eTEACHER

Data processing service for end-user engagement

WP2: WP 2 - Empower tools I – BACS add-on services ***Empower tools I - BACS add-on services***

Task 2.4 Data processing service for end-user engagement

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eTEACHER

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Technical References

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Abbreviation and Acronyms

AHU	Air handling unit
API	Application Programming Interface
BACS	Building Automation and Control System
BEMS	Building Energy Management System
BIM	Building Information Model/Modelling
BRI	Building Related Sicknesses
EER	Energy Efficiency Rating
EPA	Environmental Protection Agency
FM	Facility Manager/Management
HVAC	Heating, Ventilating and Air Conditioning
IEQ	Indoor Environmental Quality
IAQ	Indoor Air Quality
IP	Internet Protocol
KPI	Key Performance Indicator
OR	Overall Requirements
POE	Post Occupancy Evaluation
SBS	Sick Building Syndrome
UBCI	Universal BACS Communication Interface
WP	Work Package

1. Abstract

This deliverable aims at describing the data processing service for the Comfort Opinion service, Metrix and Pulse services. The deliverable itself is the working software prototype. This report gives a theoretical view on end-user engagement theories that help us understand what data is relevant to be presented to the end-users and apply theories such as flow, aesthetics, play and information interaction. In addition, we investigated about theories on human machine interfaces (HMI) which basically represent the graphical user interfaces for the development of the tools.

HMI's main purpose is supporting human thinking and operating. Because of this, its structure must correspond to a user's mental model. A user should understand how the monitored system works, and events in the GUI must correspond to the monitored processes. Therefore, the HMI development must be based on close cooperation with future HMI users. In implementing a GUI, it is important not to strive to create radical changes in users' ways of thinking.

After reviewing the theories mentioned above the proceeded with the data processing service. The methods on how data is collected, cleaned, the installation of the data processing are explained in D2.2. In this deliverable we focus in the development of the graphical user interfaces as a post processing service. In the development we considered the feasibility, organizational, technical and functionality aspects of the tool. The feedback forum 2 results also serve as a basis of what could be improved and included in the tool. For instance, indoor temperatures, indoor environmental quality scores, energy information and data, energy hints and tips, pulse (IEQ) voting and energy comparisons. Parameters that are relevant to the development the Comfort Opinion, Metrix, Pulse systems.

This deliverable focuses on the application related to Granlund development. For What if Analysis application data processing is further explained in D2.3 and the actual application and gamification in D3.5.

2. User engagement

In order to have successful technologies they not only have to be usable but must engage with its users. Chapman (1997) defines engagement as "something that draws us in, that attracts and holds our attention". Quesenbery (2005) (2005) projected that engagement is a dimension of usability, the users' first impression of an application and the enjoyment derive from using it are critical. Many studies have engagement according to different characteristics such as media presentation, perceived user control, choice, challenge, feedback, and variety (Said, 2004). All together, these attributes demonstrate the diverse components of user experiences such as the physical, cognitive and affective.

User experience has more relevance that ever before and is no longer sufficient to ensure that a system is usable but that engages with its users (Blythe *et al*., 2003). Traditionally, identifying users' perceptions, actions, and attitudes on how to make systems functional and intuitive to use has been the main focus. Now more engaging interactions are needed which is a discussion that should take place between the users and developers of computer systems and applications.

Flow theory it is commonly used to explore situations and personality variables related with computer-based tasks (Woszczynski et al, 2002) to predict and design for flow experiences (Finneran & Zhang, 2003) and to understand users' reactions and motivations for using applications (Konradt & Sulz, 2001). Engagement has been thought as a subset of flow in more passive way, and flow without user control (Webster & Ahuja, 2004). Researchers suggest that engagement may share some attributes with flow, such as focused attention, feedback, control, activity orientation and intrinsic motivation. Despite the common ideas between engagement and flow, there are some differences. Flow requires sustained, long-term focus and loss of awareness of the outside world; engagement should still occur in today's multitasking and dynamic computer environments. Other aspects to consider are aesthetics, play and interaction.

Aesthetics experiences are naturally motivating, require focused attention, stimulate curiosity and are interesting and pleasurable (Jennings, 2000). Aesthetics have been associated with engagement because of similar characteristics and has been applied by software developers in interface design. Mainly by using design principles such as symmetry, balance, emphasis, harmony, proportion, rhythm and unity (Tractinsky, 2004). Aesthetics has been linked to usability and users' skills and needs, as well as sensory aspects or format of the application. However, aesthetics is important, it is only one aspect of engagement.

Play is another important aspect for engagement. It is a physical activity that encourages learning and creativity, develops and satisfies psychological and social needs, and involves aspects of competition and collaboration. Play has also been associated with having an experience, such as news reading, browsing, educational technologies, video games and decision making (Woszczynski et al., 2002). Play has been associated with increased frequency and satisfaction of the system use and has been attributed to increased motivation, challenge, and affect. Thus, elements of play are intrinsic to engagement.

Interaction refers to the communication between the user and the computer interface where the interface is the medium enabling user experiences. The interface represents the union of information design (how data is categorized, presented, and made meaningful to the user), interaction design (how the information tells a story), and sensorial design (the techniques employed to stimulate and utilize the five senses). Information interaction is specifically the process that people use in interacting with the content of a system. For the user, this sequence of events or occurs when people use systems and is contingent upon attributes of the user (e.g. motivations, expectations), system (e.g. usability), and contextual or environmental (e.g. organizational culture) characteristics, in addition to task and content (Tractinsky, 2006). Information interaction provides the connectivity for engagement. The computer system may be aesthetically appealing with design elements that promote play. However, is the interaction between users and systems operating within a specific context that facilitates the engaging experience.

Table 1 maps the characteristics that emerge from the literature for flow, aesthetics, play, and information interaction theories (O' Brien et al., 2008). Together with these theories, an engaging experience is encouraged by the sensory appeal of the system and the level of feedback and challenge the user receives from the system. According to engaged users are affectively involved, motivated, and perceive themselves to be in control over the interaction. However, there are other characteristics inherent in flow, play, aesthetic, and information interaction theories that are unlikely to be present in engagement.

