

1. Purpose

This paper discusses the function of the EnOcean People Activity Counter (EPAC) and possible deployments. It talks of problems and solutions for more meaningful data.

2. Description

What the EPAC does:

- measures the number of activities within the last 2 minutes with a resolution of 1 second (people activity count) and reports this number approximately every 2 minutes via a D2-15-00 EnOcean telegram. It also reports a heartbeat at approximately one (1) hour of inactivity. The count counts to 65535 then rolls over. This was done incase a notification was missed; the number of counts would not be lost.
- EPAC covers an area of around 30 sqm. To reduce coverage an application note is provided for 3D printing of suited lens covers (incl. 3D printing data).
- Provides data that can easily be used to develop heat maps or of an area, usage density.

What it does not do:

- Provides no correlation between sensors.
- Provides no correlation between activities and absolute number of people in the room.

3. Theory of operation

The EPAC reports the number of triggers via a PIR sensor measured every second and is reported at 2 minutes intervals. This data is used in conjunction with the knowledge of room layout, sensor placement, ingress and egress, and typical room capacity.

Using these data one can make a model of usage for the area.

Use Case 1. Room

Since we know that the sensor sends a heartbeat on the hour when there is no occupancy, we can set the counter to zero.

Person enters conference room and is preparing to setup a meeting:

Starting the counter at zero a person enters the conference room and an EPAC triggers and we have occupancy and then as the person moves about the room movement will be counted on one second intervals and we receive numbers from our sensors every two minutes giving a count from the sensors that measured movement.

As the meeting starts, the door may open again and as people enter the room, again knowing EPAC placement and room topology, we receive data from our sensors. These counts will peak until people have settled down for the meeting upon which we see a drop

in the count of movements. As an option, adding door passage counters to a room may help with heuristics. Upon close of the meeting, we see the counts again increase in their rate, as people prepare to egress and once everyone has left, we again see the counts rate of change drop to zero for a few minutes and tells us no one is left in the room. Please note that the count reported is ever increasing but the rate of change of the count denotes the amount of movement in the room.

Use Case 2. Hallway/Building Entrance

Person enters hallway:

In **Figure 3**, we see a typical hallway. Depending on the Hallway topology and placement of the sensor, the activity count can be expected to correlate well with the number of people passing through and could be aggregated over short or longer periods of time. One could count the numbers reported ever few minutes or over a day, for example. And, of course using a passage counter would be very helpful in tracking actual numbers through a passageway.

4. Physical deployment

Device resolution relates directly to one's ability to count accurately. Partial room coverage cannot give a full picture of room occupancy. Complete coverage of sensing fields will offer the best chance for accurate detection. This, however, be dictated by cost and need for accuracy.

Deployment for a room where high accuracy is important

Below we see two different deployments for a room.

In the first room one can see significant area with incomplete coverage (Figure 1), where motion will not be detected. When one considers ingress and egress from the room, complexity to the system increases and the ability discriminate individuals becomes quite challenging.

Considerations with Counting Activity using the EPAC – EnOcean People Activity Counter

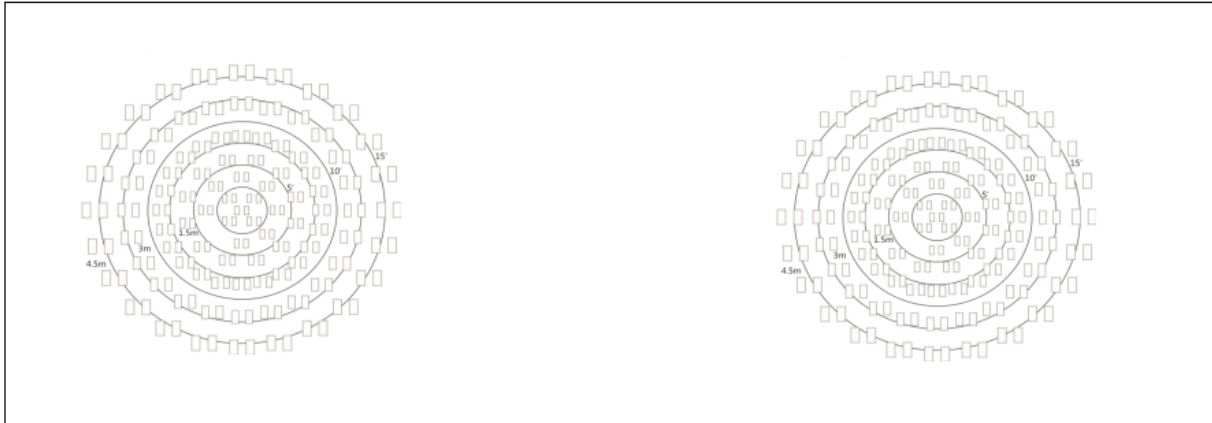


Figure 1 We see that there are significant holes in the space of interest in this example. Activity tracking becomes difficult as it becomes difficult to track individuals as they move about.

