AAL Joint Programme

Action Aimed at Promoting Standards and Interoperability in the Field of AAL

Deliverable D2

AAL Use Cases and Integration Profiles

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Deliverable D2: AAL Use Cases and Integration Profiles

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About Ambient Assisted Living Association: The Ambient Assisted Living Association (AALA) is organizing the Ambient Assisted Living Joint Programme (AAL JP). The AAL JP aims at enhancing the quality of life of older people and strengthening the industrial base in Europe through the use of Information and Communication Technologies (ICT). Therefore, the AAL JP is an activity that operates in the field of services and actions to enable the active ageing among the population. The programme is financed by the European Commission and the 22 countries that constitute the Partner States of this Joint Programme. See more at: http://www.aal-europe.eu/.

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1 Introduction

In May 2013, the AAL Joint Programme published a call for tenders for an “Action Aimed at Promoting Standards and Interoperability in the Field of AAL”, i.e. a small project with a duration of about 6 months, starting in Summer 2013. The central goal of this action is to make existing standards more easily accessible through use-cases: to identify a set of use-cases covering the AAL domain, in particular covering the topics of all six calls for proposals published by the AAL JP until 2013; to identify and match existing technical standards to these use-cases that can help promote interoperability; to analyse these existing technical standards and provide guidance on their use for AAL JP projects and the wider AAL community. This document, Deliverable D2 “AAL Use Cases and Integration Profiles” documents the results of this work: the results of the collection and analysis of use cases, the methodology for profile development, and the integration profiles and mappings to standards developed by the project.

Note: The original of this document is maintained as a hypertext Wiki at http://nero.offis.de/projects/aal-jp/d2/. The PDF document has been extracted as a “snapshot” of this Wiki. Due to this reason, various hyperlinks in this document refer to the original online location of chapters and sections, and not to the equivalent chapter or section within the document.

1.1 Background

Ambient Assisted Living (AAL) can be described as concepts, products and services that combine new technologies and social environment to improve the quality of life for people in all phases of life. Its proponents see AAL as an important “building block” for addressing the challenges of the demographic change in most industrial countries (the so-called “aging society”), by using assistive technology to keep people at work productive and healthy, to keep people at home healthy, independent and integrated, and to improve the delivery of care where and when needed. Essentially, AAL uses technology combined with social services to extend the part of life where people are productive (at work) and independent (at home), and also to improve the quality of life for people in need of care (e. g. with chronic diseases.) Many AAL systems explicitly address older people as main user base, although the vision of AAL applies to all people with special needs.

Much research has taken place in this field over the last 10 years in Europe, and while significant progress has been achieved, the transfer of research results into wide-scale adoption is only starting to emerge (e.g. the ReAAL project, http://www.cip-reaal.eu). One reason for this fact is certainly the complexity of the topic, both in terms of technology and business models / logistics.

AAL systems consist of a combination of products and components from various industrial sectors (including medical technology, home automation, telecommunications and consumer electronics) and vendors, and their operation requires an “eco system” of service providers for planning, installation, maintenance, operation and service provision. Furthermore, as AAL technology is still rather expensive, it is of key importance that AAL systems are “future- proof”, i.e. can be extended and maintained over a longer period of time, growing and adapting to the changing needs of the user. There is a very large variety of user need among older people, and at this time no vendor can offer a “one size fits all” product. This can only be achieved with modular solutions, where components (sensors, actors, but also complete AAL systems) can be combined in a flexible manner, just like Lego® building blocks. This becomes only possible with standardized interfaces between systems and system components, a property called “interoperability”, i.e. the ability of components to work together in a seamless manner. It can be argued that interoperability is a key requirement for the success of AAL solutions on the market. A standardization of functions and interfaces simplifies the comparison of products or components before purchase, combinability during installation, exchangeability during maintenance, and retrofitting during extension of a system. The primary beneficiaries of such flexibility are, therefore, the users at the end of the value chain, since a better comparability and exchangeability of components leads to more choice, more competition and, consequently lower prices. However, also vendors benefit from interoperability since they can flexibly combine their products and components with components from third parties to offer functionality not available in their own

product range.

The issue of interoperability must be addressed on multiple layers. In the communications interface between two systems or system components, the network layer, message layer (syntax) and semantics layer as well as service interoperability from a user perspective can be distinguished, roughly following the layers of the ISO network reference model. If one considers the complete AAL ecosystem including the service aspects, interoperability is also required on a legal, process and policy layer. The "usual" approach to achieving interoperability is to reach consensus across the parties and vendors involved about the interfaces between systems and system components on the different levels, including both "hardware" interfaces between sensors, actors, and IT components on one hand, and "software" interfaces between software components (services) on the other hand. Such consensus is most often codified into standards (both legal and industry standards.) A multitude of such standards that are readily applicable to the "AAL world" exist already, covering all kinds of communication protocols. A repository created by the AALIANCE2 project references more than 400 standards of relevance for the AAL sector (see AALIANCE2 Standards Repository). To some degree, this large body of standards creates a new problem: Which ones are relevant for a particular application or use case? Which standards are the best choices? Furthermore, most communications and network standards have been defined as "toolkits" that can be used to implement interoperable interfaces for many different use cases. In order to guarantee a wide applicability, many standards offer multiple "services", "options" or "profiles" – typically only devices supporting the same service, option or profile are interoperable. As an example, two devices implementing both a wireless Bluetooth interfaces are not interoperable if one system implements the "health device profile", and the other one implements the "serial port profile", both profiles frequently used with medical sensors. Furthermore, a single standard will rarely cover all requirements needed to guarantee modularity and interoperability of the systems and components involved in a complete use case or application scenario. In this case, usually components from multiple standards need to be combined. In summary, communication standards are necessary for interoperable solutions, but they are not sufficient.

An approach that has been developed over the last 15 years to address this problem is the concept of so-called "Integration Profiles". Integration profiles do not attempt to replace communication standards, but to close the gap between the individual communication standards, and the overall use case. Unlike communication standards, which try to support many different use cases, integration profiles are designed for one single use case: they describe the use case (application scenario) from a user perspective, identify the systems/components needed to implement or support the use case, and then enumerate the communication interfaces between the systems and components. Finally, the communication standards (and options, if needed) to be used for each interface are defined. From an implementer's perspective, integration profiles can be seen as design guidelines or standards-based "cook books" describing how to implement a certain use case in a way that ensures interoperability from a user perspective. The following existing organizations develop integration profiles (for different industry sectors), although not all of them actually call their specifications "integration profile":

- The Integrating the Healthcare Enterprise (IHE) initiative (http://www.ihe.net) has since 1998 developed and published about 100 integration profiles as part of their "technical frameworks". Most of this work is focused on the integration of IT systems within hospitals, but there are some profiles addressing the exchange of health information between health professionals or between patient and health professional. Furthermore, the IHE "Patient Care Devices" domain develops integration profiles describing how data from vital parameter sensors can be exchanged over local area or wide area networks, and these profiles may serve as "building blocks" in AAL scenarios. The most interesting integration profiles from an AAL perspective are the "XD* family" (XDS, XDR, XDM) and MHD, the Patient Care Coordination document formats (in particular XPHR) and the Patient Care Devices profiles.
- The Continua Health Alliance (http://www.continuaalliance.org) annually publishes the Continua Design Guidelines, which can also be considered a set of integration profiles. The guidelines cover the fields of health and fitness, chronic disease management and living independently, and are thus of immediate relevance to the AAL domain. It should be noted that Continua is closely collaborating with IHE and HITSP (see below).
- The Healthcare Information Technology Standards Panel (HITSP, http://www.hitsp.org) is a U.S. specific initiative that aims at harmonizing and integrating standards that will meet clinical and business needs for

sharing information among organizations and systems in the healthcare sector. HITSP publishes a comprehensive set of specifications that are freely available and, on a technical level, mostly based on the work done by IHE and Continua. The HITSP Interoperability Specifications describe many use cases and contain very useful high-level information that is mapped to requirements and, from there, to a selection of standards.

- The Digital Living Network Alliance (DLNA, http://www.dlna.org) develops interoperability profiles for multimedia applications, based on UPnP, and offers a certification program for compliant products. More than 18,000 different products have been certified, and there is an installed base of ca. 440 million certified devices. The DNLA Networked Device Interoperability Guidelines have been published as IEC 62481.

In the eHealth sector, the epSOS project (http://www.epsos.eu/) and the recently started Antilope project (http://www.antilope-project.eu) have both adopted this approach. Finally, the German project RAALI ("Roadmap AAL Interoperability") should be mentioned: RAALI has developed an approach for describing integration profiles that is specifically adapted to the needs of the AAL domain, and is inspired by the international standards IEC 61131-3 and IEC 61499-1 . This approach is currently being prepared for publication as a German VDE application guide (which essentially is a pre-standard.) Unlike the IHE profiles, the RAALI approach can also describe interfaces that continuously deliver data (such as analogue sensor output), whereas IHE profiles implicitly assume event-driven communication where a real-world event triggers the transmission of a message over an interface.

1.2 Approach

The approach followed in this Action is essentially similar to the approach employed by IHE or the Antilope project:

- Collect, and then select the most important use cases (see Chapter 2).
- Formalize use cases by identifying actors, transactions, process and data flow
- Map transactions to communication standards (and options where necessary)

The resulting integration profiles will have a structure similar to that of IHE integration profiles and Antilope use cases, which is described in detail in Chapter 3.

For each call topic of the AAL Joint Programme, one or two high-level integration profiles (without a mapping of the transactions to standards) are devised:

- Prevention and Management of Chronic Conditions
- Social Interaction
- Independence and Participation in the "Self-Serve Society"
- Mobility
- (Self-)Management of Daily Life Activities at Home
- Occupation in Life

These high-level integration profiles are described in Chapter 4. Finally, for two of the integration profiles, the transactions (including the mapping to standards) are worked out in full detail (see Chapter 5).

2 Collection of Use Cases

2.1 Methodology

Many AAL projects have tried to describe their vision of ambient assisted living in the form of a “storyboard”, i. e. the story of a fictitious user of the AAL system to be developed. These storyboards form the starting point for the development of integration profiles.

Storyboards have been collected from the following sources:

- Deliverables of AAL Joint Programme projects.
- Public Deliverables of FP6/FP7 AAL research projects.
- The collection of “ICT & Ageing Scenarios published by the BRAID project (Bridging Research in Ageing and ICT development) [Bra2011]. This is a booklet with a collection of scenarios from different perspectives called “life settings”. These four settings are independent living, health and care in life, occupation in life, and recreation in life.
- The AALIANCE roadmap, published in 2010, describes different scenarios in the home environment, mobile settings, community settings and working environments. In addition, enabling technologies and functions (sensing, reasoning, acting, interacting, and communicating) are defined [VCW2010].
- The recently started Antilope project (Adoption and take up of standards and profiles for eHealth Interoperability) has defined ten use cases, two of which are of interest for the AAL community:
  - Use case 8: Involvement of patient in documentation of his/her specific chronic disease and making it available via electronic communication to healthcare provider (e.g., diabetes, cardiac diseases, chronic obstructive pulmonary disease, hypertension)
  - Use case 9: Remote monitoring and care of people outside conventional care facilities involving sensors that transmit information about activity, health status, location or other
- RAALI: The German RAALI project “Roadmap AAL Interoperability” has published the final report [Eic2013] in June 2013. While not a collection of storyboards as such, this document discusses requirements on interoperability from different viewpoints (user’s perspective, operator’s perspective, tele-services, regulatory affairs, security aspects).
- The universAAL Reference Use Cases, although mostly on a different “level” than the storyboards described in the other resources listed here, will be examined [Uni2011].
- Further use cases collected by EIP-AHA Action C2, if available.

The search was performed by text-skimming with Adobe Acrobat Professional. As the terms use case, scenario and storyboard are used in different ways, the decision was to search for all terms. The search terms (with some variations in spelling) were:

- use case; use-case;
- scenario;
- storyboard; story board; story-board;

The following keywords have been later used because they appeared in the analyzed deliverables related to use case, scenarios and storyboards. They have been used in addition for the FP6/FP7 projects. The search terms (with some variations in spelling) were:

- narrative;
- user story; user stories;
- case study; case studies;

Based on the experience of creating the German-language collection of AAL storyboards in RAALI [Eic2013], it was expected that the storyboards will on one hand have much overlap, and on the other hand often describe the AAL system or systems only very implicitly. Furthermore, storyboards often describe more than one use case, since they are often designed to describe all goals a specific project attempts to achieve.

Therefore, the storyboards need to be “sorted”, i. e. systematized. The index keywords are listed below. The keywords have been assigned to the AAL JP call topics, these are

- Call 1: Prevention and Management of Chronic Conditions
- Call 2: Social Interaction
- Call 3: Independence and Participation in the “Self-Serve Society”
- Call 4: Mobility
- Call 5: (Self-)Management of Daily Life Activities at Home
- Call 6: Occupation in Life

2.2 Keywords for the analysis of use cases

In order to systematise and analyse the collection of storyboards (or use cases), a number of keywords were assigned to each text to describe the main purpose of the AAL system described there (such as compensation of a certain physical function loss, support of activities or participation, security/safety functions etc.), the stakeholders involved in the scenario, and key enabling technologies (such as indoor location services, robotics, home automation etc.) appearing in the scenarios. For this purpose, a multi-dimensional, hierarchical taxonomy for indexing the texts was developed.

The following keywords have been defined as a taxonomy that allows to describe the key features (users, system functions, key enabling technologies) appearing in use cases that are written from an end-user perspective. Several independent axes have been defined. The taxonomy is hierarchical, with a colon (”:”) denoting sub-categories.

2.2.1 User-centric keywords

(based on International Classification of Functioning, Disability and Health (ICF))

2.2.1.1 Keywords for "Body Function" (physical functions that will be addressed by the system)

Keyword	Explanation	Examples for related chronic diseases	Number of Use Cases
#mental	mental functions (ICF category b1)	dementia, depression	86
#sensory	sensory functions and pain (ICF category b2)		0
#sensory:seeing	seeing and related functions (ICF category b210-b229)	vision loss, blindness	32
#sensory:hearing	hearing and vestibular functions (ICF category b230-b249)	hearing loss, deafness	22
#sensory:pain	pain (ICF category b280-b289)	chronic pain	13
#voice_and_speech	voice and speech functions (ICF category b3)		2
#vital	functions of the cardiovascular, haematological, immunological and respiratory systems (ICF category b4)		1
#vital:cardiovascular	functions of the cardiovascular system (ICF category b410-b429)	CVD, stroke/cerebral infarction, angina pectoris	40
#vital:hematological	functions of the haematological and immunological systems (ICF category b430-b439)	cancer	1
#vital:respiratory	functions of the respiratory system (ICF category b440-b449)	COPD, asthma	16

#digestive	functions of the digestive, metabolic and endocrine systems (ICF category b5)		3
#digestive:metabolism	general metabolic functions (ICF category b540)	diabetes, adipositas	30
#digestive:water	water, mineral and electrolyte balance functions (ICF category b545)	exsiccosis	1
#genitourinary	genitourinary and reproductive functions (ICF category b6)	incontinence	1
#neuromusculoskeletal	Neuromusculoskeletal and movement-related functions (ICF category b7)		1
#neuromusculoskeletal: joints_and_bones	functions of the joints and bones (ICF category b710-b729)		19
#neuromusculoskeletal: muscle	muscle functions (ICF category b730-b749)		12
#neuromusculoskeletal: movement	movement functions (ICF category b750-b789)	frailty, back problems, arthritis, morbus parkinson	47
#skin_and_hair	functions of the skin and related structures (ICF category b8)	decubitus ulcer	6

2.2.1.2 Keywords for "Activities and Participation" (Activities that will be supported by the system)

Keyword	Explanation	Number of Use Cases
#learning	Learning and applying knowledge (ICF category d198, d199)	40
#general_tasks	General tasks and demands (ICF category d2)	0
#general_tasks:daily_routine	Carrying out daily routine (ICF category d230)	82
#general_tasks:handling_stress	Handling stress and other psychological demands (ICF category d240)	51
#human_communication	Communication (ICF category d3)	133
#mobility	Mobility (ICF category d4)	4
#mobility:body_position_and_carrying	Changing and maintaining body position, Carrying, moving and handling objects (ICF category d410-d429 & d430-d449)	15
#mobility:walking	Walking and moving (ICF category d450-d469)	37
#mobility:transportation	Moving around using transportation (ICF category d470-d489)	36
#self_care	Self-care (ICF category d5)	0
#self_care:washing	Washing oneself (ICF category d510)	9
#self_care:toileting	Toileting (ICF category d530)	5
#self_care:dressing	Dressing (ICF category d540)	5
#self_care:eating	Eating (ICF category d550)	39
#self_care:drinking	Drinking (ICF category d560)	14
#self_care:looking_after_ones_health	Looking after one's health (ICF category d570)	73
#domestic_life	Domestic life (ICF category d6)	0
#domestic_life:shopping	Acquisition of goods and services (ICF category d620)	37
#domestic_life:household_tasks	household tasks (ICF category d630-d649)	30
#relationships	Interpersonal interactions and relationships (ICF category d7)	117
#life_areas	Major life areas (ICF category d8)	0
#life_areas:education	Education (ICF category d810-d839)	18

#life_areas:work	Work and employment (ICF category d840-d859)	36
#life_areas:economic_life	Economic life (ICF category d860-d879)	19
#community	Community, social and civic life (ICF category d9)	1
#community:recreation	Recreation and leisure (ICF category d920)	59
#community:religion	Religion and spirituality (ICF category d930)	5

2.2.1.3 Keywords for "AAL at the workplace"

Keyword	Explanation	Number of Use Cases
#work	use cases related to assistive technology at the workplace	3
#work:body_position	functions invoking the position of the body	1
#work:call_center	functions involving a call centre	0
#work:care	functions to support care work	3
#work:communication	communication functions	19
#work:employees_health	health functions for employees	5
#work:ergonomics	functions regarding to ergonomics	5
#work:error_detection	error detection functions	4
#work:fatigue	functions regarding fatigue	3
#work:handicraft	functions to support handicraft work	14
#work:home_office	systems supporting home office	8
#work:lighting	lighting functions	4
#work:mentoring	mentoring functions	7
#work:office	functions to support office work	4
#work:retired	functions to support retired people	22
#work:stress_handling	functions to support stress handling	5
#work:training	training functions for specific work areas	9
#work:voluntary	functions (typically) intended to support voluntary work	9
#work:workplace	the places where somebody works	10

2.2.1.4 Keywords for stakeholders appearing in the use cases

Keyword	Explanation	Number of Use Cases
#stakeholder	stakeholders of the use case	0
#stakeholder:primary	end-user, e.g. patient	2
#stakeholder:secondary:relatives	e.g. the patient's daughter	103
#stakeholder:secondary:professional_care	e.g. a nurse	85
#stakeholder:secondary:doctors	e.g. the family doctor or radiologist	73
#stakeholder:secondary:emergency_call_services	services providing help in case of an emergency	0
#stakeholder:secondary:non_medical_services	e.g. meals on wheels	23
#stakeholder:tertiary	the device manufacturer of a sensor	14
#stakeholder:work:employer	somebody who pays somebody else to do work	0
#stakeholder:work:collegues	somebody who works in the same organization	4

Note: the primary user (end user) was always assumed to be present in all scenarios, and is characterised through the other user-centric keywords. Therefore, the #stakeholder:primary category has not been used systematically when analysing the use cases.

2.2.2 Technical keywords

2.2.2.1 Purpose of the system (other than body function or activities/participation)

There are certain system functions that cannot be properly described as either compensation/support for reduced body functions, or supporting activities and participation. This affects, for example, security, safety or comfort related functions. Additional keywords have been defined to describe these.

Keyword	Explanation	Number of Use Cases
#purpose	purpose of the system	0
#purpose:comfort	system for comfort purposes	1
#purpose:comfort:heating	comfort functions for heating (e.g. autonomous room temperature controller)	1
#purpose:comfort:lighting	comfort functions for lighting (e.g. automated illumination with a motion detector)	13
#purpose:safety	system for safety purposes	0
#purpose:safety:alert_communication	communication of an alert event to another institution or user	72
#purpose:safety:alert_detection	detection of situations that can be dangerous or unwanted for the patient	65
#purpose:safety:disease_detection	detection of diseases (e.g. Alzheimer)	9
#purpose:safety:disease_prevention	prevention of diseases (e.g. motivations for a healthy lifestyle)	13
#purpose:safety:disease_rehabilitation	rehabilitation of a disease (e.g. bicycle training for COPD patients)	19
#purpose:safety:fall_detection	detection of fall events	21
#purpose:safety:fall_prevention	prevention of falls (e.g. by automated walking assessments)	7
#purpose:safety:orientation	safety functions that support the orientation (e.g. illuminated path to the bathroom)	45
#purpose:security	system for security purposes	0
#purpose:security:access_control	security functions for access control (e.g. camera on the door)	30
#purpose:security:intruder_alert	detection of intruders	1

2.2.2.2 Key enabling technologies

A number of key enabling technologies, such as robots, mobile devices, or serious games appear in many use cases. The following keywords have been defined to describe these technologies. Note that, as the use cases are normally written from an end-user perspective, the description of the technologies underlying the system is in most cases rather vague - the use cases only describe *what* the system does, but not *how*.

Keyword	Explanation	Number of Use Cases
#key_enabling_technology	key enabling technologies	0
#key_enabling_technology:ambient	ambient sensors and actors (integrated in the environment)	108
#key_enabling_technology:body_area	e.g. vital parameter sensors in clothes	50
#key_enabling_technology:communication_functions	e.g. video telephony	194
#key_enabling_technology:environmental_parameters	acquisition and use of environmental parameters	1
#key_enabling_technology:games	e.g. games for cognitive training	46

#key_enabling_technology:health_information	e.g. personalized acquisition of disease specific information	46
#key_enabling_technology:home_automation	e.g. motion detectors, intelligent white goods	40
#key_enabling_technology:medication_dispenser	e.g. automated pill box	8
#key_enabling_technology:mobile_devices	e.g. smart phone	91
#key_enabling_technology:questionnaires	questions for the user	32
#key_enabling_technology:robotic	e.g. service robot	49
#key_enabling_technology:telemedicine	telemedicine functions (e.g. blood oxygen transmission from the patients' home to a doctor)	50
#key_enabling_technology:vital_parameters	acquisition and use of vital parameters	65
#localization	localisation functions	1
#localization:indoor	indoor localization functions	80
#localization:outdoor	outdoor localization functions	42

Note: The #localization category is missing the prefix #key_enabling_technology only for historical reasons.

2.3 Analysis of Use Cases by AAL-JP Call Topic

The clustering and analysis of use cases follows the list of topics covered by the calls for proposals of the AAL Joint Programme published so far. The goal was to develop one or two new use cases that can be considered representative for each topic, which are the basis for the development of integration profiles in chapter 4. The results of the analyses can be found here:

2.3.1 Results related to the topic of AAL-JP Call 1: Prevention and Management of Chronic Conditions

This section describes the analysis of the use cases that are thematically related to the topic of AAL-JP Call 1, “Prevention and Management of Chronic Conditions” (note that the analysis is not limited to use cases developed by projects that were actually funded under AAL-JP Call 1.)

2.3.1.1 Clustering

As described in the outline for Chapter 2, the first step in the analysis is the selection and clustering of use cases for this topic. Out of the keywords that were used to describe each use cases, the following ones are related to chronic diseases. All of these keywords are related to the International Classification of Function (ICF) and describe body functions that can be negatively affected by chronic diseases.

Keyword	Explanation	Examples for related chronic diseases	Number of Use Cases
#mental	mental functions (ICF category b1)	dementia, depression	**86**
#sensory	sensory functions and pain (ICF category b2)		0
#sensory:seeing	seeing and related functions (ICF category b210-b229)	vision loss, blindness	32
#sensory:hearing	hearing and vestibular functions (ICF category b230-b249)	hearing loss, deafness	22
#sensory:pain	pain (ICF category b280-b289)	chronic pain	13
#voice_and_speech	voice and speech functions (ICF category b3)		2
#vital	functions of the cardiovascular, haematological, immunological and respiratory systems (ICF		1

	category b4)		
#vital:cardiovascular	functions of the cardiovascular system (ICF category b410-b429)	CVD, stroke/cerebral infarction, angina pectoris	**40**
#vital:hematological	functions of the haematological and immunological systems (ICF category b430-b439)	cancer	1
#vital:respiratory	functions of the respiratory system (ICF category b440-b449)	COPD, asthma	16
#digestive	functions of the digestive, metabolic and endocrine systems (ICF category b5)		3
#digestive:metabolism	general metabolic functions (ICF category b540)	diabetes, adipositas	30
#digestive:water	water, mineral and electrolyte balance functions (ICF category b545)	exsiccosis	1
#genitourinary	genitourinary and reproductive functions (ICF category b6)	incontinence	1
#neuromusculoskeletal	Neuromusculoskeletal and movement-related functions (ICF category b7)		1
#neuromusculoskeletal:joints_and_bones	functions of the joints and bones (ICF category b710-b729)		19
#neuromusculoskeletal:muscle	muscle functions (ICF category b730-b749)		12
#neuromusculoskeletal:movement	movement functions (ICF category b750-b789)	frailty, back problems, arthritis, morbus parkinson	**47**
#skin_and_hair	functions of the skin and related structures (ICF category b8)	decubitus ulcer	6

The table clearly shows that there are two topics that are covered by the by far largest number of use cases: mental functions, cardiovascular functions, and movement. Care for patients with cardiovascular disease (CVD) is a topic that has been well-established in telemedicine for many years, and a comprehensive implementation guide for achieving interoperability in these use cases has been developed by the Continua Health Alliance. Movement, on the other hand, is the primary topic of Call 4 (Mobility). Therefore, the following analysis for Call 1 will focus on the topic of use cases related to mental functions.

2.3.1.2 Analysis of Use Cases: Mental Functions

A review of the use cases related to mental functions shows that actually two different types of mental problems are addressed by these use cases: *dementia / cognitive impairment* (50 use cases) and *depression* (3 use cases). Since dementia and depression will likely need different kinds of support and assistance, this analysis focuses on the use cases related to dementia / cognitive impairment.

The use cases related to dementia have been analysed with regard to the types of assistive function implemented by the imaginary AAL systems described in these use cases, with the following result, ordered by decreasing frequency of occurrence:

Assistive function	Description	Number of Use Cases
Behaviour monitoring	a system that monitors the behaviour of the user, recognises the activities of daily living (ADLs) and potentially dangerous situations and, if need be, informs carers or raises alarms.	10
Calendar with reminders	a system that reminds the user of appointments, activities of daily living, and medication	8
Medication reminder/dispenser	a system that monitors the medicine taken from a dispenser and reminds the user if medicine is not taken in time	6

Social network for informal carers	a social network where informal carers can connect with each other, share experiences, in some cases also ask advice from professional carers. The systems often also offer tutorials/webinars for informal carers.	5
Outdoor mobility assistant with “panic button”	a navigation system for pedestrians, partly with support for using public transportation. The systems usually offer a “panic” button that can be pressed when the user feels lost. In this case a connection to a informal or formal carer is established and the position of the user is transmitted, so that the carer can guide the user home, or organise other means of transport.	5
Communication between carers and patients	a system that enables carers to communicate with the users from remote.	4
Serious games for memory/biography training	serious games that help users train their memory or recall their biography.	3
Notification when patient leaves/arrives at home	a system that sends a notification to a carer whenever the user leaves home or arrives at home.	3
Guide for performing ADLs	a system that offers instructions or guidance on how to perform certain ADLs such as cooking, brushing one's teeth etc. Usually combined with ADL recognition (behaviour monitoring).	3
Guidance tool for informal carers	a system that offers instructions or guidance to informal carers on how to handle certain difficult situations such as aggressive behaviour of the user.	3
Detection of displaced items	a system that helps the user to find items (such as keys or glasses) that have been displaced somewhere in the apartment.	2
Recognition of dangerous situations	a system that recognises dangerous situations (such as the user watching TV while the cooker is switched on), and notifies the user.	2
Recognition of unsafe situations when leaving home	a system that recognises unsafe situations (such as windows open or cooker switched on) when the user wants to leave home, and notifies the user.	2
Fall detection	a system that without manual interaction detects falls in the apartment after which the user needs help, and raises alarm.	2
Notification of carers upon dangerous situations	a system that upon recognition of dangerous/unsafe situations notifies a carer.	2
Activity reminder	a system that reminds the user of activities (such as taking a walk) in order to keep the user active.	2
Prevent wandering outside by suggesting another activity	a system that tries to prevent wandering outside of a confused user by suggesting alternative activities	1
TV-based home-banking	a system that offers home banking with a simplified user interface suitable for users with cognitive impairment	1
Behaviour monitoring of *informal carers* to determine stress level	a system that monitors not the users (patients) but their informal carers, determines their stress level, and informs them if their stress level indicates a need for external help.	1
Lighting-based indoor guidance	a system that guides the user through the apartment by adjusting lighting, e.g. for walks to the toilet at night, or to motivate the user to go to bed by dimming the light in the living room and lighting up the bedroom.	1
Use hearing aid for voice output	a hearing aid that can be used by external systems to play voice output to the user.	1
Instructions on how to use certain devices (ATM etc.)	an assistive system for indoor and outdoor activities that recognises certain devices (such as ATMs, ticket machines etc.) and offers instructions on how to use them.	1
Diary with photos	an automatic diary that periodically adds photos and allows the user to	1

	look back at past activities.	
Intelligent walker with indoor/outdoor navigation	a walker that offers navigation functions both indoors and outdoors.	1
Early detection of depression in dementia patients by monitoring a “mood cluster”	a system that monitors the behaviour of the user, recognises early indicators of depression, and notifies a carer.	1
GPS locator in jewellery	a GPS locator that is embedded in jewellery, which regularly sends the user's position.	1
Integration with professional nursing using Personal Health Record	a system based on a personal health record (PHR) that allows for an integration of informal and formal care	1

Not all of these assistive functions are suited for the development of integration profiles. Some systems can operate in a stand-alone manner and have little need for a standardisation of interfaces between system components. This effects, for example the social network approaches, which make use of standard Web technology, a guidance tool for informal carers, or serious games. Other functions, such as the outdoor mobility assistant, are not specific to users with cognitive impairment and, covered by other call topics.

A closer look at the assistive functions furthermore reveals that some of them are closely linked to behaviour monitoring:

- Notification when patient leaves/arrives at home: This is essentially a special case of a behaviour monitoring system that only monitors the leaving and arrival at home.
- Guide for performing ADLs: This system requires a recognition of ADLs (i.e. behaviour monitoring), so that guidance can be offered in a context-sensitive manner.
- Recognition of dangerous/unsafe situations with notification of carers: This is also a special case of behaviour monitoring focusing on behaviour patterns that cause an immediate risk for the user.
- Lighting-based indoor guidance: This kind of guidance requires that the system has an “understanding” of the intentions of the user (such as the desire to visit the toilet) or the usual day-rhythm. Therefore it is unlikely that this can be implemented independently from a behaviour monitoring that establishes this knowledge.

Furthermore, some assistive functions are closely linked to the calendar with reminders:

- Medication reminder/dispenser: Taking one's medicine is a regular activity that could be maintained in a calendar, just like other ADLs. Furthermore, since the calendar offers a reminder function, this can be used for the medication reminder as well. This requires, however, that the calendar interacts with the medication dispenser, if present, to suppress reminders when medicine has actually been taken.
- Activity reminder: This is a special case of a calendar that “automatically” adds certain entries based on user preferences, whether forecast, external events such as concerts etc.

In summary, the most promising topics for the development of representative use cases and integration profiles are “behaviour monitoring” and “calendar”, extended with some of the closely linked assistive functions as optional functionality.

2.3.1.3 Representative Use Cases

Below the following information is provided for each of the representative use cases derived from the use case analysis:

- a technical description of the use case
- a narrative scenario text (in IEC SG5 format)
- an integration profile derived from this use case.

2.3.1.3.1 Behaviour Monitoring

Technical Description

Dementia / cognitive impairment is a disease that often progresses slowly over many years. In order to maintain as much independence for the patient as possible, while preventing disease-related accidents, behaviour monitoring tries to identify the activities of the user at home, to provide warnings to the user in dangerous situations, or notifications to carers if indications of a progress of the disease are measured that indicate an increased need of support.

