EnOcean Alliance – the batteryless wireless standard for smart buildings

Self-powered switches, sensors and control units save time and money during installation and guarantee higher energy efficiency.

Graham Martin, CEO & Chairman, EnOcean Alliance
Introduction
The **EnOcean Alliance** is a non-profit organization founded in 2008. Our mission: to supply standardized, interoperable solutions for intelligent buildings and Smart Homes based upon batteryless wireless technology.

Our **Aim**: to develop and market a broad range of interoperable batteryless wireless solutions for intelligent buildings, Smart Homes and IoT-applications.

Our **Vision**: to help create a better, safer, more energy-efficient and ecologically friendly world through the widespread use of intelligent, batteryless wireless sensor technology.
EnOcean in building automation

- High flexibility & simplified planning
- Energy savings of up to 30%
- Cost and time savings
- No battery problems / no maintenance
- Interoperable products from different suppliers (international standard)

The Squaire, Frankfurt: 20,000 EnOcean-based products

Networking with building automation systems

(c) EnOcean Alliance   |   Graham Martin    |   Nov 2017
EnOcean in Smart Homes

- More comfort & security
- Simplified Installation
- Interoperable products from different suppliers (international standard)
- From senior citizens’ homes to apartments and residential buildings
- No battery problems / no maintenance
- Seamless connection with different Smart Home standards and devices

Networking with Smart Home systems

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Applications in the Internet of Things (IoT) make use of networked devices in buildings and Smart Homes.

Standardized wireless communication transmits sensor data and information to IoT-applications.

Batteryless wireless devices are the key to maintenance-free wireless sensor applications.

Seamless communication in the Smart Home of the future – a broad multi-supplier network independent of standards, technologies, and devices.
The benefits of EnOcean technology
Batteryless and wireless EnOcean devices

- High degree of flexibility
- High security
- Cost savings
- Reliable, future-oriented technology
- Energy efficiency
- Minimal / no maintenance
- No cabling / power supply for sensors
- Easy to commission
Benefits of batteryless wireless technology: for investors

**Shorter build times**
- Minimized contractor-to-contractor interaction
- Reduced building-site phase

**Flexibility**
- Properties can be rented out immediately upon completion
- Fit-out by the tenants

**New areas of business**
- Full-service offers
- with reduced costs (maintenance-free sensors/actuators)

**Reduced costs**
- 15 – 20% cost reduction for new buildings
- Up to 70% cost reduction for retrofits
- Up to 40% less energy consumption
Smaller cable networks
- Cabling only in floors and ceilings.
- Reduced building-site phase.

Flexibility
- Initially „only“ the basics functions are required (lighting, HVAC per section/floor).
- Freely positionable sensors/actuators.

Reduced costs
- Approx. 20% reduction vs. conventional installation.
Benefits of batteryless wireless technology: for property users

**Reduced energy costs**
- Automated functions for minimal energy consumption without impaired comfort

**Flexibility**
- Flexible room configuration and easy / simple space conversion

**Improved workplace environment**
- Studies prove the positive effects of optimal building automation
- Higher productivity
- Less sick-leave / absence
Benefits of batteryless wireless technology: for contractors & system integrators

**Simplicity**
- No cabling necessary

**Flexibility**
- Quick and simple system adjustment to satisfy new requirements

**Integration**
- Easy integration in existing building automation systems via gateways
Benefits of batteryless wireless technology: for property owners

**Comfort**
- Enhanced comfort through automation

**Security**
- More security (window-/door-contacts, networked smoke sensors, liquid detection sensors, occupancy simulation)

**Reduced costs**
- 15 – 20% cost reduction for new buildings

**Flexibility**
- Easy restructuring of rooms, areas, floors
- Freely positionable sensors / actuators

**Energy savings**
- Maximal comfort with minimal energy consumption
Technical basics

- EnOcean principle
- Energy Harvesting | Energy conversion
- Wireless principles
  - Data transmission
  - Signal absorption
  - Range planning
- Wireless data transmission in building automation
  - Wireless technology – when does it make sense?
  - Application examples
- Security
- Interoperability / Certification
Technical basics

- **EnOcean principle**
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EnOcean principle

- EnOcean wireless protocol
  ISO/IEC-Standard 14543-3-1X

- License-free frequency bands below 1 GHz
  - 868 MHz in Europe and China
  - 902 MHz in North America
  - 928 MHz in Japan

- Uni/bi-directional communication

- Standardized protocol and sensor profile (EEP)

- Each transmitter has its unique address (32Bit-ID)
Range
- Approx. 30m indoors
- Extended range with repeaters (Level 1 and Level 2)

Secure data transmission
- Burst telegrams ~ 1ms
- 3 - 5 asynchronous repeats
- Encoding with rolling code (authentification)
EnOcean is environmentally friendly – more so than all other wireless technologies.

**COMPARISON OF HIGH-FREQUENCY POWER FLUX VALUES**

<table>
<thead>
<tr>
<th>Device / System</th>
<th>W/m²</th>
<th>Distance (m)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnOcean wireless switch</td>
<td>0.000013</td>
<td>1</td>
<td>a few ms when in use</td>
</tr>
<tr>
<td>Convent. lightswitch</td>
<td>0.0015</td>
<td>1</td>
<td>a few ms when in use</td>
</tr>
<tr>
<td>WLAN Access Point</td>
<td>0.01</td>
<td>2</td>
<td>during data transmission</td>
</tr>
<tr>
<td>Wireless LAN card</td>
<td>0.1</td>
<td>0.5</td>
<td>during data transmission</td>
</tr>
<tr>
<td>DECT telephone</td>
<td>1</td>
<td>0.1</td>
<td>during phone call</td>
</tr>
<tr>
<td>Mobile telephone</td>
<td>12-42</td>
<td>0.1</td>
<td>during phone call</td>
</tr>
<tr>
<td>GSM base station</td>
<td>0.00001</td>
<td>0.1</td>
<td>permanently</td>
</tr>
</tbody>
</table>

Full version: www.enocean.com
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Energy harvesters and their applications

**Kinetic energy**
Electromechanical generator

**Application**
Switch / push button

**Solar energy**
Module with energy reservoir

**Application**
Temperature and humidity sensors, motion detectors, room control units

**Thermal energy**
Energy generation through temperature difference

**Application**
Actuators for radiators, temperature sensors

**Magnetic-field energy**
Energy conversion from the magnetic field generated by the power cable to be monitored

**Application**
Smart metering
Energy harvesting through movement

- Linear movement (e.g. pressing a button) or rotary motion (e.g. turning a window handle) is converted into electric energy

- A minimal impulse (350 µWs) is sufficient to generate and encode a signal, and to repeat transmission 3-5 times

- Electrodynamical generator lifetime: up to 1.000.000 cycles
Energy harvesting through light

