Building of a Smart System Application (SSA) through Energy Harvesting Wireless Technology

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Abstract— A progressing point in remote sensor systems is the mean to save energy. This regularly requires improved conventions with a lessened execution and strength. One as of now effective remote innovation with an extremely strict low-control configuration is Enocean. EnOcean remote innovation utilizes a mix of energy gathering and low power remote interchanges to empower for all intents and purposes uncertain correspondences to be kept up without the requirement for energizing. This enables EnOcean customers to create self-powered wireless sensor solutions that are fundamental for efficiently managing energy in buildings and industrial applications. Using optimal techniques for energy management, that make sure, that our devices function with even the tiniest amounts of energy, to transmit sensor information via radio. Usage of intelligent software-stacks, which enable a modular, versatile and user-friendly integration into the customer application. Energy harvesting wireless technology is an attractive solution for the flexible and maintenance-free collection and transmission of all types of data. Energy harvesting turns self-powered sensors into important assistants that help us performing the tasks of our modern lives.

Key words: Micro-controller, Repeaters, Self-powered, Telegram

I. INTRODUCTION

Wireless sensor and actuator networks are picking up force in a few application ranges. Building automation is one held of enthusiasm for which the simple establishment and exibility of remote gadgets rapidly pays off and opens new showcase sections, for example, retorting old structures or present day office structures with glass dividers and exible room utilization. EnOcean is one wireless network innovation that joins the exibility of remote gadgets with inventive energy-harvesting gathering approaches that explain the famous battery issue normal for wireless gadgets. EnOcean wireless transmitters produce their vitality from the environment. This energy collecting empowers remote and battery less switches and sensors for building, home and modern computerization. Expels the requirement for energy to be specifically connected accordingly diminishing the cost of the system operation. Implanted EnOcean radios transmit exactly 300 meters in a free field the length of three soccer fields.

A remote sensor is worked by the littlest measure of encompassing energy. Pressing the button of a TV remote control takes a various of this. A minor magnet and coil system creates an electric voltage from finger pressure, for instance, like the way a dynamo for a bike light produces power. Around 50 micro joules per activity are adequate, similar to lifting 1 gram by 5 mm.

A. Energy Sources

There are three main sources of energy the EnOcean technology is using: motion, light and differences in temperature. In the process, an electro-dynamic energy converter uses kinetic motion, or a miniaturized solar module generates energy from available light in a room. Combining a Peltier element with a DC/DC converter taps into heat as an energy source. These small amounts of harvested energy are sufficient to transmit and receive wireless signals and enable operation of numerous maintenance-free sensor solutions. This includes battery-less switches, intelligent window handles, solar-powered temperature, humidity and light sensors, as well as self-powered occupancy sensors or even relay receivers.

1) Energy from motion

The mechanical energy converter ECO 200 converts mechanical energy, the press of a switch for example, into electrical energy. With an energy output of 120Ws and an according wireless battery-less module, it is possible to transmit three radio telegrams per operation. Energy from light: Miniaturized solar modules, not larger than 13 mm x 35 mm, can even use indoor light to supply electricity for ultra-low power wireless radio modules. If a measured value is transmitted every 15 minutes for example, 3.6 hours of charging in daytime and 200 Lux are adequate for an uninterrupted operation.

2) Energy from temperature differences

Thermo generators, so-called Peltier elements, gain the energy. The ECT 310 DC/DC converter already starts to resonate upwards of 10 mV input voltage. On 20 mV (temperature difference about 2 K), a useful output voltage of more than 3 V is generated

B. System Features

Firmly enhanced system solution, simple to coordinate segments: Energy converters, vitality administration and radio modules, system and correspondence programming. Operating energy is generated by pressure, movements, light, temperature, vibration, rotation, etc. Radio modules without batteries: The required operating energy is typ. 50Ws per radio telegram only (similar to lifting a mass of 1 gram up a 5 mm altitude).

Reliable signal transmission, suited for systems with several of sensors (since signal transmission time is a thousand of a second only) High transmission range: Up to 300 m open air (= length of three soccer fields), up to 30 m indoor (= ordinary scope of a private home or a fire insurance territory of a business building). Negligible outflow of energy: Less than the start radiation of a regular light switch, one million times less a cell phone (confirmed from ECOLOG organize). Prearranged transmitter to receiver assignment: Four billion code numbers are fixed, simple

learning strategy (push recipient learn button and initiate transmitters).Reliable against outer aggravations: Repeated radio signal transmission deferred aimlessly, using of regulated frequency ranges approved for pulsed signals only.

