

Harvesting wireless sensors



Smart Energy Sensor

Strategy:

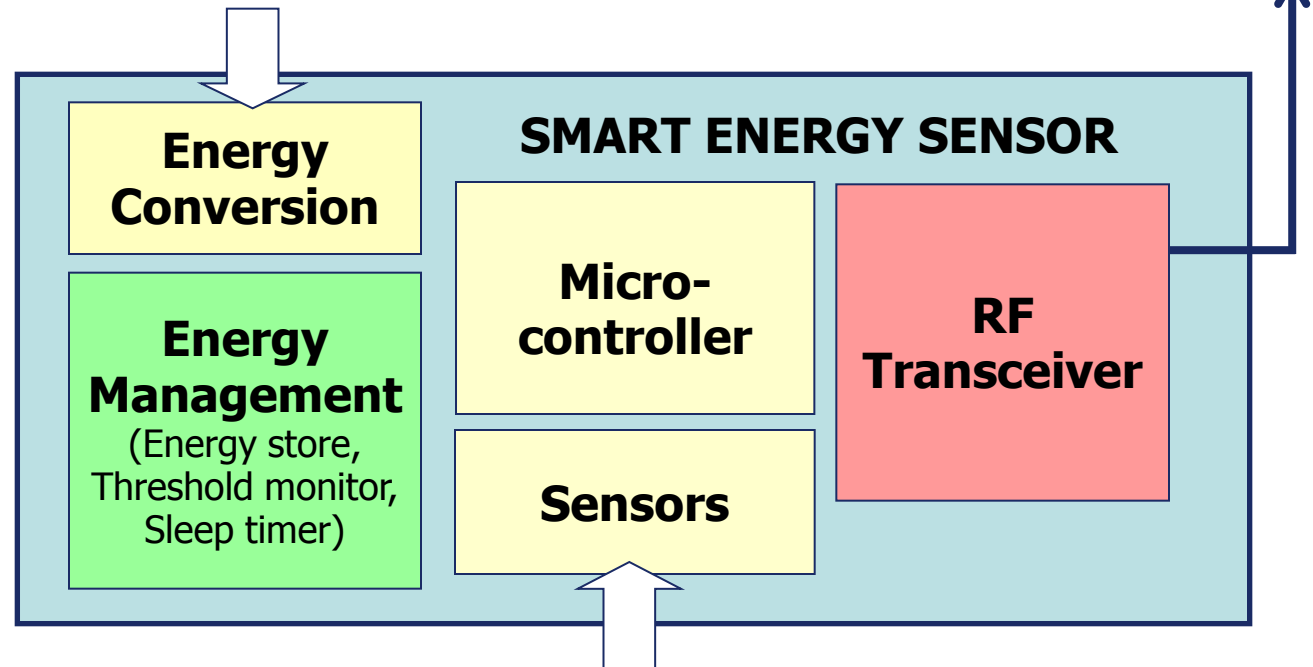
Short term supply

- Consequently switched off
- Minimized start-up phase
- Minimized operation time

Continuous supply

Strongly optimised current consumption (few nA)

Ambient Energy:
Motion, Vibration, Temperature, Light, etc.



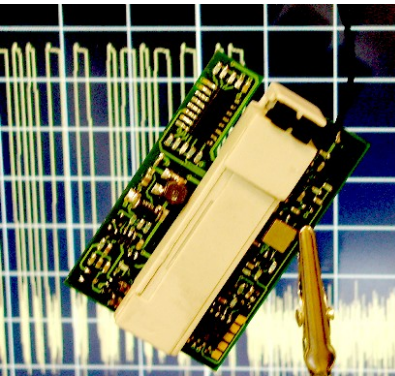
Temperature, Pressure, Position, etc.