- Light intensity indoors: 50 - 1.000 lx
- Light intensity outdoors: 1.000 - 100.000 lx
- Devices function and charge from 50 lx up
- Fully charged devices function 3 - 7 days in complete darkness

Example: typical light intensity in hotels
- Reception: 300 - 700 lx
- Restaurant: 150 - 300 lx
- Staircase: 50 - 150 lx
- Room – daylight: 200 - 900 lx
- Room – illumination: 100 - 500 lx
Background information: customary light levels in buildings

**Schools**
- Classroom blackboard area: 500 – 1,000 lx
- Typical classroom: 300 – 500 lx

**Office buildings**
- PC workplace: 200 – 500 lx
- Conference room: 300 – 700 lx
- Corridor: 50 – 100 lx

**Hotels**
- Reception: 300 – 700 lx
- Restaurant: 150 – 300 lx
- Staircase: 50 – 150 lx
A thermoelectric element generates tension at the junction between two metals having different temperatures. This effect was discovered in 1821 by Thomas Johann Seebeck.

On the other hand, whenever a current is applied to a thermoelectric element a temperature difference occurs (discovered in 1834 by Jean Charles Athanase Peltier).

Many such elements are available at low cost and constitute ideal sources of energy.
Energy harvesting through magnetic fields

- Energy conversion from the magnetic field generated by the power cable to be monitored
- Minimally invasive – smart metering without cutting the power cable.
Technical basics

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- **Interoperability / Certification**
Technical basics: data transmission

- **Frequency**
  - Use of license-free frequency bands

- **Range**
  - Low frequency, high reach
  - Locate receivers within recommended range
  - Consider absorption / penetration angles

- **Signal absorption**
  - Metal and concrete can block most signals
  - Other materials can also reduce signal range
Wireless transmission displays elliptic properties. Evaluation of maximum range therefore requires more than line-of-sight appraisal.

This must be borne in mind. For example, a maximum range of 30m means that the ellipse only measures 10m in the middle. Therefore, narrow corridors with massive concrete walls are not ideal.
Signal absorption

Radio signals can penetrate walls – however, the signals may be weakened. The degree of signal absorption depends upon the material in question.

Examples

- Wood, plaster, uncoated glass, without metal
  0 – 10%
- Brick, chipboard
  5 – 35%
- Ferroconcrete
  10 – 90%
- Metal, aluminium lamination
  90 – 100%
The angle affects the signal's path due to varying thickness of the material in its way – and, therefore, impacts the signal strength.

Signals should ideally be routed perpendicularly through masonry, and niches should be avoided.

If oblique signal paths cannot be avoided, we recommend using a repeater and/or changing the transmitter and/or receiver's position.
Routing signals along a wall is not recommended (e.g. in a long corridor).

When laying a shielded antenna cable, be sure to avoid kinking (and irreparably damaging) it.

The EnOcean receiver should not be placed within 50cm of high-frequency transmitters. Placing of EnOcean transmitters is uncritical. 868 MHz-RFID technology should not be employed in the vicinity.
Range planning: step 1

You will need the floor plan and a compass
Range planning: step 2

Mark the signal-shielding areas on the floor plan

- firewalls, elevators, stairwells, laundry rooms, service areas ....
Range planning: step 3

Mark 10-15m diameter areas on the plan

- 10m diameter areas guarantee adequate safety margins
- The center of the circle = receiver position
  (1m tolerance plays little role)
Planning example: SAP Headquarters, Walldorf
Planning example: Torre Espacio, Madrid
Range planning – equipment / measures

- Rangefinding instruments for indoor and outdoor use available.
- Prudent use of level 1 and/or level 2 repeaters recommended.
- Optimize systems, connect transmitters/sensors with 2 gateways.
- Download the information brochure „Reliable range planning“.

https://www.enocean.com/range-planning/
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Wireless technology – when does it make sense?

- Whenever building automation systems are involved (energy savings, central control systems, energy monitoring, legal & regulatory requirements)
- Whenever furniture and/or partition walls need to be periodically rearranged, or whenever glass walls are to be used
- In open-plan offices or multi-purpose buildings
- Whenever renovation calls for extensive re-cabling work (avoiding or reducing costs, time, drilling and noise/dust/dirt)
- Whenever timelines are of critical importance
- Whenever ecological certification is called for (green / sustainable building certificates)
Decentralized control system: example lighting

- Wireless actuators for each light, or group of lights, are required.
- They are installed between the lights and their power supply.
- Wireless light switches are individually connected with the actuators (pairing).
- Ideal for small-scale installations and restructuring/modernization projects.

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Centralized control system: example lighting

- Normally, one central control unit is employed for each storey (or section of a large open-plan office)
- Can also be operated as a stand-alone system (without gateway)
- Can be connected with the central building automation system (TCP/IP)
  - In smaller buildings with up to two storeys this can be achieved through wireless batteryless technology
  - In larger buildings a connection employing an Ethernet cable is recommended
- This solution can also be adopted for HVAC applications
Decentralized control for HVAC, shading and lighting

- Actuator
- 110 V
- 230 V

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Decentralized control for HVAC, shading and lighting with gateway
Centralized control for HVAC, shading and lighting

(c) EnOcean Alliance   |   Graham Martin    |   Nov 2017
Centralized control for HVAC, shading and lighting
Decentralized / centralized control for HVAC, shading and lighting

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Hardware security

- One-off, clear 32bit ID for each and every EnOcean module
  - ID cannot be changed

- Special-purpose ID
  - Preliminary, factory-programmed baseID
  - 128 IDs can be assigned (BaseID+0 .. BaseID+127)
  - BaseID can be reassigned up to ten times
Secure data transmission

- Rolling Code* protects against
  - copy & paste attack
  - copy & change attack

- Encoding* protects against
  - „eavesdropping“
  - encoded data is not legible for the „eavesdropper“

* Depending on product and manufacturer
"EnOcean security layer" integrated into the protocol stack

<table>
<thead>
<tr>
<th>Wire</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>EnOcean Equipment Profiles (EEP)</td>
</tr>
<tr>
<td>EnOcean Serial Protocol</td>
<td>EnOcean Radio Protocol</td>
</tr>
<tr>
<td>RS232 – UART</td>
<td>868.3, 315, 902, 928 MHz (Radio)</td>
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<tr>
<td>ISO/IEC 14543-3-1X</td>
<td></td>
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<tr>
<td></td>
<td>Security</td>
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- Interoperability / Certification
Standardized sensor profiles ensure interoperability between products from various different manufacturers and make interoperable system solutions possible.
Certification: interoperability for diverse solutions

**Standardized test procedures**
- in accordance with EnOcean Alliance test parameters

**Interoperability in the physical sense**
- „Air Interface“ specification

**Interoperability in terms of communication**
- „Communication Profiles“ specification

**Guidelines and documentation**
- EnOcean Alliance Certification Handbook
Certification: interoperability for diverse solutions

