Whitepaper

LoRaWAN in building automation

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DEOS.AG
Technology for intelligent buildings

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What is LoRaWAN?

LoRaWAN stands for “Long Range Wide Area Network” and it refers to an energy-efficient wireless technology with an extremely long-distance range that was specially developed for the Internet of Things (IoT). It is one of the so-called LPWAN technologies (Low Power Wide Area Networks, LoRaWAN Alliance) that offers an impressive battery life of up to 10 years, depending on the type of sensor and data transmission. Distances of up to 15 km (dependent on surroundings and ambient conditions) can be covered. An additional advantage of LoRaWAN is deep building penetration. However, the combination of low power consumption and a long range limits the maximum data bit rate to 50 kbit/s.

LoRaWAN uses ISM band frequencies (frequency range from 867 to 869 MHz) and LoRaWAN can be used licence-free in Germany. When compared to other wireless technologies such as mobile communications or WiFi, LoRaWAN is extremely economical. This combination makes LoRaWAN the ideal technology for the Internet of Things (IoT).

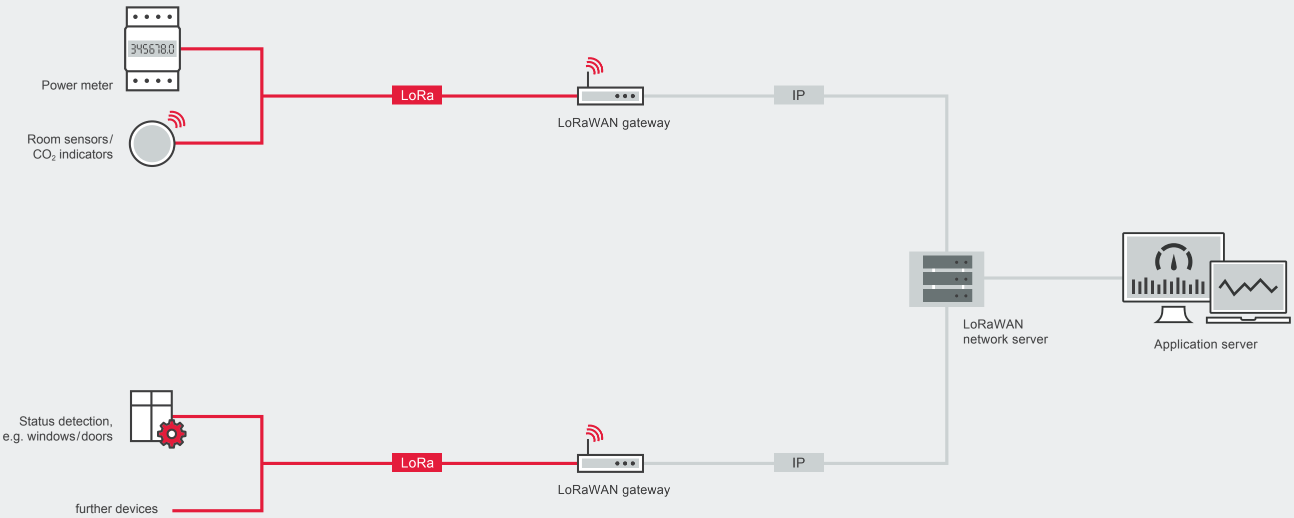
Public and private networks

Both public and private networks can be used for LoRa applications. In France, Switzerland, Belgium, the Netherlands and numerous other countries, national telecommunications service providers have adapted the LoRaWAN technology and are establishing national LoRa networks. In Germany, however, cities, communities, energy providers and IoT service providers are establishing their own networks because Deutsche Telekom or Vodafone is implementing the expansion of their own NB-IoT networks (Narrow Band IoT).

What is the structure of a LoRaWAN?

Typically, a LoRa Wide Area Network consists of three components: LoRa nodes, LoRa gateways and LoRa servers. These are usually arranged in a star topology.

Nodes are end devices such as sensors or actuators and they transmit data packets to LoRa gateways, which in turn send the collected information to a LoRaWAN server. In this process, data is encrypted by the end device and decrypted only by the server or the application. Communication is usually bi-directional. However, gateways do not use LoRa technologies for communications but a standard IP connection with the network server.