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Radio Communication

$$E = P \times t$$



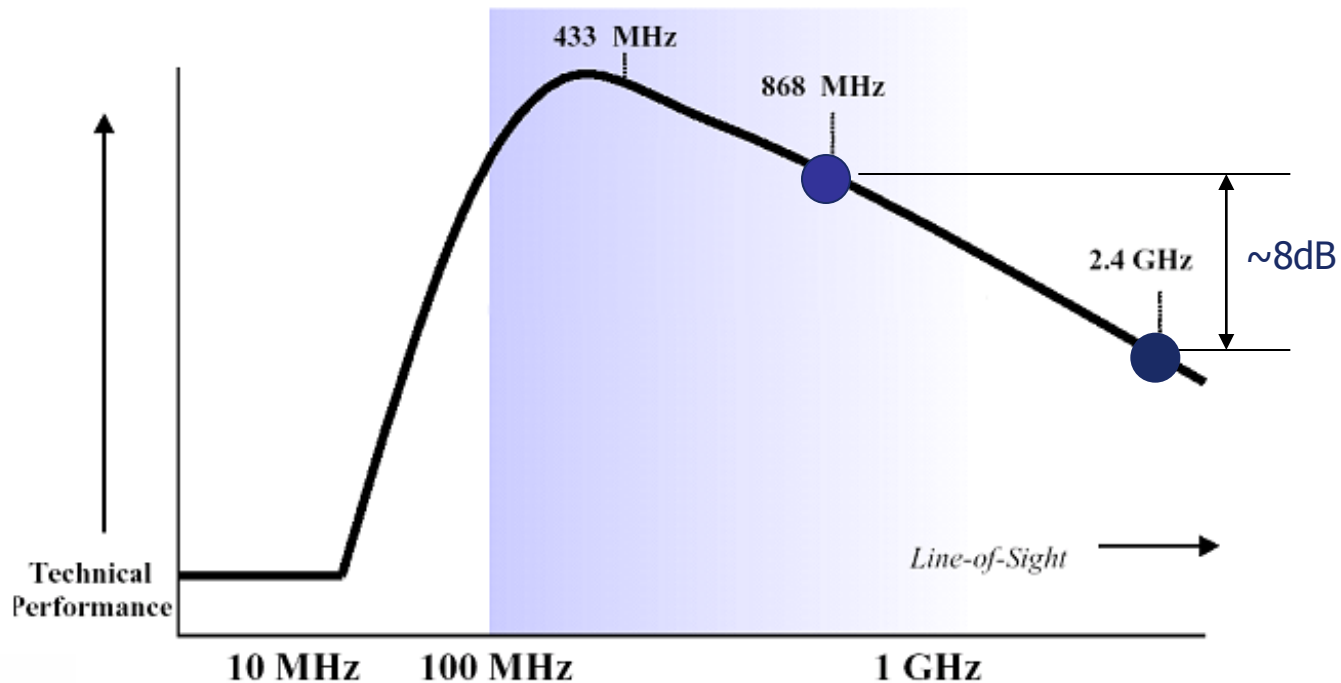
<i>Requirement</i>	<i>Realized by using (example Smart Energy radio)</i>
Low energy need	Very short telegrams = High data rate (125 kbit/s), Lowest „data overhead“
Long range	High transmission power (10mW)
Low collision probability	Very short telegrams (~ 1ms) Implementing redundancy (repetitions with random intervals)
High interference protection	Implementing redundancy (repetitions asynchronous to interference)
Expandability	Flexible telegram definition (using telegram index)



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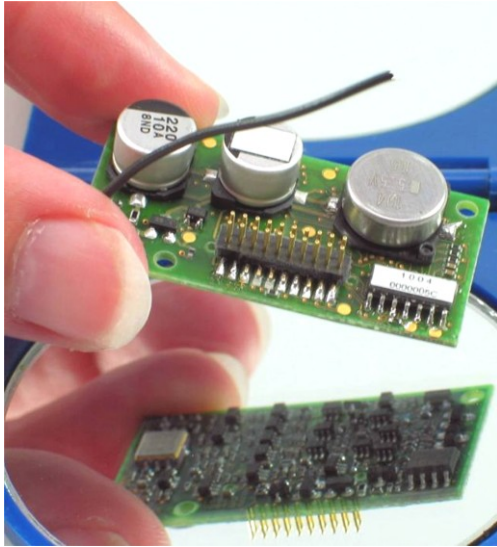
Frequency Selection

