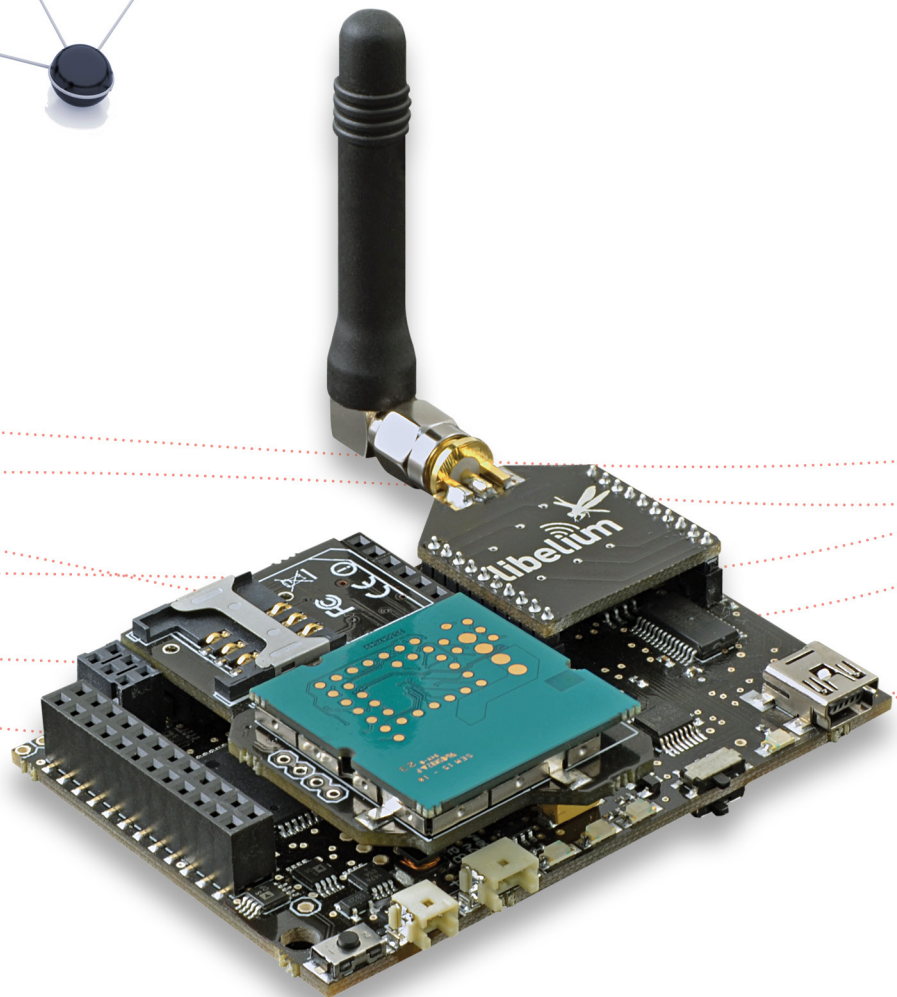
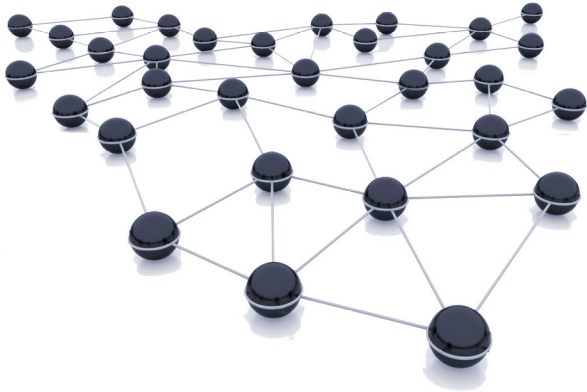


Wasp mote

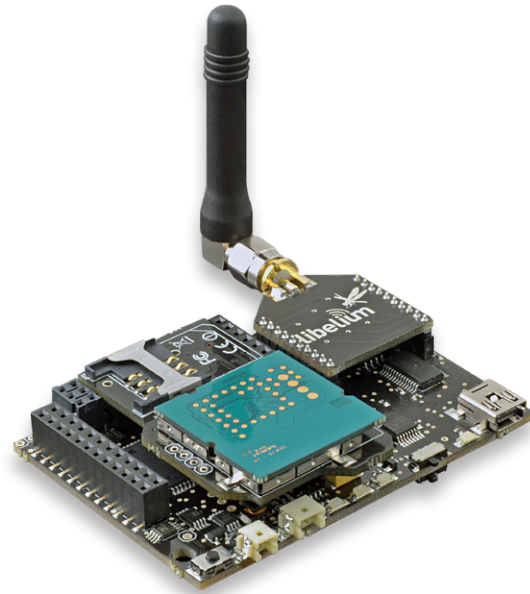
Datasheet



Waspote

General data:

Microcontroller:	ATmega1281
Frequency:	14.7456 MHz
SRAM:	8KB
EEPROM:	4KB
FLASH:	128KB
SD Card:	2GB
Weight:	20gr
Dimensions:	73.5 x 51 x 13 mm
Temperature Range:	[-10°C, +65°C]
Clock:	RTC (32KHz)



Consumption:

ON:	15mA
Sleep:	55µA
Deep Sleep:	55µA
Hibernate:	0.07µA

Operation without recharging: 1 year *

* Time obtained using the Hibernate mode as the energy saving mode

Inputs/Outputs:

7 Analog (I), 8 Digital (I/O), 1 PWM,
2 UART, 1 I2C, 1 USB, 1SPI

Electrical data:

Battery voltage:	3.3 V - 4.2V
USB charging:	5 V - 100mA
Solar panel charging:	6 - 12 V - 280mA