Table 1: Attributes of flow, aesthetics, play, and information interaction theories

	Theories				
Attributes from the theories	**Flow theory**	**Aesthtic theory**	**Play theory**	**Information interaction**	**Attribute of engagement?**
Aesthetics		✓	✓		Yes
Affective appeal		✓	✓	✓	Yes
Attention	✓	✓			Maybe
Challenge	✓	✓	✓	✓	Yes
Feedback	✓		✓	✓	Yes
Goal-directed	✓		✓		Maybe
Meaningfulness	✓	✓			Maybe
Motivation	✓	✓	✓		Yes
Perceived control	✓			✓	Maybe
Sensory appeal		✓	✓		Yes

Engaging experiences have the attention of the user, but, unlike experiences in flow and aesthetic theories, do not require users to become so focused that they lose their awareness of physical reality. In contrast to flow and play, engagement may not be dependent on the user forming specific goals for the interaction. Users may use an application without any specific purpose or desirable outcome and have an engaging experience. While information interaction focuses on the user experience with content, engagement is an expression of that interactivity. While some of the other frameworks stress the meaningfulness of the experience (i.e., aesthetics and flow), an engaging experience may make a lasting impression but have no more meaning than that the experience was enjoyable or challenging.

Based on our exploration of these four theoretical frameworks and previous research on engagement, an understanding of engagement emerges. Like flow, play, aesthetics, and information interaction, engagement builds upon the foundation of a usable system that is effective, efficient, and satisfying. The theoretical framework that informs engagement integrates system attributes (i.e., feedback, challenge, sensory appeal) with the affective propensities of the user. Thus, engagement is conceptually a holistic framework for understanding the integration of user and system variables, and how they combine to push the boundaries of user experience from merely perfunctory to pleasurable and memorable.

After discussing the point at which they became engaged, participants described what was taking place and what they felt and thought while engaged. This stage was marked by the attention interviewees were able to focus on their task and the application, the novelty of the experience, their level of interest, and their perceptions of challenge, feedback, and user control inherent in the interaction.

As described in the previous deliverables improving indoor environmental quality (IEA) is a highly important activity in almost all type of buildings. A high IEQ has a strong impact on enhancing people productivity and wellness. It has also been shown that improving air quality has a high return of investment in organizations and overall increases the property value. Measuring indoor environmental quality can be done through many different methods, such as POE or building performance evaluations, however each of them have their own limitations. For instance, end user feedback or user satisfaction are parameters that are not usually considered in a real estate transaction. The methods collect this information are not very efficient and usually time consuming.

Based on these challenges the aim is to develop a system able to evaluate the building technical systems performance, indoor air quality and end-user feedback into a single performance metric. A high-performance building usually has satisfactory IEQ conditions. However, it does not necessarily mean the users are satisfied with the building. The aim is that performance metric translated into a single score that summarizes the building conditions in real time. The score can also be used as a reference in property transactions which considers the end-user feedback and user satisfaction usually not considered when purchasing a property. Another important aspect of the system is the ability and freedom from the users to anonymously provide open feedback about the comfort conditions of the facilities they spent most of their time in. This could also be done by clicking on a comfort or discomfort icon. It is important that user feedback is open to other building occupants because its increases transparency and also helps in detecting certain patters in building complaints that can mean an early detection of sick building syndrome symptoms.

The proposal is for such a system is ambitious and there is many challenges that might allow the systems to functions as planned such as reliability, accuracy of the data, these challenges have been report in D2.2. User engagement with using different tools also poses many challenges. However, we see worthwhile developing such solution which can provide a solution for a big problem and approaches the issue from a different perspective that has been documented before. In the following chapters we detail further the Pulse solution from a installation and practical use.

3. Human machine interface

The GUI of a building is an extension of an HMI. A typical HMI of building technology is a switch that turns a light on or off. In more advanced buildings, hardwired devices and electronic panels are used, and the integrated circuit has emerged. Coming to the 21st century, personal computers and software have been created, and the Internet has allowed telecommunications anytime and anywhere. This study deals with modern HMIs that are computer-based, ubiquitous, interactional, and virtual human-machine interfaces.

HMI's primary task is supporting human thinking and operating (Solari *et al.,* 2018; Schneiderman and Plaisant, 2005; Preece *et al.,* 2007.). Due to this, its structure must correspond to a user's mental model. A user should understand how the monitored system works, and events in the GUI must correspond to the monitored processes. Therefore, the HMI development must be based on close cooperation with future HMI users. In implementing a GUI, it is important not to strive to create radical changes in users' ways of thinking.

HMI is a type of data visualisation. Visualisation is a process of transforming information and knowledge into a graphical format that utilises a person's natural ability to embrace patterns and shapes quickly. Effective visualisation solutions enable fast and efficient data manipulation, searching, navigation, filtering, and editing. These functions support the hidden patterns and regularity of detected and found data. The rapid development of data visualisation in recent years has emphasised the importance of various graphical presentations in the organisations' decision-making. (Mackinlay, 2000.) Creating exciting and functional visualisation solutions requires a deep understanding of the data and needs of the users and choosing the right visualisation technology for the problem under discussion. For example, Niskanen *et al.* (2013) say that an interactive visualisation, that allows users to navigate through a building and give feedback on the conditions of different rooms, improve user satisfaction with indoor conditions.

An ideal HMI system supports people by helping them to analyse data and make decisions while data acquisition and implementation of low-level control strategies are automated (Sheridan, 2000). Empirical studies have shown that abstract and integrated views of process data increase the effectiveness of performing routine monitoring tasks (Hollifield *et al.,* 2008). The display of process data is solidly based on situation awareness research (Wickens, 2008). In designing an HMI system, it is also pertinent to apply the ecological principles of interface design (EID) (Upton and Doherty, 2008).

Industrial HMIs are typically used to show basic functions such as machine operation, processes, alarms, and historical trends. The crucial role of the HMI in such situations is to ensure that human and automated systems can collaborate. This requires transparency, along with the lines of the "ten challenges" by Klein *et al.* (2004). These challenges are based on four principles: 1) there should be an agreement that the actors will work together; 2) the actors must be mutually predictable in their actions; 3) they must be mutually directable, and 4) they must maintain common ground.

There has been a lot of research on HMI, but the general requirements of HMI for a building have not been systematically studied (Zolotová and Landryová, 2000; Wücherer, 2001; Bengler *et al.* 2012). In the case of buildings, a general review of the principles or the identified needs of the occupants is not presented in the current literature.

