“IoT” and the “microSP” Technology

How to design “Billions” of Wireless Sensors

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Abstract

Billions of connected devices will be operational in the coming years. Much of these billions will be simple, cost-effective monodirectional wireless transmitters that can send sensor or alarm measurements and will be used in small cells. They will have to transmit the status in life (hearthbeat) and measures or alarms 24/24 for many, many years (> 20 years) without battery replacement. The "MicroSP" pulse transmission technology on the "Unlicensed" bands (ISM or SRD) is the best solution for most of these "IoT" applications.

“microSP” Technology
A new RF standard specifically devoted to “IoT” Wireless Sensors

The “IoT” Networks of wireless sensors (WSN)

"IoT" is a very broad and very diversified technology sector.
And we're talking only about "wireless" applications and in any case there are thousands of different applications. And a great proliferation of RF Standards and Communication "Protocols". I will not be here to repeat what has already been widely reported in countless "white papers", "Application Notes", etc. All documents ranging from very sophisticated applications of industrial telemetry, medical telemetry, etc. up to simpler applications and used in areas of limited extension such as private houses, offices, warehouses, but also industries or entire buildings.

The subtitle of this White-paper refers to "Billions". In practice and based on the experience accumulated over years of studies on Radio Frequency and on the realization of innumerable categories of wireless sensors, I can safely say that most of these "Billions" will be mono-directional wireless devices, of low cost, easy to install and above all with a very long life, possibly over 20 years, without battery replacement. particularly wireless communications that use "unlicensed" frequencies.
To achieve these goals, these devices will operate on sub-GHz and "Unlicensed" frequency bands

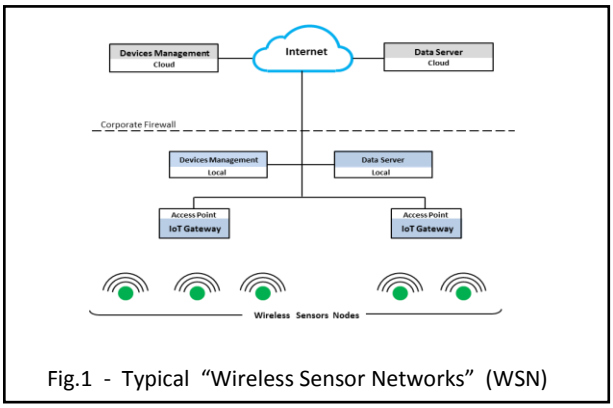


Fig.1 - Typical “Wireless Sensor Networks” (WSN)

General considerations on the “Billions”

(1) Many systems can be used to transmit data from a remote wireless sensor.
For example the cellular communication network: GPRS modem or now the NB-IoT which are systems operating on "Licensed" frequencies managed by the MNO (Mobile Network Operator). Surely the NB-IoT will take a big part in the market, but it seems unlikely that a simple on/off switch (just to give an example) that only needs to alert if a door in a cellar is closed or open needs to pass through a cellular network : there are obvious problems with energy and cost per bit. With more serious implications of "Privacy" and "Security".

(2) Wireless standards such as WiFi and Bluetooth, "ICT" systems designed for "Information Technology" applications, can be used in wireless sensor networks (WSN). But they suffer, when used for the "IoT" application, from two main problems: **(1)** problem of "coexistence" and **(2)** problem of "energy", that is excessive current consumption.
The two problems are interdependent: coexistence, that is in practice in a radio system the problem of message collision, is particularly serious on "unlicensed" bands due to the proliferation of wireless systems and in particular on the 2.4 GHz band. The "coexistance" involves sophisticated anti-collision systems and complex communication protocols which in turn lead to energy consumption incompatible with the objective of device economy and battery life. Bluetooth low energy (BLE) only partially solves these problems.

(3) Many IoT applications can be implemented with LPWAN (low-power Wide Area network), WLAN (Wireless Local Area Network), WPAN (Wireless Personal Area Network) and even WWAN (Wireless Wide Area Network).
This proliferation of terms and protocols undoubtedly reflects the complexity and multiplicity of the "IoT" sector. Systems such as LoRa or Sigfox used over long distances overlap with cellular networks (which are precisely "Wide") and do not make much sense, at least if the goal is to capture the "Billions".

(4) Long Range systems are certainly needed in many applications, for example in agriculture.
But there are also many drawbacks: very large areas in very populated places lead to problems of coexistence, of "EMI" (Electromagnetic interference). It is not just "co-channel interference", but also "Broandband Noise" produced by the continuous increase of wireless systems on adjacent frequency bands.

Therefore, clarified that the "IoT" applications will lead to "Billions" of wireless sensors, it can be said that in most cases the "WSN" will be realized by devices operating on "Free" or "Unlicensed" bands and in particular on sub-GHz frequencies and this for radio wave propagation reasons, radio channel availability and cost.
The vast majority of simple wireless devices capable of transmitting physical measurements and alarms will consist of one-way systems. What needs to be transmitted is the life status (heartbeat), measurements, alarms and battery voltage. The device must be small, easy to install and cheap, but above all it must have a very high autonomy.
The requirements are very different, but it is clear that hundreds of wireless devices, for example to monitor buildings or factories, require a lifetime of operation, without changing the battery, which can reach 20/25 years.
The concept is: "Install the device and forget it".

Fig.2 - The SKS3137-VTH
A typical "microSP" wireless sensor.