We see in the example below (Figure 2) that the room has full coverage, with as few dead zones as possible. Ingress, and egress are known and can be used as datapoints for the algorithm.

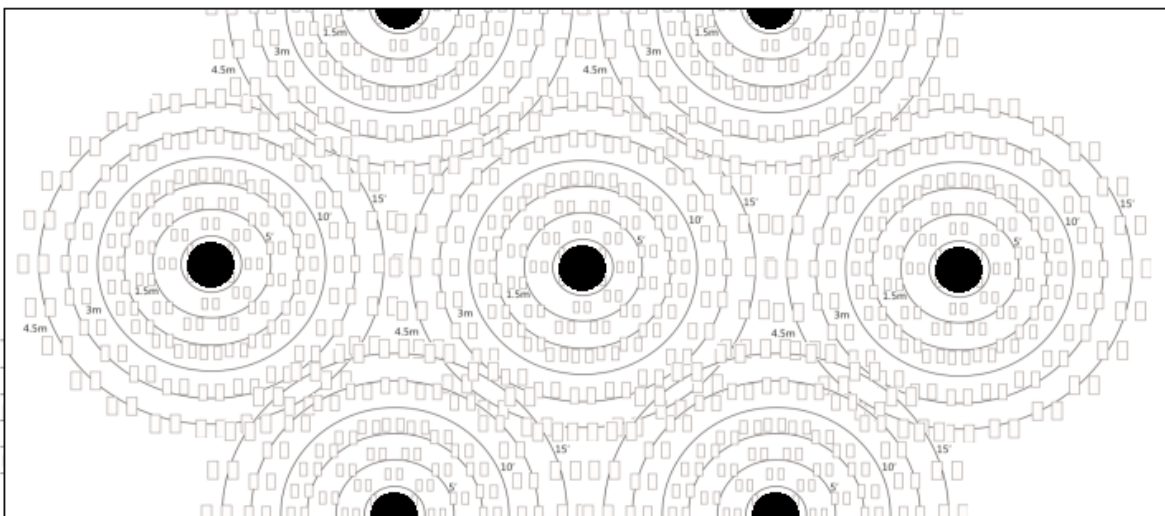


Figure 2 The example above would render meaningful data when individuals move from one sensor cover to the next.

Example: Deployment for a hallway

Since a hallway is typically used for getting from one place to another in the building this becomes a simpler case of tracking the number of individuals who pass through at any give point.

The number of sensors can be reduced and depending on the need, data can be interpreted for directional usage of the hallway. In addition, other sensors can be used such as the

EnOcean Door/Window contact sensor (EMDCU) and include door opening/closing to the aggregate data thus rendering an accurate data set for pass through.

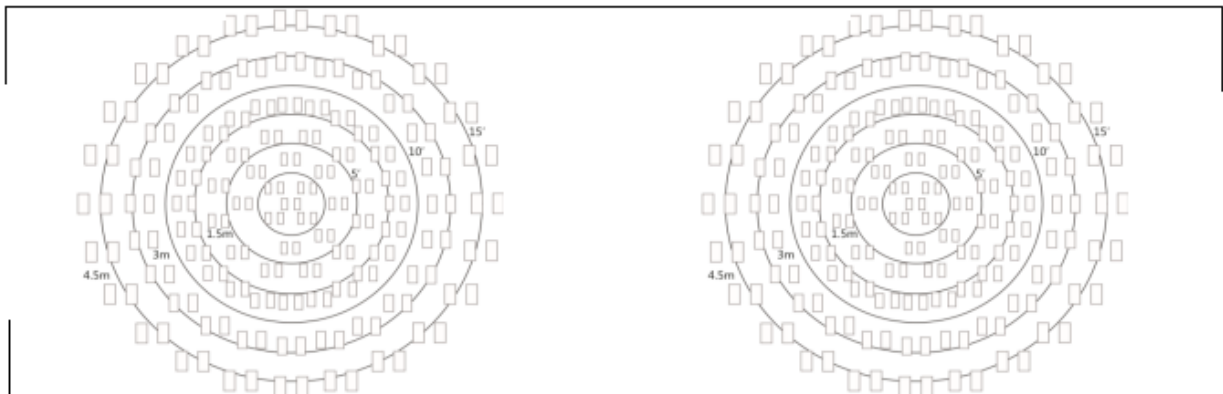


Figure 3 Hallway example

5. Heat Map Example

The term “heatmap” is a data visualization technique that tracks something, we track occupancy signals that are triggered by motion.

