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WIRELESS SENSOR SOLUTIONS FOR HOME & BUILDING AUTOMATION
- THE SUCCESSFUL STANDARD USES ENERGY HARVESTING –
- "GREEN SMART WIRELESS"

The endless opportunities and advantages of low power wireless sensor solutions have been widely publicised over the past decade. The message is a very strong and powerful one – making the world a safer, more comfortable, more energy efficient and environmentally friendlier place through the wide availability of small, cost effective wireless sensors which, if required, can also be networked. Mass deployment is now a reality thanks to en-vironmentally friendly "green wireless" energy harvesting technology: "No batteries, no wires."

Graham Martin, Vice President Strategic Alliances EnOcean

Reports of exciting new solutions which will save us 30% energy costs in buildings or ones which will make our homes safer and more comfortable through wireless control and monitoring as well as other ground breaking projects in a variety of new applications such as medical, environmental monitoring, security & homeland security, industrial monitoring, transportation & logistics can be read daily.

The ZigBee Alliance for example has been a highly successful evangelist bringing the positive message of such cost effective wireless sensor solutions to the masses over the past 6 years, with hundreds of active member companies and tens of thousands of developers taking an interest in the technology. ZigBee is an open standard software stack based on the IEEE 802.15.4 wireless standard. Many small companies such as Zensys, Coronis or SmartLabs have also actively promoted their own low power wireless sensor technologies (ZWave, Wavenis, Insteon) creating much interest. Other emerging solutions such as Wireless HART, SP100 (highest end industrial) or Wibree (short range PAN communication) also help to emphasize how exciting and wide-spread the wireless sensor networking world has become.

Where are the Products?

Who is actually winning the race for this exciting new multi-billion dollar market and why can easily be monitored by who has production proven products already with mass deployment in a variety of buildings – both commercial and residential.

ZigBee on its website currently boasts 5 compliant products (actually modules – not end products) available. Closer examination of the multiple releases about "ZigBee Products" reveals that with the exception of the above 5 modules none of these are actually ZigBee compliant products, none of these are interoperable and there are no mass deployments of ZigBee interoperable compliant products in any building anywhere in the world. Not exactly what one expects after hearing the vast marketing propaganda over the past 6 years. ZigBee currently has a 2004 and a non-compatible 2006 version released and is working on a (yet again) non-compatible new release "ZigBee Pro". Add the various different frequency variations, the various security levels and the various different application profiles and it becomes clear that "interoperable standard" is currently still a myth created by a huge, but highly effective marketing machinery.

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Insteon and ZWave claim to have 36 and 85 products respectively using their technologies on the shelves, the majority of which are (local) aftermarket products not yet achieving significant volume breakthroughs in the mass home and building automation market. Coronis has a relatively small number of successful volume deployments mainly in longer range automatic meter reading systems.

The majority of these players have only seen very limited isolated successes, so who is actually deploying the wireless products helping to create real energy saving "intelligent green buildings" and why?

One company - EnOcean – a spin-off from Siemens in 2001 – decided to follow a unique path. EnOcean believed that no-one really wants a whole bunch of battery operated systems in and around their homes and buildings. Batteries need changing every few months to few years. Empty batteries can cause system failures, frustrations and even danger – not to mention the environmentally unfriendly issue of battery disposal. Especially in a commercial building with many thousands of nodes it is a nightmare just thinking about this responsibility – let alone the cost of actually performing the task of regular battery maintenance. Batteries are cheap but maintaining and replacing them just isn't.
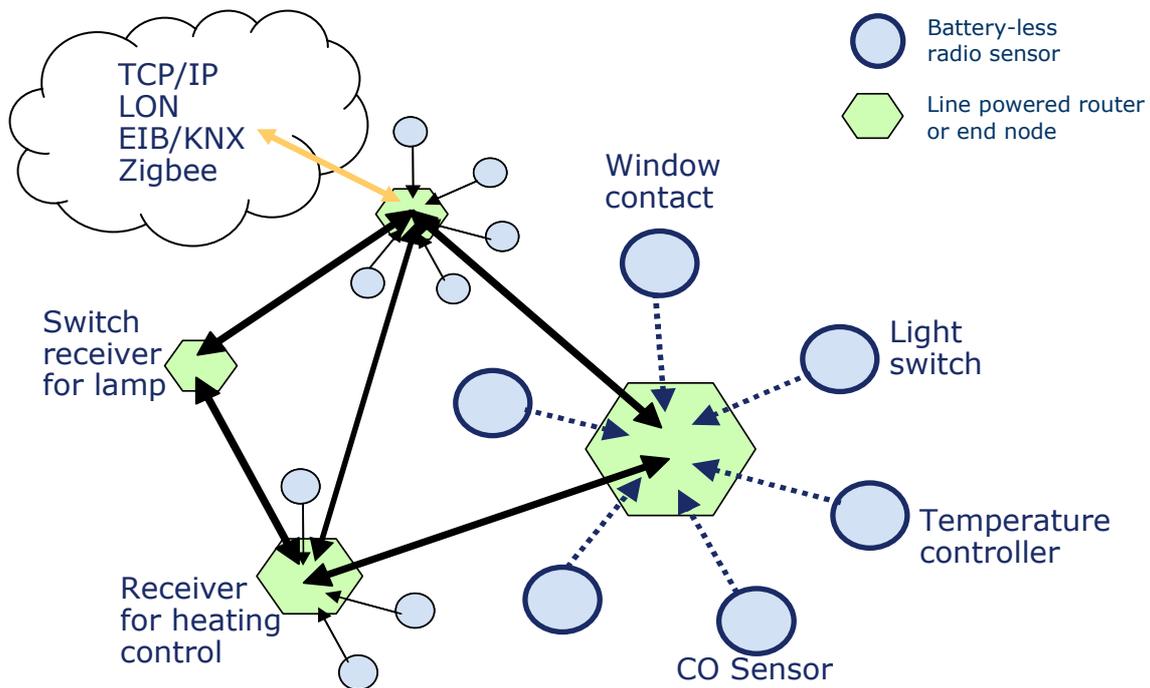