Preparation Certification
- Prepare test plan
- Appoint accredited test lab if required
- Device documentation (public)

Certification test phase
- Test procedure
- Test coverage
- Test results

Documentation Certification
- Certification documentation in product database
- Application for certificate

Product manufacturers

Approval Certification
- Numbered certificate
- Release into EnOcean product database
- Authorization for use of the logo

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System start-up & troubleshooting

- **Standard**

- „Remote commissioning“

- **Troubleshooting**
System start-up – standard

**Step 1**
Connect appliance (lighting, sunblinds, heating) with the actuator.

**Step 2**
Initialize switches and sensors once using a simple learn mode (pairing) connecting them with the actuators.

**Step 3**
Sensors and actuators interact without gateway (simple solutions).
System start-up – standard with room controller

**Step 1**
Fit actuators to the radiators

**Step 2**
Initialize actuators once using a simple learn mode (pairing) connecting them with the room controller

**Step 3**
Actuators and the room controller interact (e.g. individual room control)
System start-up – standard with gateway

**Step 1**
Connect appliance (lighting, sunblinds, heating) with the actuator

**Step 2**
Initialize sensors and actuators once using a simple learn mode (pairing) connecting them with the gateway

**Step 3**
Sensors and actuators interact via gateway (complex solutions)
System start-up & troubleshooting

- Standard
- „Remote commissioning“
- Troubleshooting
System start-up – "remote commissioning"

**Step 1**
Scan the switch (product-ID, EnOcean-ID).

**Step 2**
Add the switch to the connection list of the actuator via wireless connection. Adjust parameters if needed (e.g. mode, dimming rate).

**Step 3**
Switch can control the actuator straight away.
System start-up & troubleshooting

- Standard
- „Remote commissioning“
- Troubleshooting
System start-up

Sensor and actuator are not communicating – why?

- Establish sensor–actuator connection according to device instructions
- Delete „old“ connections (see device instructions)
- Check transmission range limit before installation (using tester, mock-up)
- Follow range-planning guidelines
- Charge sensors with solar module prior to installation (as per instructions)
System start-up

Sensor, actuator and gateway are not communicating – why?

- Establish sensor–actuator, sensor–gateway, gateway–actuator connections according to manufacturer’s instructions.
- Delete “old“ connections (see device instructions).
- Check transmission range limit before installation (using tester, mock-up).
- Follow range-planning guidelines.
- Charge sensors with solar module prior to installation (as per instructions).
- Check gateway documentation to ensure that your sensors/actuators are supported. If not, use alternative sensors/actuators.
Logic / Parameterization of scenes

Why doesn't the parameterized scene „work“ as intended?

- Conduct a plausibility check for the parameterized triggers (system status, events, times).
- Ensure that the desired parameterization is compatible with the gateway (manufacturer hotline, internet forums etc.).
- Exclude contradictory parameterization with the same devices, but with other triggers (events, times).
- Parameterize and test the scenes step by step.

Sources of interference

Why does interference occasionally disturb wireless communication between devices?

- „simple“ devices which also transmit/receive on 868 MHz may disturb EnOcean-signal reception, e.g.
  - wireless thermometer
  - wirelessly networked smoke detectors (e.g. when triggered)
Indoor/outdoor

Why are sensors/actuators malfunctioning?

- Some devices are not intended for outdoor use by the manufacturer. They may function outdoors for a short time but are not weather-resistant and therefore subject to internal corrosion etc. Please select your devices with this in mind.

Manufacturers / suppliers

Where can I find further information?

- In the manufacturer‘s documentation, webpage and online resources including video tutorials and user forums.
Calculation examples

- Time savings during installation (commercial building)
- Time savings during installation (general)
Conventionally cabled office – no automation

No automation = 100% energy consumption

Standard office: 4 lights, 4 windows, 2 radiators
Cable-based building automation – 30%...40% less energy consumption
Automation system with wireless sensors – energy savings and 70% less cables
Time savings during installation

<table>
<thead>
<tr>
<th>Office area [m²]</th>
<th>Time savings [hours]</th>
<th>Time savings [man-days]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lighting &amp; shading</td>
<td>lighting, shading &amp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>temperature control</td>
</tr>
<tr>
<td>5.000</td>
<td>408</td>
<td>583</td>
</tr>
<tr>
<td></td>
<td></td>
<td>51 - 73</td>
</tr>
<tr>
<td>10.000</td>
<td>817</td>
<td>1.167</td>
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<tr>
<td></td>
<td></td>
<td>102 - 146</td>
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<tr>
<td>20.000</td>
<td>1.633</td>
<td>2.333</td>
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<td></td>
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<td>204 - 292</td>
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<td>50.000</td>
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<td>5.833</td>
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<td></td>
<td></td>
<td>510 - 729</td>
</tr>
</tbody>
</table>

Source: ZVEH

Assumptions
- Average installation time 2.8 minutes/1m cable
- Approx. 1.8m cable per m² office space (lighting and shading)
- Approx. 2.5m cable per m² office space (lighting, shading and temperature control)
Time savings during installation (general)

<table>
<thead>
<tr>
<th></th>
<th>Step #1</th>
<th>Step #2</th>
<th>Step #3</th>
<th>Step #4</th>
<th>Step #5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional</strong></td>
<td>Preparation installation plan</td>
<td>Laying cables</td>
<td>Installing junction box</td>
<td>Connecting</td>
<td>Plastering &amp; painting</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td><strong>Labour</strong></td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td><strong>Batteryless</strong></td>
<td>Installation receiver</td>
<td>n/a</td>
<td>n/a</td>
<td>€</td>
<td>n/a</td>
<td>€</td>
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<tr>
<td><strong>Materials</strong></td>
<td>€€€</td>
<td>n/a</td>
<td>n/a</td>
<td>€€€</td>
<td>n/a</td>
<td>€€€€€€€€</td>
</tr>
<tr>
<td><strong>Labour</strong></td>
<td>€</td>
<td>n/a</td>
<td>n/a</td>
<td>€</td>
<td>n/a</td>
<td>€</td>
</tr>
</tbody>
</table>

Saving 20 – 30%
Internet of Things (IoT)
IoT applications with EnOcean

Source: www.enocean-gateway.eu

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Internet of Things (IoT) – Market overview

**Gartner 2015:**
>20 billion permanently networked devices by 2020

<table>
<thead>
<tr>
<th>Category</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer</td>
<td>2.277</td>
<td>3.023</td>
<td>4.024</td>
<td>13.509</td>
</tr>
<tr>
<td>Business Cross-Industry</td>
<td>632</td>
<td>815</td>
<td>1.092</td>
<td>4.408</td>
</tr>
<tr>
<td>Business Vertical-specific</td>
<td>898</td>
<td>1.065</td>
<td>1.276</td>
<td>2.880</td>
</tr>
<tr>
<td>Grand Total</td>
<td>3.807</td>
<td>4.902</td>
<td>6.392</td>
<td>20.797</td>
</tr>
</tbody>
</table>

