Project FoSIBLE
Fostering Social Interactions for a Better Life of the Elderly

D3.5 – Stable hardware prototypes

Responsible

Fraunhofer IMS

Mauser Care

Deliverable

D3.5 – Stable hardware prototypes

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Abstract

The objective of this work package is to develop and build a prototype of a sensor-assisted living environment. This document will extend the descriptions of the Deliverable D3.3 and therefore include parts of the document D3.3. Scope of this document is to describe the developed prototypes and how they interact.

This deliverable is the fifth of six from the work package 3 and the scope is to build a stable hardware prototype based on the results from the previous work packages. Due to the extension of the project, new requirements implemented and extended the results to date. Therefore this document is the update of the further version of this deliverable D3.5.

Table of Content

1. Introduction

1.1 Related Tasks

Task 3.1: (Responsible: Mauser Care, Collaboration: FhG IMS) Development of concepts for innovative devices/furniture, with sensors for input and output. This includes the creation of concepts on how to integrate these sensor data from the environment into the social media center applications. Currently plans target at sitting furniture, beds as well as wardrobes and sideboards. Note that in order to come up with prototypes within a short time frame, only sensors that are available on the market will be considered. Currently, application of the following sensor types is considered: proximity sensors (capacitive measurement), RFID-based sensors, infrared based sensors. Note that this list is not exhaustive.

Task 3.2: (Responsible: Mauser Care, Collaboration: FhG IMS) Development of proof of concepts (prototype based) on the basis of the developed concepts for testing validity and acceptance by end users. Development will be done in two phases. During the first phase, mock-ups will be created that provide the test users with look and feel of the final devices. These mock-ups will be used to gather first user feedback. In the next phase, a set of full functional prototypes will be created that will then used to gain detailed and exhaustive end user feedback.

Task 3.3: (Responsible: Mauser Care, Collaboration: FhG IMS) Integration of hardware and software components (platform). These prototypes will make use of standard communication solutions (wireless) to connect the sensors with the application platform.

Task 3.4: (Responsible: Mauser Care, Collaboration FhG IMS) Combine the devices for input and output and the software applications in order to make them usable for remote interaction.

Task 3.5: (Responsible: FhG IMS, Collaboration Mauser Care) Development of hardware interfaces for different locative scenarios (e.g. different rooms). This task also addresses using of the shelf domotic sensors (e.g., motion detectors) in order to gather valuable information about the current state of the habitant.

Task 3.6: (Responsible: AIT, Collaboration Mauser Care) Integration of a vision-based sensor technology into a furniture object to explore the posture and facial expression of the users.

1.2 Scope of This Deliverable

The objective of this work package is to develop and build a prototype of a sensor-assisted living environment. This document will extend the descriptions of the Deliverable D3.3 and therefore include parts of the document D3.3. Scope of this document is to describe the developed prototypes and how they interact.

This deliverable is the fifth of six from the work package 3 and the scope is to build a stable hardware prototype based on the results from the previous work packages. Due to the extension of the FoSIBLE project, new requirements will be implemented and extended the results to date. Therefore there will be an update of this document in the completion of the development.

1.3 Location

The prototypes described in this document are located in the application laboratory "Service Apartment" from the Fraunhofer-inHaus-Center. The Fraunhofer-inHaus-Center is the innovation lab of Fraunhofer-Gesellschaft for smart homes and smart buildings, especially for solutions for residential and real estate properties.

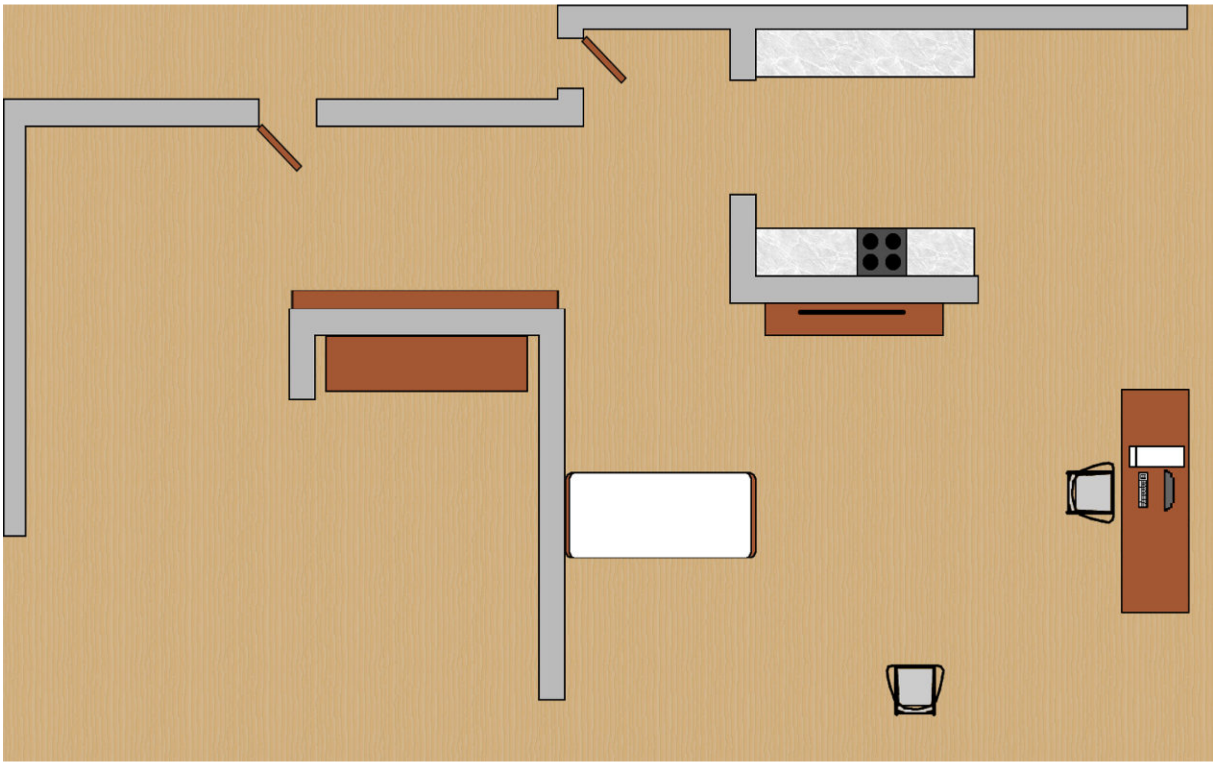

Figure 1: Floor plan of the Service Apartment in the Fraunhofer-inHaus-Center

As seen in Figure 1, different areas of an apartment are reflected in the service apartment at the Fraunhofer inHaus center. This allows testing the demonstrators in a realistic setting. Also allows the realistic environment that evaluations with participants can be performed in a general context.

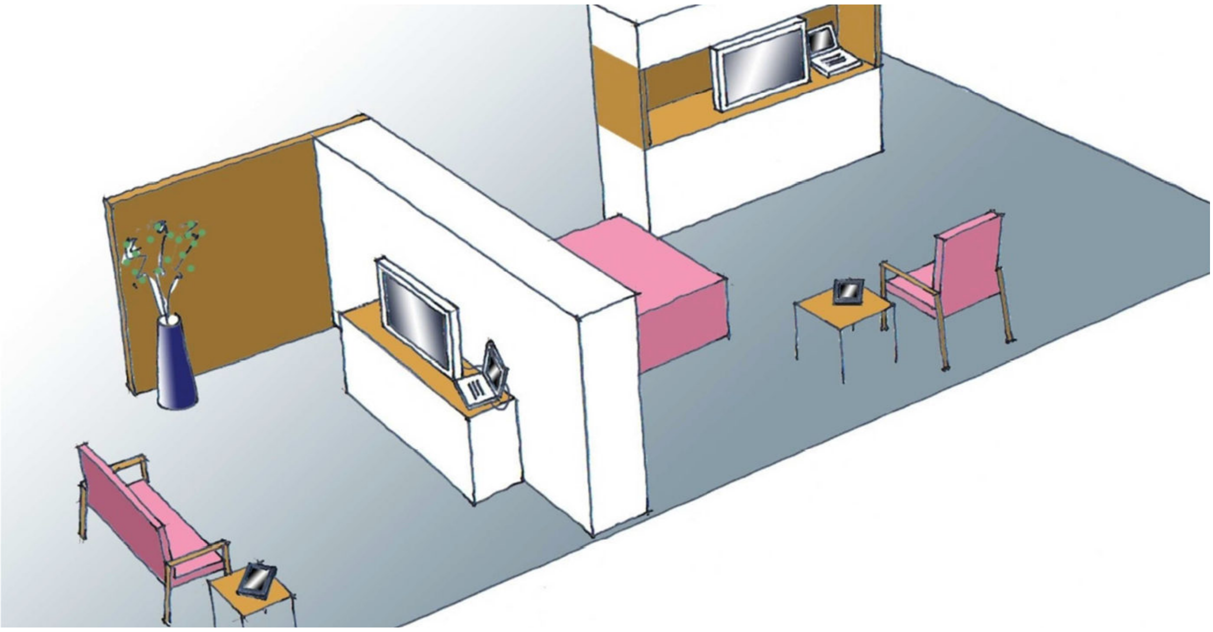

Figure 2: Configuration of the Service Apartments for the Evaluation (5)

In FoSIBLE project the interaction with the system plays an important role by multiple users. Therefore, as seen in Figure 2, the apartment has been extended for the evaluations. It was possible to perform evaluations with several participants at the same time and in the same location. The descriptions of the evaluations and the results are presented in Deliverable 6.1.