C. EnOcean Platform

EnOcean offers its OEM clients an entire plug & play arrangement of vitality converters, vitality administration, remote modules, software and development tools as well as an energy saving, very reliable radio protocol. All platform components are optimally matched to each other. Contingent upon the energy prerequisites, this total bundle empowers a few remote applications, which work without wires and batteries. In establishing this comprehensive platform, EnOcean has managed to keep the integration barriers extremely low. This enables easy integration processes, without the need for in-depth knowledge of battery-less technology.

II. ENOCEAN RADIO PROTOCOLS

The goal of EnOcean Radio Protocol is to improve performance and to enable implementation on a wide variety of RF transceiver architectures. The communication protocol is packet based and the data units can be of three different types: Frame, Sub telegram, Telegram.

A. Data Unit Description

A frame is the representation of the encoded data on the physical layer. It includes control and synchronization information for the receiver. A frame is transmitted as a bit by bit serial sequence. A subtelegram is the result of a decoding process, in which this control (PRE, SOF, INV and EOF) and synchronization information are removed from the frame. The reverse mechanism to get a frame from a subtelegram is the encoding process. The subtelegrams are handled in the data link layer. The ERP protocol is designed to work mostly as a unidirectional protocol without handshaking. To ensure transmission reliability three identical sub telegrams are transmitted within a certain time range. Each transmitted sub telegram is an atomic unit and contains all the information the composed telegram contains.

Layer	Services	Data Units
Application (API)	EnOcean Equipment Profiles (EEP) RPC/RMCC handling	DATA
Presentation	Radio Telegram Processing Encryption	DATA
Session	--- not used ---	--
Transport	Smart Ack Remote Management	TELEGRAM/ MESSAGE
Network	Addressing telegrams (ADT Encapsulation/Decapsulation) Switch telegram conversion (choice/status processing) Repeating (status processing)	TELEGRAM
Data Link Layer	Subtelegram Structure Control Sum Calculation Subtelegram Timing Listen before talk	SUBTELEGRAM
Physical	Encoding/Decoding (inverse bits) Radio reception/transmission	BITS / FRAME

Fig. 1: ERP in OSI Layers

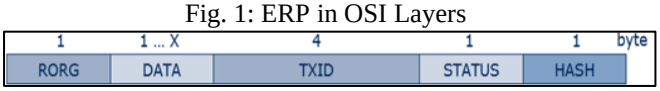

Fig. 2: Structure of a sub telegram

The universal fields are: RORG/CHOICE identifies the subtelegram type DATA the payload of the transmitted subtelegram TXID/SourceID identifies the transmitter, each having a unique 4 byte identity STATUS identifies if the subtelegram is transmitted from a repeater and the type of integrity control mechanism used. This field is not present in a switch telegram. HASH/Checksum data integrity check value of all the bytes. The length of the subtelegram is not transmitted in the subtelegram structure. The length is determined by counting the number of bytes starting with RORG and ending with HASH.

III. DATA INTEGRITY AND SECURITY

In order to check that a sub telegram has arrived intact, a hash of the telegram is calculated before transmission and attached to the sub telegram (field HASH). The attached hash value is not protected and thus only serves to detect transmission failures not protection against malicious intent. The verification is done by the device receiving the telegram, i.e., a receiving device or a repeater. If the verification of the intactness of the received sub telegram fails, the sub telegram is ignored.

A. Data Integrity

EnOcean modules transmit data parcels aimlessly interims to guarantee that the likelihood of crash and obstruction is greatly little. As a result, a range of switches and sensors using the sub 1 GHz frequency band can be operated in close proximity to each other. Besides this, each EnOcean standard module comes with a unique 32-bit identification number (ID), which cannot be changed or copied and therefore protects against duplication. This validation technique offers field-demonstrated secure and solid correspondence in building mechanization. For applications asking for extra information security, e.g. in smart home systems, EnOcean protects battery- less wireless communication in sub 1 GHz with enhanced security measures to prevent replay or eavesdropping attacks and forging of messages. These features include a maximum 24-bit rolling code (RC) incremented with each telegram and state-ofthe-art encryption using the AES algorithm with a 128- bit key.