From our well covered room from **Figure 2** above we will show what a heat map might look like and how we might render this map. This will be a map of room usage over what a full day might look like.

Example

As people move through the sensors during the day, we receive counts from sensors and collect them in an additive fashion. At the end of the day, we summate these numbers and have a known map of the room as we see in **Figure 4**.

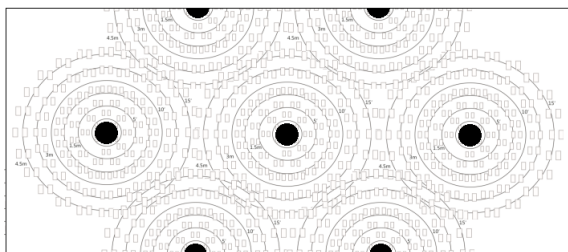


Figure 4 Layout of sensors example

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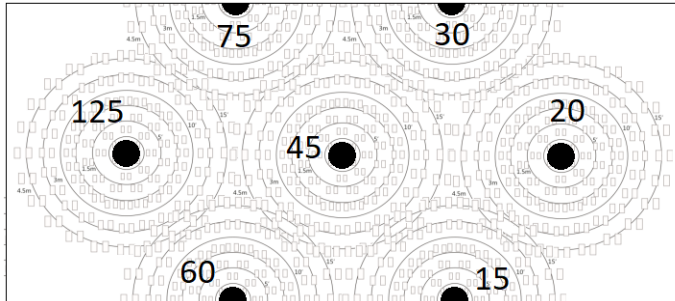


Figure 5 example of data collected, overlaid on room

In **Figure 5** we see the data collected from our sensors overlaid upon the image now as an example visualization. We now feed this into a charting package capable of generating a heat map:

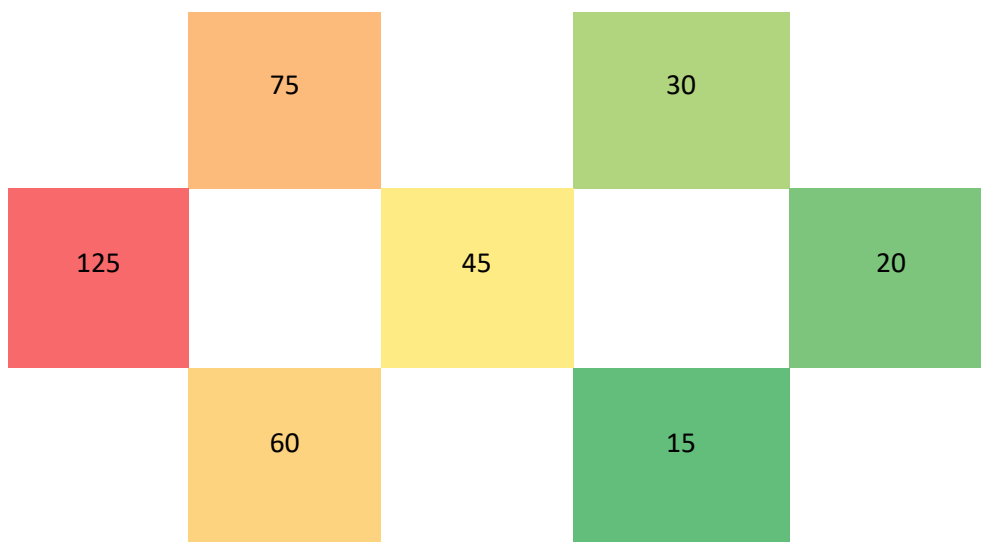


Figure 6 Heat map generated based on usage

Notes on the above:

- The example above shows time usage over a day, of course this could be broken down into smaller time periods based on the need of the application.
- Excel was used as an efficient means of demonstrating data and the resolution of the output is small from 7 sensors. Increasing the sensor density and the usage of passage counters and a statistical package for charting would render different results.

6. References and Resources

User manual

https://www.enocean.com/de/produkte/enocean_module/ceiling-mounted-occupancy-sensor-eosca-oem/user-manual-pdf/

Application note for 3D lens printing

https://www.enocean.com/fileadmin/redaktion/pdf/app_notes/AN701_EOSC_Lens_Cover_2102018.pdf

3D data for 3D printing of the lens

https://www.enocean.com/de/produkte/enocean_module/ceiling-mounted-occupancy-sensor-eosca-oem/EOSCx_3D_2D-Data_2017-06-30_03.zip/

D2-15-00 EEP (EnOcean Alliance Link)

<http://tools.enocean-alliance.org/EEPViewer/profiles/D2/15/00/D2-15-00.pdf>