Some building applications, such as building automation systems (BAS), exploit simplified industrial HMIs. The primary function of a BAS is to monitor to operations of building service systems and enable their remote control. The interpretation of a BAS is complex, as it is intended for use by technical personnel (Brambley *et al.,* 2005; Haves and Hitchcock, 2008). Due to this fact, it does not serve the occupant's or owner's use, even though it contains plenty of useful information on indoor conditions and plays a primary role in controlling energy use.

The cybersecurity must be taken into account when implementing and using GUIs. The cybersecurity means the actual situation, where it is possible to trust to the cyber operation environment, and where its operation has secured (Craigen *et al.,* 2014). The effects of targeting people moving in the building and presenting them on the GUI must be carefully considered on a case-by-case basis from the cybersecurity perspective.

Considering cybersecurity in the design, construction, maintenance and management of built assets, it is suggested to comply with the PAS 1192-5:2015 specification for security-minded building information modelling, digital built environments, and smart asset management.

4. Data processing services for Granlund tools

In the eTEACHER project data processing takes place on many levels and with different systems. See figure 2. Granlund tools are mainly targeted to be used by the facility manager or building operations personnel. However, it is important as described in previous deliverables to obtain data from the end-users of the building. From the recommendations of the user engagement theories and principles described in the previous chapters, we tried to best incorporate those ideas into our tools. However, not always possible because of the nature of the functionalities of tools dedicated to a more technical audience. Flow theories also represent an helpful resources on how to navigate through different functionalities of the applications.

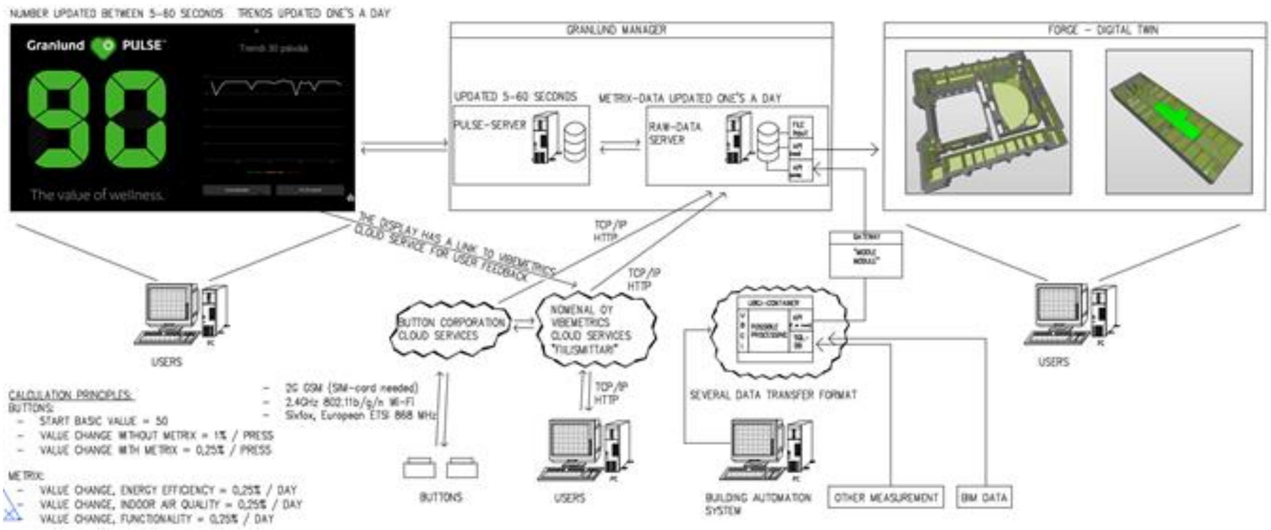

Figure 1: General overview of Granlund data integration and data transfer

Comfort Opinion Service

The comfort opinion service is tailored for the end-users of the building. In the eTEACHER one of the main objectives of the projects is to improve the people's comfort by providing better indoor air quality conditions and at the same time target to reduce energy consumption. Providing the ability for users to give feedback about the indoor air quality conditions in the buildings enables that user demands in real-time are taken into consideration. It also enable the facility manager and operations personnel to take action and better understand what are the demands of the users and also give hints about what could be possibly a technical issue with the heating or ventilation systems or an issue with the sensors. The first screen of the application is shown in the figure below. The eTEACHER application starts with a simple but straightforward questions about indoor conditions of the building. The user can select the "green happy face icon" or the "sad red face icon".

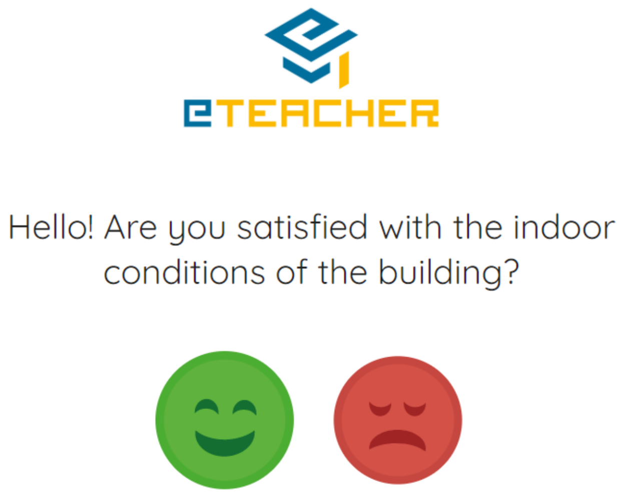

Figure 2: First window in the "Comfort Opinion" application for end-user feedback

Once the user has selected his preference the window expands asking the user "Tell Why" in case they want to give more precise information about why such feedback was given. The user can also specify, for instance, the room where the feedback was made. This would help to track in the same issue is repeated in the same location. Once the feedback is made the user can select continue that will take the user to the Dashboard view.

