WIRELESS THINGS

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Frequently asked questions

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About wireless sensor networks

A WSN (wireless sensor network) is a wireless module network that carries out **monitoring and control operations via wireless protocols**. Monitoring may relate to a wide range of environmental parameters, such as temperature, sound, vibration, pressure, movement, energy, pollutants concentration or device parameters such as water temperature, battery voltage, energy produced or consumed, etc.

How are WSNs perceived in WIRELESS THINGS?

In WIRELESS THINGS monitoring and control is technically achieved by a series of wireless enabled modules. Such modules are capable also of dispatching control outputs. These outputs typically are calculated via a control and optimization process running on a module itself. This process usually makes use of

- real time data collected locally
- real time data received over the wireless protocol from neighbor nodes
- real or non real time data received from some external provider (meteorological data, pricing data received from the electric authority, etc.).

Energy monitoring, electric and thermal is a key concept in WIRELESS THINGS; for this reason a special set of ENERGY modules has been developed to cater for diverse energy monitoring requirements.

Where can a WSN can be applied?

Wireless sensor networks are used in diverse applications. They may be placed in buildings or installed in outdoor, urban, spaces for monitoring energy consumption, energy production, energy stores (such as boilers, batteries, etc.), environmental conditions, etc. Wireless sensor networks can be used in both individual and commercial premises. They are widely used in food industries, supermarkets, restaurants, hotels and offices. Based on the safe, trustworthy wireless communication standards, a WSN provides convenient connectivity and communication with no use of wires. They can be used in storage rooms, containers, greenhouses, etc. for measuring process conditions (temperature, humidity), checking the product status or the production process, and assisting in the identification of defective material. Also, to detect the presence of pollutants such as CO, formaldehyde, etc.

Just as sensors can be applied anywhere, sensor networks can address virtually any case where data need to be collected from several points.

What is the benefit of setting up a sensor data network and not collecting the data individually?

The benefit is that in a sensor network the **nodes may communicate between themselves**. Nodes auto connect and engage in data exchange in order to create a path to reach the gateway. In this way, even remote nodes can dynamically find their closest peer and send it their data, while authorizing it to forward them further up the network, till they reach the gateway that posts them to the web.

Although this is the major benefit of the WSN there may be several other cases, as well, where inter-node communication is important. For example, when running a control algorithm that depends on data collected at another node. This functionality can be very easily implemented in a WSN; it might be very difficult and expensive to do so in un-networked sensing schemes.

What are the key design features of WIRELESS THINGS?

WIRELESS THINGS implement over the basic communication protocol. 802.15.4 a sophisticated routing protocol that allows the following:

- To collect and transfer the sensor data with the most cost effective infrastructure, the lower possible number of nodes
- To maximize battery longevity
- To make sure that there is no data loss and that loss of connectivity (for any reason) may be effectively managed, via local buffering.

Are there any limitations as regards the sensed parameters?

There are **pre- configured sensor boards** that can be immediately deployed in the application context. There are also **extension boards** that can provide connectivity to all sorts of external sensors. In this way the only real limitation is the sensor itself. Although it will not be possible to always have the sensor on board and integrated on the WIRELESS THINGS module, the connectivity to external sensors via the extension boards will always be possible.

What kind of applications can be supported by modules

WIRELESS THINGS modules are highly modular and may be used in diverse situations. There are three broad use cases:

- **Device monitoring**; collect and process real time data on the performance of an energy device, electric or thermal. Energy devices may be consuming (A/C unit, washing machine, etc.) storing (thermal boiler, battery, etc.) and producing (wind turbine, pv panel, solar panel, etc.). Analysis of device efficiency and conformance to standards are typical applications here.
- **Space monitoring**; monitor various space/ building parameters as well as energy production/ consumption at the space level. Energy efficiency can be analyzed with

regard to various operational parameters, such as thermal comfort achieved, building occupancy, meteorological conditions. \"Spaces\" can be parts of the building where we wish to assess the quality of the environment (air quality, Thermal quality) and potentially relate this to the real time measured energy (electric and thermal) consumed in the space.

- **Control applications**; WIRELESS THINGS modules are capable of executing control commands to the devices they monitor and supervise. WT IRRIG is such a control-board used for smart irrigation.

What is the module sleep mode?

The embedded routing protocol requires that radios remain switched off and are active only during the transmission of the data to the gateway. The less often sensors are sampled, the less the radio needs to wake up. In this way their battery consumption is drastically reduced (consumption on a sleeping node is typically 20 times less than on a wake-up node). Apparently this relates only to battery powered modules. Modules that are mains supplied do not need to go in sleep mode.

What is relaying and what are relay nodes

Relay nodes are WIRELESS THINGS modules that never sleep. Energy meters, as battery independent, are, typically candidates for assuming a relaying role in the routing protocol. These modules are mains and not battery powered and do not have any respective energy limitations; instead of programming them to be by default in sleep mode they can be, at no performance cost, on the alert; we can use them as relay nodes. **They offer a good, energy wise, pathway for data transmission, for nodes not directly reaching the gateway**. Very often, making use of such nodes and assigning them this special relaying role will solve the effective distance problem of the remote modules.

