whitepaper

The Connected Home

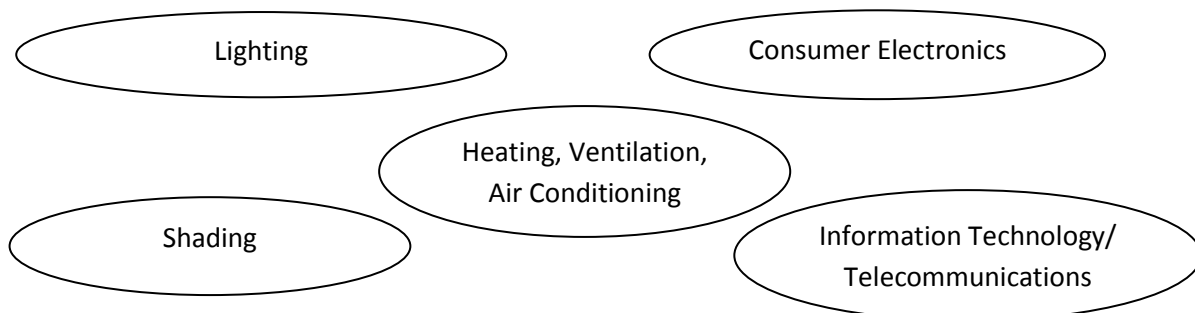## Smart Home with Batteryless Wireless Technology

Content

whitepaper

Introduction

"Homes will become more intelligent", "everything can be controlled with one device" or "one doesn't need to do anything anymore". These are typical answers to the question: "What do you have in mind exactly, when you imagine a Smart Home?". As you can see through these statements, most citizens already have a preconceived idea for the term "Smart Home". There is no doubt though that the topic is gaining awareness in public, and for many private individuals, owning a Smart Home is fact, not fiction. There are already numerous pioneers who have successfully converted their original home into an intelligent one. This is by no means a temporary trend for a few skilled technicians, as current studies show. **58% of all Germans would install an intelligent home automation system during construction, 69% would retrofit one during renovation.**[1] Industry experts also expect significant growth in the coming years: **the German Smart Home market value alone is expected to rise to 19 Billion Euros by 2025.**[2] This statement is underlined by survey results concerning the appeal of Smart Homes from the customers' view. 66% of the 500 surveyed find the offer attractive or even very attractive. This results in an addressable market of nearly 20 million households in Germany alone.[3]

What is a Smart Home?

Generally, the term "Smart Home" defines the building automation in a private home, in which single components (sensors and actuators) are networked together in order to form an intelligent system. This forms the technological foundation for an automated control as well as for the comprehensive operating options of the home automation. For an optimal operation, it is necessary to gather extensive data. For example, during heating, the current temperature of every room is an essential figure for the individual room control. A main command centre processes the information recorded by the sensors along with the set values predefined by the user and transmits appropriate commands to fitting actuators, such as lamps or radiator valves. This connection between single components combined with intelligent control increases comfort, saves energy and ensures more safety in the house. Control can be exerted either over stationary control panels or over mobile devices such as smartphones or tablets. At the same time, the user is also able to change settings through more classical means, for instance light switches, or through a remote control.

Networking different home automation disciplines enables a comprehensive spectrum of possible applications for intelligent control in various private building sectors. The most important are:

- Lighting
- Consumer Electronics
- Heating, Ventilation, Air Conditioning
- Shading
- Information Technology/ Telecommunications

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[1] "Smart Home – Positionen, Perspektiven, Praxis", trend-Studie Handelsblatt in Cooperation with JUNG
[2] "Smart Home + Building", Verband der Elektrotechnik, VDE, März 2013
[3] Smart Home – Future prospects for different industries; Capgemini Consulting; 2011

A Smart Home's system technology is comparable to a modern car's. There too, copious sensors collect different data nowadays. These are processed in order to subsequently lower fuel consumption, offer passengers more safety, and enhance relaxation whilst driving. The demands placed on the building automation system are similarly complex. On the one hand, the client wants to be able to install his system quickly and easily, and be able to expand it at any time. On the other hand, all components made by different manufacturers must be able to seamlessly work together in one system. This is the only way to centrally control and operate them over a singular user interface. In order to guarantee high functional safety, all single components must be able to communicate decentralized with each other.

New Possibilities due to Wireless

The normative, basic ideas for the Smart Home system are not new, by any means. In modern office design[3] especially, techniques which save energy and increase work space comfort are well established. Current technological progress, which simplifies installation and operation, now enables the networking and automation of private households. One central aspect here is wireless technology. During the networking of single components, radio based solutions offer clear advantages: cabling and the resulting mounting in the installation phase is dropped. Furthermore, costs for cable line are reduced. **The cost advantage during redevelopment lies up to 70% compared to wired solutions. And the costs saved using wireless solutions for new constructions are at 15%.**[4] Moreover, the user remains completely flexible even after the installation. Sensors or feelers are supplemented or moved without a problem. Not only the residents profit from these completely new possibilities. Planners and architects too profit from this newly won flexibility. Thanks to wireless technology, switches can now even be placed on thin or glass partition walls. Strong impulses are now also coming from new media carriers. More and more electronic entertainment devices, such as televisions or hi-fi systems, are equipped with wireless interfaces and thus can be easily networked with other wireless applications.

Energy Harvesting Wireless Technology

The batteryless wireless technology from EnOcean has a special position in the market. The components equipped with this technology not only work wireless but batteryless too. Due to Energy Harvesting, the wireless modules gain their energy from the environment, for example from motion, light or temperature differences. Instead of batteries, mini solar cells, electro-mechanic and thermal energy converters provide the energy needed. Through this self-sufficient operation, any maintenance usually needed with similar, battery-driven solutions, is no longer necessary. The radio transmission used has very low energy demand while simultaneously offering a large range. Outdoors, this range is about 300 meters, in buildings it lies at up to 30 meters. One reason for the low energy consumption is the short transmission period. Within just 1 millisecond (ms), the complete transmission-/reception process occurs. Not only does this save energy, the chance of collision between different telegrams is lowered. Two repeat-telegrams are sent within 30 ms in order to prevent erroneous transmissions.