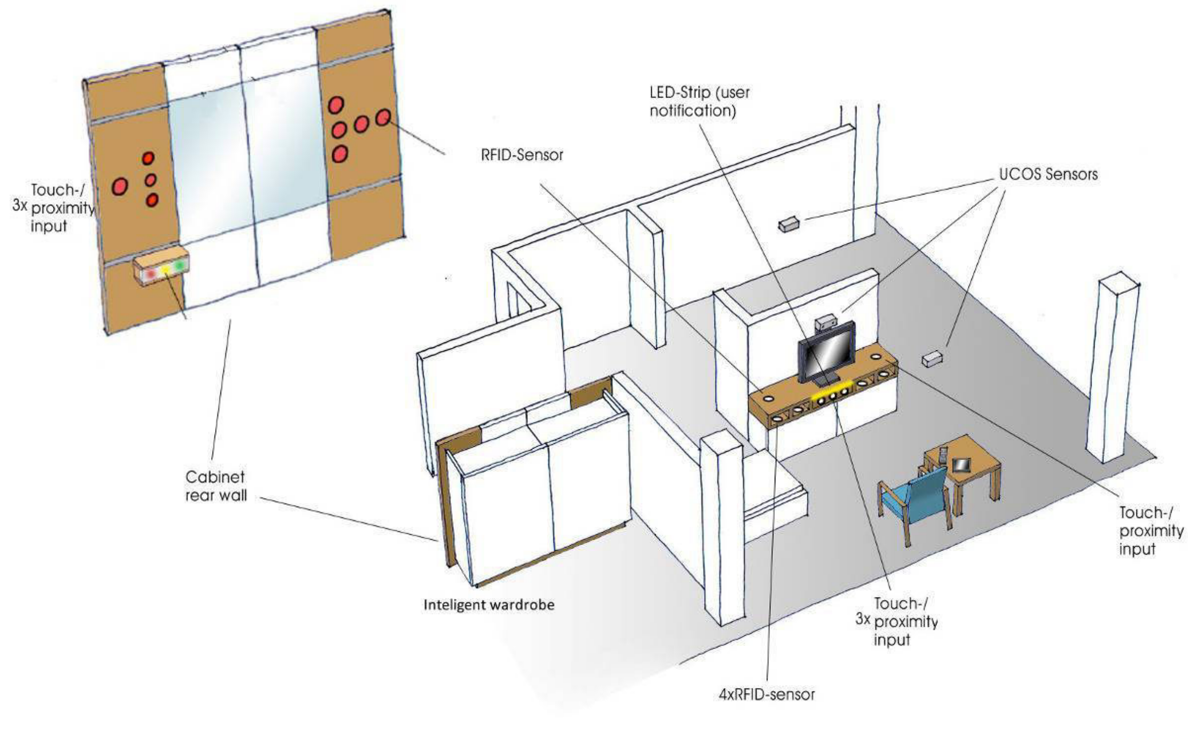

Figure 3: Overview of the final setting of the sensor-based home environment in the inHaus-Center

2. Overview

2.1 Classification in overall FoSIBLE system

The FoSIBLE system consists of several components. As seen in Figure 4 the primary display (WP 4) is a HBBTV enabled TV. The contents are supplied via a web platform (WP 4). Furthermore, there are various hardware components which interact with the user via the television. These consist of a gesture recognition module (WP 5), a tablet and a game console (WP 4) and the sensor-based home environment (WP 3) which is represented by the Mauser / IMS box. This document addresses the sensor-based home environment and describes the properties.

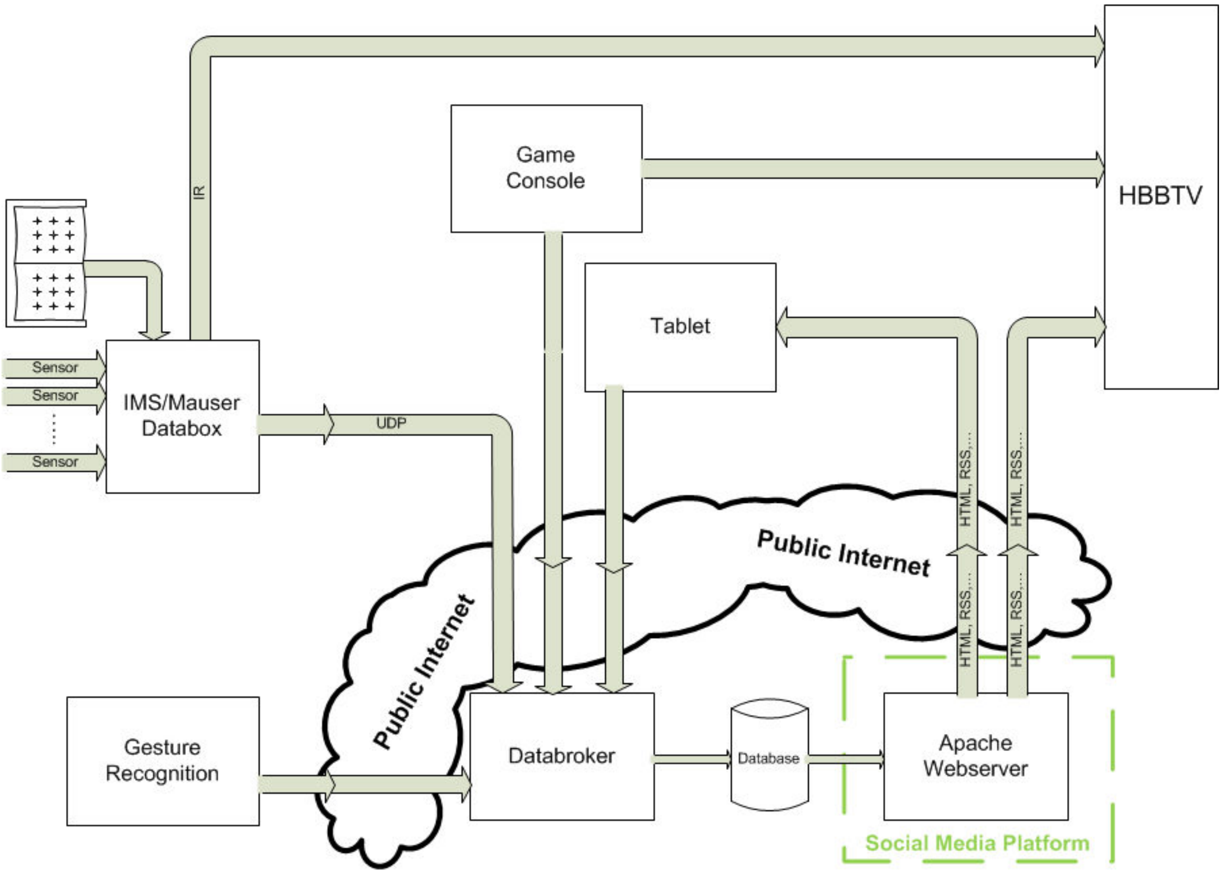

Figure 4: Overall FoSIBLE Hardware diagram (4)

2.2 Sensor-based home environment

The aim of work package 3 is to assist the resident in the home environment while interacting with a social community platform. The focus is on the user and his home environment. Furniture as everyday objects is a promising tool for this purpose. Through the integration of technology into familiar everyday objects it will be attempt to overcome technical barriers. Parts of the technique are not perceived by the user and operate in the background. Others are used deliberately by the user, but are not necessarily seen as a technology because they are integrated in the furniture.

In order to achieve integration of the components in the environment, the sensors have been distributed in the apartment. There are different types of integrations. As seen in Figure 5, cabinet elements are equipped with sensors for detection of the door opening (reed contacts). In addition, sensors for detecting the use of certain items (RFID technology) and to trigger events (proximity sensors) are integrated in several cabinet elements. Loose environmental sensors and parts of the sensors in the furniture, are connected via a wireless bus (enOcean) and can therefore communicate with a central analysis unit.

