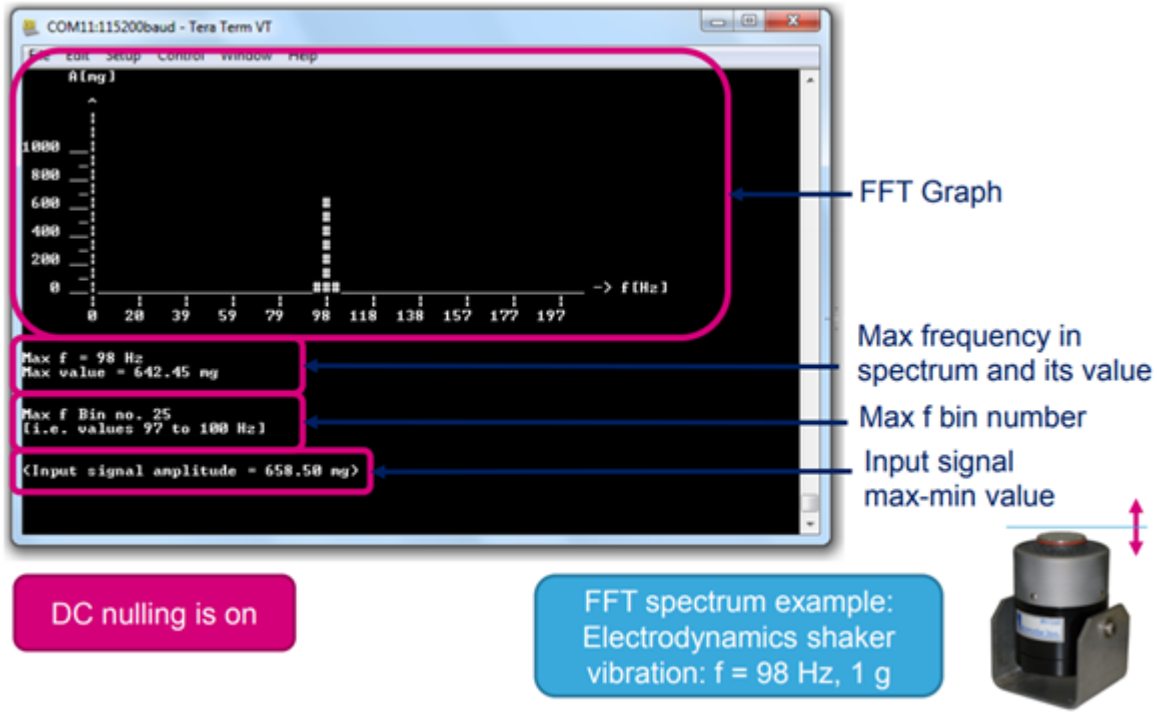
FP-CLD-WATSON1 (2)

Vibration Analysis Feature

- Vibration Analysis (VA), applied in an industrial or maintenance environment aims to reduce maintenance costs and equipment downtime by detecting equipment faults
- To analyze vibrations, accelerometer time domain signal is transferred to frequency domain for more effective analysis. This is achieved with FFT (LSM303AGR or IIS2DH are needed)
- Output of the FFT library
  - Maximum frequency of detected vibration
  - Amplitude for the frequency
  - Motor Status (OK, warning, failure)



Please consult the Quickstart Guide and User Manual for detailed information
http://www.st.com/en/embedded-software/fp-cld-watson1.html

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SensorTile to IBM Watson IoT

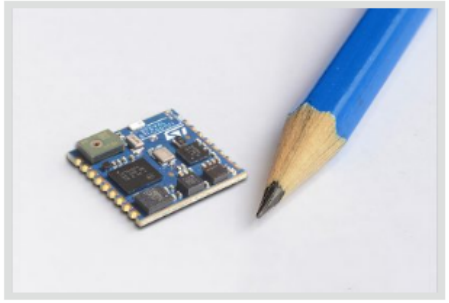
IBM developerWorks Marketplace

developerWorks Recipes Home All recipes My recipes

Internet of Things (IoT) Mobile development

Connect ST Sensor Tile to IBM Watson IoT Platform

STM32-ODE
Published on July 19, 2017 / *Updated on July 19, 2017*



Contents

Overview
Ingredients
Assemble the SensorTile
Install the ST BlueMS application in your mobile phone
Connect the mobile phone to SensorTile via Bluetooth using BlueMS app