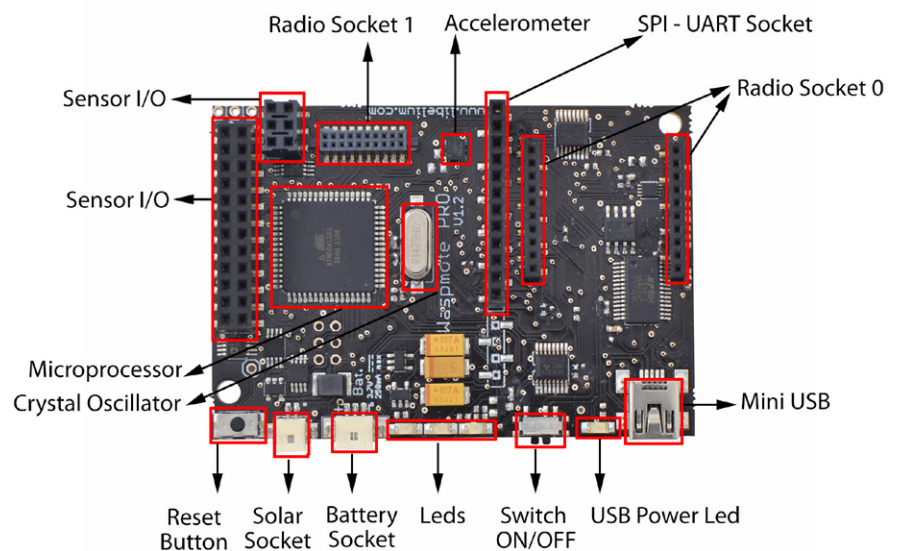


Figure 1: Waspote Board Top

Built-in sensors on the board:

Temperature (+/-): -40°C , +85°C. Accuracy: 0.25°C

Accelerometer: ±2g/±4g/±8g

Low power: 0.5 Hz/1 Hz/2 Hz/5 Hz/10 Hz

Normal mode: 50 Hz/100 Hz/400 Hz/1000 Hz

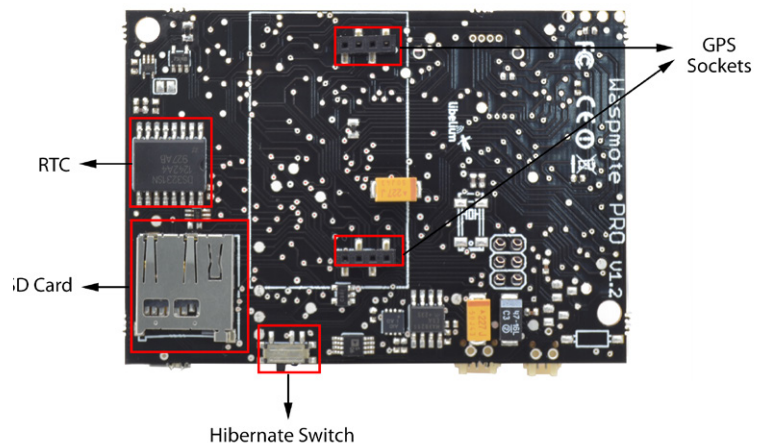


Figure 2: Waspote Board Bottom

802.15.4/ZigBee

Model	Protocol	Frequency	txPower	Sensitivity	Range *
XBee-802.15.4	802.15.4	2.4GHz	1mW	-92dB	500m
XBee-802.15.4-Pro	802.15.4	2.4GHz	100mW	-100dBm	7000m
XBee-ZB	ZigBee-Pro	2.4GHz	2mW	-96dBm	500m
XBee-ZB-Pro	ZigBee-Pro	2.4GHz	50mW	-102dBm	7000m
XBee-868	RF	868MHz	315mW	-112dBm	12km
XBee-900	RF	900MHz	50mW	-100dBm	10km

* Line of sight and Fresnel zone clearance with 5dBi dipole antenna



Figure 3: XBee

Antennas: 2.4GHz: 2dBi / 5dBi
868/900MHz: 0dBi / 4.5dBi

Connector: RPSMA

Encryption: AES 128b

Control Signal: RSSI

Standards: XBee-802.15.4 - 802.15.4 Compliant / XBee-ZB - ZigBee-Pro v2007 Compliant