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[4] EnOcean

Batteryless wireless technology combines the respective advantages of both wired and wireless systems: it works maintenance-free, guarantees reliable operation and is flexible and cheap to install.

The benefits of EnOcean wireless technology at a glance:

➢ Reduced installation costs in comparison to wired Bus systems covering the same functionalities:
   ➢ 15% cost savings in new constructions[1]
   ➢ 70% cost savings in retrofits[1]
➢ Flexible positioning of sensors, even after installation
➢ Maintenance-free, no batteries
➢ Optimized measurements due to flexible positioning of sensors
➢ Variety of products of an established eco-system (EnOcean Alliance)
➢ Product interoperability
➢ International ISO/IEC standard (ISO/IEC 14543-3-10)
➢ Large number of successful projects worldwide

[1] EnOcean

Secure Data Transmission

In a Smart Home sensors and actuators send and receive different values and information. The security and reliability of the data plays an important role. EnOcean-radio already offers basic functions for a secure two-way communication in the home automation. Every data packet includes a checksum, which ensures the integrity of the telegram and thus avoids transmission errors. Also, every module possesses a unique 32 bit long identification number, in order to avoid telegram overlaps and to authenticate sensor identities. Further methods are based on these basic security features. As a permanently self changing security mechanism, every telegram is created with a rolling code. The current rolling code forms the basis in order to generate an authentication code. The receiving system can validate the data packet with help from the rolling code and protects itself from repeat attacks. A further measure is the encryption of the data packets through the transmitter. A high encryption protection is offered by the AES-algorithm with 128 bit-keys, which is also used for car key wireless.

The safety functions offer high protection for data traffic in a networked home and can be adapted to the receptive requirements. **This makes it possible to connect EnOcean wireless technology with security relevant applications such as door lock switches.** An important point regarding a useful and cost-effective solution is the appropriate adjustment of the security level for each respective application, as higher security means higher energy demands for the transmission and calculation of the telegrams.

Less Electro Smog than with Conventional Switches

An investigation by the independent ECOLOG institute has shown that the high frequency fields produced by batteryless wireless technology are a hundred times less powerful than classical,

wired solutions. Additionally, the devices, in contrast to other wireless standards such as WiFi, only transmit for a few milliseconds, and only when an activity is necessary. As a result, even radio-sensitive people can use building radio systems without a problem. Furthermore, the products don't create any low-frequency electro-magnetic emissions.

Encrypted Data Transmission

The safety of data is the highest priority, especially in regard of the requirements of a networked home. Unwanted intrusions into privacy, data interception or losing control of the system are the main concerns. Therefore, an intelligent networking in the building requires further security levels for wireless systems.

One central protective measure against the abuse of a radio system is the encryption of data. This also applies for Smart Homes. The data is encrypted by each transmitter individually and then de-crypted by the respective receiver. Batteryless wireless technology uses an ever self-changing securi-ty mechanism, for example a 16-bit or 24-bit-long Rolling Code (RC), which is incremented with every telegram. Telegram header, telegram data and the current Rolling Code in turn form the basis, in order to generate a 24- or 32-bit-long number-based authentication code (Cypher-based Message Authentication Code, CMAC). The CMAC is likewise protected through a 128-AES-encryption algo-rithm. Based on the code, the receiver system can conclusively verify a data packet. This functionality protects networks, especially from repeat attacks, so called Replay Attacks. Another mechanism is the encryption of data packets through the transmitter. The data is encrypted by the AES-algorithm with a 128-bit key. That way, eavesdropping is prevented.

Broad Product Range

EnOcean wireless is internationally standardized as ISO/IEC 14543-3-10. This standard is optimized for radio solutions with particularly low energy consumption and Energy Harvesting. Together with application profiles (EnOcean Equipment Profiles) from the EnOcean Alliance, the prerequisites for a completely interoperable and open radio technology, comparable with Bluetooth or WiFi, are given. In this way, products from diverse manufacturers can work together in one system without a prob-lem. In Europe, batteryless wireless technology uses the frequency channel 868 MHz, which is only approved for pulse signals.

EnOcean exclusively offers its batteryless wireless technology to product manufacturers (OEMs), which then integrate it into their solutions. **These partners are organized in the EnOcean Alliance, an independent initiative with over 350 members, who have already successfully brought more than 1,200 interoperable products into the market.** The offer covers batteryless switches, intelligent window handles, temperature-, humidity-, or light sensors, presence detectors, as well as actuators, gateways, and switchboards, along with complete Smart Home systems. Since 2013, radiator valve attachments are also offered, which use the temperature differences present at radiators, in order to power communication and changes in stroke.

Members of the EnOcean Alliance

What Does a Smart Home Offer?

There are a lot of reasons for the use of intelligent control systems. The most important aspects here are improvement in comfort, saving energy and thereby reducing costs, improving safety standards and supporting measures for the elderly.

Presently, the majority of Smart Home applications sold is from the field "secure living". According to a GFK-survey, craftsmen made 46% of their profit there.[5] Applications for comfort improvement and health care are in the second place. Only a few users will invest in this new technology for feasible savings in energy costs. However, rising energy prices and, encouraged by current politics, increasing

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[5] Intelligentes Gebäude – Das E-Haus zeigt, wie's geht!; zveh; 2012

environmental awareness, leads to more interest. A survey from Capgemini Consulting shows that rational applications in the Smart Home area have a high relevance for clients nowadays.[6] According to this review, useful applications, which serve as security or lower energy costs, are in demand, not just trendy products with high entertainment value.