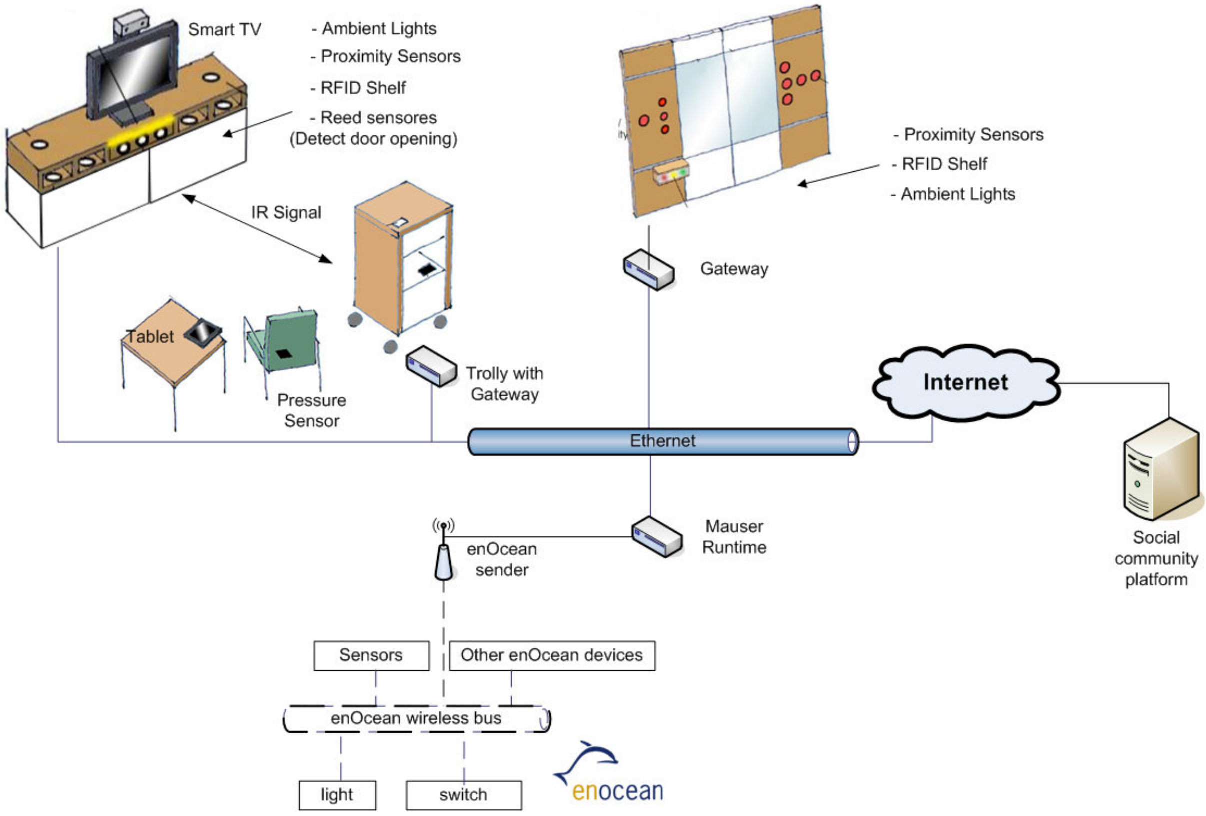

Figure 5: Technical overview sensor-based home environment

The central software which is responsible for the communication of all devices is the Mauser Runtime. This is described in chapter 4. The Runtime generates abstract events from the sensor information in the apartment and transmits them to applications. Thou the applications do not have to worry about processing the sensor information and can directly work with the events.

Because the content of the social community platform are primarily mediated through a SmartTV, there is a connection to the TV via Ethernet (WP4) and in our case for direct communication a connection via IR signals. A further illustration of a simple content such as notifications is achieved with light (enOcean actuators). This allows feedback from the social community platform for the user without switched on TV.

3. Hardware Components

3.1 Ambient Sensors

The service apartment is equipped with several sensors and actuators to recognize the opening and closing of the cabinet doors, the using from several specific objects, the switch of from equipment or light and register movements or usage from other objects. These allow us to analysis the current situation of the user. Based on this recognition can trigger actions that can assist the user in the interaction with the environment and the social community platform.

Figure 6: Cabinet elements in the Service Apartment

Correspondingly are sensors in the cabinets and drawers available, so-called reed contacts, which can detect if a cabinet door or a drawer are opened or closed. Based on these values it is possible to infer the currently executed activity from the user. Detail description of the detection is entered in chapter 4.

Figure 7 shows the integration from the sensors in the cabinet. In the same line all the sensors are installed in the apartment. Simple reed sensors detect the opening or closing of the door, as in this case, the magnetic contact is opened or closed. Behind every major unit, e.g. a wall unit is a microcontroller board that receives the 1-bit signals from the reed sensors and sends them as whole to the Mauser Runtime. The sending takes place via TCP to the FoSIBLE sensor interface. This takes up the signals and processes them. (3)

Figure 7: (a) Sensors in the cabinet door (b) Detailed view

In addition to the reed contacts at some points RFID antennas are installed. These make it possible to detect objects that are tagged with an RFID transponder. By detecting various events are triggered, which were defined in a rule (chapter 4) in the "Mauser Runtime".

Figure 8: RFID tags in different sizes (6), RFID Antenna (7)

To connect the RFID antennas small computer in the cabinets are installed. The RFID antennas can be connected through the USB protocol and communicate via Ethernet with the "Mauser Runtime".

Figure 9: Books extended by several RFID tags

To account the objects in the interaction, they are extended by RFID tags (Figure 9). This allows that can be generated an automatic message, when detecting the tag by an RFID antenna.

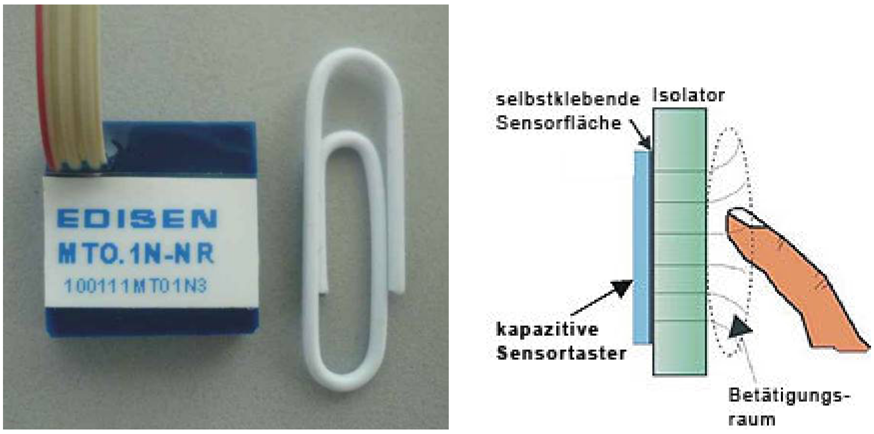

Figure 10: Proximity Sensor (8), function (9)

For the integration of switches in the furniture proximity sensors were used (Figure 10). These react to approximation of water also through an insulator. Therefore, it is possible to achieve by the touch of a furniture element, a switching signal. The proximity sensors can be read similar to the reed contacts.

Figure 11: Used enOcean components (10)

For the connection of the remaining sensors, such as pressure switches, motion detectors and switch actuators the enOcean technology was used. Therefore a enOcean gateway via the USB protocol was attached to the "Mauser Runtime" hardware. The Gateway connects to the domotic components via wireless enOcean protocol.

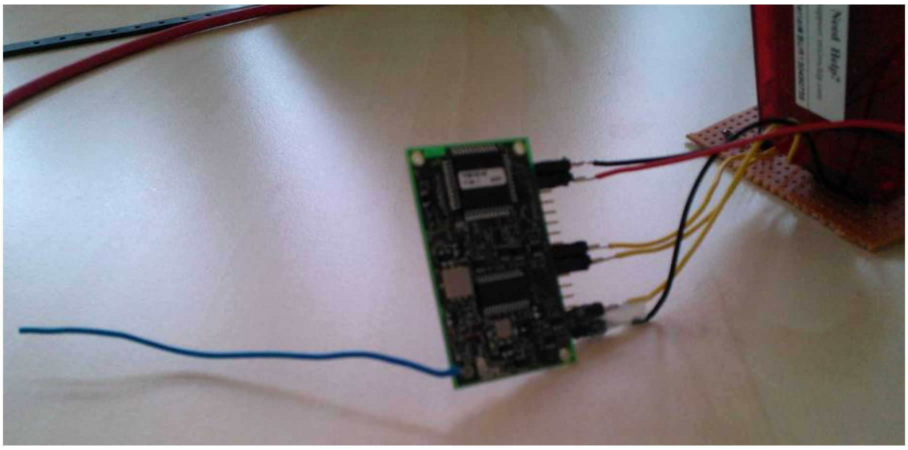

Figure 12: enOcean transmitter modules

Sensors without enOcean connection are also extended through enOcean transmitter modules (Figure 12). This allows using new and also own sensors in our framework.

3.2 Ambient Interaction Lights

In the user's interaction with the living environment we needed a way to give feedback to the user regarding his actions. Because acoustic feedback can be disturbing, it has been appropriate to implement visual feedback. Therefore lights were integrated in the living environment close to the interaction surface. These lights were also combined with proximity switches. Here, we resorted to an available technology on the market (Figure 13).

Figure 13: Illuminated pushbutton with proximity switches

These lights illuminate when new messages in the social community widget are available and can then be de-activated by the user. The ambience interaction lamps are, therefore, displays and input devices in one.

3.3 UCOS Sensors

The UCOS sensors (Figure 14) have been developed by the research partners AIT and described among others in deliverable 3.6. In this deliverable, they serve as two types of input devices.

Figure 14: UCOS sensor for ceiling installation.

First the UCOS sensors can recognize the number of people for a defined area. This allows us to submit extended status messages of the user (Figure 15).