Topologies: star, tree, mesh

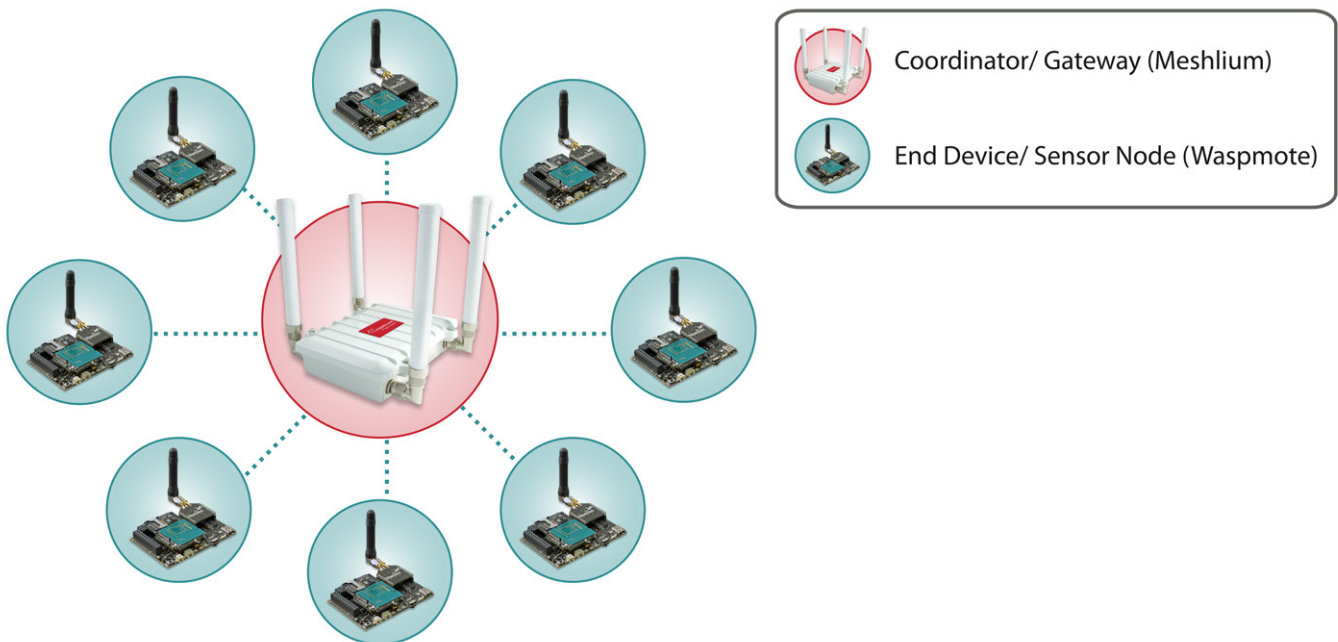


Figure 4: Star

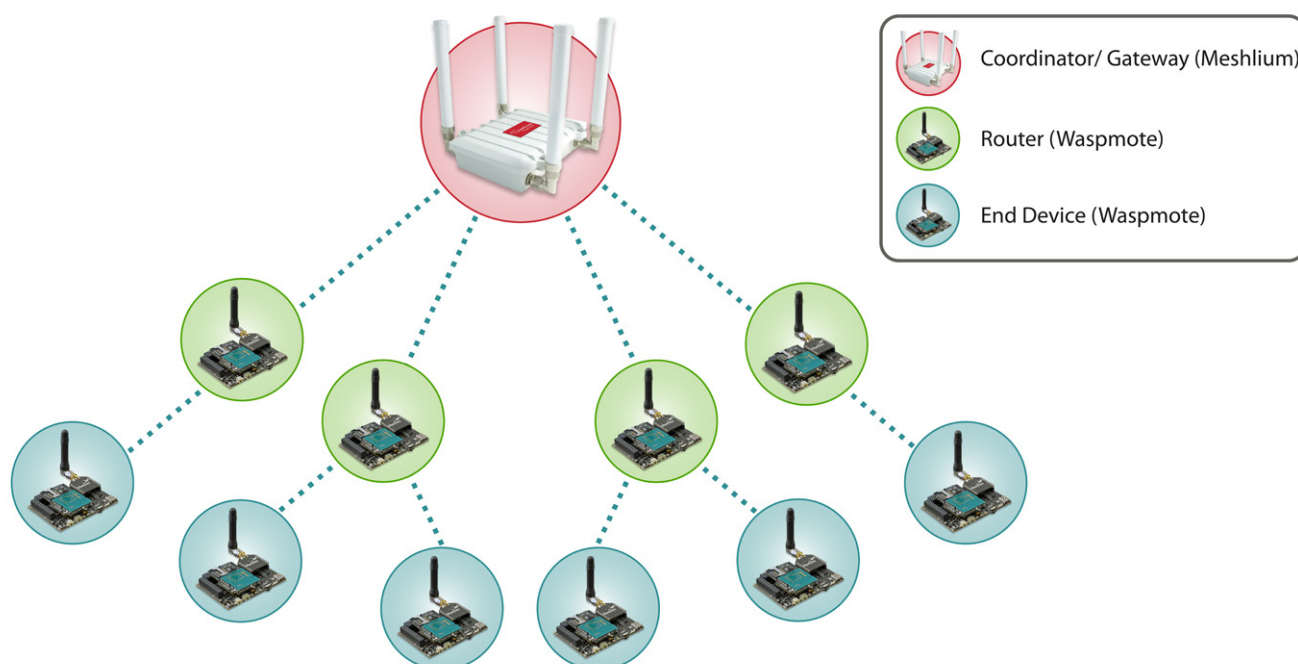


Figure 5: Tree

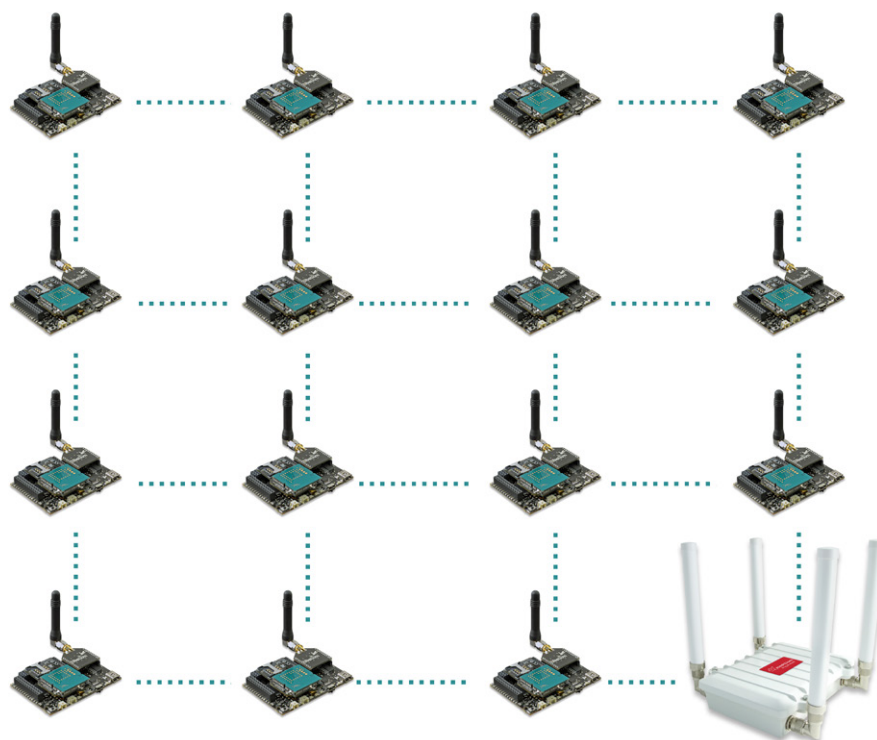


Figure 6: Mesh

Over the Air Programming (OTA)