Cost Reduction through Energy Savings

Distributing German households' total energy consumption shows that the largest energy use – and therefore also the largest energy savings potential – lies with indoor heating (see fig. 1). **A total of 71% of energy used in private households falls into this segment.**[7] As a comparison: only 2% of the total energy consumption is used for lighting. Therefore, the costs for heating are proportionally high. **In 2010, heating and warm water allocation together made up 63% of the total energy costs.**[8] Buildings make up 40% of the European primary energy consumption. This large number clearly shows the effect savings could have, especially when looking at CO_2-emissions.[9]
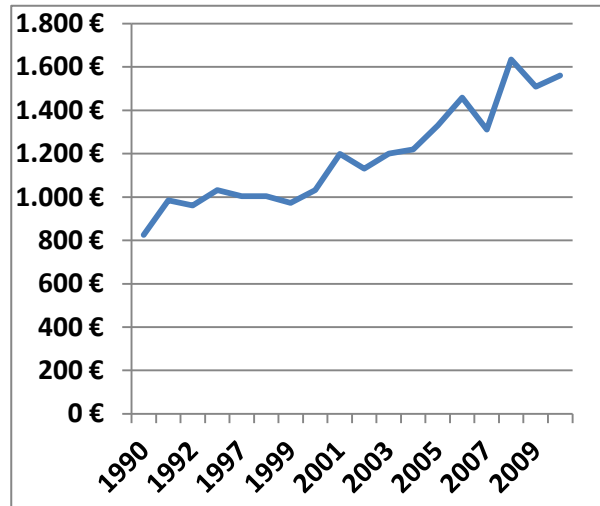

Energy costs have risen significantly

Fig. 1: Household expenditure on energy (except fuels) increased by 89% from 1990 to 2010.[1] Changes to this trend are not expected.

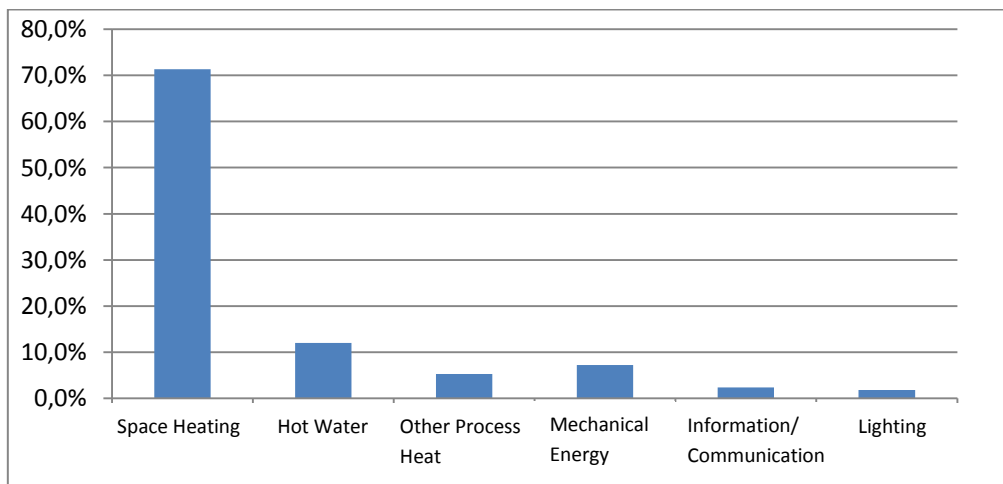[1] Energy costs of private households; Federal Ministry of Economics and Technology; October 28, 2011

Fig. 2: Breakdown of households' final energy consumption according to application areas 2007[10]

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[6] Smart Home – Future prospects for different industries; Capgemini Consulting; 2011
[7] Breakdown of households' final energy consumption according to application areas 2007 in PJ; Bundesverband der Energie- und Wasserwirtschaft e.V; 2008
[8] Energy costs for private households in Germany; Federal Ministry of Economics and Technology et al.; 2011
[9] Buildings' energy efficiency will be improved; European Parliament / Silvia-Adriana; April 22, 2009
[10] Breakdown of households' final energy consumption according to application areas 2007 in PJ; Bundesverband der Energie- und Wasserwirtschaft e.V; 2008

Energy Savings in the Field of Heating

Due to this significant portion of the costs and through constantly increasing fuel prices, investments are supposed to be made more attractive to private households. But despite the enormous savings potential in the field of building heating, relatively few consumers invest in energy saving measures. Energetic building renovations are becoming more frequent, but large initial investment costs deter many consumers. This is precisely where our idea starts, saving a lot of heating energy and thus money, with low amounts of investment. The main starting point is heating when appropriate. **The goal is to only provide heating in rooms when it is actually needed. Interferences in existing heating systems are kept within limits.** The basic structure of the heating installation, consisting of a boiler and radiators, does not need to be changed. Only loop system components have to be exchanged. These include radiator valve attachments and room controllers, in particular. Another reason for the relatively low investment costs is the quick and simple installation. Thanks to EnOcean wireless, no cables need to be laid. Moreover, any maintenance costs are dropped, because the system components work without batteries.

Networking and automating the integrated components ensures the customized adaption to the new heating consumption. A survey from the Frauenhofer Institut für Bauphysik IBP has mathematically compared the standard- and single room- heating control. An automatic shutter control was also taken into account in their inspection. **Depending on the user profile, saving potentials varied from 17% for families, around 21% for senior citizens, and about 38% for singles, with regards to how many new and old buildings exist.**[11]

Compared to other investment measures, such as thermal insulation, this option is a lot less price intensive than the rest. **The price for properly insulating a detached house lies at about 70.000 €. However, the price of converting an existing heating system is aimed at only 1.500 €.**[12] Large differences can also be found when comparing payback periods. Typically, around 30 years pass until all initial costs for the insulation of the building shell are covered by energy savings. In contrast to energetic measures for heating, which amortize in about three years.[13]

Smart Metering for Further Energy Savings

Another energy saving potential is provided by Smart Metering. Clients are offered different energy prices, depending on the time of day. The goal is to automate the control over certain energy consumers, for example washing machines or dishwashers, with a market for energy prices. Through certain measures, private households are to be integrated into the network as consumers, but also as energy producers, for example through photovoltaic systems. A so-called Smart Grid optimizes the complete system, in terms of efficiency and security. **Until 2020 Smart Meters are forecasted to reach an 80% market penetration in Europe.** Here, France and Great Britain are trailblazers. A total of 53 million Smart Meters are to be installed in private households and in industrial buildings by

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[11] Arithmetic comparison of useful heat of a single room control compared to a standard control using an exemplary detached house; Frauenhofer-Institut für Baufphysik IBP / im Auftrag von RWE; 07.06.2011
[12] EnOcean
[13] EnOcean

2019.[14] Such a large market share is not immediately expected for Germany, as the use isn't obligatory for now.

