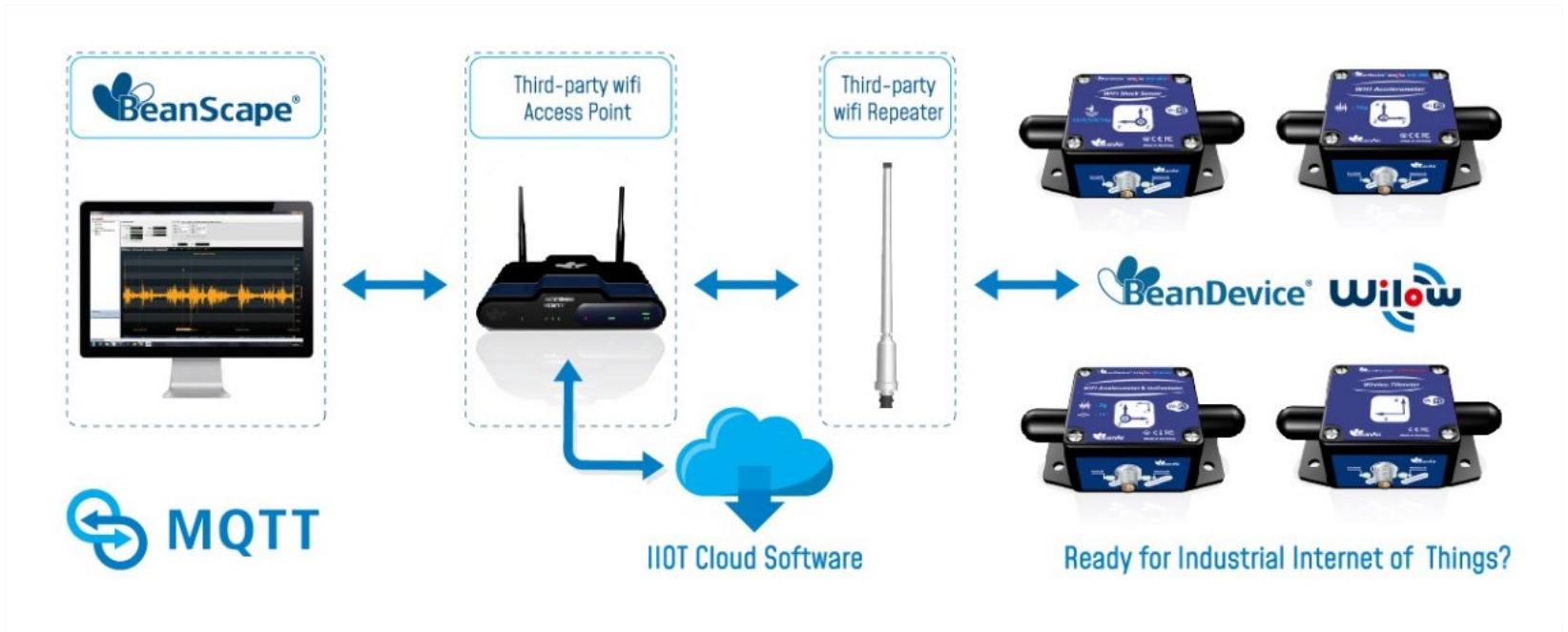




*Ready for Industrial Internet of Things ?*



## *WiLow (Wifi Low Power) Sensor Series presentation*

*October 2020 – Version V1.7*



*Beanair® GmbH, Wolfener Straße 32 - 34  
12681 Berlin - Germany*

*Mathias Grueman, Beanair GmbH*



## • *Protocol*

- Built on the IEEE 802.11 standard
- A vibrant standard and industry alliance of close to 300 members
- Conformance testing performed by the non-profit Wi-Fi Alliance (formed in 1999)
- A huge installed base of over 2 billion Wi-Fi-certified devices;



## • *Consumer Wi-Fi Growth (2009 - 2019)*

- +198% growth in Wi-Fi enabled consumer electronics
- +190% cell phones
- +78% laptops
- +45% Wi-Fi connected 3-D TVs



## • *Embedded Systems*

- Evangelizes on huge hotspot availability
- Provides data with ultra-low cost transport