There are two different OTA methodologies:

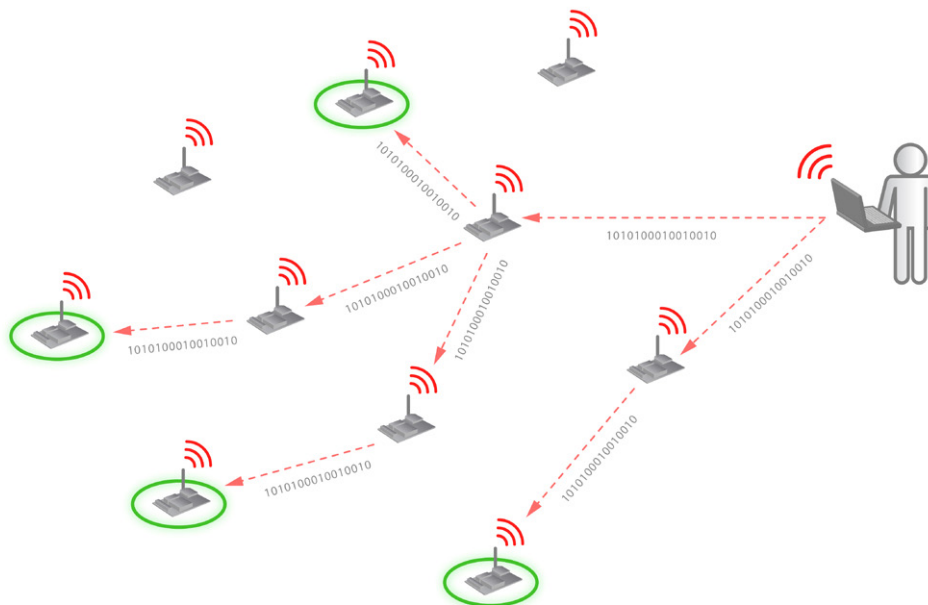
- OTA with 802.15.4/ZigBee modules
- OTA with 3G/GPRS/WiFi modules via FTP

OTA with 802.15.4/ZigBee modules

Benefits:

- Enables the upgrade or change of firmware versions without physical access
- Discover nodes in the area just sending a broadcast discovery query
- Upload new firmware in few minutes
- No interferences: OTA is performed using a change of channel between the programmer and the desired node so no interferences are generated to the rest of the nodes

Over The Air Programming with 802.15.4 / ZigBee



Topologies:

- Direct access: when the nodes are accessed in just one hop (no forwarding of the packets is needed).
- Multihop: when the nodes are accessed in two or more hops. In this mode some nodes have to forward the packets sent by the Gateway in order to reach the destination.

Modes:

- Unicast: Reprogram an specific node
- Multicast: Reprogram several nodes at the same time sending the program just once
- Broadcast: Reprogram the entire network sending the program just once

OTA with 3G/GPRS/WiFi modules via FTP

Benefits:

- Enables the upgrade or change of firmware versions without physical access.
- Upgrades the new firmware by querying a FTP server which helps to keep battery life.
- Upload new firmware in few minutes.

Topologies:

- Protocols which support FTP transmissions are directly connected to the Network Access Point.

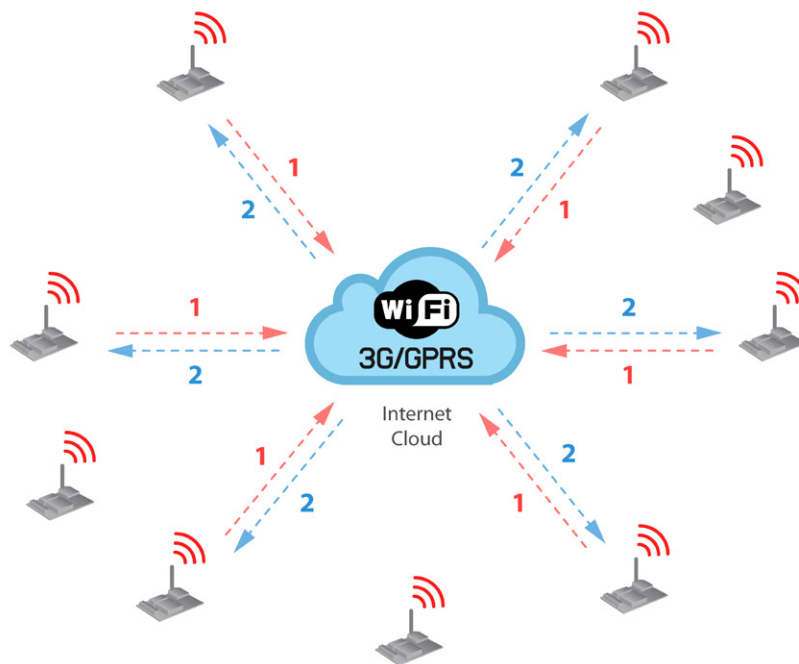


Figure 7: OTA with GPRS/3G/WiFi fundamentals

Encryption Libraries

The new Encryption Libraries are designed to add to the Waspote sensor platform the capabilities necessary to protect the information gathered by the sensors. To do so three cryptography layers are defined:

1°- In the first one all the nodes of the network share a common **presared key** which is used to encrypt the information using **AES 128**. This process is carried out by specific hardware integrated in the same 802.15.4/ZigBee radio, allowing the maximum efficiency of the sensor nodes energy consumption. This first security layer ensures no third party devices will be able to even connect to the network (access control).

