„Smart Building“ trends – a comparison of wireless standards for automation and control

by Prof. Dr. Michael Krödel (IGT – Institut für Gebäudetechnologie)

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Building automation is in the advance. Systems are becoming increasingly sophisticated, offering more and more value-added service features thanks to IT-based systems which surpass what room-/building-management systems could offer until now.

These systems are heavily reliant upon data from within spaces and buildings, which can easily be gathered and transmitted using wireless technology. Various wireless standards are available. The most suitable wireless technology can only be identified, case by case, according to the specific application and the „use cases“.

In this context, it has become apparent that the so-called „Wide Area Networks“ are unsuitable for today's and tomorrow's Smart Building applications. This technology is well suited to integrating wireless devices into public areas, i.e. where it is impossible to establish one's infrastructure. In modern buildings, however, setting up an own infrastructure or establishing mesh networks presents no problems and makes excellent sense in consideration of the density of the sensor networks.

Other wireless technologies are more – or less – suited to this kind of application. The possibility of integrating wireless devices (especially sensors) into building automation systems – e.g. controllers and DDC-systems – is of particular relevance. The support for specific wireless technologies offered by controller manufacturers plays an important role. As does the possibility of sourcing a broad range of compatible components on the open market. Not to mention the great advantages offered by self-powered wireless devices requiring neither batteries nor mains power.

From these points of view, the EnOcean and Z-Wave wireless standards appear to be ideal for use in „Smart Buildings“. EnOcean achieved a mean score of 1.9 points on the suitability index followed by Z-Wave with 1.5 points.

However, these technologies cater to different market segments. EnOcean is predestined for use in professionally-installed integrated systems for Smart Home and non-residential building solutions and features higher levels of interoperability. In contrast, Z-Wave is better suited to „DIY“ Smart Home consumer-level retrofit applications.

Use Cases in modern buildings

The foreseeable Use Cases form the basis for the evaluation of the suitability of different wireless data transmission standards. One must first define what needs to be automated to evaluate the best solution amongst the various wireless standards available.

Typical room-/building-automation Use Cases include

- Individual room temperature regulation according to human presence and window status.
- Individual room ventilation and cooling depending on air temperature, air quality (CO_2 and/or VOC loads), and humidity.
- Individual room lighting - illumination can be dimmed when areas are not in use. Switches can govern individual lights or groups of lights as needed. The artificial light intensity can also vary according to natural light intensity depending on the weather and time of day.
- Sunblinds/shutters can be deployed automatically in the function of room temperature (summertime heat protection).
- Switches for illumination and external light shading can be optimally placed, with the free positioning of furniture and partitions/walls. Handheld remote-controls can also be employed.
- The supply of warmth for heating systems or refrigeration for cooling systems can be regulated to match current and projected system demands (including criteria for flow temperatures and pump rotation speed regulation).
- Multiple heat/cold-generating units can be governed according to system performance requirements and loads
- Heat regeneration for ventilation systems can be configured to avoid icing or overheating.
- Fault alarms, operating hours, and energy consumption can be protocolled and evaluated.
- Further **value-added services** currently seeing intensive development include:
- The smartphone-based dynamic booking/release of conference-room facilities and workplaces in open-plan offices. Meetings finishing ahead of schedule and unoccupied workplaces can be recognized and taken into account for optimal facility management.
- Occupancy sensors can, for instance, be used to analyze the use of meeting rooms, recognize resource usage patterns, protocol no-shows, manage workspace efficiently, and organize catering services.
- The analysis of usage patterns enables the flexible allocation of employee workspace. Unutilized areas can be set to energy-saving mode, thereby cutting heating/cooling/electric power costs.
- Building occupancy can be displayed graphically by employing "Heat Maps" or "Moving Trails" illustrating how many persons are occupying which areas.
- Such insight provides the perfect basis for zone planning purposes (e.g. room size, the position of meeting rooms, etc.).
- Employees and visitors can be easily guided through the building complex, making orienteering simpler in unfamiliar facilities e.g. when looking for a specific meeting room
- Canteen usage (i.e. foreseeable waiting times) can be monitored and visualized from the workplace.
- The frequency of washroom usage can be monitored and translated into appropriate cleaning schedules.
- Usage of lifts, coffee machines, etc. can be monitored and translated into adequate maintenance schedules.
- Sensors within the building automation network monitor pumps, cleaning machines, HVAC systems, lifts, etc. and report any malfunction in real-time for better fault-finding and more efficient pre-emptive measures.