In a broader sense, Smart Metering also includes the client himself taking specific measurements of particular devices. Through the presentation of consumption curves on a PC or smartphone, energy saving potentials, such as a device's power consumption in stand-by mode, are determined. In the best case scenario, this sensitization leads to energy saving behavior.

Additional Comfort

Multimedia carriers play a significant role in Smart Homes. Their enormous influence is explained by their unique interface tasks between humans and technology. Due to the outstanding innovations in the last few years, consumers identify themselves with technology like never before. Smartphones and Tablet-PCs have become our constant companion in daily life. New operation possibilities and demands are the consequence. The client wants to be able to control as much

> **The Internet will become a constant companion, a rapid change**
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> The sales of smartphones exceed even the expectations of experts. Instead of the bulky PC, consumers are turning to the tablet. In Germany, more and more tablet computers are purchased, eight million in 2013 alone.[1] **Already today, 35 % of US citizens have a tablet.**[2]
>
> [1] BITKOM „Boom bei Tablet Computern hält an"; Oktober 2013
> [2] Pew Research Center, „Tablet and E-reader Ownership Update", October 2013

as possible from as few devices as possible. Why use a stationary control unit or walk to a single switch to lower the shutters in the living room and kitchen, if a touch on your smartphone or tablet suffices? Further, many actions usually performed with a remote control such as turning on the TV, HiFi, lights and blinds are going to be integrated into a smartphone or tablet.

Mobile operating units also allow remote access for applications. The Joonior system from Telefunken is an ideal example. Turning on the heating 15 minutes before arriving at home or controlling if all windows are closed is all possible via an app.

Next to the simple handling, the focus also lies in the flexible and individual composition of the system. For instance, users can create unique light scenes, which can subsequently be activated by just one touch. Clients also often demand a self configurable "central on/off button", which can be located at the entrance or in the bedroom, and with which all lighting products and stand-by devices can be turned off at once.

Ambient Assisted Living

An important application area of the smart home is the support of the elderly during everyday life, so-called Ambient Assisted Living (AAL). Specifically, technical helpers facilitate life at home. On the one hand, residents are offered a higher standard of living, as lights, room temperature or other applications are automated appropriately, and can be changed personally. The particular user interfaces are fitted precisely to the needs of senior citizens. On the other hand, smart home solutions can

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[14] Smart Meter: Intelligente Zähler erobern Europa; Newstoptarif.de / incl. Materials of Frost & Sullivan; August 26, 2011

also monitor vital signs and send for help quickly in case of an emergency. Motion detectors or sensor mats can register a person lying on the floor and immediately call emergency services.

As of now, professional smart home craftsmen already generate 38% of their turnover with ambient assisted living systems.[15] Technological progress and the increasing need due to our ageing society will see such applications rise steadily in the future. Until 2030, the share of people over 80 will increase to over 60%.[16]

Here especially, wireless solutions play an important role. They can be installed quickly and easily in homes, without longer installation measures which strain the residents' nerves. Furthermore, they offer total flexibility for the users. That is why 50% of already installed components work on a radio basis.[17] Using batteryless wireless technology from EnOcean also negates the need for changing batteries, something older people often find very difficult.

Secure Living

At this point in time, security measures generate the largest turn-over in the smart home area.[18] In an all-around system, motion detectors, cameras and the alarm system are networked together and connected with a security service. Moreover, the owner can access the cameras on the go comfortably. The monitoring system can be configured and expanded according to customer requirements. For many clients, buying a security package for their house is the first step to an intelligent home.

Guarantee of Flexibility and Interoperability

The term "Smart Home" does not stand for the obligatory networking of all eligible components. **Moreover, it is a constantly expandable system, which the user can change according to individual needs and technical advancement.** If at first a security system is installed, later on the system can be extended to include comfort functions, for example. Basic modules such as the control unit, but also single components, can be used continuously. Presence detectors from a security system can be also usedwith luminaries. Generally, all controls of a building technology, from the blinds to the heating control, are included. The prerequisite here is that all system components fall back on a standardized communication process.

The international EnOcean wireless standard and the EnOcean Alliance's uniform application profiles make sure that all components from different integration manufacturers are compatible with each other and stay compatible in the future. **Gateways guarantee the reliable exchange of information to other systems such as KNX, LON, ZigBee, GSM or WiFi.** This especially is a fundamental feature for the use of batteryless wireless technology in the smart home. Due to different requirements concerning data rates and energy consumption, many communication systems are used there. If sensors communicated via WiFi for example, they would have to be supplied externally with electricity. On the other hand, the transfer of a video from a smartphone to a TV via the EnOcean radio protocol would take days. The core function of the batteryless wireless technology in a smart home is the

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[15] Intelligentes Gebäude – Das E-Haus zeigt, wie's geht!; zveh, 2012
[16] Bau-, Stadt- und Raumforschung (BBSR); 2012
[17] EnOcean
[18] Intelligentes Gebäude – Das E-Haus zeigt, wie's geht!; zveh, 2012

connection of sensors and actuators until the very last meter. Other systems are responsible for the optimum transfer of information via other channels, such as from a gateway to a smartphone.