2.4 GHz is worldwide ISM band,
but 2 times better range at 868 MHz



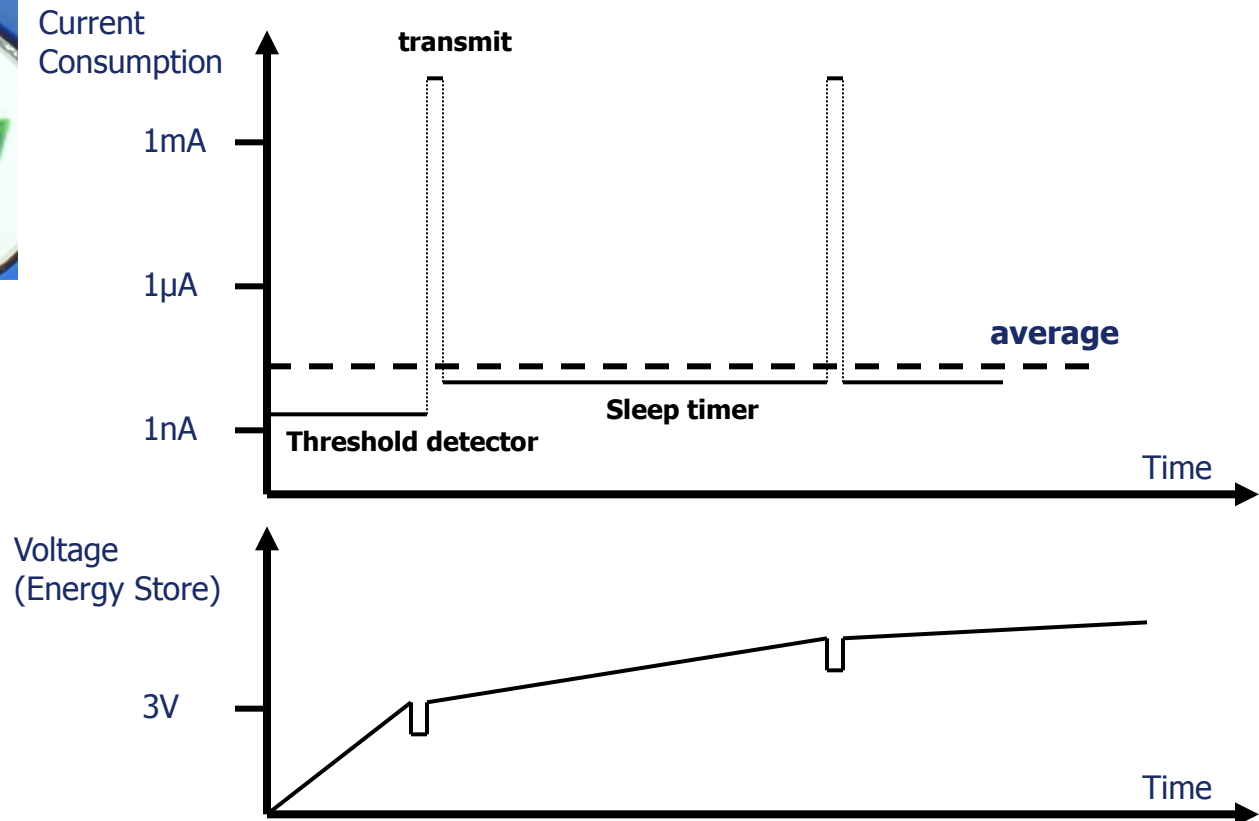
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Energy Management