Internet of Things Units Installed Base by Category [Millions of Units], Gartner (November 2015)

**TSensor Summit** (October 2013):
50 trillion networked sensors by 2032

How can 50 trillion sensors be powered and connected?
Energy for the Internet of Things (IoT): trillions of sensors

Batteries – not always practical or useful

Manufacturing 10 trillion CR 2032 batteries takes 1 million tons of lithium

- Current global yearly lithium production - approx. 20,000 tons*
- Total global lithium reserves - estimated 11 million tons*

Batteries can fail and require substitution, stocking and disposal

Discharged batteries mean inactive devices and system failures requiring service calls (Hotline) and, perhaps, onsite technical support

* Source: www.rohstoff-welt.de
Wireless sensors – sensory organs for the IoT
- Sensors connected by cables and/or powered by batteries can be excluded due to practical, ecological and economic reasons
- Batteryless, wireless technology is the only way forward

SmartHome – one of countless IoT applications
- In a few years' time, SmartHome technology will be the norm
- The demand for retrofits in older properties will become huge

Outdoor applications
- IoT applications for outdoor use will also play an important role
- Parking and traffic management
- Smart Agriculture
- Water management (supply and disposal, flood management)
Cognitive (learning) buildings
Evolution: from automated to cognitive (learning) buildings

**Automated buildings**
(1980 – 2000)

- Control & visualization
  - Good for manual monitoring
  - Recognizes serious problems
  - No information concerning inefficient use of energy

**Intelligent buildings**

- Energy management
  - Monitors energy consumption of central systems and rooms
  - Only monitors the main parameters

**Cognitive buildings**
(> 2015)

- Learning behaviour
  - Model-based control at individual workplace level
  - Understands energy flow in the building and its allocation/utilization
  - Learns user behaviour (comfort) and the influence of context, e.g. the weather
  - Requires analytic tools capable of elaborating a large quantity of data

Source: IBM Global Business Services 2016
Cognitive building: example hotel/campus

**Problem**
Most hotel rooms and student rooms are unoccupied more than 2/3 of the time whilst HVAC and other appliances are left to run – and waste vast amounts of energy.

**Consequence**
Higher running costs and unnecessary environmental impact (CO₂).

**Solution**
Existing spaces can easily be modernized with maintenance-free wireless batteryless sensors - without disturbing ongoing operation of the facility. Energy costs can be reduced by up to 30-40% room by room.

**Solution in detail**

- **Batteryless wireless occupancy sensors** adjust room temperature and turn off the lights when the room is not in use.

- **Batteryless wireless switches** govern lighting and shading.

- **Batteryless wireless window contacts** turn off the HVAC system when the windows are open.

- **CO₂ and humidity sensors** monitor air quality.

- **Batteryless wireless card-readers** activate/deactivate the lighting and HVAC system whenever someone enters or leaves the room.

- **Batteryless wireless room controllers** guarantee high comfort and low energy consumption.

Source: IBM
Problem
Today, office space has almost become a luxury. Many rooms are used for less than 70% of the time (meeting rooms, canteen spaces, warehouse space, special workspace areas).

Consequence
Unnecessarily high running costs (HVAC, lighting, maintenance).

Solution
Easy-to-fit maintenance-free wireless sensors collect raw data which is then processed by the automation system, putting the building’s management in the picture with valuable information on usage patterns and potential for optimization.

Solution in detail
- Batteryless wireless occupancy sensors adjust room temperature and turn off the lights when the room is not in use.
- Batteryless wireless switches govern lighting and shading.
- Batteryless wireless door contacts turn on lighting and HVAC system upon entering the room.
- Wireless batteryless seat occupancy sensors govern AC power supply and IT systems for individual workstations.

Source: IBM
EnOcean applications

- Office building
  - Office / open-plan office
  - Administration building

- School

- Hospitality
  - Hotel room
  - Student’s room

- Hospital

- Ambient Assisted Living (AAL)

- Residential building
  - Living room
  - Kitchen
  - Bedroom
  - Children’s room
  - Bathroom
  - Detached house
  - Apartment building

- Retail facility

- Historic building

- Industrial facility
Office / open-plan office
Office / open-plan office
Office / open-plan office

- **Occupancy sensors** switch off lights and HVAC in unoccupied rooms.
- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Batteryless wireless switches** govern lighting and shading.
- **Batteryless light sensors** optimize lighting control.
- **Wireless actuators** control radiators.
- **Individual room controls** for minimal energy consumption and maximal comfort.
- **Batteryless wireless window handles or window contacts** turn off the HVAC system when the windows are open.
- **Sunblind actuators** govern shutters according to sunlight intensity and time of day.
- **Batteryless wireless seat occupancy sensors** govern AC power supply and IT systems for individual workstations.
Office / open-plan office

**Benefits**

*Occupancy sensors* switch off lights and HVAC in unoccupied rooms.
*Networked smoke sensors* reliably detect smoke and warn of fire risk.
*Individual room controls* for minimal energy consumption and maximal comfort.
*Batteryless wireless switches* act as remote controls.
*Batteryless wireless window handles or window contacts* turn off the HVAC system when the windows are open.
*Wireless actuators* control radiators.
*Sunblind actuators* govern shutters according to sunlight intensity and time of day.
*Batteryless light sensors* optimize lighting control.

**Architects**
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

**Specifiers**
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

**System integrators / Contractors**
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

**Investors / Property Owners**
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- Fast space conversion for quick tenant turnaround
- High energy savings
- Higher productivity

**Facility Managers**
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Less noise/dust/dirt
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions

**Facility users**
- Enhanced comfort
- Pleasant, productive working environment

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Administration building
Administration building
Batteryless wireless sensors monitor temperature, humidity and light intensity.

Actuators govern HVAC and shading according to requirements.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

Batteryless door contacts monitor door status.

Occupancy sensors switch off lights and HVAC in unoccupied rooms.

