Wireless and Sensor Technologies Enable Smart City and Smart Home
Wireless Technology Enables Smart City

STM32 Nucleo development & expansion boards

ST Portfolio for SMART CITY

Leshan OMA Lightweight M2M

Contiki 6LoWPAN

Demo implementation details
Wireless Mesh Network

1. Ambient sensors
2. Vibrations
3. Garbage

Smart Street Lights
Smart Parking

Wi-Fi Gateway
IPv6
6LoWPAN

Cloud

Leshan
OMA Lightweight M2M

Ambient sensors
ST augmenting the Smart Home experience

Connect
sensors, thermostats, lights

Nodes over Bluetooth Smart

Access
smart devices remotely

WiFi to Cloud

Control
smart devices

BLE SDK
For smart phones
ST augmenting the Smart Home experience

**BlueNRG-MS** low-power BLE Sensor Node Network connected to the Cloud

- Smart RGB Lights
- Weather Station
- Remote Controller
- BLE Controller
- Wireless bridge
- Cloud connected

IBM Bluemix™
Wireless Technology Enables Smart City

- Smart Waste Collector
- Smart Street Lighting & Multi-Services
- Smart Home
- Smart Meter Gas, Power and Water
- Smart Building
- Smart Parking
Wireless Mesh Network for Smart City

Sensor nodes everywhere
Wireless network
Efficient Energy Management
Monitor & Control Infrastructure
Network System Architecture

Motion / Environmental / Proximity Sensors / Lighting

STM32 Nucleo

32bit MCU

X-NUCLEO-IDS01Ax

Wireless Network Module

IPv6
6LoWPAN

Nucleo Gateway

Monitoring & Control
Smart City: Contiki 6LowPan

Contiki Solution for SubGHz 6LoWPAN

Smart City 6LoWPAN Network
Smart light
Smart dumpster
Earthquake
Ambient Sensor

Broad portfolio of ST components
- Nucleo board with STM32L1 ultra-low power MCU
- Nucleo board with STM32F4 High performance MCU
- Distance ranging STM32 Nucleo expansion board
- Motion & Environmental sensors STM32 Nucleo expansion board
- Sub-GHz wireless transceiver
Ambient sensors

Wireless Mesh Network

Smart Street Lights
Smart Parking

Vibrations

Garbage

IPv6
6LoWPAN

Cloud

Wi-Fi Gateway

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OMA Lightweight M2M

Ambient sensors
Smart City: Contiki 6LowPan

- 3x Smart street light
- 2x Smart ambient sensor
- 1x Garbage collector
- 1x Earthquake Sensor

Street lighting

Garbage

Environmental data

Vibration

1. Temperature (°C)  
   - Full
   - High
   - Mid
   - Empty

2. Humidity (%)
   - High
   - Mid
   - Low
   - Normal

3. Pressure (hPa)
   - High
   - Mid
   - Low
   - Normal
STM32 Nucleo Board

Open development platform with STM32 Microcontroller

- High performance 32bit MCU: STM32F4
- Fast development of Software & Hardware
- Add-on functions through expansions
STM32 Nucleo Development Board

- Powered by ST’s 32-bit ARM® Cortex®-M based STM32 microprocessors
- A complete product range from ultra-low power to high-performance
- Integrated hardware for programming and debug
- Two connectors to connect to expansion boards
- Power supply through USB or external source
- Integrated ST-Link/V2-1: Mass storage device flash programming
- 2 Push button, 2 color Leds
- Arduino Uno v3 extension connectors
- Easy access for add-ons
- One STM32 MCU flavor with 64 pins
- ST morpho extension headers
- Direct access to all MCU I/Os

www.st.com/stm32nucleo
Motion & Environmental
STM32 Nucleo expansion board

- Easy to add-in functions to STM32 Nucleo
- 3 x Motion sensor & Environment sensors

6-axis Motion Sensor
LSM6DS0

Temperature & Humidity Sensor
HTS221

Pressure Sensor
LPS25H
FlightSense™ Distance Ranging
STM32 Nucleo expansion board

- Easy to add-in functions to STM32 Nucleo
- Proximity sensor based on Time-of-Flight (ToF) technology
Spirit1 SubGHZ Transceiver
STM32 Nucleo expansion board

- Easy to add-in functions to STM32 Nucleo
- Contiki 6LowPan ready
STM32 - Broadest 32-bit MCU Portfolio

**Real time performance**
ART Accelerator, up to 1000 CoreMark and up to 200MHz/428DMIPS

**Outstanding power efficiency**
<1uA RTC, 188uA/MHz, 0.3uA standby

**Standard and advanced peripherals**
USB-OTG HS, Camera, Ethernet, CAN, CRYPTO, SD 16-bit ADC, PGA, SDRAM interface, TFT with Chrom-ART

