ArchIoT - Sensor network for monitoring archives

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Managing the environmental conditions of archives is crucial to ensure the quality of the stored documents. ArchIoT is a solution to monitor several environment parameters. These includes in wall humidity measurement, providing insight into the underlying humidity problem, and books internal humidity, assuring protection for valuable items.

Motivation

Many smaller cities and municipalities use former bunkers as archives for their documents, which they are legally required to store. To ensure the longevity of the documents stored, dataloggers or thermo-hygrometers are used to monitor the relative humidity. While these sensors can indicate that certain rooms have humidity issues, it's rather challenging to understand where the moisture is coming from. A dense network of sensors can create a dataset that allows for an understanding of how moisture enters the room. The focus of this thesis is the hardware for such a network.

Concept

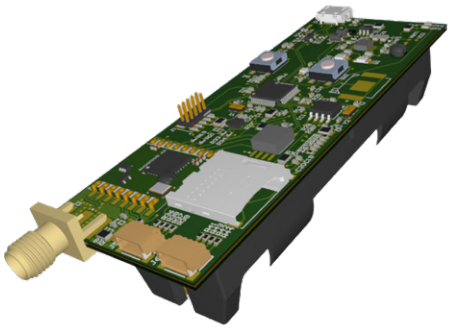
The Node has a microcontroller that reads data from various sensors and communicates with a gateway to transmit the sensor values. This Node should be able to operate for at least 3 months with the included battery. The node operates at a very low power to ensure that it can run for as long as possible. LoRa is used for communication because it can penetrate the thick bunker walls and is highly energy-efficient. The Nodes need to be able to make synchronous measurements with other nodes to get a clear picture of the humidity gradients within the room and the walls.

Implementation

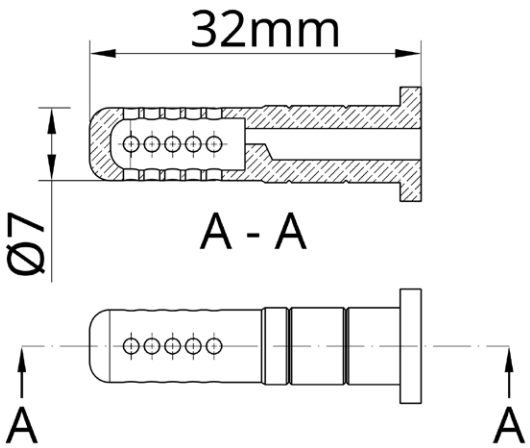
The low-power SAMD21 microcontroller, paired with an RFM95 LoRa chip, is used to process and transmit the data to a Gateway. The node also incorporates a real-time clock to have accurate timestamps. To store data on the node, a 128 Mbit Flash is used to continue collecting data even if the LoRa communication fails. For in-situ measurements inside the walls, a custom sensor housing was developed that incorporates a Sensirion SHT45 humidity sensor and fits an 8mm hole. The node is powered by a 18650 battery that has a capacity of 3200mAh. The LoRa message is forwarded by the gateway to the TTN network server and interpreted on the Akenza application server. Akenza can send alerts based on certain anomalies via SMS or email.

Result

The nodes are working as intended. With a measuring interval of 1 hour, the node achieves an average power consumption of 440 µA. This allows it to take measurements for up to 10 months. In the first experiments, the measurements of the in-situ sensor show a 15 % increase in absolute humidity compared to the sensor in the room, indicating that water is entering from outside.



Sensor Node



Sensor housing for in-wall measurements

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