Batteryless liquid detection sensors monitor fluid leaks.
Administration building

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
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Facility Managers
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- Optimized servicing
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- No cabling, no drilling, no noise/dust/dirt
- Increased safety levels
- Faster reactions to system faults
- Interoperable and scalable standard solutions

Facility users
- Enhanced comfort
- Pleasant, productive working environment

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School
School

**Occupancy sensors** switch off lights and HVAC in unoccupied rooms.

**Networked smoke sensors** reliably detect smoke and warn of fire risk.

**Individual room controls** for minimal energy consumption and maximal comfort.

**Batteryless wireless switches** govern lighting and shading.

**Temperature, humidity and CO2 sensors** monitor air quality.

**Actuators** govern HVAC and shading according to requirements.

**Batteryless wireless window handles or window contacts** turn off the HVAC system when the windows are open.

**Wireless actuators** control radiators.
### Benefits

<table>
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</tbody>
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### Facility Managers

- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions

### Facility users

- Enhanced comfort
- Pleasant, productive learning environment

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Hotel room
Hotel room
**Hotel room**

- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Occupancy sensors** switch off lights and HVAC in unoccupied rooms.
- **Batteryless wireless switches** govern lighting and shading.
- **Batteryless wireless window contacts** turn off the HVAC system when the windows are open.
- **Actuators** govern HVAC and shading according to requirements.
- **Batteryless wireless card-reader** activates/deactivates the lighting and HVAC system whenever someone enters or leaves the room.
- **Individual room controls** for minimal energy consumption and maximal comfort.
- **Batteryless wireless actuators** control radiators, **room controllers** govern underfloor heating.
- **Batteryless liquid detection sensors** monitor fluid leaks.
Occupancy sensors switch off lights and HVAC in unoccupied rooms.

Batteryless wireless switches govern lighting and shading.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

Actuators govern HVAC and shading according to requirements.

Wireless actuators control radiators, room controllers govern underfloor heating.

Batteryless liquid detection sensors monitor fluid leaks.

Hotel room

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt

Investors / Property Owners
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- Less downtime during renovation
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions

Facility users
- Enhanced comfort
Student room
Student room
Student room

**Networked smoke sensors** reliably detect smoke and warn of fire risk.

**Actuators** govern HVAC and shading according to requirements.

**Occupancy sensors** switch off lights and HVAC in unoccupied rooms.

**Batteryless wireless switches** govern lighting and shading.

**Batteryless wireless card-reader** activates/deactivates the lighting and HVAC system whenever someone enters or leaves the room.

**Batteryless liquid detection sensors** monitor fluid leaks.

**Batteryless wireless window contacts** turn off the HVAC system when the windows are open.

**Wireless actuators** govern underfloor heating.

**Networked smoke sensors**

**Actuators**

**Occupancy sensors**

**Batteryless wireless switches**

**Batteryless wireless card-reader**

**Batteryless liquid detection sensors**

**Batteryless wireless window contacts**

**Wireless actuators**
Student room

**Benefits**

**Architects**
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
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- Speedy, flexible installation / system start-up
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**Investors / Property Owners**
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- Less downtime during renovation
- High energy savings
- Interoperable and scalable standard solutions

**Facility Managers**
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions

**Facility users**
- Enhanced comfort
- Increased safety levels

Networked smoke sensors reliably detect smoke and warn of fire risk.

Occupancy sensors switch off lights and HVAC in unoccupied rooms.

Batteryless wireless switches govern lighting.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

Batteryless liquid detection sensors monitor fluid leaks.

Batteryless wireless card-reader activates/deactivates the lighting and HVAC system whenever someone enters or leaves the room.
Hospital room
**Hospital room**

- **Occupancy sensors** switch off lights and HVAC in unoccupied rooms.
- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Actuators** govern HVAC and shading according to requirements.
- **Individual room controls** for minimal energy consumption and maximal comfort.
- **Batteryless wireless switches** govern lighting and shading.
- **Temperature, humidity and CO2 sensors** monitor air quality.
- **Batteryless wireless switches** govern lighting and shading.
- **Batteryless wireless switches** govern lighting and shading.
- **Wireless actuators** control radiators.
- **Batteryless liquid detection sensors** monitor fluid leaks.
- **Batteryless wireless seat/mattress occupancy sensors** monitor occupancy.

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Hospital room

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Investors
- Reduced cost of installation and operation
- Less downtime during renovation
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- Flexible space reallocation (patient room, therapy room or staff room)
- Combinable with nurse call systems

Facility users
- Enhanced comfort
- Better air quality

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Ambient Assisted Living (AAL)
Ambient Assisted Living (AAL)
Ambient Assisted Living (AAL)

- **Occupancy sensors** switch off lights and HVAC in unoccupied rooms.
- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Wireless batteryless seat/mattress occupancy sensors** monitor occupancy.
- **Batteryless wireless window contacts** turn off the HVAC system when the windows are open.
- **Gateway**
- **Wireless actuators** control radiators, **room controllers** govern underfloor heating.
- **Individual room controls** for minimal energy consumption and maximal comfort.
- **Batteryless wireless switches** act as remote controls.
- **Sunblind actuators** govern shutters according to sunlight intensity and time of day.
- **Batteryless wireless window handles** turn off the HVAC system when the windows are open.
- **Wireless connectors** control and monitor household appliances.
- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Wireless batteryless seat/mattress occupancy sensors** monitor occupancy.
- **Batteryless wireless window contacts** turn off the HVAC system when the windows are open.
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- **Sunblind actuators** govern shutters according to sunlight intensity and time of day.
Ambient Assisted Living (AAL)

**Benefits**

**Architects**
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

**Specifiers**
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

**System integrators / Contractors**
- Speedy, flexible installation / system start-up

**Investors / Property Owners**
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space reallocation
- High energy savings
- All-encompassing solutions

**Facility users**
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

**Occupancy sensors** switch off lights and HVAC in unoccupied rooms.

**Networked smoke sensors** reliably detect smoke and warn of fire risk.

**Wireless actuators** control radiators, room controllers govern underfloor heating.

**Wireless sensor (c) EnOcean Alliance | Graham Martin | Nov 2017**
Ambient Assisted Living (AAL)
Ambient Assisted Living (AAL)
Ambient Assisted Living (AAL)

**Occupancy sensors** switch off lights and HVAC in unoccupied rooms.

**Networked smoke sensors** reliably detect smoke and warn of fire risk.

**Actuators** govern HVAC and shading according to requirements.

**Individual room controls** for minimal energy consumption and maximal comfort.

**Temperature, humidity and CO₂ sensors** monitor air quality.

**Batteryless wireless switches** govern lighting and shading.

**Batteryless wireless switches** govern lighting and shading.

**Batteryless liquid detection sensors** monitor fluid leaks.

**Batteryless wireless seat/mattress occupancy sensors** monitor occupancy.

**Wireless actuators** control radiators.

Batteryless wireless **window handles or window contacts** turn off the HVAC system when the windows are open.

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Ambient Assisted Living (AAL)

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Facility users
- Enhanced comfort
- Freely positionable and retrofittable products e.g. emergency call button, mattress sensors

Investors
- Simple retrofit
- Reduced cost of installation
- Less downtime during renovation
- High energy savings
- Interoperable and scalable standard solutions

Facility Managers
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- Flexible space reallocation (patient room, therapy room or staff room)
- Combinable with nurse call systems

Batteryless wireless switches govern lighting and shading.