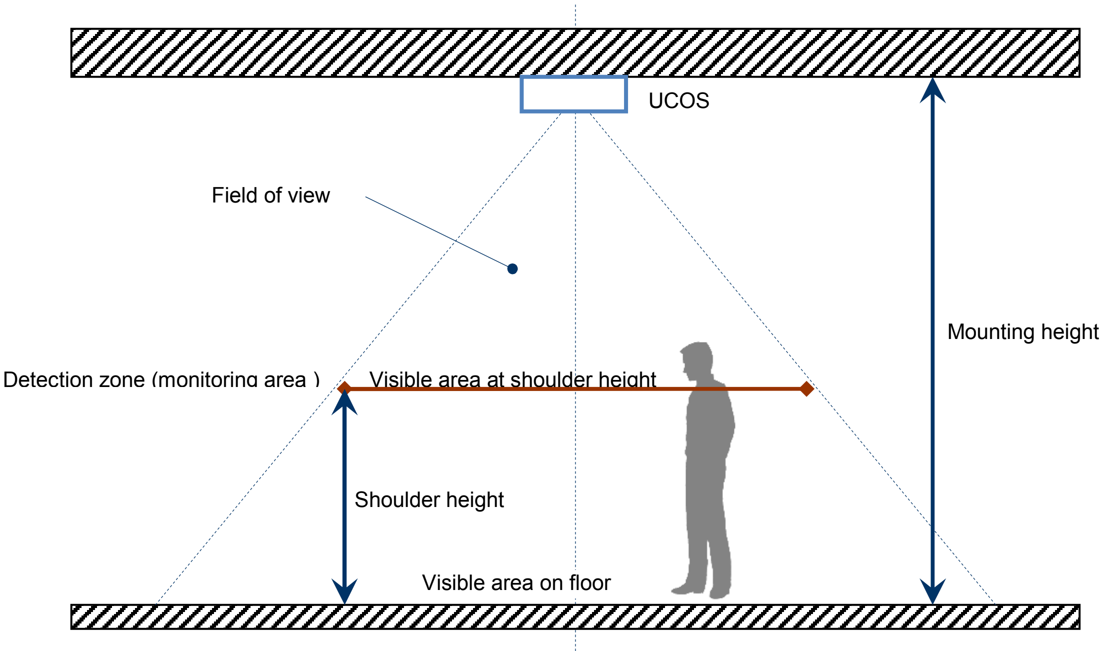

Figure 15: Visualisation of the dimensions in the sensor settings.

In addition, the UCOS sensor is used for the gesture recognition. This allows for the control of the SmartTV widgets using simple gestures.

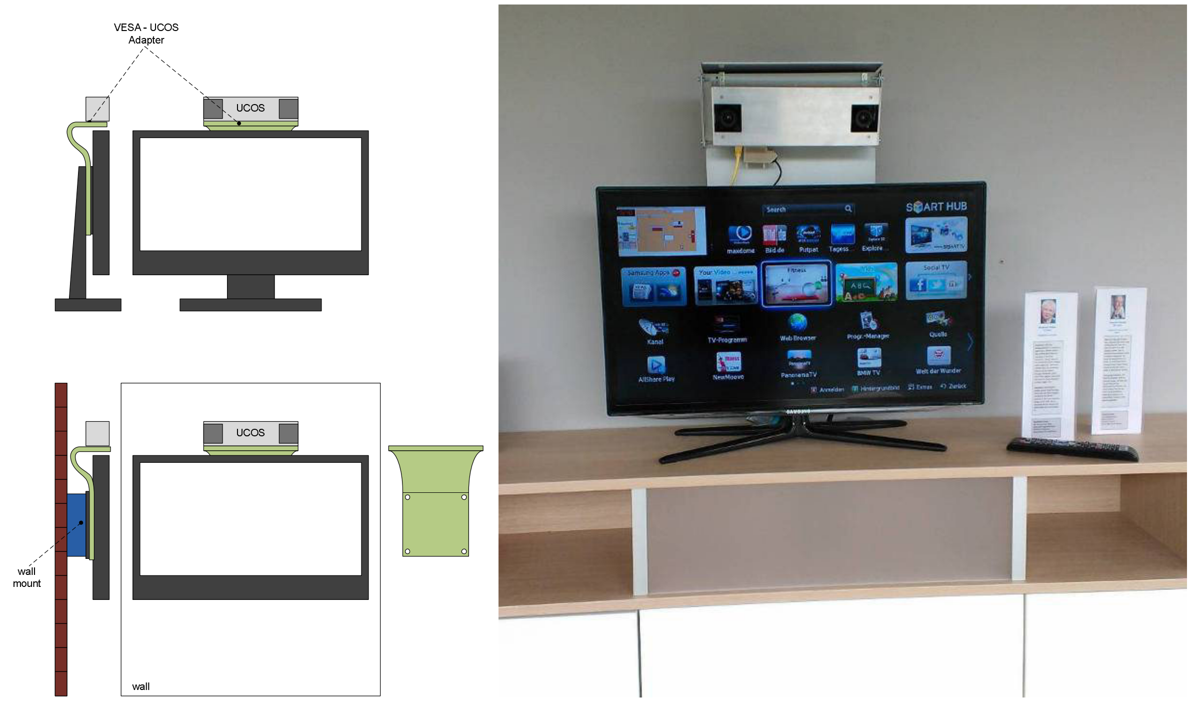

Figure 16: VESA Sensor mounting adapter selected for use in the project.

The gesture control and the connection with the Mauser Runtime is described in Deliverable D3.6.

3.4 Smart Trolley

Based on the knowledge acquired in the project, that users usually are reluctant to change the familiar furniture, has therefore led to the development of a new concept in Deliverable D3.2. The new mobile element (Figure 17) has been designed for the integration of controls, which serves as an extension to existing furniture. The newly worked out element is to be regarded as a mobile unit that can be placed on the required position and used there. This has the advantage that the user can use the FoSIBLE functions not only in the chair, but at several places. The user can carry the piece of furniture and thus has the interaction elements in the immediate vicinity.

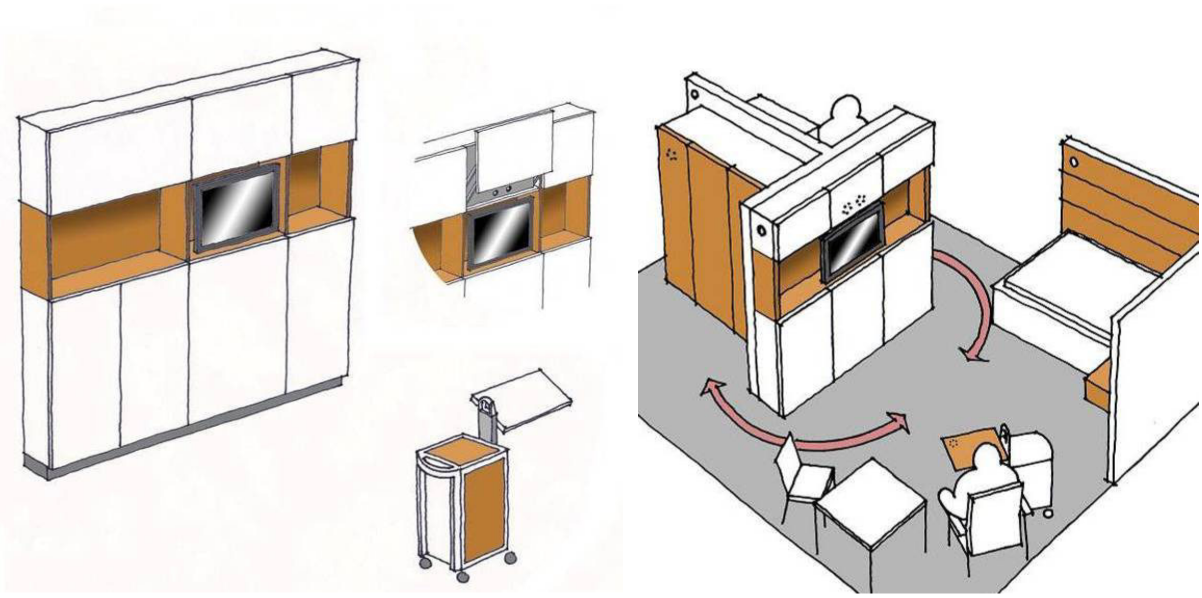

Figure 17: TV environment with mobile unit

The "Smart Trolley" consists of various components. We realized in the middle of the surface a gesture input area (Figure 18) that responds to different touch gestures. This touch gestures allow us to control the environment on the basis of simple inputs. The installation of the touch surface in the Trolley is only seen as an example application. For use in the cabinets therefore was resorted sensors proximity to those described in Chapter 3.1.

Figure 18: (a) Touch screen for gesture recognition (b) Integration under the wood panel

The control of the TV takes place via the wiping gestures. In this example (Figure 19), the wipe from left to right is interpreted as the TV remote control input "right" and sends this signal to the TV. Furthermore, basic functionalities are marked as buttons on the surface. This can be seen in Figure 18 (a) as points and on Figure 19 as the underlying functions.