Figure 3: Expanding view to give a written explanation and location specification

In the dashboard view the user can see the building, location, question, week and date. This view is only editable by the administrator however, visible to all users. The dashboard also contain the Pulse Score that will be later explained in this section, the "Vibes" that represent the opinions or moods and the comments. In the comments section if you select "open"

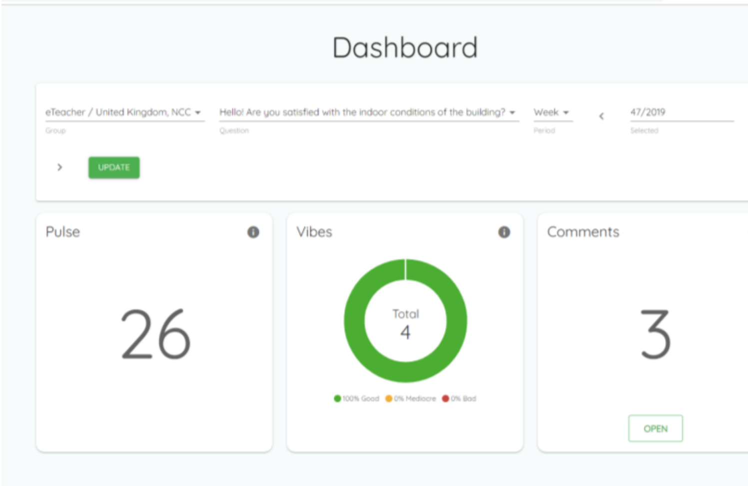

Figure 4: Dashboard view for detailed results

In the comments section if you select "open" you can a detailed view about the comments that have been made, you can leave reply or agree or disagree with the comment. Similar to the feedback feed used in Facebook to enhance the familiarity with the user.

As described above the comfort opinion is aimed for the end user of the building. The results are used for the calculation of the Pulse score. It also provides insights for the facility manager and operations personnel on what to improve in the building.

The next service described is the Metrix service designed mainly for technical user, facility manager or maintenance personnel.

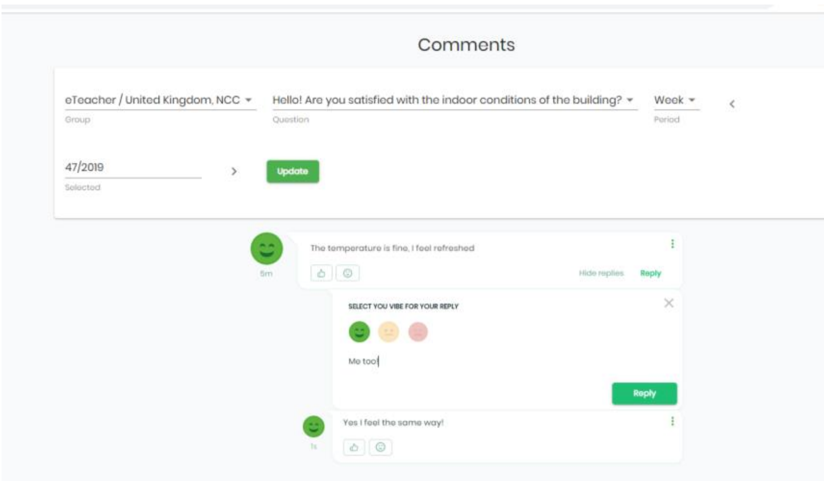

Figure 5: End-users comments view

Metrix

Metrix is part of the pulse service and can be used as a measure of a property's performance and conditions as well as supporting property maintenance. The score of the pulse can be calculated solely on the basis of feedback service explained above, but its formation can be accompanied by the persistence of real estate conditions and performance. The formula is described in more detail in D2.2

Setting up Metrix and starting a data transfer is more complicated than just providing feedback. There are many ways to implement Metrix, depending on the level of analysis that is applied to the building in question. At Metrix, you can look at just the conditions, the energy efficiency or the performance of the property, or all of them in various combinations.

In the Teacher Project, we have focused more on the Matrix perspective to monitor temperature and space conditions, so this outlines the basics of data processing with regard to temperature monitoring.

Initially, a new table or database is created in the raw data database, where data from different systems will be stored. See Figure 6 below for eTeacher database tables.

5	UKDjanogly	UKDjanogly	UKDjanogly	1	MVu
6	UKNCC	UKNCC	UKNCC	1	MVu
7	RomaniaInCity	RomaniaInCity	RomaniaInCity	1	MVu
18	SpainArcoiris	SpainArcoiris	SpainArcoiris	1	MVu
19	SpainGuarena	SpainGuarena	SpainGuarena	1	MVu
20	SpainTorrente	SpainTorrente	SpainTorrente	1	MVu
21	SpainOAR	SpainOAR	SpainOAR	1	MVu
22	SpainResidential	SpainResidential	SpainResidential	1	MVu
23	SpainVillafranca	SpainVillafranca	SpainVillafranca	1	MVu

Figure 6: Part view of eTeacher building databases in Granlund Manager

Once the data transfer and database are established, the Manager property will be linked to the raw data measurement database from the metrix setup pages. From the same setup page, you also set the time of use of the space or the time program of the IV machine, and determine the outdoor temperature sensor to be used in different calculations. It is also possible to configure HVAC devices or room sensors via the same site.

When defining a new building in The Metrix, spaces are first created by floor or by zone. Usually this is done manually. Once the spaces are created for the property in the database, a room sensor can be linked to each space. See figure 7 below. You can select a mode and a sensor can be selected from among the points to be transferred to the database. It is also possible to view the measurement history. This ensures that the sensor is the right one. Once you have successfully paired the sensor, you can return to the previous menu if the connection is visible. See Figure 8 below.

