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.

### 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).

![Figure 1: query the BEDsense status with the app](image1)

### 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.

### Conclusion
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)](image2)

**Over-The-Air Firmware updates**
A strategy to update the BEDsense firmware wirelessly to make it future proof is designed and implemented.

### 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: