Avnet Silica Sensor Node

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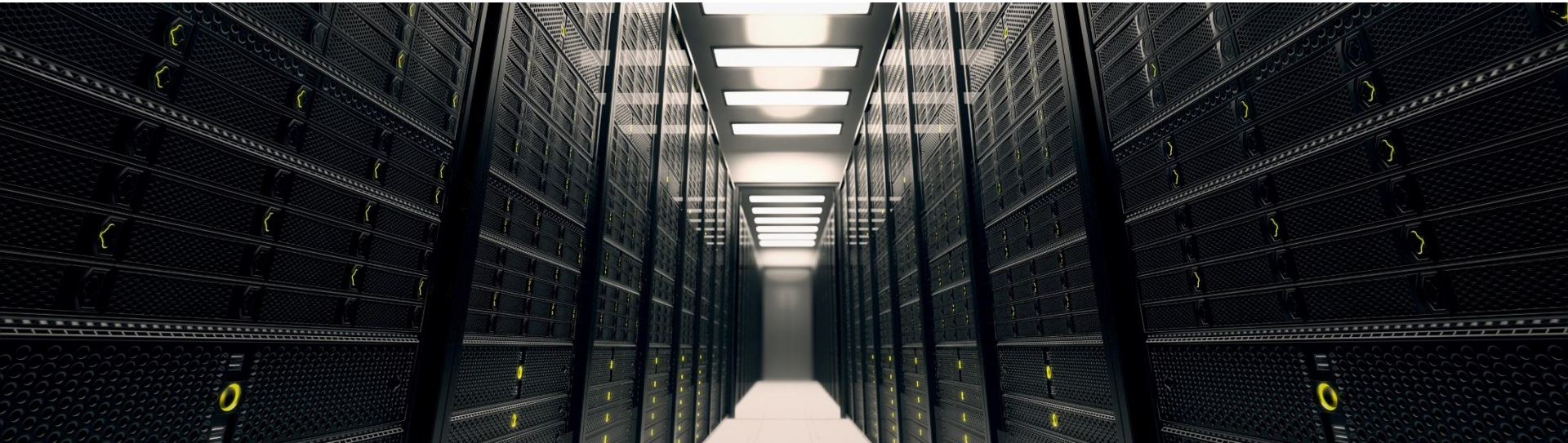
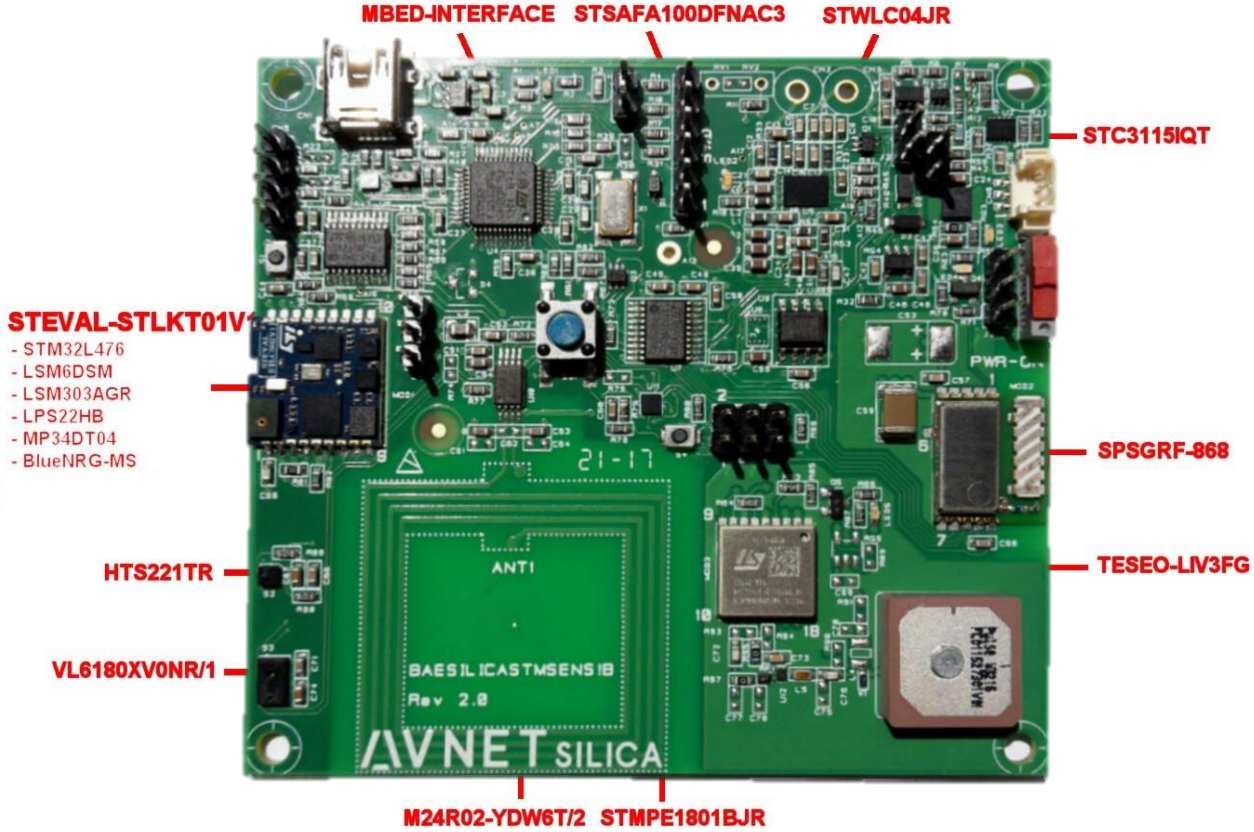
March 2017

AVNET SILICA



Avnet Silica Sensor Node



Features

STM SensorTile module – 13 x 13 mm module including

- Ultra-low-power STM 32 L4 Arm Cortex M4 Mcu
- Accelerometer
- Gyroscope
- Magnetometer
- Barometer
- Microphone
- Bluetooth Smart – BlueNRG-MS

Additional on-board connectivity

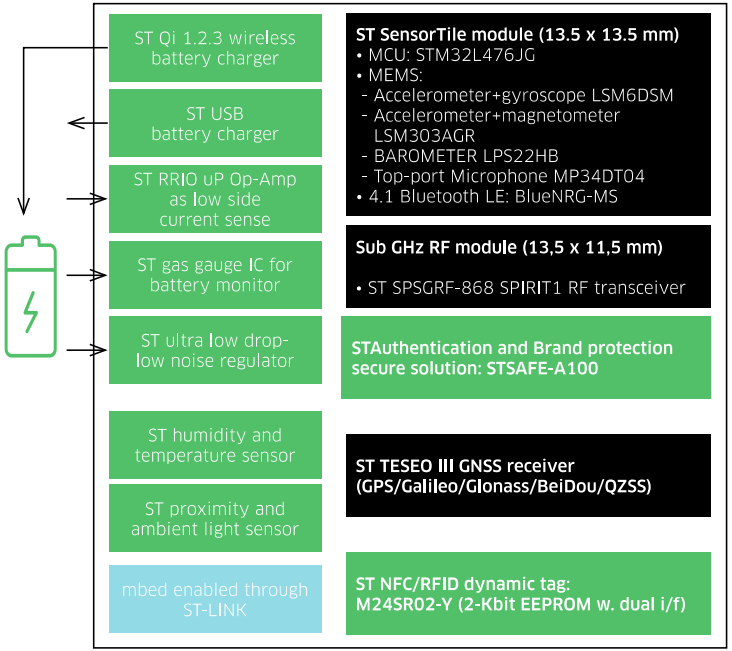
- STM SPSGRF-888 Spirit sub-ghz module (13.5 x 11,5 mm)
- STM TESEO-LIV3 GNSS module (9,7 x 10,1 mm) supporting GPS/Galileo/Glonass/BeiDou/QZSS
- STM M24SR02 Dynamic NFC/RFID Tag (2-Kbit EEPROM with dual interface)

Additional on-board sensors

- STM humidity and temperature sensor
- STM proximityandambientlightsensor VL6180x , gestures

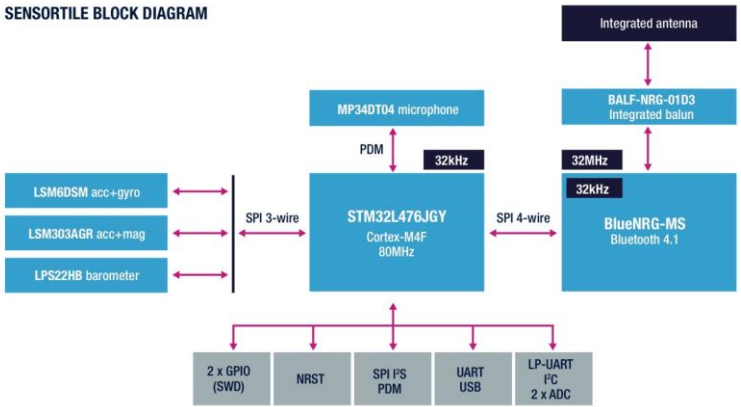
Additional features

- mbed enabled board with embedded interface for programming and debugging (ST-LINK)
- STM Qi 1.0 wireless battery charger
- STSAFE-A100 Security Module



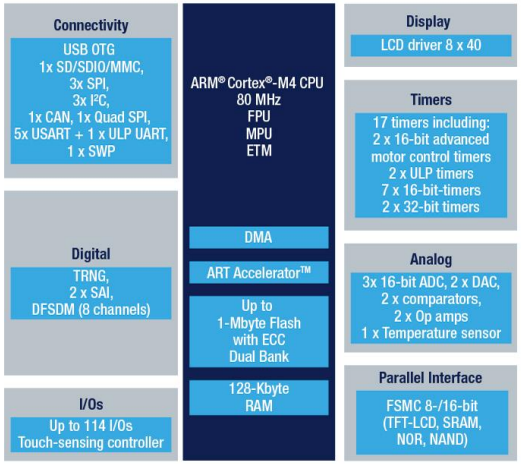
SensorTile - An IoT design lab on the tip of a pencil

- **STLCS01V1 SensorTile component board features**
- Very compact (13.5 x 13.5 mm) module for motion, audio and environmental sensing and Bluetooth low energy connectivity
- Pluggable or solderable interface
- SWD interface for debugging and programming capability
- **Main components:**
  - STM32L476 – 32-bit ultra-low-power MCU with CortexM4F
  - LSM6DSM – iNEMO inertial module: 3D accelerometer and 3D gyroscope
  - LSM303AGR – Ultra-compact high-performance eCompass module: ultra-low power 3D accelerometer and 3D magnetometer
  - LPS22HB – MEMS nano pressure sensor: 260-1260 hPa absolute digital output barometer
  - MP34DT04 – 64dB SNR Digital MEMS Microphone
  - BlueNRG-MS – Bluetooth low energy network processor
  - BALF-NRG-01D3 – 50 Ω balun with integrated harmonic filter
  - LD39115J18R – 150 mA low quiescent current low noise LDO 1.8 V
  - 2 V-5.5 V power supply range
  - External interfaces: UART, SPI, SAI (Serial Audio Interface), I2C, DFSDM, USB OTG, ADC, GPIOs

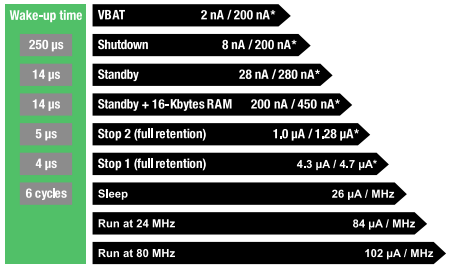


STM32L476JG- **Ultra-low-power with FPU ARM Cortex-M4**

- **Key Features**
- Ultra-low-power with FlexPowerControl
  - 1.71 V to 3.6 V power supply
  - -40 °C to 85/105/125 °C temperature range
  - 100 µA/MHz run mode
- Core: ARM 32-bit Cortex-M4 CPU with FPU, Adaptive real-time accelerator (ART Accelerator™)
- RTC with HW calendar, alarms and calibration
- LCD 8 × 40 or 4 × 44 with step-up converter
- Up to 24 capacitive sensing channels: support touchkey, linear and rotary touch sensors
- 16x timers: 2 x 16-bit advanced motor-control, 2 x 32-bit and 5 x 16-bit general purpose, 2x 16-bit basic, 2x low-power 16-bit timers (available in Stop mode), 2x watchdogs, SysTick timer
- Up to 114 fast I/Os, most 5 V-tolerant, up to 14 I/Os with independent supply down to 1.08 V
- Memories
  - 1 MB Flash, 2 banks read-while-write, proprietary code readout protection
  - 128 KB of SRAM including 32 KB with hardware parity check
  - External memory interface for static memories supporting SRAM, PSRAM, NOR and NAND memories
  - Quad SPI memory interface
- 4x digital filters for sigma delta modulator
- Rich analog peripherals (independent supply)
  - 3× 12-bit ADC 5 Msps, up to 16-bit with hardware oversampling, 200 µA/Msps
  - 2x 12-bit DAC, low-power sample and hold
  - 2x operational amplifiers with built-in PGA
  - 2x ultra-low-power comparators
- 18x communication interfaces
  - USB OTG 2.0 full-speed, LPM and BCD
  - 2x SAIs (serial audio interface)
  - 3x I2C FM+(1 Mbit/s), SMBus/PMBus
  - 6x USARTs (ISO 7816, LIN, IrDA, modem)
  - 3x SPIs (4x SPIs with the Quad SPI)
  - CAN (2.0B Active) and SDMMC interface
  - SWPMI single wire protocol master I/F
- 14-channel DMA controller
- True random number generator
- CRC calculation unit, 96-bit unique ID
- Development support: serial wire debug (SWD), JTAG, Embedded Trace Macrocell™



Outstanding Low-Power Modes

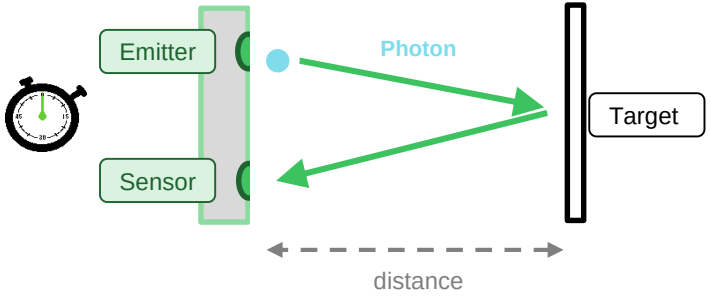


* without RTC / with RTC

FlightSense™ Breakthrough Technology

Measurement at the speed of light ! 1cm round-trip at 67ps

FlightSense™ Principle



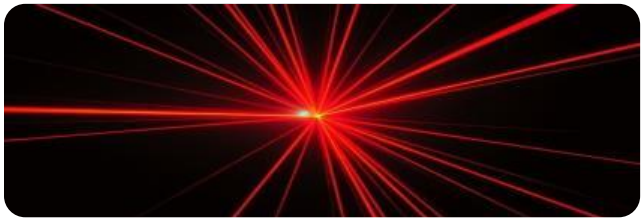
Measured distance = Photon travel time /2 x Speed of light

Fully Integrated Time of Flight Module
ST #1 World Wide Supplier

True distance measurement
Independent of target size, color & reflectance

Very fast (few ms)

Low power



Introducing F**light**Sense™ technology
Time-of-Flight Added Value

– **Conventional IR technology**

1 Output

- Signal Amplitude only
  - Low precision Signal
  - Unknown distance
  - Measure only distance variation

- **Time-of-Flight technology**

2 Outputs

- Accurate Signal Amplitude
- Distance Accuracy by Measure of photon flight time
  - Two independent results:
    - Actual accurate distance
    - Estimation of the field of view occupied by the target object

- 1D Basic Gesture Recognition
  - Phone Platform available for Demo

ST's FlightSense™ - ToF Sensors Mass-market products

VL6180X

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

In Mass production

- 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
  - 850nm IR emission (Vcsel)
- Major use cases:
  - Proximity distance measurement
  - Proximity detection
  - Lighting control
  - Basic gesture

VL53L0X

- **Ranging sensor**
- Up to 200cm ranging

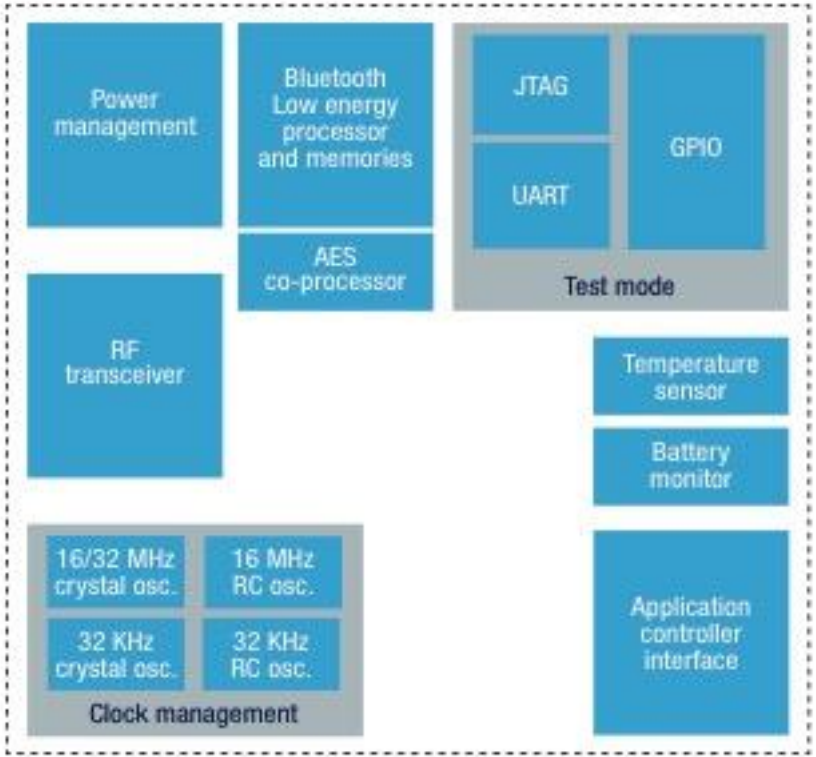
In Mass production
Mass Market availability: June 2016