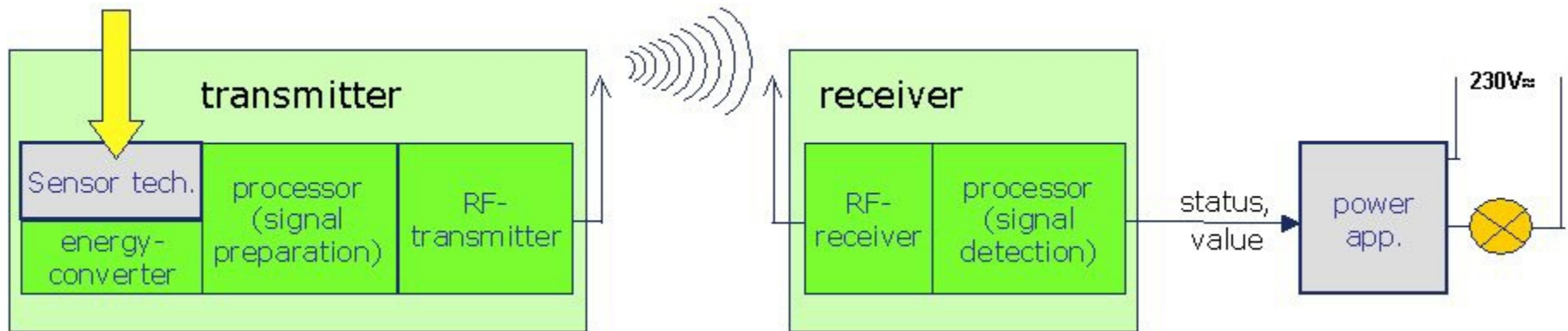
EnOcean STM 100 module
(20 nA sleep timer)

- 1.) Low duty cycle: $t_{\text{active}} \text{ (ms)} \ll t_{\text{sleep}} \text{ (s)}$
- 2.) Ultra-low-power Threshold Detection and Sleep Timer (few nA)



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EnOcean communication



Energy Harvesting

- Sensors are powered by tiny changes in the environment!
 - Mechanical
 - Solar
 - Thermal



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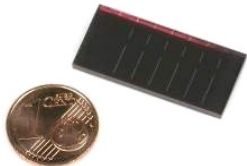
Energy Converters – in Detail



ECO 200

Mechanical: Energy by fingertip

- Electrodynamic Energy Generator
- User-independent energy conversion with button press
- Maintenance free 50.000 operations
- Allows small and flat rocker designs



ECS 200

Solar: natural and indoor light

- Small solar cell 13x35mm with energy storage
- Energy harvesting with „quick start“ and 24/7 operation
- Function follows design