Overview

Skill Level: Any Skill Level

All developers and system integrators

Connect the SensorTile platform to IBM Watson IoT cloud using a mobile phone as a gateway. SensorTile is a tiny, square-shaped module that can fit snugly in your IoT hub or sensor network node and become the core of your solution.

Ingredients

- SensorTile development kit (available on st.com: STEVAL-STLKT01V01). The SensorTile is a tiny, square-shaped IoT module that packs powerful processing capabilities leveraging an 80 MHz STM32L476JGY microcontroller and Bluetooth low energy connectivity based on BlueNRG network processor as well as a wide spectrum of motion and environmental MEMS sensors, including a digital microphone.

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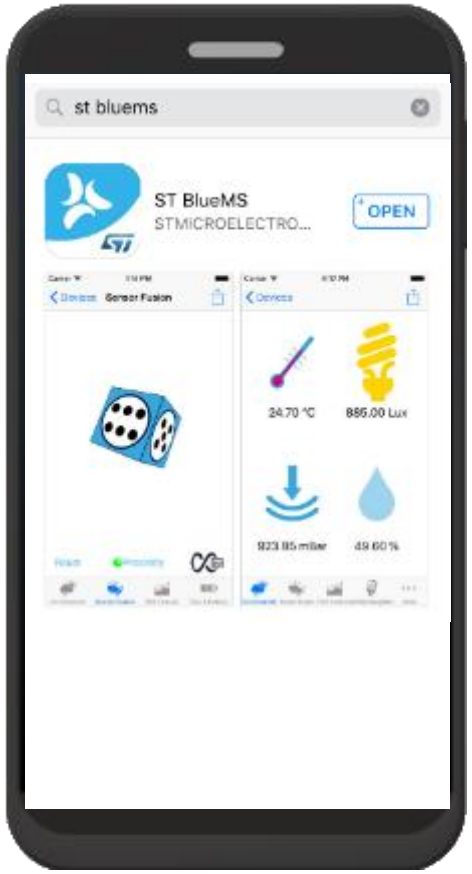
SensorTile & ST BlueMS App

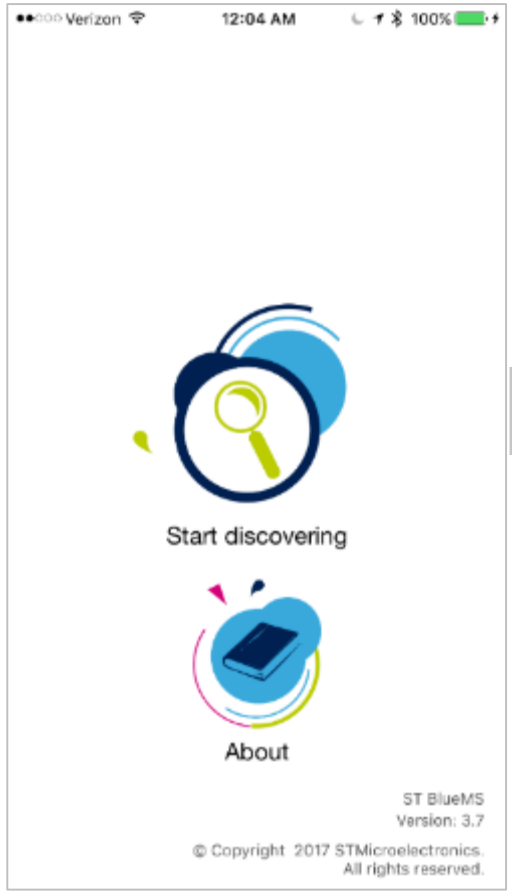


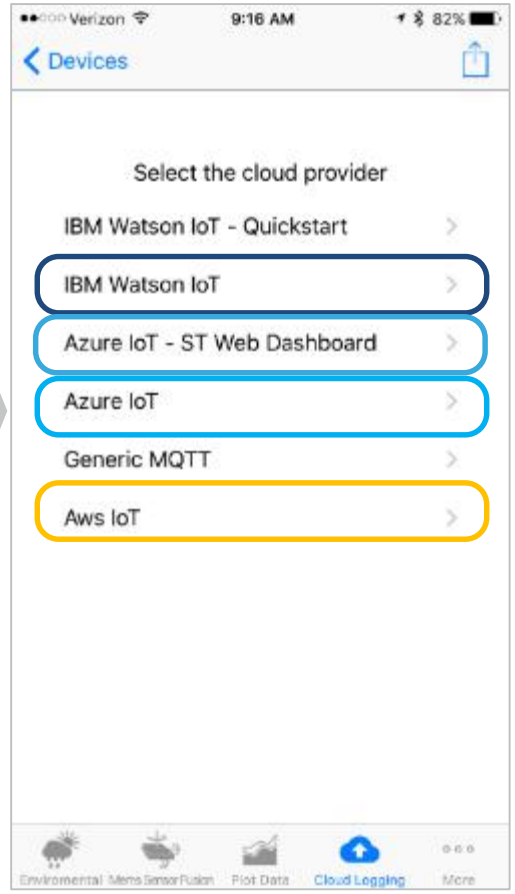
Download on the App Store

GET IT ON Google Play

ST BlueMS

STMICROELECTRONICS INC





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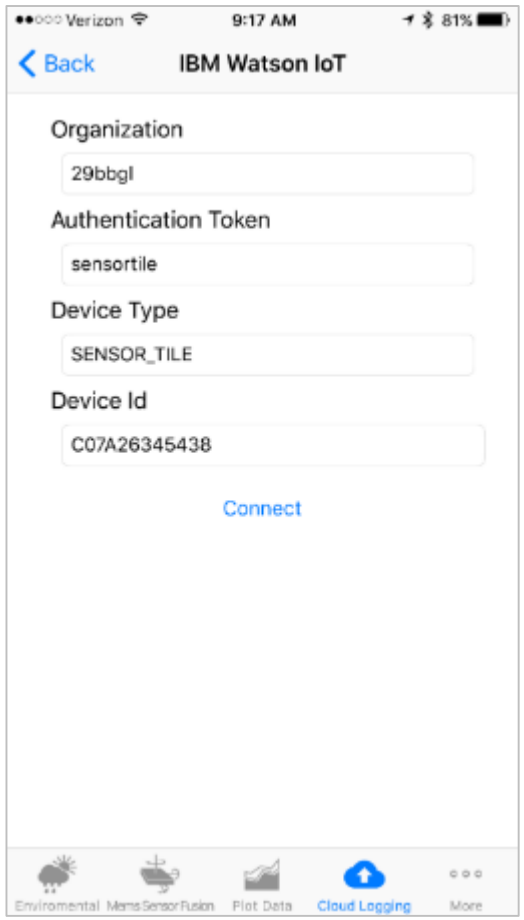
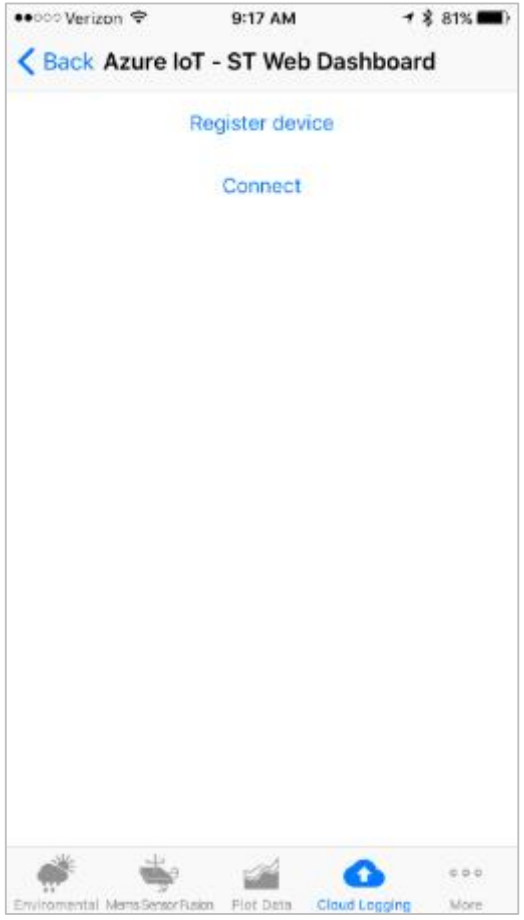
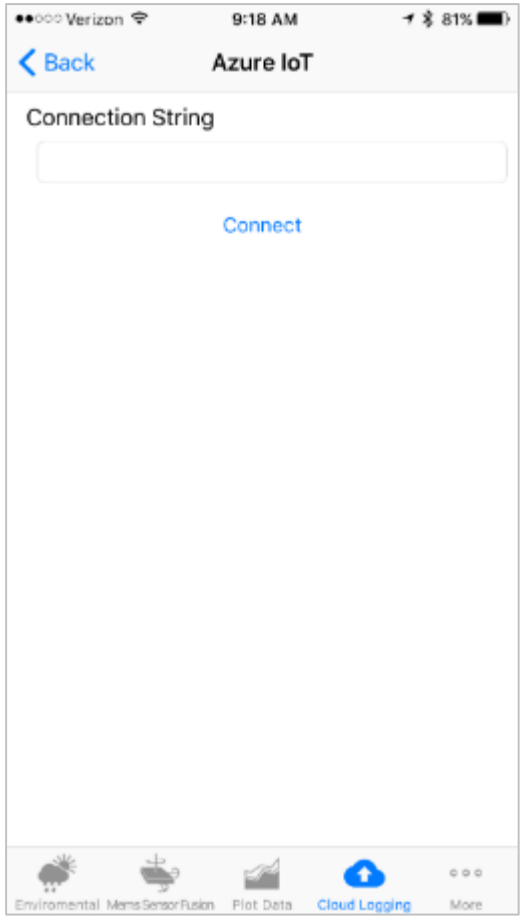
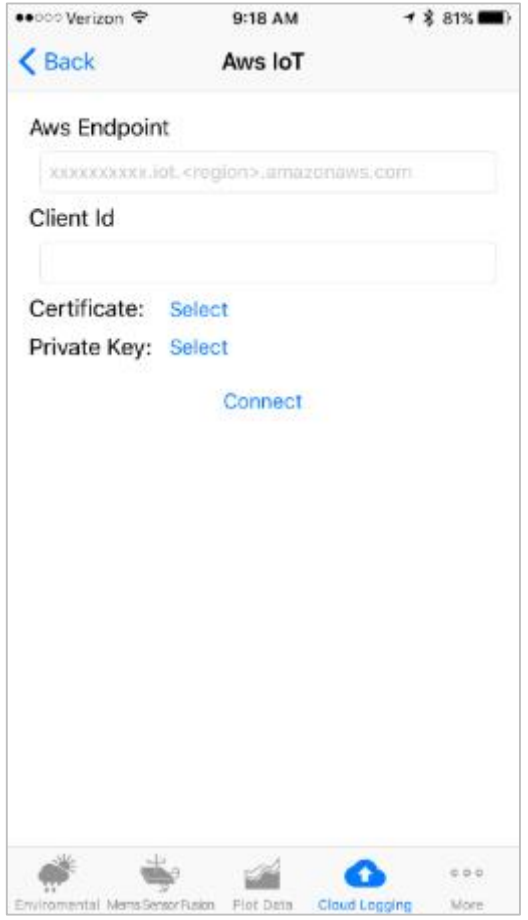
SensorTile Enables Cloud Applications









STM32ODE IoT Web Dashboard

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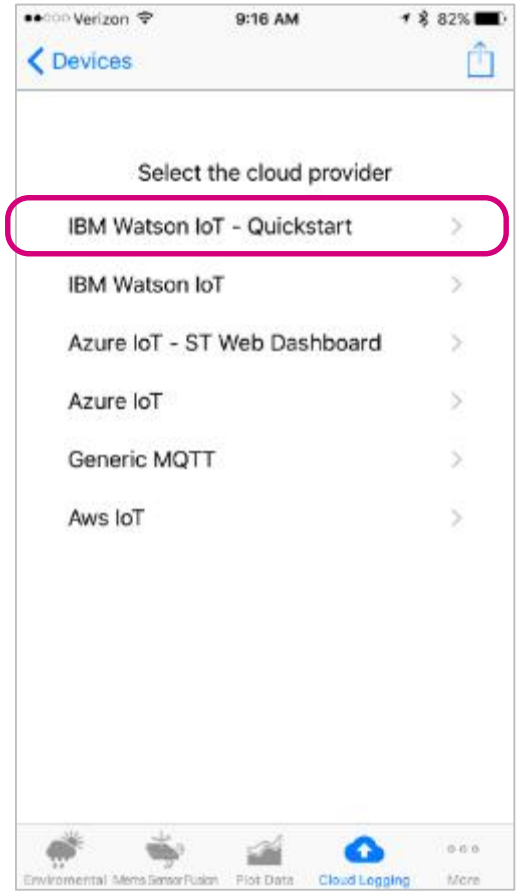
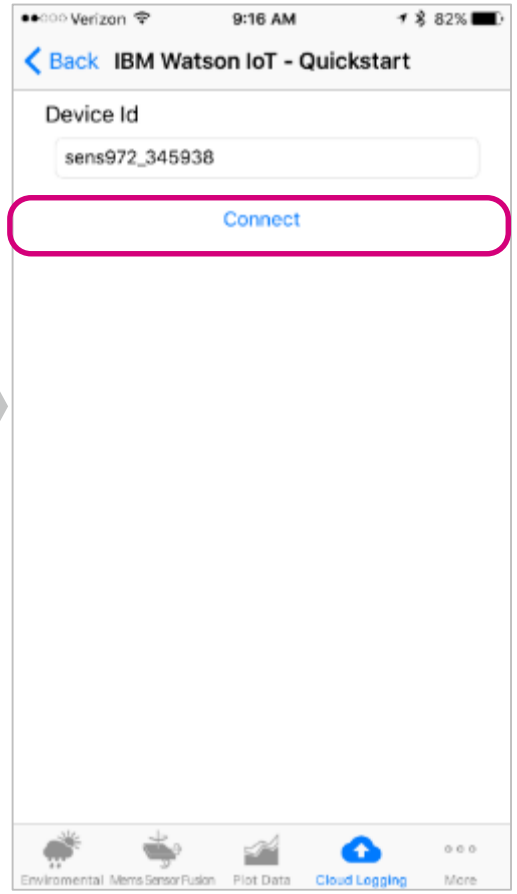
Post SensorTile Sensor Data on IBM Watson