2°- In the second security layer each node uses a point to point encryption scheme with Meshlium -the Gateway of the network-. This way even the intermediate nodes of the network (the ones which forward the information to the destination) will not be able to see the sensor data transmitted. To perform this technique each node interchanges with the Gateway a new encryption key using **RSA 1024 (Public/Private keys)** what ensures at the same time authentication and integrity. Once the key has been confidentially interchanged the rest of the communication is encrypted by using **AES 256** via software as it ensures complete confidentiality and privacy while maintaining the minimum resources of the node in term of computing cicles and energy consumption.

The "point to point" encryption key is cyclically changed using again RSA encryption in a process know as **key renewal**.

3°- The third security technique is carried out in Meshlium -the Gateway- where **HTTPS** and **SSH** connections are used to send the information to the Cloud server located on the Internet.

A fourth optional encryption layer allows each node to encrypt the information using the Public key of the Cloud server. This way the information would keep confidential all the way from the sensor device to the web or data base server on the Internet.

The two main cases of the usage of the Encryption Libraries for Waspote are:

- Transmission of sensor data
- Key initial sharing and key renewal

Transmission of sensor data:

Information is encrypted in the application layer via software with **AES 256** using the key shared exclusively between the origin and the destination. Then the packet is encrypted again in the link layer via hardware with **AES 128** so that only trusted packets be forwarded, ensuring access control and improving the usage of resources of the network.

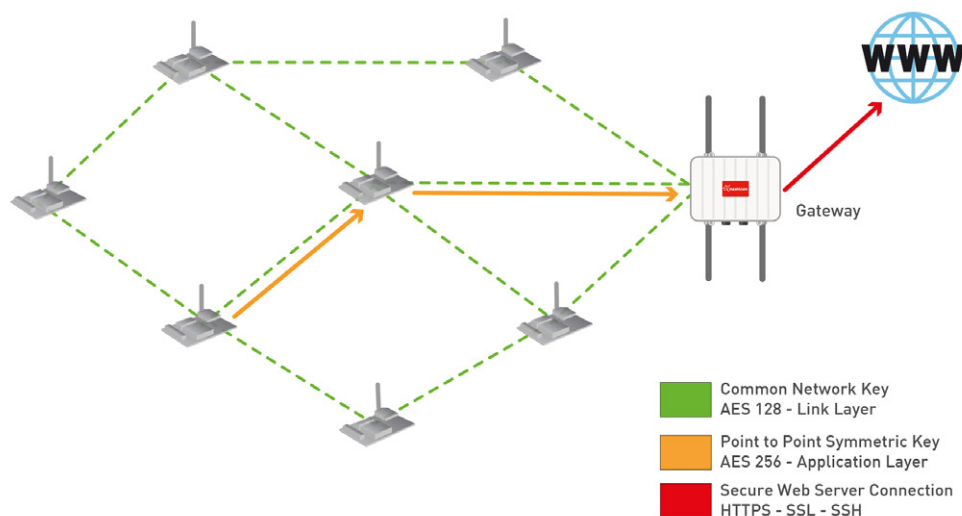


Figure 8: Communication diagram

Key sharing and key renewal

Prior to start with the software encryption with AES 256 we need to share a key between each node (origin) and the Gateway or the Cloud Server (destination). To do so we encrypt the new key using **RSA 1024** using both **Public/Private** keys. This way, we ensure authentication, confidentiality and message integrity (as we add also a seed along with the key to generate randomness in the packet transmission). Once we get the shared key we will use it to start encrypting the sensor information as seen in the previous diagram as **AES** it ensures the maximum performance and minimum message overload.

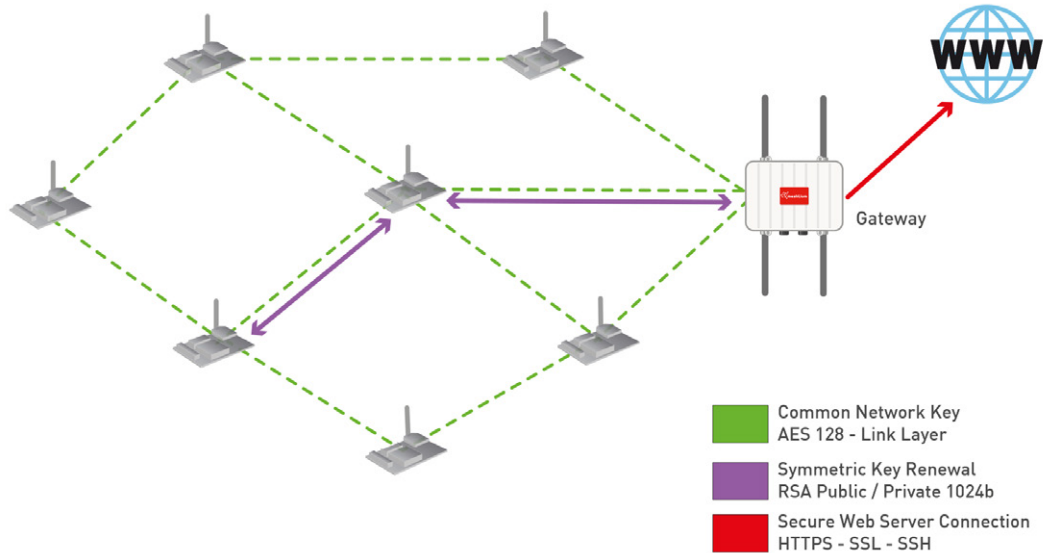


Figure 9: Symetric key renewal diagram

WiFi

Protocols: 802.11b/g - 2.4GHz

TX Power: 0dBm - 12dBm (variable by software)