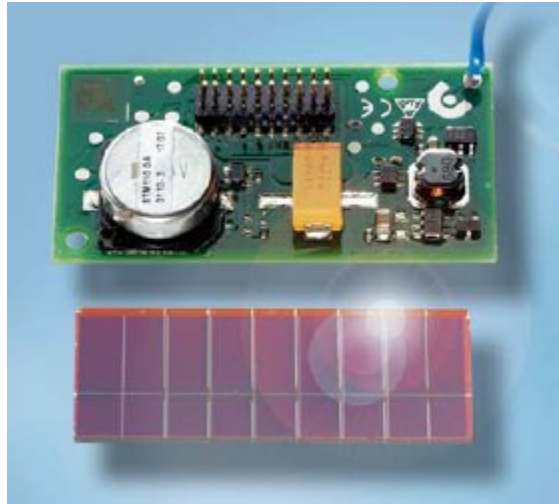


ECT 300

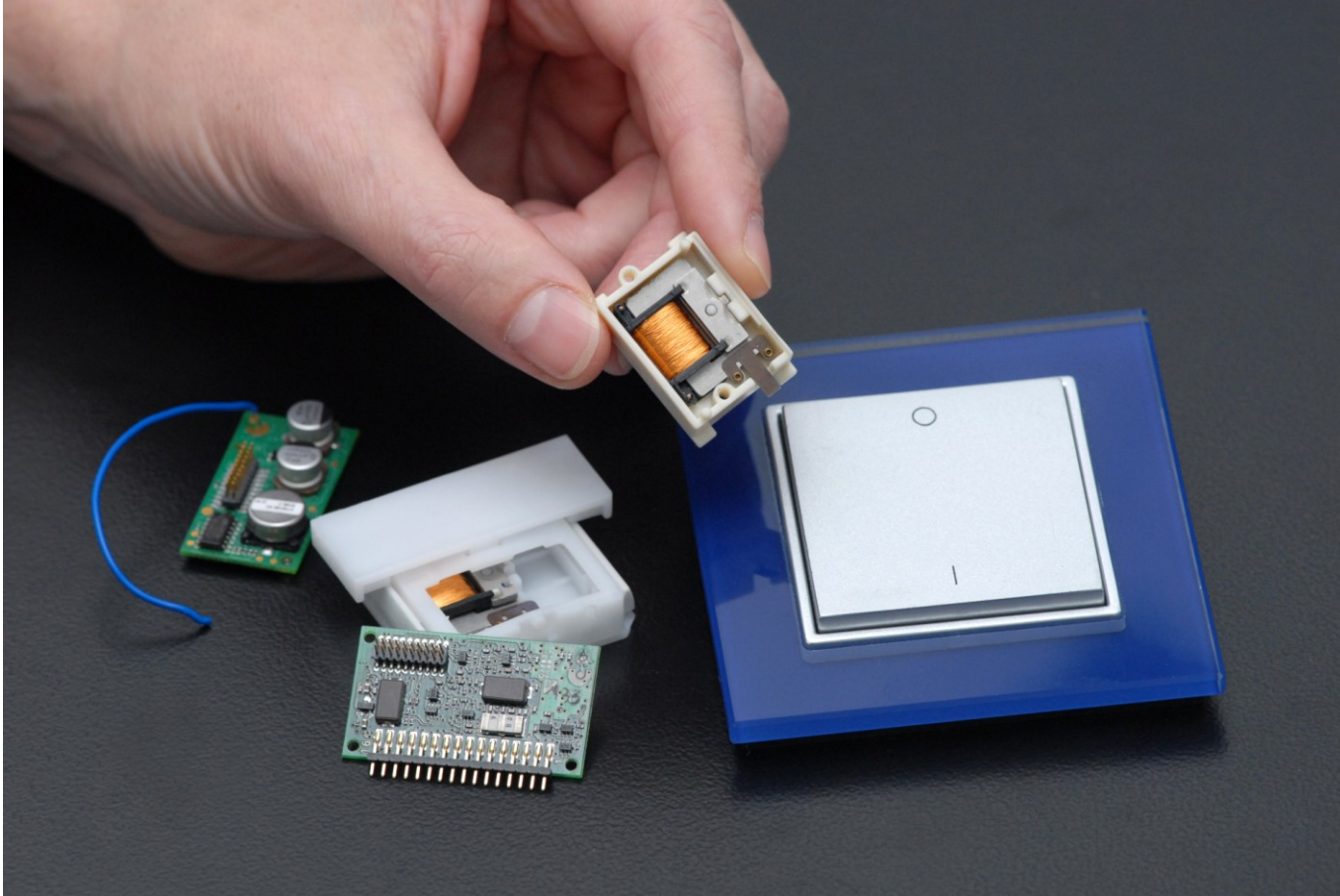
Thermal: 2 Kelvin @ Peltier

- Standard peltier element in combination with EnOcean ultra low power DC/DC converter
- Maintenance free, full integration possible
- Allows energy harvesting actuators

Hardware modules 1st generation



Structure of EnOcean switch



Smart Energy Sensors: Building Applications

UNIQA Tower



Headquarter of UNIQA
insurance in Vienna

Installed Buildings:

- New SAP headquarter in Walldorf
- New UNIQA headquarter in Vienna
- New BSH headquarter in Munich
- NESTLE Paris
- IBM Zürich
- SIEMENS Munich
- MAN Munich
- FESTO Esslingen
- Messe Frankfurt
- Semperoper Dresden
- Etc., etc.