Networking Structures

A far-reaching networking of devices also brings the highest benefits of use. That's why all trades gravitate this way in their development. **First of all, all components in one area are networked together. In the second step, a supervisory connection between the applications is created, for example between central control and smartphone.** The following figure shows the step-by-step construction of this networking structure.
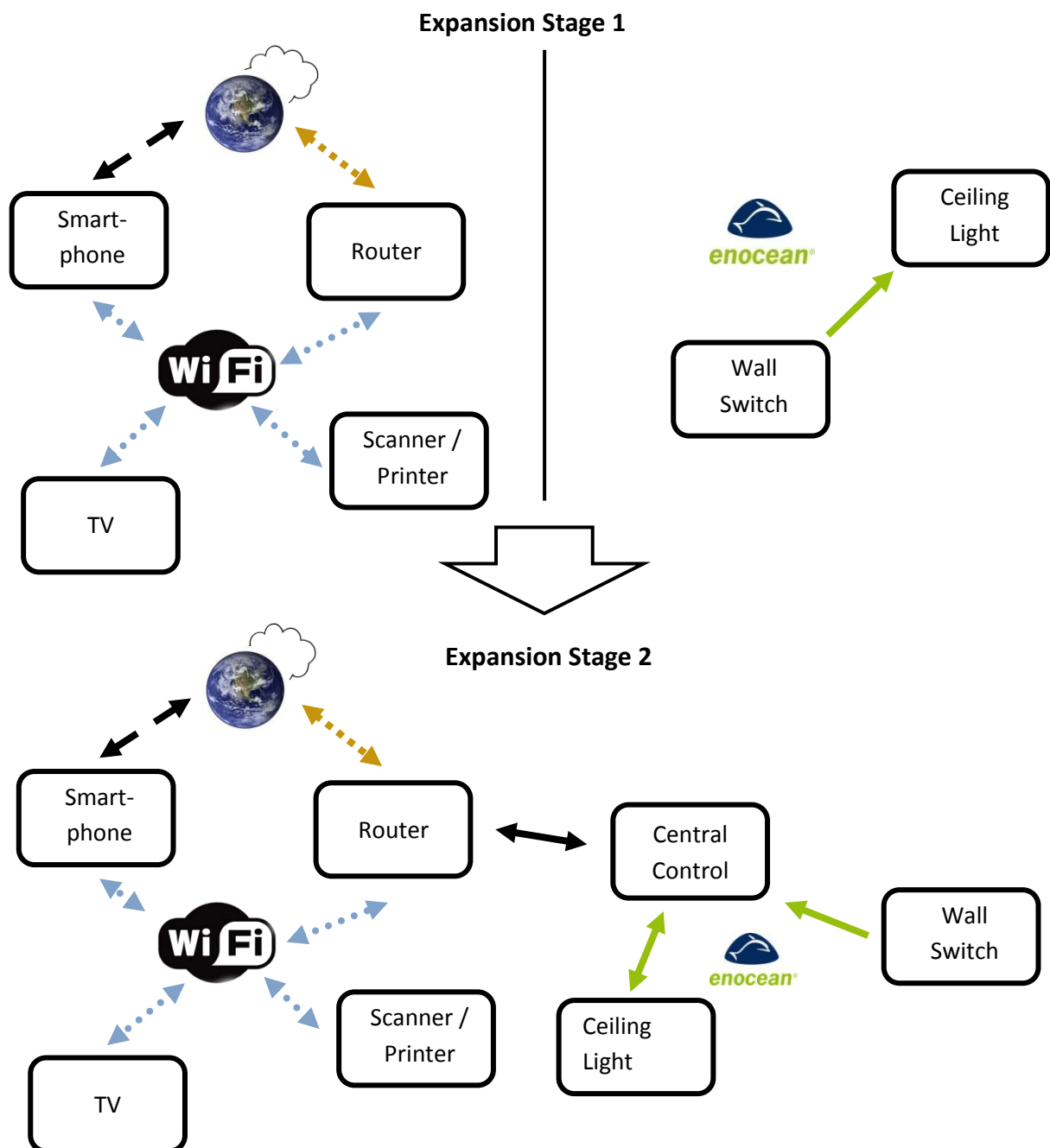
Expansion Stage 1

Expansion Stage 2

Fig. 3: Change in the network structure

As you can see from the image, single components are networked differently, depending on which technology is best suited. But because a smart home binds all devices, different Bus-systems must also be connected with each other. If a user sits on his couch in the living room, he wants to be able to control the temperature via his smartphone, in addition to playing music on the HiFi and all that with one simple and comfortable application. **Current products available on the market show that this technical problem can be realized without much effort.** A good example would be the Vitocomfort 200 packet manufactured by TELEFUNKEN Smart Building and distributed by Viessmann. With it, the user can control devices from afar or read conditions such as the room temperature. The two standards, WiFi and EnOcean-wireless are connected via gateway.

Possible Positions for the Control Intelligence

The control intelligence can be positioned at different places during the networking structure. Different architecture can be realized, with different characteristics.

Until now, smart home solutions found on the market, such as the batteryless system from Eltako or the smart home solution from RWE, are based on a local approach. Information is sent from sensors and detectors to a central control station, processed there, and corresponding commands sent to actuators (see Fig. 4).
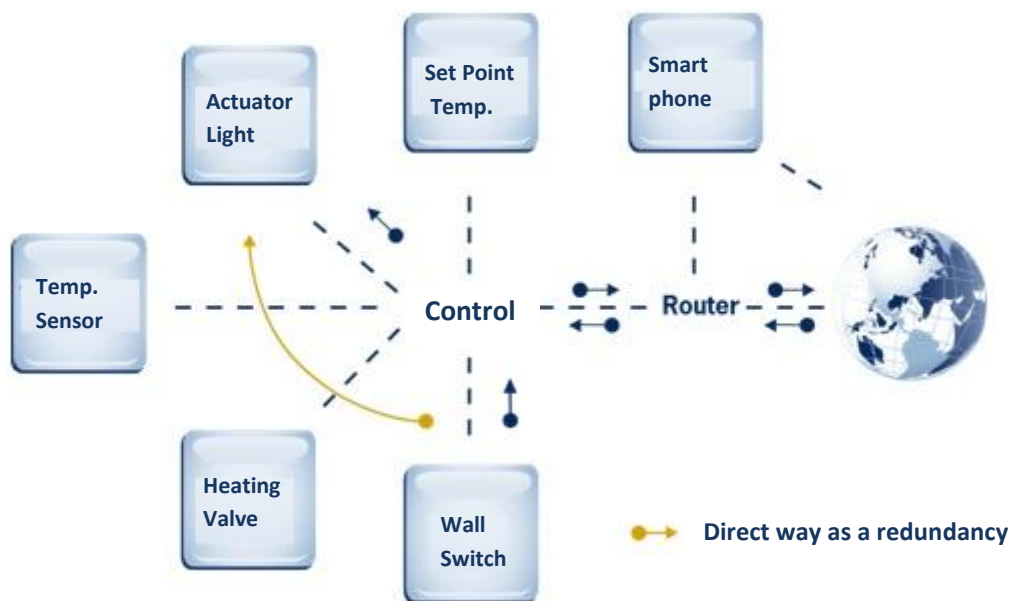