The sensor continuously samples vibration level and measures temperature and humidity. It periodically transmits the measurements, battery status and a "heartbeat" message. Powered by a CR2430 lithium battery, it has a lifespan of over 25 years

"microSP" Technology

The new RF "Standard" especially devoted to solve "IoT" applications

The "microSP" Technology is an RF Standard that uses Pulse Modulation for Data Transmission.
It is a "PPM" (Pulse Position Modulation) where the data message is encoded in the time position of the RF pulses. The pulses are very short (2 µs) and the message average time between the pulses is typically more than 200 µs : the duty-cycle of the transmission is therefore < 1/100. Between two successive pulses, the consumption of the Tx is zero and the current from the battery is only that of the "Ultra Low Power" MCU . Thus eight or sixteen-byte messages can be transmitted with a high RF peak power (+14 or even +20 dBm), but with an average Tx current of less than 1mA. Typical message time is 10ms and if, as an example, it is transmitted every 10s the final duty-cycle of the transmission is 1/1000 and the average current required from the battery is less than 1µA.

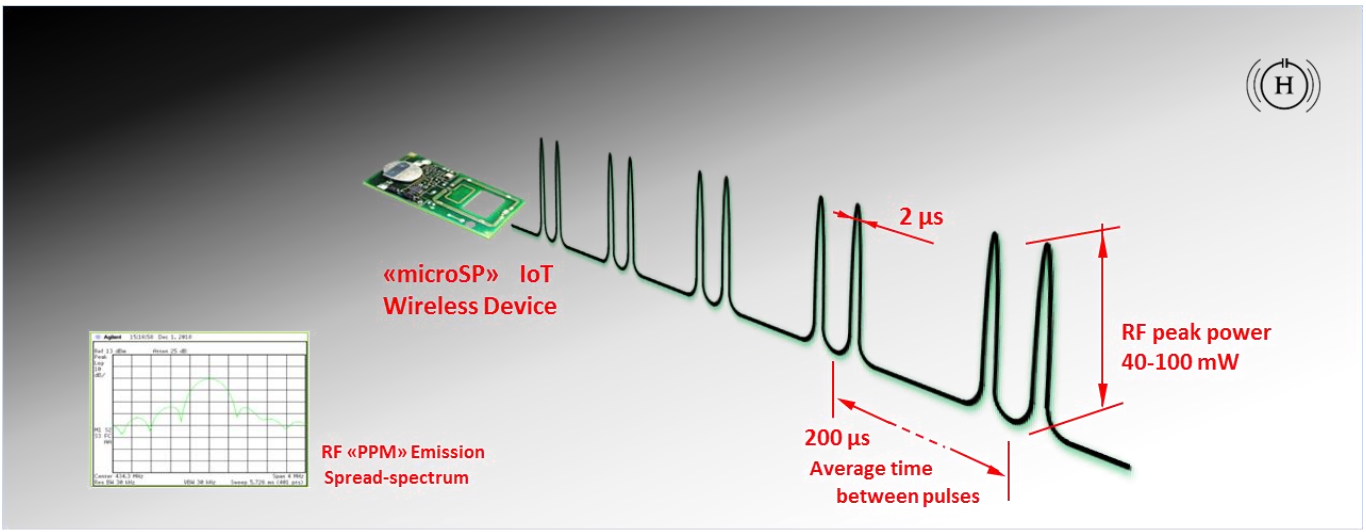


Fig.3 - "microSP" Technology and the RF pulsed "PPM" emission .

A +14/20 dBm peak power (25/100 mW) allows a remarkable security of the RF link, even in the case of obstacles and low efficiency antennas. The average energy involved is still very small and the RF power density is also very low and this facilitates the compliance with the various "Low Power" and “Short Range Devices” regulations.

The above is clearly a simplified description of the "microSP" Technology. Transmission timing and message length obviously depend on the type of application and the type of sensors or alarms that must be implemented. There is a patent on the design of the Tx "microSP": the patent does not concern the type of pulse modulation, which is a normal RF technique, but the design of an oscillator circuit capable of generating, using a single transistor and a low cost SAW resonator, very accurate RF pulses with nanosecond rise time and above all absolutely replicable in the production phase. A complete description of the “microSP” Transmitter can be found on the AN-901 Application Note , where it is also reported the description and the design of the oscillator and the related patent.

The following is an example of a "microSP" wireless sensor

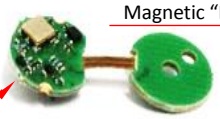
The PM9712 “Microcap” TPMS sensor

The PM9712 “Microcap” is a good example of what it is possible to do with the “microSP” Technology. The TPMS sensor measures the pneu pressure in a very small dimension with a lenght of 12x40 mm . The Lithium battery has a diameter of only 9mm , a capacity of 30mA/h and the PM9712 transmits pneu pressure every 30s with > 7 Years.lifespan.

Actually no other transmission system can assure similar performances.

“Microcap” electronics and antenna

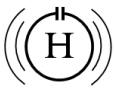
Magnetic “Loop” Antenna

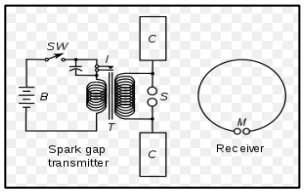


“microSP Transmitter

Appendix

The “microSP” Logo





The Logo of the "microSP Alliance" is intended as a tribute to the discovery of electromagnetic waves made by Rudolf Hertz and his experiments conducted with what we can certainly call a "Magnetic Loop" and with a spark generator of Hertzian pulses.