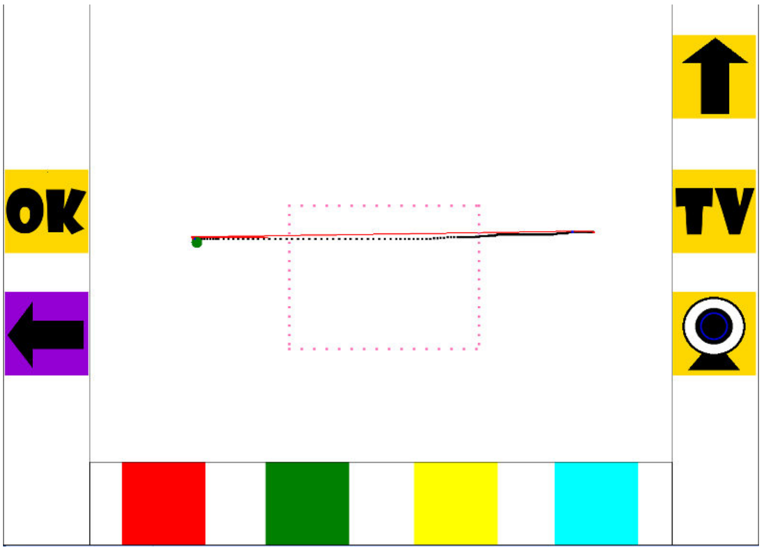

Figure 19: Interpretation of the touch input, here gesture "right"

The sending of the control information is sent to the TV via an infrared transmitter (Figure 20). This can completely replace the TV remote control. The entering of text via gestures is not optimal. Therefore, only the basic functions have been used.

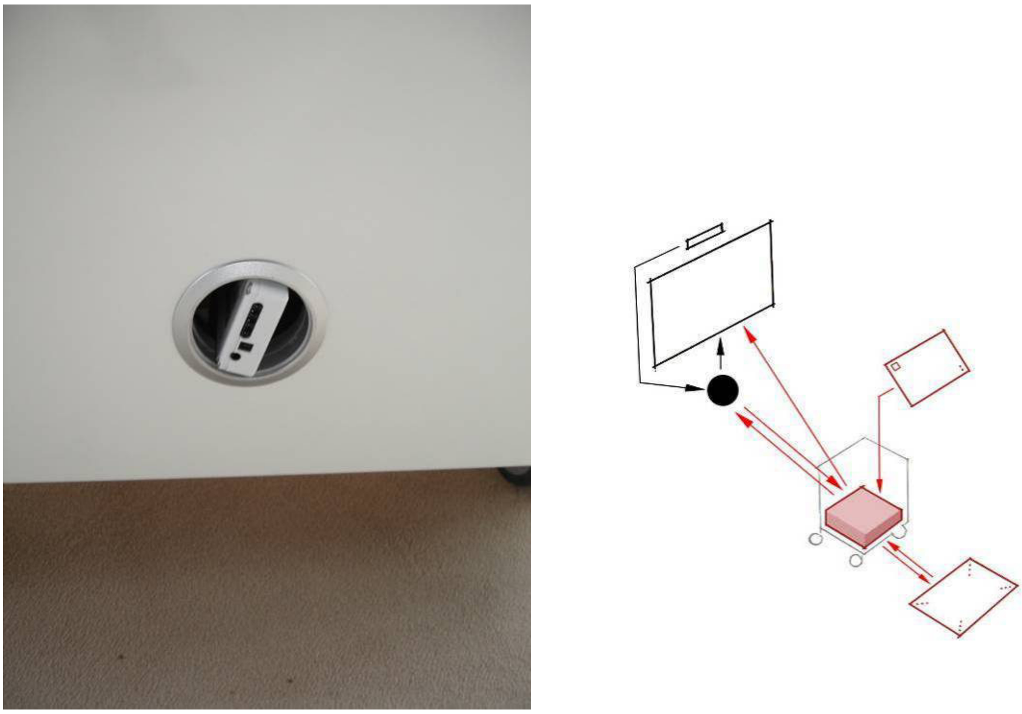

Figure 20: IR sender intigrated in the trolley

The "Smart Trolley" also includes the runtime as the central element. In this way the apartment must not already be smart. The trolley comes with the basic functions of a smart home. These can then be expanded using the trolley. For this purpose the Mauser Runtime is compatible with others systems. The project was used for the demonstration of an enOcean gateway. This allows setting up all functions from a smart home.

4. Mauser Runtime

The Mauser Runtime is the central software which is responsible for the communication of all devices in the service apartment. The sensor information can be prepared for the further processing. Subsequently the FoSIBLE-specific interpretation of sensor events occurs on a higher application layer.

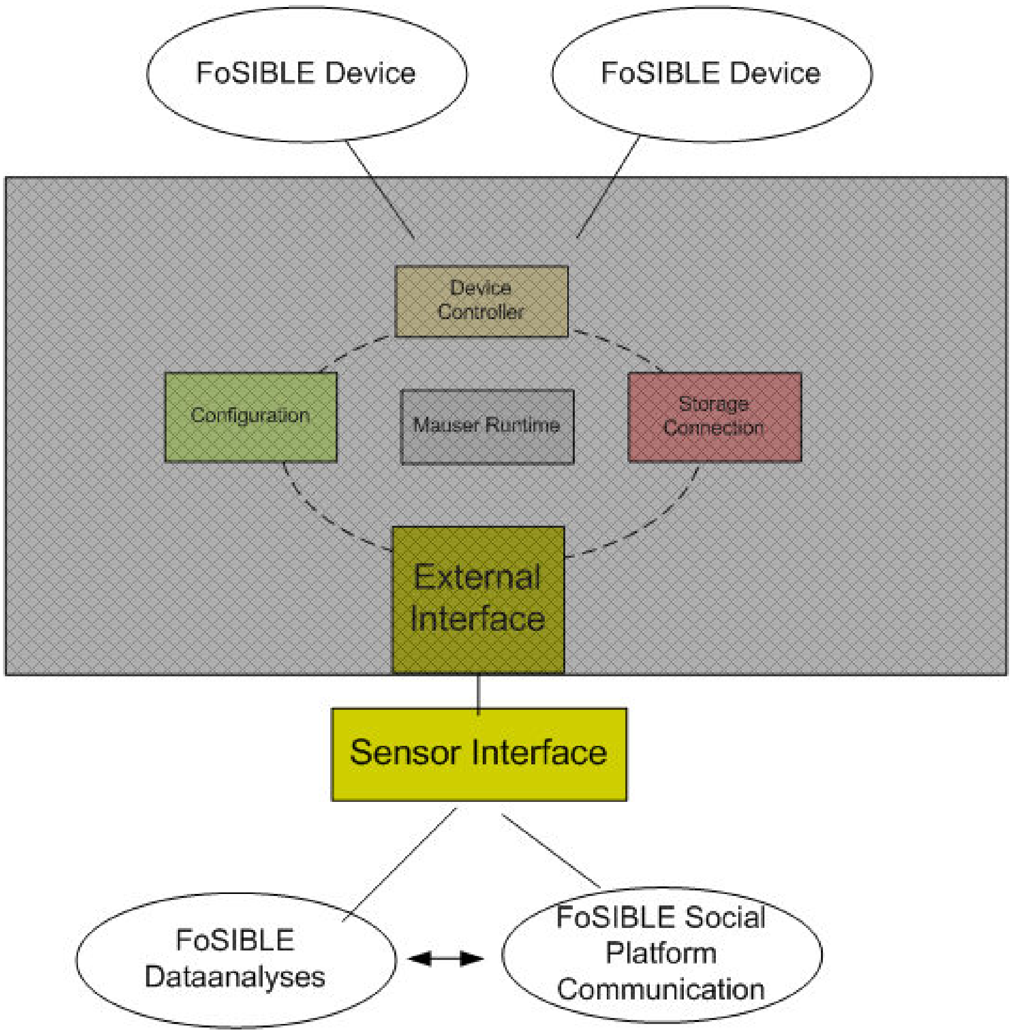

Figure 21: Overview Mauser Runtime

Developed for this purpose the Mauser Runtime (Figure 21) allows the integration of multiple sensors of the building automation bus "enOcean". These afford the sensors to receive and provide content for other applications. The device access used in the Mauser Runtime is, based on the changeability of the requirements, abstract, so that the currently used components can be replaced in the future, without any adverse effects taking place at a higher application layer. In addition, applications can create their own events, which in turn can be used by other applications. This has the advantage that the individual components are easily maintainable and interchangeable.