Fig. 4: Approach 1, data processing by a local control

A different approach is the processing of information in the Internet, in mainframes situated outside of the home. Only data used for control is meant here, though. Media content such as pictures or data can be used independently from these approaches via cloud services.

The information must be sent via router into the Internet. After processing, the appropriate commands are sent back over the router to the gateway, which then transmits the information to the respective actuator. If the user changes the set temperature at the local user interface in the living room, this figure, together with the measured value (the room temperature), is sent via the gateway and the router to a mainframe. There, the relative control parameter of the heating valve cap is cal-

culated. Via the router and the gateway, the information ultimately arrives back at the actuator (see Fig. 5).

The crucial advantage lies in the shift of computing power. Instead of the central control unit in the house, only a gateway is needed, which is considerably cheaper. Due to the relatively small computing time, the processing on mainframes generates next to no costs. Encryption and authentication procedures provide for a secure data transfer outside of the home.
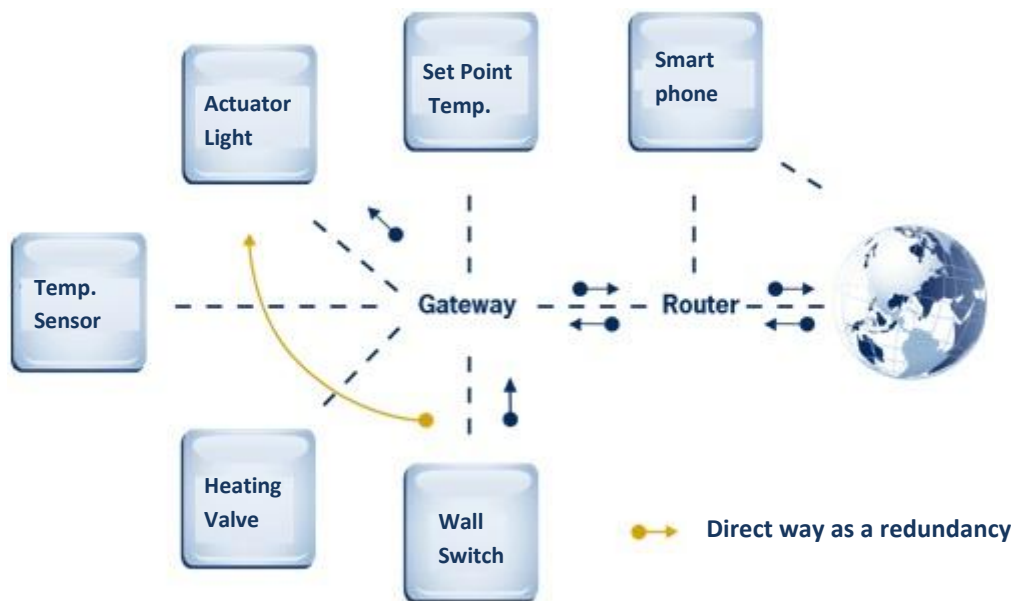

Fig. 5: Approach 2, data processing via mainframes (Internet-connected)

System with very high Reliability

If one component fails, the system stays functional. The system technology can be configured, so that in the event of failure, commands can be sent directly from the switch to the actuators. This applies to both control variants, the local one in the home, or the one in the cloud. Thus, room temperature can even be regulated if the router or the gateway fails.

Further protection and comfort is offered by the centre from myHomeControl from BootUp. The system regularly saves the configuration on a web server. In the unlikely case that the centre needs to be reset or exchanged, the settings are automatically reconstructed in the cloud.

Smart Home – Innovation of Single Disciplines

Hereafter, technical innovations in single disciplines are presented more precisely, **also considering the respective expansion stage of each system.** As mentioned before, users needn't invest in a complete solution all at once. By choosing the right components from the start, they can be expanded continuously.

Heating, Ventilation and Air Conditioning (HVAC)