LoRa Network Server (LNS)

A LoRa network server can execute numerous tasks such as managing the used data bit rate for each end device in the network with the aid of an Adaptive Data Rate algorithm (ADR). The selection of the ideal data bit rate is a compromise between the duration of information transmission and the covered area. LoRaWAN data bit rates range from 0.3 kbit/s up to 50 kbit/s. This maximises the battery life of the end devices and enables energy-efficient operation.

Since data packets sent from end devices are not always received by only one gateway and forwarded to the server, the server must filter out redundant data and remove superfluous data packets. This is what makes the transfer of data in a LoRaWAN extremely secure. The renewed encryption of information to end devices is also one of the tasks of the network server that ensures security.

LoRa end devices

Class A end devices
Communication with class A end devices works according to the ALOHA method. Every time a data packet is sent (uplinked) to the gateway, two reception windows (downlinks) are available, in which the end device is ready to receive the data. Information such as device parameters can be transferred here from the application to the end device. After finishing communication, class A end devices go into energy-saving mode and are reactivated only for the next uplink interval. As a result, it can take longer and involve a latency for changed values to be written to the end device. Nevertheless, this transmission interval is what makes class A end devices one of the most energy-efficient devices with an extremely long battery life. Typical examples of class A end devices include window contacts, level sensors and leak sensors.

Class B end devices
In addition to the reception window of class A end devices, class B end devices open additional reception windows (downlinks) at predefined intervals. As a result of these predefined schedules, the maximum latency can be programmed up to 128 seconds. This ensures that a reception window is opened for the writing of data at a fixed time at the latest. The end device consumes more energy due to the increased reception capacity, still, class B end devices can be used without any problems for battery-operated applications. Typical examples of class B end devices include thermostatic heads, temperature sensors or humidity sensors.

Class C end devices
The reception window of class C end devices is continuously open unless the devices themselves send data. Hence, class C end devices have the lowest latency among LoRa end devices but they are more energy-intensive than class A or class B end devices. Depending on the application and end device, class C devices are also operated, in part, via an external power supply. IO modules are examples of a typical class C end device.

What is the difference between LoRa and LoRaWAN?

LoRaWAN defines the standard communication protocol and the system architecture for the entire network and enables standardised communication among individual network nodes. This way, LoRaWAN-capable products can be integrated without any problems into an existing LoRaWAN.

LoRa, by contrast, refers to the actual radio technology developed by Semtech Corporation, which enables energy-efficient and long-range communications. LoRa is used only between the node (e.g., a sensor) and the gateway. The gateway typically communicates via LTE/LAN with the network server and provides the Internet of Things with data.

The communication protocol and the system architecture have the greatest impact on the battery life of an end device (node), the network capacity, security and the variety of applications served by the network.

What is LPWAN?

Low Power Wide Area Networks (LPWANs) are often called Low Power Networks (LPNs). They are wireless networks that cover a large geographical region and they have been specially developed for IoT applications where they are used to transmit small IoT data packets. They are characterised by low energy consumption.