The Mauser Runtime consists of associated device controllers that are responsible for processing the device data. The devices are kept abstract, so that a replacement of a device does not disrupt the system itself. The collected data can be buffered in a database, so that by switching off the Mauser Runtime the content will not be lost and it can be retrieved after rebooting again. For connecting external applications the Mauser Runtime includes an interface that can be addressed via TCP. (3)

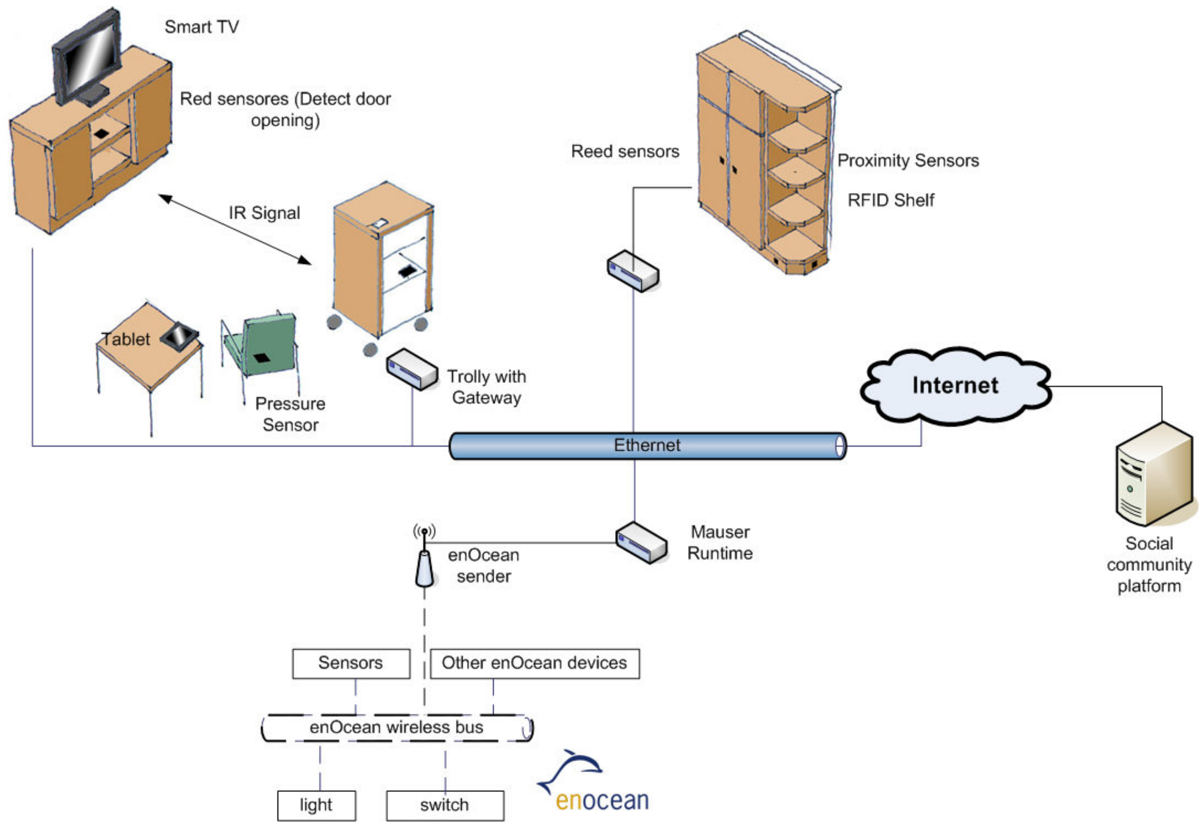

Figure 22: Technical overview sensor-based home environment

As illustrated in Figure 22 the individual components communicate with each other by the Mauser Runtime. Mauser Runtime processes the incoming signals into virtual events and afterwards they can be interpreted by applications. Via LAN all components can exchange data, whereat the device signals will be readout by the Mauser Runtime by radio or cable and then converted for sending them by IP, so that they can be sent via LAN too. (3)

4.1 FoSIBLE Sensor Interface

The FoSIBLE sensor interface allows external applications to communicate with the Mauser Runtime by the TCP protocol. Therefore a port on the Runtime monitors incoming inquiries to start an initialization in which external applications can register to the Mauser Runtime. After successful registration various methods for external applications are available.

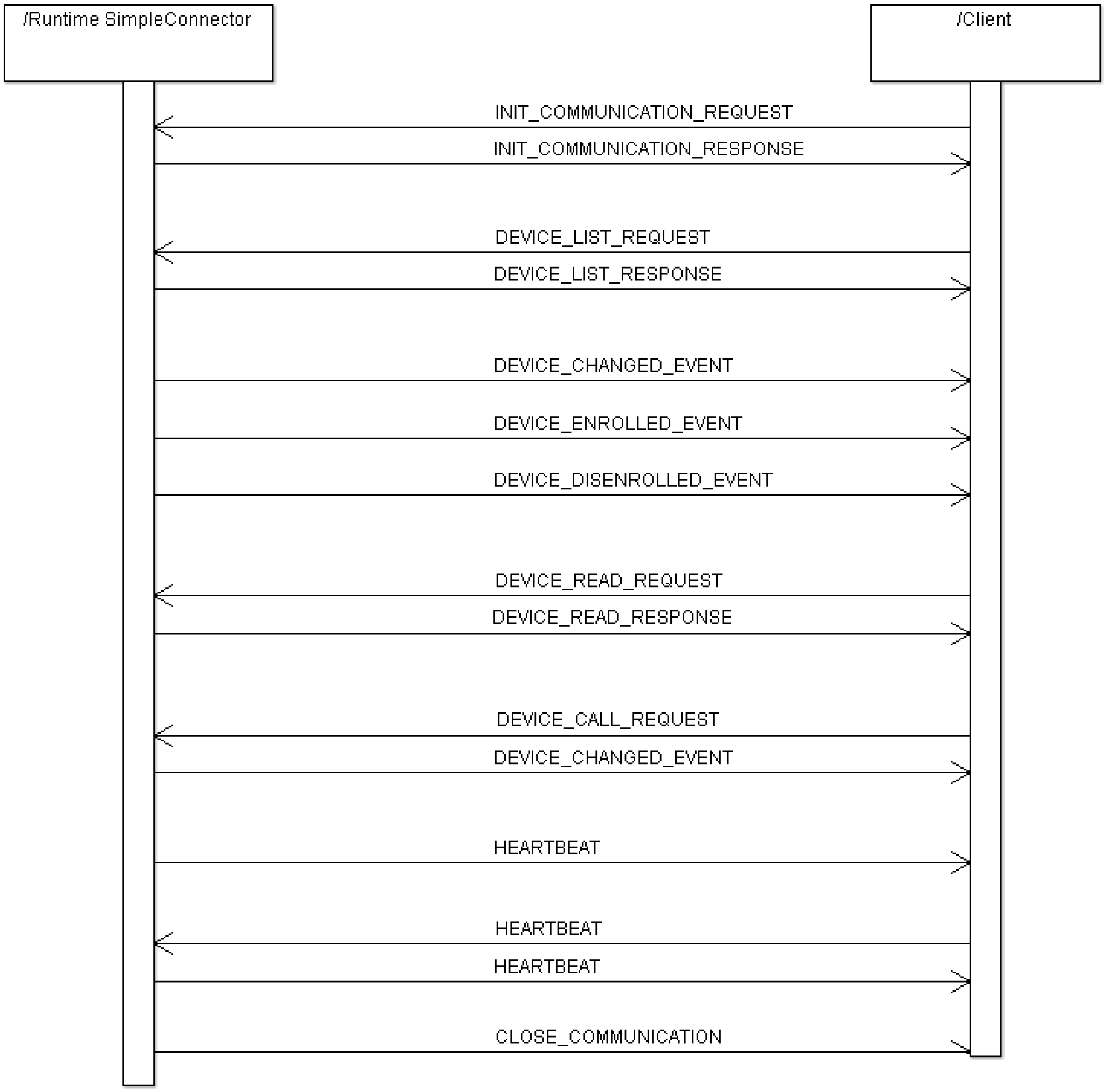

Figure 23: JSON Schema

Furthermore relevant events for the external application will be forwarded, so they can react. The data exchange occurs by so-called JSON objects, because they do not need large amounts of data and are easy to parse.

4.2 Activity detection

The activity configuration allows the definition of rules to link to any sensor events with actions. To the current time, the rules are defined using an XML configuration. The configuration tool registers sensor events in the "Mauser Runtime". Is then an event triggered by a sensor, it will be checked against all the existing rules. Unless a rule applies accordingly a filed action can be performed. The rules are arranged internally in a chain. The rules in the rule chain can be arranged. A rule consists of a set of conditions that must be met and the amount of relevant actions that are executed subsequently.

IF (Condition [1] AND Condition [2] AND ... AND Condition [N])
THEN Action[1] AND Action [2] AND ... AND Action [M]

Figure 24: Example rule

A condition consists of the following four parameters: The device name (Unique device name of the sensor), the device parameter, relational operator and the device state.

<condition devicename = "SensorName" device parameter = "STATE_CLOSED" operator = "EQUAL" devicestate = "1.0" />

Figure 25: Example condition

An action consists of the following three parameters: the device name (Unique Device Name of the actuator), the device parameter and the device state (New value of the actuator).

<action devicename = "ActorName" device parameter = "STATE_CLOSED" devicestate = "1.0" />

Figure 26: Example action

By the specified combination of conditions for sensor events and subsequent action definitions, a thereby defined activity can be achieved. In this case an action can also by a message to the FoSIBLE social community platform.

4.2.1 Activity Index

A Use for the sensor interpretation is the “Activity Index”. It can determine different context information to an "Activity Index" which indicates whether the user was in the last time very active or not. Using this value, the user should be tempted to do more. The decrease of the index can be counteracted by a course visit, playing a game or sporting activities. These are recorded by the system and afterwards provide the opportunity to give comments and share the event information among each other. Through the sharing of the events, other participants of the social community become aware of the user’s activities; thereby the other participants can be motivated to join the user during the next course. This scenario can be applied to games in the same way.