While at home, the location and activities of the user are monitored by means of ambient, unobtrusive sensors. The system recognises physical activity and behaviour patterns (the so-called activities of daily living), and identifies sequences of events that either indicate a dangerous situations (such as the user sitting in front of the TV for a longer time while the cooker is switched on, or a fall event after which the user does not stand up anymore), as well as sequences of events that indicate long-term behaviour changes that indicate an increased need for support (such as reduced activity, a user not cooking regularly anymore etc.) Depending on the classification of the situation the system either notifies the user, sends a notification to a formal or informal carer, or raises an alarm (e.g. sends a high-priority message to a emergency call centre). Furthermore, the system may initiate actions of home automation actors (in particular lighting and shutters), for example to provide ambient lighting to the bathroom when the user gets up at night, or to unobtrusively guide the user to the bedroom at night. In technical terms, the monitoring is implemented using several types of sensor technologies:

- Home automation sensors (presence detectors, door contacts, light barriers, electricity metering devices, smart appliances) provide coarse-grained location and information about physical activity (e.g. walking through the apartment, using electrical appliances).
- Optionally, high-resolution indoor localization sensors such as floor-mats provide more precise location information and may also be used to detect fall events.
- Alternatively, optical sensors (cameras) can also be used to determine information about location and activities.
- The information acquired by ambient sensors may be extended with information acquired by sensors worn on the body, such as an accelerometer (physical activity, falls) or vital parameters (e.g. to detect stress).

Narrative

The narrative use case text can be found here: Behaviour Monitoring.

Integration Profile

The integration profile related to this use case can be found here: Integration Profile 1: Behaviour Monitoring.

2.3.1.3.2 Calendar Service

Technical Description

The Calendar Service is a system that is mostly intended for older adults with a cognitive impairment. Such users will often be able to still live independently, but they tend to forget things (appointments, activities, and in particular medication). Furthermore, this user group tends to over time reduce activities such as walking outsides, participating to social live and community events, which in turn may help to worsen the cognitive impairment.

The Calendar Service system acts as an “intelligent” calendar that reminds the user of appointments, notifies the user if certain activities of daily living are forgotten, and reminds the user of the medicine that is to be taken. Furthermore, the system monitors Web resources maintaining community event calendars and, based on a profile indicating the preferences of the users, creates suggestions for events the user might be interested in. The system also retrieves a weather forecast and suggests outdoor activities if the weather conditions are OK.

The system can optionally be coupled with a medication dispenser. In this case the system “knows” whether or not the uses has taken the medicine out of the dispenser. If medicine is not taken regularly, carers can be notified. (Note, however, that the system cannot detect if the user really *takes* the medicine, or only takes it from the dispenser.)

Narrative

The narrative use case text can be found here: Calendar Service.

Integration Profile

The integration profile related to this use case can be found here: Integration Profile 2: Calendar Service.

2.3.2 Results related to the topic of AAL-JP Call 2: Social Interaction

This section describes the analysis of the use cases that are thematically related to the topic of AAL-JP Call 2, “Social interaction” (note that the analysis is not limited to use cases developed by projects that were actually funded under AAL-JP Call 2.)

2.3.2.1 Clustering

The first step in the analysis is the selection and clustering of use cases for this topic. Out of the keywords that were used to describe each use cases, the following ones are possibly related to social interaction.

Keyword	Explanation	Number of Use Cases
#human_communication	Communication (ICF category d3)	**133**
#relationships	Interpersonal interactions and relationships (ICF category d7)	117
#community	Community, social and civic life (ICF category d9)	1
#community:recreation	Recreation and leisure (ICF category d920)	59
#community:religion	Religion and spirituality (ICF category d930)	5
#key_enabling_technology: communication_functions	e.g. video telephony	194

As the last line in this table shows, communication functions are a very frequent component of AAL use cases. However, not all of these communication functions are really social interactions - for example, this keyword also relates to monitoring systems where in an emergency case a call centre can be contacted.

The use cases that have been assigned the keywords #human_communication and #relationships show a large overlap of about 70%, as to be expected. The scenarios that have the keyword #relationships but not the keyword #human_communication have been analysed and determined to be not relevant for this topic, as they mostly affect either the management of chronic diseases (call 1), or mobility (call 4). Therefore, the use cases with the keyword #human_communication have been chosen as the basis for further analysis below.

2.3.2.2 Analysis of Use Cases

2.3.2.2.1 Reason for chosen analysis design

Human communication has been well analysed by communication science and many models of communication have been developed. For this reason the clustering of human communication follows a different concept than the analysis of other call topics.

One of the most popular communication models is the Shannon–Weaver model [WS1968] which is used below for clustering the scenarios on human communication. The model contains several building blocks; the core of the model embodies information source, message, channel, receiver and many more which are not relevant for this clustering. The *information source* in this context is always the user and, therefore, not used as a basis for defining clusters. The *message* concept contains the content of communication in general and the function of human communication in specific. The *channel* describes the devices used and the *receiver* is the communication partner (other than the end-user).

2.3.2.2.2 Communication Functions

Communication function	Description	Number of Use Cases
Video conference	video conferencing	21
Location Services Outdoor	determines location of the user when outdoors	13

Online Gaming	multi-player games	11
Emergency Call Service Communication	routing/escalation of emergency calls (automatically or manual released)	11
Virtual Communities / Social Network for Elderly	social networks with contents for elderly	10
Emergency Button / Panic button / stress button	a button that can be pressed in emergency situation, in which case a communication line with a carer is opened immediately	9
Virtual Communities / Social Network	e.g. Facebook	7
Sharing Media (Photos, Videos, etc)	services for sharing media (like Flickr)	5
Remote / Virtual teaching	online teaching, web based training	4
Virtual Communities / Social Network on Regional Basis	social networks connecting neighbourhood/local community	4
Collaborative Working in Care	empowering people to assist carers remotely and immediately	4
Text communication	unspecified text communicating (SMS, chat)	3
Virtual Communities for Informal Carers	sharing experiences, discussing problems	3
Indoor Location Services	locating the resident inside the housing unit	3
Virtual Presence / 3d effects	e.g. holograms	2
Simulated human communication	technology/robots communicating (active!) in natural language	2
Human-like interaction with technology	controlling technology with natural language	2
Voice Recognition / Audio to text	conversion of speech to text, e.g. voice control of a system	2
eMail	classical e-mail	9
SMS	short message service texting	7
VoIP	telephony using voice over IP	5
Virtual Communities / Social Network for Patients / Support groups	sharing illness experience, supporting self-help groups	4
Virtual Communities / Social Network for Rehabilitation	supporting/connecting rehabilitants among themselves	4
Text chat	classical online chat	4
Writing Real Letters	pen and paper	3
Watching TV together online	shared screen with communication functions	3
Informal Carer Network	supporting an informal care network around a specific patient	3
Formal Care Network	supporting an formal care network around a specific patient	2
Online Cooking	communication functions in the kitchen, shared recipes and nutrition advices	2
Collaborative Navigation Planning	remote human assistance (synchronous/asynchronous) in navigation planning	2

2.3.2.2.3 Communication Devices

Communication device	Description	Number of Use Cases
Communication by tablet / smart phone	tablet/smart phone as universal communication hub (text, video, audio)	14
Interactive TV / Smart TV	smart TV as universal communication hub (text, video, audio)	9
Telephone calls by smart phone / smart device	classical telephone calls	6

Communication by wrist device / bracelet	smart watch	5
Video conference calls by TV	using the TV only for video communication	4
Video conference by robot	robot with a video call unit (integrated screen and camera)	3
Phone Calls by robot	robot with a audio call unit (integrated microphone and speaker)	3
Text communication by smart phone	SMS, text chat	2
Video conference calls by PC	using desktop computer for video communication	1
Communication Belt device	a belt with integrated communication functions	1

2.3.2.2.4 Communication Partners

Communication partner	Description	Number of Use Cases
Communication Doctor-to-Patient	communication between end-user and e.g. family doctor	15
Communication Carer-to-patient	communication between end-user and formal or informal carer (e.g. relative)	11
Communication with Call Centre	communication between end-user and call-centre, e.g. in emergency situations	7
Communication Carer-to-relative	communication between formal and informal carers	2
Communication Doctor-to-relative	communication between doctors and informal carers	1

A smart TV and/or a mobile device (smart phone) seem to be the most essential technical components of supporting systems for human communication. They allow human communication via various communication channels (text, audio, video). Other devices occurring are robotics (with enriched functions regarding human communication) or devices only supporting one communication channel. Thus the representative use case will include a smart TV and a smart phone.

In the identified scenarios these devices support three different communication areas like classical human-to-human communication (e.g. video conferencing), enriched human-to-human communication (e.g. online gaming, media sharing) and targeted human-to-human communication (emergency communication, online teaching). The representative use case will contain aspects from all three areas.

Finally, two main target groups of communication are addressed: relatives and medical professions (doctors, carers). Both will be considered in the representative use case.

2.3.2.3 Representative Use Cases

Below the following information is provided for each of the representative use cases derived from the use case analysis:

- a technical description of the use case
- a narrative scenario text (in IEC SG5 format)
- an integration profile derived from this use case.

2.3.2.3.1 Social Interaction with Smart TV

Technical Description

The representative use case scenario for human communication is based on a smart TV and a smart phone connected to the TV. The smart TV offers additional functions like video conferencing, internet browsing, online gaming and other services like shopping. The connected smart phone can be used as remote control, game controller, for navigation and location services and has a panic button app which can be used in emergency situations inside and outside the home. A nursing service nearby is hosting this service.

The user can use video conferencing to chat with his children as well as with other relatives (grandchildren) and friends. Besides video conferencing the included online games can be used with contacts or stand-

alone. The system can also be used for video calls with general practitioners.

Narrative

The narrative use case text can be found here: Social Interaction with Smart TV.

Integration Profile

The integration profile related to this use case can be found here: Integration Profile 3: Social Interaction with Smart TV.

2.3.3 Results related to the topic of AAL-JP Call 3: Independence and Participation in the "Self-Serve Society"

This section describes the analysis of the use cases that are thematically related to the topic of AAL-JP Call 3, "Independence and Participation in the 'Self-Serve Society'" (note that the analysis is not limited to use cases developed by projects that were actually funded under AAL-JP Call 3.)

2.3.3.1 Clustering

The first step in the analysis is the selection and clustering of use cases for this topic. Out of the keywords that were used to describe each use cases, the following ones are possibly related to independence and participation in the 'self-serve society'.

Keyword	Explanation	Number of Use Cases
#learning	Learning and applying knowledge (ICF category d198, d199)	40
#mobility:transportation	Moving around using transportation (ICF category d470-d489)	36
#domestic_life	Domestic life (ICF category d6)	0
#domestic_life:shopping	Acquisition of goods and services (ICF category d620)	**37**
#domestic_life:household_tasks	household tasks (ICF category d630-d649)	30
#life_areas:education	Education (ICF category d810-d839)	18
#life_areas:economic_life	Economic life (ICF category d860-d879)	19
#community	Community, social and civic life (ICF category d9)	1
#community:recreation	Recreation and leisure (ICF category d920)	**59**
#community:religion	Religion and spirituality (ICF category d930)	5

Topics related to "learning" and "education" are less suitable for the development of integration profiles, because e-learning systems require little integration between actors. Mobility is the primary topic of call 4, and, therefore, also ignored here. Consequently, "Shopping" and "Recreation and leisure" have been selected as topics for further analysis of the related use cases.

2.3.3.2 Analysis of Use Cases for "Shopping"

2.3.3.2.1 Reason for chosen analysis design

For the analysis of the results for the topic "shopping", the Shannon–Weaver model [WS1968] from call 2 is used again but with a slight difference. The target group does refer to the sender and not the receiver as the receiver will be in nearly all cases some instance of a shopping service (food, drugs, etc.). As shopping can be understood as a communication process, this analysis design seems suitable.

2.3.3.2.2 Functions

Assistive function	Description	Number of Use Cases
Normal shopping with shopping list	Walk to the shop, purchase goods, walk home	5

Home/online shopping with delivery service	Purchase online, goods are delivered	5
Virtual communities / dedicated social network for elderly		5
Communication doctor-to-patient		5
Advisor for healthy / dietary food during normal shopping	May consider specific dietary needs due to chronic diseases	4
Video conference		4
Location services (outdoor)	GPS navigation, can be assumed to be built-in into smartphones, tablets etc.	4
Automated stockpiling and ordering of basic goods		3
Panic button (when confused while shopping)	Covered by “Mobility assistant” integration profile	3
Automated stockpiling and ordering of drugs		2
Community shopping: shopping service by friends	A friend receives the shopping list, performs the shopping	2
Reminder to go out for shopping		2
Route planner for shopping		2
Access to shopping information (prices, range of goods etc.)		2
Telephone calls by smartphone		2
Text communication by smartphone		2
Virtual communities / social network		2
Virtual communities / social network on regional basis		2
Communication carer-to-patient		2
Communication with call centre		2
Online gaming		2
Emergency call service communication	Covered by “Mobility assistant” integration profile	2
Mobile device that connects to shop infrastructure while shopping normally		1
Function to ask for assistance by shop staff while shopping normally		1
Shareconomy		1
Buying aged care services		1
Buying meals on wheels		1
Buying online sessions		1
Application store		1
Natural communication with technology		1
Simulated human communication		1
Human-like interaction with technology		1
Shopping navigation (to locate shops and items inside the shops)		1
Shopping simulation / shopping game		1
Reading aid		1
Paying assistance (PIN reminder, Near-field communications)		1

Remote/virtual teaching		1
Virtual communities for informal carers		1
Communication doctor-to-relative		1
Text chat		1
Watching TV together online		1
Emergency button / panic button / stress button		1
Indoor location services (within a shop)		1

2.3.3.2.3 Devices

Device	Description	Number of Use Cases
Smart TV		7
Communication by tablet / smart phone	human communication	7
Tablet / touchscreen		4
Smart phone		4
Smart Walker		2
Intelligent fridge		1
Intelligent drug dispenser		1
Printer		1

2.3.3.2.4 Target Group

Target Group	Description	Number of Use Cases
Older adults with mild cognitive impairment (MCI)		4
Older adults with malnutrition		3
Older adults with adipositas		2
Older adults with frailty		2
Shop staff		1
Older adults with diabetes		1
Older adults with osteoporosis		1
Older adults with presbyacousis		1
Older adults with short sight		1

2.3.3.2.5 Representative Use Cases

Technical

Shopping is one of the activities where the transformation of the industrialized countries into “self-service societies” can be felt most. Supermarkets with relatively small staff and little human support for older customers are the norm, not the exception today. However, the ability to purchase one's goods for daily living are an important aspect of participation and independence for older adults, and, furthermore, a typical outdoor activity that is important to keep people active and mobile. Malnutrition and dehydration are frequent problems in older adults, so any assistive system for shopping purposes should also be able to support and advise the user to buy food adapted to the user's personal health situation. Finally, not all goods may be available in shops sufficiently close for a walk, and some goods (e.g. drinks) may be too heavy. Therefore, shopping service with door-to-door delivery should also be supported.

The Shopping and Nutrition Planner is an assistive system for nutrition planning and shopping. Both “home shopping” with door-to-door delivery and the assembly of a shopping list for conventional shopping are

supported. The system furthermore supports connections with storage systems that can automatically report low stock of certain goods (“intelligent fridge”), and it can be connected with a home automation infrastructure to enable reminders if the user has assembled a shopping list but forgotten to actually go shopping.

Narrative

The narrative use case text can be found here: R04: Shopping and Nutrition Planner.

Integration Profile

The integration profile related to this use case can be found here: Integration Profile 4: Shopping and Nutrition Planner.

2.3.3.3 Analysis of Use Cases for "Recreation"

The use cases related to Recreation have been analyzed with regard to the kind of activity supported, with the following results, ordered by decreasing frequency of occurrence:

Supported recreational activity	Description	Number of Use Cases
Virtual Communities	e.g. Facebook	24
Going outside	activities outside the home, e.g. hiking, biking, walking	18
Online Games	multi-player games	10
Events	support to participate to events	9
Entertainment	e.g. watching TV	8
Active Sports	e.g. jogging, fitness training	5
Music	e.g. listening to music, music-making	2
Vacation	support during vacations	1
Other hobbies	other hobbies not fitting in the other categories	1

A closer look at the most frequent topics shows that some of the topics are already covered by other use-cases and/or are suited not for the development of integration profiles. In detail these are:

- Virtual Communities: uses standard web technologies
- Going outside: see R05: Mobility Assistant
- Online Games: see R03: Social Interaction with Smart TV
- Events: various approaches starting from event planning (see R02: Calendar Service), navigation support or buying tickets (see R04: Shopping and Nutrition Planner)
- Entertainment: watching TV, see R03: Social Interaction with Smart TV for enhanced functions
- Active Sports: see R06: Personal Trainer

2.3.3.3.1 Representative Use Cases

For this reason a separate representative use case covering recreation is not formulated here.

2.3.4 Results related to the topic of AAL-JP Call 4: Mobility

This section describes the analysis of the use cases that are thematically related to the topic of AAL-JP Call 4, “Mobility” (note that the analysis is not limited to use cases developed by projects that were actually funded under AAL-JP Call 4.)

2.3.4.1 Clustering

As described in the outline for Chapter 2, the first step in the analysis is the selection and clustering of use cases for this topic. Out of the keywords that were used to describe each use cases, the following ones are related to chronic diseases. All of these keywords are related to the International Classification of Function

(ICF) and describe body functions that can be negatively affected by chronic diseases.

Keyword	Explanation	Number of Use Cases
#mobility	Mobility (ICF category d4)	4
#mobility:body_position_and_carrying	Changing and maintaining body position, Carrying, moving and handling objects (ICF category d410-d429 & d430-d449)	15
#mobility:walking	Walking and moving (ICF category d450-d469)	**37**
#mobility:transportation	Moving around using transportation (ICF category d470-d489)	**36**

The table clearly shows that there are two topics that are covered by the by far largest number of use cases: walking, and transportation. Both topics will be used for the further analysis process.

2.3.4.2 Analysis of Use Cases

The use cases related to mobility have been analysed with regard to the types of assistive function implemented by the imaginary AAL systems described in these use cases, with the following result, ordered by decreasing frequency of occurrence:

Assistive function	Description	Number of Use Cases
Environment/health aware / obstacle avoiding indoor/outdoor navigation	a system that guides the user through indoor and outdoor settings and takes the environment into account.	18
Communication between patients and healthcare professionals	a system that enables doctors / nurses and other healthcare professionals to communicate with the users from remote.	13
Health related information tracking by an EHR/PHR like system	a system that stores health information in a database. Most of the system including functions for shared access or visualization of the stored data.	10
Outdoor mobility assistant with “panic button”	Some kind of device (e.g. a walker) that helps the user to move from one place to another.	9
Guidance tool for autonomous physical training	a system that enables the user to perform a physical training (e.g. on a bicycle ergometer) by himself.	8
Finding people with similar interests	a system that helps someone to find someone else with similar interests or problems.	7
Social network for informal carers	a social network that is specialized on the needs of caregivers (e.g. relatives of a patient).	7
Calendar with reminders	system that reminds the user of appointments, activities of daily living, and medication	6
Notification of carers upon dangerous situations or falls	a system that contacts someone in the case of a dangerous situation (e.g. if the user goes out and the stove is still on).	6
Communication between patients and relatives	a system that enables patients and relatives to speak, read, see each other.	6
Physical Activity monitoring	a systems that tracks the physical activity of a person.	5
Fall detection	a system that without manual interaction detects falls in the apartment after which the user needs help, and raises alarm.	5
Computer aided test tools for physical and neurological impairments	a system that performs an assessment of different types (e.g. a questionnaire) to detect physical or neurological problems.	5
Serious games for physical training	games, which are used to motivate the user to perform physical activity.	5
Tool for smart/healthy teleshopping	a system that performs teleshopping in a way that supports healthy lifestyle or a certain diet.	5
Serious games for memory/biography	games, which are used to train the brain.	4

training		
Behavioral monitoring, i.e. recognition of ADLs	a system that monitors the behaviour of the user, recognises the activities of daily living (ADLs) and potentially dangerous situations and, if need be, informs carers or raises alarms.	4
Automated home automation	a system that uses actors and sensors of the home automation to support high level system functions (e.g. a stove that turns of, if the user left his home).	4
Recognition of dangerous situations	a system that detects dangerous situations (e.g. if the user left his home and the stove is still on).	3
Human supervised tele-training	a system that enables a human controlled training session (e.g. yoga with video support by a real trainer).	3
Tele-gaming for recreation purposes	all types of games, which are played by users without the idea to work on a specific health related problem (like in serious games).	3
Sensor-enhanced training devices	a mobile device, which is used to support a physical or mental training programme.	3
Contactless payment	a system that enables the user to pay for something without the need to use cash or a card that has to be inserted in some kind of device.	3
Indoor localization	a system that detects the position of a person inside of buildings.	2
Support for healthy cooking	a system that support the user to cook healthy / dietary meals.	2
Medication reminder/dispenser	a system that monitors the medicine taken from a dispenser and reminds the user if medicine is not taken in time.	2
2 Detection of displaced items	a system that localizes an item when the user lost it.	1
Pressure adapting compression stockings	stockings, which adapt their compression level.	1
Performing activities of daily living with the TV	a system that shows the user how to perform activities of daily living (e.g. put on clothes).	1
Robotic phone talks to the communication partner and physically come to the user		1
Information extraction based on communication monitoring	a system that derives information from the communication of its users (e.g. automatic calendar entry of appointments)	1
Remote controlled robots for human assistance / evaluation	a robot that is tele-controlled by somebody else.	1
Smart card /NFC to access public services		1
Autonomic driving car that interacts with voice communication		1
Ticket automaton adapts interface to the users (language, preferences) needs		1
NFC triggered manual for household devices	a system that displays / downloads a manual for one specific item in the household.	1
Hearing loss adapted sound system	speakers, which can be configured individually to change the sound to compensate hearing loss.	1
Wheelchair that detects obstacles and manipulates household objects	the wheelchair drives around objects (e.g. a bag that stands in its way) to reach a specific destination.	1
Wheelchair finds the right way on the basis of patient records in a hospital	the wheelchair brings patients from one place to another inside a hospital.	1
Automatic oxygen supply	a system that regulates the oxygen supply for a user accordingly	1

	to his current needs.	
Virtual / augmented cultural activities	a system that support people when they attend a cultural activity (e.g. reads information texts in a museum for blind people).	1

Not all of these assistive functions are suited for the development of integration profiles. Some systems can operate in a stand-alone manner and have little need for a standardisation of interfaces between system components:

- Communication between patients and relatives
- Finding people with similar interests
- Social network for informal carers
- Tool for smart/healthy teleshopping
- Tele-gaming for recreation purposes
- Calendar with reminders
- Automated home automation
- Sensor-enhanced training devices
- Support for healthy cooking
- Medication reminder/dispenser
- Pressure adapting compression stockings
- Performing activities of daily living with the TV
- Robotic phone talks to the communication partner and physically come to the user
- Information extraction based on communication monitoring
- Remote controlled robots for human assistance / evaluation
- NFC triggered manual for household devices
- Hearing loss adapted sound system
- Wheelchair that detects obstacles and manipulates household objects
- Automatic oxygen supply
- Virtual/augmented cultural activities

Closely linked themes for the two main system components:

Environment/health aware obstacle avoiding indoor/outdoor navigation:

- Outdoor mobility assistant with “panic button”
- Notification of carers upon dangerous situations or falls
- Fall detection
- Recognition of dangerous situations
- Contactless payment
- Indoor localization
- Detection of displaced items
- Autonomous driving car that interacts with voice communication
- Smart card /NFC to access public services
- Ticket automaton adapts interface to the users (language, preferences) needs
- Wheelchair finds the right way on the basis of patient records in a hospital

Communication between patients and healthcare professionals

- Health related information tracking by an EHR/PHR like system

- Guidance tool for autonomous physical training
- Computer aided test tools for physical and neurological impairments
- Physical Activity monitoring
- Serious games for physical training
- Serious games for memory/biography training
- Behavioral monitoring, i.e. recognition of ADLs
- Human supervised tele-training

The second scenario is partially already covered by the representative scenario 7 (Personal Trainer). For that reason, the following representative scenario focus to the functionality of the top topic "Environment/health aware obstacle avoiding indoor/outdoor navigation" and regards only a few components of the second component "Communication between patients and healthcare professionals".

2.3.4.3 Representative Use Cases

Below the following information is provided for each of the representative use cases derived from the use case analysis:

- a technical description of the use case
- a narrative scenario text (in IEC SG5 format)
- an integration profile derived from this use case.

2.3.4.3.1 Mobility Assistant

Technical Description

Many people with physical disabilities experience problems with mobility, which can make it difficult for them to live in disabled independence, get out and carry out everyday activities.

The core hardware of the system is a mobility assistant (e.g. a conventional walker) that is extended with sensors and actors. A computing unit (e.g. a smartphone) is combined with the assistant and linked with further wired or wireless sensors. These sensors are used to record vital signs (e.g. heart rate or blood pressure) and acceleration. The latter data is used to detect dangerous situations like falls. A GPS-sensor and / or an indoor localization system localize the position of the user. This information can be used in case of an emergency situation. If the system does not detect the dangerous situation by itself, the user can also press the panic button to request help though contacting an emergency contact system. The collected medical data can be also being sent to a personal health record which can share the information on the users' request (and with his permission) with the electronic health record in the professional domain (e.g. the doctor's office of the family doctor).

Narrative

The narrative use case text can be found here: Mobility Assistant.

Integration Profile

The integration profile related to this use case can be found here: Integration Profile 5: Mobility Assistant.

2.3.5 Results related to the topic of AAL-JP Call 5: (Self-) Management of Daily Life Activities at Home

This section describes the analysis of the use cases that are thematically related to the topic of AAL-JP Call 5, "(Self-)Management of Daily Life Activities at Home" (note that the analysis is not limited to use cases developed by projects that were actually funded under AAL-JP Call 5.)

2.3.5.1 Clustering

Out of the keywords that were used to describe each use cases, the following ones are related to the call topic "Self Management of Daily Life Activities at Home":

Keyword	Explanation	Number of Use Cases
#self_care	Self-care (ICF category d5)	0
#self_care:washing	Washing oneself (ICF category d510)	9
#self_care:toileting	Toileting (ICF category d530)	5
#self_care:dressing	Dressing (ICF category d540)	5
#self_care:eating	Eating (ICF category d550)	39
#self_care:drinking	Drinking (ICF category d560)	14
#self_care:looking_after_ones_health	Looking after one's health (ICF category d570)	**73**
#general_tasks:daily_routine	Carrying out daily routine (ICF category d230)	**82**

The table clearly shows that there are two topics that are covered by the by far largest number of use cases: looking_after_ones_health, and daily_routine. Both topics will be used for further analysis.

2.3.5.2 Analysis of Use Cases

The use cases related to mobility have been analysed with regard to the types of assistive function implemented by the imaginary AAL systems described in these use cases, with the following result, ordered by decreasing frequency of occurrence:

Assistive function	Description	Number of Use Cases
Communication between patients and relatives	a system that enables patients and relatives to speak, read, or see each other.	23
Health related information tracking through an EHR-like system	a system that stores health information in a database. Most of the system including functions for shared access or visualization of the stored data.	19
Medication reminder/dispenser	a system that monitors the medicine taken from a dispenser and reminds the user if medicine is not taken in time.	19
Guidance tool for autonomous physical training	a system that enables the user to perform a physical training (e.g. on a bicycle ergometer) by himself.	17
Calendar with reminders	a system that reminds the user of appointments, activities of daily living, and medication	17
Communication between patients and healthcare professionals	a system that enables doctors / nurses and other healthcare professionals to communicate with the users from remote.	16
Behavioral monitoring, i.e. recognition of ADLs	a system that monitors the behaviour of the user, recognises the activities of daily living (ADLs) and potentially dangerous situations and, if need be, informs carers or raises alarms.	13
Environment / health aware / obstacle avoiding indoor/outdoor navigation	a system that guides the user through indoor and outdoor settings and takes the environment into account.	12
Social network for informal carers	a social network that is specialized on the needs of caregivers (e.g. relatives of a patient).	12
Tool for smart/healthy teleshopping	a system that performs teleshopping in a way that supports healthy lifestyle or a certain diet.	12
Physical Activity monitoring	a systems that tracks the physical activity of a person.	11
Computer-aided support for carrying out activities of daily living	a system that performs an assessment of different types (e.g. a questionnaire) to detect physical or neurological problems.	11
Finding people with similar problems / interests	a system that helps someone to find someone else with similar interests or problems.	10
Serious games for memory/biography training	games, which are used to train the brain.	10

Serious games for physical training	games, which are used to motivate the user to perform physical activity.	9
Notification of carers upon dangerous situations or falls	a system that contacts someone in the case of a dangerous situation (e.g. if the user goes out and the stove is still on).	8
Automated home automation	a system that uses actors and sensors of the home automation to support high level system functions (e.g. a stove that turns of, if the user left his home).	7
Tele-gaming for recreation purposes	all types of games, which are played by users without the idea to work on a specific health related problem (like in serious games).	7
Robots for physical assistance / evaluation	a robot that performs or supports physical activities of the user.	5
Recognition of dangerous situations	a system that detects dangerous situations (e.g. if the user left his home and the stove is still on).	5
Outdoor mobility assistant with “panic button”	some kind of device (e.g. a walker) that helps the user to move from one place to another.	4
Support for (healthy) cooking	a system that support the user to cook healthy / dietary meals.	4
Fall detection	a system that without manual interaction detects falls in the apartment after which the user needs help, and raises alarm.	4
Human supervised teletraining	a system that enables a human controlled training session (e.g. yoga with video support by a real trainer).	4
Detection of displaced items	a system that localizes an item when the user lost it.	3
Information extraction based on communication monitoring	a system that derives information from the communication of its users (e.g. automatic calendar entry of appointments)	3
Guidance / Training for caregivers	a system that educates or supports caregivers in their care-related activities.	3
Smart access for public services	a system that enables the user to access a public service (e.g. purchasing a bus ticket) with compensation functions.	2
Intelligent Clothes measure vital signs	sensors in clothes measure vital parameters (e.g. heart rate).	2
Computer aided test tools for physical and neurological impairments	a system that performs an assessment of different types (e.g. a questionnaire) to detect physical or neurological problems.	2
Behaviour adapted Entertainment functions	a system control the entertainment depending on the current state of the user	1
Robot used to correct social behaviour	a robots is used to train a person social acceptable behaviour.	1
Virtual / augmented cultural activities	a system that support people when they attend a cultural activity (e.g. reads information texts in a museum for blind people).	1
Personalized information retrieval	a system retrieves information, which is individualized for the user	1
NFC triggered manual for household devices	a system that displays / downloads a manual for one specific item in the household.	1
Pressure adapting compression stockings	stockings, which adapt their compression level automatically.	1
Performing activities of daily living with the TV	a system that shows the user how to perform activities of daily living (e.g. put on clothes).	1
Robotic phone talks to the communication partner and physically come to the user		1
Sensor-enhanced training devices	a mobile device, which is used to support a physical or mental training programme.	1

Not all of these assistive functions are suited for the development of integration profiles. Some systems can operate in a stand-alone manner and have little need for a standardisation of interfaces between system

components:

- Communication between patients and relatives
- Calendar with reminders
- Social network for informal caregivers
- Tele-gaming for recreation purposes
- Behaviour adapted Entertainment functions
- Robot used to correct social behaviour
- Virtual / augmented cultural activities
- Personalized information retrieval
- NFC triggered manual for household devices
- Pressure adapting compression stockings
- Performing activities of daily living with the TV
- Robotic phone talks to the communication partner and physically comes to the user
- Sensor-enhanced training devices

Closely linked themes of the two main system components:

Health related information tracking through an EHR-like system:

- Guidance tool for autonomous physical training
- Communication between patients and healthcare professionals
- Environment / health aware / obstacle avoiding indoor/outdoor navigation
- Tool for smart/healthy teleshopping
- Physical Activity monitoring
- Finding people with similar problems / interests
- Serious games for memory/biography training
- Serious games for physical training
- Notification of caregiver upon dangerous situations or falls
- Automated home automation
- Outdoor mobility assistant with “panic button”
- Support for (healthy) cooking
- Fall detection
- Human supervised teletraining
- Information extraction based on communication monitoring
- Computer aided test tools for physical and neurological impairments

Medication reminder / dispenser

- Behavioral monitoring, i.e. recognition of ADLs
- Computer-aided support for carrying out activities of daily living
- Robots for physical assistance / evaluation
- Recognition of dangerous situations
- Detection of displaced items
- Guidance / Training for caregivers
- Intelligent Clothes measure vital signs

In summary, the most promising topics for the development of representative use cases and integration

profiles are “Health related information tracking through an EHR-like system” and “Medication reminder / dispenser”, extended with some of the closely linked assistive functions as optional functionality. The second scenario is already covered by the representative scenario 1. For that reason, the following representative scenario regards to the functionality of the top topic “Health related information tracking through an EHR-like system” and the associated top system components.

