

White Paper

LONMARK® International and EnOcean Alliance team-up for optimal network topologies in building automation

Wired, LON bus systems tend to be the backbone for carrying information in building automation. But wireless systems have been growing in popularity since the arrival on the scene of energy-autonomous and service-free wireless components based on EnOcean technology. Practical experience shows that the two technologies side by side exhibit advantages that maintain the right balance. So an installation optimized in engineering and cost terms will transmit its information both wired and wirelessly – combining the strong points of both.

1. Wired and wireless compared

Features	Wired	Wireless
Range	++	-
Installation effort and flexibility	--	++
Data volume	++	--
Availability of information in room	-	++
Reliability	++	+
Cost	+	++

Table 1: Features of wired and wireless transmission media

This collective assessment of major criteria relevant for the market indicates that neither of the two transmission media comes out alone on top in a building automation scenario. For an optimal solution it takes both, each implemented where it is better than the other. These criteria are looked at below.

Range

If you want to transmit data over long stretches in a building (more than 30 meters for instance) there is no economical alternative to a wired bus. An obvious example is the transmission of sensor and actuator information across many floors from a central point.



Fig. 1: UNIQA Tower in Vienna, where the backbone links a large number of floors (© UNIQA Versicherungen AG – courtesy of Johnson Controls Inc. and Thermokon Sensortechnik GmbH)

But signal transmission within the same floor in a radius up to about 30 meters is easily handled by EnOcean wireless technology. What matters here is the choice of sub-gigahertz frequencies (868 MHz in Europe and Middle East and 315 MHz in the USA and Far East) that, in contrast to wireless systems like ZigBee and Bluetooth nestling in the 2.45 GHz band, exhibit especially low attenuation through walls, and achieve about twice the range for the same transmitting power.

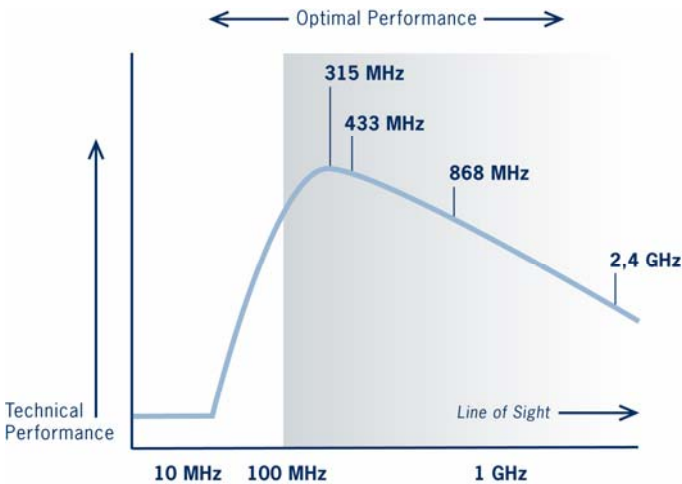


Fig. 2: Transmission loss vs. frequency

Figure 2 illustrates the performance of wireless systems in buildings as a function of their frequency. Frequencies below 250 MHz are at a disadvantage because of the inefficiency of their antennas if these are made compact enough to match market requirements. While frequencies of 1 GHz and more suffer increasingly from propagation loss through walls and

other obstacles. Between about 300 MHz and 1 GHz you find low attenuation and thus the range needed to make a system economical, i.e. few nodes per area covered.

Installation effort and flexibility

When it comes to installation effort, building alterations and subsequent wishes for expansion, the advantages are clearly on the side of wireless technology. Wireless components can be fitted fast, for little cost, even on surfaces inaccessible for wired solutions. Speed and flexibility are advantages not only when expanding and altering at a later date but also during initial planning and final installation; where components' placement can be changed at the last minute – a relatively common occurrence in building operations.

Data volume

Images, voice, software, database content, and other large amounts of data cannot be transmitted wirelessly in a way that saves energy (i.e., batteryless and service-free). Wired bus systems are the better choice for these purposes, with fewer bandwidth limits and energy restrictions set by governments.

Wireless sensors are in principle more suitable for sending measured data and control commands, which in most cases are of small data volume.

Availability of information

A basic advantage of wireless systems is that the information they send is accessible anywhere in a room or space – not just along the wires. So components can be optimally positioned without bothering about wires already laid and the inaccessibility of places for wiring. Here again, wireless is not just a substitute for wire; instead, it opens-up new application possibilities.



Fig. 3: Window contact



Fig. 4: Bidirectional wireless room sensor

Reliability

The reliability of wired bus systems has been adequately proven in practice.

