White Paper

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

When it comes to choosing a facility's backbone for carrying building-automation information, wired LON® bus systems have become the norm. However, wireless systems have been growing in popularity since the arrival 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 an ideal wired / wireless balance—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.

<u>Range</u>

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. For communication between buildings, long distances, and for very large amounts of data, fiber optic networks are a good option.

Fig. 1: UNIQA Tower in Vienna, where the backbone links a large number of floors (© UNIQA Versicherungen AG)

But signal transmission within the same floor, in a radius up to about 30 meters, is easily handled by the right wireless technology: EnOcean. The differentiator that sets EnOcean above other, potential wireless choices is the use of sub-gigahertz frequencies: 868 MHz in Europe and the Middle East, and 315 MHz in the USA and the Far East. These frequencies are in contrast to wireless systems like those based upon 802.15.4 RF radios and Bluetooth, nestled in the 2.45 GHz band. The lower, more optimal frequencies exhibit lower attenuation through walls and achieve about twice the range for the same transmitting power.

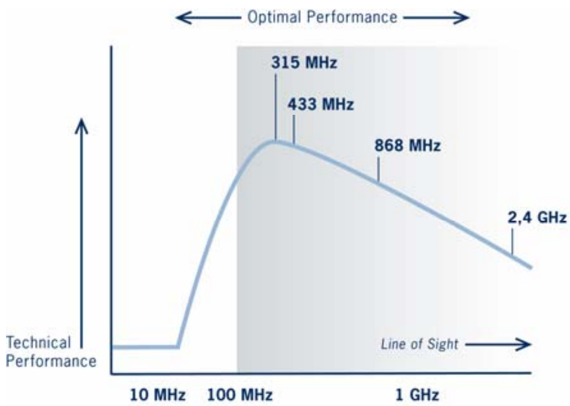

Fig. 2: Transmission loss vs. frequency

Figure 2 illustrates the performance of wireless systems in buildings as a function of their frequency. Frequencies below 250 MHz are unfavorable because of the inefficiency of their antennas, if these are to be made compact enough to match market requirements. On the opposite end, frequencies of 1 GHz and higher suffer increasingly from propagation loss through walls and other obstacles. The ideal range is found between around 300 MHz and 1 GHz, where you find low attenuation and the range needed to make a system economical; *i.e.*, fewer devices per square meter.

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 easily fitted, 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

Battery-less and service free wireless sensors are ideal for sending measured data packets and control commands, which in most cases are of small data volume.

These data packets can then be funneled back to monitoring stations or shared with other devices in different locations via a wired infrastructure, where higher bandwidths are available, where fully isolating routing can be achieved, and where fewer government restrictions are imposed.

Availability of information

A benefit of using wireless is that the information sent by devices is accessible anywhere in a room or space, not just along the wires. So components can be optimally positioned without concern for existing wires or inaccessibility of places for wiring. Combining a wired LON system with EnOcean wireless components allows an installation to benefit from both technologies.

Fig. 3: Window contact

Fig. 4: Bidirectional wireless room sensor

Reliability
The reliability of wired LON bus systems has been proven for decades in over 100 million devices.

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

First, the technical issues 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 servicing." The use of freely available, ambient energy—generated by the sun, motion, heat, or vibration, for instance—is a key benefit of the 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 would 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 at face value. Although the use of batteries may initially be more cost-attractive, the service, disposal (toxic waste), and malfunctions can quickly negate the initial savings.

Cost

Today's wireless systems already offer cost benefits of as much as 15% upon first-time installations (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%.

Tying the EnOcean systems into the LON network allows those benefits to increase by extending the physical reach of the data they share.

2. Examples of EnOcean plus LON

Energy saved through energy efficiency

About 40% of the energy needs of industrial nations are consumed in buildings—where the potential for savings is quite enormous. How often have you driven past an office block late in the evening where all the lights are on, but only a handful of people can be seen 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 US$100 per barrel of oil. It is especially due to the prediction that many nations will simply not have enough energy in the future to satisfy their needs.

Energy savings, therefore, increasingly becomes a challenge; in answer to which, a success rate of 100% is a rarity. Costly schemes governed by demand for those regions highly affected are merely a short-term necessity. The most effective solution is to construct new buildings, or alter older ones, to make them energy-efficient. In a typical reconstruction case, it is possible to save more than 30% 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 using 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 sub-network in a room or area; doing away with conventional cabling precisely where the configuration of the room is most-frequently altered. This also obviates the need for those associated costs.

Communication with the control or supervision level can then travel through LON interfaces, each linking many rooms or intelligent sub-networks 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 attached simply 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, and ceilings).

Ideally suited for room automation

EnOcean nodes avoid the 2.45 GHz band of Bluetooth and WLAN. Devices in that range have to share a limited number of channels. The more popular this band becomes (the more WLAN-enabled PCs are available), the greater the problems will become through interference with networks and other permanently active systems, such as mobile phones, Bluetooth, and cordless video monitors.

Future, second-generation interfaces will allow entirely bidirectional communication: Data generated by EnOcean sensors can be retrieved directly by LON actuators and controllers. LON controllers can in turn communicate with EnOcean actuators.

Typical applications are those revolving around energy savings, such as dimming or turning-off the lights when a room is empty; HVAC halting when windows are open; or standby mode of heating, ventilating, 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 directly 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 interfaces 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 multi-sensors 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

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 wireless components. Apart from 230 VAC sockets and the computer network installed in floor tanks, the offices are cable-less, 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 multi-sensors 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 bidirectional LON interface, the outside blinds, lighting, and heating valves will also be wirelessly controlled by I/O modules. At the moment, these outside blinds are still manually controlled. 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 based of field-proven wireless building automation networks in the world.

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