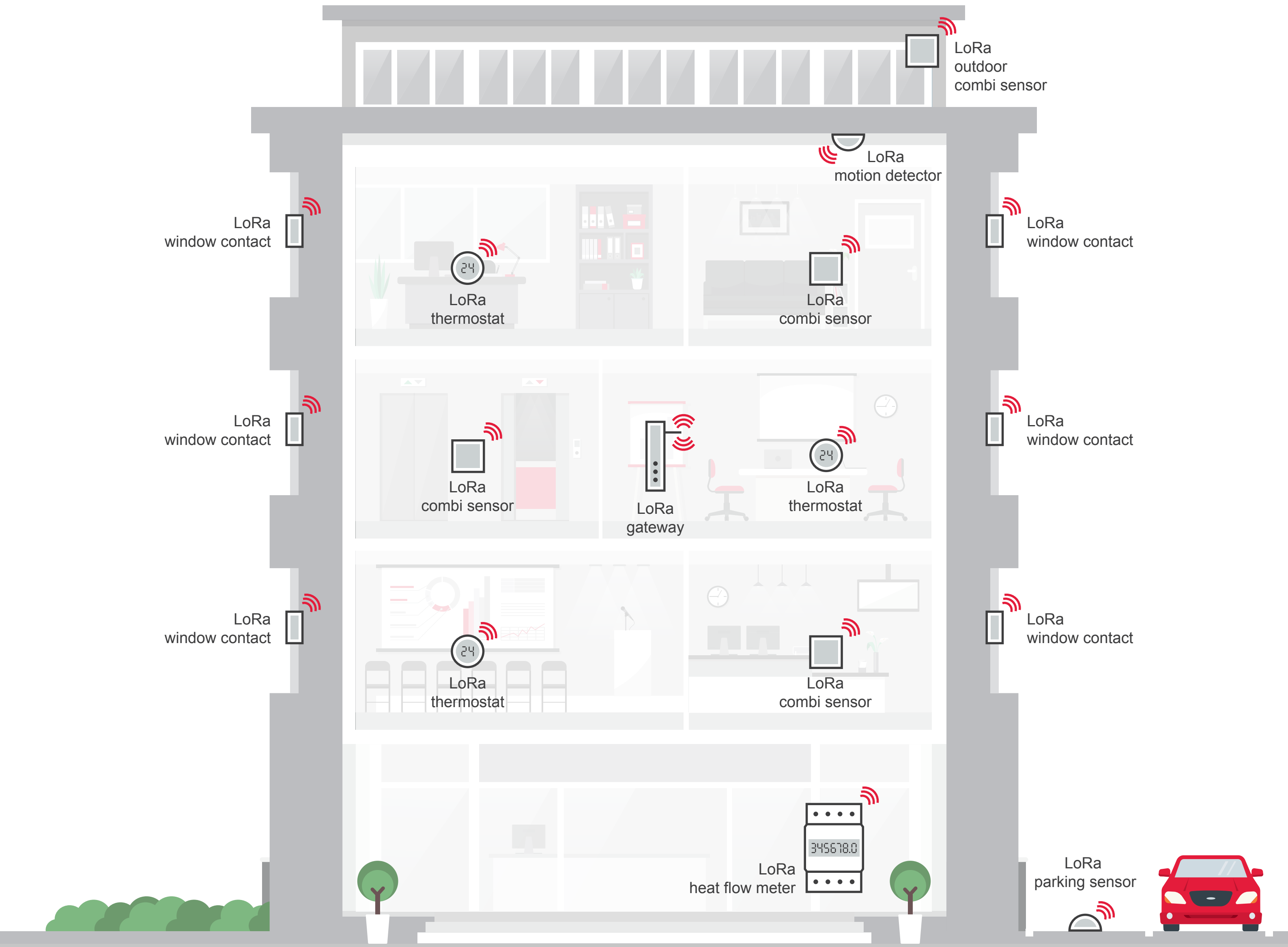
Such wireless networks are well suitable to meet the challenges of guaranteeing the transmission of data in a city, community, or within a building. Battery-operated sensors and actuators can often send and receive IoT data for years. LoRaWAN, Sigfox, EnOcean and NB-IoT are some of the best-known technologies and they all have similar characteristics.

LoRaWAN in in building automation

In building automation and especially in smart buildings, data transparency plays a central role when it comes to operating buildings as energy-efficiently as possible. LoRaWAN has been developed to meet the requirements of the Internet of Things (IoT) and offers an impressive wireless range and excellent building penetration. It takes only one gateway to fully cover an entire business complex with associated premises. Even basements do not pose a problem to LoRa wireless networks and they can be easily integrated into the network. Since IoT sensors and actuators use very little data, virtually any number of sensors can communicate with the network server via a single gateway. This is what makes the integration of LoRa wireless sensors extremely cost-effective: they do not require numerous gateways or repeaters.

Low power data transmission also enables the energy-efficient operation of LoRa sensors and LoRa actuators using batteries. A battery life of up to 15 years is not uncommon in this case. This reduces time-consuming maintenance work involving facility management to a minimum and enables retrofit measures to be implemented in existing buildings in no time flat because no post install cabling needs to be done.