# IEEE 802.11 network standards & amendments

| <i>IEEE 802.11 protocol</i> | <i>Release</i> | <i>Freq. (GHz)</i> | <i>Data Rate (Mbit/s)</i> | <i>Modulation</i> | <i>Approximate indoor range (m)</i> | <i>Approximate outdoor range (m)</i> |
|-----------------------------|----------------|--------------------|---------------------------|-------------------|-------------------------------------|--------------------------------------|
| <i>a</i>                    | Sept 1999      | 5                  | 6 to 54                   | OFDM              | 20                                  | 120                                  |
|                             |                | 3.7                |                           |                   | /                                   | 5000                                 |
| <i>b</i>                    | Sept 1999      | 2.4                | 1 to 11                   | DSSS              | 40                                  | 170                                  |
| <i>g</i>                    | June 2003      | 2.4                | 6 to 54                   | OFDM, DSSS        | 38                                  | 140                                  |
| <i>n</i>                    | Oct. 2009      | 2.4/5              | 600 max                   | OFDM              | 70                                  | 250                                  |
| <i>ac</i>                   | Nov.2011       | 5                  | up to 866                 |                   | 70                                  | 250                                  |

## Amendments

- **IEEE 802.11i-2004:** security mechanisms implemented as WPA2
- **IEEE 802.11e -2005:** Quality of service
- **IEEE 802.11s - 2011:** Mesh Networking

## In process:

- **IEEE 802.11ah :** Sub 1 GHz sensor network, smart metering (May 2015)



| Main Features                        | Conventional WIFI  | ULP WIFI                        |
|--------------------------------------|--------------------|---------------------------------|
| Radio TX                             | 280-350 mA(+12dBm) | 120 mA (+0dBm) , 190mA (+12dBm) |
| Radio RX                             | 75 mA              | 38 mA                           |
| Data Processing                      | 65 mA              | < 15 mA                         |
| Receive Sensitivity                  | -91 dBm            | -97dBm @ 1Mbps                  |
| Battery saver Mode                   | N.A.*              | 300 uA                          |
| Bandwidth                            | 108 Mbps           | 1-16 Mbps                       |
| Max Output power                     | + 22 dBm           | +18 dBm                         |
| Time to wake from battery saver mode | N.A.*              | 2.5 ms                          |

**\* Not applicable : comparable state does not exist**

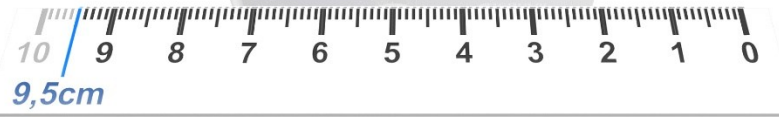
- ✓ **Ultra Low Power Wifi utilizes IEEE 802.11b/g/n standard**
- ✓ **Lower power and longer range using 802.11b**



Vibration and Velocity  $\pm 2g$  &  $\pm 10g$



Vibration and Shock/impact detection  $\pm 2/4/8/16g$





Inclinometer  $\pm 15^\circ$  or  $\pm 30^\circ$

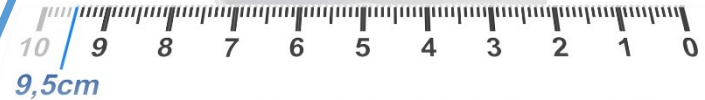


Inclinometer  $\pm 15^\circ$  or  $\pm 30^\circ$



Vibration  $\pm 2g$  &  $\pm 10g$

Vibration and Shock/impact detection  $\pm 2/4/8/16g$



First combo sensors on the market integrating both Vibration, Inclinometer and Shock sensors

Great Inclination Repeatability:  $\pm 0.003^\circ$  Full Scale @  $25^\circ$





## Outstanding features



ULP (Ultra Low Power) Wifi technology - IEEE 802.11 b/g/n



USB 2.0 for device configuration (including firmware update)



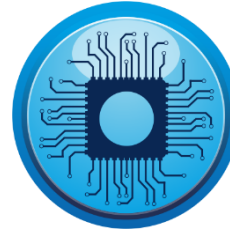
Store & Forward+ : lossless data transmission with hard real-time