What is buffering?

When a module communication is problematic, **data buffering is used to eliminate the danger of data loss**. The module internal memory guarantees that data will not be lost in the case of a system fault, blackout etc. If a module fails to communicate and send its data, it initiates buffering, i.e., writing the data that were not able to be transmitted, to its local memory until the moment it is able to transmit data (new and stored data). Nodes can store data for 1-2 days, enough time to have the problem automatically (e.g. Internet connectivity restored) or manually (e.g. the PC hosting the gateway is again put on-line) solved.

Where can I find more information about the routing protocol behind WIRELESS THINGS?

Check at videos at the Building Warden YouTube channel; there is also a paper published at:

http://article.sciencepublishinggroup.com/pdf/10.11648.j.ijssn.20130101.11.pdf

Both provide some further, detailed information on the key aspects of routing protocol backing WIRELESS THINGS.

How is a WIRELESS THINGS WSN commissioned?

We will need to have remote access to a WINDOWS PC at the monitored premises. This PC must have Internet connectivity and is used for two purposes:

- To host on a USB slot the network gateway via which all data will be pushed to the web database. **There is an alternative to use a wifi WT module.**
- (**ver 1.0**) To host some middleware software that we will supply you with and on this PC; this is called the WT Bridge. This software is used to connect to all data modules, download configuration files, update software, etc. This PC must run WINDOWS; any version after vista will do. The closest to the data collection area the better. The footprint of the Bridge software we will install is minimal. Thus, you can run whatever else you wish on the PC. We will need to have remote access to this PC, via some licensed remote administration software that we will send you. After this we will be able to log on the PC, install the Bridge software and manage remotely the data network. The remote access may be disabled after proper installation has been achieved. However, new firmware updates can only be installed wirelessly, via air flash; no site visits are possible for such updates. In such a case reactivation of the remote access may be required. As to the modules themselves, some of them, those with embedded sensor boards, are plug and play. You will receive them and without any difficulty set them up. If low voltage connections are required, e.g., for external sensors, you will be advised in detail how to carry on the connections. **However, in the case of EnergyBoards it is essential to have the assistance of an experienced electrician. Please pay due attention to this issue!**
- In **ver 2.0** the WT Bridge has migrated to the web and is not running on the host PC.

What if I am not happy? Is there any take back policy in action?

Upon acceptance of our offer, an invoice will be issued and should be paid immediately after the system is setup and working; this must be decided within a month as a **monthly take back period applies**. The customer may within this period send back the equipment, bearing only the shipping costs. In such a case a credit invoice will be issued.

About the behaviour mobule (BM)

The Behaviour Module (BM) is a **modular**, **low cost**, **real time** (RT), **IPMVP aware** and **flexible**

application framework aiming at **highlighting instances of energy waste related to user behavior**. BM tracks events as low level as 'open window' and builds a stacked view of 'waste' where each of these stacks is associated to the events modelled.

Please note that the BM is not yet a commercial product! We anticipate its market launch towards the end of 2018!

How has the BM been conceived?

The BM is part of the project (read here). It has been co-funded by the EC within the HORIZON programme. HIT2GAP aims at emerging into an operating system for interconnected energy applications. The BM is one out of the many modules of this ambitious suite.

How is the BM modular?

The BM is able to **easily extend its event library** and **use the same RT engine to provide for the modeling and monitoring of the events**. Depending on the event type it might, however, be necessary to introduce in the platform new types of sensors.

How is the BM of a low cost?

By consciously and meticulously avoiding over-metering. Over-metering can result to complex, intrusive and expensive solutions that are of no interest. As an example, we have tried to completely avoid energy metering.

BM operates at the room level so if it would be dependent on energy metering we would require energy meters (electricity heating/ cooling) in all these rooms. As a result, we would end up with an impractical solution. Instead of this approach we introduce the concept of degree minutes as the metric of energy and especially energy waste. A **heating/ cooling degreeminute is** is the deviation between the actual indoor temperature and the set point temperature integrated within the study period. Of course in order for such a deviation to contribute to waste we need to integrate in a season specific way, depending on whether we are in the cooling or heating period. When cooling, the deviation will contribute to waste *only if temp (in) < temp (set)*; vice versa for the heating period.

This said, the BM is perfectly able to integrate energy meters, if the user so requires. It is only our anticipation that this will in generally not be required that has mandated our key design approach. In principle, we look forward **to an all inclusive price profile ranging from 200-1000E per space**, depending on the events modelled and monitored.

How is the BM real time?

By being based on parameters that are scanned in the real time. As said above, we have striven

to reduce these to the minimal possible. The modular design allows to start from very simple scenarios/ events with minimal instrumentation and escalate to more complex ones with more and advanced sensoring in place. Parameters can of course be scanned at **any** sampling rate required. As a default, **a rate of 1 min is used, to be compatible with the degree- minute concept.**

How is the BM IPMVP(*) aware?