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

BlueNRG-MS - Bluetooth Low Energy Network Processor

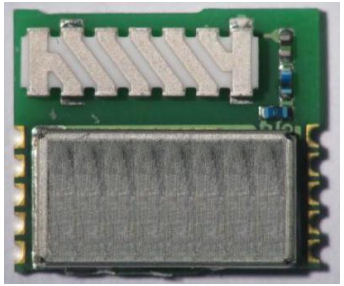
- Bluetooth specification v4.1 compliant master and slave single-mode Bluetooth low energy network processor
- Embedded Bluetooth low energy protocol stack: GAP, GATT, SM, L2CAP, LL, RF-PHY
- Bluetooth low energy profiles provided separately
- Operating supply voltage: from 1.7 to 3.6 V
- 8.2 mA maximum TX current (@0 dBm, 3.0 V)
- Down to 1.7 µA current consumption with active BLE stack
- Integrated linear regulator and DC-DC step-down converter
- Up to +8 dBm available output power (at antenna connector)
- Excellent RF link budget (up to 96 dB)
- Accurate RSSI to allow power control
- Proprietary application controller interface (ACI), SPI based, allows interfacing with an external host application microcontroller

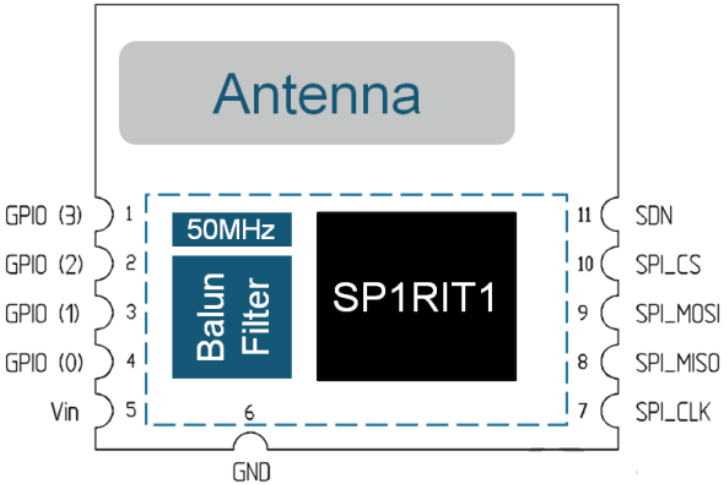
- Full link controller and host security
- High performance, ultra-low power Cortex-M0 32-bit based architecture core
- Upgradable BLE stack (stored in embedded Flash memory, via SPI)
- AES security co-processor
- Low power modes
- 16 or 32 MHz crystal oscillator
- 12 MHz ring oscillator
- 32 kHz crystal oscillator
- 32 kHz ring oscillator
- Battery voltage monitor
- Compliant with the following radio frequency regulations: ETSI EN 300 328, EN 300 440, FCC CFR47 Part 15, ARIB STD-T66
- Available in QFN32 (5 x 5 mm) and WLCSP34 (2.66 x 2.56 mm) packages
- Operating temperature range: -40 °C to 85 °C



SPSGRF-868- Sub-GHz RF Module

- Module based on:
  - SPIRIT1 low-power sub-GHz transceiver
  - BALF-SPI-01D3 balun and filter
  - Surface mount antenna
- Tiny size:13.5x11.5mm
- 500Kbits/s data rate
- Temperature range from -40 to 85°C
- Receiver sensitivity:–118dBm
- Output power up to +11.6dBm
- RX: 9 mA, Tx: 21 mA @ +11 dBm
- Shutdown: 2.5nA
- SPI host interface
- CE compliant

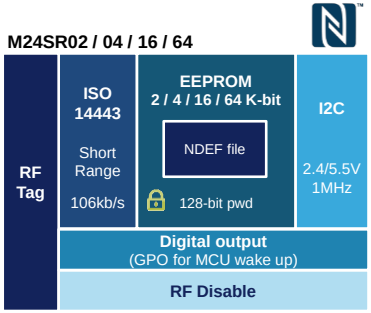




M24SR02-Y

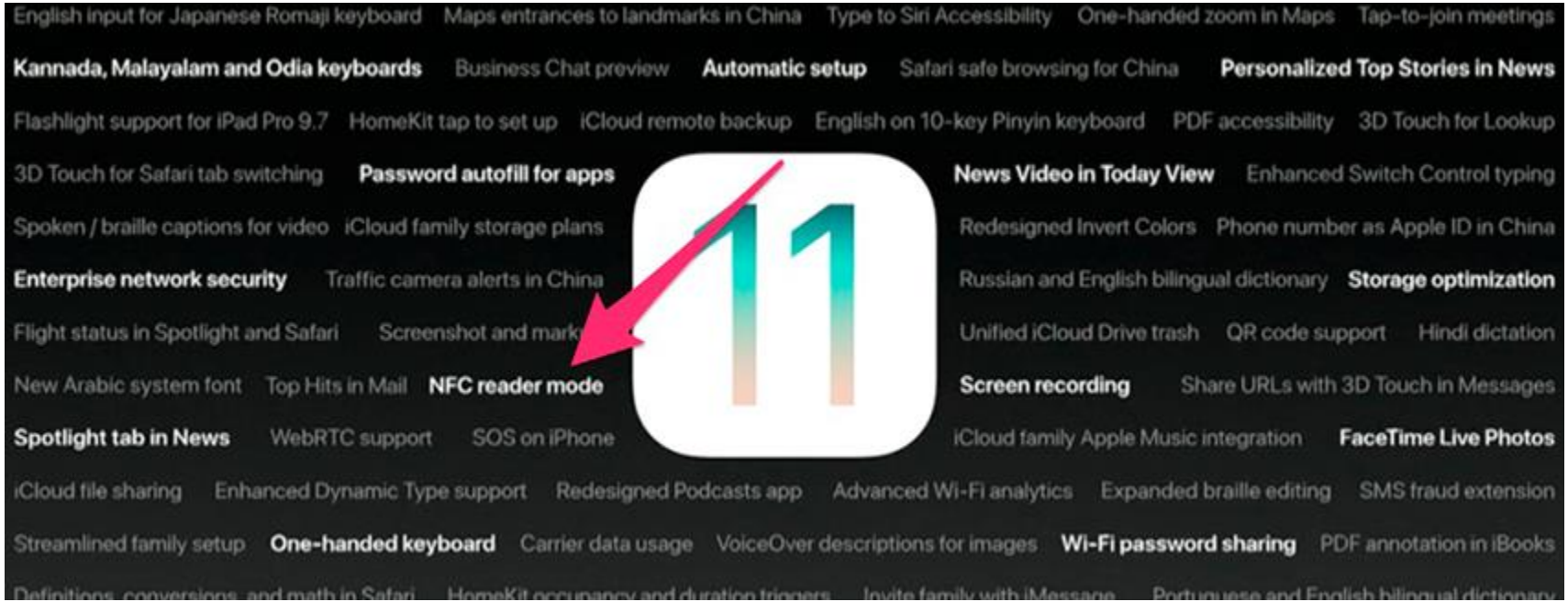
2-Kbit Dynamic NFC/RFID tag NFC forum Type 4 with I2C interface and password protection