Wireless batteryless seat/mattress occupancy sensors monitor occupancy.

Networked smoke sensors reliably detect smoke and warn of fire risk.

CO2 sensors monitor air quality.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Batteryless liquid detection sensors monitor fluid leaks.

Occupancy sensors switch off lights and HVAC in unoccupied rooms.
Living room
Living room
**Living room**

- **Occupancy sensors** switch off lights and HVAC in unoccupied rooms.
- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Sunblind actuators** govern shutters according to sunlight intensity and time of day.
- **Batteryless wireless window handles** monitor window status.
- **Individual room controls** for minimal energy consumption and maximal comfort.
- **Batteryless wireless switches** govern lighting and shading.
- **Wireless actuators** control radiators, **room controllers** govern underfloor heating.
- **Gateway**
- **Batteryless wireless window contacts** turn off the HVAC system when the windows are open.
- **Batteryless wireless switches** act as remote controls.
- **Wireless connectors** control and monitor household appliances.

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Living room

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

Investors / Property Owners
- Reduced cost of installation and operation
- Simple retrofit
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

Facility users
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
Kitchen
Kitchen
Kitchen

Individual room controls for minimal energy consumption and maximal comfort.

Light actuators control lighting.

Batteryless wireless switches control lighting and shading.

Batteryless liquid detection sensors monitor fluid leaks.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Sunblind actuators control the sunshade elements.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.
Kitchen

Individual room controls for minimal energy consumption and maximal comfort.

- Light actuators control lighting.
- Sunblind actuators control the sunshade elements.
- Batteryless liquid detection sensors monitor fluid leaks.
- Batteryless wireless window contacts turn off the HVAC system when the windows are open.
- Networked smoke sensors reliably detect smoke and warn of fire risk.
- Batteryless wireless switches control lighting and shading.

Benefits

**Architects**

- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

**Specifiers**

- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

**System integrators / Contractors**

- Speedy, flexible installation / system start-up

**Investors / Property Owners**

- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

**Facility users**

- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt
Bedroom
Bedroom
Individual room controls for minimal energy consumption and maximal comfort.

Wireless connectors control and monitor household appliances.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Sunblind actuators govern shutters according to sunlight intensity and time of day.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

Batteryless wireless switches control lighting and shading.

Wireless actuators govern underfloor heating.
Individual room controls for minimal energy consumption and maximal comfort.

Wireless connectors control and monitor household appliances.

Batteryless wireless switches control lighting and shading.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

Sunblind actuators govern shutters according to sunlight intensity and time of day.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Wireless actuators govern underfloor heating.

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
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System integrators / Contractors
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Investors / Property Owners
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

Facility users
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

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Children’s room
Children’s room
Batteryless wireless temperature sensors monitor room temperature.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Sunblind actuators govern shutters according to sunlight intensity and time of day.

Batteryless wireless actuator handles or window contacts turn off the HVAC system when the windows are open.

Batteryless wireless switches control lighting and shading.

Wireless actuators govern underfloor heating.

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Batteryless wireless temperature sensors monitor room temperature.

Batteryless wireless switches control lighting and shading.

Sunblind actuators govern shutters according to sunlight intensity and time of day.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Wireless actuators govern underfloor heating.

**Benefits**

**Architects**
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

**Specifiers**
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

**System Integrators /**
- Speedy, flexible installation / system start-up

**Investors / Property Owners**
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

**Facility users**
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt
Bathroom
Bathroom
Batteryless wireless switches control lighting and shading.

Batteryless wireless temperature/humidity sensors monitor temperature and humidity.

Wireless actuators govern radiators.

Sunblind actuators govern sunblinds or shutters.

Batteryless wireless window handles turn off the HVAC system when the windows are open.

Batteryless liquid detection sensors monitor fluid leaks.
Batteryless wireless switches control lighting and shading.

Batteryless wireless window handles turn off the HVAC system when the windows are open.

Sunblind actuators govern sunblinds or shutters.

Wireless actuators govern radiators.

Batteryless liquid detection sensors monitor fluid leaks.

Batteryless wireless temperature/humidity sensors monitor temperature.

Benefits

**Architects**
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

**Specifiers**
- Simplified planning and high flexibility through freely positionable sensors
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

**System integrators / Contractors**
- Speedy, flexible installation / system start-up

**Investors / Property Owners**
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- Interoperable and scalable solutions
- All-encompassing solutions

**Facility users**
- Increased safety levels
- Enhanced comfort
- Simple retrofit
- Freely positionable products
- Cost-effective SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt

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Detached house
Detached house
Detached house

**Networked smoke sensors** reliably detect smoke and warn of fire risk.

**Occupancy sensors** switch off lights and HVAC in unoccupied rooms.

**Actuators** govern HVAC and shading according to requirements.

Batteryless wireless **window contacts** turn off the HVAC system when the windows are open.

**Individual room controls** for minimal energy consumption and maximal comfort.

**Batteryless door contacts** monitor door status.

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Detached house

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up

Investors / Property Owners
- Simple retrofit
- Reduced cost of installation and operation
- Flexible space planning and easy restructuring
- High energy savings
- All-encompassing solutions
- More attractive purchase proposition

Facility users
- Increased safety levels
- Enhanced comfort
- Pleasant living environment
- Simple retrofit
- Freely positionable products
- Cost-efficient SmartHome solutions
- No cabling, no drilling, no noise/dust/dirt
Apartment block
Apartment block
Actuators govern HVAC and shading according to requirements.

Batteryless wireless sensors monitor temperature, humidity and light intensity.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Occupyance sensors switch off lights and HVAC in unoccupied rooms.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

Batteryless liquid detection sensors monitor fluid leaks.

Batteryless door contacts monitor door status.

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Actuators govern HVAC and shading according to requirements.

Batteryless wireless window contacts turn off the HVAC system when the windows are open.

Batteryless door contacts monitor door status.

Benefits of using batteryless wireless sensors

**Architects**
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

**Specifiers**
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

**System integrators / Contractors**
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt

**Investors / Property Owners**
- Reduced cost of installation and operation
- Flexible space reallocation
- Easy modernization
- High energy savings
- Interoperable and scalable standard solutions

**Facility Managers**
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- No cabling, no drilling, no noise/dust/dirt

**Facility users**
- Extensive energy savings
- Enhanced comfort

Networked smoke sensors reliably detect smoke and warn of fire risk.