RX Sensitivity: -83dBm

Antenna connector: RPSMA

Antenna: 2dBi/5dBi antenna options

Security: WEP, WPA, WPA2

Topologies: AP and Adhoc

802.11 roaming capabilities

Actions:

- TCP/IP - UDP/IP socket connections
- HTTP and HTTPS (secure) web connections
- FTP and FTPS (secure) file transfers
- Direct connections with iPhone and Android
- Connects with any standard WiFi router
- DHCP for automatic IP assignation
- DNS resolution enabled



Figure 10: WiFi Module

GSM/GPRS

Model: SIM900 (SIMCom)

Quadband: 850MHz/900MHz/1800MHz/1900MHz

TX Power: 2W(Class 4) 850MHz/900MHz, 1W(Class 1) 1800MHz/1900MHz

Sensitivity: -109dBm

Antenna connector: UFL

External Antenna: 0dBi

Consumption in sleep mode: 1mA

Consumption in power off mode: 0mA

Actions:

- Making/Receiving calls
- Making 'x' tone missed calls
- Sending/Receiving SMS
- Single connection and multiple connections TCP/IP and UDP/IP clients
- TCP/IP server
- HTTP Service
- FTP Service (downloading and uploading files)

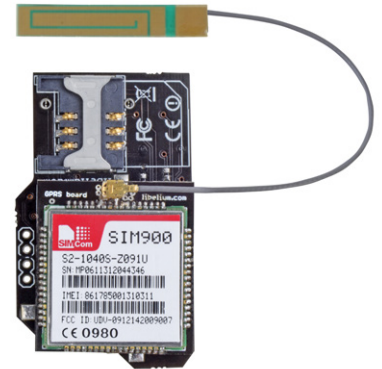


Figure 11: GSM/GPRS

3G + GPS module

Model: SIM5218E (SIMCom)

Tri-Band UMTS 2100/1900/900MHz

Quad-Band GSM/EDGE, 850/900/1800/1900 MHz

HSDPA up to 7.2Mbps

HSUPA up to 5.76Mbps

TX Power:

- UMTS 900/1900/2100 0,25W
- GSM 850MHz/900MHz 2W
- DCS1800MHz/PCS1900MHz 1W

Sensitivity: -106dBm

Antenna connector: UFL

External Antenna: 0dBi

Consumption in sleep mode (RF circuits power off previously): 1mA

Actions:

- WCDMA and HSPA 3G networks compatibility
- Videocall using 3G network available with Video Camera Sensor Board
- Record video (res. 320 x 240) and take pictures (res. 640 x 480) available with Video Camera Sensor Board
- Support microSD card up to 32GB
- 64MB of internal storage space
- Making/Receiving calls
- Making 'x' tone missed calls
- MS-assisted (A-GPS), MS-based (S-GPS) or Stand-alone GPS positioning
- Sending/Receiving SMS
- Single connection and multiple connections TCP/IP and UDP/IP clients
- TCP/IP server.
- HTTP and HTTPS service
- FTP and FTPS Service (downloading and uploading files)
- Sending/receiving email (SMTP/POP3)

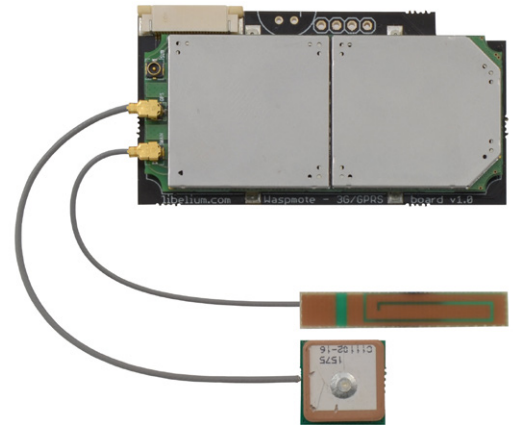


Figure 12: 3G/GPRS board

Bluetooth module for device discovery

Protocol: Bluetooth 2.1 + EDR. Class 2

TX Power: 3dBm

Antenna: 2dBi

Max Scan: Up to 250 unique devices in each inquiry

Power levels: 7 [-27dBm, +3dBm]

Application:

- Vehicular and pedestrian traffic monitoring

Features:

- Received Strength Signal Indicator (RSSI) for each scanned device
- Scan devices with maximum inquiry time
- Scan devices with maximum number of nodes
- Scan devices looking for a certain user by MAC address
- Class of Device (CoD) for each scanned device



Figure 13: Bluetooth module for device discovery

RFID/NFC

13.56MHz

- **Compatibility:** Reader/writer mode supporting ISO 14443A / MIFARE / FeliCaTM / NFCIP-1
- **Distance:** 5cm
- **Max capacity:** 4KB
- **Tags:** cards, keyrings, stickers

Applications:

- Located based services (LBS)
- Logistics (assets tracking, supply chain)
- Access management
- Electronic prepaid metering (vending machines, public transport)
- Smartphone interaction (NFCIP-1 protocol)

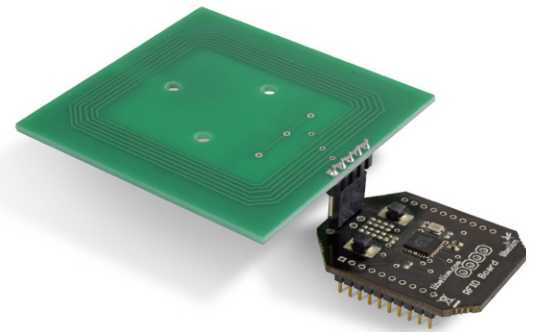


Figure 14: 13.56MHz RFID/NFC module

125KHz

- **Compatibility:** Reader/writer mode supporting ISO cards - T5557 / EM4102
- **Distance:** 5cm
- **Max capacity:** 20B
- **Tags available:** cards, keyrings