Rugged aluminum casing  
Waterproof IP67 | NEMA 6



SSD (Smart Shock Detection), WILO<sup>®</sup> sensor can wakeup on a shock detection (software configurable)



Embedded data logger: up to 5 million data points (with event dating)



Smart and flexible power supply, compatible with USB and Solar power sources



Excellent radio link relying on the radio antenna diversity designed by Beanair<sup>®</sup>



Over the Air firmware upgrade via WIFI

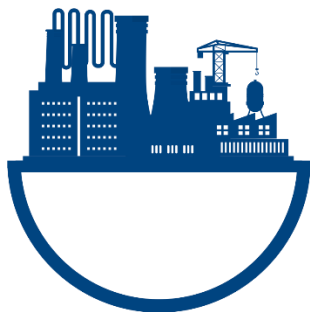
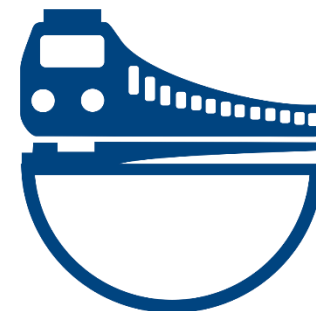


Precision Time Protocol over WIFI Network (  $\pm 30$ ms of precision )



## Structural Health Monitoring

## Test & Measurement



## Ground vibration monitoring





# Wifi - Peer-to-peer communication link



WIFI Link





# Wifi star network

Wifi Access Point or  
Wifi Router



WIFI Link



BeanDevice® Wilow



BeanDevice® Wilow



BeanDevice® Wilow



BeanDevice® Wilow



BeanScape® Wilow  
BASIC



# Wifi Cluster-Tree network

Wifi Extender

Wifi Extender

WIFI Link

WIFI Link

Wifi Access Point or  
Wifi Router



BeanDevice® Wilow

BeanDevice® Wilow

BeanDevice® Wilow

BeanDevice® Wilow



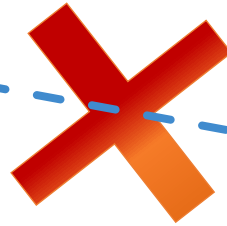
For more information about WIFI Bridging: [Click here](#)



# Store and Forward+ : Lossless data transmission mechanism



*Wireless link is broken*



*The BeanDevice® WiLow® records automatically all the current measurements on the on-board flash IC*



*Wireless link is restored*

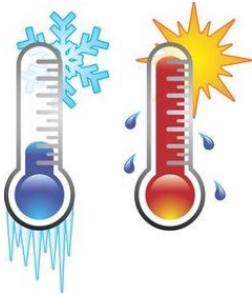
*The BeanDevice® WiLow® transmits automatically all the recorded measurements to the Wifi Access Point*





## Internal Battery : 750 mAh

Lithium-Polymer battery



Extended operating temperature: -40°C up to 60°C

## USB 5VDC power source

User can connect it to any kind of USB Powerbank



## Option for Energy Harvesting power source

Easy connection to any kind of energy harvesting power source

Compatible with small solar panel from 5VDC to 17VDC, no need an external solar power manager