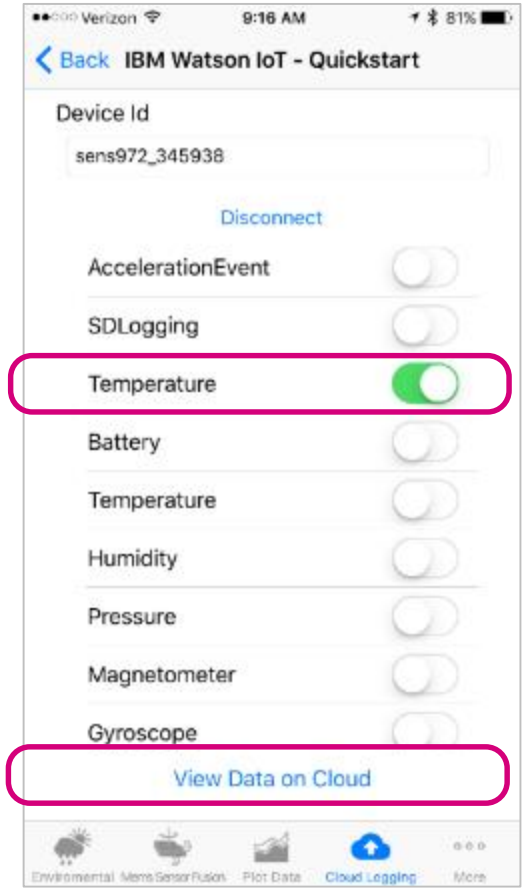
Select “IBMQuickstart”



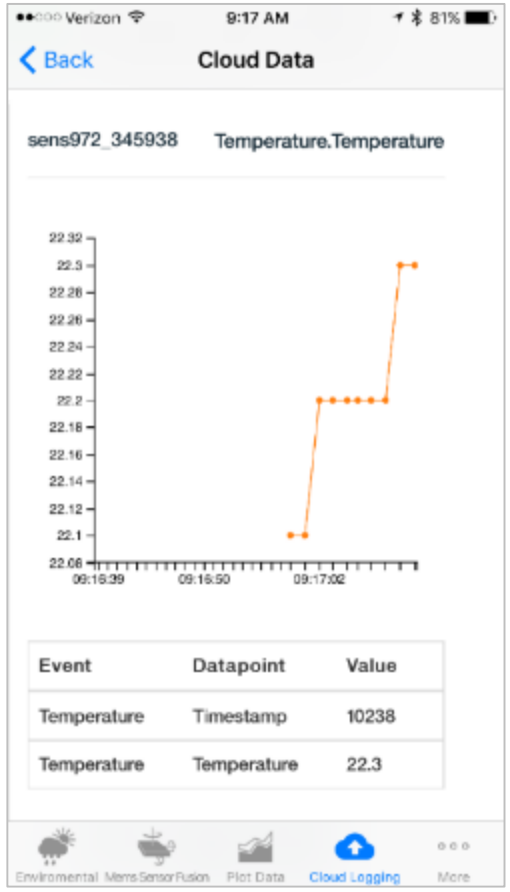
Click “Connect”



Select a feature



Plot of selected feature



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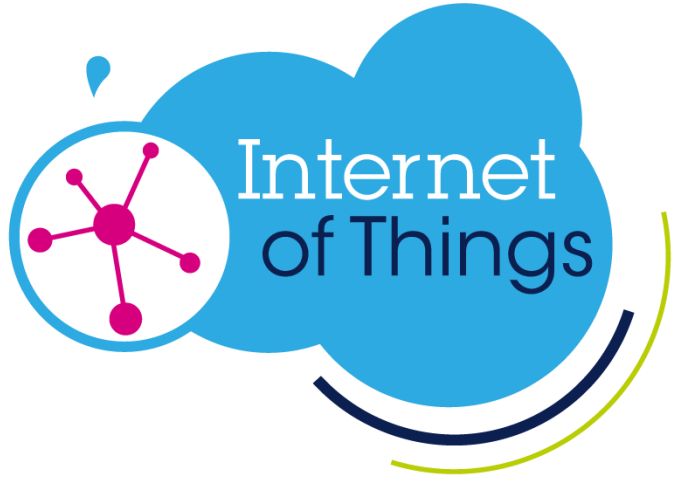
Takeaways

- ST has all the building blocks for IoT ready for the different needs of diverse applications
  - Processing and security
  - Sensing and actuating
  - Signal conditioning and protection
  - Wired and wireless connectivity
  - Power and energy management



- ST makes development of devices for the IoT fast and affordable and provides device kit and FW packages to connect to the major Cloud providers