For the integration into an existing building automation system, some LoRa gateways come equipped with standardised building automation interfaces such as Modbus, for example. This way collected data from LoRa end devices can simply be returned to the building automation control system. This type of communication works in a bi-directional manner and enables straightforward and cost-effective integration into the building automation system.



LoRaWAN in practical comparison

The growing importance of the IoT in conjunction with the high demand for application-relevant solutions, currently bring many new technologies to a highly competitive market. A direct comparison is a difficult undertaking as each one of these technologies has a right to exist. It is essential to take the distinct application scenario into account when opting for a specific technology.

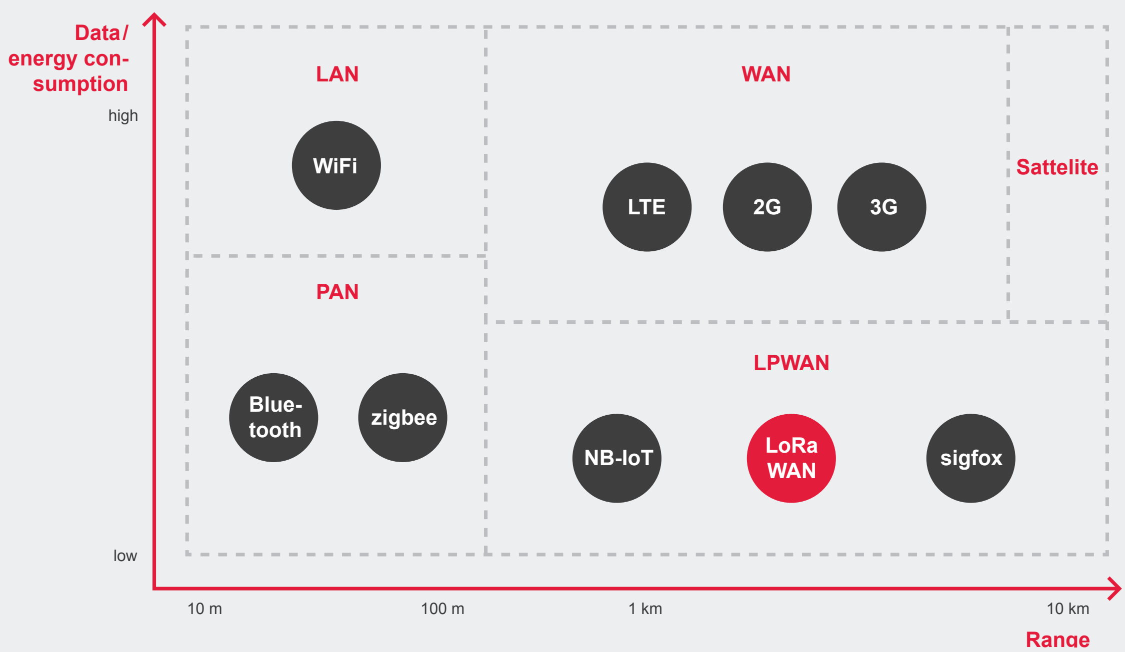
The tables below show a comparison between LoRaWANs and common WAN technologies such as WiFi and Bluetooth as well as alternative LPWAN technologies on the market.

Comparing LoRaWAN with conventional WAN technologies

Currently, many technologies are being used on the Internet of Things that have been adapted to meet the requirements for a long battery life and small quantities of data (bandwidth) since the rise of the IoT.

Protocols such as WiFi and Bluetooth are often used in the smart home consumer sector to control or read data associated with lighting, shading and the acquisition of room information such as temperature. This is mainly due to the fact that the infrastructure usually exists already and that it often fully meets the needs of homeowner applications.

However, Local Area Networks (LANs) rarely meet or even fail to meet the requirements of industrial applications. LANs have been designed primarily to manage large quantities of data in a short distance range and they are also extremely cost-intensive. A large bandwidth is not required though because there is usually very little data traffic in smart buildings. Roughly 99.9 % of all LPWAN devices consume fewer than 150 kbytes of data a month according to 3GPP ((3rd Generation Partnership Project) global cooperation of standard development committees for standardising mobile communications). The quantity of data, energy consumption and range are in direct relation to one another.