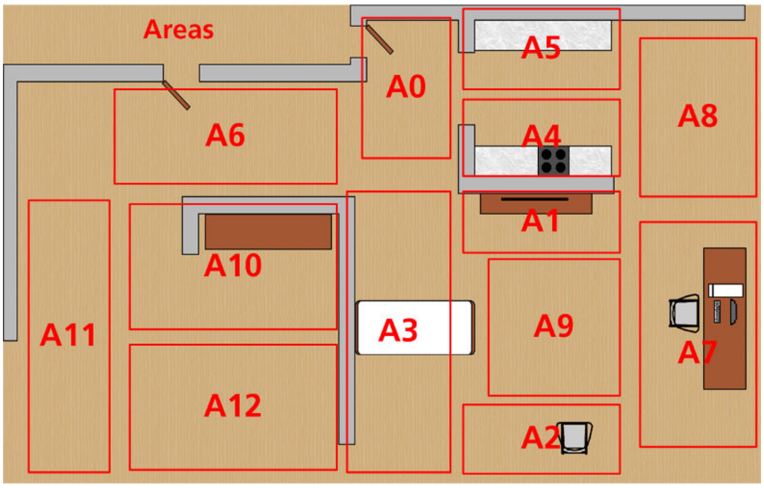

Figure 27: Subdivision in areas

To determine the value the service apartment is divided into different areas (Figure 27). First the stretches of way between the areas are converted into a graph (Figure 28), which includes the distances between the adjacent areas. Based on the graph it is possible to determine the travelled distance by the user with the help of a simple algorithm. For this purpose, the triggered events are assigned to an area. In addition, the area in which the last event has occurred is marked. Once an event is executed in a different area, the travelled distance is determined based on the graph. The travelled distance is then added to the "Activity Index" depending on the required time based on the user-specific mean values. If too much time passes by without an event taking place in another area there is a reduction of the "Activity Index", so the value may also decline again.

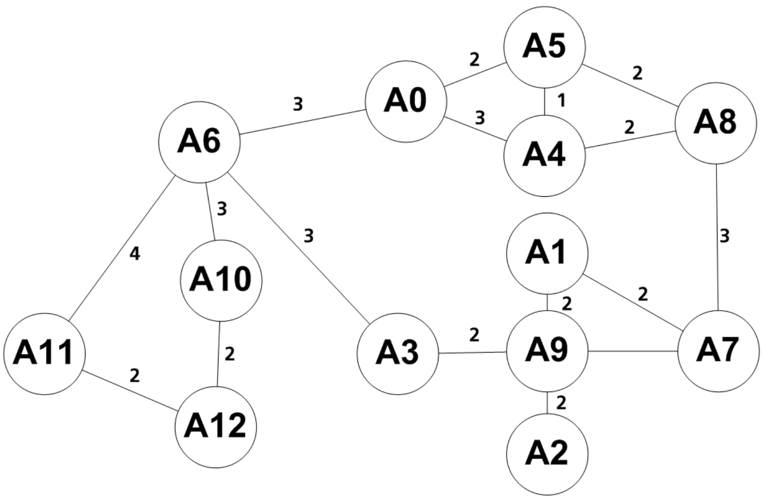

Figure 28: Graph representation of the areas

This index can be displayed in the community so that the user can see a direct connection between his actions in real life and in the virtual world. The index can also be used as a value in a point system, allowing the user to collect points in order to show his activity in the community. His points can be increased by the "Activity Index", as well as by participating in events. So the user will have an incentive to register and comment to attended events. (3)

Figure 29: Activity index in the FoSIBLE widget

4.3 FoSIBLE Social Community Platform Interface

The FoSIBLE Social Platform is a web-based server solution, which is simply accessible by internet connection. For this reason the Mauser Runtime receives a HTTP-protocol-based interface, which affords a communication with the Social Platform. This allows the Social Platform to receive different status messages by the Mauser Runtime, as well as to leave simple messages at the user-specific presentation-site of the Social Platform. In this way it is possible to create several messages at furniture and send them directly to the Platform. This message can be for example an advice to the user's actual condition, which can be pictured by icons.

Figure 30 shows an XML file that includes a method called "insert". There are also four values which are used as parameters for that method.

```
&lt;?xml version="1.0" ?&gt;
- &lt;methodCall&gt;
    &lt;methodName&gt;insert&lt;/methodName&gt;
  - &lt;params&gt;
    - &lt;param&gt;
      - &lt;value&gt;
          &lt;int&gt;63&lt;/int&gt;
        &lt;/value&gt;
      &lt;/param&gt;
    - &lt;param&gt;
      - &lt;value&gt;
          &lt;string&gt;Sensor 1&lt;/string&gt;
        &lt;/value&gt;
      &lt;/param&gt;
    - &lt;param&gt;
      - &lt;value&gt;
          &lt;double&gt;36.0&lt;/double&gt;
        &lt;/value&gt;
      &lt;/param&gt;
    - &lt;param&gt;
      - &lt;value&gt;
          &lt;string&gt;params&lt;/string&gt;
        &lt;/value&gt;
      &lt;/param&gt;
    &lt;/params&gt;
  &lt;/methodCall&gt;
```

Figure 30: HTTP Post FoSIBLE communication, XML Scheme

4.4 Application Interface

Applications in the Mauser runtime have the opportunity to access the events described. By using the OSGi structure the Mauser runtime supports declarative service. These allow for subscribing the sensor events and the identified activities as services and react based on these.

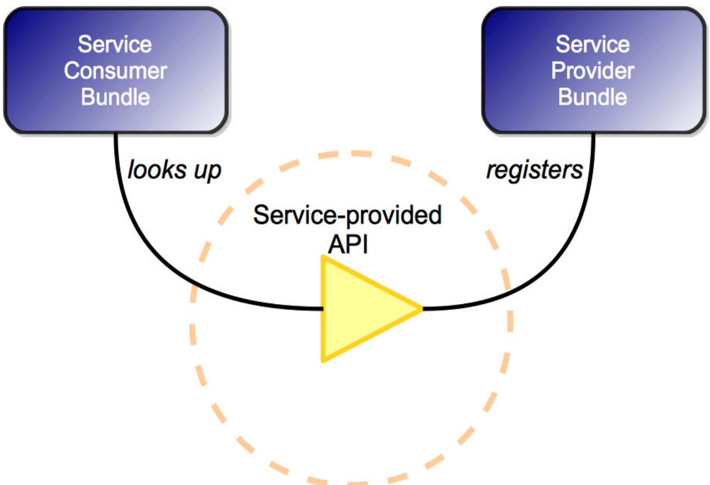

Figure 31: OSGi Service Registry (13)

As seen in Figure 31, they are created by the components described in the previous section for this purpose services. These can then be used by arbitrary applications in the Mauser runtime.

5. Interaction Scenario

The interaction can be carried out in different locations with different devices. As seen in Figure 32, four types can be distinguished. The red marks describe the sensors that are integrated into the furniture and provide no direct interaction with the user. These are for example RFID antennas which detect that an object has been removed. The blue markings described the ambient interaction lights.

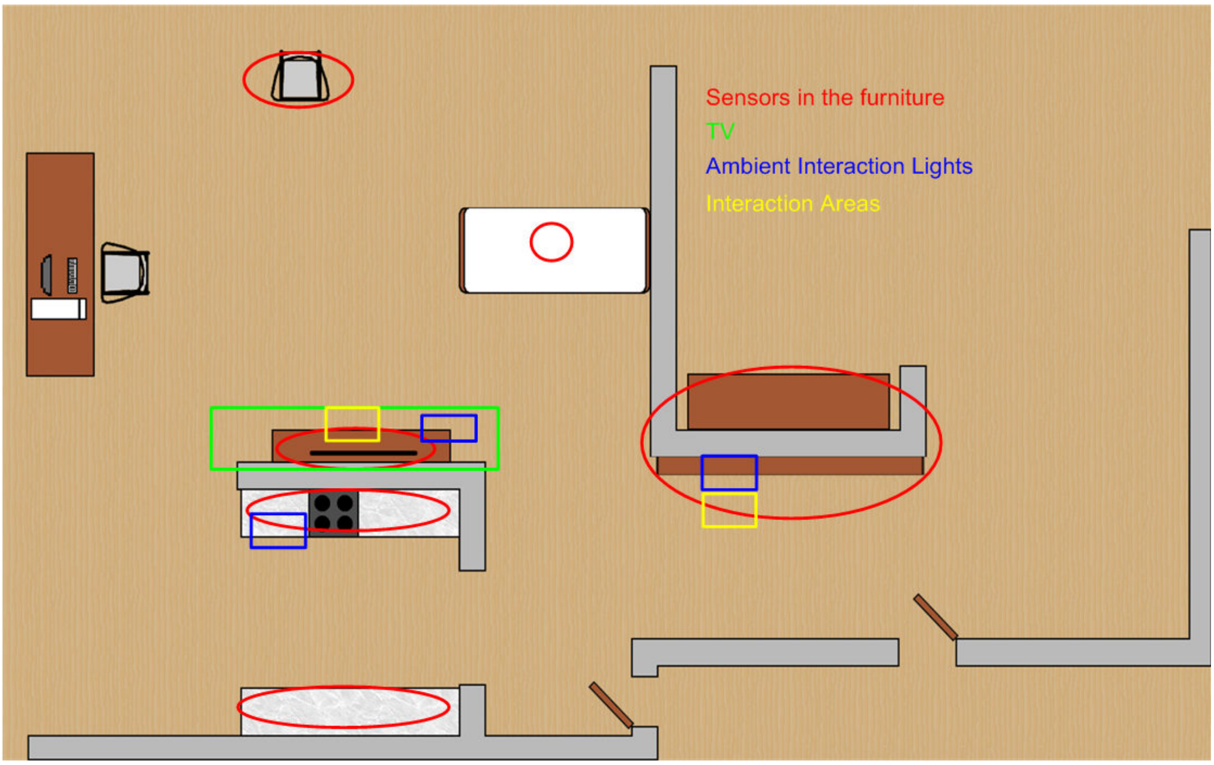

Figure 32: Interaction locations and devices

These lights with incoming messages and can be actuated by the user. The yellow markings are proximity switches, which are integrated into the furniture. These are used by the user to enable or to send something. Finally, the green marker describes the TV. TV interaction with the user is achieved through dialogs.