- I^2 C interface
  - Two-wire I^2 C serial interface supports 1 MHz protocol
  - Single supply voltage: 2.7 V to 5.5 V
- Contactless interface
  - NFC Forum Type 4 Tag
  - ISO/IEC 14443 Type A
  - 106 Kbps data rate
  - Internal tuning capacitance: 25 pF
- Memory
  - 256-byte (2-kbit) EEPROM
  - Support of NDEF data structure
  - Data retention: 200 years
  - Endurance: 1 million erase-write cycles
  - Read up to 246 bytes in a single command
  - Write up to 246 bytes in a single command
  - 7 bytes unique identifier (UID)
  - 128 bits passwords protection

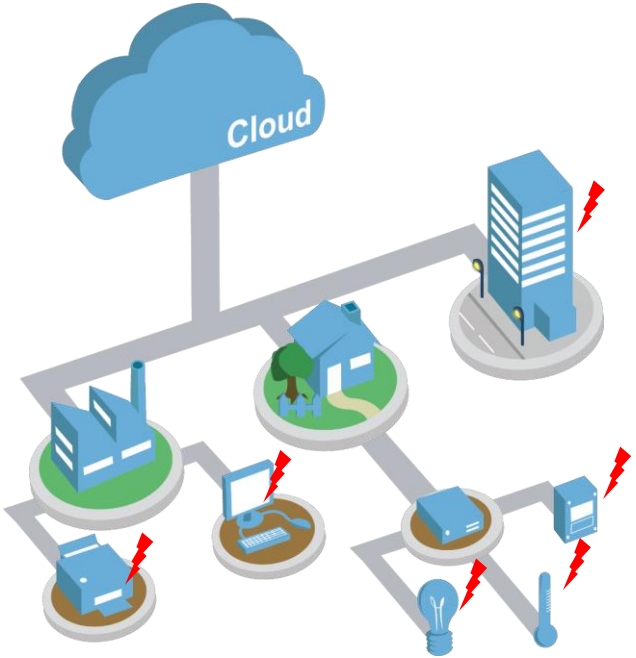


Apple iOS 11 Support Reading NFC Tags

iPhone 7 and iPhone 8 with Core NFC API



STSAFE-A100 for Strong Authentication
Securing the Internet of Things – The Threats



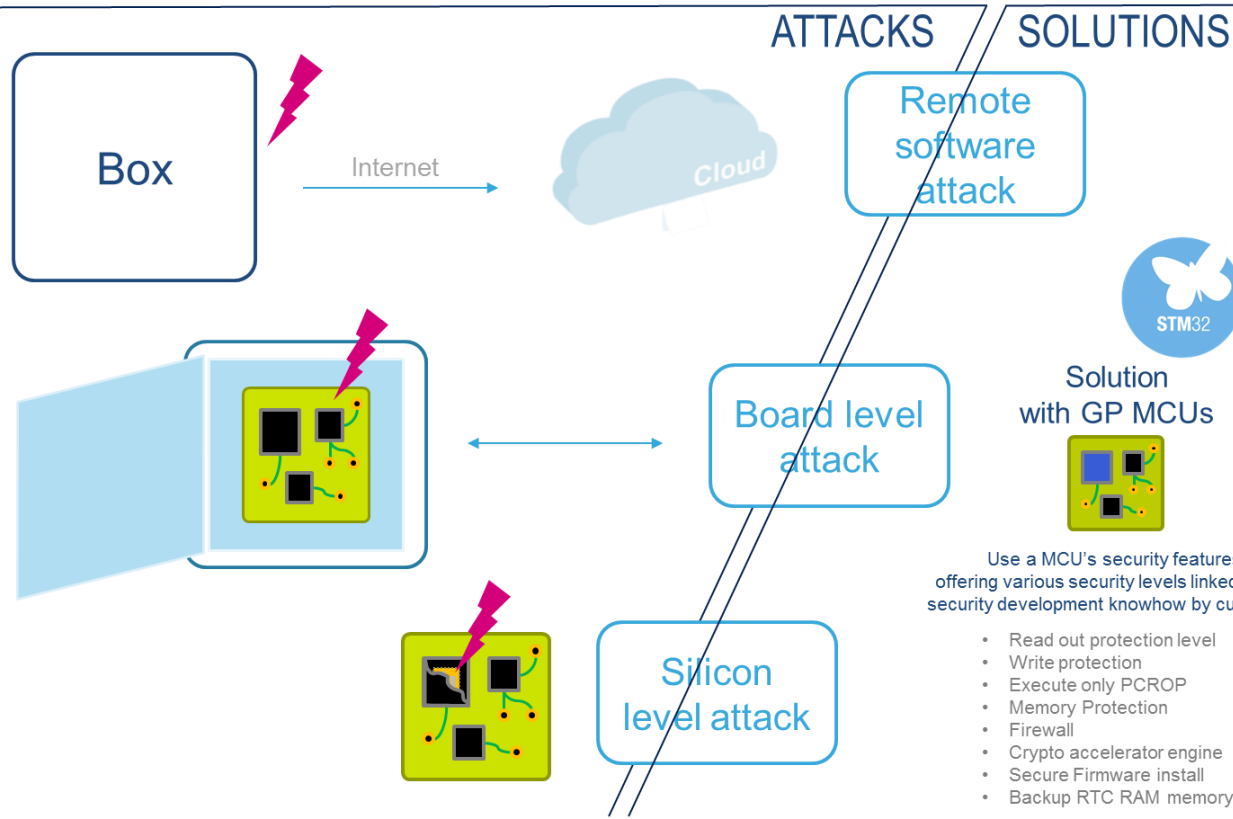
- User data corruption
- Device counterfeiting
- Device malfunction
- Service & network access corruption

Secure Element – Definition

A Secure Element (SE):