Figure 1: Example of EnOcean Wireless Networking System with battery-less nodes

"No Batteries, No Wires"

EnOcean therefore quietly developed and deployed wireless sensor systems based on energy harvesting techniques. It is for example possible to switch on and off or dim a light with a standard size light switch without any batteries nor any wires – utilizing merely the mechanical energy necessary to press the switch.   The mechanical energy used to move a window or door handle can be utilized to send a wireless signal to a security system or to control an HVAC unit ultimately saving large amounts of energy.   Solar driven motion or occupation sensors, thermostats, CO sensors, industrial sensors, window / door contacts and many more have already been successfully deployed on a wide-scale allowing low cost, flexible and reliable wireless monitoring and control.   EnOcean enabled solutions retain the benefits of wireless: low cost deployment, portability and widespread availability of information with the "install and forget" attributes of a wire.
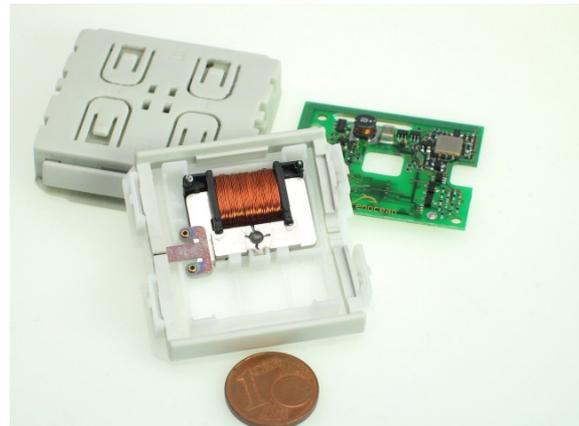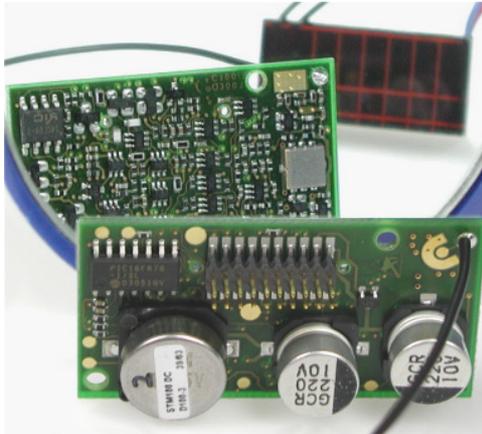
Picture 1: EnOcean Battery-less Modules

Lowest Power Wireless Solutions

EnOcean systems not only offer the unique and deciding factor of no battery requirement, but also offer superior performance (See Table 1). The energy required to successfully transmit signals using the EnOcean standard is around one-tenth to one hundredth that of other low power wireless technologies available today. An EnOcean solar driven system can therefore operate for many days in total darkness using the simplest small and cost effective solar panels. Signals can be sent over 300m in free space and typically around 30m in buildings. The EnOcean solution also avoids the shorter range and overcrowded 2,4GHz band (WLAN, Microwaves, Bluetooth,…) and therefore does not have the extremely worrisome issue of lost or destructed signals – even to the point of complete system failure – other low power wireless sensors have to cope with. Each EnOcean transmission signal is repeated multiple times at optimal time-slots giving the industry maximum in signal reception reliability.

First generation energy harvesting solutions are based upon linear motion or solar energy, new generation products in development will also include thermal, rotational and vibration energy harvesting opening up even more new markets. In the future, OEMs will choose different energy harvesters based upon their environment, whilst retaining interoperability between finished devices.

All in all, EnOcean has quietly met the needs and requirements of users in home and building automation resulting in wide-scale deployment success. The recipe: no batteries, no wires, no maintenance, simple to install, highly reliable, interoperable, green, cost saving, …no propaganda.