In the time benchmarking (comparing a space performance across time) provided by the BM it is necessary to offset the performance results against **weather**. In this way we can be sure that any efficiency registered is due to the BM and not due to externalities such as weather. This is a typical problem with performance reporting that we fully address in the BM. The exact way this is implemented is based on concepts published in the press (read here); in short one needs to calculate heating or cooling degree-hours for the periods out in comparison. A linear model is proposed although more sophisticated ones may be attempted. In the space bench-marking (comparing the relevant performance of spaces) this does not make sense as all selected spaces are compared within the same time frame; therefore the weather impact is inherently offset.

In addition by measuring occupancy (wherever the event requires so) we are also able to include occupancy in the benchmarking exercise. A space operating under higher than design occupancy is a more energy efficient space. We believe that introducing occupancy/ headcount consideration in energy efficiency will radically reshape our very perception of energy efficiency. A space having a small energy consumption per square meters is not necessarily an energy efficient space! All depends on occupancy. If the space is practically empty then it may be a very inefficient space indeed. At the end **energy is meant to serve occupants and not square meters!**

(*) The **International Performance Measurement and Verification Protocol** (IPMVP®) defines standard terms and suggests best practice for quantifying the results of energy efficiency investments and increase investment in energy and water efficiency

How is the BM flexible, e.g. how can it link to a BMS in place?

The BM can use real physical time sensors **but can also model, so called, calculated sensors**. The BM engine, including visualization, treats them in exactly the same way. Thus, if some of the parameters required by the BM are already available in an existing BMS, the BM will define these as calculated sensors and will "agree" with the BMS **on a method to read the data in this calculated sensor**; probably this will some .xml or other file; this depends solely on the export capabilities of the BMS.

One should recall that the BM is a very low cost solution; **in many cases it might therefore not be justified, cost-wise, to create these file exchangers when the physical sensor is**

something like 150E. All these decisions depend on a very concise environment analysis that will reveal the best solution from the user point of view. The flexibility however is fully in place.

What kind of events can be modelled in the BM?

Check with the Behavioural Event Library document in the same section (FIND OUT MORE) of the web site.

What is the difference between space occupancy and presence?

Occupancy is an analog value representing the **actual headcount of a space**. Presence is a digital on/ off value indicating **if the space is empty or not**. *Occupancy* is clearly a super-set to *presence*, a much more complex and interesting concept as it can provide important information of space and energy use.

WT has developed cutting edge technology in occupancy metering. This will be incorporated in the BM whenever this information is important and can provide additional information to a simple presence sensor. There is a lot of information on the web site on this development

Where does occupancy metering make sense in the BM?

On the one hand an occupancy sensor can be a substitute for a presence sensor. This alone however, will not justify the metering of occupancy. **Occupancy real time metering will only make sense of you are interested to gain insight in the usage of your spaces**; this has an energy impact, as the higher the occupancy the more efficient the use of spaces. However its may provide much wider insight, well beyond energy, and can support many work and space re-organisation decisions, affecting, **in essence the building use. In this version of the BM we have not linked occupancy to any specific event, although this is most likely to happen in the very near future.**

Are all the BM events related to user behaviour?

Not all, but most of them. **We wish to highlight and foster the BM as one of the first commercial behaviour trackers**. There is however no fundamental reason why one should restrict to behavioural issues alone. In addition, very often there are so tightly connected with systems issues that one can hardly keep them apart. Thus, the BM is exhaustive about the behavioural events but also expands other considerations, such as systems performance and pricing.

What is there to the BM besides event modelling and monitoring?

Benchmarking and **alarm management** via user notification.

How is benchmarking integrated in the BM?

BM supports two types of bench-marking

- **in time**; here we analyze the performance of a given space (office, floor, building) across time. This allows to evaluate how user awareness created by the BM or how incentives that have been launched for energy efficiency have actually performed.
- **across spaces**; here we analyze the impact of the BM across different spaces and within the same time-frame. I order to do so you need to enter the gaming platform www.energygames.org. This platform will be available in 2018 only.

In the first case as time-frame changes it is necessary to offset the performance results against weather. In this way we can be sure that any efficiency registered is due to the BM and not due to externalities such as weather (please see the IPMVP question above). Both types of benchmarking produce performance reports.

How is alarm management integrated in the BM?

Alarms **may** or **may not** be related to specific events. For example we can set an alarm whenever the waste minutes exceed a special value within a 24h time-frame. This alarm would be then clearly linked to an event. An alarm however can also be set when, for example, CO2 value exceeds some threshold. This is not a waste event per se. **It is an incident of bad indoor quality.** In either case a sophisticated real time alarm management system is in place that may notify predefined users about the specific alarm.

How does the BM notify users?

The **dashboard** is where all events and all their history are reported upon. However, in some cases a more real time notification is required as some prompt action may be required. Such notifications can be easily set up **over SMS and/ or email**. The recipient of the notification must of course be a registered user of the BM installation.

Is a BM installation public in access?

By default, the **visualization dashboard is public**; anyone with the URL in hand can access it, unless the user requests a different set-up. The **BM configuration and notification service (SMS/ emails) will require registration**; This is an off line procedure as user authentication must be secured Following this, access to configuration and notification services will be possible over an embedded to the dashboard interface.