- is a tamper-resistant platform (typically a one chip secure microcontroller)
- capable of securely hosting applications and storing their confidential and cryptographic data
- in accordance with the rules and security requirements set forth by a set of well-identified trusted authorities

Identify the classes of Attacks



STM32

Solution with GP MCUs

Use a MCU's security features offering various security levels linked to FW security development knowhow by customers

- Read out protection level
- Write protection
- Execute only PCROP
- Memory Protection
- Firewall
- Crypto accelerator engine
- Secure Firmware install
- Backup RTC RAM memory

Secure MCU

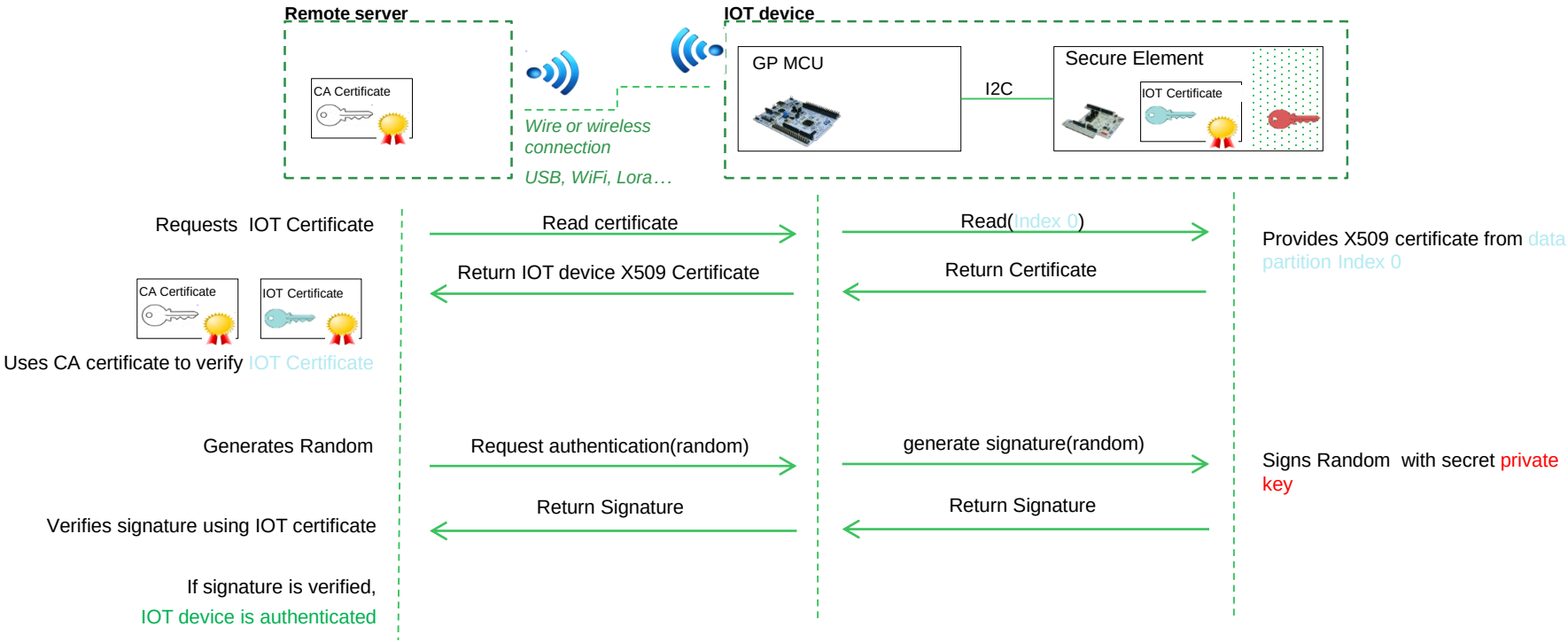
Adding Secure Element

Add a Certified (CC EAL5+) Secure Element for security improvements

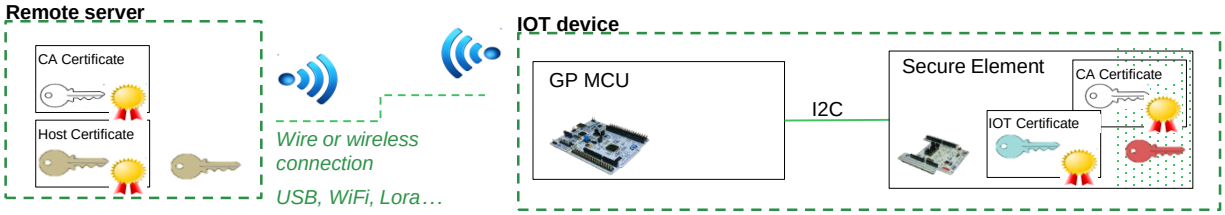
which guaranties optimum security against Remote, Board and Silicon level attack

- Protection against faults injection
- Protection against side-channel attacks
- Monitoring of environmental parameters
- Memory obfuscation, Active shields
- Strong authentication / crypto services
- Secure key storage and handling
- Secure code storage and execution
- Secure key provisioning

1st Use case example : Peripheral authentication



2nd Use case example : TLS Handshake V1.2 (RFC 5246)



Client Hello (client random)

Client provides supported TLS version, algorithms and a random

Replies algorithms choices

Server Hello (server random)

Provides X509 certificate and signed

Certificate (), signed client random

Request IOT device X509 certificate

Certificate Request ()

Provides EC public key and the curve to use

Server Key Exchange ()

Server Hello done ()

Processing
- Verify Server host certificates with CA certificate
- Authenticate server verifying signature
- Generate ephemeral EC key pairs
- Computes shared secret using Remote server public key

Verifies IOT Device certificate and authenticate IOT device

Certificate (), signed server random

Provides IOT device X509 certificate and signed random

Computes Diffie-Hellman shared secret

Client Key Exchange ()

Provides ephemeral public key

Certificate Verify ()

Change Cipher Spec ()

Starts exchange ciphering

Client Finished ()

Change Cipher Spec ()

Starts exchange ciphering

Server Finished ()