When it comes to wireless systems, some people are still skeptical but increasingly feeling more confident. After all, there are already tens of thousands of buildings benefiting from the advantages of EnOcean wireless technology. They include corporate headquarters (SAP, IBM, Bosch, Siemens, Nestlé), public buildings (schools, hospitals, government facilities), historical buildings, residences, landmarks, and hotels.

First, the technical issue of wireless transmission are addressed by a quality technology quite different from the lower quality products marketed by various providers. Well-founded planning is the next building block in the reliability of wireless systems. Here, EnOcean offers the support of instrumentation tailored to that purpose; plus, planning guidelines proven in practice.

How wireless components obtain their energy is a further and major aspect of secure, reliable installation. Reduced range, rather than failure of sensing, is the result of batteries running out of power, which results in having to replace batteries to keep the system functioning as a whole. In the EnOcean technology, the focus is "no batteries; so, no service." That is what makes the use of freely available ambient energy – generated by the sun, motion, heat, or vibration, for instance – a key benefit of wide market acceptance of this wireless solution, especially in office buildings. The concerns of builders, architects, and facility managers regarding battery-powered wireless sensors are quite justified when you think of the thousands of batteries in a modern building that need regular replacement. But these concerns do not apply to EnOcean sensors. Additionally, data published about the expected, average lifetime of batteries can seldom be taken taken at face value. Although the use of batteries may initially be more cost-attractive, service, disposal (toxic waste), and malfunctions can fast negate the initial savings.

Cost

Today's wireless systems already offer cost advantages of as much as 15 percent upon first-time installation (depending on complexity) compared to some wired solutions with the same range of functions. When alterations or expansions are undertaken (statistics show that the average office building is reconfigured about every five years) the cost benefit can go up to 80 percent.

2. Examples of EnOcean plus LON

Energy saved through energy efficiency

About 40 percent of the energy needs of industrial nations are consumed in buildings – where the potential for saving is quite enormous. How often have you driven past an office block late in the evening where all the lights are on, but apparently only a handful of people are still working? How often have you entered an empty room where the heating or air-conditioning has been going full blast for hours?

The necessity to save energy is not only driven by its high cost, with current prices of over \$100 per barrel of oil. It is especially due to the fact that in the future many nations simply will not have enough energy at their disposal.

Energy saving, therefore, increasingly becomes a challenge; in answer to which, a success rate of 100 percent is a rarity. Costly schemes governed by demand for those regions highly affected are merely a shortterm necessity. The most-effective solution is to

construct new buildings, or alter older ones, to make them energy-efficient. In a typical case, it is possible to save more than 30 percent of the building's energy consumption.

Putting LON and EnOcean together

The joint objective of LONMARK International and the EnOcean Alliance is: simple but substantial reduction of the energy requirement in buildings. The two technologies match optimally for the purpose: LON is the leading wired technology (over twisted-pair cable, coaxial cable, optical fiber, and power-line mains) for intelligent building-services management with around 100 million devices with the technology; while EnOcean represents wireless-based automation technology, with already tens of thousands of systems implemented in buildings worldwide.

For example, self-powered sensors and actuators communicate wirelessly as an intelligent subnetwork in a room or area, doing away with conventional cabling precisely where the configuration of the room is most frequently altered, and of course avoiding the associated costs.

Communication with the control or supervision level can then travel through LON gateways, each linking many rooms or intelligent subnetworks to the LON backbone of building automation. In this way, the flexibility of a wireless system is ideally combined with the large bandwidth and range of a wired backbone.

The rooms in modern office buildings are rearranged on average about every five years, so wireless systems provide just the right flexibility. More and more, interior architects are discovering the new possibilities of design and installation presented by wireless systems. Where a switch or sensor is located no longer by where electric wires are located. They can be put in the best place in ergonomic terms. Switches to control lighting and blinds can be simply attached to each workplace of an open-plan office, for example. Light switches can be adhered to the headboard of a hotel bed, to a mirror, the tiles, or near the shower partition in the bathroom.

Room temperature sensors no longer need to be installed near doors, avoiding corruption of the temperature reading by the opening and closing of a door. Products enabled by EnOcean reduce the laying of cables inside and outside buildings, allowing the user to place sensors just about anywhere (e.g. on glass, furniture, windows, ceilings).

Ideally suited for room automation

EnOcean nodes avoid the 2.45 GHz band of Bluetooth and WLAN, using instead the frequency of 868 MHz, which is license-free in Europe and the Near East (the counterpart is 315 MHz in North America and the Far East). All systems using the 2.45 GHz band have to share a limited number of channels. And the more popular this band, the more PCs with a WLAN link are stacked together, the greater the problems will become through interference with networks and other permanently active systems such as mobile phones, Bluetooth, and cordless video monitors.