**Maximum integration**
Up to 2MB Flash/256kB SRAM, Reset Circuit, Voltage Reg., Int. RC, PLL, PVD, POR

**Extensive Ecosystem**
ARM+ST ecosystem (EVAL boards, discovery kits, Arduino, SW lib, RTOS)
STM32L ULP Offer

STM32L4 completes the ultra-low-power family

**Cost-smart ULP champion**

STM32 L0

Cortex-M0+ @ 32 MHz
Operating range: 1.65 to 3.6V
8/16-bit applications
Numerous pin counts

- 3 product lines
- Cost-effective
- Smaller packages
- USB, LCD, Analog
- 16 to 192 Kbytes of Flash
- Up to 20 Kbytes of SRAM

**Broad range foundation**

STM32 L1

Cortex-M3 @ 32 MHz
Operating range: 1.65 to 3.6V
Wide choice of memory sizes

- 3 product lines
- USB, LCD, AES
- Rich Analog
- True EEPROM
- Dual bank Flash (RWW)
- 32 to 512 Kbytes of Flash
- Up to 80 Kbytes of SRAM

**ULP with performance**

STM32 L4

Cortex-M4 w/ FPU @ 80 MHz
Operating range: 1.71 to 3.6V
Advanced Peripheral Performance

- 3 product lines
- USB, LCD, AES
- ADC 5 Msps, PGA, Compar., DAC, op amp,
  USB OTG, LCD, AES
- True EEPROM
- Dual bank Flash (RWW)
- 256 Kbytes to 1 Mbyte of Flash
- Up to 128 Kbytes of SRAM
• Multi band: 150MHz, 433, 868 to 956MHz
• Ultra low current consumption
• Mod.: 2-FSK, 2-GFSK, MSK, OOK, ASK
• Programmable output power up to +16dBm
• Excellent receiver Sensitivity: -121dBm
• Wireless MBUS, 6LoWPan
• Certified Modules:
  • **SP1ML-868/915**: SPIRIT1+STM32L1
  • **SPSGRF-868/915**: SPIRIT1

USA/Canada: FCC, Europe: ETSI, Japan/Korea: ARIB standard
Sub GHz Modules

**SP1ML-868 - (868 MHz)**
- AT Command
- Output power up to +11.6dBm
- CE compliant and FCC certified
- Air data rate up to 500kbps
- Modulation schemes: 2-FSK, GFSK, MSK, GMSK, OOK,
- 1.8V to 3.6V supply
- Operating temperature: -40°C to 85°C

**SP1ML-915 - (915 MHz)**

**SPSGRF-868 @ 868MHz**
- SPI host interface
- Output power up to +11.6 dBm
- RX: 9mA, Tx: 21mA @ +11dBm
- CE compliant and FCC certified
- Air data rate up to 500kbps
- Receiver sensitivity: -118 dBm
- Shut Down: 2.5nA
- Operating temperature: -40°C to 85°C

**SPSGRF-915 @ 915MHz**

**SPIRIT1 transceiver, STM32L1 MCU and BALF-SPI balun/filter**
- SPIRIT1 transceiver and BALF-SPI balun/filter

**SPIRIT1 transceiver and BALF-SPI-01D3 balun/filter**
- SPI host interface
- Output power up to +11.6 dBm
- RX: 9mA, Tx: 21mA @ +11dBm
- CE compliant and FCC certified
- Air data rate up to 500kbps
- Receiver sensitivity: -118 dBm
- Shut Down: 2.5nA
- Operating temperature: -40°C to 85°C
RF SubGHz

6LoWPAN Wireless MESH

- Contiki 3.0 open source code based
- Contiki OS based
- HTTP, WebSocket, CoAP
- UDP and TCP socket APIs
- IPv4/IPv6 stack, RPL, 6LoWPAN, 802.15.4

SubGHz 6LoWPAN network

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Sensors – A Complete Offering

- Motion sensors
  - Accelerometer
  - Gyroscope
  - Magnetometer
  - 6 and 9-axis Inertial modules
  - Image stabilization

- Environmental sensors
  - Humidity
  - Temperature
  - Pressure
  - UV index

- Acoustic
  - Digital microphone
  - Microphone array
  - Voice processing
Motion MEMS

Accelerometers and e-Compasses

Accelerometers

- Small footprint for ultra-compact solutions
- Low power consumption and ultra-low power operating modes that allow advanced power saving and smart sleep-to-wake functions
- Embedding motion recognition algorithm