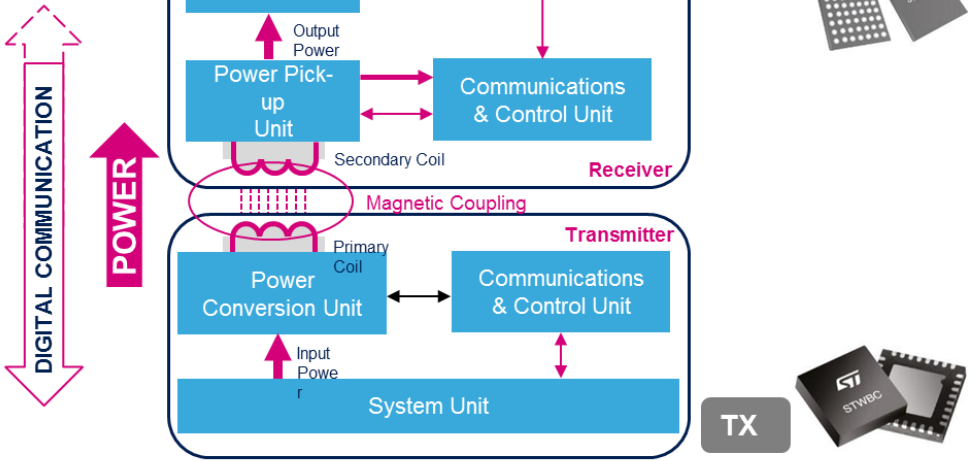
STSAFE-A100

Authentication, state-of-the-art security for peripherals and IoT Devices

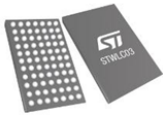
- Authentication (of peripherals, IoT and USB Type-C devices)
- Secure channel establishment with remote host including transport layer security (TLS) handshake
- Signature verification service (secure boot and firmware upgrade)
- Usage monitoring with secure counters
- Pairing and secure channel with host application processor
- Wrapping and unwrapping of local or remote host envelopes
- On-chip key pair generation
- **Security features**
  - Latest generation of highly secure MCUs
    - CC EAL5+ AVA_VAN5 Common Criteria certified
    - Active shield
    - Monitoring of environmental parameters
    - Protection mechanism against faults
    - Unique serial number on each die
    - Protection against side-channel attacks
  - Advanced asymmetric cryptography
    - Elliptic curve cryptography (ECC) with NIST or Brainpool 256-bit and 384-bit curves
    - Elliptic curve digital signature algorithm (ECDSA) with SHA-256 and SHA-384 for digital signature generation and verification
    - Elliptic curve Diffie-Hellman (ECDH) for key establishment
  - Advanced symmetric cryptography
    - Key wrapping and unwrapping using AES-128/AES-256
    - Secure channel protocols using AES-128
  - Secure operating system
    - Secure STSAFE-A100 kernel for authentication and data management
    - Protection against logical and physical attacks
- **Hardware features**
  - Highly secure MCU platform
  - 6 Kbytes of configurable non-volatile memory
    - Highly reliable CMOS EEPROM technology
    - 30 years' data retention at 25 °C
    - 500 000 erase/program cycles endurance at 25 °C
    - 1.62 V to 5.5 V continuous supply voltage

ST Wireless Charging

Consumer | **Wearable** | **Automotive**



RX



TX

- Multiple Qi and PMA standards supported
- Digital feedback from RX to TX
- Foreign object detection (FOD)
- Customizable end-applications

System know-how for complete solution with TX and RX

STWLC family – Receiver

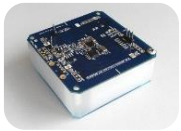
For applications up to 15 W, supporting both Qi and PMA standards

SmartPhone

STWLC03

High-performance receiver for applications up to 7.5 W

- Wireless power transfers up to 7.5 W
- Programmable buck converter with current and voltage regulation (FSW=1MHz)
- Multi Mode Qi 1.1.2 and PMA SR1 standards
- Embedded MCU with 16Kb ROM and 2Kb NVM
- 76% total system efficiency
- Flip Chip 3.1x4.7mm2



STEVAL-ISB036V1
Available Q3-2016

Wearable

STEVAL-ISB038V1R
Available Q3-2016

STWLC04

High-performance receiver for wearable applications

- Wireless power transfers up to 1 W
- Programmable buck converter with current and voltage regulation (FSW=1MHz)
- Embedded MCU with 16Kb ROM and 2Kb NVM
- 76% total system efficiency
- Flip Chip 3.1x4.7mm2

SmartPhone

STWLC33

High-performance receiver for applications up to 12 W

- Wireless power transfers up to 12 W
- Low drop regulator with input voltage regulation loop
- Multi Mode Qi 1.2, PMA SR1 Wireless Power Receiver
- Precise internal current sensor
- ARM cortex M4 MCU with 32MHz clock, 32MHz for PWM timers
- 32kB ROM memory for firmware, 8kB RAM, 4 kBits of NVM
- FOD
- Direct charging support
- Flip Chip <1mm2