Second generation of gateways will allow entirely bidirectional communication in the future. Data generated by EnOcean-enabled sensors can be retrieved direct by LON-based actuators and controllers. LON-based controllers can in turn communicate with EnOcean-enabled actuators.

Typical applications are energy-saving ones, such as dimming or turning-off the lights when a room is empty, HVAC halting when windows are open; or standby mode of heating, ventilation, and air-conditioning when a room is not being used.

EnOcean technology has become a standard among architects and system integrators all over Europe, and is now well set to satisfy big markets in North America and the Near East. Unlike meshed wireless networks, the wireless switches are not active and do not transmit all the time – only when actuated. Interestingly, the electromagnetic emission of an EnOcean switch is much less than that of a comparable, conventional switch for a 100 W bulb. Initial medical concerns about the high-frequency radiation from wireless sensors were satisfied by scientific experiments. The use of EnOcean switches can thus be recommended, without concern, in hospitals, schools, kindergartens, and government and office buildings. Likewise, there are no environmental or biological concerns regarding attaching such a wireless switch direct to the headboard of a bed or to a bedside table.

Deployment examples of LON and EnOcean

The combined advantages of LON and EnOcean have been proven in multiple deployments such as the office building shown in Fig. 5.

Four EnOcean/LON gateways were installed in the suspended ceilings of the corridors, each communicating with several offices, all featuring room temperature sensors, switches for lighting and blinds, window contacts to monitor the status of balcony doors, and multisensors to detect motion and brightness. Altogether, wireless components were installed in the reception, the kitchen, the lunch room, the engineering offices, the conference room, and six offices (the largest more than 1000 square feet).



Fig. 5: Office Building with LON/EnOcean Technology (courtesy of Thermokon Sensortechnik GmbH)



Fig. 6: LON service room

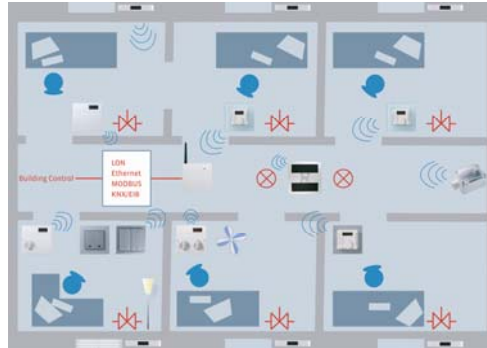


Fig. 7: Layout LON/EnOcean Installation



Fig. 8: Wireless Sensor on glass

The installation is a good illustration of seamless interaction between wired LON sensors and EnOcean-enabled wireless components. The gateways are above the suspended ceilings in the corridors. Apart from 230 Vac sockets and the computer network installed in floor tanks, the offices are cableless, avoiding any excessive cost if and when the rooms are reconfigured.

The heating and lighting of the single offices are automated. As soon as the wired LON multisensors detect a movement in an office, the lights go on – either the entire lighting or just single lamps depending on ambient light.

The setpoint of the heating system—controlled by the signal of the motion detector—increases from standby to normal when the balcony door is closed. The heating valves are controlled by LON I/O modules, communicating with the wireless room temperature sensors and window contacts. With the availability of the new bidirectional LON gateway, the outside blinds, lighting, and heating valves will also be wirelessly controlled by I/O modules. At the moment these outside blinds are still controlled manually. There are also plans to link automation to a weather station.

About LONMARK International

Since its inception in 1994 and new corporate structure in 2003, LONMARK International has become a major driving force in the establishment of interoperable guidelines for building, industrial, transportation, residential, and utility automation.

LONMARK membership is open to any manufacturer, distributor, engineer, system integrator, or end-user committed to the development, specification, and use of open, interoperable products utilizing ANSI/CEA 709.1 and related standards.

LONMARK International is a non-profit, mutual-benefit trade association with close to 600 members worldwide, and local affiliates in the Americas, Asia, and Europe. LONMARK's mission is to create, support, and promote the standards for open, interoperable LON - based products, systems, and professionals. For more information about LONMARK International, testing, and educational opportunities please visit www.lonmark.org.

Products, which have been verified to conform to the LonMark interoperability guidelines, are eligible to carry the LONMARK logo.

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About the EnOcean Alliance

The EnOcean Alliance is a consortium of over 60 companies working to further develop and promote self-powered wireless monitoring and control systems for sustainable buildings by formalizing the interoperable wireless standard. It has the largest installed base of field-proven wireless building automation networks in the world.

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