Applications:

- Located based services (LBS)
- Logistics (assets tracking, supply chain)
- Product management
- Animal farming identification

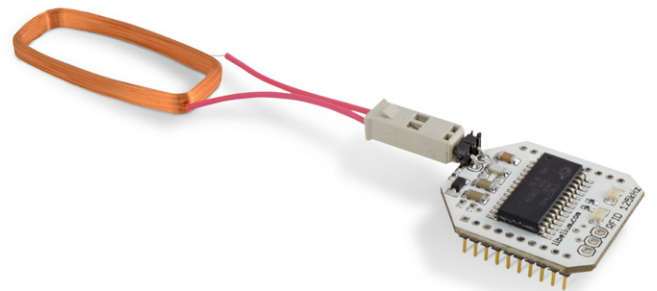


Figure 15: 125KHz RFID module



Figure 16: RFID cards



Figure 17: RFID keyrings



Figure 18: RFID sticker

Expansion Radio Board

The Expansion Radio Board allows to connect two radios at the same time. This means a lot of different combinations are now possible using any of the 10 radios available for Waspote: 802.15.4, ZigBee, Bluetooth, RFID, RFID/NFC, WiFi, GSM/GPRS, 3G/GPRS, 868 and 900.

Some of the possible combinations are:

- ZigBee - Bluetooth
- ZigBee - RFID
- ZigBee - WiFi
- ZigBee - GSM/GPRS
- Bluetooth - RFID
- RFID - 3G/GPRS
- etc

Remark: the GSM/GPRS module and the 3G/GPRS module do not need the Expansion Board to be connected to Waspote. It can be plugged directly in the GPRS socket.

Applications:

- Multifrequency Sensor Networks: (2.4GHz - 868/900MHz)
- Bluetooth - ZigBee hybrid networks
- NFC (RFID) applications with 3G/GPRS
- ZigBee - WiFi hybrid networks

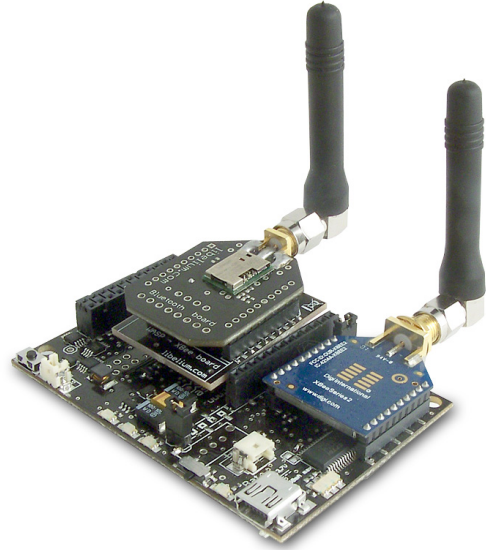


Figure 19: Expansion Radio Board

GPS

Model: JN3 (Telit)

Sensitivity :

- Acquisition: -147 dBm
- Navigation: -160 dBm
- Tracking: -163 dBm

Hot Start Time: <1s

Cold Start Time: <35s

Antenna connector: UFL

External antenna: 26dBi

Possitional accuracy error < 2.5 m

Speed accuracy < 0.01 m/s

EGNOS, WAAS, GAGAN and MSAS capability

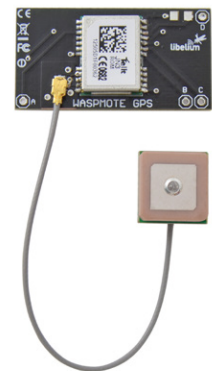


Figure 20: GPS

Available information: latitude, longitude, altitude, speed, direction, date/time and ephemerids management.

Programmable interruptions

- **Asynchronous**
 - Sensors (programmable threshold)
 - Accelerometer: Free-fall, impact (programmable threshold)
 - XBee (DigiMesh)
- **Synchronous:**
 - Watchdog: programmable alarms: from 32ms to 8s
 - RTC: programmable alarms: from 1s to days

Sensor Boards

GASES



Figure 21: Gases Board

APPLICATIONS

- **City pollution**
CO, CO₂, NO₂, O₃
- **Emissions from farms and hatcheries**
CH₄, H₂S, NH₃
- **Control of chemical and industrial processes**
C₄H₁₀, H₂, VOC
- **Forest fires**
CO, CO₂

SENSORS

- Carbon Monoxide – CO
- Carbon Dioxide – CO₂
- Oxygen – O₂
- Methane – CH₄
- Hydrogen – H₂
- Ammonia – NH₃
- Isobutane – C₄H₁₀
- Ethanol – CH₃CH₂OH
- Toluene – C₆H₅CH₃
- Hydrogen Sulfide – H₂S
- Nitrogen Dioxide – NO₂
- Ozone – O₃
- Hydrocarbons – VOC
- Temperature
- Humidity
- Atmospheric pressure

EVENTS



Figure 22: Events Board

APPLICATIONS

- **Security**
Hall effect (doors and windows), person detection PIR
- **Emergencies**
Presence detection and water level sensors, temperature
- **Control of goods in logistics**

SENSORS

- Pressure/Weight
- Bend
- Hall Effect
- Temperature (+/-)
- Liquid Presence
- Liquid Flow
- Luminosity
- Presence (PIR)
- Stretch

SMART CITIES

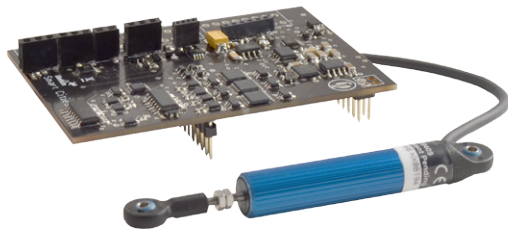


Figure 23: Smart Cities Board

APPLICATIONS

- **Noise maps**
Monitor in real time the acoustic levels in the streets of a city
- **Structural health monitoring**
Crack detection and propagation
- **Air quality**
Detect the level of particulates and dust in the air
- **Waste management**
Measure the garbage levels in bins to optimize the trash collection routes