MEMS inertial sensor 3-axis
LIS2DH12: LGA 2x2mm; FS ±2g/±4g/±8g/±16g; ODR 1 Hz to 5.3 kHz; I2C/SPI
LIS3DSH: LGA 3x3mm; FS ±2g/±4g/±8g/±16g; ODR 3.125 Hz to 1.6 kHz, I2C/SPI
H3LIS331DL: TFLGA 3x3mm; FS ±100g/±200g/±400g, ODR 0.5 Hz to 1 kHz; I2C/SPI.
LIS344ALH: LGA 4x4mm; FS ±2 g / ±6 g; max ODR 1.8 kHz; Analog OUT

e-compass (Accelerometer + Magnetometer)

- Superior sensing precision combined with low power consumption
- Very small package to address footprint reduction
- Temperature detection for advanced thermal drift compensation

3D magnetometer
LIS3MDL : LGA-12 (2.0x2.0x1.0 mm); FS ±4/ ±8/ ±12 ±16 gauss magnetic; 16-bit data output; I2C/SPI
3D accelerometer and 3 magnetometer module
LSM303C : LGA-12 (2.0x2.0x1.0 mm); Acc. FS ±2/±4/±8 g; FS ±16 gauss magnetic, 16-bit data output, SPI / I2C

Accelerometer

- Free fall condition
- Direction detection
- Spatial orientation
- Step counter
- Gesture recognition

e-compass

- Pointing
- Positioning
- Absolute heading
- Maps orientation & LBS
MEMS Gyroscopes and Inertial Modules

Digital Gyroscopes

- Wide full-range for optical image stabilization and smart user interfaces
- High performance combines with low power consumption to address demanding application and extend battery life
- Embedded FIFO for smart data storage and power saving
- L3GD20H: LGA-16 (3x3x1 mm); ±245/±500/±2000 dps; 16 bit rate value data output; I2C/SPI

Digital Gyroscopes

- More sensors in a single package for a smaller form factor
- Thermal and mechanical stability
- Enhanced user experience and motion-sensing realism in wearable devices

iNEMO Inertial Modules (Gyroscope + Accelerometer + Magnetometer)

- Advanced & smart motion detection
- Gaming
- Optical image stabilization

- Complex gesture recognition
- Smart pointers
- Motion recognition

6 and 9-axis Inertial modules

iNEMO inertial modules
- LSM330: 3D accelerometer and 3D gyroscope; ±2/±4/±6/±8/±16 g; ±250/±500/±2000 dps
- LSM6DS0: 3D accelerometer and 3D gyroscope; ±2/±4/±8 g; ±245/±500/±2000 dps
- LSM9DS0: 3D accelerometer, 3D gyroscope, 3D magnetometer; LGA-24 (4x4x1.0 mm); ±2g/±4g/±6g/±8g/±16g; ±2/±4/±8/±12 gauss ; ±245/±500/±2000 dps
Environmental Sensors
Pressure and Humidity

LPS25HB: Absolute pressure sensor
- Unique ultra thin full-molded package
- Dust-free and water resistant
- High shock survivability
- 260 to 1260 hPa absolute pressure range
- High resolution mode: 1 Pa RMS
- Embedded FIFO (noise reduction), interrupts, thresholds and auto-zero

HTS221: Relative humidity and temperature sensor
- Worldwide lowest power consumption
- 3.5% RH accuracy
- 0 to 100% RH range
- -40 to 120 °C temperature range
- Low Power Consumption: 1 µA @ 1Hz ODR
- 16 bit ADC measurement

Pressure
Humidity
Temperature
FlightSense™ Breakthrough Technology

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

Measurement at the speed of light! 1cm round-trip at 67ps
Contiki 3.0

6LoWPAN Wireless MESH

- Contiki 3.0 open source code based
- Contiki OS based
- HTTP, WebSocket, CoAP
- UDP and TCP socket APIs
- IPv4/IPv6 stack, RPL, 6LoWPAN, 802.15.4

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Contiki OS/6LoWPAN on STM32 Nucleo

STSW-CONTIKI6LP

- Based on Contiki OS
- Contiki 6LoWPAN protocol stack 3.x
- Applications running on a STM32 Nucleo
- Support for mesh networking technology, RPL protocol
- CoAP based REST server (Erbium)
- Free user-friendly license terms
Contiki 3.0 Nodes