1) Data Security

EnOcean radios are low vitality however not low power. Energy is the result of energy duplicated by time. The transmitting power decides the remote range, so there must be no reserve funds here. EnOcean innovation should thus be to a great degree quick. The span of a run of the mill EnOcean radio wire is short of what one thousandth of a moment. The microcontroller, the estimation hardware and the RF transmitter of the remote sensor are driven for only a couple of thousandths of a moment for each activity Sensor components associated with the controller A/D converter convey information that, gave a recognizable proof number and a checksum, are sent by the RF transmitter as a computerized information wire. Energy store and rest clock are parts of the remote sensor that need ceaseless supply. These hardware parts are viably upgraded for power utilization of some Nano amperes just, making it conceivable to work them on small measures of collected encompassing energy.

2) Low Risk

The transmission medium of wireless is of course the air, which has to be used by all wireless transmitters alike. When a number of transmitters is operating on the same frequency, there is always the risk that two data telegrams are transferred simultaneously, and that the information they carry is destroyed through collision. The collision probability of EnOcean radio telegrams is extremely slight because the signals are so short. In addition, the telegrams are sent repeatedly within a few milliseconds and randomly offset from one another in time. So, hundreds of wireless sensors successfully coexist. Each sensor is programmed with a unique 32 bit address that is transferred with each radio telegram. More than four billion transmitters can be distinguished from one another.

B. Ecological Importance

The operation of an ordinary switch delivers a breakaway start, at the end of the day, a broadband radiation beat specifically on the switch. This breaks down in the wake of voyaging a short separation. Be that as it may, it about dependably hits the individual at the switch. When a remote switch with low- control electronic hardware is worked, no breakaway start is delivered.

Rather a moderately low-controlled remote flag is sent to a collector for a thousandth of a moment. The current is exchanged on at the collector, which is about dependably a couple meters far from the individual, and the broadband radiation beat (electro smog) in this manner breaks down noticeable all around. There is considerably less cabling in the divider, so low frequency 50/60 Hz radiation is additionally decreased. EnOcean remote modules are altogether produced in accordance with the new European RoHS mandate, prohibiting the utilization of dangerous substances in electrical and electronic gadgets

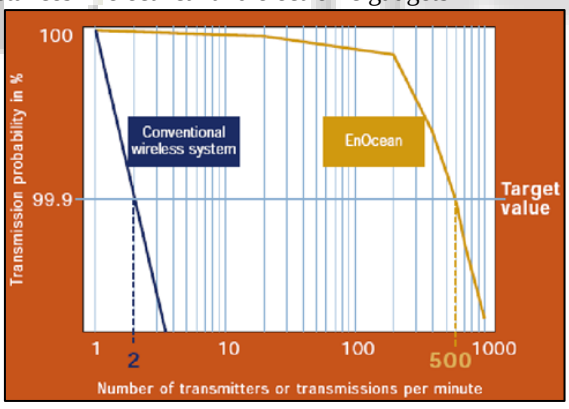

Fig. 3: Low collision risk through extremely short telegrams allows hundreds of transmitters in a single radio cell

C. Real Time Usage

1) Building Automation Home System

Energy harvesting wireless applications are very well established in the building automation and smart home sector. The self-powered sensors and switches bridge the last meters in a communication sys- tem, delivering the needed data from many different points for intelligent HVAC, lighting or shutter control to reduce energy consumption and increase comfort and security. Solutions range from window contacts and temperature, brightness and humidity sensors to presence detectors, CO_2 metering devices and even thermal-powered heating radiator valves or complete smart home systems.

2) Machine-to-Machine

Due to its unique characteristic of combining wireless, battery-less and maintenance-free operation, energy harvesting wireless technology is rapidly becoming the established standard for the last leg communication level in M2M applications. The vigilant sensors can warn against danger, monitoring liquid and gas leaks, for example, or can be used in early warning systems for avalanches. In addition, agricultural monitoring is a M2M application with a highly promising future. In this case, long range self-powered wireless sensors are placed over large areas to provide early warnings or to monitor farm animals and plants in order to react very quickly to changing conditions. Sensors monitor the degree of humidity or soil nutrients for an optimal supply of water and care for plants. Similar sensors can monitor parameters related to structural health of buildings, bridges, tunnels, dams or drilling platforms. This includes integrity, position, and vibrations and acting as an early warning system. The energy harvesting wireless technology also enables wireless bus stop buttons and facilitates continuous, maintenance-free monitoring of logistics processes and cold chains.