Figure 33: Dialog on the TV

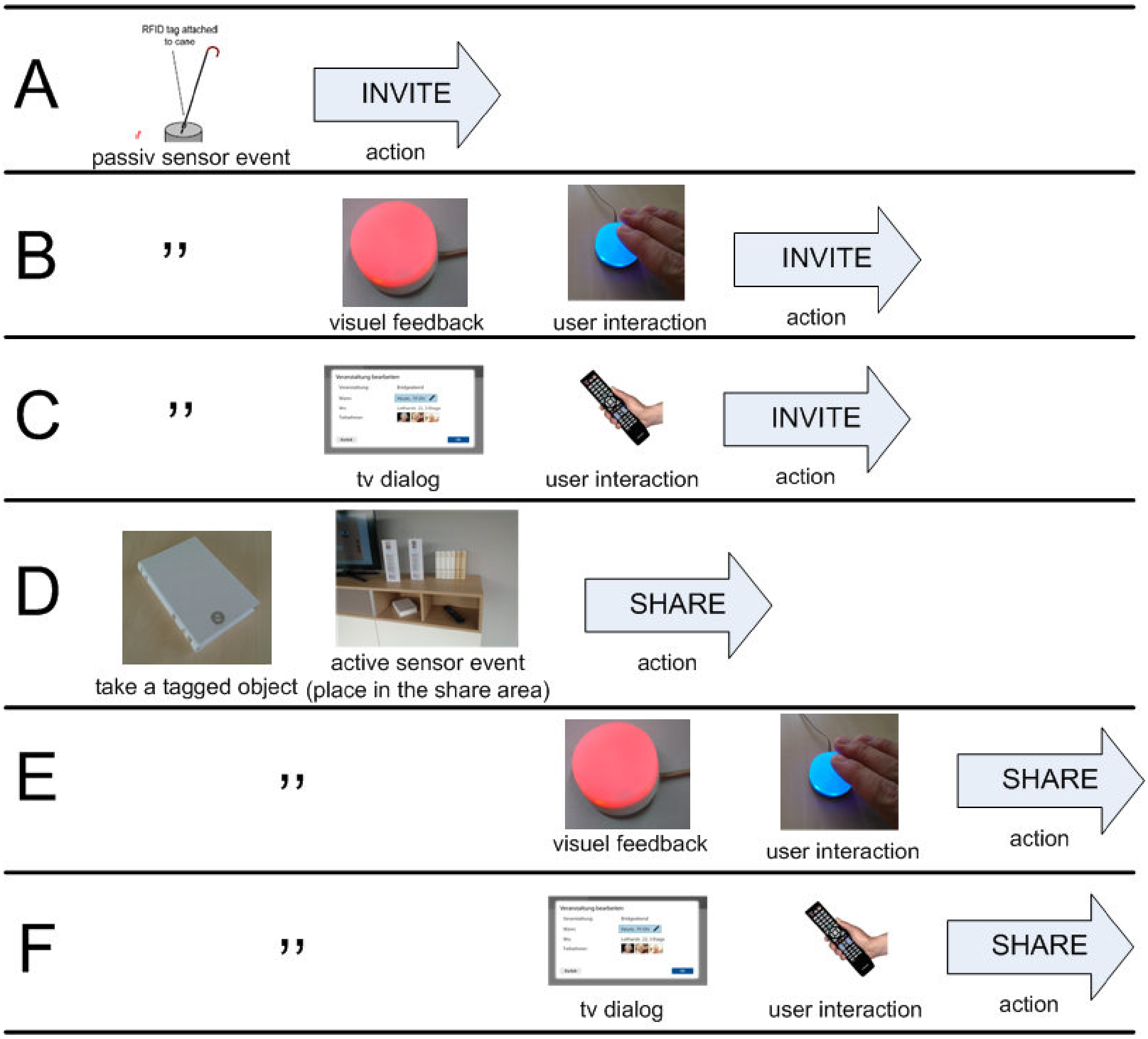

Figure 34: Possibilities of interaction with the environment

As seen in Figure 34, there are different ways of interacting with the environment. It is possible to send messages without the user's interaction. However, this should be avoided, because the user can thus quickly be patronized. Because the user might not want to go to the television each time, alternatives are provided. Near the interaction area there are buttons that can be operated with. Using this, default messages are sent. For example, an invitation to walk can be created during the removal of a walking cane. In this case default values could be the time and the participants.

6. Applications

Based on the interaction scenario and the available sensor events described in chapter 5 variable applications can be defined. For this purpose, a defined rule described in Chapter 4.2 is required. This rule describes, which default activity is connected to which senor combination. Using these rules, dialogs can be created on TV. In addition, default values can be defined, which allow, for example, invitations without recurring configuration effort for the proximity switches.

6.1 Types of application messages

6.1.1 Share a message

In the cabinets in which an RFID antenna is installed, some of them are marked as "share space". By keeping the approach of tagged objects, the object is determined and sent to the defined friends. This type of sensor makes it possible to send messages without having to make a text input.

Figure 35: Tagged book and RFID antenna to read the RFID tag

6.1.2 Send a status

Using the activity detection described in Chapter 4 it is possible with the combination of various sensors to achieve a certain status. The use of some sensors in the kitchen (Figure 7) obtains therefore that the system either accepts that the user is currently cooking. Furthermore, the UCOS sensor can provide information about the number of persons. A possible message in the online status of the FoSIBLE widget would be: “Is in company”.

Figure 36: Person counting in the kitchen

This information can then be shared through the activation of a proximity switch to the social community platform. This kind of status messages can be used in many different forms.

6.1.3 Invite Friends

In a similar manner as described in the previous section, invitations can be sent to users in the social community platform. For this purpose, certain objects and activities can be set in relation to an event. If these objects are used or a specific activity is detected, the user has the possibility to send an invitation by the use of a proximity switch. The definition of the invitation is previously configured. Thus it is possible to invite all friends or only send the invitation to a specific group.

6.2 Example Applications

Since the application has already been described in Deliverable 3.4, here only some applications that are intended to illustrate the possibilities of the sensor environment will be describe.

6.2.1 Post a book

Example: Theresa would like to share a book that she likes with others.
Theresa is currently reading a book and finds it very interesting. She wants to share this book with their friends.

The book is equipped with a transponder / RFID chip that information such as title, author and other information.

She puts this book on a "share area", which can read the information of the book. On her interactive TV a message appears, indicating whether and with whom she wants to share this book. She confirms this with the remote control and selects her acquaintances, friends or family members, who now get the message that this book has been recommended by Theresa and – if provided – her recommendation message.

Figure 37: Tagged book in the share area

6.2.2 Nordic Walking

Example: Theresa would like to invite friends to Nordic Walking.
Theresa wants to go to the afternoon Nordic walking like today. Until now she always phoned some friends to ask them to join her.

Recently, her son has equipped her Nordic walking poles with transponders and entered information on this subject in the system. Now in order to invite her friends for the afternoon for walking, she holds her Nordic walking poles to a share area. Then the question whether and who should be invited for Nordic walking appears on her TV. She confirms that she wants to share the event, and selects certain friends or acquaintances from the shown list. Then she selects a date (today) and a time and the place. Theresa then confirms the event and those who are selected receive a message.
Shortly before the event starts Theresa gets a message, who will appear.

6.2.3 Dinner together

Example: Theresa is in the kitchen and wants to prepare lunch / coffee / dinner. The system suggests she invite other with.

Theresa prepares a dinner. The fact that Theresa is in the kitchen and opens various cabinets or the refrigerator is recognized by the system interpreted as the information that she is preparing the dinner. Since Theresa likes to cook together with others the ambient interaction light in her kitchen provides a feedback that a new message is on their iTV. She goes to the iTV. The system asks if she wants to invite her neighbors / relatives / friends. She confirms this with the remote control and sends them an invitation.

7. Impressions

Figure 38: TV Sideboard with integrated sensors

Figure 39: Wardrobe with automatic opening and closing security

Figure 40: Cabinet with integrated interaction elements

8. References

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