Production in Q2-2016

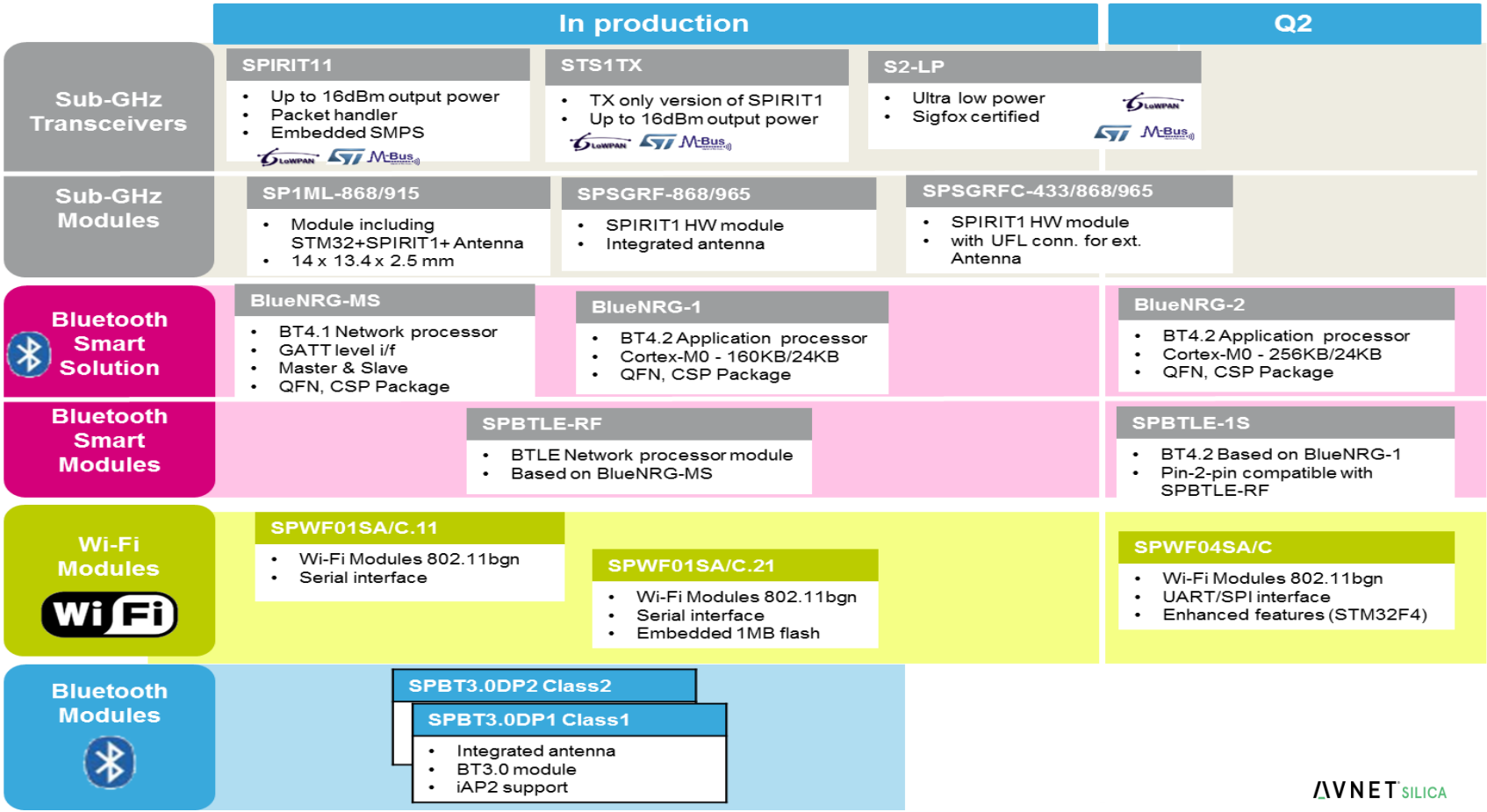
ES Available Q3-2016

mbed Enabled

- Develop quickly in mbed envinroment
- Online compiler with a great community
- Support for offline IDEs, including debugging capabilities like
  - Keil µVision® IDE
  - IAR
  - STM System Workbench for STM32

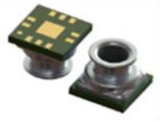
Products Update

ST RF Portfolio



AVNET SILICA

NEW ST Sensors

Accelerometer	6-axis IMU	E-Compass	Pressure	Pressure
LIS2DW12	**LSM6DSL**	**LSM303AGR**	**LPS22HB**	**LPS33HW**
				
2x2x0.7 mm	2.5x3x0.86 mm	2x2x1 mm	2x2x0.76 mm	3.3x3.3x2.9 mm
✓ 12 to 14bit resolution ✓ Noise level flex ✓ <<1µA in LP MODE	✓ Low Power ✓ Ultra Low Noise A+G ✓ Embedded Algo	✓ AMR, 50Ga FS ✓ 3mGa noise ✓ Offset cancellation	✓ Low noise ✓ Low power ✓ Temp compensated	✓ Waterproof Apps ✓ Low noise ✓ Temp compensated

ST MEMS shipped 11 BILLION

OPEN MEMS

MARKET POSITION

- Lower **POWER**
- Lower **NOISE** & Higher **ACCURACY**
- High level of **FLEXIBILITY** and **EASY** integration
- **SOFTWARE** & **TOOLS** available

Thank you!

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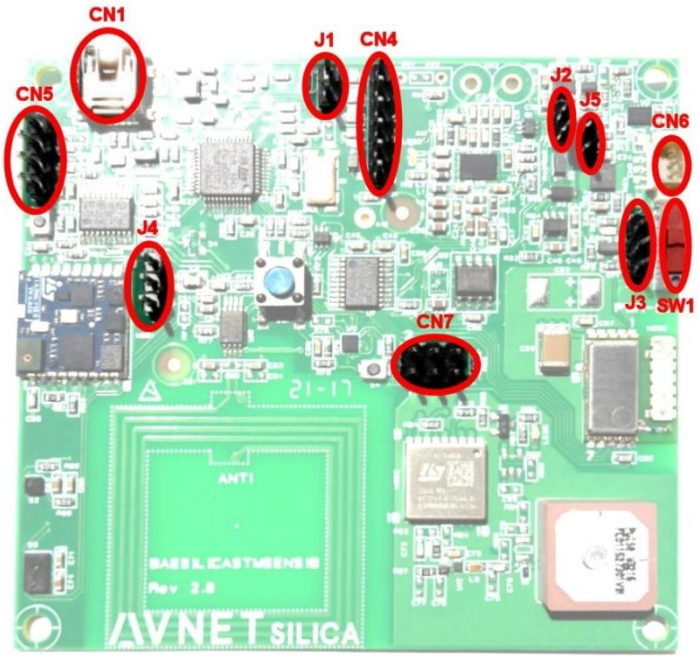

- **CN1**
  - Mini-USB connector
- **CN4**
  - SWD emulator debug interface
- **CN5**
  - closed: ST-Link emulator enabled on SensorTile
  - opened: ST-Link emulator enabled on CN4
- **CN6**
  - battery connector
- **CN7**
  - Teseo connector for uploading firmware
- **SW1**
  - ON/OFF power (OFF when managed by ST-Link)
- **J1**
  - In case the board is powered by an USB charger, there is no USB enumeration, so target MCU is not powered. In this specific case the jumper J1 needs to be set on ON, allowing target MCU to be powered anyway
- **J2**
  - closed: battery charger powered by USB and Wifi
  - opened: battery charger powered by Wifi only
- **J3**
  - closed pins 1-2: power supply by battery
  - closed pins 2-3: power supply by Mini-USB
- **J4**
  - closed pins 1-2: Sensortile UART redirected to ST-Link emulator debug port
  - closed pins 2-3: SensorTile UART redirected do Teseo
- **J5**
  - closed: battery charge current power 100mA
  - opened: battery charge current power 50mA

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