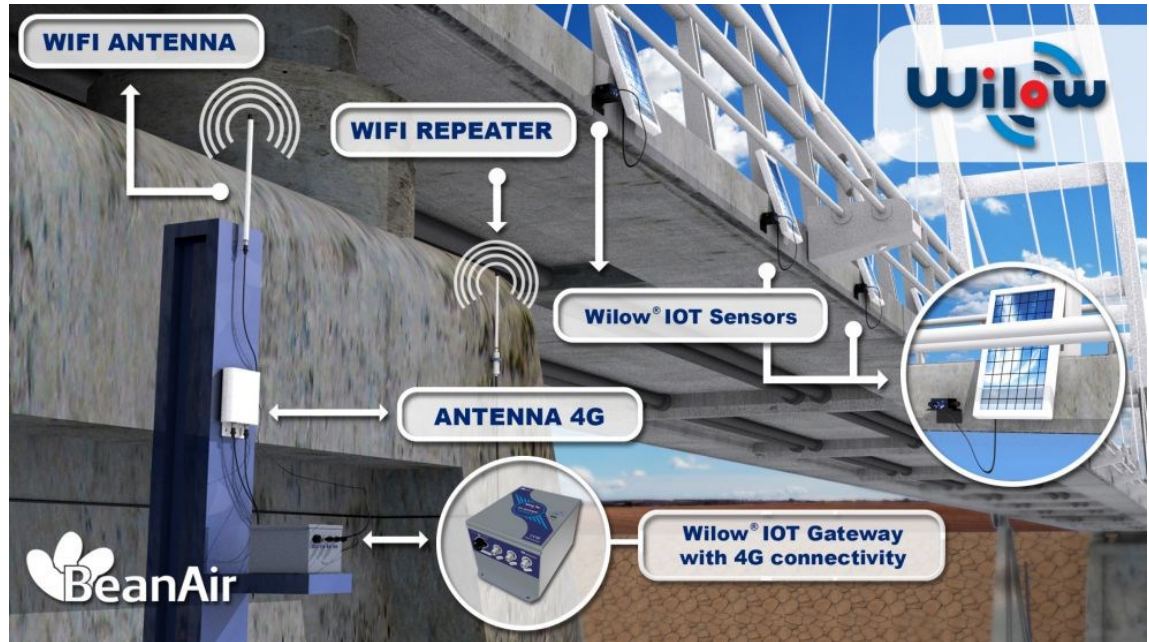
# How to enable a remote access on Monitoring site (1/2) ?



The **Wilow® IOT Gateway** supports both WIFI and 3G/4G/LTE wireless protocols and allows a very easy connection to our Wilow® IOT sensors.

Thanks to WDS (Wireless Distribution System) function, a wireless bridging with other WIFI Bridges/Repeaters can be configured for a better wireless network coverage.

- Consult our dedicated webpage for dedicated to : [click here](#)