Source: Peha



Source: Distech



Source: Omnia



Source: Aqualisa



Source: Bticino



Source: Hoppe

Source: Thermokon



Source: Wieland



Source: MSR

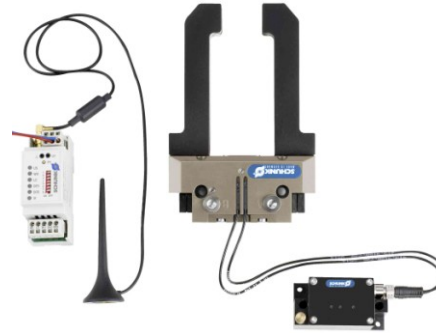


Source: Sevoda

Smart Energy Sensors: Industrial Applications



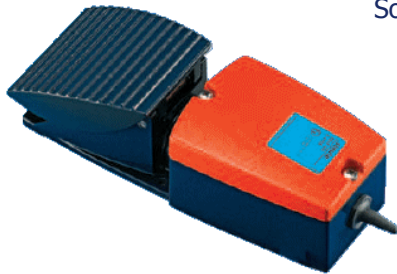
Source: Steute



Source: Schunk



Source: Steute



Source: Steute



Source: Balluff



Source: WMT



Uni-directional Self-powered Sensors



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Hardware modules 2nd generation



Bi-directional Self-powered Sensors

Solar-powered HVAC sensor



Dolphin API – Smart Ack

1st telegram:
Measurement Value
(e.g. temperature,
humidity)



2nd telegram:
Sensor Parameter Update
(e.g. set-point zero,
clock sync, window status)