There are now over 265 products on the shelves from over 60 OEMs enabled by this revolutionary energy harvesting technology. Tens of thousands of commercial and residential buildings are already enjoying the flexibility and advantages of this "no wires, no batteries" intelligent technology, many of which have many thousands of nodes interoperating. Examples include the SAP Headquarters, IBM Offices, Bosch-Siemens Headquarters, UNIQA Tower in Vienna, Office Buildings in King of Prussia, PA, and the 57 floor "Torre Espacio" with over 4,000 wireless nodes driven by EnOcean technology.

Picture 2: SAP Headquarters with over 2,000 EnOcean enabled Switches and Gateways

Picture 3: Bosch-Siemens Headquarters with EnOcean enabled Thermostats and Switches, installed 2003

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Picture 4: Office Building 1,000 Continental, King of Prussia, PA with EnOcean enabled wireless sensors
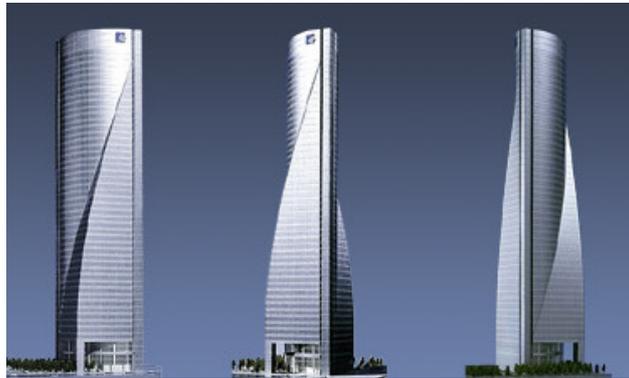
Picture 5: "Torre Espacio" 57 floors in construction with over 4,000 EnOcean enabled wireless sensor nodes. The worlds tallest building with wireless sensor networking.

What is a Global Standard?

A standard requires multiple OEMs and multiple products which are compatible and interoperable. A standard can be created by a number of companies who spend many years creating basically a compromise of ideas with the aim at the end of the day that this will be suitable for mass deployment. Bluetooth was initially proposed as the short range wireless solution for virtually every application, yet after many years found its sweet spot in cable replacement in mobile phones / wireless headsets. ZigBee based on IEEE 802.15.4 is still searching to discover its true niche, conflicted over how to be competitive in low cost residential applications yet robust enough for the highest end industrial uses. The lack of interoperability of the various ZigBee stacks and application profiles continues to delay adoption and market acceptance. Over time if the standard matures and interoperable solutions for specific niches become widely available, ZigBee networks will likely play a role as part of a larger ecosystem bridging better suited and proven technologies such as EnOcean energy harvesting nodes for end nodes with hard-wired existing backbones such as the Internet, LonWorks or Bacnet.

A leading standard can also be created by multiple OEMs with multiple products already successfully deploying interoperable products to a mass market requesting the formalization and regulation of the revolutionary technology. This is the model applicable to EnOcean which is currently forming the EnOcean Alliance for Green Intelligent Buildings and will shortly formalize the worlds only true low power interoperable wireless networking standard for home and building automation.
"Green, smart, wireless"

	EnOcean	ZigBee	Z-wave	Insteon	Wavenis
Target Market	Residential & Commercial	Industry, Medical, Telecom, Consumer, Residential, Commercial,…	Residential Aftermarket	Residential Aftermarket	Long-range Meter Reading
Offering	Complete Modules	Complex Software Stack for RF Chip	RF Chip + basic software	RF Chip + basic software	RF Chip + basic software
Battery & Maintenance Free	YES	NO	NO	NO	NO
Frequency	868/315MHz (2,4GHz)	2,4GHz (868 / 915MHz)	868 / 908MHz	904MHz	400 / 868 / 915MHz
Interference Risk	Very low	Very high (2,4GHz)	Medium	Medium	Low
Minimum Telegram	0,6ms	Typ. 4ms	20ms	28ms	
Sleep Current	0,08µA	1µA	2,5µA		1,8µA
Data Rate	125kbps	250kbps	9,6kbps	2,9kbps	9,6kbps
Total System Energy Requirements	Factor 1	Factor 10-100s	>Factor 50	>Factor 50	>Factor 100
Range: Line of Sight (LOS)	300m	30 – 100m	300m	50m	1000m
Product Interoperability	YES	Limited (multiple non-interoperable stacks/profiles)	Limited	YES	Limited
Life Cycle - Cost	Excellent	Good	Good	Good	Good
OEM Products on Shelves	>265	<10	c. 100	< 100	< 25

Table 1: Comparison of low power wireless sensor solutions

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About the Author

Graham Martin is a veteran in the electronics industry with 25 years experience in analogue and RF solutions at various Engineering, Sales and Marketing positions in USA, GB, Germany, Austria and Norway. Before joining EnOcean in 2007 he was a worldwide pioneer in low power wireless sensor networks at leading start-up Chipcon (purchased 2006 by Texas Instruments) where he conducted the worldwide business development activities, served as President of Figure8Wireless and was Vice President and on the Board of Directors of the ZigBee Alliance. Graham is a Physics Graduate from the University of Edinburgh, Scotland.
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