Networked liquid detection sensors monitor fluid leaks.
Retail facility
Retail facility
Retail facility

- **Occupancy sensors** switch off lights and HVAC in unoccupied rooms.
- **Sunblind actuators** govern shutters according to sunlight intensity and time of day.
- **Batteryless wireless switches** govern lighting and shading.
- **Light actuators** control lighting according to requirements.
- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Individual room controls** for minimal energy consumption and maximal comfort.
- **Wireless actuators** control radiators.
- **Sunblind actuators** govern sunblinds or shutters.
- **Batteryless wireless window contacts** turn off the HVAC system when the windows are open.
- **Occupancy sensors** switch off lights and HVAC in unoccupied rooms.
- **Networked smoke sensors** reliably detect smoke and warn of fire risk.
- **Individual room controls** for minimal energy consumption and maximal comfort.
- **Wireless actuators** control radiators.
- **Batteryless wireless switches** act as remote controls.
## Benefits

### Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

### Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

### System Integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

### Investors / Property Owners
- Reduced cost of installation and operation
- Flexible space reallocation and easy restructuring
- Less downtime during renovation
- High energy savings
- Better sales figures

### Facility Managers
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults

### Facility Users
- Enhanced comfort
- Easy analysis of floorspace usage
Historic building
Historic building
Actuators govern HVAC and shading according to requirements.

Batteryless door contacts monitor door status.

Networked smoke sensors reliably detect smoke and warn of fire risk.

Batteryless wireless switches govern lighting and shading.

Batteryless liquid detection sensors monitor fluid leaks.

Batteryless wireless window handles or window contacts turn off the HVAC system when the windows are open.

CO2 sensors monitor air quality.

Occupancy sensors switch off lights and HVAC in unoccupied rooms.

Batteryless temperature and humidity sensors monitor air quality.
**Benefits**

**Architects**
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

**Specifiers**
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

**System integrators / Contractors**
- Speedy, flexible installation / system start-up
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**Investors / Property Owners**
- Reduced cost of installation and operation
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- Easy modernization
- High energy savings
- Interoperable and scalable standard solutions

**Facility Managers**
- Flexibility and freedom from maintenance
- Optimized servicing
- Effective manpower use
- Increased safety levels
- Faster reaction to system faults
- Interoperable and scalable standard solutions
- No cabling, no drilling, no noise/dust/dirt

---

**Batteryless liquid detection sensors** monitor fluid leaks.

**Batteryless wireless window handles or window contacts** turn off the HVAC system when the windows are open.

**Batteryless wireless switches** govern lighting and shading.
Industrial facility
Industrial facility
Industrial facility

**Light actuators** control lighting.

**Occupancy sensors** switch off lights and HVAC in unoccupied rooms.

**Networked smoke sensors** reliably detect smoke and warn of fire risk.

**Sub-meters** generate data for internal cost allocation.

**Batteryless light sensors** optimize lighting control.

**Batteryless door contacts** monitor door status.

**Batteryless wireless switches** govern lighting and shading.

**Batteryless liquid detection sensors** monitor fluid leaks.

(c) EnOcean Alliance   |   Graham Martin    |   Nov 2017
Industrial facility

Benefits

Architects
- Maintenance-free, interoperable wireless sensors
- Freely positionable products which can be placed on glass, stone, wood or furniture as required
- Flexible room configuration

Specifiers
- Simplified planning and high flexibility through freely positionable devices
- Interoperable products
- Compatibility with other building automation systems (KNX, LON, BACnet, TCP/IP)

System integrators / Contractors
- Speedy, flexible installation / system start-up
- No cabling, no drilling, no noise/dust/dirt
- Simple retrofit during undisturbed operation

Investors / Property Owners
- Reduced cost of installation and operation
- Flexible space reallocation and easy restructuring
- Less downtime during renovation
- High energy savings

Facility Managers
- Fewer cables thanks to maintenance-free wireless sensors
- Flexibility and freedom from maintenance
- Reduced cost of installation and operation
- Interoperable and scalable standard solutions
- No noise/dust/dirt
Impact of building automation and of EnOcean upon the certification of buildings
EnOcean’s role in building automation and certification (e.g. DGNB)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Criteria group</th>
<th>N.</th>
<th>Criteria</th>
<th>Share of overall score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ENV 1.1</td>
<td>Ecological balance – emission-based environmental impact</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ENV 1.2</td>
<td>Risk for the local environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ENV 1.3</td>
<td>Ecologically friendly material procurement</td>
</tr>
<tr>
<td></td>
<td>Effect on global and local environment</td>
<td>ENV 2.1</td>
<td>Ecological balance – primary energy</td>
<td>5,6%</td>
</tr>
<tr>
<td></td>
<td>Resource impact and waste management</td>
<td>ENV 2.2</td>
<td>Drinking water and waste water balance</td>
<td>2,3%</td>
</tr>
<tr>
<td></td>
<td>Resource impact and waste management</td>
<td>ENV 2.3</td>
<td>Space requirement</td>
<td>2,3%</td>
</tr>
<tr>
<td></td>
<td>Lifecycle costs</td>
<td>ECO 1.1</td>
<td>Building-related lifecycle costs</td>
<td>9,6%</td>
</tr>
<tr>
<td></td>
<td>Value development</td>
<td>ECO 2.1</td>
<td>Flexibility and reutilization potential</td>
<td>9,6%</td>
</tr>
<tr>
<td></td>
<td>Value development</td>
<td>ECO 2.2</td>
<td>Marketability</td>
<td>3,2%</td>
</tr>
</tbody>
</table>

Relevant criteria for EnOcean technology is highlighted

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“
EnOcean’s role in building automation and certification (e.g. DGNB)

<table>
<thead>
<tr>
<th>Topic</th>
<th>Criteria group</th>
<th>N.</th>
<th>Criteria</th>
<th>Share of overall score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-cultural and functional quality (SOC)</td>
<td>Health, comfort and user satisfaction</td>
<td>SOC 1.1</td>
<td>Thermic comfort</td>
<td>4,3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 1.2</td>
<td>Indoor air quality</td>
<td>2,6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 1.3</td>
<td>Acoustic comfort</td>
<td>0,9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 1.4</td>
<td>Visual comfort</td>
<td>2,6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 1.5</td>
<td>User’s influence</td>
<td>1,7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 1.6</td>
<td>Outdoor air quality</td>
<td>0,9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 1.7</td>
<td>Safety and risk of malfunction</td>
<td>0,9%</td>
</tr>
<tr>
<td></td>
<td>Functionality</td>
<td>SOC 2.1</td>
<td>Barrier-free access</td>
<td>1,7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 2.2</td>
<td>Public access</td>
<td>1,7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 2.3</td>
<td>Bicycle comfort</td>
<td>0,9%</td>
</tr>
<tr>
<td></td>
<td>Creative qualities</td>
<td>SOC 3.1</td>
<td>Procedure for urban and artistic concept</td>
<td>2,6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 3.2</td>
<td>Artistic building</td>
<td>0,9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOC 3.3</td>
<td>Layout quality</td>
<td>0,9%</td>
</tr>
</tbody>
</table>

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“
EnOcean’s role in building automation and certification (e.g. DGNB)

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“

Integrated building automation impacts the following topics: ecological quality (ENV), economic (ECO), socio-cultural and functional quality (SOC) and technical quality (TEC). 11 out of 29 DGNB criteria are positively and sustainably affected*. The application of EnOcean technology influenced 10 out of 29 criteria.