Apart from these main indicators, further criteria need to be taken into account in practice before a case-by-case decision can be made in favour of one of the different IoT technologies. The information shown in the table of comparison relates to a smart building application and the degree of suitability for this type of application.

	LoRa	Wi-Fi	Bluetooth
Typical application	Transmission of non-time-critical IoT data such as temperature, humidity or meter readings	Multimedia applications that have high data traffic such as downloading software	Multimedia applications that have high data traffic such as streaming music to Bluetooth speakers
Data transfer rate	**Up to 50 kbit/s**	**Up to 9600 Mbit/s (Wi-Fi 6)**	**Up to 50 Mbit/s (Bluetooth 5)**
Range Note: These values are based on optimum ambient conditions.	**Rural: up to 50 km** **Urban: up to 5 km** LoRaWAN is designed to cover long ranges and penetrate several buildings so that a distinction is made between rural and urban surroundings.	**Outdoors: up to 100 m** **Indoors: 3 to 50 m** The range is significantly limited in office buildings so that only one room might be covered.	**Outdoors: up to 100 m** **Indoors: 1 to 50 m** High interference is associated with Bluetooth ranges so that they are often limited to cover the direct surroundings such as one room.
Penetration	**Extremely deep building penetration** In some cases, one gateway can cover entire buildings; multiple floors and basements pose no problem.	**Low building penetration** Often many access points (repeaters) must be used to provide coverage for an entire area.	**Extremely low building penetration** Often provides coverage for only a few meters; to some extent reaching the next room.
Energy requirement	**Extremely low** Can be battery-operated for years.	**High** An external power supply is usually required for IoT end devices such as sensors.	**Moderate** An external power supply is usually required for IoT end devices such as sensors.
Provisioning cost	**Low**	**High**	**High**
End device integration	Virtually any number of IoT devices can be connected to one LoRa gateway.	End device integration is limited by the number of available IP addresses in the network (254 addresses in a class C network).	Flexible integration of additional end devices. This depends to a large extent on the infrastructure because extremely poor building penetration is associated with the use of Bluetooth.
Scalability	New end devices can easily be joined in the existing network "over the air" and can log themselves out (OTAA). New gateways may need to be deployed.	The limitation of network nodes complicates system expansion. This means high consequential cost and problems with further system expansion.	The extremely low building coverage provided by Bluetooth makes such an undertaking almost impossible.
IoT suitability	✓	✗	✗

LoRaWAN and alternative LPWAN technologies

A comparison of all technologies is almost impossible owing to the prevalence of the IoT and the continuously growing market of technologies and providers. For these reasons, this comparison focuses on the most popular and advanced technologies. We will compare the most important parameters with respect to suitability for smart buildings because LPWANs often have very similar characteristics.

	LoRa	sigfox	enocean
Data transfer rate	**Up to 50 kbit/s**	**Up to 600 bit/s**	**Up to 125 kbit/s**
Range Note: These values are based on optimum ambient conditions.	**Rural: up to 50 km** **Urban: up to 5 km** LoRaWAN is designed to cover long ranges and penetrate several buildings so that a distinction is made between rural and urban surroundings.	**Rural: 30 to 50 km** **Urban: up to 10 km** Sigfox is designed to cover long ranges and penetrate several buildings so that a distinction is made between rural and urban surroundings.	**Outdoors: up to 300 m** **Indoors: up to 30 m** EnOcean is not designed to cover long distances so that a distinction is made between indoor and outdoor ranges.
Penetration	**High** LoRaWAN can penetrate several walls, including basements, owing to sensitivity values of up to -137 dBm.	**High** Sigfox achieves similar building penetration values as a LoRa network and is also perfectly suitable for deployment in buildings.	**Moderate** For planning purposes, it is advisable to plan with a range of only 10 meters and a maximum penetration of two ceilings because building penetration is limited. In order to cover the entire building, additional repeaters and gateways must be installed.
Energy requirement	**Excellent** A battery life of up to 10 years is possible thanks to low energy consumption.	**Excellent** A battery life of up to 10 years is possible thanks to low energy consumption.	**Excellent** With the aid of energy harvesting, EnOcean sensors can operate without a battery or an external power supply.
Provisioning cost	**Low** Thanks to a deep building penetration, it takes less money to build the infrastructure. Affordable device prices round out this solution.	**Moderate** The cost of infrastructure is as low as with LoRa networks, but the individual components are more expensive than LoRa devices.	**High** A high cost is associated with establishing the infrastructure due to low building penetration. Numerous gateways and repeaters increase the cost of infrastructure.
Security	✓	✓	✓
Private network	✓	✗	✓
Portfolio	✓	✓	✓