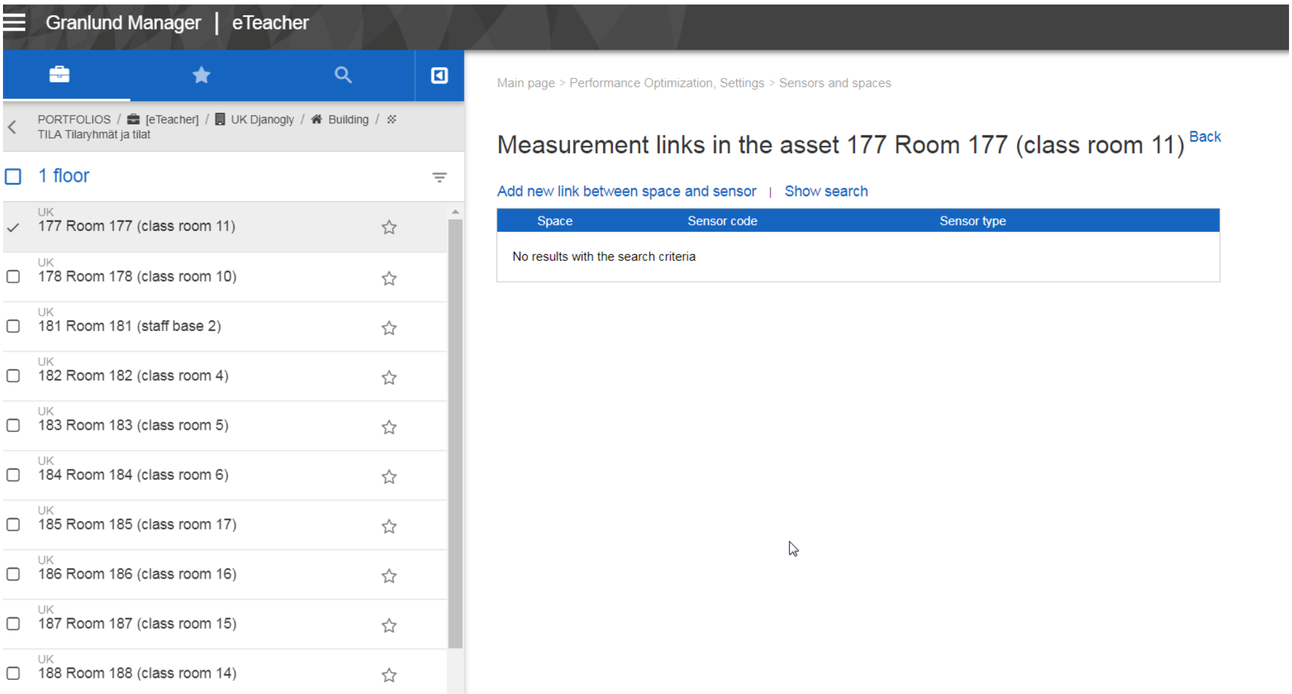

Figure 7: Connecting measurements to a room and floor in Granlund Manager

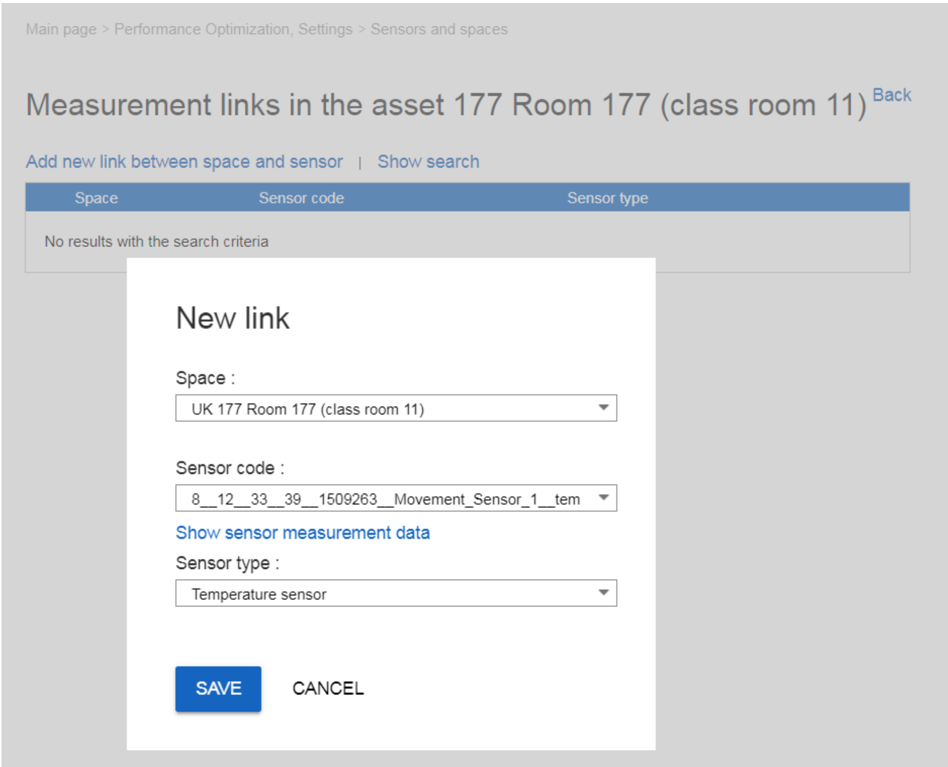

Figure 8: Detailed definition of a room sensor for a specific space in Granlund Manager

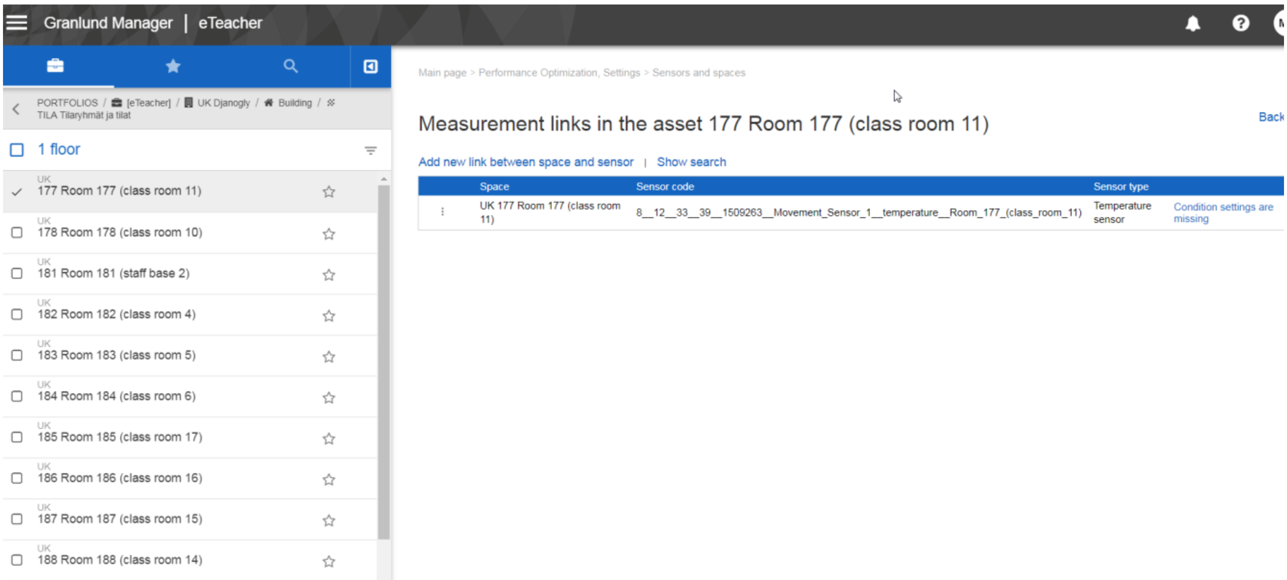

Figure 9: View in Granlund Manager when the measurement point is connected specific space.