* Source: „Peer Schmidt, Nachhaltigkeit durch Gebäudeautomation am Beispiel der DGNB-Kriterien (Gebäudeautomation, Jahrbuch 2015)“

<table>
<thead>
<tr>
<th>Topic</th>
<th>Criteria group</th>
<th>N.</th>
<th>Criteria</th>
<th>Share of overall score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical quality (TEC)</td>
<td>Quality of the technical execution</td>
<td></td>
<td>TEC 1.1 Fire protection</td>
<td>4,1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TEC 1.2 Sound insulation</td>
<td>4,1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TEC 1.3 Heat and dampness protection qualities of the building’s cladding</td>
<td>4,1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>TEC 1.4 Adaptability of the technical systems</strong></td>
<td>2,0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TEC 1.5 Ease of cleaning and maintenance of the building’s structure</td>
<td>4,1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TEC 1.6 Ease of dismantling</td>
<td>4,1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TEC 1.7 Immission protection</td>
<td>0,0</td>
</tr>
</tbody>
</table>

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### Process quality (PRO)

#### Planning quality

- **PRO 1.1** Quality of project preparation: 1.4%
- **PRO 1.2** Integral planning: 1.4%
- **PRO 1.3** Proof of optimization and complexity of the planning approach: 1.4%
- **PRO 1.4** Safeguards for sustainability in the tender and award process: 1.0%
- **PRO 1.5** Creation of preconditions for an optimal utilization and management: 1.0%

#### Execution quality

- **PRO 2.1** Building site, building process: 1.0%
- **PRO 2.2** Quality assurance for the building process: 1.4%
- **PRO 2.3** Orderly system start-up: 1.4%

---

Excerpt „Bewertungsmatrix für Neubau Büro und Verwaltungsgebäude Version 2012 in Anlehnung an DGNB (Teil 1/2)“

An optimized planning process, and the resulting construction with a systematic start-up phase and an implemented quality assurance system, can significantly improve process quality (criteria PRO 1.1 to PRO 2.3).

**Source:**
Peer Schmidt, Nachhaltigkeit durch Gebäudeautomation am Beispiel der DGNB-Kriterien (Gebäudeautomation, Jahrbuch 2015)
The application of EnOcean technology, together with an adapted planning and execution process, positively and sustainably affected **18 out of 37 DGNB criteria**. These 18 criteria account for more than 2/3 of the overall ranking.
Case studies / References
Case study: multi-purpose building
The Squaire – Frankfurt Airport

Device quantity

<table>
<thead>
<tr>
<th>Devices</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnOcean terminals</td>
<td>1,838</td>
</tr>
<tr>
<td>EnOcean switches</td>
<td>12,000</td>
</tr>
<tr>
<td>EnOcean room sensors</td>
<td>6,000</td>
</tr>
<tr>
<td>PLC for Plants and Room Automation</td>
<td>899</td>
</tr>
<tr>
<td>PLC for BACnet communication</td>
<td>56</td>
</tr>
<tr>
<td>PLC for DALI</td>
<td>25</td>
</tr>
<tr>
<td>MP Bus-Terminal</td>
<td>2,119</td>
</tr>
<tr>
<td>DALI terminal</td>
<td>89</td>
</tr>
<tr>
<td>EIA422/485 terminal</td>
<td>6</td>
</tr>
<tr>
<td>KNX terminal</td>
<td>20</td>
</tr>
</tbody>
</table>

Basic facts

- Length: 660 metres (2 x Eiffel Tower)
- Width: 65 metres
- Height: 45 metres (9 storeys)
- Usable area: 140,000 m²
- Project costs: 1.4 billion €
  - 21 million € thereof spent on automation
- More than 20,000 EnOcean sensors and actuators in place
4.200 batteryless wireless devices
- Light switches
- Occupancy sensors
- Light sensors

Savings*
- 30% to 40% of the cost of lighting
  - Ambient-light-dependent interior lighting
  - Occupancy-sensor-triggered light shutdown
- 32 km cables, saving
  - 1.2 t copper / 4.5 t CO₂
  - 2.8 t PVC / 7.5 t CO₂
  - Many man-years in installation time
- 42,000 batteries (over 25 years)
- Thereafter: 80% of restructuring costs

* own calculation
References: office buildings

Schneider Electric Research and Development, Montreal (Canada)

NYC Department of Sanitation (USA)

Vossloh-Schwabe Office Shanghai (China)

ADAC Headquarters Munich (Germany)
References: hotels

- Energy Saving Hotels (USA)
- Platzl Hotel, Munich (Germany)
- Springhill Suites, Natomas (USA)
- Hainan Airline Hotel (China)
References: hospitals and AAL

Senior citizens home, Asslar (Germany)
VA Medical Center, Dayton, OH (USA)
Institut de Cardiologie (Canada)
Müritz Clinic (Germany)
References: residential buildings

- Empowerhouse, Washington D.C. (USA)
- B10 Active House (Germany)
- Shanghai Villa (China)
- Weberhaus (Germany)
References: retail facilities

- Changi City Point (Singapur)
- Morrisons Distribution Center (UK)
- Toys R Us (UK)
- Xtramart Convenience Store (USA)
References: schools

Center for Virtual Engineering ZVE (Germany)

Sir Isaac Newton Academy (UK)

Georgia Institute of Technology (USA)

University of Western Ontario (Canada)
References: industrial facilities

Wayne County Airport Authority Maintenance Facilities (USA)  

BMW production plant (Germany)  

Agrreko Factory (UK)  

Cardboard production plant (Canada)
References: historic buildings

Taimadera
Buddhistischer Temple (Japan)

Semperoper, Dresden (Germany)

Queen Anne's Gate (UK)

St. Andrews Cathedral (Canada)
References: further projects

Entega Loge (Germany)

Imtech Arena (Germany)

SCHEIBER Boats

Yacht "Feretti 830" (Brazil)
Case study: green building certifications

Leggat MacCall Properties, Boston

Promutuel Insurance Company, Quebec

“Tower 185” PWC Frankfurt
Videos

www.enocean-alliance.org
www.youtube.com/user/EnOcean
Videos

EnOcean YouTube channel: EnOcean technology for intelligent and green buildings

Part 1: why wireless & batteryless?

Part 2: EnOcean technology

Part 3: the installation

Part 4: range planning basics

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Any questions?

Contact
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