SENSORS

- Microphone (dBSPLA)
- Crack detection gauge
- Crack propagation gauge
- Linear displacement
- Dust - PM-10
- Ultrasound (distance measurement)
- Temperature
- Humidity
- Luminosity

SMART PARKING

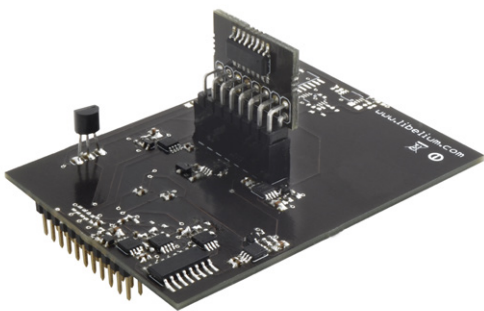


Figure 24: Smart Parking Board

APPLICATIONS

- Car detection for available parking information
- Detection of free parking lots outdoors
- Parallel and perpendicular parking slots control

SENSORS

- Magnetic Field
- Temperature

AGRICULTURE

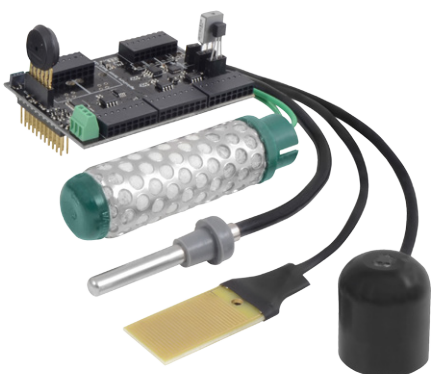


Figure 25: Agriculture Board

APPLICATIONS

- **Precision Agriculture**
Leaf wetness, fruit diameter
- **Irrigation Systems**
Soil moisture, leaf wetness
- **Greenhouses**
Solar radiation, humidity, temperature
- **Weather Stations**
Anemometer, wind vane, pluviometer

SENSORS

- Air Temperature / Humidity
- Soil Temperature / Moisture
- Leaf Wetness
- Atmospheric Pressure
- Solar Radiation - PAR
- Ultraviolet Radiation - UV
- Trunk Diameter
- Stem Diameter
- Fruit Diameter
- Anemometer
- Wind Vane
- Pluviometer
- Luminosity

VIDEO CAMERA



Figure 26: Video Camera Sensor Board

APPLICATIONS

- Security and surveillance
- Take photos (640 x 380)
- Record video (320 x 240)
- Realtime Videocall using 3G network
- Night Vision mode available

SENSORS

- Image sensor
- Luminosity
- Infrared
- Presence (PIR)

RADIATION



Figure 27: Radiation Board

APPLICATIONS

- Monitor the radiation levels wirelessly without comprising the life of the security forces
- Create prevention and control radiation networks in the surroundings of a nuclear plant
- Measure the amount of Beta and Gamma radiation in specific areas autonomously

SENSORS

- Geiger tube [β , γ] (Beta and Gamma)

SMART METERING



Figure 28: Smart Metering Board

APPLICATIONS

- Energy measurement
- Water consumption
- Pipe leakage detection
- Liquid storage management
- Tanks and silos level control
- Supplies control in manufacturing
- Industrial Automation
- Agricultural Irrigation

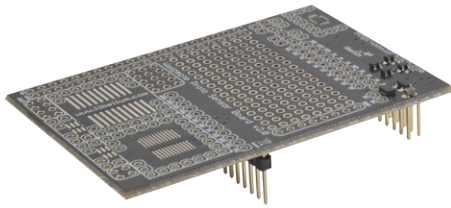
SENSORS

- Current
- Water flow
- Liquid level
- Load cell
- Ultrasound
- Distance Foil
- Temperature
- Humidity
- Luminosity

PROTOTYPING SENSOR

APPLICATIONS

SENSORS



- Prepared for the **integration of any kind of sensor.**

- Pad Area
- Integrated Circuit Area
- Analog-to-Digital Converter (16b)

Figure 29: Prototyping Sensor Board

Power supplies

- 1150mA/2300mA/6600mA Li-Ion rechargeable // 13000mAH **non - rechargeable**
- Solar Panel: rigid (7V – 500mA) and flexible (7.2V – 100mA)
- USB (220V-USB, car lighter USB)

USB-PC interface

Model: Waspote Gateway *

Communication: 802.15.4/ZigBee - USB PC

Programmable buttons and leds

**Included in the developers Kit*

Compiler:

- IDE-Waspote (open source)
- Language: C++
- Versions Windows, Linux and Mac-OS



Figure 30: Waspote Gateway

Wasmote vs Wasmote Plug & Sense!

Wasmote is the original line in which developers have a total control over the hardware device. You can physically access to the board and connect new sensors or even embed it in your own products as an electronic sensor device.

The new Wasmote Plug & Sense! line allows developers to forget about electronics and focus on services and applications. Now you can deploy wireless sensor networks in an easy and scalable way ensuring minimum maintenance costs. The new platform consists of a robust waterproof enclosure with specific external sockets to connect the sensors, the solar panel, the antenna and even the USB cable in order to reprogram the node. It has been specially designed to be scalable, easy to deploy and maintain.



Figure 31: Wasmote



Figure 32: Wasmote Plug & Sense!

For more information about Wasmote Plug & Sense! go to:

http://www.libelium.com/plug_&_sense

Certifications

- CE (Europe)
- FCC (USA)
- IC (Canada)