2.3.5.3 Representative Use Cases

Below the following information is provided for each of the representative use cases derived from the use case analysis:

- a technical description of the use case
- a narrative scenario text (in IEC SG5 format)
- an integration profile derived from this use case.

2.3.5.3.1 Personal Trainer

Technical Description

The system in this use case determines the amount of physical activity that is performed by the user, gives feedback, performs an individual training plan and gives concrete tips to improve the performance of specific activities.

The amount of physical activity is determined by a body activity sensor that is worn by the user. This device collects the raw sensor data and sends it to an activity determination, which can be implemented as a smart phone app. The user can use the smart phone to get feedback, but does not have to. The activity determination component sends the activity information to a personal health record (PHR), which collects this information, presents it to the user and is also able to share it with clinical IT-systems (Electronic Health Records) if the user wants to. The PHR can include a component which educates the user in the optimization of certain physical or household activities. The PHR is also used to import information from clinical IT-systems to parameterize training devices. A doctor can review the collected activity data as well as former training results and create individualized training plans.

The training / game devices (e.g. a bicycle ergometer or an interactive computer game which involves physical activity) can be used to perform an individualized physical training that is adapted to the needs of the user. Depending on the training modality the user can also wear a Body Area Sensor that records his vital signs which are used for the short-term adaptation of the training plan.

Narrative

The narrative use case text can be found here: Personal Trainer.

Integration Profile

The integration profile related to this use case can be found here: Integration Profile 6: Personal Trainer

2.3.6 Results related to the topic of AAL-JP Call 6: Occupation in Life

This section describes the analysis of the use cases that are thematically related to the topic of AAL-JP Call 6: Occupation in Life (note that the projects funded under AAL JP Call 6 have not started at the time of this analysis, the following results were extracted from AAL JP Call 1 to 5 and other sources).

2.3.6.1 Clustering

The first step in the analysis is the selection and clustering of use cases for this topic. Out of the keywords that were used to describe each use cases, the following ones are possibly related to occupation in life.

Keyword	Explanation	Number of Use Cases
#life_areas:work	Work and employment (ICF category d840-d859)	**69**
#work	use cases related to assistive technology at the workplace	3
#work:body_position	functions invoking the position of the body	1

#work:call_center	functions involving a call centre	0
#work:care	functions to support care work	3
#work:communication	communication functions	19
#work:employees_health	health functions for employees	5
#work:ergonomics	functions regarding to ergonomics	5
#work:error_detection	error detection functions	4
#work:fatigue	functions regarding fatigue	3
#work:handicraft	functions to support handicraft work	14
#work:home_office	systems supporting home office	8
#work:lighting	lighting functions	4
#work:mentoring	mentoring functions	7
#work:office	functions to support office work	4
#work:retired	functions to support retired people	22
#work:stress_handling	functions to support stress handling	5
#work:training	training functions for specific work areas	9
#work:voluntary	functions (typically) intended to support voluntary work	9
#work:workplace	the places where somebody works	10

In total 69 use cases were assigned to the keyword #life_areas:work and describe assisting work scenarios. All these use cases have more assigned keywords in the category #work.

Since there is a very wide scope of scenarios a first differentiation was conducted between the kind of work which is supported, which work activities are supported and the kind of technical support. These tables are already arranged in descending order.

2.3.6.1.1 Kind of Work: Handicraft vs. Office Work (Office, Home Office)

Kind of Work	Explanation	Number of Use Cases
Retired workers		22
Handicraft work		14
Office work		8
Voluntary work		7
Home office work		4
Care work		3

2.3.6.1.2 Supported work activities

Supported work activity	Explanation	Number of Use Cases
Training		9
Mentoring		7
Health		5
Stress handling		5
Error detection		4
Fatigue		3
Body Position		1

Communication Functions		19
Technical aids at workplace		10
Ergonomics		5
Lightning		4

2.3.6.2 Analysis of Use Cases

2.3.6.2.1 Retired workers and voluntary work

These use cases describe in majority social networks/virtual communities to let retired persons participate to the society. This is part of the Integration Profile Social Interaction with Smart TV and will not be analysed any more in this section.

2.3.6.2.2 Handicraft Work

Kind of support	Description	Number of Use Cases
Professional virtual community	e.g. a social network for experts	4
Environmental sensors	sensors similar used in home automation but with a more industrial background (air pollution, amount of particles in the air, gas sensors)	3
Environmental alarms	alarm notifications based on environmental sensors	3
Employees' health		2
Building automation actors	e.g. opening windows, activating air filters	2
Body area devices	e.g. smart watches or bracelets	2
Smart workstation		2
Lightning Adaption/ Seeing Aid		2
Tool/object recognition		2
Learning/virtual class room		2
Emergency alarms	based on vital signs	1
Exoskeletons		1
Mobile device	e.g. tablet	1
Assisting robot	not an industrial production robots	1
Ergonomics adaption		1
Communication functions		1

For handicraft work the most promising scenarios seem to be the support of employees' health by monitoring the environment and detection dangerous situations. This scenario might be enriched by body area devices and building automation actors. Furthermore, virtual professional networks have no specific need for standardisation.

2.3.6.2.3 Office work

The analysis of scenarios for office work and scenarios for home office work showed that the kind of assisting technologies are quite similar. For this reason both categories are subsumed under the keyword “Office work”.

Kind of support	Description	Number of Use Cases
Telepresence/avatars	displaying 3d models of persons and things to other places, e.g. for spatial distributed conferences	4
Video conferences		3

(Ambient) Calendar functions		3
Social networks/job portals		3
Gesture commands	controlling devices with hand movements	2
Biometrical identification		2
Ergonomics adaption		2
Handprint character recognition		1
Vital parameters		1
Fatigue detection		1
Body area device		1
Lightning adaption		1

2.3.6.2.4 Results

As an interim conclusion it can be stated that scenarios describing retired workers, voluntary work and office work have a quite large overlap with scenarios describing social interaction. For this reason a representative use case will be written describing a handicraft work scenario.

2.3.6.3 Representative Use Cases

Below the following information is provided for each of the representative use cases derived from the use case analysis:

- a technical description of the use case
- a narrative scenario text (in IEC SG5 format)
- an integration profile derived from this use case.

2.3.6.3.1 Environmental Health Monitoring and Alarms at Work

Technical Description

The representative use case scenario for occupation in life is an environmental health monitoring system for handicraft and industrial settings. Its scope is to monitor the working environment regarding dangerous situations like air pollution, gas leaks, etc. The stationary system is equipped with environmental sensors and home automation sensors (presence detection). Home automation actors for opening windows and doors are also part of the stationary system. All components are controlled via a home automation gateway. In a case of an emergency an alarm notification is sent to the workers' mobile devices (e.g. request to leave polluted area) and, in parallel, to a notification receiver (e.g. works fire service). The system is also able to open windows and doors in polluted areas to ensure fresh air supply.

The mobile part of the system consists of body area sensors for monitoring vital parameters (e.g. heart rate, pulse, depending on the work setting and the end-user) and a body area network to forward and receive messages. In an emergency case (heart attack, faint) the mobile system sends an alarm to the stationary system in order to guide the rescue team to the place of accident (e.g. light the way, opening doors). A second alarm message is sent to the notification receiver to start the rescue process.

The notification receiver can receive messages from the mobile and the stationary system and is able to monitor vital signs of the person and environmental parameters of the work place. The notification receiver can also start the rescue chain and sends an ambulance to the place of accident.

Narrative

The narrative use case text can be found here: Environmental Health Monitoring And Alarms At Work.

Integration Profile

The integration profile related to this use case can be found here: Integration Profile 7: Environmental Health Monitoring And Alarms At Work (Call 6).

2.4 Representative Use Cases

The following pages contain the “representative use cases” developed in this project as a result of the analysis of use cases described above. These use cases are the starting point for the integration profiles in chapter 4.

2.4.1 UC R01-01: Behaviour Monitoring

2.4.1.1 General

Name of Use Case				
ID	**Domain Role**	**Function**	**Name of Use Case**	
R01	Home	Complex Cross-function service control and support	Behaviour Monitoring	
Version Management				
Changes / Version	**Date**	**Name Author(s) or Committee**		**Approval Status draft, for comments, for voting, final**
01	2013-12-06	Marco Eichelberg		Draft
Basic Information to Use Case				
Source(s) / Literature	**Link**		**Conditions (limitations) of Use**	
AAL-JP Action on Standards and Interoperability - D2	Link		Freely available	
Maturity of Use Case (in business operation, realized in demonstration project, realized in R&D, in preparation, visionary …)				
Visionary				
Generic, Regional or National Relation				
Generic				
View				
Business				
Further Keywords for Classification				
#mental, #purpose:safety:fall_detection, #purpose:safety:disease_detection, #purpose:security, #key_enabling_technology:home_automation, #key_enabling_technology:ambient, #key_enabling_technology:body_area, #key_enabling_technology:vital_parameters, #key_enabling_technology:environmental_parameters, #localization:indoor				
Scope and Objectives of Use Case				
Daily life support: Dementia / cognitive impairment is a disease that often progresses slowly over many years. In order to maintain as much independence for the patient as possible, while preventing disease-related accidents, behaviour monitoring tries to identify the activities of the user at home, to provide warnings to the user in dangerous situations, or notifications to carers if indications of a progress of the disease are measured that indicate an increased need of support.				

2.4.1.2 Narrative of Use Case

Narrative of Use Case
Short Description
An older lady with mild cognitive impairment uses the system, which recognizes dangerous events and changes of

behaviour patterns and, depending on the type of event either notifies the user or calls for help.
Complete Description
Jane Miller is an 85-year old lady who still lives independently in her own apartment. Since her husband has passed away a few years ago she lives alone. Her children live some 50km away, close enough to see her once or twice a week, but not every day. Despite several chronic diseases that require her to take many different drugs three times a day, she is doing relatively well. However, recently she has started to forget things and make mistakes that were unheard of before. The family doctor has diagnosed her with a mild cognitive impairment, i.e. an early form of dementia that may or may not worsen over time. A few months ago she switched on the cooker, forgot about it, and went shopping. The cooker caused a fire in the kitchen that could well have burned down the house - fortunately it was discovered and extinguished quickly, before serious damage could occur. Since then her family is worried that a similar accident has happened, and with her consent had a “behaviour monitoring” system installed in her home. The system consists of several sensors that are mounted to the walls, and a small computer that processes the sensor data. Most of the time the system is silent, but it monitors her activities and notifies her if something that is potentially dangerous, happens. Last week she again started cooking, but since the water took rather long to boil, she went to the living room, switched on the TV, and forgot about the kitchen. 15 minutes later the system displayed a message on the TV reminding her of the cooking water. When she opens the front door in order to leave the house, the system reminds her if windows are still open, electrical appliances in the kitchen still switched on, etc. There is also a new switch next to the front door that allows her with one press to bring the house into a “safe” configuration, with everything switched off and electrical lighting reduced to a safe minimum. Should she ever fall at home, and not be able to get up, then the system would automatically notify an emergency call service, which would then first try to call her on the phone, and then send somebody to look after her. The system can be extended with some sensors worn on the body, in which case the fall detection would also work outside, but she prefers not to use this at the moment. Finally, the system recognizes when there are changes in her daily activity patterns that indicate an increased need for support, such as an overall reduction of physical activity, or lack of certain activities of life, such as cooking. In this case a notification would be sent to her daughter, who could then look for appropriate support.

2.4.1.3 Details

Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders			
Actor Name	Actor Type	Actor Description	Used Technology
Mrs. Smith	Primary user	Older adult with mild cognitive impairment	-
Daughter	Secondary user	Informal carer	-
Emergency Call Centre	Service provider	Call centre for emergencies at home	-
Behaviour monitoring system	System	The main AAL system described in this scenario	various
Sensors	System component	Various sensors: home automation, body area, location, optical, smart appliances	various
Actuators	System component	Home automation and smart appliances actuators that enable a safe “everything off” setting for the apartment	various
Issues: Legal Contracts, Legal Regulations, Constraints and others			
Issue - here specific ones	Impact of Issue on Use Case	Reference – law, standard, others	
Informed consent of user required	-	-	
Connections to emergency call centres	-	-	

may be affected by national regulations				
Referenced Standards and / or Standardization Committees (if available)				
Standard needed for	Standards have to be considered in the Use Case	Relevant Standardization Committees	Standard Status/ Current Version	Link to Standards Wiki
See related Integration Profile 1: Behaviour Monitoring integration profile.				
Relation with other known use cases				
Known use case	Source	UC Status		
The behaviour monitor can be coupled with use case R02: Calendar Service.	AAL-JP Action on Standards and Interoperability - D2	Draft		

2.4.1.4 General Remarks

none.

2.4.2 UC R02-01: Calendar Service

2.4.2.1 General

Name of Use Case				
ID	**Domain Role**	**Function**	**Name of Use Case**	
R02	Home	Complex Cross-function service control and support	Calendar Service	
Version Management				
Changes / Version	**Date**	**Name Author(s) or Committee**		**Approval Status draft, for comments, for voting, final**
01	2013-12-06	Marco Eichelberg		Draft
Basic Information to Use Case				
Source(s) / Literature	**Link**		**Conditions (limitations) of Use**	
AAL-JP Action on Standards and Interoperability - D2	Link		Freely available	
Maturity of Use Case (in business operation, realized in demonstration project, realised in R&D, in preparation, visionary …)				
Visionary				
Generic, Regional or National Relation				
Generic				
View				
Business				
Further Keywords for Classification				
#general_tasks:daily_routine, #self_care, #domestic_life, #community, #key_enabling_technology:environmental_parameters, #key_enabling_technology:medication_dispenser				
Scope and Objectives of Use Case				

Daily life support: The Calendar Service is a system that is mostly intended for older adults with a cognitive impairment. The Calendar Service system acts as an “intelligent” calendar that reminds the user of appointments, notifies the user if certain activities of daily living are forgotten, and reminds the user of the medicine that is to be taken. Furthermore, the system monitors Web resources maintaining community event calendars and, based on a profile indicating the preferences of the users, creates suggestions for events the user might be interested in. The system also retrieves a weather forecast and suggests outdoor activities if the weather conditions are OK. The system can optionally be coupled with a medication dispenser.

2.4.2.2 Narrative of Use Case

Narrative of Use Case
An older lady with mild cognitive impairment uses the system, which reminds her of appointments, reminds her to taker her medication, and, if needed, reminds her of activities of daily living she has forgotten. The system furthermore tries to keep her active by suggesting outdoor activities such as walks or community events. If she does not take her medicine over a longer time despite the reminders, a carer is notified.
Complete Description
Jane Miller is an 85-year old lady who still lives independently in her own apartment. Since her husband has passed away a few years ago she lives alone. Her children live some 50km away, close enough to see her once or twice a week, but not every day. She has recently been diagnosed with a mild cognitive impairment, i.e. an early form of dementia that may or may not worsen over time. Since she tends to forget things, such as taking her medicine, and because she knows that maintaining social and physical activity is important to keep her independent as long as possible, she has agreed with her family to have a calendar service system installed in her home. The calendar service regularly scans the internet for community events in her city that she might be interested in and suggests these to her. If she agrees, a reminder is automatically added to her calendar. The system also retrieves the weather forecast and, if there is good weather, suggest to her to take a walk outside if she has not left her home for too long. Perhaps most importantly, the system reminds her to take her medicine three times a day. The system is coupled with a drug dispenser that is filled every week by her daughter, and a reminder is generated by the calendar whenever she forgets to take the next box of pills out of the dispenser when it's time. Should she still forget to take her medicine despite the reminders, a notification would be sent to her daughter after two days, who could then see what the problem is. The events on her personal calendar are kept in “the cloud” - in her case, on Google calendar, so that also her daughter can create entries and reminders there. Finally, since she also has a “behaviour monitor” installed in her home, that system is coupled with the calendar and notifies the calendar service about the activities of daily living (such as the morning toilet, bathing, cooking, eating etc.) that were recognized by the system. Should her mental impairment worsen to an early form of dementia, the system would also remind her of activities of daily living she might have forgotten (such as brushing her teeth, opening the windows from time to time to let in fresh air, or simply the fact that it's time for the next meal). Fortunately, she does not need this functionality yet, but she understands that this will make it possible for her to live at home independently for a longer time than without this technology, should her condition worsen.

2.4.2.3 Details

Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders			
Actor Name	Actor Type	Actor Description	Used Technology
Mrs. Smith	Primary user	Older adult with mild cognitive impairment	-
Daughter	Secondary user	Informal carer	-
Calendar service	System	The main AAL system described in this scenario	various
Medication dispenser	System component	Medication dispenser that notifies the calendar service if medicine has been taken out of the dispenser	-
Weather service	External system	Web resource where	-

		the current whether forecast can be queried		
Events calendar	External system	Web resource where local community events can be queried	-	
Issues: Legal Contracts, Legal Regulations, Constraints and others				
Issue - here specific ones	Impact of Issue on Use Case	Reference – law, standard, others		
Informed consent of user required	-	-		
Referenced Standards and / or Standardization Committees (if available)				
Standard needed for	Standards have to be considered in the Use Case	Relevant Standardization Committees	Standard Status/ Current Version	Link to Standards Wiki
See related Integration Profile 2: Calendar Service integration profile.				
Relation with other known use cases				
Known use case	Source	UC Status		
The calendar service can be coupled with use case R01: Behaviour Monitoring.	AAL-JP Action on Standards and Interoperability - D2	Draft		

2.4.2.4 General Remarks

none.

2.4.3 UC R03-01: Social Interaction with Smart TV

2.4.3.1 General

Name of Use Case				
ID	**Domain Role**	**Function**	**Name of Use Case**	
R03	Home	Complex Cross-function service control and support	Social Interaction with Smart TV	
Version Management				
Changes / Version	**Date**	**Name Author(s) or Committee**		**Approval Status draft, for comments, for voting, final**
01	2013-12-01	Lars Rölker-Denker		Draft
Basic Information to Use Case				
Source(s) / Literature	**Link**		**Conditions (limitations) of Use**	
AAL-JP Action on Standards and Interoperability - D2	Link		Freely available	
Maturity of Use Case (in business operation, realized in demonstration project, realised in R&D, in preparation, visionary …)				
Visionary				

Generic, Regional or National Relation
Generic
View
Business
Further Keywords for Classification
#human_communication, #key_enabling_technology:communication_functions
Scope and Objectives of Use Case
Assistive technology can help older adults to stay in contact with friends, family and carers despite limited mobility by offering advanced communication functions such as easy-to-use video telephony. Smart TVs and smart phones /tables are devices that are well suited to this type of application.

2.4.3.2 Narrative of Use Case

Narrative of Use Case
Short Description
An older adult uses a smart TV and a smartphone as communication device to stay in contact with family, friends, carers and medical doctors.
Complete Description
Peter is an 83 year old person living in the suburbs of a big German city. His wife died 4 years ago and his son Michael has moved to another city about 200 km away. He is suffering from lung cancer, frailty and is not good on feet anymore. In the past he never got used to computers and mobiles but since the new generation of smartphones and tablets with touch screen have been available, he is more keen on technology. In addition he owns a new smart TV with some additional functions like video conferencing, internet browsing and online gaming. His smart phone is connected to the TV and can be used as remote control, game controller but also has a “panic button app” installed, which he can use in emergency situations inside and outside his home. A nursing service nearby is hosting this service. Peter loves to use video conferencing in the evening to chat with his son Michael and his wife Julia as well with his three grandchildren. Sometimes he calls his good friend Horst who has moved to Spain, and they talk about the good old times or play cards. Today Peter has a video call with his general practitioner to talk about his latest lab results. Since there is no need for any other examination they both agreed on this video call. After the call Peter decides to buy some food in the supermarket up the road. He picks up his walker and uses the elevator. As the weather is very good today, he takes the route through the park. While he is walking along the little lake he is feeling dizzy and he decides to take a rest on his walker. He takes out his smart phone and presses the panic button. After a few seconds a carer responds his emergency call. As the smart phone has a localisation application installed, the carer can see where Peter is and speaks to him. Since Peter is complaining of dizziness and seems to start panicking, the carer sends out an ambulance to pick him up. As he is already feeling better by the time the ambulance arrives, they bring him back home. With the help of his smart TV he orders his food from the supermarket's shopping service. In the evening Peter calls his son Michael and tells him about the incident in the morning. Michael decides to give his father a visit at the weekend.

2.4.3.3 Details

Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders			
Actor Name	Actor Type	Actor Description	Used Technology
Peter	Primary user	Older adult	smart TV, smart phone
Michael	Secondary user	Informal carer / relative	-
Horst	Secondary user	Friend	-
Emergency Call Centre	Service provider	Call centre for emergencies when mobile	-
Smart TV	System	First AAL system described in this scenario	-

Smart phone	System	Second AAL system described in this scenario	-	
Issues: Legal Contracts, Legal Regulations, Constraints and others				
Issue - here specific ones	Impact of Issue on Use Case	Reference – law, standard, others		
Connections to emergency call centres may be affected by national regulations	-	-		
Referenced Standards and / or Standardization Committees (if available)				
Standard needed for	Standards have to be considered in the Use Case	Relevant Standardization Committees	Standard Status/ Current Version	Link to Standards Wiki
See related Integration Profile 3: Social Interaction with Smart TV integration profile.				
Relation with other known use cases				
Known use case	Source	UC Status		
The transmission of an emergency notification to a notification receiver (such as a call centre) is a function appearing in multiple use cases, such as Behaviour Monitoring.	AAL-JP Action on Standards and Interoperability - D2	Draft		

2.4.3.4 General Remarks

none.

2.4.4 UC R04-01: Shopping and Nutrition Planner

2.4.4.1 General

Name of Use Case				
ID	**Domain Role**	**Function**	**Name of Use Case**	
R04	Home	Complex Cross-function service control and support	Shopping and Nutrition Planner	
Version Management				
Changes / Version	**Date**	**Name Author(s) or Committee**		**Approval Status draft, for comments, for voting, final**
01	2014-01-06	Lars Rölker-Denker		Draft
Basic Information to Use Case				
Source(s) / Literature	**Link**		**Conditions (limitations) of Use**	
AAL-JP Action on Standards and Interoperability - D2	Link		Freely available	
Maturity of Use Case (in business operation, realized in demonstration project, realised in R&D, in preparation, visionary …)				

Visionary
Generic, Regional or National Relation
Generic
View
Business
Further Keywords for Classification
#domestic_life:shopping, #key_enabling_technology:home_automation, #key_enabling_technology:mobile_devices
Scope and Objectives of Use Case
Shopping is one of the activities where the transformation of the industrialized countries into “self-service societies” can be felt most. Supermarkets with relatively small staff and little human support for older customers are the norm, not the exception today. However, the ability to purchase one's goods for daily living are an important aspect of participation and independence for older adults, and, furthermore, a typical outdoor activity that is important to keep people active and mobile. Malnutrition and dehydration are frequent problems in older adults, so any assistive system for shopping purposes should also be able to support and advise the user to buy food adapted to the user's personal health situation. Finally, not all goods may be available in shops sufficiently close for a walk, and some goods (e.g. drinks) may be too heavy. Therefore, shopping service with door-to-door delivery should also be supported. The Shopping and Nutrition Planner is an assistive system for nutrition planning and shopping. Both “home shopping” with door-to-door delivery and the assembly of a shopping list for conventional shopping are supported. The system furthermore supports connections with storage systems that can automatically report low stock of certain goods (“intelligent fridge”), and it can be connected with a home automation infrastructure to enable reminders if the user has assembled a shopping list but forgotten to actually go shopping.

2.4.4.2 Narrative of Use Case

Narrative of Use Case
Short Description
An older adult uses an assistive system comprised of a shopping planner, online ordering, and a mobile shopping assistant for conventional shopping.
Complete Description
Michael is 72 years old, lives on his own and suffers from mild cognitive impairment (MCI). Due to MCI he often has problems with healthy nutrition and related shopping tasks. A few weeks ago his son Klaus installed the new shopping assistant on Michael’s smart TV and mobile phone. The shopping assistant can be used for home shopping as well as for the assistance of normal shopping. There are also some upgrades available, one is on malnutrition and one with reminder functions. Michael is able to plan his shopping trip with the smart TV sitting on the couch or with his smart phone at any place. The shopping assistant recommends more fruits for Michael and put some apples and bananas on his shopping list. The system also knows that the stock of sparkling water is running out. As Michael is not able to carry heavy beverage crates any more the system sends an automated order to the next beverage store. As Michael is not leaving his home (a door contact is monitoring the front door) the shopping assistant reminds him for his shopping trip. Michael leaves his home and the shopping assistant on standby to navigate if Michael is leaving his normal route for a longer period of time. In case of bad weather or feeling discomfort Michael can use the home shopping application out of his living room. The home shopping application includes several regional providers of food, clothes and other articles of daily use. Michael places his order in the system and, depending on time of the day, up to 6 hours the items are delivered.

2.4.4.3 Details

Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders			
Actor Name	Actor Type	Actor Description	Used Technology
Michael	Primary user	Older adult with mild cognitive impairment	-
Klaus	Secondary user	Informal carer	-
Beverage store	Service provider	Delivery service	-

		accepting online orders		
Shopping assistant	System	The main AAL system described in this scenario	-	
Smart TV	System component	Runtime platform for the planning component of the shopping assistant	-	
Smartphone	System component	Runtime platform for the mobile component (navigation and electronic shopping list) of the shopping assistant	-	
Door contact	System component	Home automation sensor	-	
Issues: Legal Contracts, Legal Regulations, Constraints and others				
Issue - here specific ones	Impact of Issue on Use Case	Reference – law, standard, others		
-	-	-		
Referenced Standards and / or Standardization Committees (if available)				
Standard needed for	Standards have to be considered in the Use Case	Relevant Standardization Committees	Standard Status/ Current Version	Link to Standards Wiki
See related Integration Profile 4: Shopping and Nutrition Planner integration profile.				
Relation with other known use cases				
Known use case	Source	UC Status		
The navigation function of the shopping assistant is described in R05: Mobility Assistant.	AAL-JP Action on Standards and Interoperability - D2	Draft		

2.4.4.4 General Remarks

none.

2.4.5 UC R05-01: Mobility

2.4.5.1 General

Name of Use Case				
ID	**Domain Role**	**Function**	**Name of Use Case**	
R05	Home	Complex Cross-function service control and support	Mobility Assistant	
Version Management				
Changes / Version	**Date**	**Name Author(s) or Committee**		**Approval Status draft, for comments, for voting, final**
01	2013-12-18	Axel Helmer		Draft

Basic Information to Use Case		
Source(s) / Literature	**Link**	**Conditions (limitations) of Use**
AAL-JP Action on Standards and Interoperability - D2	Link	Freely available
Maturity of Use Case (in business operation, realized in demonstration project, realised in R&D, in preparation, visionary …)		
Visionary		
Generic, Regional or National Relation		
Generic		
View		
Business		
Further Keywords for Classification		
#vital:cardiovascular; #neuromusculoskeletal:movement; #neuromusculoskeletal:muscle; #mobility:walking; #stakeholder:primary; #stakeholder:secondary:relatives; #stakeholder:secondary:doctors; #stakeholder:secondary:emergency_call_services		
Scope and Objectives of Use Case		
Maintain mobility: amyotrophia and cardiovascular weakness / diseases are big challenges, which leading to a feeling of insecurity that can prevent older people to be physically active. They reduce their mobility and thereby often decrease their quality of life and increase their need for help. A mobility assistant enables elderly people to preserve their mobility and can reduce the feeling of insecurity.		

2.4.5.2 Narrative of Use Case

Narrative of Use Case
Short Description
An older lady stays mobile with the help of a mobility assistant that is also able to detect emergencies and call for help. Her activity data can be stored and transmitted to her physician.
Complete Description
Clara is a very active person. She uses her free time for long walks in the “hood” like it’s been called by her grandchildren. She loves these excursions, because they make her feel strong and independent even though she uses her beloved walker. Although the nice Doctor Hibbert told her that walking is very healthy and that she should walk as long as she likes. To view the change of the seasons had always been fascinating her. But in this year’s autumn as leafs changed their colours she forgot to drink enough before her walk and became a little disoriented and also felt a weakness in her legs. She began to ask herself what would happen if she would have slipped and fell so far away from home. Clara discusses her concerns with her son-in-law Jerry. He is in the computer business and tells her about a new device that she can use to “update” her current walker. Jerry explains that this convenient “mobility assistant” can be easily attached to her walker. The device shows a big red button which she can press if something happens and that she will get help immediately. Clara thinks that this is a nice and easy to use thing, but normally she has a sharp mind and is not like other “old” people who forget everything. So she tells Jerry that this button is ok, but it won’t help her, if she would be unconscious and could not get up to press it. Jerry smiles as if he anticipated her thought. He tells her that this special assistant has the ability to detect dangerous situations and would call an emergency contact immediately. Even more, this small thing is also able to record vital parameters like the machines in Doctor Hibbert’s office. Clara is impressed but also a little bit sceptical how Doctor Hibbert would know about this information, when she is not in her office. Although she is an independent person who does not want that the Doctor sees all of her medical information without asking her. Jerry tells her that she is absolutely right to have her privacy whenever she wants. He explains to her that the assistant would communicate this medical information only to a thing called “Personal Health Record” which is like a safe for her data. Only, if she decides to show some of her data to Doctor Hibbert this thing would transfer it to him. She even can control it with her old but well-known TV remote control. Clara is convinced and curious about this new thing. She rejects Jerry’s offer to bring her to the store happily, as she wants to walk there by herself.

2.4.5.3 Details

Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders				
Actor Name	Actor Type	Actor Description	Used Technology	
Clara	Primary user	Older adult with increasing mobility issues	-	
Son in law	Secondary user	Informal carer	-	
Doctor Hibbert	Secondary user	Doctor	-	
Emergency Call Centre	Service provider	Call centre for emergencies at home	-	
Mobility Assistant	System	The main AAL system described in this scenario	various	
Sensors	System component	Various sensors: Vital parameter sensor, Indoor localization sensor, Panic button	various	
PHR	System	Personal Health Record (PHR) stores health related information in a non-professional setting and offers the opportunity to share this information with other systems and persons	various	
EHR	System	Electronic Health Record (EHR) stores health related information in a professional setting and offers the opportunity to share this information with other systems and persons	various	
Issues: Legal Contracts, Legal Regulations, Constraints and others				
Issue - here specific ones	Impact of Issue on Use Case	Reference – law, standard, others		
Informed consent of user required	-	-		
Connections to emergency call centres may be affected by national regulations	-	-		
Referenced Standards and / or Standardization Committees (if available)				
Standard needed for	Standards have to be considered in the Use Case	Relevant Standardization Committees	Standard Status/ Current Version	Link to Standards Wiki
See related Integration Profile 5: Mobility Assistant integration profile.				
Relation with other known use cases				

Known use case	Source	UC Status
The mobility assistant can be coupled with use case R06: Personal Trainer.	AAL-JP Action on Standards and Interoperability - D2	Draft

2.4.5.4 General Remarks

none.