LoRaWAN advantages in summary

The use of LoRaWANs in Europe is virtually indispensable for smart cities. Numerous cities, communities and energy service providers are establishing their own regional LoRaWANs to be able to offer efficient and smart services in smart cities. Smart buildings also stand to benefit from LoRaWAN advantages since the borders between smart cities and smart buildings continue to dissolve and applications like smart metering are used in both scenarios. Some of the most important advantages include a long-distance range and deep building penetration, long battery life, low cost of infrastructure, and widespread use in cities and communities.

Extremely long range

A LoRaWAN achieves an impressively long range. In theory, ranges of up to 50 km are possible. In practice, however, ambient factors need to be considered. A range of about 3 km between an end device and a gateway can be achieved in urban areas; roughly 5 to 10 km in areas with fewer buildings, and up to 15 km in rural areas. Thanks to this fact, large areas or buildings can be fully covered by only one gateway.

Penetration and low susceptibility to interference

A LoRaWAN features an extremely low susceptibility to interference. Sensitivity values of up to -137 dBm can also be achieved so that several walls can be penetrated all the way down to the basement. This way, it takes only one gateway to fully cover entire business buildings and their associated premises.

Several years of battery life

A long battery life is possible due to the low energy consumption of LoRaWAN sensors and actuators. Battery life is dependent on the specific type of device, transmission interval, signal reception strength and data quantity. Especially with meters, which often transfer consumption data only once a day, battery lives of up to 10 years are feasible. This reduces time-consuming maintenance work involving facility management to a minimum and enables retrofit measures to be implemented in existing buildings in no time flat.

Low cost of network establishment

The entire LoRaWAN infrastructure incurs significantly fewer costs than using alternative technologies. Thanks to the long range and deep penetration, it takes fewer gateways to establish a private network. Those who rely on public LoRaWANs, can typically do without their own gateways and use the shared gateways of "The Things Network". Even the cost of end devices is relatively low.

Widespread and growing quickly

Cities, communities and energy service providers in Germany are heavily promoting the expansion of LoRaWANs. The popularity of LoRaWANs is also growing on a global scale. The LoRa Alliance is the non-profit organisation with the strongest growth in the IoT technology sector. It is an alliance of globally renowned technology companies such as IBM, Google, Amazon, Orange, Cisco or Microsoft.

LoRaWAN applications in building automation

LoRaWANs offer compelling advantages and continue to grow in popularity and importance. What exactly should LoRaWAN-based solutions be used for in building automation? We would like to present some of the most interesting application scenarios in smart buildings:

Digitisation of existing buildings

Roughly 80 % of the overall building cost are associated with the utilisation phase and/or building operation. A great savings potential can be realised here. Especially old buildings can be extremely expensive in operation and could therefore gain the most from digitisation. Since LoRa wireless sensors can be easily integrated, the heating control system, for example, can be digitised and automated in no time. This would considerably cut the energy cost at a low investment cost.

Heating control system using smart thermostats

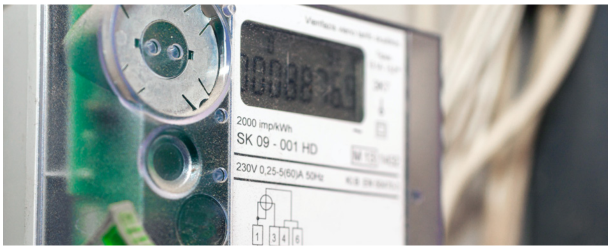
The energy efficiency of existing buildings with old radiators can be increased with smart LoRaWAN thermostats. The heating system would then no longer be controlled manually, but intelligently and fully automatically as needed. With the aid of a configured energy savings plan, the heat output would be reduced to a minimum on a fixed schedule, during weekends, for example.