Parameters for the analysis of wireless standard suitability for automation and control

The Use Cases enable us to make accurate assumptions concerning the suitability of individual wireless standards. These are the relevant criteria:

- **Suitability of the frequency band (KO-criterion)**: the Use Cases typically feature small data packets (10-100 bytes), latency times from 0.1 to 1 second, and a range from 10 to 100m. The suitability of the frequency band is of decisive importance - any functional limitation, even if partial, would essentially disqualify the wireless standard in question for this type of application.
- **Manufacturer dependence**: in the best interests of the user, wireless standards should operate across as many suppliers as possible. Wireless technology should be standardized to allow for maximal interoperability between devices produced by different suppliers.
- **Infrastructure**: ideally, an own infrastructure should not be required. This is a given when signals can be transmitted over greater distances and are particularly relevant when sensor network density is low. In return, an infrastructure consisting of cable-connected antennas and gateways allowing for meshed communication is required.
- **Integrability**: ideally, wireless standards should be broadly supported by multiple manufacturers of commercially-available controllers and gateways, with proven reference project information.
- **Broad availability of the necessary hardware components**: all the necessary sensors must be freely available on the open market.
- **Measuring and testing**: the appropriate fault-finding equipment and user documentation must be available.
- **Power supply**: one of the main advantages of wireless technology consists of the free positioning of sensor devices. A cabled power supply represents a hindrance. Ideally, sensors should be self-powered. For battery-powered devices, low power consumption is of great importance.
- **Data encryption**: data security and integrity must be guaranteed by encryption technology
- **Wireless standard suitability for building automation and control**

This table shows a comprehensive comparison. Details can be found in the study mentioned below:

Criterion	5G/ NB-IoT/ Sigfox/ WLAN	BLE	EnOcean	KNX RF	LoRa	Thread	ZigBee	Z-Wave
Suitability of the frequency band (**KO criterion**)	Low (unnecessarily high data rates/ range/ energy consumption)	High	High	High	Middle	High	High	High
Manufacturer dependence	Irrelevant due to unsatisfactory frequency band characteristics	Middle	Low	Low	High	Low	Middle	Middle
Infrastructure		Infrastructure/ Mesh	Infrastructure	Infrastructure	Infrastructure	Infrastructure/ Mesh	Infrastructure/ Mesh	Infrastructure/ Mesh
Integrability		Middle	High	Middle	Middle	Middle	Middle	Middle
Broad availability of the necessary hardware comp.		Middle	High	Middle	Middle	Low	Middle	High
Measuring and testing		High	High	Middle	Middle	Middle	High	High
Power supply		Middle	High	Middle	Middle	Middle	Middle	Middle
Data encryption		High	High	High	High	High	High	High
Overall suitability	**Low** (KO criterion)	Middle (Ø 1,4 Pt)	High (Ø 1,9 Pt)	Middle (Ø 1,4 Pt)	Middle (Ø 1,0 Pt)	Middle (Ø 1,3 Pt)	Middle (Ø 1,4 Pt)	High (Ø 1,5 Pt)

Source: „Smart Building“ trends – a comparison between various wireless standards; IGT – Institut für Gebäudetechnologie; 2020

About EnOcean Alliance

The EnOcean Alliance is an international association of leading companies in the building and IT industries founded in 2008. The open, non-profit organization is committed to enabling and promoting interoperable, maintenance-free, and proven eco-systems based on the wireless EnOcean radio standard (ISO/IEC 14543-3-10/11). With their decades of experience, EnOcean Alliance members strive to co-create a healthy, safe, and sustainable environment in smart homes, intelligent buildings, and smart spaces for the benefit of all. The EnOcean Alliance headquarters are located in San Ramon, California.

www.enocean-alliance.org

Press Contact (for more information)

Evelyn Gilde-Back EnOcean Alliance

M +49 (0)176 636 13 964

press@enocean-alliance.org