2.4.6 UC R06-01: Personal Trainer

2.4.6.1 General

Name of Use Case				
ID	**Domain Role**	**Function**	**Name of Use Case**	
R06	Home	Complex Cross-function service control and support	Personal Trainer	
Version Management				
Changes / Version	**Date**	**Name Author(s) or Committee**		**Approval Status draft, for comments, for voting, final**
01	2013-12-20	Axel Helmer		Draft
Basic Information to Use Case				
Source(s) / Literature	**Link**		**Conditions (limitations) of Use**	
AAL-JP Action on Standards and Interoperability - D2	Link		Freely available	
Maturity of Use Case (in business operation, realized in demonstration project, realised in R&D, in preparation, visionary …)				
Visionary				
Generic, Regional or National Relation				
Generic				
View				
Business				
Further Keywords for Classification				
#vital:cardiovascular; #vital:respiratory; #neuromusculoskeletal:muscle; #neuromusculoskeletal:movement; #learning; #general_tasks:daily_routine; #mobility:walking; #self_care:dressing; #self_care:washing; #self_care:looking_after_ones_health; #domestic_life:household_tasks; #life_areas:education; #stakeholder:primary; #stakeholder:secondary:relatives; #stakeholder:secondary:relatives; #stakeholder:secondary:doctors; #purpose:safety:fall_prevention; #purpose:safety:disease_prevention; #purpose:safety:disease_rehabilitation; #key_enabling_technology:mobile_devices; #key_enabling_technology:communication_functions; #key_enabling_technology:telemedicine; #key_enabling_technology:health_information;				
Scope and Objectives of Use Case				
Maintain or recover the physical performance of ADLs: amyotrophia and cardiovascular weakness / diseases are big challenges, which leading to fragility and the reduction of physical activities. The system tracks the physical activity of the user and combines it with medical information to create a personalized training plan and to show learning media like video tutorials to the user.				

2.4.6.2 Narrative of Use Case

Narrative of Use Case
Short Description
An older lady becomes more certain and secure in the performance of ADLs with a personalized workout and training program.
Complete Description
Frieda has become a little fragile in the last years. She feels that it is harder to be really active during the day. Many household activities slowly became a big burden for her. Her Doctor said that she should continue her activities as long as she can. So, the doctor gave her a little device that she wears on her wrist and that tracks her physical activity. Her Doctor also gave her a small box which is connected to her TV. She doesn't know anything about this technical stuff, but her son Hubert installed the box for her. Hubert told her that the box helps her to get help whenever she needs it. The box also shows her videos with little tricks which she can apply to simplify the performance of household activities and her activities of daily living (e.g. dressing herself). It also suggested special workout training. She already bought herself a bicycle ergometer which she can now use to drive her personal training plan. Also, the box plays some small games with her, which is exhausting but fun. She tried this stuff a few months and soon she realized that she became fitter and even more secure when she performs her daily activities.

2.4.6.3 Details

Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders				
Actor Name	Actor Type	Actor Description	Used Technology	
Frieda	Primary user	Older fragile adult.	-	
Son: Hubert	Secondary user	Informal carer	-	
Doctor	Secondary user	Doctor	-	
Body Activity Sensor	System component	Collects sensor Data for activity determination purposes	Various sensors: Body temperature, Accelerometer, GPS	
Activity Determination	System component	Combines sensor data to determine the activity (e.g. in kilo joule).	various	
PHR	System	Personal Health Record (PHR) stores health related information in a non-professional setting and offers the opportunity to share this information with other systems and persons	various	
EHR	System	Electronic Health Record (EHR) stores health related information in a professional setting and offers the opportunity to share this information with other systems and	various	

		persons			
Training / Game Device	System	Devices that support the physical training of the user	various		
Body Area Sensor	System component	Sensor to catch vital parameters during a physical training session.	various		
Issues: Legal Contracts, Legal Regulations, Constraints and others					
Issue - here specific ones	Impact of Issue on Use Case	Reference – law, standard, others			
Informed consent of user required	-	-			
Referenced Standards and / or Standardization Committees (if available)					
Standard needed for	Standards have to be considered in the Use Case	Relevant Standardization Committees	Standard Status/ Current Version	Link to Standards Wiki	
See related Integration Profile 6: Personal Trainer integration profile.					
Relation with other known use cases					
Known use case	Source	UC Status			
The personal trainer can be coupled with use case R05: Mobility Assistant.	AAL-JP Action on Standards and Interoperability - D2	Draft			

2.4.6.4 General Remarks

none.

2.4.7 UC R07-01: Environmental Health Monitoring And Alarms At Work

2.4.7.1 General

Name of Use Case				
ID	**Domain Role**	**Function**	**Name of Use Case**	
R07	Public buildings	Complex Cross-function service control and support	Environmental Health Monitoring And Alarms At Work	
Version Management				
Changes / Version	**Date**	**Name Author(s) or Committee**		**Approval Status draft, for comments, for voting, final**
01	2014-01-23	Lars Rölker-Denker		Draft
Basic Information to Use Case				
Source(s) / Literature	**Link**		**Conditions (limitations) of Use**	
AAL-JP Action on Standards and Interoperability - D2	Link		Freely available	

Maturity of Use Case (in business operation, realized in demonstration project, realised in R&D, in preparation, visionary …)
Visionary
Generic, Regional or National Relation
Generic
View
Business
Further Keywords for Classification
#life_areas:work; #work:employees_health; #work:handicraft; #work:workplace; #purpose:safety:alert_communication; #purpose:safety:alert_detection; #key_enabling_technology:ambient; #key_enabling_technology:body_area; #key_enabling_technology:environmental_parameters; #key_enabling_technology:home_automation; #key_enabling_technology:mobile_devices; #key_enabling_technology:telemedicine; #key_enabling_technology:vital_parameters; #localization:indoor
Scope and Objectives of Use Case
Dangerous situations in industrial work settings occur through environmental factors like air pollution and workers' health incidents. For this reason the representative use cases introduces a system that monitors the workers' environment and also the workers' health. The system can react to emergency situation occurring and can calls help if needed.

2.4.7.2 Narrative of Use Case

Narrative of Use Case
Short Description
An industrial company uses environmental sensors and home automation sensors/actors to monitor the workplaces of the employees and detect dangerous situation (air pollution, gas leak). The employees carry a mobile device, their vital parameters are monitored and in a case of emergency, notification messages are sent to a rescue unit.
Complete Description
Manuel works auxiliary industries for a medium size paint shop producing parts for the automotive industry. He is responsible for clamping and releasing parts from the fixation for the powder coating machine. As he just working on another part the red lights begins to flash and a siren signal occurs. One second later his mobile emergency device which is mounted to his belt also begins to vibrating and beeping. The environmental sensors have detected a dangerous concentration of air pollution in his area. Despite his protection clothing and mask he immediately leaves the polluted area. Doors and windows are automatically opened to release the polluted air. Manuel waits in the break room until the dangerous situation is over. He suddenly feels dizzy and his sensor vest with an integrated ECG detects ventricular fibrillation. Since Manuel had myocardial infarction (vulg. heart attack) in the past, he is additionally equipped with this device. His mobile emergency device immediately sends an alarm message to the work fire service including Manuel’s current location. They soon arrive to the break room and give first aid until the emergency physician arrives.

2.4.7.3 Details

Actors: People, Systems, Applications, Databases, the Power System, and Other Stakeholders			
Actor Name	Actor Type	Actor Description	Used Technology
Manuel	Primary user	Industrial worker	Mobile emergency device, sensors
Work fire service	Notification receiver	Responsible for firefighting, hazardous goods handling and first aid	-
Emergency doctor	Notification receiver	Responsible for emergency care	-
Mobile emergency device	Mobile system	Processes BAN parameters, sends and	-

		receives notifications, tracks current position of user		
BAN gateway	Mobile system component	Forwards BAN parameters to mobile emergency device	sensors, mobile system	
Sensor vest	Mobile system component	Collects vital parameters	mobile system component	
Home Automation Gateway	System	collects and processes data from sensors (home automation, environmental), sends and receives alarm notifications	various	
Sensors	System Component	Various sensors: home automation, environmental, location, optical, smart appliances	various	
Actors	System Component	Home automation and smart appliances actuators that enable a safe “everything off” setting for the apartment	various	
Issues: Legal Contracts, Legal Regulations, Constraints and others				
Issue - here specific ones	Impact of Issue on Use Case	Reference – law, standard, others		
Connections to emergency call centres may be affected by national regulations	-	-		
Usage of sensor vest with ECG may be affected by national medical devices regulations	-	-		
Referenced Standards and / or Standardization Committees (if available)				
Standard needed for	Standards have to be considered in the Use Case	Relevant Standardization Committees	Standard Status/ Current Version	Link to Standards Wiki
See related Integration Profile 7: Environmental Health Monitoring And Alarms At Work integration profile.				
Relation with other known use cases				
Known use case	Source	UC Status		
The transmission of an emergency notification to a notification receiver (such as a call centre) is a function appearing in multiple use cases, such as Behaviour Monitoring.	AAL-JP Action on Standards and Interoperability - D2	Draft		

2.4.7.4 General Remarks

none.

3 Process of Defining Integration Profiles

3.1 Defining Integration Profiles

In the second phase, the most important storyboard / use-case will be selected for each of the six categories, and a semi-formal description showing systems and system components (“actors”) and interactions between these components (“transactions”) will be derived. The idea is to only identify components based on a specific function that they contribute to the overall system, components that could be implemented as a separate product (software or hardware). The internal functionality (e. g. algorithms, user interface concept) of an actor is not considered in an integration profile – an actor is considered as a “black box”, only the interfaces of which are defined.

While in the eHealth sector this concept has been used with much success for the last 15 years, one significant difference of AAL is that no established product base exists in the AAL market. For example, the boundaries of an actor in one of the IHE integration profiles typically follows established product categories: An IHE “Admission/Discharge/Transfer” actor is typically a functionality offered by Hospital Information Systems, an IHE “Order Filler” actor is typically identical to a departmental information system such as a Radiology Information System, and an IHE “Image Manager” is typically the archive component of a PACS (picture archiving and communications system). In contrast, in AAL it is not yet completely clear where the boundaries of products and product components will be. As an example: Will sensors such as presence detectors or temperature sensors be implemented as simple components transmitting their measurements over an analogue line or simple protocol (e.g. Bluetooth serial port profile), or will there be a computing node combined with each sensor, such that each sensor becomes an intelligent “node” in a partly or fully distributed sensor network? The Continua Design Guidelines [Con2012] are based on the first approach and the universAAL middleware system [HMH+2011] on the second one. This is a decision that needs to be taken for the definition of an integration profile, and, therefore, will necessarily reduce implementation choice. For the integration profiles to be developed during this action, both approaches will be worked out as alternative options of the integration profile.

Another design decision that needs to be made is the kind of formalism used to describe actors and transactions, where two related, but not identical concepts are available: The IHE actor/transaction diagram (Fig. 1), and the RAALI function block diagram (Fig. 2).

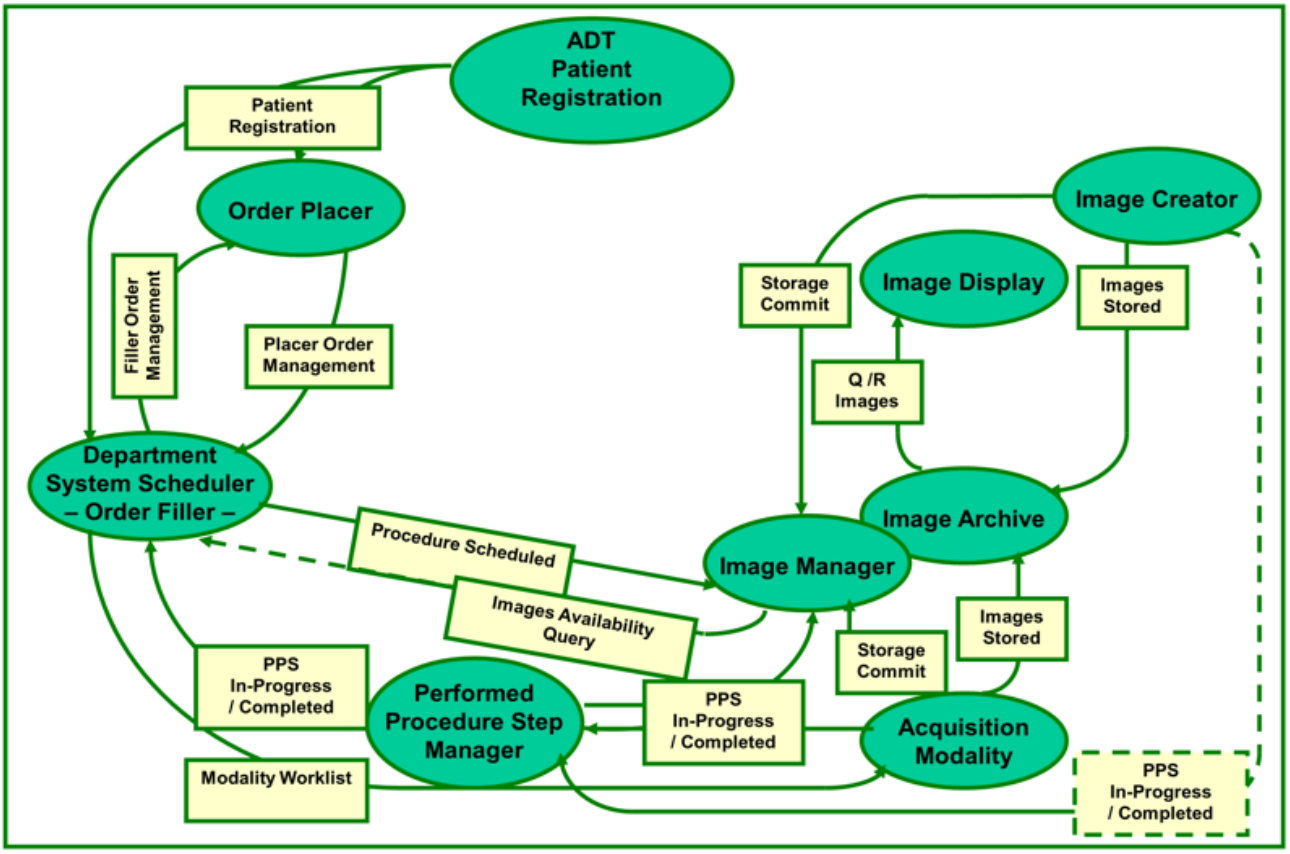


Figure 1: IHE-Style Actor/Transaction Diagram (Source: IHE Radiology Technical Framework)

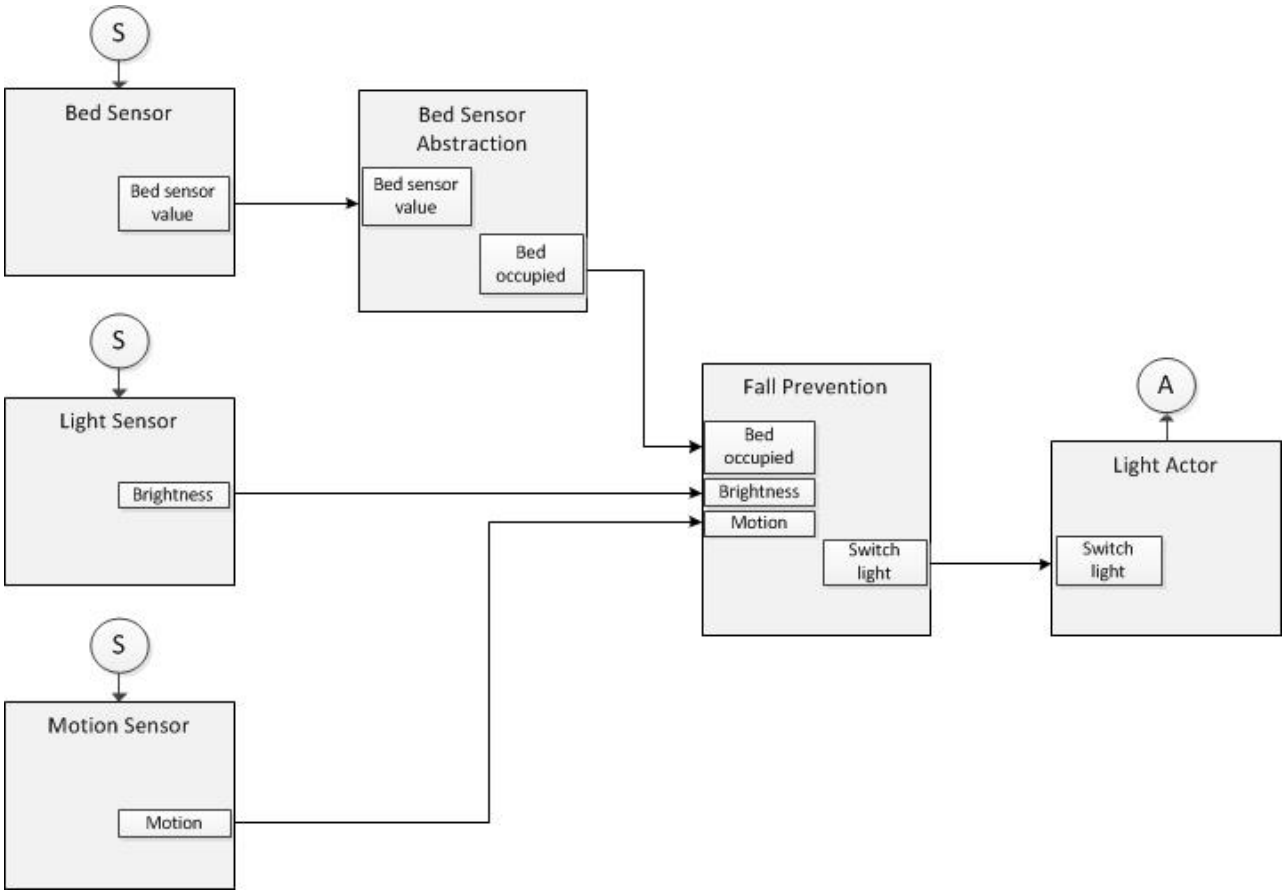


Figure 2: RAALI-Style Function Block Diagram (Source: RAALI Project [WBK+2013])

In the IHE diagram, each “actor” is represented by an oval labelled with the actor name. Transactions are represented by arrows labelled with the transaction name. The RAALI diagram, which is derived from IEC 61131-3 and IEC 61499-1, two standards frequently used in the building automation domain, distinguishes input interfaces (shown on the left-hand side of an actor) and output interfaces (shown on the right-hand side of an actor). The interfaces/transactions (arrows) as such are unlabelled, but the label essentially derives from the names of the input/output interfaces it connects. Physical input (sensor data) and physical output (actors) are annotated as circles showing (S) or (A), respectively. Unlike the IHE diagram type, the RAALI diagram can also represent analogue interfaces where a continuous delivery of values takes place, while IHE implicitly assumes event-driven message-based digital communication. RAALI also foresees a graphical concept for hierarchically combining several actors (“function blocks”) into a “superblock” where only inputs and outputs of the superblock remain visible.

In summary, the differences between the diagram types are rather small. The IHE type is arguably better known and will also be used in other projects such as Antilope, while the RAALI type has a bit more expressive power. For this project, the IHE diagram type will be used, as this improves the “compatibility” of the results with those worked out by the Antilope project.

Once the actors and transactions are defined, the high-level process and data flows are defined, for example as a series of UML sequence diagrams showing alternative sequences of events and the involved process and data flows (see Fig. 3). As a rule of thumb, not all possible sequences of events can be described, but the most important – both regular and irregular – sequences should be described, including the expected behaviour of the actors.

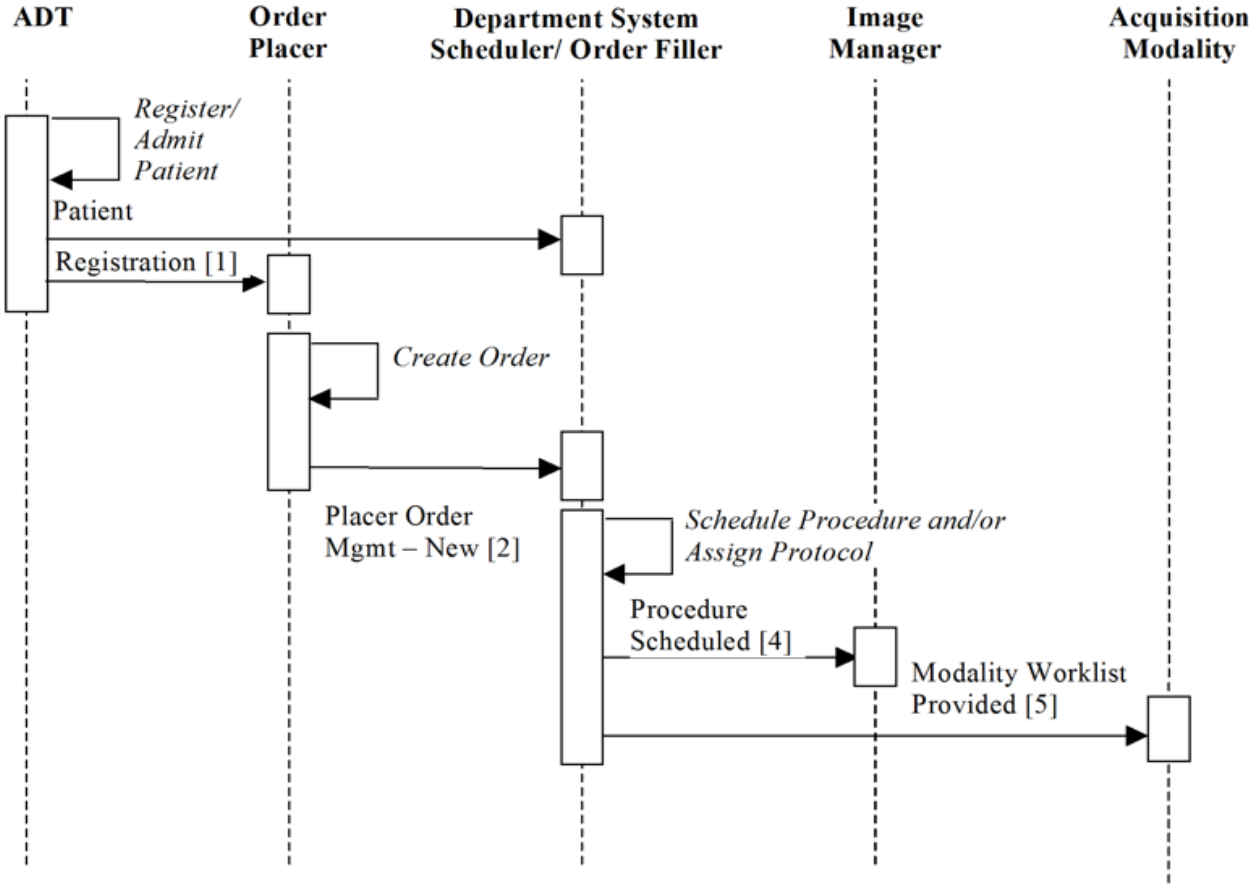


Figure 3: IHE-Style Sequence Diagram (Source: IHE Radiology Technical Framework)

As described above, the results of this work will be maintained in the online repository, which simplifies the linkage between storyboards, actor/transaction diagrams, sequence diagrams, etc.

In summary, the result of the second phase will be actor and transaction diagrams, and the high-level process and data flows (e.g. sequence diagrams and description of behaviour of actors).

3.2 Mapping to Standards and Options

In the third phase, a mapping to communication protocol standards will be defined for each transaction of a single representative use case from phase 2 that will be chosen such that components of the major domains of relevance for AAL (medical devices, home automation, communication with external parties outside the user's home) are involved. This mapping will follow the structure of transaction definitions in the IHE Technical Frameworks:

1. *Scope*: A brief scope statement describing the purpose of the transaction
2. *Use Case Roles*: A UML use case diagram showing the actors involved in the transaction, followed by a brief description of the role performed by each actor.
3. *Referenced Standards*: A list of references to the standards that are used to define the transaction. Links to the AALIANCE2 repository of standards will be added here to simplify the look-up of standards by readers and implementers.
4. *Interaction Diagram*: A UML sequence diagram showing the messages involved in this single transaction. For each message, separate subsections define the following properties of each message exchange:
   - *Trigger Events*: Circumstances under which this message is transmitted
   - *Message Semantics*: Detailed description of the message, including additional requirements that go beyond the minimum set of requirements defined by the standards in terms of options and optional fields that need to be supported by the sender or receiver for this particular message in the context of this transaction and trigger event.
   - *Expected Actions*: Colloquial description of the actions expected by the involved actors upon transmission of the message.
5. *Protocol Requirements*: Additional requirements on the implementation of the communication protocol standards that are common to all messages of the transaction can be enumerated in this optional section.
6. *Actor Requirements*: Actions expected by the involved actors upon execution of the message (i. e. behaviour that is related to the complete transaction and not individual messages) can be described in this optional section.
7. *Security Considerations*: In this optional section, security considerations concerning the transaction, such as additional requirements when executed over a public network, logging requirements etc. can be described in this section.

The critical part in the definition of transactions is obviously the choice of communication protocol and content standards that together cover all seven layers of the ISO/OSI reference model. There is no simple way of guaranteeing that the best choice has been made, and the example of IHE shows that only implementation experience tells – often after a few years – whether or not a choice was appropriate. This can be seen in cases where IHE has retired integration profiles, or released revised or alternative profiles that implement the same use case, but are based on different standards (e. g. HL7 version 2 vs. HL7 version 3.)

Furthermore it is well possible that for certain transactions no existing standard can be identified. In this case, the gap can be pointed out to the relevant standards bodies, but it is not the task of this Action to actually define new standards for "gaps" in the standards landscape.

A final issue to be considered in the definition of transactions is the prevalence of competing, incompatible standards in fields where it may not be acceptable to choose a single standard and exclude all others. Examples for this problem include field buses for home automation, where at least three standards (KNX, LON, BACnet) cover large parts of the market and various newer competitors are also of relevance since they focus on wireless retrofittable technology (e. h. EnOcean, Zigbee, Z-Wave). In this case, it might be necessary to define alternative options for an integration profile such as a "KNX option", "LON option" and "BACnet option" where only actors implementing the same integration profile with the same option are expected to be interoperable. The concept of integration profile options is also frequently used in the IHE Technical Profiles, sometimes for additional actor capabilities and sometimes for alternative implementation choices.

4 High-Level Integration Profiles

This chapter defines the high-level integration profiles derived from the representative use cases.

4.1 Integration Profile: Behaviour Monitoring

4.1.1 Rationale

4.1.1.1 Introduction

Dementia / cognitive impairment is a disease that often progresses slowly over many years. In order to maintain as much independence for the patient as possible, while preventing disease-related accidents, behaviour monitoring tries to identify the activities of the user at home, to provide warnings to the user in dangerous situations (e.g. hot plate switched on when leaving the apartment), or notifications to carers if indications of a progress of the disease (e.g. decline in activities of daily living) are measured that indicate an increased need of support.

4.1.1.2 Purpose & Scope

This profile addresses the monitoring of the user's location and activities at home (including ADLs), combined with notifications to carers e.g. when the patient leaves/arrives at home, or when a decline of ADLs is measured. The profile also addresses the recognition of dangerous/unsafe situations and can be used to provide lighting-based indoor guidance for dementia patients. The recognition of ADLs can furthermore be used to offer guides (explanations) for performing ADLs.

4.1.2 Storyboard

While at home, the location and activities of the user are monitored by means of ambient sensors. Since several sensor technologies are used for this purpose, the profile offers options

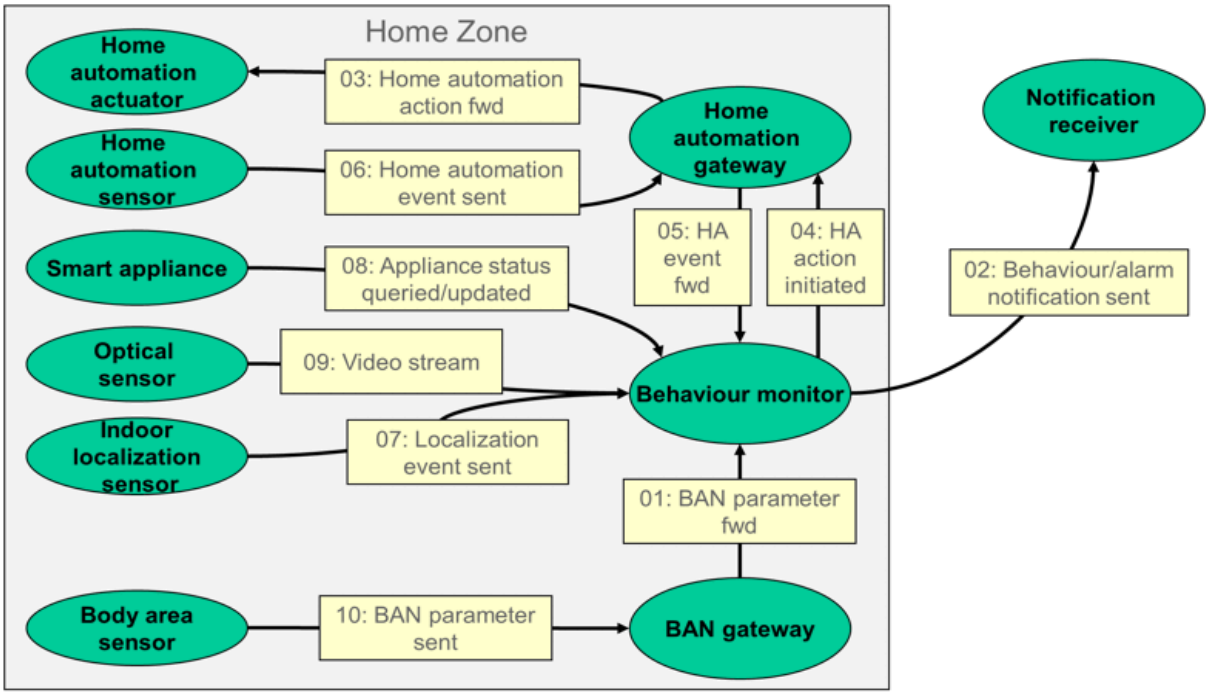
- Home automation sensors (presence detectors, door contacts, light barriers etc.) provide coarse-grained location and information about physical activity (walking through the apartment)
- Power sensors provide information about the use of electrical devices (oven, TV set, lights etc.)
- Optionally, indoor localization sensors such as floor-mats provide more precise location information and may also be used to detect fall events.
- Alternatively, optical sensors (cameras) can also be used to determine information about location and activities.

The behaviour monitor receives and processes the sensor data and derives information about ADLs, physical activity, and sequences of events indicating dangerous situations. At its own discretion, the behaviour monitor sends behaviour/alarm notification messages to an external Notification receiver (informal or formal carers). The information acquired by ambient sensors may be extended with information acquired by sensors worn on the body, such as an accelerometer (physical activity, falls) or vital parameters (e.g. to detect stress). Finally, the behaviour monitor may initiate actions of home automation actuators (in particular lighting and shutters), for example

- to provide ambient lighting to the bathroom when the user gets up at night
- to unobtrusively guide the user to the bedroom at night

4.1.3 Actors, Transactions and Options

4.1.3.1 Actors and Transactions



Behaviour Monitoring: Actors and Transactions

Actor Descriptions:

- *BAN gateway:* A component carried by the user such as a smartphone that receives vital parameters or accelometry data from sensors worn on the body using a short-range wireless protocol and forwards these parameters to the behaviour monitor using a wireless network connection (WLAN or GSM).
- *Behaviour monitor:* The central actor of this profile, a computer that receives and processes sensor data, determines the user's activities of daily living from the sensor data, recognises dangerous situations or changes in behaviour patterns indicating an increased need for support, and notifies the user or external carers.
- *Body area sensor:* A vital parameter sensor or accelerometer worn on the body.
- *Home automation actuator:* A home automation actuator such as lighting, shutters, or a window opener.
- *Home automation gateway:* A system that translates between one home automation field bus (KNX or ZigBee) and a field bus independent, generic network protocol that is used by the behaviour monitor to interact with the home automation independent from the implemented field bus.
- *Home automation sensor:* A home automation sensor such as a presence detector, light switch, light barrier, smoke detector, or a metering device that can be used to recognise the use of electrical appliances in the apartment.
- *Indoor localization sensor:* A device such as a floor mat that provides information about the location of the user within the apartment.
- *Notification receiver:* An external system operated by a call centre, a formal carer or an informal carer that receives either emergency calls (e.g. fall detection) or notifications about relevant (but not urgent) facts such as behaviour changes.
- *Optical sensor:* An optical sensor (camera) that provides a video stream to the behaviour monitor for image analysis.
- *Smart appliance:* An electrical appliance (oven, refrigerator, cooker, microwave etc.) that supports communication over powerline. The status of the appliance can be queried and certain commands can be

sent, such as switching off a hot plate.

Transaction Descriptions:

- *01: BAN parameter forwarded:* A BAN gateway forwards a vital parameter or accelerometry data received from a sensor in the body area network to the behaviour monitor.
- *02: Behaviour/alarm notification sent:* A notification or an alarm is sent by the behaviour monitor to a notification receiver, which is located outside the user's home.
- *03: Home automation action forwarded:* A home automation gateway forwards a command received from the behaviour monitor (such as switching light on/off, opening/closing windows etc.) to a home automation actuator.
- *04: Home automation action initiated:* A behaviour monitor sends a command intended for a home automation actuator to the home automation gateway using a field-bus independent protocol.
- *05: Home automation event forwarded:* A home automation gateway forwards some home automation event received from a home automation sensor to the behaviour monitor, using a field-bus independent protocol.
- *06: Home automation event sent:* A home automation sensor sends an event (e.g. smoke detected, presence detected, metering data) to the home automation gateway.
- *07: Localization event sent:* An indoor localisation sensor sends a message containing the current position of the user to the behaviour monitor.
- *08: Appliance status queried/updated:* A behaviour monitor either queries the status of a smart appliance, or sends a command to a smart appliance.
- *09: Video stream:* An optical sensor provides a continuous stream of video data to a behaviour monitor.
- *10: BAN parameter sent:* A body area sensor sends a measured parameter or set of parameters to the BAN gateway.

4.1.3.2 Profile Options

The following table describes which transactions must be supported by which actor. Possible types are: R (required), O (optional) or C (conditional). For conditional transactions, the condition under which the transaction is required is documented in a note below.

Actor	Transaction	Optionality
BAN gateway	01: BAN parameter forwarded	R
	10: BAN parameter sent	R
Behaviour monitor	01: BAN parameter forwarded	O
	02: Behaviour/alarm notification sent	R
	04: Home automation action initiated	O
	05: Home automation event forwarded	C (1)
	07: Localization event sent	O
	08: Appliance status queried/updated	O
	09: Video stream	C (1)
Body area sensor	10: BAN parameter sent	R
Home automation actuator	03: Home automation action forwarded	R
Home automation gateway	03: Home automation action forwarded	R
	04: Home automation action initiated	R
	05: Home automation event forwarded	R
	06: Home automation event sent	R
Home automation sensor	06: Home automation event sent	R
Indoor localization sensor	07: Localization event sent	R

Notification receiver	02: Behaviour/alarm notification sent	R
Optical sensor	09: Video stream	R
Smart appliance	08: Appliance status queried/updated	R

The following table describes so-called “profile options”, which are either optional extensions to certain actors, or alternative implementation approaches. Possible types are: R (required), O (optional) or C (conditional). For conditional profile options, the condition under which the profile option is required is documented in a note below. Interoperability can only be expected to be given between systems or system components implementing complementary roles of one transaction *using the same profile option*. In this integration profile, two sets of alternative profile options have been defined:

- The home automation sensors and actuators can be connected either using a classical (in most cases cable-based) KNX field bus (KNX option), or alternatively using a wireless connection based on the ZigBee Home Automation profile (ZigBee option). It is understood that there are further standardised home automation buses, such as LON, BACnet or EnOcean that might be considered for future extensions of this profile. For now, only these two home automation standards have been selected.
- The integration between the behaviour monitor, the two gateway actors, and the indoor localization sensor may be alternatively implemented either using the “conventional” option based on syntactic interoperability standards, or using the “universAAL” option based on the universAAL middleware, which uses semantic communication between nodes.
- For the connection between body area sensors and the BAN gateway, three alternative communication stacks are defined in compliance with the Continua Design Guidelines: Bluetooth Health Device Profile (wireless), Bluetooth Low Energy (wireless, low energy usage), USB (wired).

Actor	Profile Option	Optionality
BAN gateway	Conventional option	C (3)
	universAAL option	C (3)
Behaviour monitor	Conventional option	C (3)
	universAAL option	C (3)
Body area sensor	Bluetooth HDP option	C (4)
	Bluetooth LE option	C (4)
	USB option	C (4)
Home automation actuator	KNX option	C (2)
	ZigBee option	C (2)
Home automation gateway	KNX option	C (2)
	ZigBee option	C (2)
	Conventional option	C (3)
	universAAL option	C (3)
Home automation sensor	KNX option	C (2)
	ZigBee option	C (2)
Indoor localization sensor	Conventional option	C (3)
	universAAL option	C (3)
Notification receiver	-	-
Optical sensor	-	-
Smart appliance	-	-

Notes:

- (1) Either “Video Stream” or “Home automation event forwarded” or both shall be supported.

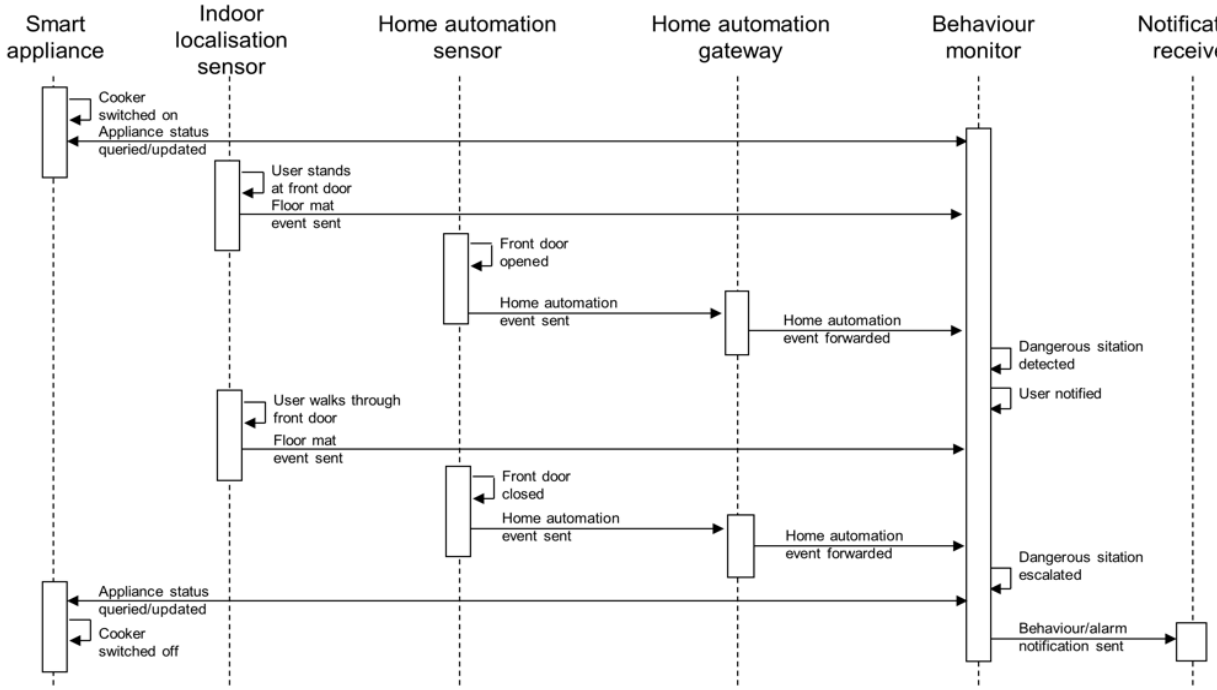
- (2) Either “KNX option” or “ZigBee” option or both shall be supported.
- (3) Either “Conventional” or “universAAL” option shall be supported.
- (4) At least one of the options “Bluetooth HDP”, “Bluetooth LE” or “USB” shall be supported. Multiple options may be supported.

4.1.4 High level process and data flow

A multitude of process and data flows are possible. Basically all sensors present (home automation, smart appliance, indoor localisation, body area, optical) deliver sensor data to the behaviour monitor at an implementation-defined frequency. It is the task of the behaviour monitor to fuse this data and, based on context information about the sensor location, behaviour patterns of the user etc. derive information about recognised activities of daily living.

At the discretion of the behaviour monitor, certain sequences of events may be classified as a dangerous situation. The behaviour monitor may then either directly interact with the user (note that in integration profiles human-machine interfaces are never shown, so that this kind of interaction is not visible in the actor/transaction diagrams), send a message to an external notification receiver, or initiate a direct action by sending a command to a home automation actuator or a smart appliance (e.g. to switch off a hot plate after the user has left the apartment). The behaviour monitor may furthermore classify sequences of events as indicating a relevant long-term trend that requires a notification of external carers and in this case initiate a notification. There is only one transaction for external notifications, which covers both emergency cases and notifications about long-term trends, since the protocol chosen for this transaction supports both.

The following sequence diagram shows a sequence of events in which the behaviour monitor detects a dangerous situation:

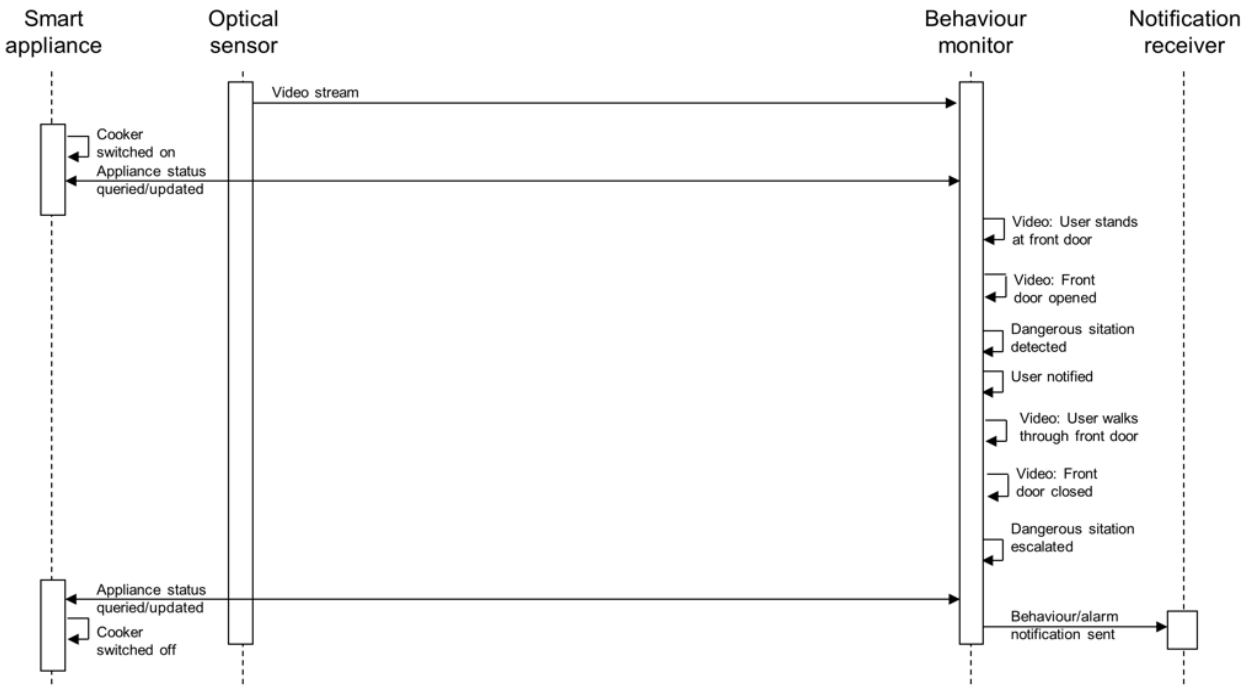


High level process flow - example 1: dangerous situation detected using home automation sensors

The behaviour monitor first detects that the cooker is switched on (note that the protocol technically requires this information to be queried, i.e. polled at regular intervals, by the behaviour monitor), then receives location information indicating that the user is at the front door, and then receives the information that the front door was opened. The behaviour monitor classifies this as a potentially dangerous situation (the user is trying to leave home with a cooker switched on) and first initiates a direct communication with the user, and informs the user. The user nevertheless leaves the home and closes the door, as reported by the indoor

localisation sensor and a home automation sensor on the front door. The behaviour monitor classifies this as a dangerous situation and initiates a command to the cooker in order to switch it off. Furthermore, a (non-emergency) notification is sent to the notification receiver (here representing a formal or informal carer) indicating that a dangerous situation has occurred, but was addressed by the system.

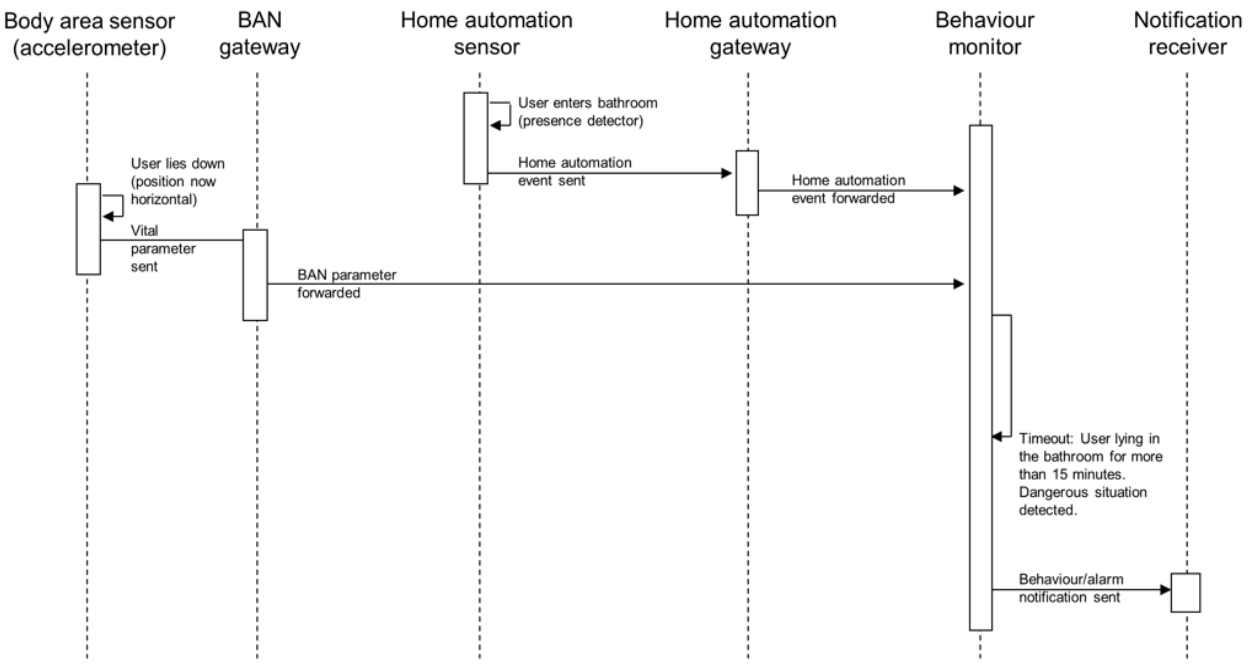
The second sequence diagram below shows the same sequence of events, but in this case in a system that uses video streams (i.e. cameras in the different rooms) instead of home automation actors and floor mats to detect the location and activities of the user. Here most events occur internally within the behaviour monitor as part of the signal processing of the video streams.



High level process flow - example 2: dangerous situation detected optical sensors

Many more set-ups are possible - for example, the cooker might be a conventional electrical appliance without the capability to communicate with the behaviour monitor. In this case the fact that the cooker is switched on might be detected by a metering device (home automation sensor) detecting the electrical currant indicating that the cooker is in use. In this case the behaviour monitor might either have the possibility to cut the electrical supply of the cooker by initiating a home automation actuator, or may only be able to send a notification - which in this case would be urgent - to an external notification receiver who would then have to address the problem in person.

The third sequence diagram below shows an example of a fall detection.



High level process flow - example 3: fall detection

In this example a home automation sensor detects that the user enters the bathroom and reports this to the behaviour monitor. Then a body area sensor (accelerometer) detects that the user has fallen (i.e. is now lying horizontally). This information is forwarded to the behaviour monitor via the BAN gateway. Furthermore, no indication that the user has stood up (such as the accelerometer returning to vertical position) is received within 15 minutes, which is interpreted by the behaviour monitor as a likely fall event. Consequently, a notification is sent to an external notification receiver.

It should be noted that this integration profile does not define the algorithms by which the behaviour monitor derives information from the sensor input, and the profile also defines no requirements concerning a permitted false positive or false negative rate of detected events. In this particular example, the user could simply have disrobed and taken a bath or a shower, causing the accelerometer, which is in fact fixed to the clothes and not to the human body, now being in horizontal position, i.e. the sequence of events shown in the sequence diagram above is no reliable indication of a fall.

4.1.5 Ethical and Legal Considerations

Information about activities of daily living, and in particular information from which a possible cognitive impairment of the user can be derived, must be considered as very sensitive personal data. This profile has been designed such that the “raw” data never leaves the behaviour monitor, only notifications do. If the behaviour monitor is located inside the user's home, appropriate measures need to be taken to secure the transmission of the notifications (transaction 02) from unauthorised eavesdropping or tampering. Furthermore, the behaviour monitor as such needs to be protected from unauthorised access, especially from remote.

Should an implementor decide to locate the behaviour monitor (or parts thereof, such as the signal data processing algorithms) outside the home environment, e.g. implement them as a cloud resource, then additional data protection requirements arise, as in this case additional personal data would leave the home and be potentially subject to unauthorised eavesdropping or tampering.

A behaviour monitoring system cannot be installed and used without the informed consent of the user, or in the case of users who are unable to give informed consent, their legal guardians. It is furthermore desirable that the user has the ability to turn off the system temporarily (e.g. when visitors are in the home or in situations where the user wants to be unmonitored), and it should be possible for the user to determine whether the system is currently in “activated” or “deactivated” status.

While this integration profiles defines no requirements concerning the permitted false positive and false negative detection rate of the behaviour monitor, these will certainly be important in practice. In particular,

the behaviour monitor must be able to correctly handle situations in which more than one person is present in the apartment, leading to sequences of sensor measurements that may seem “abnormal” otherwise.

Finally, the availability of the communication system over which the “behaviour/alarm notification” transaction is sent, as well as the availability of the notification received, should be considered. If high priority messages (such as notifications about emergency situations) are transmitted, then the notification receiver must be able to react 24 hours a day, 7 days a week. Furthermore, in these cases a redundant communication infrastructure with two independent transports (such as cabled internet and GSM wireless) should be considered, in order to maximise the overall availability of the system.

4.1.6 Transaction Definitions

The transactions for this profile are defined in chapter 5 of this document.

- Transaction 01: BAN parameter forwarded
- Transaction 02: Behaviour/alarm notification sent
- Transaction 03: Home automation action forwarded
- Transaction 04: Home automation action initiated
- Transaction 05: Home automation event forwarded
- Transaction 06: Home automation event sent
- Transaction 07: Localization event sent
- Transaction 08: Appliance status queried/updated
- Transaction 09: Video stream
- Transaction 10: BAN parameter sent
- Integration Profile 2: Calendar Service

4.2 Integration Profile: Calendar Service

4.2.1 Rationale

4.2.1.1 Introduction

The Calendar Service is a system that is mostly intended for older adults with a cognitive impairment. Such users will often be able to still live independently, but they tend to forget things (appointments, activities, and in particular medication). Furthermore, this user group tends to over time reduce activities such as walking outsides, participating to social live and community events, which in turn may help to worsen the cognitive impairment.

4.2.1.2 Purpose & Scope

The Calendar Service system acts as an “intelligent” calendar that reminds the user of appointments, notifies the user if certain activities of daily living are forgotten, and reminds the user of the medicine that is to be taken. Furthermore, the system monitors Web resources maintaining community event calendars and, based on a profile indicating the preferences of the users, creates suggestions for events the user might be interested in. The system also retrieves a weather forecast and suggests outdoor activities if the weather conditions are OK.

The system can optionally be coupled with a medication dispenser. In this case the system “knows” whether or not the uses has taken the medicine out of the dispenser. If medicine is not taken regularly, carers can be notified. (Note, however, that the system cannot detect if the user really *takes* the medicine, or only takes it from the dispenser.)

4.2.2 Storyboard

The Calendar Service in the first place is a calendar that allows the user to maintain a schedule of daily

activities. The system has a user interface that allows the user to be reminded of calendar entries. The type of user interface is not restricted by this integration profile, and may range from classical graphical user interfaces (GUIs) on a PC or tablet computer to audio-visual interaction, which may be more appropriate for end-users with little computer literacy and, possibly, a mild cognitive impairment.

This profile does not describe who, and how, appointments are entered into the calendar; it is assumed that the calendar is a “standard” calendar application running either on hardware within the home, or as an Internet service, which would allow formal or informal carers to interact with the calendar by adding or removing entries.

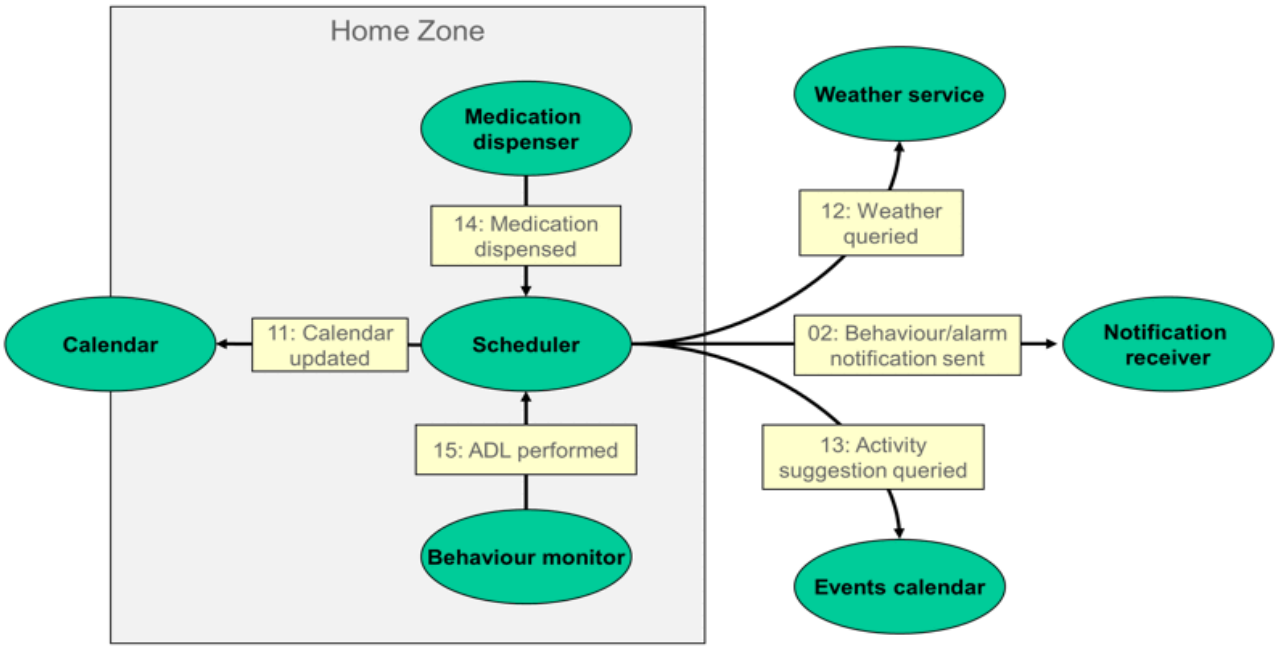
The calendar is amended by an application which makes up the assistive part of the system. This application tries to keep the user active by suggesting community events, which are queried from Internet resources and filtered according to the user's preferences, and outdoor activities based on the current weather and weather forecast, which are also queried.

The system can furthermore be combined with a drug dispenser. In this case the system can remind the user whenever he or she forgets to take the medicine. Should the user not take the medicine over a longer period despite reminders, a notification can be sent to the carers, as this may indicate a health hazard.

Finally, for users with early forms of dementia, the system can be coupled with a behaviour monitor (see Integration Profile 1: Behaviour Monitoring), which notifies the calendar service application whenever an Activity of Daily Living (such as cooking, eating, washing, or vacuum cleaning of the home) are recognised. The calendar service application can compare this with a list of expected activities and create additional reminders as calendar entries when activities of daily living are overdue.

4.2.3 Actors, Transactions and Options

4.2.3.1 Actors and Transactions



Calendar Service: Actors and Transactions

Actor Descriptions:

- *Calendar:* a “standard” calendar application running either on hardware within the home, or as an Internet service, with a user interface that allows the user to be notified of appointments, activities and reminders.
- *Scheduler:* an application that tries to keep the user active by suggesting community events and outdoor activities, based on information queried from Internet resources, and also keeps tracks of activities of daily living and drug intake (when coupled with a behaviour monitor or medication dispenser, respectively).

- *Medication dispenser:* An “automatic pill box” that can be loaded with the user's medication for a certain period (such as a week) in advance. The device will dispense each compartment (“box”) at the pre-programmed time and after a user interaction only. The device sends an information to the scheduler whenever a medication has been dispensed, or the medication is overdue, in which case the calendar service will remind the user.
- *Behaviour monitor:* A behaviour monitor (of the Behaviour Monitoring integration profile) that notifies the scheduler of recognised activities of daily living (ADLs).
- *Weather service:* An Internet resource that allows the current weather and weather forecast for the place of living of the user to be accessed in a machine readable format.
- *Notification receiver:* An external system operated by a call centre, a formal carer or an informal carer that receives notifications - in this case the information that medicine has not been taken over a period of time.
- *Events calendar:* An Internet resource that lists local community events that may be of interest to the user, and can be accessed in a machine-readable format.

Transaction Descriptions:

- *02: Behaviour/alarm notification sent:* The scheduler sends a notification to an external receiver (formal or informal carer) because medication has not been taken from the medication dispenser for a (configurable) period of time despite reminders.
- *11: Calendar updated:* The scheduler adds or removes a calendar entry.
- *12: Weather queried:* The scheduler queries a Weather service actor for the current local weather and weather forecast.
- *13: Activity suggestion queried:* The scheduler queries an Events calendar for community events that may be of interest to the user.
- *14: Medication dispensed:* The medication dispenser notifies the scheduler that either medication has been taken from the dispenser, or that medication is overdue and a reminder should be generated.
- *15: ADL performed:* The behaviour monitor notifies the scheduler that a certain ADL was recognised, so that reminders for this ADL can be removed for a certain period of time (depending on type of ADL and system configuration).

4.2.3.2 Profile Options

The following table describes, which transactions must be supported by which actor. Possible types are: R (required), O (optional) or C (conditional). For conditional transactions, the condition under which the transaction is required is documented in a note below.

Actor	Transaction	Optionality
Calendar	11: Calendar updated	R
Scheduler	02: Behaviour/alarm notification sent	C (1)
	11: Calendar updated	R
	12: Weather queried	R
	13: Activity suggestion queried	R
	14: Medication dispensed	O
	15: ADL performed	O
Medication dispenser	14: Medication dispensed	R
Behaviour monitor	15: ADL performed	R
Weather service	12: Weather queried	R
Notification receiver	02: Behaviour/alarm notification sent	R
Events calendar	13: Activity suggestion queried	R

The following table describes so-called “profile options”, which are either optional extensions to certain

actors, or alternative implementation approaches. Possible types are: R (required), O (optional) or C (conditional). For conditional profile options, the condition under which the profile option is required is documented in a note below. Interoperability can only be expected to be given between systems or system components implementing complementary roles of one transaction *using the same profile option*.

In this integration profile, transaction 15: ADL performed can be implemented either using the “conventional” option based on a Web Service call, or using the “universAAL” option based on the universAAL middleware, which uses semantic communication between nodes.

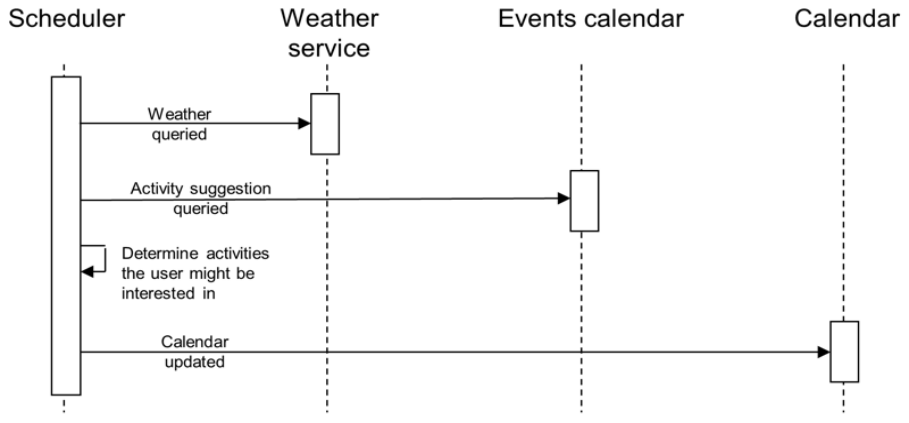
Actor	Profile Option	Optionality
Calendar	-	-
Scheduler	Conventional option	C (2)
	universAAL option	C (2)
Medication dispenser	-	-
Behaviour monitor	-	-
Weather service	-	-
Notification receiver	-	-
Events calendar	-	-

Notes:

- (1) Shall be supported if “14: Medication dispensed” is supported. May be supported otherwise.
- (2) Either “Conventional” or “universAAL” option shall be supported.

4.2.4 High level process and data flow

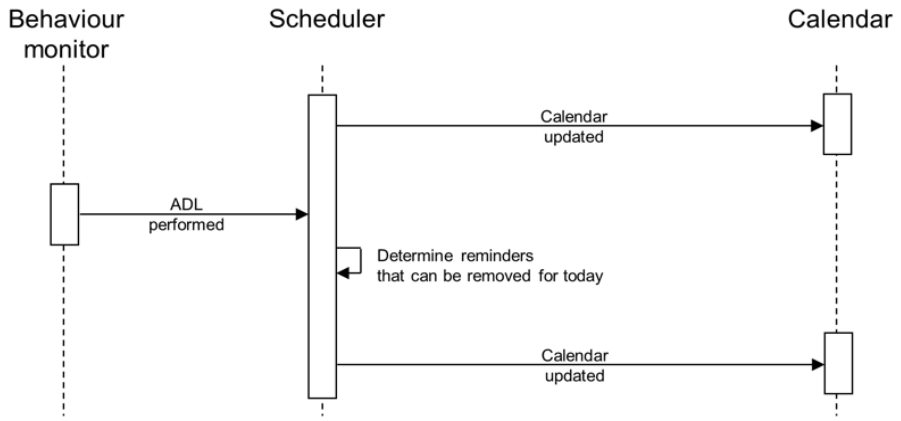
The following sequence diagrams show the most important process and data flows for this integration profile. The first diagram below shows how the scheduler queries internet resources for local weather information and community events and, based on an internal reasoning that is not further described in this profile, derives recommendations for activities for the user. These suggestions are then sent to the calendar as proposed entries. The user confirms or refuses these suggestions with the user interface implemented by the calendar actor, and the calendar then notifies the user of upcoming calendar entries.



High level process flow - example 1: keeping the user active by suggesting activities

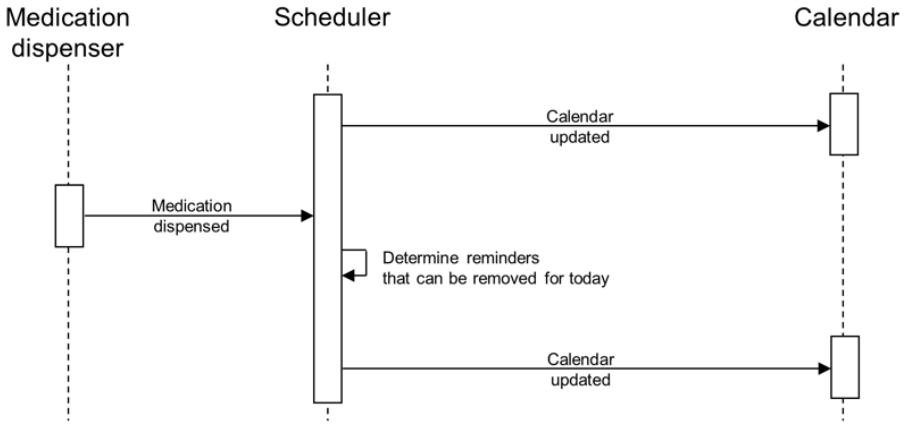
The second sequence diagram shows the integration of the calendar service with a behaviour monitor. In the morning the scheduler generates a series of calendar entries for the relevant activities of daily living (ADL); each activity is associated with the time when the calendar should remind the user.

Whenever the behaviour monitor recognises an activity, it sends a notification to the scheduler, which in turn removes the reminder entry from the calendar for the day, so that the user only receives reminders about ADLs that have not yet taken place.



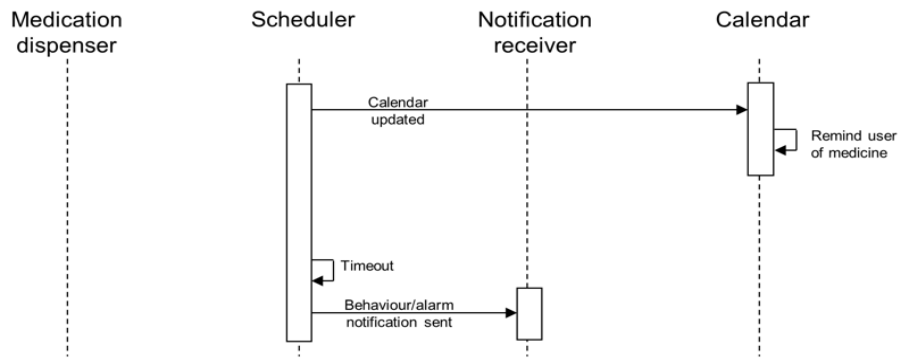
High level process flow - example 2: behaviour monitor integration with ADL reminders

The third sequence diagram shows the integration of the calendar service with a medication dispenser. In the morning the scheduler creates calendar entries for the medication “events” of the day, each associated with the time the medicine should be taken latest. Every time the user takes medicine from the dispenser, a notification is sent to the scheduler, which then removes the reminder from the calendar service.



High level process flow - example 3: medication dispenser integration

The last sequence diagram shows a different sequence of events for the medication dispenser. Again, the scheduler creates calendar entries in the morning for the medication “events” of the day. Since the user does not take the medication out of the medication dispenser by the scheduled time, the calendar reminds the user of this activity. However, the user still does not take the medicine from out of the dispenser. After a configurable timeout, and possibly a certain number of times this timeout has been reached within a week, the scheduler determines that a notification of the responsible carer is required, and thus sends a notification message to an external notification receiver.



High level process flow - example 4: medication dispenser integration with notification of external receiver

4.2.5 Ethical and Legal Considerations

The notification of external actors about medication not being taken (transaction 02: Behaviour/alarm notification sent) cannot be used without the informed consent of the user, or in the case of users who are unable to give informed consent, their legal guardians.

For ethical and legal considerations concerning the behaviour monitor, see the related discussion in Integration Profile 1: Behaviour Monitoring.

4.2.6 Transaction Definitions

Not all transactions for this profile are defined at this time, since the scope of the project is to only develop transactions for two integration profiles, and only develop the high-level part of the profile (i.e., this page) for the others.

Transactions that are defined for this profile can be recognised by links shown in green colour. The transactions are defined in chapter 5 of this document.

- Transaction 02: Behaviour/alarm notification sent
- Transaction 11: Calendar updated
- Transaction 12: Weather queried
- Transaction 13: Activity suggestion queried
- Transaction 14: Medication dispensed
- Transaction 15: ADL performed
- Integration Profile 3: Social Interaction with Smart TV

4.3 Integration Profile: Social Interaction with Smart TV

4.3.1 Rationale

4.3.1.1 Introduction

Social Well-being is one the key factors to health related to the WHO definition of health [WHO1946]. Social interaction is one basic factor for social well-being (more specific factors for social well-being see Call 3 topics). Technical solutions to support social interaction have a broad variety. They can start with technical aids to support physical limitations (hearing aids, seeing aids, assistance in voice and speech), bridging the physical distance between or bringing people together physically.

One possible technical device could be a smart TV (also called “connected TV”) for the following reasons:

- Dissemination: A TV is the most common technical product, nearly each household in Europe owns a TV.
- Acceptance: A TV is accepted by nearly all age groups.

- Ease of use: A TV can be controlled via remote control unit.
- Technical Diversity: Modern TV offer a wide band of extra services like broadband connection, additional applications and connectivity to other devices.

4.3.1.2 Purpose & Scope

The described Smart TV can be used as a central communication unit at home. It offers various ways of communicating through video conferencing, chatting or even online gaming. It is connected to external servers providing these services.

The Smart TV can be controlled via a classical remote control unit or a remote control application installed on a mobile device (smartphone, tablet PC) offering additional functions such as a remote display.

4.3.2 Storyboard

The central element of this integration profile is a Smart TV. A Smart TV is an enhanced TV set offering more functionality to the end-user. Besides watching TV, the end-user can use additional services on the Smart TV like video-conferencing, chatting and online gaming. For this purpose the Smart TV offers more interfaces like a classic TV set containing LAN, WLAN or Bluetooth. This list of functionalities might not be finishing, future developments can add further functionalities to this system, like the Shopping and Nutrition Planer. The Smart TV can be controlled via a classical remote control unit or a remote control application installed on a mobile device (Smartphone, tablet PC) offering new functions like remote display.

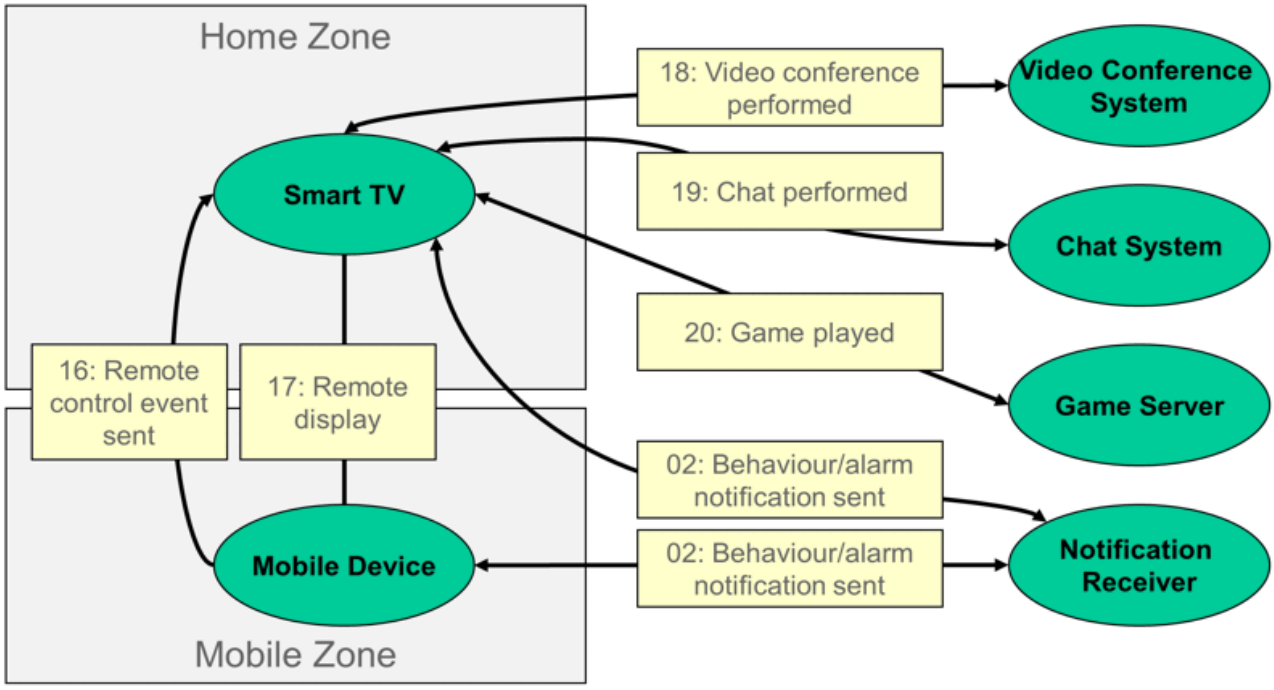
This control application on a mobile device is the other central part of this integration profile. A control application can be installed on a mobile device like smart phone or tablet PC and this device can than be used as remote control unit with enhanced functionalities. The end-user can use this device as video camera and/or microphone for video conferencing, as keyboard for chatting or game controller for online gaming. It is also possible to transfer media from the mobile device to the Smart TV. Vice versa the remote application can receive content from the Smart TV like Dual View (TV signal on mobile device) or Second Screen (additional information on running programme on mobile device).

Additional actors in this integration profile are external servers running additional services like video conferencing, chat platforms or game servers. The Smart TV connects to these services via an internet connection; this applies to other clients (chat partners, game partners).

Finally an emergency application is available on Smart TV and mobile device. In case of an emergency (fire, feeling dizzy) the end-user can call the emergency service centre by only pressing on button. On the other side a notification receiver handles the alarm.

4.3.3 Actors, Transactions and Options

4.3.3.1 Actors and Transactions



Social Interaction with Smart TV: Actors and Transactions

Actor Descriptions:

- *Smart TV:* a modern Smart TV offering internet access through LAN and WLAN and the possibility of installing applications.
- *Mobile Device:* a mobile device (smart phone, tablet PC) that can be used as a remote control unit with an installed remote application. These applications are already offered by TV vendors (e.g. Panasonic Viera Application).
- *Video Conference System:* This system offers video conferencing; the clients can connect via internet.
- *Chat System:* A text-based chat-system.
- *Game Server:* A game-server running different kinds of online games, whether single or multi-player.
- *Notification Receiver:* An external system operated by a call centre, a formal carer or an informal carer that receives notifications - in this case the information that medicine has not been taken over a period of time.

Transaction Descriptions:

- *02: Behaviour/alarm notification sent:* The scheduler sends a notification to an external receiver (formal or informal carer) because medication has not been taken from the medication dispenser for a (configurable) period of time despite reminders.
- *16: Remote control event sent:* The remote control unit sends different kinds of commands: Classical remote command like switching channels or modifying volume, application related parameters like game controls or selecting chat contacts, keyboard commands for writing text and transferring media contents from the mobile device to the smart TV like videos and images.
- *17: Remote display:* The Smart TV sends two kinds of contents to the remote control unit: shared screen components like social media channels or chat windows, and a twin desktop to have the TV screen on the mobile device while moving through the apartment.
- *18: Video conference performed:* The Smart TV sends and receives audio and video streams to/from the video conferencing system.

- *19: Chat performed:* The Smart TV sends and receives text messages to/from the chat system.
- *20: Game played:* The Smart TV sends game commands to the game server and receive game-related content from the game server.

4.3.3.2 Profile Options

The following table describes, which transactions must be supported by which actor. Possible types are: R (required), O (optional) or C (conditional). For conditional transactions, the condition under which the transaction is required is documented in a note below.

Actor	Transaction	Optionality
Smart TV	02: Behaviour/alarm notification sent	C (1)
	16: Remote control event sent	R
	17: Remote display	C (1)
	18: Video conference performed	C (1)
	19: Chat performed	C (1)
	20: Game played	C (1)
Mobile Device	02: Behaviour/alarm notification sent	O
	16: Remote control event sent	R
	17: Remote display	O
Video Conference System	18: Video conference performed	R
Chat System	19: Chat performed	R
Game Server	20: Game played	R
Notification Receiver	02: Behaviour/alarm notification sent	R

The following table describes so-called “profile options”, which are either optional extensions to certain actors, or alternative implementation approaches. Possible types are: R (required), O (optional) or C (conditional). For conditional profile options, the condition under which the profile option is required is documented in a note below. Interoperability can only be expected to be given between systems or system components implementing complementary roles of one transaction using the same profile option. In this integration profile, two sets of alternative profile options have been defined:

Actor	Profile Option	Optionality
Smart TV	WLAN Option	C (2)
	Bluetooth Option	C (2)
Mobile Device	WLAN Option	C (2)
	Bluetooth Option	C (2)
Video Conference System	-	-
Chat System	-	-
Game Server	-	-
Notification Receiver	-	-

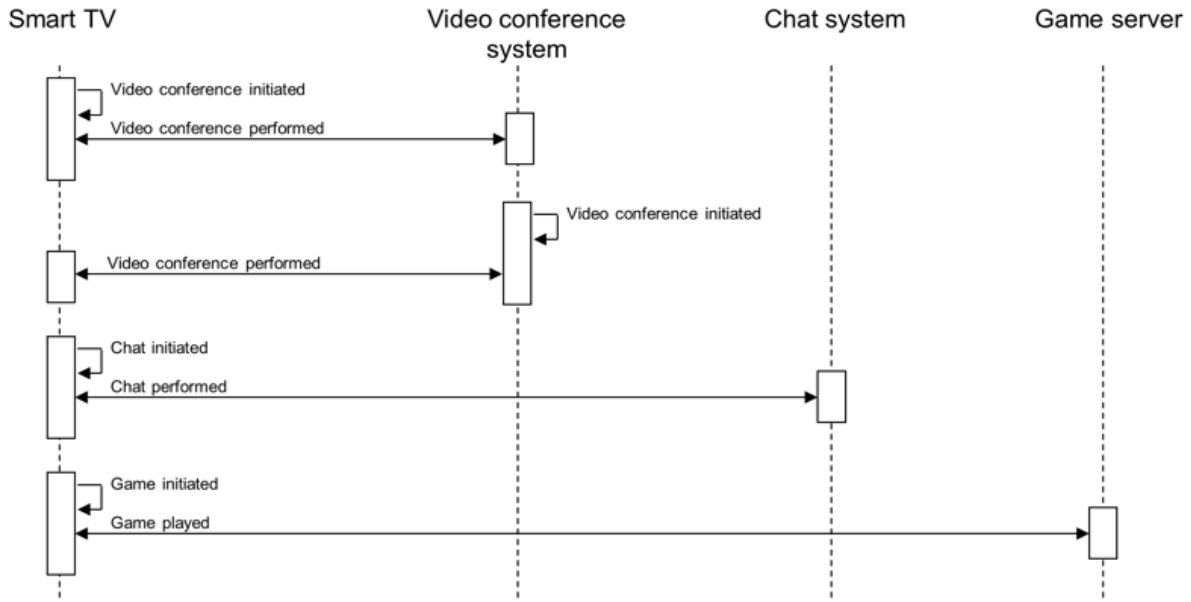
Notes:

- (1): At least one of these transactions must be supported. More than one of these transactions may be supported.
- (2): At least one profile option must be supported.

For the communication between the Mobile Device and the Smart TV, two alternative communication protocols are supported, since both are supported by a large number of devices: WLAN communication, or Bluetooth.

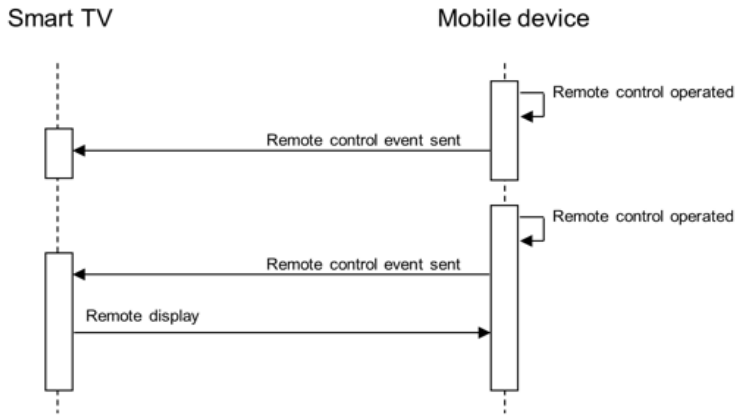
4.3.4 High level process and data flow

The first sequence diagram below shows the different forms of social interaction that are enabled by this integration profile. The smart TV can be used as a videoconference device, communicating with a remote video conference system. This transaction can be initiated by both actors. The smart TV can also be used for text messaging (“chatting”) by connecting to a chat relay (chat system). Finally, the smart TV can be used to play games (single-player or multi-player) that connect to a game server.



High level process flow - example 1: social interaction with the smart TV

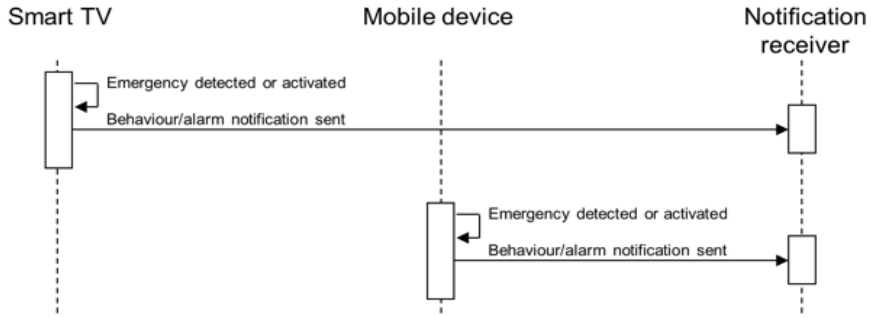
The second sequence diagram shows the interactions between the mobile device and the smart TV in this integration profile. The mobile device can, first of all, be used as a remote control that will typically offer a more comfortable user interface than classical remote controls. Secondly, if supported by both actors, the mobile device can enable the “remote display” functionality, in which case the mobile device will receive a video stream from the smart TV and act as a secondary display that can, for example, be carried into a separate room to follow the TV program even if the user needs, for example, to look after the cooker in the kitchen.



High level process flow - example 2: interaction between smart TV and mobile device

The third sequence diagram shows how the smart TV or the mobile device can be used to transmit an alarm message to a remote notification received (e.g. social alarm call centre). Note that the transaction shown in

this picture supports the establishment of a voice or video connection between the user and the notification receiver as part of the process.



High level process flow - example 3: Alarm notification using smart TV or mobile device

4.3.5 Ethical and Legal Considerations

Having a Smart TV with the described communication functions there might be always the danger that people get isolated of real physical contacts and only have social contacts in the digital world. This ethical aspect should be considered during the development of additional communication features for Smart TVs.

The availability of the communication system over which the “behaviour/alarm notification” transaction is sent, as well as the availability of the notification received, should be considered. If high priority messages (such as notifications about emergency situations) are transmitted, then the notification receiver must be able to react 24 hours a day, 7 days a week. Furthermore, in these cases a redundant communication infrastructure with two independent transports (such as cabled internet and GSM wireless) should be considered, in order to maximise the overall availability of the system.

4.3.6 Transaction Definitions

Not all transactions for this profile are defined at this time, since the scope of the project is to only develop transactions for two integration profiles, and only develop the high-level part of the profile (i.e., this page) for the others.

Transactions that are defined for this profile can be recognised by links shown in green colour. The transactions are defined in chapter 5 of this document.

- Transaction 02: Behaviour/alarm notification sent
- Transaction 16: Remote control event sent
- Transaction 17: Remote display
- Transaction 18: Video conference performed
- Transaction 19: Chat performed
- Transaction 20: Game played

4.4 Integration Profile: Shopping and Nutrition Planner

4.4.1 Rationale

4.4.1.1 Introduction

Shopping is one of the activities where the transformation of the industrialized countries into “self-service societies” can be felt most. Supermarkets with relatively small staff and little human support for older customers are the norm, not the exception today. However, the ability to purchase one's goods for daily

living are an important aspect of participation and independence for older adults, and, furthermore, a typical outdoor activity that is important to keep people active and mobile.

Malnutrition and dehydration are frequent problems in older adults, so any assistive system for shopping purposes should also be able to support and advise the user to buy food adapted to the user's personal health situation.

Finally, not all goods may be available in shops sufficiently close for a walk, and some goods (e.g. drinks) may be too heavy. Therefore, shopping service with door-to-door delivery should also be supported.

4.4.1.2 Purpose & Scope

The Shopping and Nutrition Planner is an assistive system for nutrition planning and shopping. Both “home shopping” with door-to-door delivery and the assembly of a shopping list for conventional shopping are supported. The system furthermore supports connections with storage systems that can automatically report low stock of certain goods (“intelligent fridge”), and it can be connected with a home automation infrastructure to enable reminders if the user has assembled a shopping list but forgotten to actually go shopping.

4.4.2 Storyboard

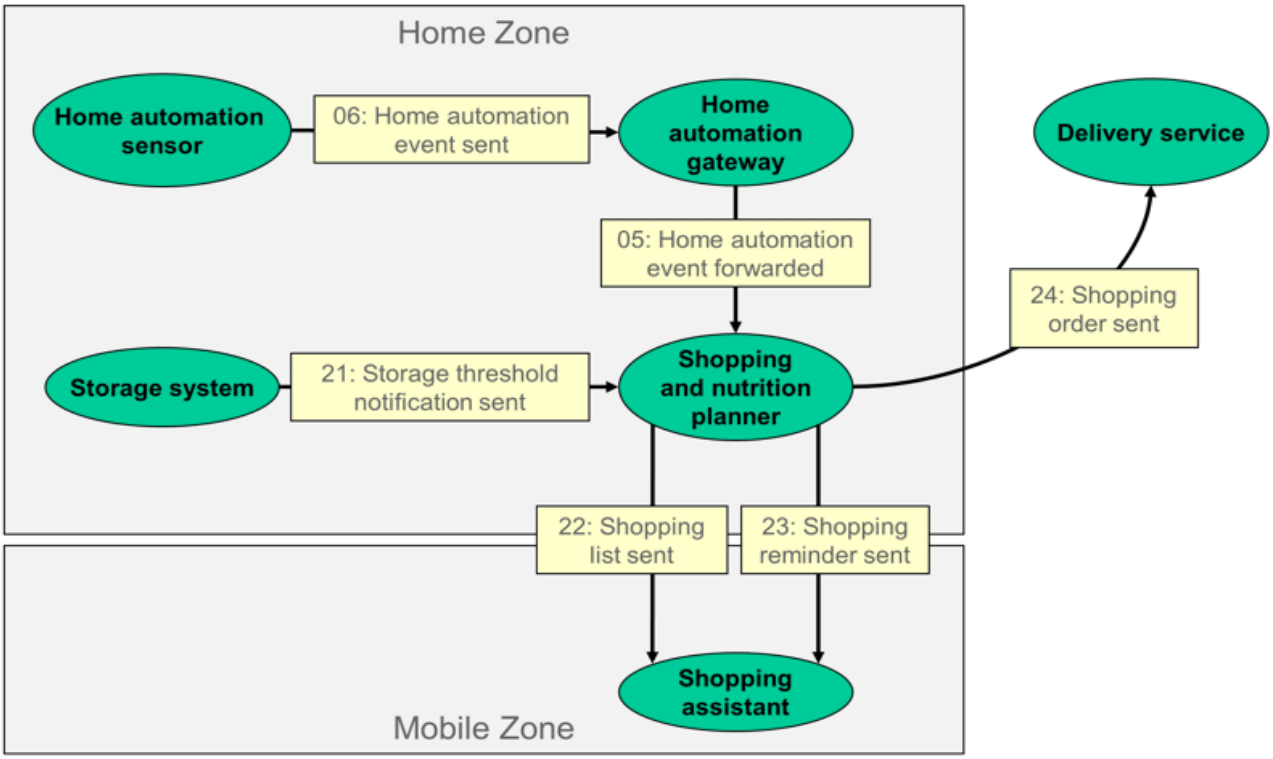
The “Shopping and nutrition planner” is the core of this integration profile: a system that allows the user to assemble a shopping list, which can then either be transferred to a mobile device for conventional shopping, or be sent to a shopping service for door-to-door delivery, in the case of goods that are too heavy, shops too far away, or simply due to bad weather periods. The device needs to furthermore support the splitting of a shopping list into a part to be transferred to the mobile device, and parts for online ordering from (possibly multiple) shops. As the name indicates, the system furthermore contains a “nutrition planner” component that may contain recipes according to the preferences of the user, but may also have advisory functions to support a healthy lifestyle and a nutrition adapted to the personal needs of the user (e.g. under consideration of chronic diseases such as diabetes). Possible device types for this actor may be a smart TV, a tablet, or a smartphone, although this profile does not define any restriction with regard to the type of device used as the “Shopping and nutrition planner”.

The second component in this integration profile is the “shopping assistant” actor, a mobile device that acts as an electronic shopping list. This actor may either be a separate mobile device (especially if the shopping and nutrition planner is implemented on a stationary device such as a smart TV), or may be grouped with the shopping and nutrition planner, i.e. both actors may be running on the same physical mobile device. The shopping assistant will often be grouped with the “mobility assistant” actor from Integration Profile 5: Mobility Assistant, i.e. offer outdoor and possibly indoor pedestrian navigation functions.

Optional components are “storage systems”, i.e. devices such as intelligent fridges that can report the stock level of certain goods, such that items can be automatically added to the shopping list if needed, and home automation actors “reporting” when the user leaves home or arrives at home, thus enabling a reminder displayed on the shopping assistant when a shopping list has been created but the user has forgotten to actually go shopping.

4.4.3 Actors, Transactions and Options

4.4.3.1 Actors and Transactions



Shopping and Nutrition Planner: Actors and Transactions

Actor Descriptions:

- *Home automation sensor:* A home automation sensor reporting an event when the user leaves home. This may be a door contact on the apartment door.
- *Home automation gateway:* A system that translates between one home automation field bus (KNX or ZigBee) and a field bus independent, generic network protocol that is used by the Shopping and nutrition planner to interact with the home automation independent from the implemented field bus.
- *Storage system:* A system such as an intelligent fridge that reports the stock level of stored goods, so that items getting low on stock can automatically be added to the next shopping list.
- *Shopping and nutrition planner:* A system that allows the user to assemble a shopping list which can then either be transferred to a mobile device for conventional shopping, or be sent to a shopping service for door-to-door delivery. The system furthermore contains a “nutrition planner” component.
- *Shopping assistant:* A mobile device that acts as a portable electronic shopping list, and may be grouped with the “mobility assistant” actor from Integration Profile 5: Mobility Assistant, i.e. offer outdoor and possibly indoor pedestrian navigation functions.
- *Delivery service:* A third-party service provider that accepts orders in electronic form and delivers the goods to the customer's home.

Transaction Descriptions:

- *06: Home automation event sent:* A home automation sensor sends an event (e.g. user opens front door) to the home automation gateway.
- *05: Home automation event forwarded:* The home automation gateway forwards some home automation event received from a home automation sensor to the shopping and nutrition planner, using a field-bus independent protocol.
- *21: Storage threshold notification sent:* A storage system sends a message indicating that the stock for a

certain good has fallen short of the pre-defined threshold.

- *22: Shopping list sent:* The shopping and nutrition planner transfers the shopping list for conventional shopping to the mobile shopping assistant.
- *23: Shopping reminder sent:* The shopping and nutrition planner determines, based on timeouts and home automation events, that the user may have forgotten the shopping list and sends a reminder to the shopping assistant, which in turn presents the reminder to the user.
- *24: Shopping order sent:* The shopping and nutrition planner transmits an order in electronic form to an online shop offering home delivery.

4.4.3.2 Profile Options

The following table describes, which transactions must be supported by which actor. Possible types are: R (required), O (optional) or C (conditional). For conditional transactions, the condition under which the transaction is required is documented in a note below.

Actor	Transaction	Optionality
Home automation sensor	06: Home automation event sent	R
Home automation gateway	05: Home automation event forwarded	R
	06: Home automation event sent	R
Storage system	21: Storage threshold notification sent	R
Shopping and nutrition planner	05: Home automation event forwarded	O
	21: Storage threshold notification sent	O
	22: Shopping list sent	R
	23: Shopping reminder sent	C (1)
	24: Shopping order sent	R
Shopping assistant	22: Shopping list sent	R
	23: Shopping reminder sent	R
Delivery service	24: Shopping order sent	R

The following table describes so-called “profile options”, which are either optional extensions to certain actors, or alternative implementation approaches. Possible types are: R (required), O (optional) or C (conditional). For conditional profile options, the condition under which the profile option is required is documented in a note below. Interoperability can only be expected to be given between systems or system components implementing complementary roles of one transaction *using the same profile option*. In this integration profile, two sets of alternative profile options have been defined:

- The home automation sensors and actuators can be connected either using a classical (in most cases cable-based) KNX field bus (KNX option), or alternatively using a wireless connection based on the ZigBee Home Automation profile (ZigBee option). It is understood that there are further standardised home automation buses, such as LON, BACnet or EnOcean that might be considered for future extensions of this profile. For now, only these two home automation standards have been selected.
- The integration between the Shopping and nutrition planner, the home automation gateway, and the shopping assistant may be alternatively implemented either using the “conventional” option based on syntactic interoperability standards, or using the “universAAL” option based on the universAAL middleware, which uses semantic communication between nodes.

Actor	Profile Option	Optionality
Home automation sensor	KNX option	C (2)
	ZigBee option	C (2)
Home automation gateway	KNX option	C (2)
	ZigBee option	C (2)

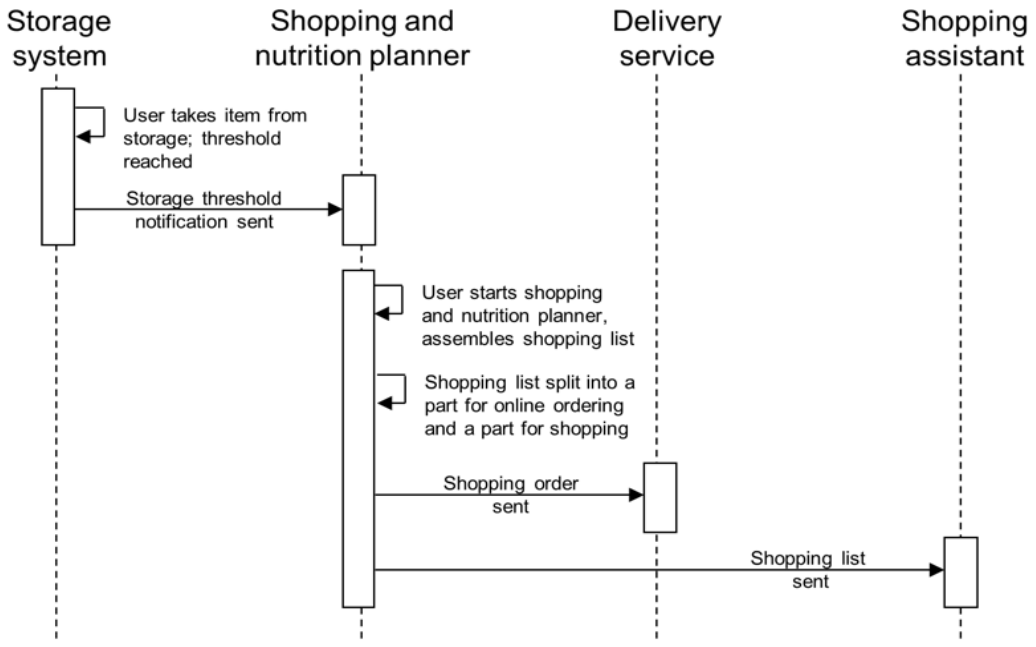
	Conventional option	C (3)
	universAAL option	C (3)
Storage system	-	-
Shopping and nutrition planner	Conventional option	C (3)
	universAAL option	C (3)
Shopping assistant	Conventional option	C (3)
	universAAL option	C (3)
Delivery service	-	-

Notes:

- (1) Shall be supported if transaction 05: Home automation event forwarded is supported.
- (2) Either “KNX option” or “ZigBee” option or both shall be supported.
- (3) Either “Conventional” or “universAAL” option shall be supported.

4.4.4 High level process and data flow

The following sequence diagrams show the most important process and data flows for this integration profile. The first diagram below shows the basic operation of the profile for the preparation and use of shopping lists. A storage system (which is an optional feature in this profile) sends a message whenever a pre-defined threshold for a certain stock item is reached. This information is stored in the shopping and nutrition planner and used when the user initiates a shopping session. The user may now assemble a shopping list, making use of recipes and suggestions from the shopping and nutrition planner. The user then decides which items should be ordered from a delivery service, and which items he/she will buy while visiting the shops. The system then transmits a shopping order to a delivery service, and transmits the shopping list with the items to be purchased conventionally to the mobile shopping assistant. The user takes the shopping assistant as an electronic shopping list when going shopping.