There are also some tools and lists available for defining spaces and measurepoints that speed up the basic configuration work.

A very important part of Metrix is the individual definition of conditions and energy efficiency targets. Target values and target areas may vary by country or even within a country. Special attention should be paid to this when there are buildings to be determined in different countries. Metrix's usability and reliability are largely based on properly set targets. The customer, the user and the expert should be involved in defining the target range in order to achieve a good result.

Target values must be defined for each quantity to be measured. You can do this manually or use different lists as a tool. See figure 10 below.

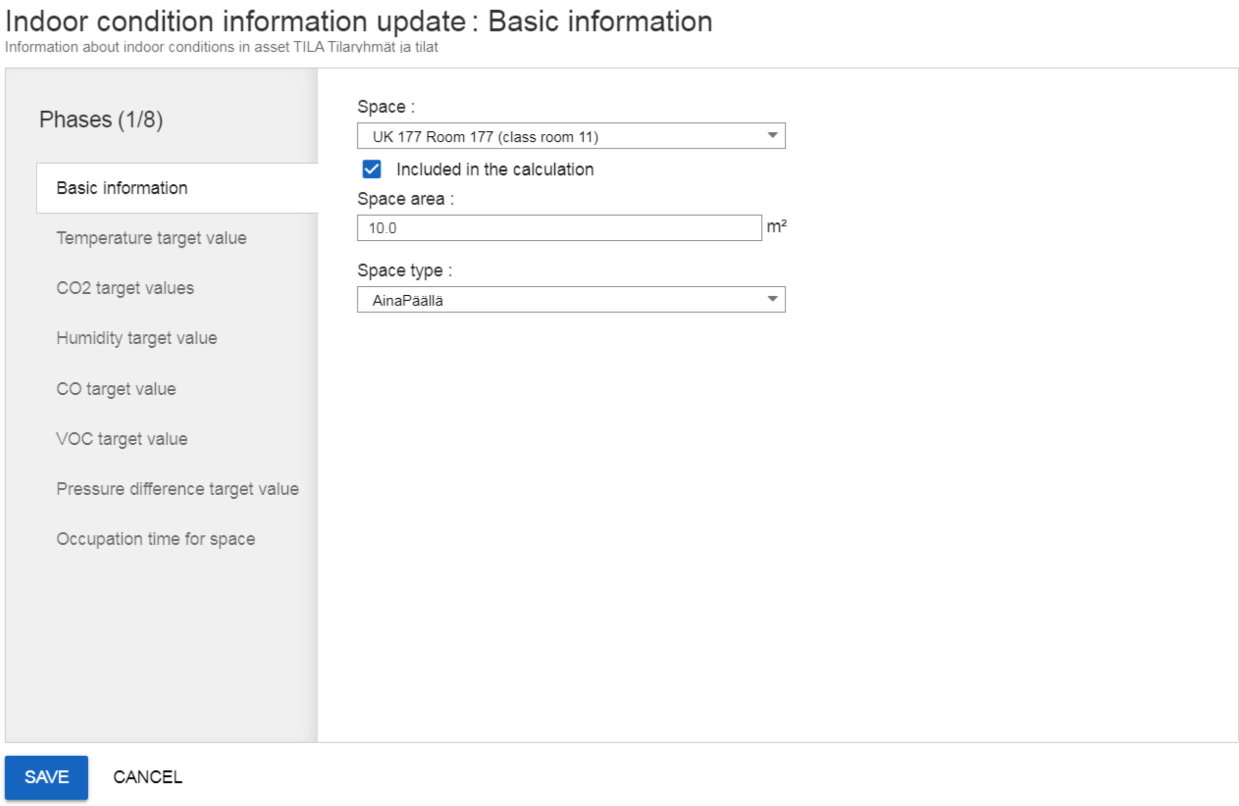

Figure 10: Target range setting page in Granlund manager

Finally, once all the configurations and data transfer preparations have been completed, the end user can utilize the refined data shown for example figure 11 and 12 below. Persistance, lowest and highest measurement, average values of measurements, temperature perisistece and indoor condition are e.g. calculated values that are presented to the user in a visual, user-friendly form. You can also view historical data and temperature versus targets or outdoor temperature.

The problems appear in the last figure (figure 12) For example, it quickly indicates that the outdoor temperature sensor is not working properly. Indoor air temperatures have also been quite low in June, but when we do not know the correct outdoor temperature, the reasons for the activity are harder to find. It is also observed from the figure that the temperature limits may be too high. The emphasis here is on getting feedback and finding the right temperature level for the user and energy savings.

Indoor conditions | Temperature | CO2 | Relative humidity | CO | VOC | Pressure difference