# How to enable a remote access on Monitoring site (2/2) ?

**Internet**



**3G/4G Network**



**Monitoring site**

**Wilow® IOT Gateway**

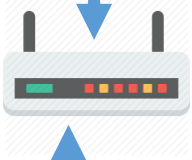


**3G/4G connection**

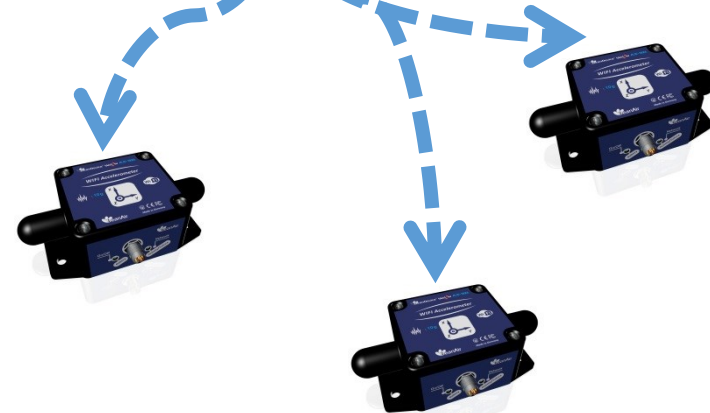


**End-user Office**

**ADSL/4G Modem**



**LAN or WIFI Connection**



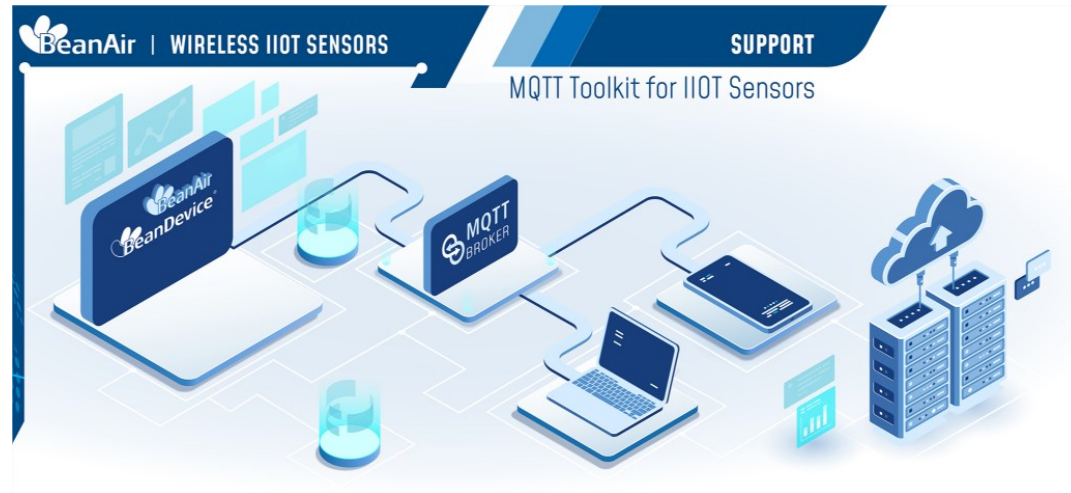
**Wilow® sensors**





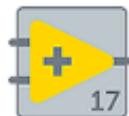
Ready for Industrial IOT (Internet of things) applications, the Beandevic<sup>®</sup> Wilow<sup>®</sup> integrates MQTT (Message Queuing Telemetry Transport) data frame, a lightweight and open-source (OASIS & ISO/IEC 20922:2016 standards) Internet of Things protocol.

MQTT is based on publish/subscribe paradigm, therefore user can easily connect, configure and manage several Wilow devices at the same time from a unique IOT software.



For more information about our MQTT Toolkit: [Click here](#)

Source codes are available for free in C#, Android, NodeRed, Python and Labview:



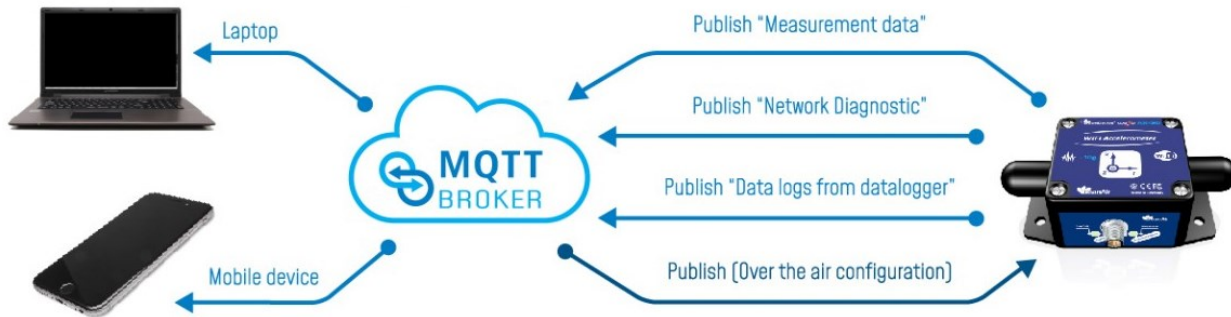


## How is that working ?

The Beandevic<sup>®</sup> Wilow<sup>®</sup> is hosting both a Publisher (Data Acquisition, Network Diagnostic) and a Subscriber (Over the air firmware upgrade, Over the air configuration). MQTT Broker will play an important role in data exchange:

Should the connection from a subscribing client (Laptop or Mobile device) to the broker get broken, the broker will buffer messages and push them out to the subscriber when it is back online.

Should the connection from the publishing client (BeanDevice<sup>®</sup> Wilow<sup>®</sup>) to the broker be disconnected without notice, the broker can close the connection and send subscribers a cached message with instructions from the publisher.