HVAC plays a central role in a smart home. This is due in large part to the remarkable energy savings potential, but also due to the added comfort the user is offered via new operating options.
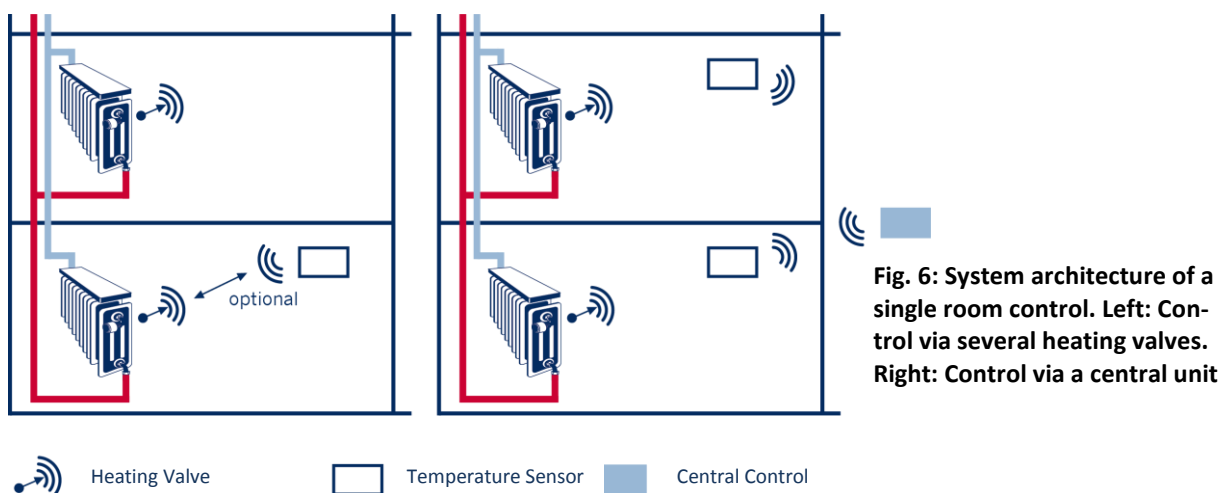
To meet the demands of an appropriate and cost-saving heating system, each room needs to be controlled separately. Depending on the depth of automation and networking, different regulation modules are conceivable. In the easiest case, the cap on a heating valve regulates the room temperature. The cap itself measures the values needed. As an optional extension, a room temperature sensor would gather more precise measurements. Networking would proceed via wireless here. Compared to classical valve caps, day- and week-specific profiles can be created with this one. For example, the bathroom will only be heated in the morning and in the evening, during the main usage periods.

A considerably more optimized system is offered by the next expansion stage. Here, single valve caps are networked with a central control unit. The regulation does not happen decentralized, instead, one control unit monitors each individual room's arrangements. Temperature sensors transfer the values to the central control unit. In turn, appropriate commands are sent to the actuators, i.e. the valve caps. The user can adjust the desired temperature in various ways, via an app connected with the central control system, or via a stationary operation unit in the building. Furthermore, the classical way via valve cap is also available (see Fig. 6).

> **Needs-oriented adjustment of flow temperature provides additional savings**
>
> Indirect influence on the room temperature, for example by sunlight or people and equipment, the flow temperature can be reduced accordingly.
>
> This results in lower heat losses of the boiler and piping systems leading to energy and cost savings.

Fig. 6: System architecture of a single room control. Left: Control via several heating valves. Right: Control via a central unit

optional

Heating Valve　　Temperature Sensor　　Central Control

Big advantages are offered by the batteryless products from the EnOcean partners. Due to batteryless operation, any maintenance work is no longer necessary, as not only the sensors, but also the actuators obtain the energy needed from the surroundings. Also, installation is very simple. **Such a batteryless valve cap is offered by Kieback&Peter for example with the intelligent single room control en:key.** The necessary energy is generated through a Seebeck-generator, which uses the

temperature differences between the heating valve and the surroundings. Temperature sensors or -regulators however obtain their energy via solar cells.

Lighting

The wireless technology from EnOcean is especially suited for controlling luminaries. Pressing down on the light switch generates enough energy to send wireless telegrams. The many integration manufacturers ensure a broad product range of switches, which satisfy all tastes and have different functions, such as dimming, too.

Figure 7 shows the schematic expandability of the system. All wall switches and switch actuators of the main circuit remain unchanged. If the client decides against a central control during renovation or construction, he or she can retrofit at anytime later on.
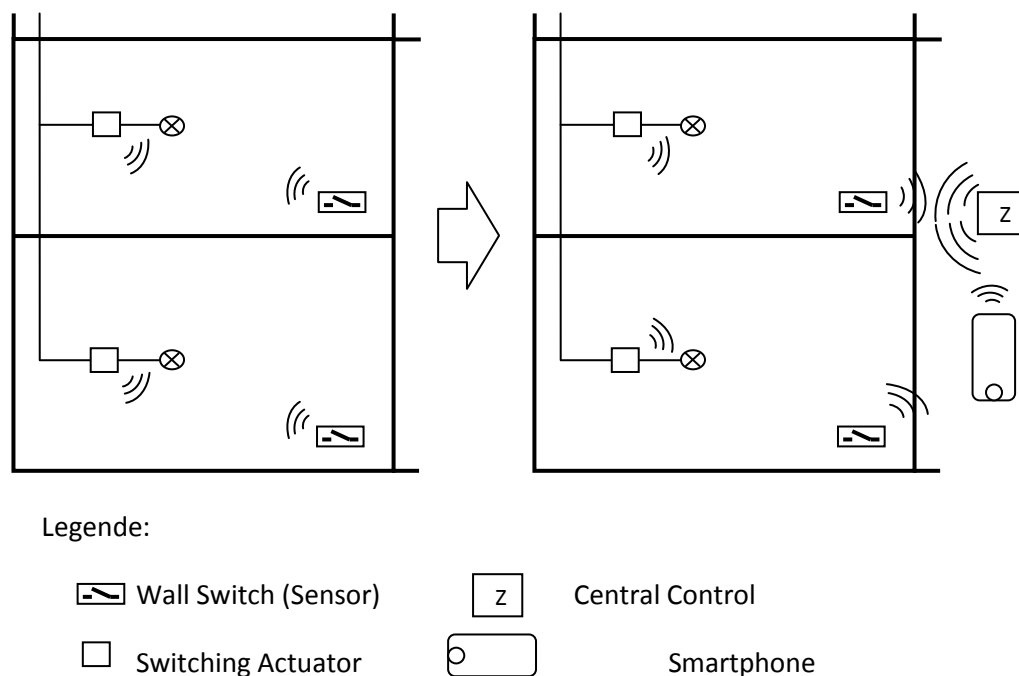

Legende:

⊡ Wall Switch (Sensor)   [z] Central Control

▢ Switching Actuator   Smartphone

Fig. 7: The devices' interoperability allows a flexible expansion

Products of the lighting technology, which are based on the EnOcean wireless technology, also offer further advantages:

