

Abstract

The goal for this document is to review and correct the technical specifications from the wireless communication comparison in the IFS Pest Control Guideline [20] on a technical level to lay a proper foundation for more technical competitions between different vendors by using different radio standards in different products / use cases.

A comparison of the radio interfaces by looking at the maximum distances is not sufficient enough, because the maximum distance is based on various environmental parameters (walls, location, weather, etc.) and may differ. It's also recommended to not focus on a single radio interface / standard, because each interface / standard has its own advantages / disadvantages.

It's also recommended to use a modern encryption standard when choosing a radio interface to make sure that the communication is private and protected. Encryption in general is heavily based on a proper implementation of the key generation / key exchange. A faulty implementation may tend to security issues during communication.

Please take a look at the following example image ([21]) for a brief overview of the different standards and the different data transmission capabilities in comparison to the hardware costs.

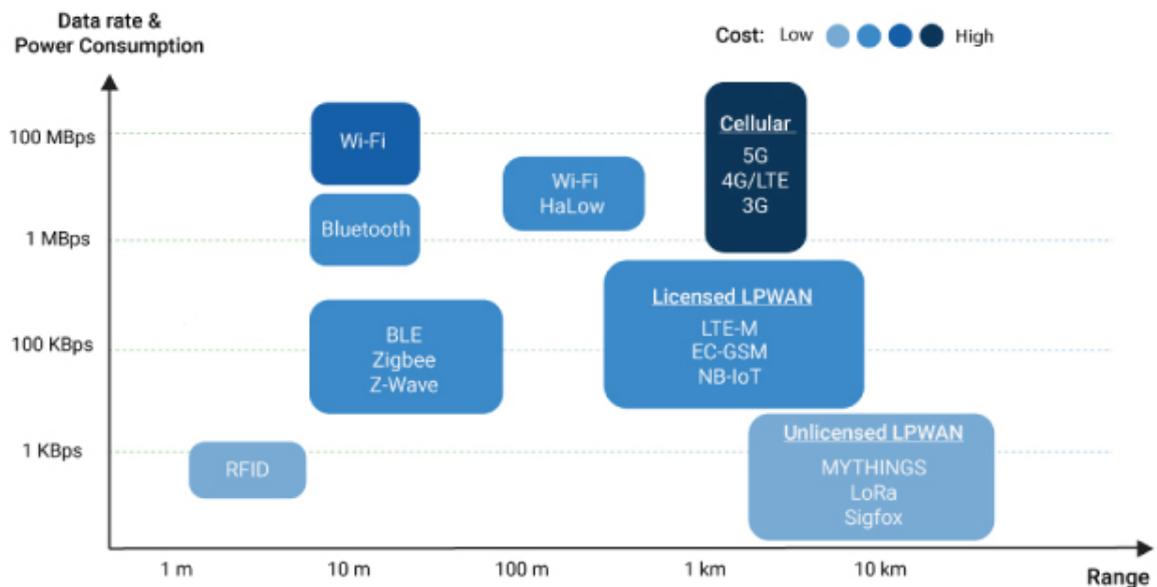


Image 1: Wireless technologies [21]

Bluetooth

	Recom- mended	Distance	Energy consump- tion	Advantages	Disadvantages	Areas of application
Bluetooth	 no	 2-5 m	 very low	 low costs	 low range, low security, gateway required	 private households

 excellent
  good
  sufficient
  insufficient

Image 2: Bluetooth comparison [20]

Distance

The maximum distance depends on the transmission power and the used Bluetooth standard and the environment. Ranges up to 100 m are possible [1].

Power Consumption

Depends on the Bluetooth interface. The Bluetooth standard contains BLE (Bluetooth Low Energy) for low power and low performance connection. BLE typically uses 100 times less power than Bluetooth [2].

Advantages

What does low-cost mean? The average costs for the Bluetooth hardware are depending on the required Bluetooth specification and the transmission rate. It's possible to get Bluetooth chips for up to 1.10 euros [3]. Why is this low price only a “good” criterion when the higher price for cellular modems isn't covered?

Disadvantages

Security

Bluetooth (and BLE) is using different modern encryption standards like AES and EEC. EEC is used for the key generation and these keys are used for AES. Both standards are state of the art and there is no vulnerability known or both. The security depends on the key quality of the EEC algorithm. The current Bluetooth standards (i. e. 5+) also support different additional security features, like Man-In-The-Middle and Replay Attack protection [2].

Low Range

It depends on the range that must be covered and the use case. For the typical use cases of Bluetooth (and BLE) the range might be enough.

Areas of Application

Not only private households. Short range connectivity, also for industrial applications like barcode scanner, mobile payment, etc.

Long Range / Short Range

	Recommended	Distance	Energy consumption	Advantages	Disadvantages	Areas of application
Long Range ShortRange 868 Mhz	 yes	 50 m – 2 km	 very low	 secure infrastructure solution with repeaters and gateways, secure, private network, easy to set up, long battery life	 Infrastructure (higher effort than e. g. GSM/4G)	 unlimited

 excellent  good  sufficient  insufficient

Image 3: Long Range / Short Range comparison [20]

Unclear which Interface should be covered here?