3) Internet Of Things

EnOcean has also conquered the IoT consumer market with a self-powered switch module that operates in the 2.4 GHz range. Users can thus control their LED light systems at home with the kinetic energy from pressing a button. The energy harvesting light switch is practical, especially when no smart phone is at hand or if it would be inconvenient to start the app only to switch on the lights. The intelligence to make use of the data can and will be implemented anywhere, but the systems that collect the initial information need to be reliable and perpetual so that you can install and forget this. This is where energy harvesting wireless sensors come in: the Things in the Internet of Things.

IV. Conclusion

Remote frameworks are presently solidly set up in building establishment. Be that as it may, no remote framework can fulfil all the distinctive necessities to the full. The WLAN and Bluetooth guidelines are more suited for information overwhelming applications. Adaptable control of building capacities or identification of sensor information creates a requirement for cable less sensors or switches. This is the place batteries are regularly not needed or unsuitable due to the administration speculation. EnOcean is the main standard empowering the execution of such battery less in addition to remote frameworks. With this innovation it is conceivable to make support free frameworks notwithstanding for expansive structures with numerous hundred transmitting gadgets in one radio cell. The main driver for the implementation of such an energy management solution is economic.

References

[1] H. Dibowski, C. Oezluek, J. Ploennigs, and K. Kabitzsch.Realizing the automated design of building automation systems. In INDIN - 4th IEEE Int. Conf. on Ind. Informat., pages 251256, Singapore, 16.18. Aug. 2006.

[2] G.Anastasi, M. Conti, M. D. Francesco, and A. Passarella. Energy conservation in wireless sensor

networks: A survey. Ad Hoc Networks, 7(3):537568, 2009.
[3] P.Buchholz and J. Pl onnigs. Analytical analysis of Access schemes of the CSMA-type. In WFCS - 5th IEEE Int.Workshop on Factory Communication. Syst., pages 127136, Vienna, Austria, 22.24. Sept. 2004.
[4] Enocean equipment proles, July 2009.
[5] W. Kastner, G. Neugschwandtner, S. Soucek, and H. M.Newman. Communication systems for building automation and control. Proc. IEEE, 93(6):11781203, 2005.
[6] J. Ploennigs, P. Buchholz, M. Neugebauer, and K. Kab itzsch. Automated modeling and analysis of CSMA type access-schemes for building automation networks. IEEE Transaction. Ind. Information. 2(2):103111, May 2006.
[7] J. Ploennigs, M. Neugebauer, and K. Kabitzsch. Diagnosis and consulting for control network performance engineering of CSMA-based networks. IEEE Trans. Ind. Informat.,4(2):7179, May 2008.
[8] J. Ploennigs, V. Vasyutynskyy, and K. Kabitzsch. Comparison of energy- efcient sampling methods for WSN sin building automation scenarios. IEEE Trans. Ind. Information 6(3), Aug. 2010.
[9] K. Kant. Introduction to computer system performance evaluation. McGraw-Hill, New York, 1992.
[10] J. Plonnigs, Neugebauer, and K. Kabitzsch. A Traffic model for networked devices in the building automation. In WFCS - 5th IEEE Int. Workshop on Factory Communication system., pages 137145, Vienna, Austria, 22.24. Sept. 2004.
[11] C. Reinisch, W. Kastner, G. Neugschwandtner, and W. Granzer. Wireless technologies in home and Building automation. In INDIN - 5th IEEE Int. Conf. on Ind. Information., volume 1, pages 9398, 23.27. July 2007.
[12] J. Ploennigs, V. Vasyutynskyy, and K. Kabitzsch. Ultra-low power wireless communication. IEEE Press, 2 edition, 2010.
[13] L. Kleinrock and J. Silvester. Optimum Transmission radio for packet radio networks or why six is a magic number.In IEEE Nat. Telecom. Conf., volume 4, pages 14, 1978.
[14] A. Willig. Scheduling multiple streams with (m,k)-deadlines having different importance over markovian channels. In ETFA - 10th IEEE Int. Conf. on Emerging Technol. and Factory Autom., pages 7985, Catania, Italy,19.22. Sept. 2005.
[15] A. Willig, M. Kubisch, C. Hoene, and A. Wolisz. Measurements of a wireless link in an industrial environment using an IEEE 802.11-compliant physical layer. IEEE Trans. Ind. Electron. 43(6):12651282, 2002.