- **Full flexibility in the positioning** of the wall switches in the room, as the devices are only glued to the wall. Planners and architects are given completely new possibilities.
- **Maintenance work is not necessary due to the self-sufficient operation.**
- Empty switches are a part of the past, as they are easily removed.
- **In comparison to cabled solutions with central control characteristics, installation costs during construction and retrofitting are 15% and 70% cheaper respectively.**[19]

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[19] EnOcean

Shading Technology

During new constructions especially, more and more owners are opting for electric shading. Not only does this make things more comfortable when the blinds go up and down by pushing a button, it also increases energy savings. Through the automated control, the additional insulation can be used optimally. The operation and control of the actuators is increasingly done by wireless technology. **Now already, the market share is at approximately 25% in the area of shading technology.**[20] For many, the blind technology is the entry way to the Smart Home. The market share of prefabricated houses is a perfect example for this. About 50% of all sold Weber prefabs are equipped with a blind control, which can later be expanded on to other applications.[21]

Multimedia Devices and Household Appliances – the Trend to Networking

Private and professional data is being increasingly consumed on both stationary and mobile devices. Innovative hard- and software solutions ensure easy and automated data matching. **More and more devices, such as cameras for example, are now fitted with a WiFi interface.** New apps take care of the uncomplicated data transfer between different components. Cloud services take a different approach, as data from different devices is deposited in the Internet and then accessed flexibly. **The Internet is thus turned into a mobile data carrier**.

The latest products of large electronic manufacturers show that the networking trend encompasses more and more components in the private living space. Why not easily surf the web from your living room via the large TV instead of using the small smartphone screen? All communication takes place via WiFi, which offers a large data rate. Content can nearly always be exchanged bidirectionally. Films saved on your PC or smartphone can be played on your TV with just a few clicks. The user can also directly control his TV via smartphone. Also, TV recordings can be played on mobile carriers.

Trade fairs show: many more household appliances will be integrated in future. Next to mobile carriers, washing machines or dishwashers are also shown increasingly. Through networking, these devices would be controlled via the electricity costs. During the night, when electricity is extremely cheap, the dish washer would turn itself on.

Outlook

Next to the level of networking, networking methods are also improving. Open interfaces, different standards and technologies can be brought together in one optimal system. The user can compile his own smart home solution flexibly – manufacturer independent. Organizations such as HGI, the OSGi Alliance or the EnOcean Alliance emphatically support bringing different standards together. In the long term, this will create sustainable smart home business models with high user acceptance. At the same time, this will create prerequisite for the so-called Internet of Things, in which single sensors, actuators and domestic appliances each have their own IP-address. The user will be able to directly contact each component – and for example turn off the accidentally left on iron, no matter to which power outlet it is connected to.

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[20] EnOcean
[21] EnOcean

References

Ruby House – USA	Challenge	Solution	Benefits	Partners
	(1) Wireless lighting control (2) Wireless shutter control (3) Control via smartphones/PC	(1) Verve Living Systems light switches (2) Illumra hand-held switch (3) BSC remote control (4) Magnum energy metering (5) Gateway EnOcean to WiFi	(1) High flexibility (2) Complete interoperability (3) Individual programming (4) High comfort (5) High energy savings	(1) Magnum (2) Verve Living Systems (3) Illumra (4) BSC Computer

Weberhaus – Germany	Challenge	Solution	Benefits	Partners
	(1) A high-class, intelligent home control (2) Setting of new ecological standards (3) Integration of building automation and smart metering	(1) Four comfortable smart home models based on EnOcean solutions	(1) High flexibility (2) Easy installation (3) Cost-efficient (4) Suitable for radio-sensitive people	(1) Eltako (2) PEHA (3) Thermokon (4) BSC Computer (5) BootUp

Villa Torri – Italy	Challenge	Solution	Benefits	Partners
	(1) Central control of HVAC, shading and light (2) Remote access (3) Flexible system adaption	(1) Smart home system based on myGEKKO (2) WAGO actuators (3) EnOcean-based switches, occupancy sensors	(1) High comfort (2) High energy savings (3) Low installation costs	(1) myGEKKO (2) WAGO

DOMO LOGIS TEC – Belgium	Challenge	Solution	Benefits	Partners
	(1) Integration of KNX and EnOcean (2) System of cross-vendor solutions (3) Intelligent networking of several building areas	(1) Automated control of several energy efficiency measures (2) Network of geothermal energy, lighting, rain water and single room control depending on the actual situation	(1) High energy savings (2) High comfort (3) Easy control (4) Solution for individual needs	(1) ABB (2) Theben (3) Zenino (4) EnOcean

Dream World 2008 – China	Challenge	Solution	Benefits	Partners
	(1) Home automation for highest comfort needs (2) Energy savings (3) State-of-the-art lighting control	(1) eKontrol	(1) High energy savings (2) High comfort (3) Easy control (4) Control via smartphones and tablets (5) Light sceneries	(1) YTL

Viebrockhaus – Germany	Challenge	Solution	Benefits	Partners
	(1) Modular, future-proof home automation (2) High quality and design needs (3) Sophisticated special functions	(1) Opus® greenNet system	(1) Individual solutions (2) High living comfort and security (3) Access to all consumers (light, shutters, heating) (4) Control via smartphones and tablets (5) Easy retrofitting	1) Jäger Direkt

Baufritz – Germany	Challenge	Solution	Benefits	Partners
	(1) Modular, future-proof home automation (2) High quality and design needs (3) Flexible installation	(1) 35 sensors and actuators including Software FVS-Home	(1) High living comfort and security (2) Significant energy savings (3) Easy expansion	1) Eltako

Empowerhouse – USA	Challenge	Solution	Benefits	Partners
	(1) Energy-efficient and comfortable model house (2) Different construction material (3) Flexible installation	(1) CAN2GO gateway controller (2) Thermokon temperature and occupancy sensors (3) Leviton wireless switch	(1) Integrated automation (2) High comfort standard (3) Easy expansion (4) Energy savings	(1) CAN2GO (2) Leviton (3) Thermokon