The terms “Long Range” and “Short Range” aren't clear enough to discuss on a technical level and are highly dependent on the range coverage of one interface in comparison to another interface. The 868 MHz frequency band is the standard ISM frequency band for the European market. Thus this frequency band can be used by different RF applications from different vendors.

Example

“Long Range” can imply LoRa, because “LoRa” is the short form for “Long Range” and LoRa is using the 868 MHz frequency band in Europe. On the other hand i. e. “EnOcean” is a good example for a “Short Range” standard (in comparison to LoRa) [25]. The communication of both interfaces is located on the 868 MHz ISM band in Europe and both standards are highly different to each other.

EnOcean

	Recommended	Distance	Energy consumption	Advantages	Disadvantages	Areas of application
EnOcean	 yes	 50 m – 2 km	 very good (no battery needed)	 secure infrastructure solution with repeaters and gateways, secure, private network, and good, easy set-up battery life and millions of home automation applications worldwide	 medium range, but can be extended	 unlimited

 excellent  good  sufficient  insufficient

Image 4: EnOcean comparison [20]

Distance

Where does the 2 km distance come from? The EnOcean alliance (the official maintainer of the standard) is publishing a range up to 300 m [5].

Power Consumption

No battery needed is not correct. The interface is designed for low power and can be driven without a battery when the actor or sensor provides a solution to harvest enough energy for a data transmission (i. e. Induction or some sort of Piezo crystal). The energy harvested from that source is typically enough for one single transmission.

Advantages

Security

Why is EnOcean more secure than Bluetooth? Both techniques are using AES-128 as encryption standard [6].

An additional aspect to consider when using EnOcean is that on 11/14/22 the German EnOcean GmbH which is providing the EnOcean cloud platform was purchased by Parabellul, an American acquisition company [24]. This means that using the EnOcean cloud platform may lead to additional problems with the GDPR when the cloud servers are not located in Europe or moved out of Europe.

Disadvantages

Medium range

Please explain why a range of 50 m up to 2 km is called “medium range” and a disadvantage in terms of EnOcean and “long range” and an advantage in terms of LoRaWAN / Sigfox.

Passive sensors

Passive sensors with EnOcean aren't recommended for pest control applications, because:

- The device is unable to repeat a transmission in case of a transmission failure
 - This may lead to undetected catches, because messages can get lost
- The device is unable to transmit a device status when no energy harvesting event occurs
 - This may lead to an unknown device status
 - The pest controller (or other interested persons) can not make sure that the device is available and fully functional
 - This will result in a lack of documentation for each device

Cellular

	Recommended	Distance	Energy consumption	Advantages	Disadvantages	Areas of application
GSM/LTE (2G/3G/4G)	yes	99% coverage of the world	good	very safe, very easy to set up	SIM costs	unlimited
NB-IoT/ Cat-M	yes	99% coverage of the world	good	very safe, very easy to set-up Unique: better signals through walls. The future standard of the IoT.	SIM costs	unlimited

excellent good sufficient insufficient

Image 5: Cellular comparison [20]

Distance

The statement with 99% global coverage isn't correct in general. The coverage is depending on the cellular standard (i. e. the coverage for LTE is maybe higher than for the 2G standard). A good start to check the coverage for a given standard is to take a look at a global map like in [22].

Power Consumption

What does a “good” power consumption mean? The power consumption is highly dependent on various factors like the data rate, the “complexity” of the protocol, the coverage, the antenna, the selected frequency band, the supported power-saving features, etc.

NB-IoT and LTE CAT-M are designed for low data and low power applications (i. e. light bulbs). 2G, 3G and LTE CAT-4 (and above) are designed for data transmission rates up to 150 Mbit/s. The difference in the data transmission rate is resulting in different power consumptions. A quantitative statement is therefore very complicated and probably not possible as you can see in the comparison ([23]) between NB-IoT and LTE-M for example.

Advantages

Security

Why is cellular very safe and Bluetooth / BLE not? You share a wide area network with others in comparison with a local area network with Bluetooth / BLE. So, the risk for an attack is much higher than with Bluetooth.

Better signals through walls

Why for LTE CAT-M and not for LoRa. Both interfaces can share (nearly) the same frequency bands (i. e. bands 5, 8, 18, 19, 20 and 26) to achieve nearly the same results.

Future standard of the IoT

Why? There are several other well-designed standards (LoRaWAN, Mioty, ZigBee, etc.). Each of these standards is called “Future standard for IoT”.

Why is big data unnecessary?