NUCLEO-L152RE

based on the STM32L152RET6 ultra-low power microcontroller

X-NUCLEO-IDS01A4 or X-NUCLEO-IDS01A5

SPIRIT1 868 and 915MHz RF SubGHz module evaluation board

X-NUCLEO-IKS01A1

Motion MEMS and environmental sensor evaluation board

SPSGRF-868 or SPSGRF-915

EEPROM

HTS221

LPS25HB

LSM6DS0

LIS3MDL

STM32L1RB

Ultra-low-power MCU

SPIRIT1

868 MHz, sub-GHz

LPS25H

MEMS pressure sensor

LSM3DS0

3D accel.+ 3D gyroscope

LIS3DMDL

3D magnetometer

HTS221

Humidity & temperature sensor
ST augmenting the Smart Home experience

**BlueNRG-MS** low-power BLE Sensor Node Network connected to the Cloud

- Smart RGB Lights
- Weather Station
- Remote Controller

Bluetooth Smart to Wi-Fi bridge

Cloud connected via IBM Bluemix™

BLE Controller
ST augmenting the Smart Home experience

BlueNRG-MS low-power BLE Sensor Node Network connected to the Cloud

Smart Home Network

BLE Controller

Bluetooth Smart to Wi-Fi bridge

Wireless bridge

Cloud connected Remote Controller
Once all BLE Services and Characteristics are discovered, the STM32 Nucleo starts receiving sensor data from peripheral nodes.

Data received by the STM32 Nucleo from peripheral nodes are sent to the IBM Cloud Platform and can be remotely controlled by means of a cloud connected client at the URL shown during the Wi-Fi initialization phase on the serial console.
Wi-Fi IDW01M1- IBM Cloud vertical

End-to-end application to transmit sensors data to a cloud service based on IBM Bluemix, visualize them on a web page and receive commands back to Nucleo.

MQTT library running on Nucleo + TLS

Cube based

Nucleo + Wi-Fi + Sensor board

Telemetry, data visualization, alerts, rules etc.
STSSensNet app for Android/iOS

- After starting to receive data from peripheral nodes, the STM32 Nucleo, acting simultaneously as BLE Master and Slave, is able to accept connection from a BLE client (an Android/iOS device).
- After downloading and installing the STSSensNet app available both on the Google Store and on the Apple Store, the Android/iOS device can be used to locally monitor and control the BLE network.

Node ID
Temperature value in °C
Pressure value in mBar
LED status
Humidity value in %
BlueNRG Sensor Node

BlueNRG-MS low-power BLE connectivity with LED Driver

Key features

- Embedded BLE stack
- Supply voltage: from 1.7 to 3.6 V
- TX current: 8.2 mA (@0 dBm, 3.0 V)
- Sleep current: Down to 1.7 μA (with active BLE stack)
- Output Power: Up to +8 dBm
- Excellent RF link budget (up to 96 dB)
- Accurate RSSI to allow power control
- Full link controller and host security
- 32-bit based architecture core
- On-chip non-volatile Flash memory
- AES security co-processor
- Low power modes
BlueNRG Sensor Node

X-NUCLEO-IKS01A1: motion MEMS and environmental sensor evaluation board system

Key features
• All sensor sensors are connected on a single I²C bus
• Sensor I²C address selection
• Each sensor has separate power supply lines allowing power consumption measurement
• Sensor disconnection (disconnect the I²C bus as well as the power supply)
• Interrupt and DRDY signals from sensors
• DIL24 socket (Compatible to STEVAL-MKI***V MEMS adapter boards, i.e. STEVAL-MKI160V1)

Key Product on board
• LSM6DS0: MEMS 3D accelerometer
• LIS3MDL: MEMS 3D magnetometer
• LPS25HB: MEMS pressure sensor
• HTS221: humidity and temperature
BlueNRG Sensor Node

BlueNRG-MS low-power BLE connectivity with LED Driver

Key features
- Main Features
- Wide DC input voltage range: 8 V – 24 V
- Single channel LED Driver, 350 mA constant current
- PWM and analog brightness control with the STM32 Nucleo board
- Selectable boost or SEPIC converter topology
- Up to 92% efficiency (boost converter)
- Compatible with Arduino™ UNO R3 connectors
- Compatible with STM32 Nucleo boards

LED6001

PWM dimmable single channel LED driver with integrated boost controller

Connect Sense Motion sensor Environmental sensor

LED Driver

STM32 Nucleo

LED6001
Bluetooth Smart to WiFi Gateway

BlueNRG-MS low-power BLE and SPWF01S Wi-Fi module

Key features
- High efficiency Antenna on board and FCC, IC, CE certified
- ST low-power Wi-Fi bgn certified SoC
- Complete software IP stack making the module “cloud compatible”
- TLS and SSL to ensure end-to-end security
- REST API (HTTP Get and Post)
- Can operate as socket server and socket client
- WEB Server functionality
- Operates as a client STA, or miniAP; as a miniAP, the module features a very simple method to transfer SSID and PWD
- FW update Over The Air (FOTA)