Asset	Area (m²)	Target value (°C)	Lowest measurement (°C)	Highest measurement (°C)	Average value of the measurements (°C)	Temperature persistence	Indoor conditions
UK TILA Tilaryhmät ja tilat	140		16	25.5	21.4	10 %	10
UK 1 floor	140		16	25.5	21.4	10 %	10
UK 177 Room 177 (class room 11)	10	23.5 - 25.5	17.5	24.1	19.8	2 %	2
UK 178 Room 178 (class room 10)	10	23.5 - 25.5	17.5	23.7	19.8	2 %	2
UK 181 Room 181 (staff base 2)	10	23.5 - 25.5	19.9	25	22.3	20 %	20
UK 182 Room 182 (class room 4)	10	23.5 - 25.5	17.1	25.3	22.1	19 %	19
UK 183 Room 183 (class room 5)	10	23.5 - 25.5	16	25.4	22.4	26 %	26
UK 184 Room 184 (class room 6)	10	23.5 - 25.5	19.8	25.2	22.7	30 %	30
UK 185 Room 185 (class room 17)	10	23.5 - 25.5	19.3	23.9	21.3	1 %	1
UK 186 Room 186 (class room 16)	10	23.5 - 25.5	19.2	24	21.2	1 %	1
UK 187 Room 187 (class room 15)	10	23.5 - 25.5	19	24.3	20.9	1 %	1
UK 188 Room 188 (class room 14)	10	23.5 - 25.5	18.5	22.9	20.7	0 %	0
UK 45 Room 45	10	23.5 - 25.5	18.4	25.3	21.8	10 %	10
UK 46 Room 46	10	23.5 - 25.5	20.1	25.5	22.2	17 %	17
UK 48 Room 48	10	23.5 - 25.5	17.2	24.4	21.6	9 %	9
UK 49B	10	23.5 - 25.5	17.9	23.9	20.3	0 %	0

Figure 11: Key calculated values of temperature in Granlund Manager

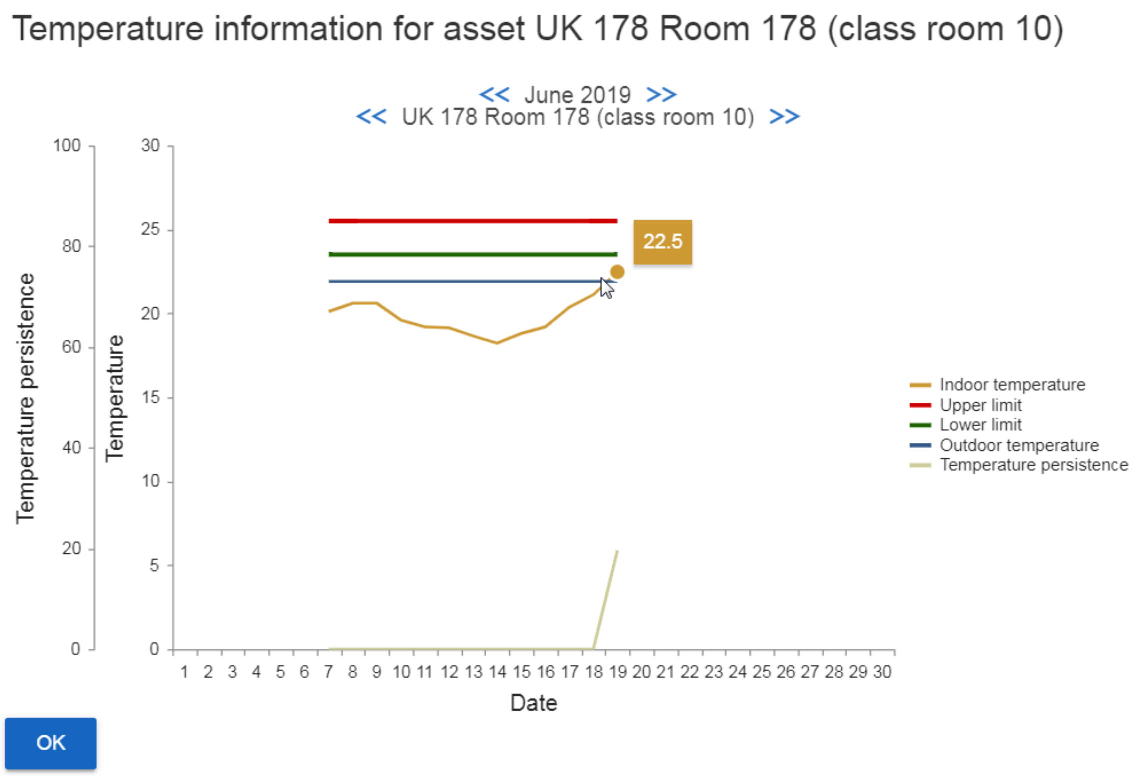

Figure 12: History view of temperature behavior and target values.

Intuitive performance metrics

In the project we are exploring the possibility of adding short term weather data to different UIs, but mainly to the virtual building. Short term weather data can be connected to UI either directly or in combination with a metrix or pulse key score, allowing weather effects to be monitored for real estate conditions and energy efficiency.

5. Granlund additional proposed solution for engagement – Virtual Building

Feedback Forum Findings

A total of 9 Feedback Forum sessions were held covering a total of all 12 eTEACHER pilot buildings in the UK, Spain and Romania. Building user feedback data was collected from 48 participants. Feedback forums were designed to engage the building users throughout the development stage of the eTEACHER ICT tool. Feedback Forum 2 assessed what users would include in their “ideal” eTEACHER tool and what functions they thought are important for them (reference).

The findings of Feedback Forum 2 indicate that building users would like the eTEACHER tool to include informative options such as indoor temperatures, indoor environmental quality scores, energy information and data, energy hints and tips, pulse (IEQ) voting and energy comparisons. Overall energy information and data was ranked the most important with 89% of participants ranking it very important or important. Other options which ranked high were energy hints and tips (88%), building specific profiles (86%) and reporting functions (84%). Indicating a preference for a practical informative tool, which is still visually engaging. However, social networks were not seen as important by participants with many stating they would not be interested in platforms such as Facebook, Twitter or Instagram being linked to the eTEACHER tool.

The proposed solution aims at applying the theories and recommendations in previous chapters to develop an engaging solution the involves the facility managers and building users. Mainly applying flow theory, aesthetics theory and information interaction.

Graphical User Interface Idea

The GUI is a comprehensive BIM-based interface for web-browsers and presents the conditions in colours on a 3D view. It allows feedback and service requests. The application is versatile, but the aim is that it is fast and simple to use. The users can have quick look on the conditions of the floor plan. This can help users but also the facility managers to detect maintenance issues.