The amount of data depends on the use case and normally you choose the radio interface based on these use cases. There shouldn't be a limit for the data rates, because this limit will reduce the degrees of freedom for the products. Image driven pest controlling solutions were a good example. The amount of data is much higher than the data from a regular snaptrap, but these images provide a lot more information to the pest controller. As an example:

It might be interesting for the pest controller to digitize insect traps by using some sort of camera based system. This camera based system offers a good benefit to the pest controller, because he can check the status of the insect trap, the amount and the type of insects remotely. But this device has to provide an image which consists of a lot more data (i. e. 100 kB instead of a few bytes from a regular snaptrap).

WiFi

	Recom- mended	Distance	Energy consump- tion	Advantages	Disadvantages	Areas of application
WLAN	 no	 3 – 10 m	 high energy consumption	 large data can be sent (not necessary for Pest Control)	 low range, insecure networks offer loopholes for hacking software (virus), dependence on the customer (password, etc.)	 private households

 excellent  good  sufficient  insufficient

Image 6: WiFi comparison [20]

Distance

The distance for WiFi is depending on the WiFi frequency used (2.4 GHz, 5 GHz, 6 GHz or even 868 MHz). The higher the frequency, the shorter the distance. Each WiFi standard can cover more than 10 m [7]. The WiFi IEEE 802.11ah standard can cover distances up to 1 km [8].

Power Consumption

Why does WiFi consume more energy than Bluetooth? Classic Bluetooth consumes around 30% more energy than WiFi [9] and Bluetooth is listed as “very low”.

Disadvantages

Security

The WPA2 standard is vulnerable by the protocol itself, but the attacker won't get the passwords [10]. This means the attacker must stay next to the trap systems. Typically, the data transmitted over WiFi is encrypted on a second level by using SSL / TLS when the device accesses some sort of a web server which prevents the manipulation of the data. This means that an attacker only gets access to the encoded data packets after hacking the WiFi interface.

Private households

That's not correct. WiFi is also used in the industry (supermarkets, airports, etc.) and WiFi also contains industrial standard encryption.

Why is big data unnecessary?

Same as for cellular.

LoRaWAN

	Recommended	Distance	Energy consumption	Advantages	Disadvantages	Areas of application
LoRaWan/ Sigfox	 no	 50 m – 2 km	 good	 long range	 low security, not scalable, network coverage insecure, decentralised solution for hobby use	 not recommended

 excellent  good  sufficient  insufficient

Image 7: LoRaWAN comparison [20]

Do not handle LoRaWAN and Sigfox with the same arguments. Both are different protocols on the same physical interface!

Distance

LoRaWAN is using LoRa as a radio interface. Thus, LoRaWAN covers the same range as the LoRa interface [11] [12].

Advantages

Why not cover the added encryption of LoRaWAN messages in comparison to raw LoRa?
Why not cover the advanced device provisioning mechanism for devices in comparison to LoRa?

Disadvantages

Security

LoRaWAN is using AES-128 to encrypt the messages on the device [13] [14]. The algorithm isn't broken and the security of this algorithm depends on the quality of the key. It's recommended to use the more secure OTAA process instead of the ABP to achieve the highest security level in the network [15]. LoRaWAN devices are not directly connected to the internet (or a company network) which avoid access to critical structures through an insecure device.

Scalability

Why not scalable? LoRaWAN is designed for huge sensor networks. The whole device provisioning mechanism is designed to provide a good and easy way to add new devices to a network.

Decentralized Solution

In terms of security reasons and system stability, a decentralized solution is the more reliable way to go [16].

Hobby use

That's not correct. LoRaWAN is very popular for industrial purposes, smart cities, etc. [17] [18].

Sigfox

Distance

Sigfox can cover distances up to 40 km [19].

Disadvantages

Security

Sigfox is using AES-128 to encrypt the messages on the device [20] with no key exchange over the radio interface. Sigfox also offers three different security models for the encryption key [20]. Sigfox devices are not directly connected to the internet (or a company network) which avoid access to critical structures through an insecure device.

Scalability

Why not scalable? Sigfox is designed for huge sensor networks and to be very scalable. Even the data transmission size of max. 12 bytes is optimized for a small airtime and a good coverage of the frequency spectrum [20].

Decentralized Solution

Same as for LoRaWAN.

References

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Additional Resources

- [Security LoRa]
https://lora-alliance.org/resource_hub/lorawan-is-secure-but-implementation-matters/
- [Security EnOcean]
https://www.enocean.com/de/enocean_pressrelease/enocean-expands-enhanced-data-encryption-to-its-complete-868-mhz-batteryless-wireless-portfolio/
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Authors

traplinked GmbH

- Tim Kirchhof (t.kirchhof@traplinked.com)
- Daniel Kampert (d.kampert@traplinked.com)

WAINS GmbH

- Steffen König (steffen.koenig@wains.info)
- Benjamin Ruoff (benjamin.ruoff@wains.info)

Gemex Hygiene + Vorratsschutz GmbH

- Tobias Sommer (tobias.Sommer@gesa.de)
- Anja Stadie (anja.stadie@gesa.de)

The Things Industries

- Wienke Giezeman (wienke@thethingsindustries.com)