Indoor air monitoring using CO_2indicators

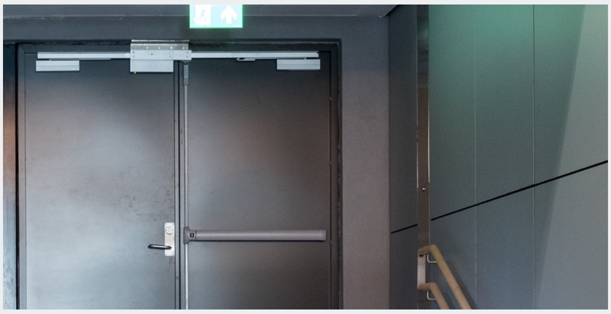
Monitor and optimise the indoor air quality for people in the building using LoRaWAN-capable CO_2 indicators or other sensors. This would provide people in the building with a sense of added safety, especially with the coronavirus pandemic. Improving the indoor air quality can even demonstrably increase the productivity and reduce the sickness absence rate.

Smart metering

LoRaWAN-based wireless solutions are suitable to automate the time-consuming and error-prone reading of meters. The recording and historisation of data help to increase the transparency and verifiability of the data from previous periods. Even interfaces to billing systems are conceivable. Meters no longer need to be read manually, which further facilitates facility management.



Automatic door closing



The closing of doors at the end of a workday can take quite a bit of time, especially in large buildings. Some doors also must be opened or closed at specific times for reasons of safety. Using LoRaWAN sensors and actuators, the door status can be indicated and changed at any time at the push of a button. There is no need for labour-intensive inspection rounds and possible malfunctions are immediately detected. Such a solution helps further increase fire safety because a fire source can be contained from a remote location.

Making energy consumption transparent

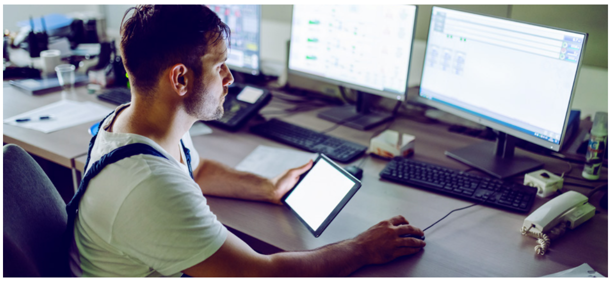
Transparency of energy consumption in a building is essential. LoRaWAN energy meters facilitate making the energy consumption of your building visible. Likewise, verification about the building energy efficiency can be readily collected and used to further optimise the building energy flow.

Cleaning on demand

The attendance hours of employees continue to vary widely. Periods with a varying degree of utilization have become normal. On one day the facilities are almost empty while on other days they are packed beyond capacity. For need-based cleaning, utilisation data is collected and forwarded to the service provider using LoRaWAN presence detectors. This data helps increase the efficiency of cleaning services.

Predictive Maintenance

LoRaWAN-based solutions can be used to alleviate facility management workloads and to identify potential errors or malfunctions before they occur. To this end, the status of an application or a device is monitored and a notification issued in good time whenever critical values are reached. For example, it is possible to have the status of a filter mat contamination level in the ventilation system transmitted so that components can be replaced in good time and downtimes can be avoided.



Detecting leaks immediately

LoRaWAN leakage sensors are often used to monitor basements or utility rooms, which are prone to leakage. Whenever sensors are used to detect water leakage, the status information can be directly forwarded to the facility management department. This way, action can be taken quickly so that major damage can be avoided to the extent possible.

Do you have questions about a specific application?

Let us find a solution together.

There are a great many ways to implement smart applications using a LoRaWAN. We would be happy to assist you in finding the best solution for your concern.