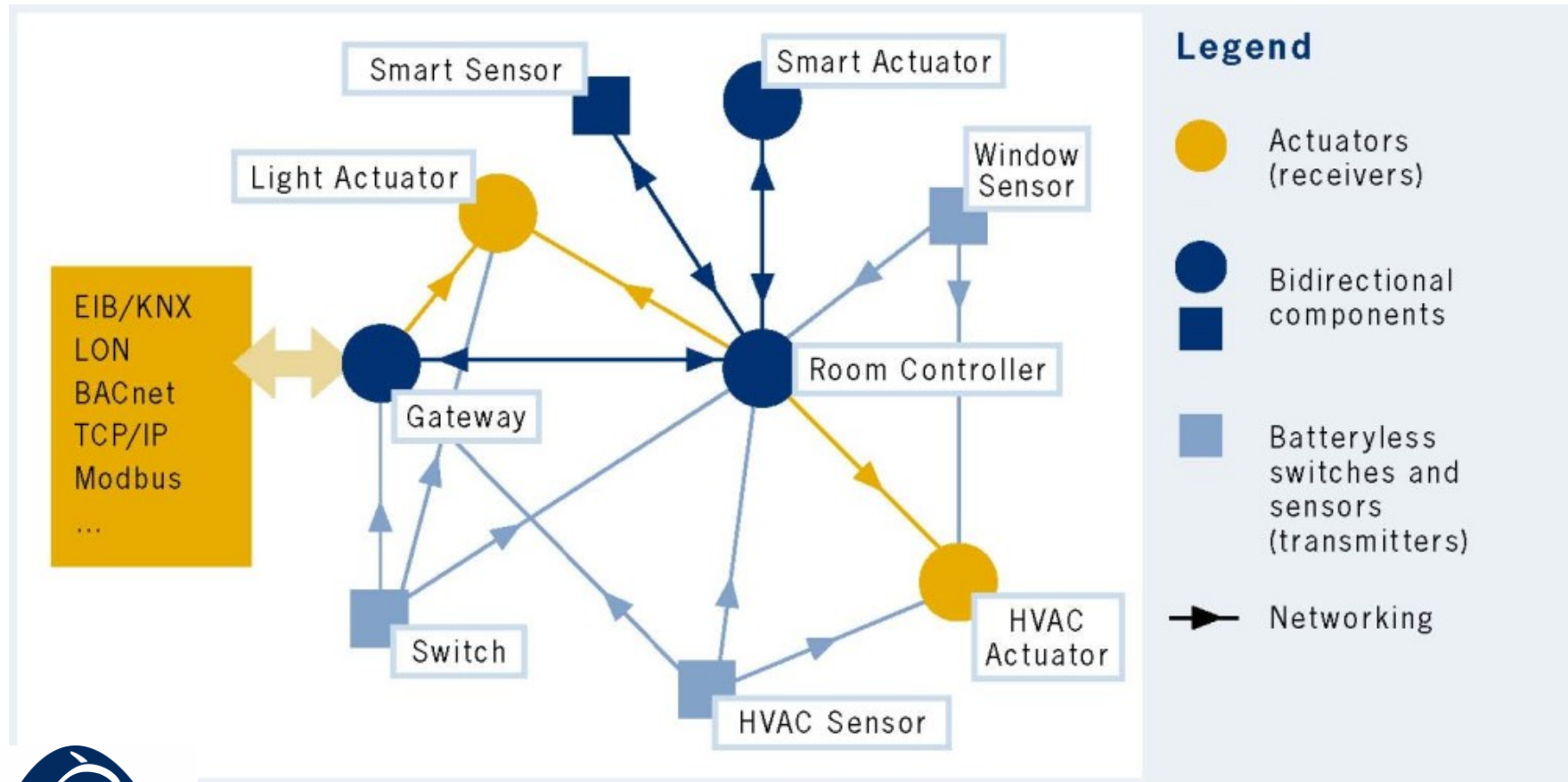
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Harvesting temperature difference



EnOcean Wireless Sensor Network

- System Architecture with uni- and bi-directional communication



Actuators



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Wireless applications





- 1 Batteryless wireless switches control lighting and shading.
- 2 Batteryless outdoor light sensors automatically match lighting to daylight.
- 3 Occupancy sensor adjusts temperature and turns off lights when a room is not in use.
- 4 Room temperature sensor for minimal energy consumption and maximum comfort

- 6 7 Position sensors – window handle and window contact – cut out heating and air-conditioning when windows are open.
- 8 Central control on a touch panel or PC/notebook.
- 9 Remote monitoring and control by a mobile phone or on the Internet.

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1 Batteryless wireless switches control lighting.

2 Batteryless handhelds control light scenes (light and blind).

3 Room temperature sensor for minimal energy consumption and maximum comfort.

4 Climatic sensors (humidity and CO₂) monitor indoor air quality.



- 1 Batteryless wireless switches control lighting and shading.
- 2 Key card switch controls access to a room and turns on heating and lighting when entering a room.
- 3 Occupancy sensor adjusts temperature and turns off lights when a room is not in use.
- 4 Room temperature sensor for minimal energy consumption

- 5 Climatic sensors (humidity and CO₂) monitor indoor air quality.
- 6 7 Position sensors – window handle and window contact – cut out heating and air-conditioning when windows are open.
- 8 Central control on a touch panel or PC/notebook.

EnOcean references



Over 100,000 Buildings "enabled by EnOcean"



Offices



Industrial



Hospitals



Historical Buildings



Residential



Hotels



Schools, Colleges & Nurseries

Enocean Alliance Eco-System



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