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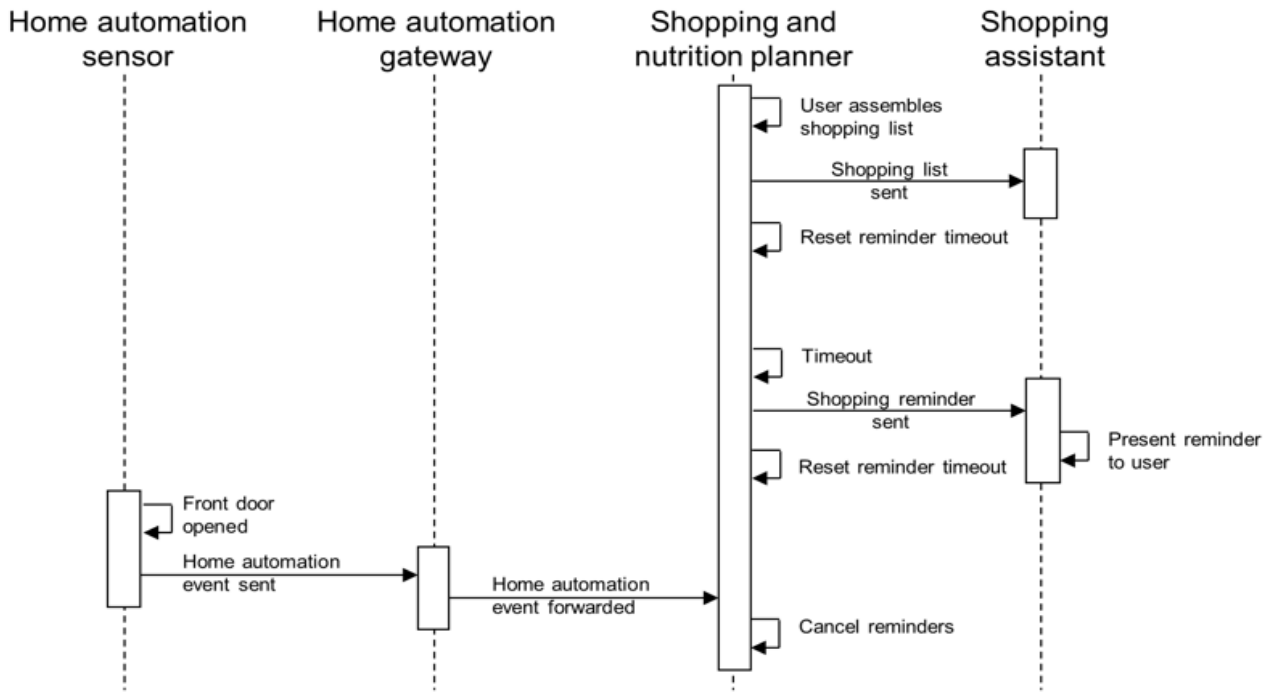
High level process flow - example 1: preparing a shopping list

The second diagram shows the reminder service. Again the user uses the shopping and nutrition planner to assemble a shopping list, which in this example is completely transferred to the mobile shopping assistant.

The shopping and nutrition planner furthermore starts a timeout counter for reminding the user to go shopping. As the timeout runs out, the Shopping reminder sent transaction is invoked, which causes the mobile shopping assistant to present an audiovisual reminder to the user. The shopping and nutrition planner then re-sets the timeout and waits again. Finally the user decides to go shopping and leaves home. This causes a home automation event to be generated and forwarded to the shopping and nutrition planner, which then stops its reminder service.



High level process flow - example 2: reminder service

It may seem strange, at first, that reminders are *presented* by the mobile shopping assistant, but *generated* by the shopping and nutrition planner. This approach has been chosen for two reasons:

- In an implementation with a stationary shopping and nutrition planner and a mobile shopping assistant, it is preferable to connect the home automation infrastructure to the stationary device for security reasons.
- The shopping reminder sent transaction may be initiated by the shopping and nutrition planner as a result of an incoming storage threshold notification sent transaction (i.e. the information that a certain item is out of stock), even if no shopping list has been created yet. This information is simply not available at the mobile shopping assistant.

Since the mobile shopping assistant may have additional information about the status of the shopping (e.g. certain goods may have been ticked off the shopping list, or a navigation system may indicate that the user is indeed shopping and not, e.g., visiting a friend), the presentation of reminders is a shared task between both actors. The shopping assistant may generate additional reminders (e.g. based on the fact that the shopping list has not been “ticked off”) or may suppress reminders received from the shopping and nutrition planner (e.g. based on the fact that the shopping list has in fact been marked as “done”).

4.4.5 Ethical and Legal Considerations

Since the transaction “Shopping order sent” will cause a legally binding contract to be closed between the user and the online shop, this transaction needs to be protected from inadvertent activation due to user error or software errors. Furthermore, a means of cancelling orders (if need be by means of human communications) should be established.

As recommendations concerning healthy nutrition may have an influence on the health status of the user, the set of facts and rules used by the shopping and nutrition planner should follow the state of the art in

nutritional science and should be updated from time to time to follow current knowledge.

4.4.6 Transaction Definitions

Not all transactions for this profile are defined at this time, since the scope of the project is to only develop transactions for two integration profiles, and only develop the high-level part of the profile (i.e., this page) for the others.

Transactions that are defined for this profile can be recognised by links shown in green colour. The transactions are defined in chapter 5 of this document.

- Transaction 05: Home automation event forwarded
- Transaction 06: Home automation event sent
- Transaction 21: Storage threshold notification sent
- Transaction 22: Shopping list sent
- Transaction 23: Shopping reminder sent
- Transaction 24: Shopping order sent

4.5 Integration Profile: Mobility Assistant

4.5.1 Rationale

4.5.1.1 Introduction

Many people with physical disabilities experience problems with mobility, which can make it difficult for them to live in disabled independence, get out and carry out everyday activities.

4.5.1.2 Purpose & Scope

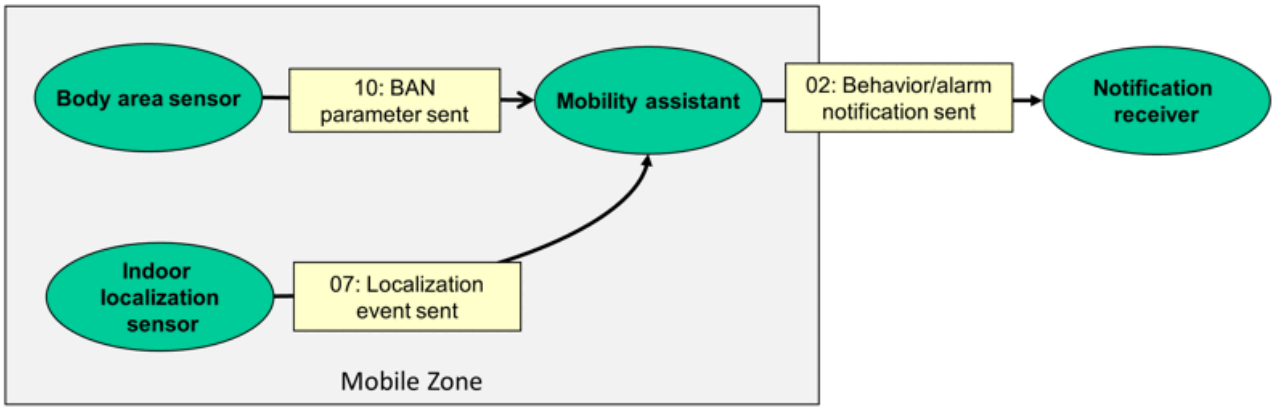
The core hardware of the system is a mobility assistant (which may be a mobile device such as a smartphone, or a “smart walker” that is extended with a computing unit). The mobility assistant is linked with further wired or wireless sensors. These sensors are used to record vital signs (e.g. heart rate or blood pressure) and acceleration. The latter data is used to detect dangerous situations like falls. A GPS sensor and possibly an indoor localization system localize the position of the user. This information can be used in case of an emergency situation. If the system does not detect the dangerous situation by itself, the user can also press a “panic button” to request help by contacting an emergency call centre.

4.5.2 Storyboard

The Mobility assistant is the main AAL system that is described in this scenario. The assistant is a piece of hardware that helps persons to maintain their mobility. Widely known implementations are canes, crutches, walkers, and wheelchairs. In this scenario, the conventional hardware is extended with a computing device (e.g. a smartphone or some specialized hardware). The device can rely on built-in sensors (e.g. an alert button) or it can be connected with the Body area sensor and processes the collected information to detect dangerous situations (e.g. falls). It also receives localization information from an Indoor localization sensor. If a dangerous situation has been detected the device will automatically send an alert to a Notification receiver (e.g. an emergency department).

4.5.3 Actors, Transactions and Options

4.5.3.1 Actors and Transactions



Mobility Assistant: Actors and Transactions

Actor Descriptions:

- *Mobility assistant:* The central actor of this profile, a computerized mobility device receives sensor information such as accelerometer data or vital signs. The information may be transferred to a PHR or used in case of an emergency to send an alert.
- *Body area sensor:* A vital parameter sensor or accelerometer worn on the body.
- *Indoor localization sensor:* A device such as a floor mat that provides information about the location of the user within the apartment.
- *Notification receiver:* An external system operated by a call centre, a formal carer or an informal carer that receives either emergency calls (e.g. fall detection) or notifications about relevant (but not urgent) facts such as behaviour changes.

Transaction Descriptions:

- *02: Behaviour/alarm notification sent:* A notification or an alarm is sent by the behaviour monitor to a notification receiver, which is located outside the user's home.
- *07: Localization event sent:* An indoor localisation sensor sends a message containing the current position of the user to the mobility assistant.
- *10: BAN parameter sent:* A body area sensor sends a measured parameter or set of parameters to the BAN gateway - in this case the mobility assistant.

4.5.3.2 Profile Options

The following table describes, which transactions must be supported by which actor. Possible types are: R (required), O (optional) or C (conditional). For conditional transactions, the condition under which the transaction is required is documented in a note below.

Actor	Transaction	Optionality
Mobility assistant	10: BAN parameter sent	O
	02: Behaviour/alarm notification sent	R
	07: Localization event sent	O
Body area sensor	10: BAN parameter sent	R
Notification receiver	02: Behaviour/alarm notification sent	R
Indoor localization sensor	07: Localization event sent	R

The following table describes so-called “profile options”, which are either optional extensions to certain

actors, or alternative implementation approaches. Possible types are: R (required), O (optional) or C (conditional). For conditional profile options, the condition under which the profile option is required is documented in a note below. Interoperability can only be expected to be given between systems or system components implementing complementary roles of one transaction *using the same profile option*.

In this integration profile, transaction 07 (Localization event sent) can be implemented either using the "conventional" option, or using the "universAAL" option based on the universAAL middleware, which uses semantic communication between nodes.

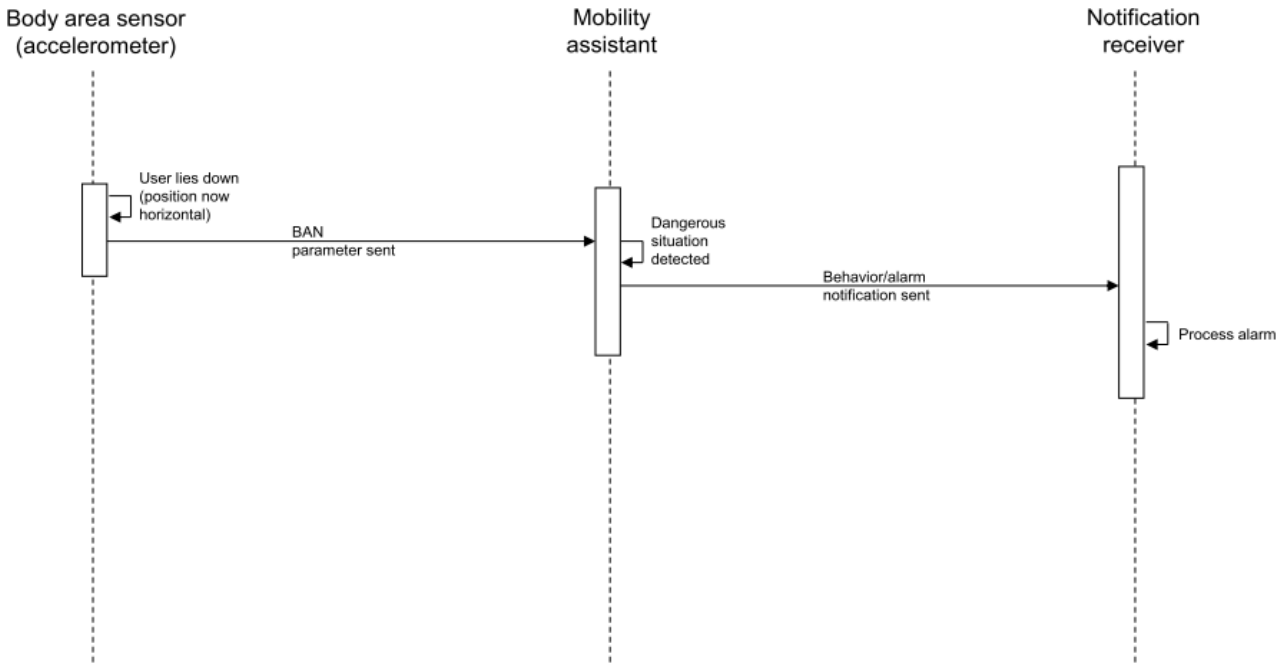
Actor	Profile Option	Optionality
Mobility assistant	Conventional option	C (1)
	universAAL option	C (1)
	Bluetooth HDP option	C (2)
	Bluetooth LE option	C (2)
	USB option	C (2)
Indoor Localization Sensor	Conventional option	C (1)
	universAAL option	C (1)
Body area sensor	Bluetooth HDP option	C (1)
	Bluetooth LE option	C (1)
	USB option	C (1)
Notification receiver	-	-

Notes:

- (1) Either "Conventional" or "universAAL" option shall be supported.
- (2) At least one of the options "Bluetooth HDP", "Bluetooth LE" or "USB" shall be supported. Multiple options may be supported.

4.5.4 High level process and data flow

The following sequence diagrams show the most important process and data flows for this integration profile. Basically all sensors connected to the mobility assistant (Body area sensor, indoor localization sensor) deliver sensor data at an implementation-defined frequency. It is the task of the mobility assistant to fuse this data and derive information about recognized dangerous situations. In the case that such a situation has been detected or that the user presses the "panic button" manually, the system sends a notification to the notification receiver (e.g. an emergency call centre):



|*High level process flow - example: alert detection and notification*

4.5.5 Ethical and Legal Considerations

The mobility assistant can be couples with sensors, which localize the user and determining his physical activity state. The recorded information is processed on the computing hardware which is attached to the mobility device (e.g. the walker). Thereby, the user has to secure the mobility device. As the only interaction with the device required by this scenario is the alert button, the data shall be stored in an encrypted database and deleted when not needed anymore.

The transmission between the Body area sensor and the mobility assistant has to be encrypted and the device has to use a secure (e.g. PIN-based) pairing mechanism.

4.5.6 Transaction Definitions

The transactions for this profile are defined in chapter 5 of this document.

- Transaction 02: Behaviour/alarm notification sent
- Transaction 07: Localization event sent
- Transaction 10: BAN parameter sent

4.6 Integration Profile: Personal Trainer

4.6.1 Rationale

4.6.1.1 Introduction

Amyotrophia and cardiovascular weakness are big challenges in older adults, leading to fragility and a reduction of physical activities, and in the end in a reduced ability to perform activities of daily living. Physical exercise is, therefore, as important for older adults as it is for young people.

4.6.1.2 Purpose & Scope

The Personal Trainer is a system that tracks the physical activity of the user and combines this data with medical information to create a personalized training plan and to offer learning media like video tutorials to the user.

4.6.2 Storyboard

The Personal Trainer determines the amount of physical activity that is performed by the user, gives feedback, and performs an individual training plan.

The amount of physical activity is determined by a body activity sensor that is worn by the user. This device collects the raw sensor data and sends it to an activity determination module, which can be implemented as an smart phone app. The user can use the smart phone to get feedback, but does not have to. The activity determination component sends the activity information to a personal health record (PHR), which collects this information, presents it to the user and is also able to share it with clinical IT systems (Electronic Health Records) if the user wants to. The PHR can include a component that educates the user in the optimization of certain physical or household activities. A doctor can review the collected activity data as well as former training results and create individualized training plans. These training plans will be explained to the user in person, so that he is able to perform them by himself at his training devices at home (see (RM1)).

The training / game devices (e.g. a bicycle ergometer or an interactive computer game that involves physical activity) can be used to perform an individualized physical training that is adapted to the needs of the user. Depending on the training modality the user can also wear body area sensors that record his/her vital signs (e.g. heart rate, SpO2), which are used for the short-term adaptation of the training plan.

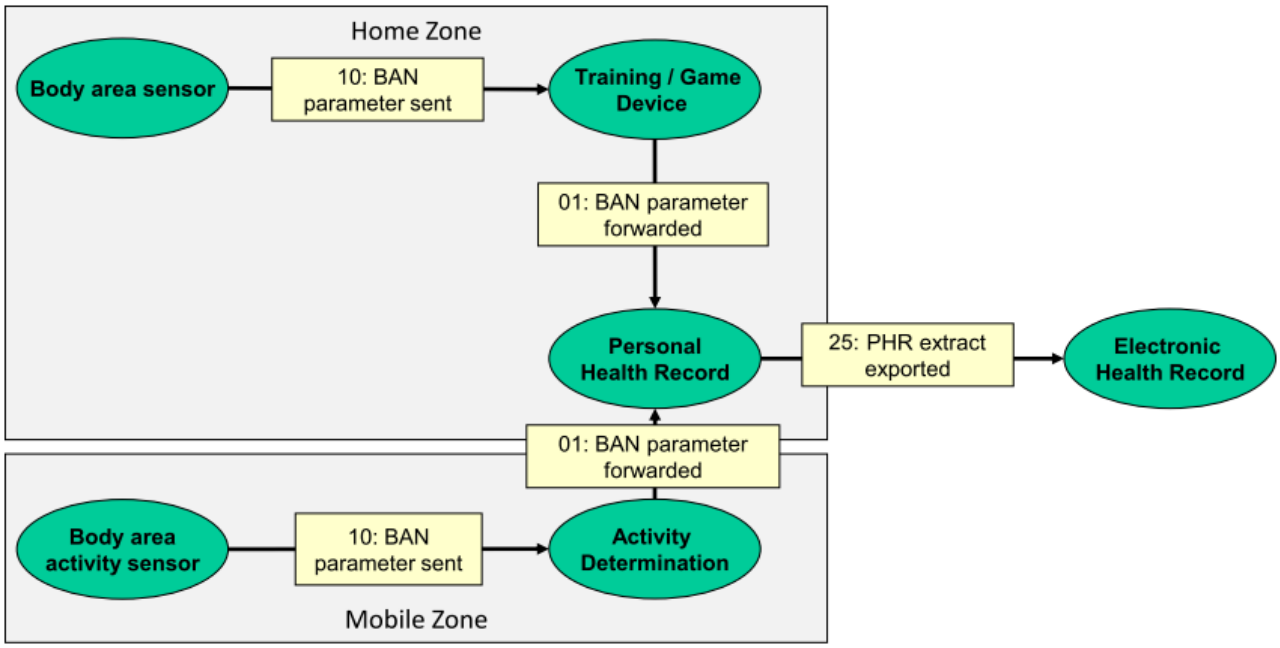
(RM1): *Remark from the authors: This system behaviour as specified in this integration profile still leaves room for improvement, because the user has to enter the training parameters manually into the training device. A better approach would be a transmission of these values in the interoperability profile. This workflow was chosen because currently no open standard for the transmission of training or rehabilitation data plans seems to exist. The following possibilities were found during the research in this topic, but were rated as insufficient:*

8. *There are existing data formats for such a transmission (*example*), but these are proprietary and do not reach a wide market penetration. They are also not appropriate for the transmission of training data through the internet.*
9. *HL7 has a template for* rehabilitation data*, but this template is only sufficient for billing purposes and can not transport training parameters.*
10. *A German research project states that they currently defining a template based on the clinical document architecture that reflects a training plan (see* newspaper article in German language*). The project started 2010, but until this day no HL7 ballot or other information on the internet shows that a usable result has been accomplished.*

We conclude that the definition of a workflow and a document template / data format for the transmission of training / rehabilitation plans is not finished yet.

4.6.3 Actors, Transactions and Options

4.6.3.1 Actors and Transactions



Personal Trainer: Actors and Transactions

Actor Descriptions:

- *Body area sensor:* A Body area sensor that is specialized for the measurement of performed physical activity. This can be done by the measurement of vital signs, accelerometric information, temperature etc. The sensor is connected with the Activity determination and sends none or low processed raw data.
- *Training/game device:* A device interacting with the user so that he performs a specific physical activity at a certain level.
- *Personal health record:* A personal health record (PHR) is a collection of electronic health information about patients that is managed by the patient himself or another related person. The patient controls the information (sharing, entering, deleting) inside the record.
- *Body area activity sensor:* A Body area sensor that is specialized for the measurement of performed physical activity. This can be done by the measurement of vital signs, accelerometric information, temperature etc. The sensor is connected with the Activity determination and sends none or low processed raw data.
- *Activity determination:* A computer program that includes algorithms, which determine the amount of performed physical activity from sensor data. The program may send this information to a personal health record.
- *Electronic health record:* An electronic health record (EHR) is a collection of electronic health information about patients. Typically, it is used in practices or hospitals and is managed and controlled by health care professionals like doctors or nurses.

Transaction Descriptions:

- *01: BAN parameter forwarded:* A BAN gateway forwards a vital parameter or accelerometry data received from a sensor in the body area network to the personal health record.
- *10: BAN parameter sent:* A body area activity sensor sends a measured parameter or set of parameters to the BAN gateway - in this case the activity determination and the game / training device.
- *25: PHR extract exported:* A summary of the health related information inside the PHR is generated and send to an EHR where it may be revised or included in the local EHR.

4.6.3.2 Profile Options

The following table describes, which transactions must be supported by which actor. Possible types are: R (required), O (optional) or C (conditional).

Actor	Transaction	Optionality
Electronic Health Record	25: PHR extract exported	R
Personal Health Record	25: PHR extract exported	O
	01: BAN parameter forwarded	R
Training / Game Device	01: BAN parameter forwarded	R
	10: BAN parameter sent	R
Body area sensor	10: BAN parameter sent	R
Activity Determination	01: BAN parameter forwarded	R
	10: BAN parameter sent	R
Body area activity sensor	10: BAN parameter sent	R

The following table describes so-called “profile options”, which are either optional extensions to certain actors, or alternative implementation approaches. Possible types are: R (required), O (optional) or C (conditional). For conditional profile options, the condition under which the profile option is required is documented in a note below. Interoperability can only be expected to be given between systems or system components implementing complementary roles of one transaction *using the same profile option*.

In this integration profile, transaction 07 (Localization event sent) and transaction 01 (BAN parameter forwarded) can be implemented either using the “conventional” option, or using the “universAAL” option based on the universAAL middleware, which uses semantic communication between nodes.

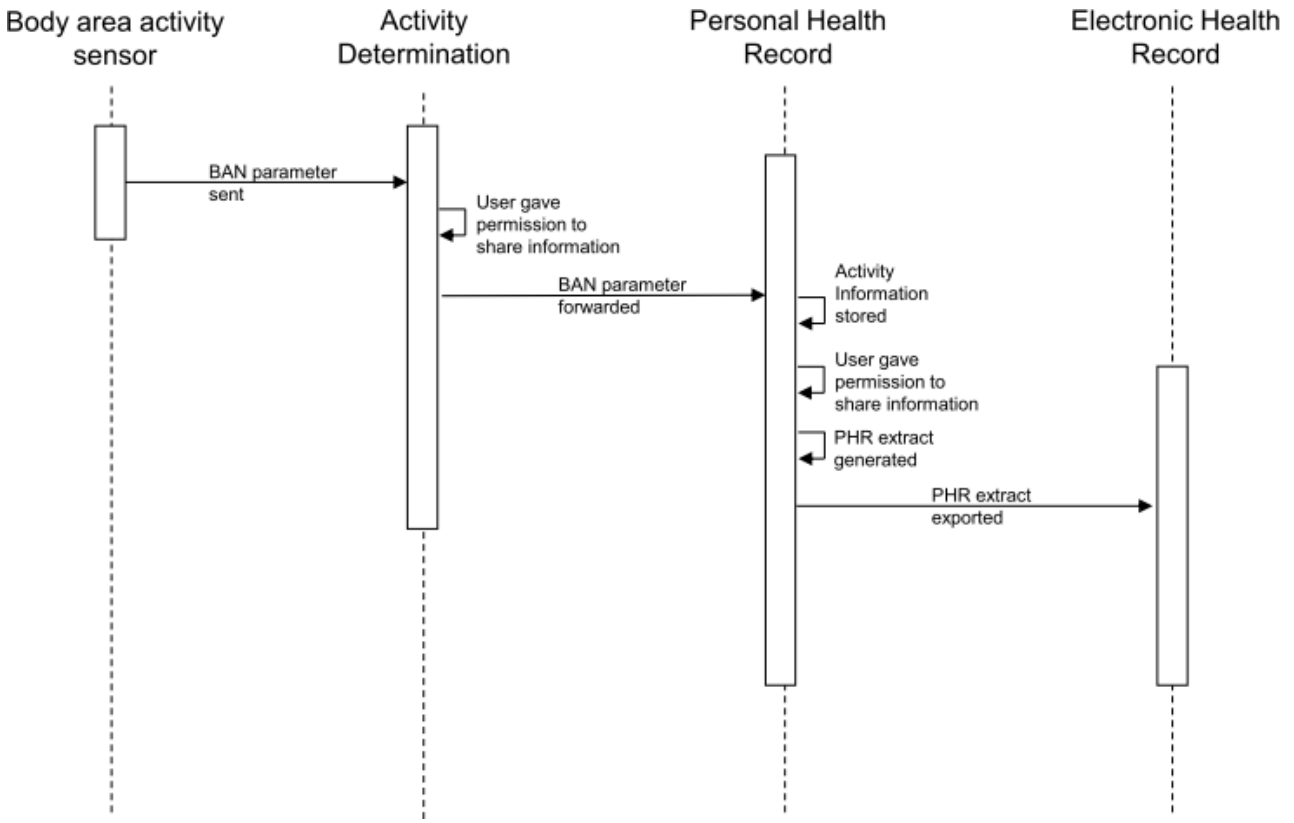
Actor	Profile Option	Optionality
Electronic Health Record	-	-
Personal Health Record	Conventional option	C (1)
	universAAL option	C (1)
Training / Game Device	Bluetooth HDP option	C (2)
	Bluetooth LE option	C (2)
	USB option	C (2)
Body area sensor	Bluetooth HDP option	C (2)
	Bluetooth LE option	C (2)
	USB option	C (2)
Activity Determination	Conventional option	C (1)
	universAAL option	C (1)
	Bluetooth HDP option	C (2)
	Bluetooth LE option	C (2)
	USB option	C (2)
Body area activity sensor	Conventional option	C (1)
	universAAL option	C (1)
	Bluetooth HDP option	C (2)
	Bluetooth LE option	C (2)
	USB option	C (2)

Notes:

- (1) Either “Conventional” or “universAAL” option shall be supported.
- (2) At least one of the options “Bluetooth HDP”, “Bluetooth LE” or “USB” shall be supported. Multiple options may be supported.

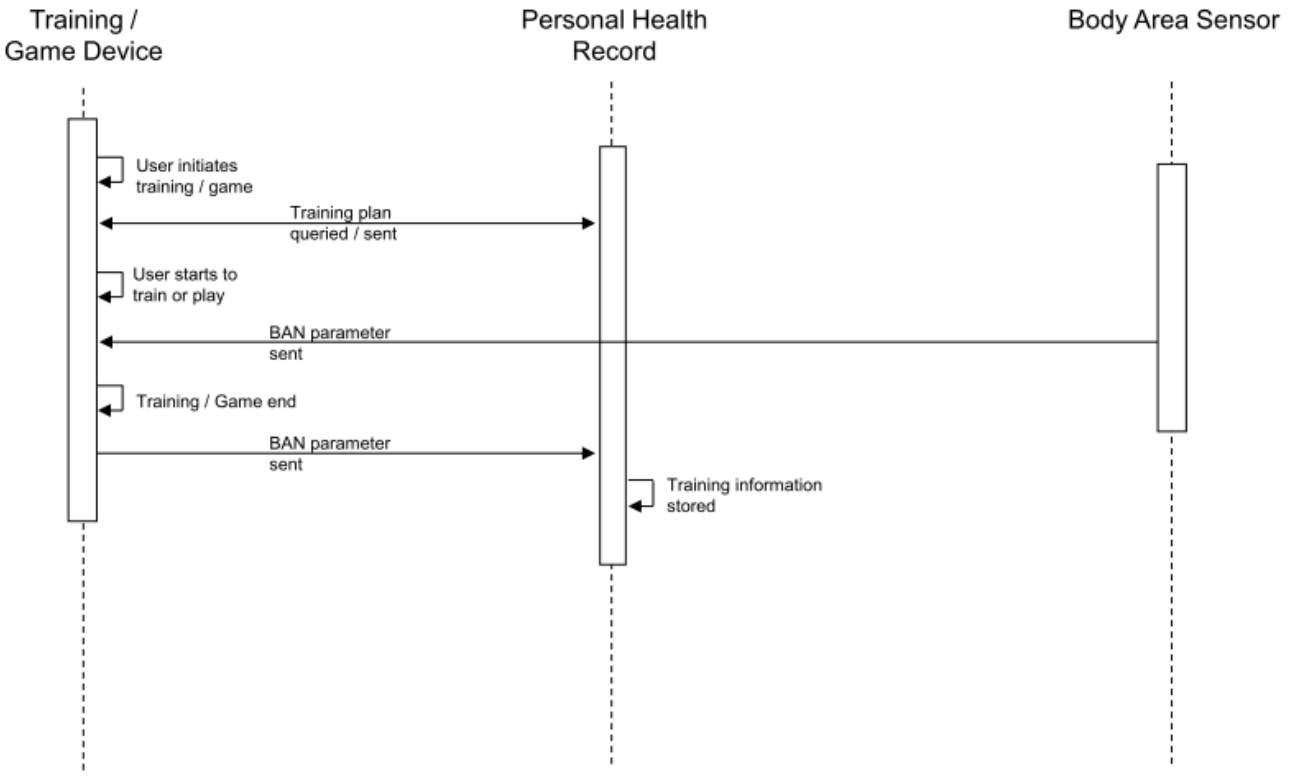
4.6.4 High level process and data flow

The following sequence diagrams show the most important process and data flows for this integration profile. The body area activity sensors (e.g. accelerometer, heart rate sensor, and calorimeter) connected to the activity determination deliver sensor data at an implementation-defined frequency. It is the task of the activity determination to derive activity information and present it to the user. If there is a connection to a personal health record and the user decides to transmit his information in his PHR the information is forwarded. If the user decides to share his information with a healthcare professional, then a PHR extract is generated and transmitted to an electronic health record. If the healthcare professional creates a personalized training plan for the user, the electronic health record updates the PHR.



Recording personal health data, collect it and share with an electronic health record.

When the user starts to train or play with his Training / Game Device the training plan is queried from the PHR and sent to the device. The user may monitor his vital signs by the Training / Game device, which adapts the training plan. After the training – and presumed that the user gave the permission – the training results will be transmitted to the PHR.



Performence of a personalized training session.

4.6.5 Ethical and Legal Considerations

The term “personal training device” already implies that the processed data is of a personal nature. However, the recorded activity data is processed on the smart phone of the user. So, the user takes the responsibility to secure the phone when he decides to install the Activity Determination Application on his device. However, the transmission between the Body area activity sensor and the Activity determination has to be encrypted and the device has to use a secure (e.g. PIN-based) pairing mechanism. Data should be stored encrypted and after being processed the raw data should be deleted. The higher aggregated data reflects only the physical activity without the chance to derive other information than these. Although the user should be informed about the data processing and he have to accept the transmission to the personal health record.

The use of a personal health record and the data exchange between the PHR and the electronic health records is critical, as personal identifiable health information is transferred. The user has to sign an informed consent, when he uses the system to exchange data with an EHR. Furthermore the PHR-system has to provide the possibility to review his own health information before its transmitted and every transmission has to be accepted by him, explicitly. The PHR-system has to store the data and time when the user accepted the transmission. Furthermore the application has to log every activity that is related to health data that is stored in the PHR. The system should inform the user that he is responsible for data loss, e.g. due to a hard disc crash. Further data protection mechanisms should be considered depending on national laws. The Electronic Health Record is under the control and protection level of a professional healthcare system and the according national laws. Data transfer to this system should be secured as well as data storage and access. As well as in the PHR-system protection from data loss is an important point.

