Master's Thesis Engineering Technology

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Secure and flexible sleep tracking device communications for integration in Smart Home networks

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Background

Zenseri B.V. is currently developing a sleep sensor, called BEDsense, which integrates into Smart Homes to control lighting, heating, alarms when residents go to bed. Additionally, the BEDsense data can be used via an external server and data analysis to monitor the sleep of persons in a Smart Home.

Objectives

The first goal is to investigate, design and in part implement BEDsense communication means for seamless integration into Smart Home networks. A second goal is to create a strategy whereby BEDsense data is transformed into sleep profiles and recommendations to improve their sleep.

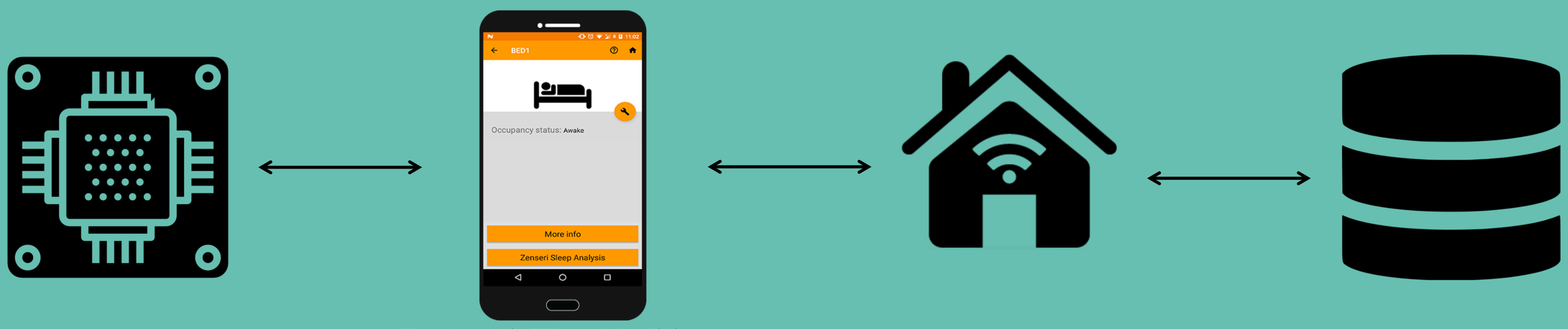

Figure 1: query the BEDsense status with the app

BEDsense

Is a headless device (without an embedded user interface) with limited resources in memory, computing power and communication bandwidth. Therefore we need to study and design efficient strategies for a good trade-off of performance against low computing power

BEDsense app

Because the device is headless, a mobile app is developed that provides an easy UI for the BEDsense. Using the app, BEDsense can be configured and provisioned. The app has also been developed to test the implementation of SSDP and sleep tracking (Fig. 1).

Smart Home network

Smart Home networks are equipped with networking protocols according to the UPnP device architecture [1]. Because of BEDsense's limited resources, these protocols can only be partially implemented.

Server

User data will be obtained from the Smart Home networks. algorithms will analyze the user profile against big data. This results in sleep quality metrics and recommendations for the user to improve their sleep performance.

Smart Home Integration

Provisioning

Provisioning is the process of connecting a new (headless) device to a network. Two ways are implemented: WPS and AP-mode using the app.

Service Discovery

BEDsense is discoverable for other network devices due to the implementation of nano-SSDP.

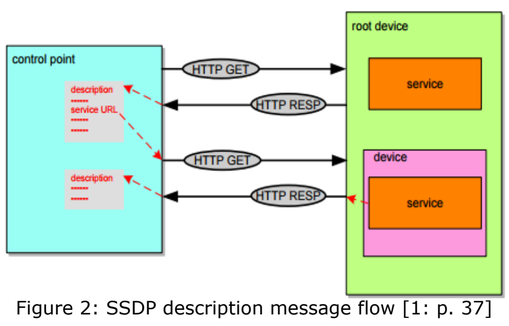

Figure 2: SSDP description message flow [1: p. 37]

Over-The-Air Firmware updates

A strategy to update the BEDsense firmware wirelessly to make it future proof is designed and implemented.

Sleep analysis

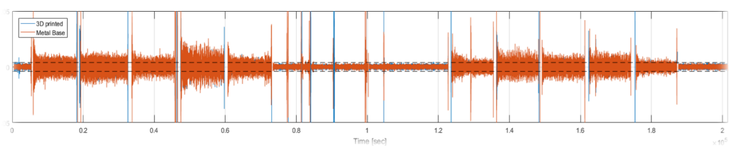

Figure 3: Raw data derived from external fiber optics.

- The algorithms convert the raw data (Fig. 3) into events that are suitable for storage and transmission.
- A failover system makes sure that events are stored on non-volatile memory for when network connection is interrupted.
- The app requests the events and processes them for visualization (Fig. 4).

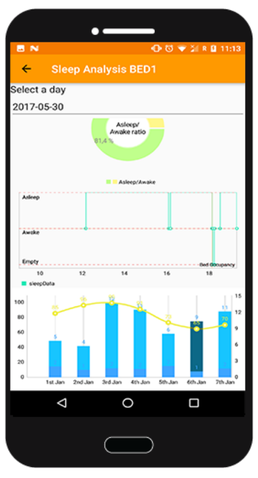

Figure 4: visualization of sleep data with the app

Conclusion

Results

A BEDsense prototype is successfully equipped with necessary communication means needed for integration into Smart Home environments.

The developed app provides a user interface for configuration and makes it possible to test the performance.

Subsequently, a system is elaborated where raw data is transformed into a format that is suitable for storage and transmission.

The results of this thesis facilitate further development of the BEDsense system and are a major step to the ultimate goal of Zenseri; integration in Smart Home environments and collection of sleep data to improve the user's sleep lifestyle.

References:

[1] UPnP Device Architecture Version 1.1, ISO/IEC 29341-1-1, 2011

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