Read our technical note about MQTT communication protocol : [Click here](#)

Download our examples of MQTT for Android/NodeRed/C#: [Click here](#)

Read our User Guide about how to use our MQTT Toolkit built with C#: [Click here](#)

Read our Guideline about how to use our MQTT Toolkit built with NodeRed : [Click here](#)

Read our SSL TLS Encryption over MQTT for Wireless IOT Sensors: [Click here](#)

Read our MQTTT to FTP user guide: [Click here](#)





| Features                   | ULP WIFI  | BLE ( Bluetooth Low Energy)                                |
|----------------------------|---|--|
| Wireless range             | 200 meters , wireless range can be extended by adding a Wifi Bridge/Extender  | 100 meters<br>No Bluetooth wireless extender on the market |
| Low Power                  | ✓ ✓   | ✓ ✓ ✓ ✓  |
| Integration with IT system | PLC, Wifi Access Point, Smartphone, PC  | Smartphone and PC only                                     |
| Network architecture       | Peer-to-Peer, Star Network & Cluster Tree Network                             | Peer-to-Peer & Star network                                |
| Data rate                  | Up to 16 Mbits/s , compatible with dynamic measurement (vibration & acoustic) | Up to 1 Mbits/s  |
| Markets                    | Industrial applications   | Medical device   |

**Conclusion: BLE is more adapted for medical devices and doesn't allow to setup a real wireless IOT infrastructure**

**ULP Wifi is more adapted for industrial IOT**



# ULP WIFI VS LONG RANGE WIRELESS NETWORK






| Features                   | ULP WIFI  | LORA or SIGFOX  |
|----------------------------|---|---|
| Wireless range             | 200 meters , wireless range can be extended by adding a Wifi Extender   | 10 Km   |
| Low Power                  |   |   |
| Integration with IT system | <br>PLC, Wifi Access Point, Smartphone, PC | <br>No |
| Network architecture       | Peer-to-Peer, Star network & Cluster tree network   | Peer-to-Peer & Star network   |
| Data rate                  | Up to 16 Mbits/s, compatible <b>with dynamic measurement (vibration, Velocity &amp; acoustic)</b>                           | Up to 1-2 Kbits – not dedicated to dynamic measurement                                    |
| Markets                    | Industrial applications   | Metropolitan Network deployment   |

**Conclusion:** Long Range wireless sensor networks is more adapted for static measurement (tilt, crack, temperature) although ULP Wifi is more adapted for dynamic measurement (vibration, deformation, acoustic).



| Industrial Device               | Comments  |
|---------------------------------|---|
| PLC & DAQ system                | 92% of industrial PLC integrate a Wifi access point       |
| Wifi Access Point & Wifi Router | More than 300 providers of wifi access point & Router     |
| Smartphone                      | 100 % of Smartphone on the markets integrate Wifi a/b/g/n |
| PC                              | 100 % of PC on the markets integrate Wifi a/b/g/n         |
| Wifi Extender                   | More than 150 providers of Wifi Extender                  |



|  |                        |    |
|--|--|---|
| Wireless range in Line-of- Sight (L.O.S.) and Non Line-of-Sight (NLOS) | 200 m in L.O.S.<br>20-50 m in N.L.O.S.<br>Wireless range can be extended by adding WIFI bridge/repeaters | 500 m in L.O.S.<br>30-100 m in N.L.O.S  |
| Wireless Technology  | IEEE 802.11 b/g/n @2.4GHz  | 2.4GHz wireless based on IEEE 802.15.4E   |
| Open Standard or proprietary protocol                                  | Open-Standard protocol   | Proprietary Protocol  |
| Need a specific Wireless Network Coordinator ( Gateway ) ?             | NO   | YES   |
| Low Power  |                        |    |
| Aggregation capacity   |                        |    |
| Available sensors/DAQ  | Vibration & Peak Particle Velocity, shock, Inclinometer  | temperature, IR temperature, humidity, dew point, Vibration & Peak Particle Velocity, shock, inclinometer, analog DAQ (4-20mA, ±20 mV, ±5V, ±10V) |
| IIOT Ready (MQTT protocol)   | YES. Free source codes available in C#, Labview, Android and NodeRed                                     | NO  |
| Energy Harvesting ( Solar power supply )                               | YES  | NO  |
| USB Link   | USB 2.0  | NO  |
| USB power supply   | YES  | NO  |
| Easy Firmware update   | USB and Wifi   | NO  |
| Store and Forward+   | YES  | NO  |
| Clock- synchronization   | ±30 ms   | ±2.5 ms   |
| Encryption on Wireless Link  | WEP, WAP, WAP2   | NO  |
| Wakeup function  | Timer and Shock detection  | Timer   |





**Rethinking Sensing Technology**



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