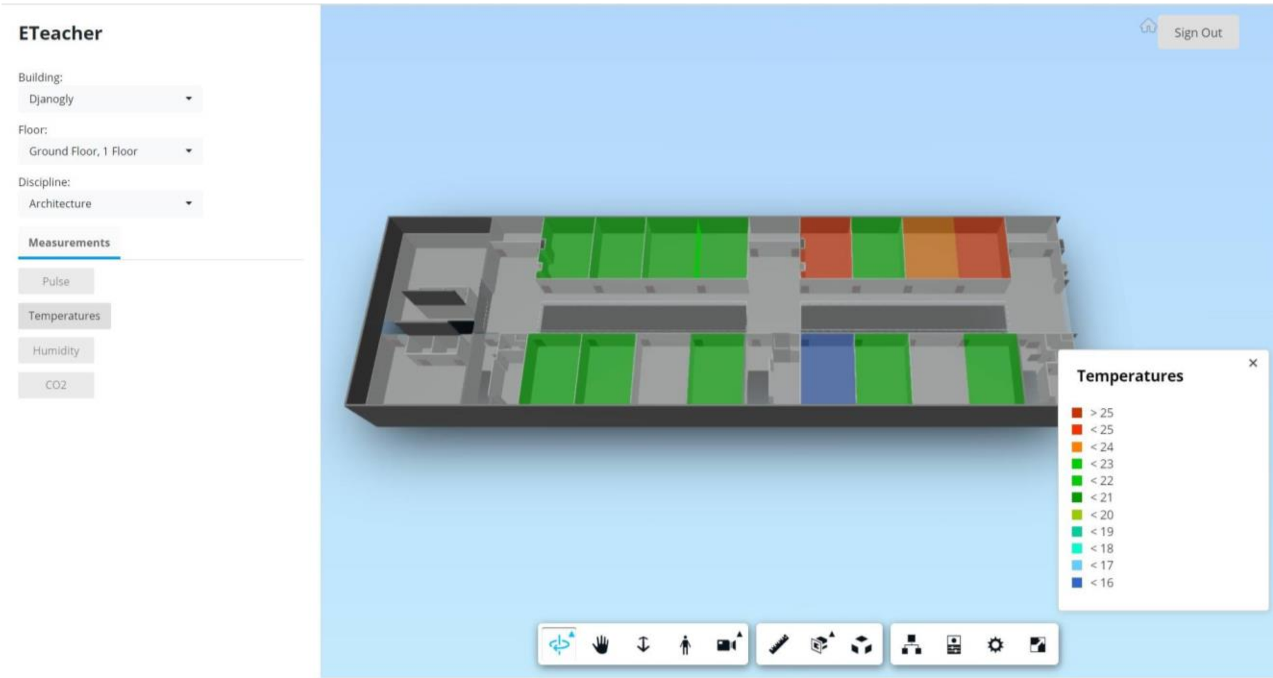

Figure 13: Monitoring of indoor temperature

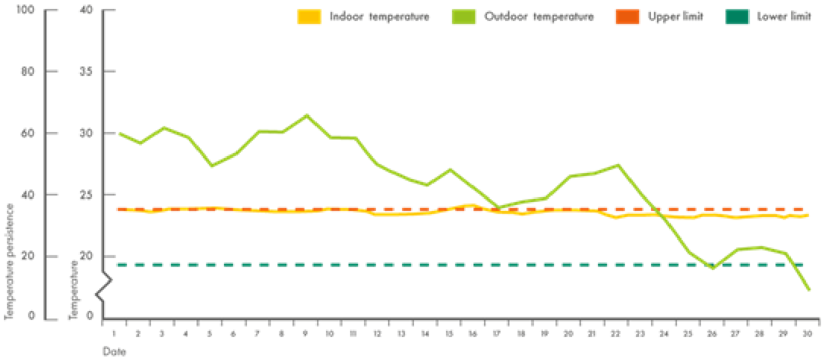

Figure 14: Visualization of indoor air quality trends

6. Experiences and conclusion of installation

The most difficult and time consuming part of installing systems is managing the details of multiple systems. Often, those little details can stop the entire fine system and data processing chain. The Djanogly building had long been investigating the data communication shortcomings of the Pulse buttons until a defect was finally discovered. The fault interrupted the entire data processing chain and the error was caused by one wrong letter. In Djanogly, this letter was 0 (zero), which should have been an o-letter.

Even if we have different API interfaces and interfaces to define data from one system to another, system implementation is slower and more expensive if it involves a lot of manual work. In the real estate industry, data processing systems, architectures, semantics and ontology are currently under development, and standards such as IFC or BRICK also have a slack that reduces uniqueness and machine readability. Before interfaces and their processing systems and standards evolve better, we will have to rely heavily on manual configuration when installing data processing systems.

Therefore, it is advisable to look for new ways or improve existing ways to process and manage your data. The eTeacher project developed a "middle module" that collects data from a database and connects it to the MetrixAPI interface. Data collection is performed such that each time data is collected, it is automatically checked whether new measurement points have become available in the database and API interface.

Particular attention has also been paid to the transmission of data through the automatic detection of errors. If data is missing due to occasional interruptions in data transmission, finding and repairing these data gaps manually is a huge task.

Usually in real-time data transfer, some history data is collected to correct data gaps. Middle module automatically collects data in the UBCA container based on what information in the database has not yet been transferred and what is not found in the Metrix.

The Pulse service can be deployed on two different scales, including either a measured portion or a user feedback portion, or both. For metrix deployment, measured data on the conditions of the premises and measurements of building technology processes are required to assess energy efficie

If building automation is available in the building, the alarms in it should also be included as part of the functionality analysis and read into the metrix software.

In the broadest implementation of Metrix, IoT or building automation systems require the following information:
- Energy efficient module: Measurements of building technology processes
- Condition module: Condition measurements
- Functionality module: Alarm listings for building automation system

In practice, to install the Pulse service, the necessary measurements and data transfer must be defined and installed in the measurement system so that the data can be transferred to the Granlund server. When data transfer from the measurement system is created for Granlund, install Granlund services based on measurement data. Granlund's service describes the conditions, energy efficiency, or functionality level in one score. The definitions required to implement Metrix are described in more detail in report D2.2.

The user feedback can be collected in two ways, either by using the physical buttons or by the web application. Both ways can be used simultaneously. Web UI is built by Granlund's installation process. Deployment is usually carried out by property maintenance personnel. To install and deploy the buttons, Granlund gives instructions for use and guides for commissioning. Buttons connects via mobile data, Wi-Fi or SIGFOX and runs on batteries or USB charger. To connect the buttons to the Internet, you need access to the property's wireless LAN, through which the button information is sent to the server.

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