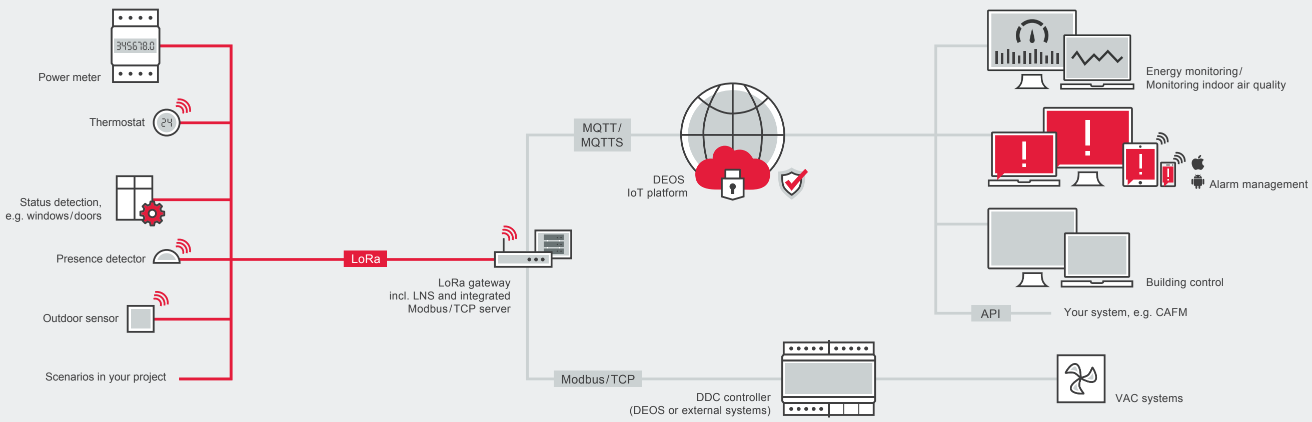
Get LoRaWAN consulting now

LoRaWAN with DEOS

DEOS AG is one of the first manufacturers in the building automation sector to offer practical LoRaWAN-based solutions to facilitate the digitisation of existing buildings.

Our LoRa portfolio is adapted to the requirements of building automation. LoRa gateways from DEOS are equipped with a built-in LoRa network server (LNS), for example, to keep the IoT data within a local network. A standard Modbus TCP interface enables the extraction of IoT data at any Modbus-capable DDC controller in the building. This way, LoRa end devices can exchange data bi-directionally with the existing building automation system or make available all collected data to the IoT platform of DEOS. The platform visualises the data for various applications such as smart metering, cleaning on demand or predictive maintenance. It is also possible to forward the data via MQTT to the IoT platform of DEOS or any MQTT broker. Customers are offered a mass integration tool to further simplify the commissioning of LoRa sensors with solutions from DEOS. This way, it takes just a few clicks to integrate numerous sensors into the network and activate them. This reduces provisioning costs to a minimum.

The solution provided by DEOS therefore offers all the advantages associated with the wireless LoRaWAN protocol plus complementary features and services specially geared towards the application in the building automation sector.



LoRaWAN rather than EnOcean

As a manufacturer of building automation, we make every effort to incorporate new IoT technologies in the products we develop. In contrast to the international market, in Germany, EnOcean is often mentioned as an IoT communication protocol. We have opted against EnOcean for some practical reasons.

Due to low building penetration, one of the major advantages of wireless technologies does not apply to EnOcean: little cabling effort. An EnOcean network requires a great number of repeaters and gateways so that in the end, the cabling effort is comparable to that of conventional sensors without wireless technology. In addition, the required infrastructure would further drive up the cost for providing a comprehensive network in a building.

This is exactly where LoRa offers decisive advantages for smart buildings, which we have already put to the test in numerous projects.

A brief introduction to DEOS AG

Technology for intelligent buildings

As an owner-managed and internationally operating company, we have been developing and manufacturing intelligent products, solutions and services for the automation and digitisation of buildings and facilities for 55 years. With our passion for innovation and dedication to quality, we deliver a sustainable product portfolio that combines the fields of heating, ventilation and air conditioning into an efficient and forward-looking overall system with the help of the latest IT technology. The simple system integration of building technology plays a particularly vital role for us. Every day, our employees are committed to system partners, specialist planners, end customers as well as operators and building owners all over the world. We do this to ensure the energy-efficient and sustainable operation of buildings. **For buildings that inspire.**

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