The Training / Game device should store as less health related information as possible. As Training results can be stored in the PHR the system should be designed to clear the complete memory when a training session is completed and the training report has been transmitted to the PHR system. The Body area sensor should also use a secure pairing mechanism and encrypted data transmission.

4.6.6 Transaction Definitions

The transactions for this profile are defined in chapter 5 of this document.

- Transaction 01: BAN parameter forwarded

- Transaction 10: BAN parameter sent
- Transaction 25: PHR extract exported

4.7 Integration Profile: Environmental Health Monitoring And Alarms At Work

4.7.1 Rationale

4.7.1.1 Introduction

Empowering people to participate to the world of employment no matter what restrictions they have (whether depending on diseases or age-related effects) is a key challenge for the future. There was already a lot of previous work regarding workplace ergonomics and safety improvements, but with emerging assisting technologies new scenarios are conceivable. This integration profile introduces a combination of home automation components and mobile devices for detecting dangerous situations and emergencies regarding the workers' health.

4.7.1.2 Purpose & Scope

This profile addresses a home automation system with sensors and actuators, connected to a corporate infrastructure. This infrastructure consists of environmental sensors which are not common in the domestic environment, e.g. for detecting air pollution or gas leaks. In case of an emergency this information is simultaneously forwarded to the workers in the affected areas and (corporate) emergency services. The workers carry mobile emergency devices with them to receive these alerts. These devices can be enriched with body area sensors for recording vital parameters if a previous disease is indicated.

Note: In this profile, the term "home automation" is used instead of "building automation" for reasons of consistency with the other profiles. Technically, both terms refer to the same set of protocols in the transactions specified in this document, that is, KNX and ZigBee.

4.7.2 Storyboard

During working time the environmental health monitor tracks all necessary sensor data through two types of sensors:

- Home Automation Sensors: these sensors can detect open doors and windows, presence of persons and other information.
- Environmental Sensors: these sensors measure the air quality (air pollution, gas leaks), temperature and other environmental information that can affect workers' health or cause dangerous situations. Since the environmental sensors actually use home automation field buses (KNX, Zigbee) to communicate, they are a special case of a home automation sensor, and do not establish a new type of actor or require a separate transaction.

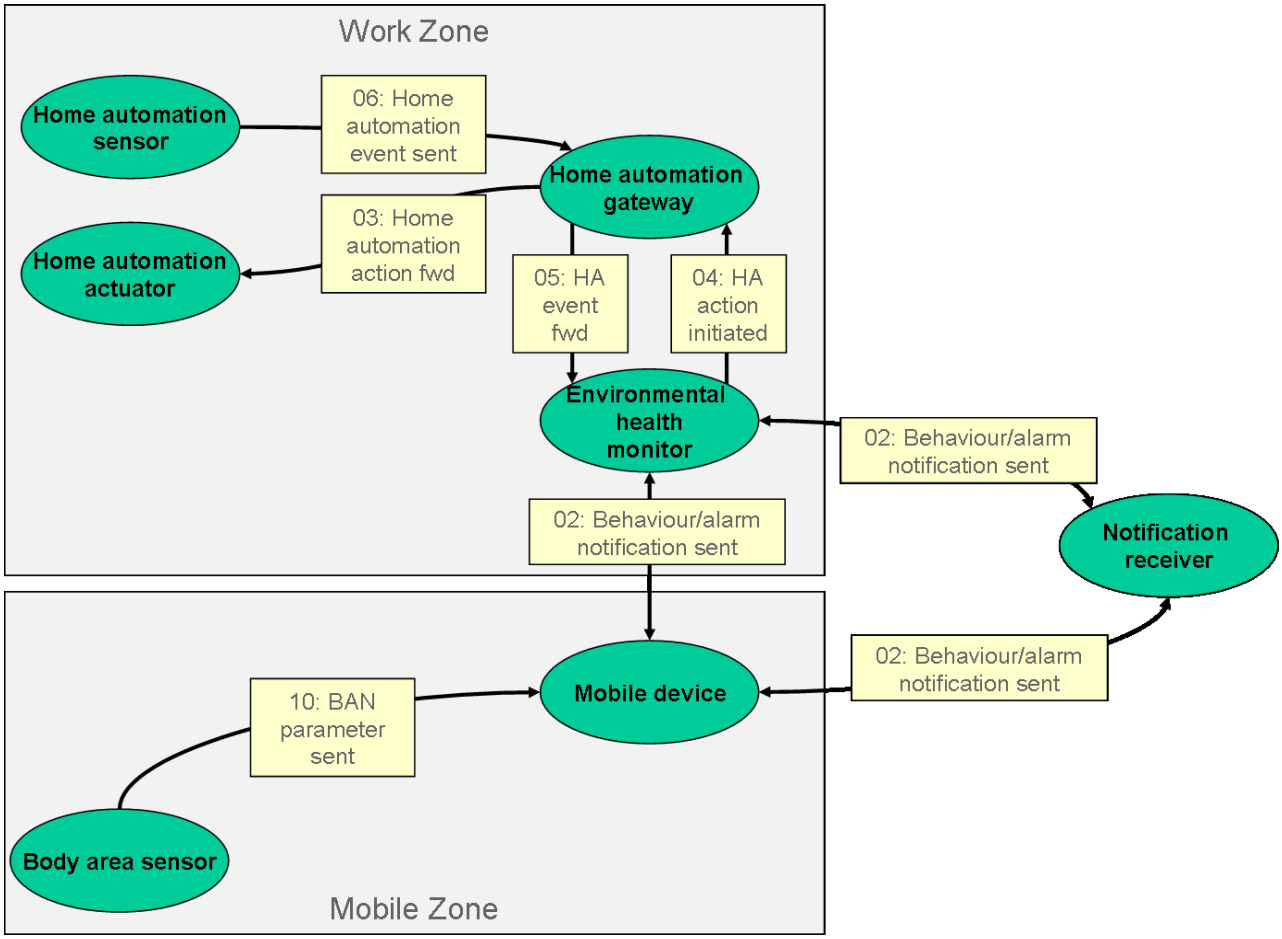
All information is processed by the environmental health monitor. In case of an emergency alarm messages to the workers' mobile emergency devices are initiated and home automation actuators are activated in order to open doors and windows, turning on emergency lightning and other activities to ensure safety at the work place (depending on the kind of emergency).

The mobile emergency device is worn by the workers and has two main tasks:

- Receiving emergency notification by the environmental health monitor.
- Optionally: if a worker has a clinical history, the mobile part of the system can be enriched by body area sensors to track disease-related vital parameters. The scenario addresses myocardial infarction and ventricular fibrillation, but with emerging technologies new fields of application are conceivable, e.g. detection of strokes or epileptic fits.

4.7.3 Actors, Transactions and Options

4.7.3.1 Actors and Transactions



Actor Descriptions:

- *Body Area Sensor*: A vital parameter sensor or accelerometer worn on the body.
- *Environmental Health Monitor*: The central actor of this profile, a computer that receives and processes sensor data (whether from home automation/environmental sensors or the mobile device), recognises dangerous situations, control the home automation actuators in order to handle dangerous situations, receives and sends emergency notifications to the user and external carers.
- *Home Automation Actuator*: A home automation actuator such as lighting, shutters, or a window opener.
- *Home Automation Gateway*: A system that translates between one home automation field bus (KNX or ZigBee) and a field bus independent, generic network protocol that is used by the behaviour monitor to interact with the home automation independent from the implemented field bus.
- *Home Automation Sensor*: A home automation sensor such as a presence detector, light switch, light barrier, or an environmental sensor such as a gas or smoke detector.
- *Mobile Device*: Device that can be carried around and acts like a notification receiver and sender as well as a body area gateway. A body area gateway is a component that receives vital parameters or accelometry data from sensors worn on the body using a short-range wireless protocol and forwards these parameters to the environmental health monitor using a wireless network connection (WLAN or GSM).
- *Notification Receiver*: An external system operated by a call centre, a formal carer or an informal carer that receives either emergency calls (e.g. fall detection) or notifications about relevant (but not urgent) facts such as behaviour changes.

Transaction Descriptions:

- *02: Behaviour/alarm notification sent*: A notification or an alarm is sent by the environmental health monitor to an external notification receiver and the mobile device of the user, for the case that the user is located outside the workplace.
- *03: Home automation action forwarded*: A home automation gateway forwards a command received from the environmental health monitor (such as switching light on/off, opening/closing windows etc.) to a home automation actuator.
- *04: Home automation action initiated:* A environmental health monitor sends a command intended for a home automation actuator to the home automation gateway using a field-bus independent protocol.
- *05: Home automation event forwarded*: A home automation gateway forwards some home automation event received from a home automation sensor to the environmental health monitor, using a field-bus independent protocol.
- *06: Home automation event sent*: A home automation sensor sends an event (e.g. smoke detected, presence detected) to the home automation gateway.
- *10: BAN parameter sent*: A body area sensor sends a measured parameter or set of parameters to the BAN gateway.

4.7.3.2 Profile Options

The following table describes, which transactions must be supported by which actor. Possible types are: R (required), O (optional) or C (conditional). For conditional transactions, the condition under which the transaction is required is documented in a note below.

Actor	Transaction	Optionality
Body area sensor	10: BAN parameter sent	R
Environmental Health Monitor	02: Behaviour/alarm notification sent	R
	03: Home automation action forwarded	R
	04: Home automation action initiated	R
Home automation actuator	03: Home automation action forwarded	R
Home automation gateway	03: Home automation action forwarded	R
	04: Home automation action initiated	R
	05: Home automation event forwarded	R
	06: Home automation event sent	R
Home automation sensor	06: Home automation event sent	R
Mobile device	02: Behaviour/alarm notification sent	R
	10: BAN parameter sent	O
Notification receiver	02: Behaviour/alarm notification sent	R

The following table describes so-called “profile options”, which are either optional extensions to certain actors, or alternative implementation approaches. Possible types are: R (required), O (optional) or C (conditional). For conditional profile options, the condition under which the profile option is required is documented in a note below. Interoperability can only be expected to be given between systems or system components implementing complementary roles of one transaction using the same profile option. In this integration profile, two sets of alternative profile options have been defined:

Actor	Profile Option	Optionality
Body area sensor	Bluetooth HDP option	C (3)
	Bluetooth LE option	C (3)
	USB option	C (3)
Environmental health monitor	Conventional option	C (2)

	universAAL option	C (2)
Home automation actuator	KNX option	C (1)
	ZigBee option	C (1)
Home automation gateway	KNX option	C (1)
	ZigBee option	C (1)
	Conventional option	C (2)
	universAAL option	C (2)
Home automation sensor	KNX option	C (1)
	ZigBee option	C (1)
Mobile Device	Bluetooth HDP option	C (3)
	Bluetooth LE option	C (3)
	USB option	C (3)
Notification receiver	-	-

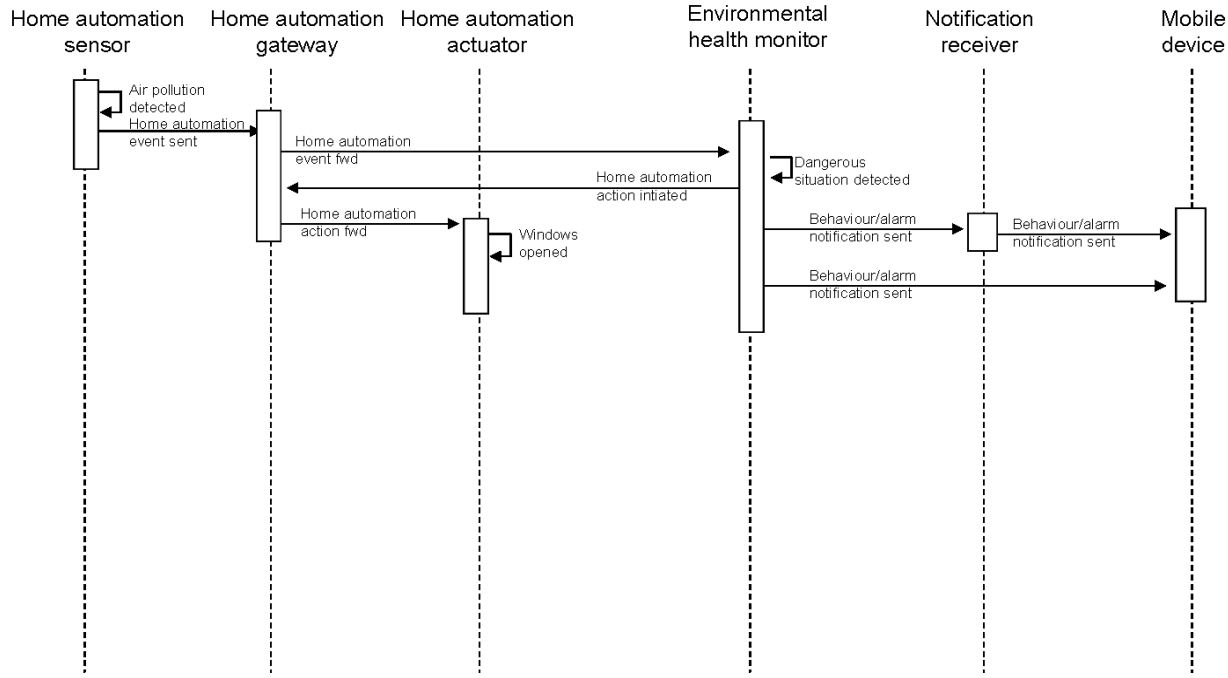
Notes:

- (1) Either “KNX option” or “ZigBee” option or both shall be supported.
- (2) Either “Conventional” or “universAAL” option shall be supported.
- (3) At least one of the options “Bluetooth HDP”, “Bluetooth LE” or “USB” shall be supported. Multiple options may be supported.

4.7.4 High level process and data flow

A multitude of process and data flows are possible. Basically all home automation sensors deliver sensor data to the environmental health monitor at an implementation-defined frequency. All body area sensors deliver sensor data to the mobile device at an implementation-defined frequency.

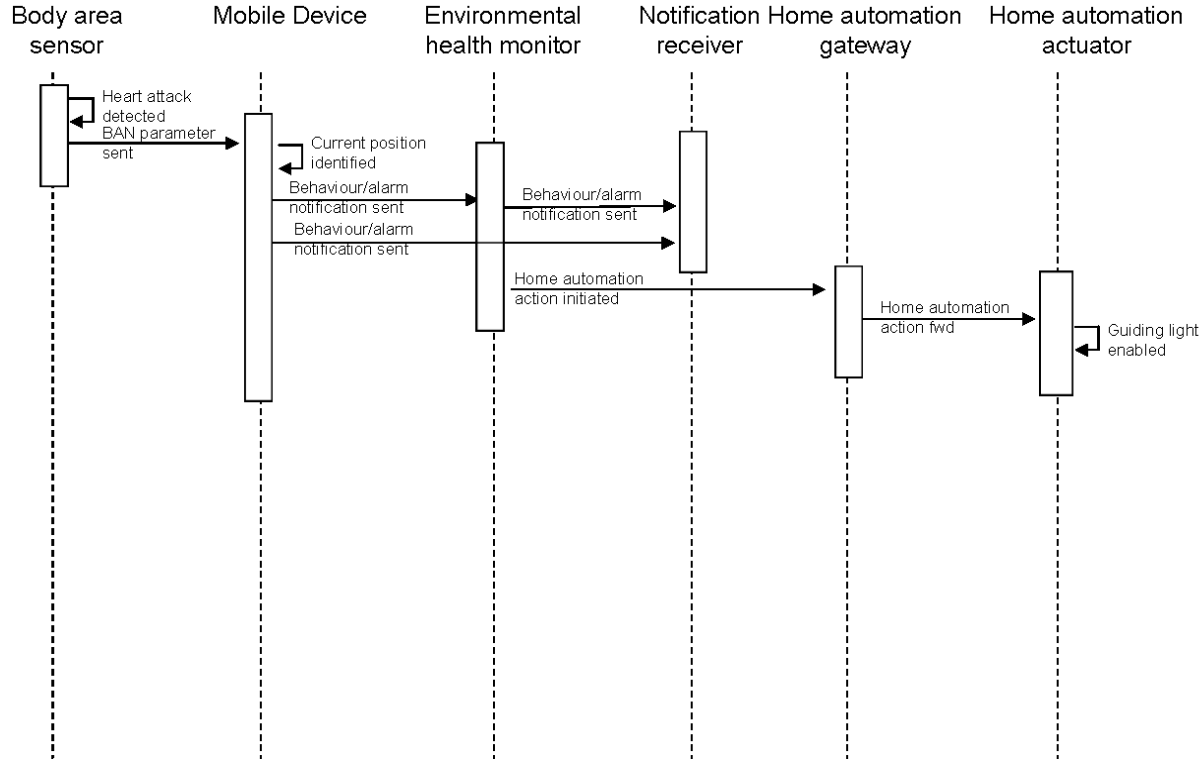
The first sequence flow shows an emergency detected by a home automation sensor:



The home automation sensor (air quality sensor) detects polluted air at the workplace and sends this information to the home automation gateway. The home automation gateway forwards this information to the environmental health monitor. Now, the environmental health monitor processes three actions in parallel:

- A home automation action is initiated (order to open the windows in the contaminated area) and sent back to the home automation gateway. The home automation gateway forwards this order to the home automation actuator which performs the action.
- A message to the notification receiver is sent with information about the incident, the home automation actions performed and the workers in the area. The notification receiver sends this information the mobile devices of the workers in order to inform the workers to leave the contaminated area (this procedure step is performed for safety reason in case the environmental health monitor cannot send the notification to the mobile devices).
- A message to the mobile device is sent in order to inform the workers to leave the contaminated area.

The second sequence flow shows an emergency detected by a body area sensor:



The body area sensor (sensor vest with ECG) detects a hear attack and sends this information to the mobile device. The mobile device localises the position of the user and performs two procedure steps in parallel:

- First it sends the health information together with the localisation to the environmental health monitor. The environmental health monitor now forwards this information to the notification receiver and initiates a home automation action. Via the home automation gateway a guiding light to the place of accident is set up by the home automation actuators (in this case by the lightning in the work area).
- In parallel it sends the health information and localisation also to the notification receiver. In case environmental health monitor is out of order at least the information about the accident can be transported to the notification receiver.

4.7.5 Ethical and Legal Considerations

From the perspective of informational self-determination it might be a problem to inform the employer about employees' health status. Having chronic diseases might be a reason for the employer not to employ a person.

An environmental health monitor cannot be installed and used without the informed consent of the workers. A worker not willing to take part in this system should not be adversely affected for any reason.

Finally, the availability of the communication system over which the "behaviour/alarm notification" transaction is sent, as well as the availability of the notification received, should be considered. If high priority messages (such as notifications about emergency situations) are transmitted, then the notification receiver must be able to react during work time. Furthermore, in these cases a redundant communication infrastructure with

two independent transports (such as cabled internet and GSM wireless) should be considered, in order to maximise the overall availability of the system.

4.7.6 Transaction Definitions

The transactions for this profile are defined in chapter 5 of this document.

- Transaction 02: Behaviour/alarm notification sent
- Transaction 03: Home automation action forwarded
- Transaction 04: Home automation action initiated
- Transaction 05: Home automation event forwarded
- Transaction 06: Home automation event sent
- Transaction 10: BAN parameter sent

5 Transaction Definitions

This chapter defines the technical details (mapping to standards etc.) for the transactions defined in the first two of the integration profiles in Chapter 4.

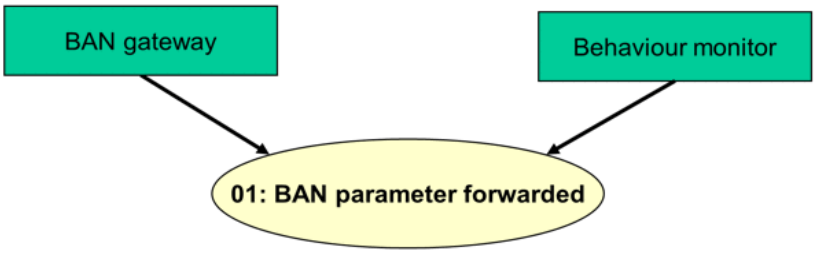
5.1 Transaction 01: BAN parameter forwarded

5.1.1 Scope

The BAN Gateway uses this transaction to forward sensor data to a behaviour monitor. The sensor data has been received by the BAN Gateway from a Body Area Sensor using the “BAN parameter sent” transaction.

This transaction may be alternatively implemented either using the “conventional” option based on the Continua Design Guidelines, or using the “universAAL” option based on the universAAL middleware, which uses semantic communication between nodes.

5.1.2 Use Case Roles



use case roles

Actor: BAN gateway (in Continua this is a “WAN Observation Sender Device”)

Role: Sends (forwards) sensor data received over the body area network.

Actor: Behaviour monitor (in Continua this is a “WAN Observation Receiver Device”)

Role: Receives sensor data from the body area network and fuses it with other sensor data to determine activities of daily living and emergency situations such as falls.

5.1.3 Referenced Standards

5.1.3.1.1 Standards and specifications related to the conventional option

- Continua Health Alliance: Continua Design Guidelines, Version 2012
- Health Level 7 (HL7), Version 2.6: Chapter 7 Observation Reporting
- IEEE Std 11073-10406:2011 Health informatics – Personal health device communication – Part 10406: Device specialization – Basic electrocardiograph (ECG) (1- to 3-lead ECG)
- IEEE Std 11073-10420:2010 Health informatics – Personal health device communication – Part 10420: Device specialization – Body composition analyzer
- ISO/IEEE 11073-10101:2004 Health informatics – Point-of-care medical device communication – Part 10101: Nomenclature
- ISO/IEEE 11073-10404:2010 Health informatics – Personal health device communication – Part 10404: Device specialization – Pulse oximeter
- ISO/IEEE 11073-10407:2010 Health informatics – Personal health device communication – Part 10407: Device specialization – Blood pressure monitor
- ISO/IEEE 11073-10408:2010 Health informatics – Personal health device communication – Part 10408:

Device specialization – Thermometer

- ISO/IEEE 11073-10415:2010 Health informatics – Personal health device communication – Part 10415: Device specialization – Weighing scale
- ISO/IEEE 11073-10417:2010 Health informatics – Personal health device communication – Part 10417: Device specialization – Glucose meter
- ISO/IEEE 11073-10421:2010 Health informatics – Personal health device communication – Part 10421: Device specialization – Peak expiratory flow monitor (peak flow)
- ISO/IEEE 11073-10441:2008 Health Informatics – Personal health device communication - Part 10441: Device specialization–Cardiovascular fitness and activity monitor
- ISO/IEEE 11073-10442:2008 Health Informatics – Personal health device communication - Part 10442: Device specialization - Strength fitness equipment
- ISO/IEEE 11073-10471:2008 Health informatics – Personal health device communication – Part 10471: Device specialization - Independent living activity hub
- ISO/IEEE 11073-10472:2010 Health Informatics – Personal health device communication – Part 10472: Device specialization – Medication monitor
- ISO/IEEE 11073-20601:2010 Health informatics – Personal health device communication – Part 20601: Application profile – Optimized exchange protocol
- Integrating the Healthcare Enterprise - IT Infrastructure Technical Framework, Volume 2x (ITI TF-2x), Revision 10.0: Appendix V: Web Services for IHE Transactions
- Integrating the Healthcare Enterprise - Patient Care Device (PCD) Technical Framework, Volume 2 (PCD TF-2), Revision 3.0: Section 3.1 PCD-01 Communicate PCD Data
- OASIS Security Assertion Markup Language 2.0 http://saml.xml.org/saml-specifications
- OASIS Web Services Reliable Messaging (WS-ReliableMessaging) Version 1.1 http://docs.oasis-open.org/ws-rx/wsrm/v1.1/wsrm.html
- RFC 2246: The TLS Protocol, Version 1.0, 1999.
- RFC 3164: The BSD (Berkeley Software Distribution) Syslog Protocol
- RFC 3195: Reliable Delivery for Syslog
- RFC 3268: Advanced Encryption Standard (AES) Ciphersuites for Transport Layer Security (TLS), 2002.
- RFC 3881: Security Audit and Access Accountability Message XML Data Definitions for Healthcare Applications
- SOAP Version 1.2 Part 1: Messaging Framework (Second Edition), W3C Recommendation 27 April 2007
- Web Services Interoperability (WS-I) Basic Profile Version 1.1, 2006.
- Web Services Interoperability (WS-I) Basic Security Profile Version 1.0, 2007.

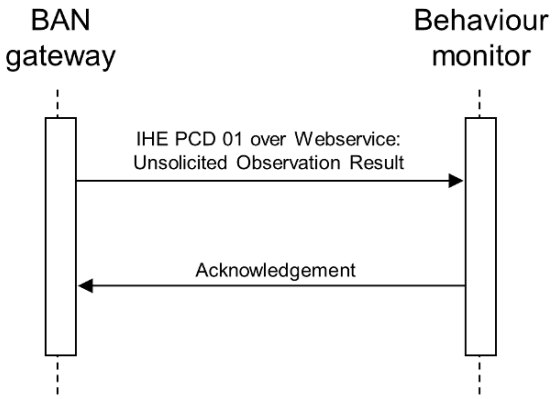
5.1.3.1.2 Standards and specifications related to the universAAL option

- AllSeen Alliance: Introduction to the AllJoyn Framework, December 10, 2013, https://allseenalliance.org/sites/default/files/resources/intro_alljoyn_framework.pdf
- JGroups reliable messaging toolkit, http://www.jgroups.org/
- MQ Telemetry Transport (MQTT) V3.1 Protocol Specification, http://public.dhe.ibm.com/software/dw/webservices/ws-mqtt/mqtt-v3r1.html
- OWL 2 Web Ontology Language Document Overview (Second Edition). W3C Recommendation 11 December 2012, http://www.w3.org/TR/owl2-overview/
- RDF Semantics. W3C Recommendation 10 February 2004, http://www.w3.org/TR/rdf-mt/
- RDF/XML Syntax Specification (Revised). W3C Recommendation 10 February 2004, http://www.w3.org/TR/rdf-syntax-grammar/
- TURTLE: Terse RDF Triple Language. W3C Working Draft 09 August 2011, http://www.w3.org/TR/turtle/
- universAAL ISO 11073-10415 Weighing Scale and 10407 Blood Pressure Devices ontology,

http://forge.universaal.org/wiki/ontologies:X73

- universAAL ISO 11073-10471 Activity Hub ontology, http://forge.universaal.org/wiki/ontologies:ActivityHub
- universAAL Reference Documentation, http://forge.universaal.org/wiki/support:Reference_Documentation

5.1.4 Interaction Diagram



interaction diagram

Note: This interaction diagram shows the “conventional option”.

5.1.5 Messages

5.1.5.1 Conventional Option: Unsolicited Observation Result

5.1.5.1.1 Trigger Events

The transmission is initiated by the BAN gateway whenever new sensor data has been received from a Body area sensor, in order to forward the data to the behaviour monitor. Since the protocol is intended for episodic or periodic transmission of sensor data in a “batch mode”, and not for streaming purposes, the BAN gateway may freely decide how many measurements received from the BAN are packed into one message and how long the maximum delay between receipt from the BAN and transmission to the behaviour monitor may be.

5.1.5.1.2 Message Semantics

This message is based on the “WAN Interface” of the Continua Design Guidelines, which specify the transmission of an HL7 v2.6 ORU^R01 message formatted according to the rules of the IHE Patient Care Devices (PCD) transaction PCD-01 “Communicate PCD Data”.

The sensor data is encoded using the terminology defined in the various parts of the ISO/IEEE 11073 multi-part standard; the mapping from ISO/IEEE 11073 to HL7v2 is described in detail in Appendix A of the IHE Patient Care Devices Technical Framework, Volume 2 and in the Continua Design Guidelines.

In compliance with the Continua Design Guidelines, the transport protocol used to deliver the message is a Web Service call based on the definitions of the “Web Services for IHE Transactions” (IHE IT-I Technical Framework, Volume 2x, Annex V). This is a SOAP 1.2 message taking into account the WS-I Basic Profile 1.1.

Furthermore, since the message may be sent over a public network, the Web Service is secured according to the WS-I Basic Security Profile 1.0, making use of a Transport Layer Security (TLS) 1.0 secure “channel”. AES encryption as described in RFC 3268 must be supported.

Finally, the Web Service is also used to transfer an entity assertion (i.e. proof of identity for the user or application such as a certificate or service ticket). This feature is required for sender and receiver and is based on a WS-Security Header (SAML Token Profile 1.1) with a SAML 2.0 assertion as security token.

The Continua Design Guidelines describe the use of the WS-ReliableMessaging specification for this transaction in order to guarantee that high-priority messages are reliably delivered exactly once (using

"ExactlyOnce" message delivery), whereas low-priority messages may be delivered using "AtMostOnce" message delivery. This capability is optional for the BAN gateway, but required for the Behaviour Monitor, which must support WS-ReliableMessaging as an RM Source for CommunicatePCDDataResponse messages (i.e. incoming messages with sensor data) and as an RM Destination for CommunicatePCDDataResponse messages (i.e. the acknowledgements).

5.1.5.1.3 Expected Actions

Upon receipt of the message, the behaviour monitor is expected to confirm receipt. This confirmation is a HL7v2 ACK^A01 acknowledgement also transmitted through a Web Service as described in the IHE PCD Technical Framework.

Furthermore, the behaviour monitor is expected to integrate the received sensor data into the local knowledge base, with means not defined in this integration profile, and to make use of the data for the recognition of activities or emergencies.

5.1.5.2 universAAL Option

5.1.5.2.1 Trigger Events

The transmission is initiated by the BAN gateway whenever new sensor data has been received from a Body area sensor, in order to forward the data to the behaviour monitor. Since the protocol is intended for episodic or periodic transmission of sensor data in a "batch mode", and not for streaming purposes, the BAN gateway may freely decide how many measurements received from the BAN are packed into one message and how long the maximum delay between receipt from the BAN and transmission to the behaviour monitor may be.

5.1.5.2.2 Message Semantics

universAAL is a distributed middleware that makes the distribution of messages and services transparent to the API user. For universAAL option, both actors (BAN gateway and behaviour monitor) are expected to run an instance of the universAAL middleware connected through the discovery and peering mechanisms of universAAL. This means that the actors will share three message buses: the context bus, the service bus and the user interface bus. The context bus publishes event messages describing changes in the context the system is running in (such as sensor data), the service bus is used to call services (APIs), and the user interface bus is used for messages related to user interface interactions. Messages sent over a bus can be received by software components independent from the actor they are physically located on.

The "messages" exchanged over the three buses are objects representing an instance of an ontology in RDF/OWL format each. When a message is passed between middleware platform instances, each object is serialised using TURTLE and then transmitted using a reliable transport protocol. At this time, universAAL uses JGroups for this purpose, but in the future also other communication protocols such as MQTT and AllJoyn will be supported. This means that the communication protocol is not guaranteed to be stable across all universAAL instances, but the API within the middleware platform is.

For the purposes of this transaction, sensor data shall be communicated as a sequence of events on the universAAL context bus.

While universAAL does not yet define an ontology or set of ontologies that would cover all sensor types supported by this transaction (as a consequence of being supported by Transaction 10: BAN parameter sent), sensors related to ISO/IEEE 11073-10471 (Activity Hub), ISO/IEEE 11073-10407 (Blood pressure monitor) or ISO/IEEE 11073-10415 (Weighing scale) shall use the universAAL *ont.activityhub* or *ont.X73* ontologies, respectively.

5.1.5.2.3 Expected Actions

The behaviour monitor is expected to integrate the sensor data received over context bus events into the local knowledge base, with means not defined in this integration profile, and to make use of the data for the recognition of activities or emergencies.

5.1.5.3 Protocol Requirements

Not applicable.

5.1.5.4 Actor Requirements

Not applicable.

5.1.5.5 Security Considerations

Since this transaction may be carried out over a public network, secure transmission is always enabled, based on a TLS secure channel, which involves point-to-point authentication of sender and receiver, and the transmission of a SAML assertion concerning the identity of the sender (user or device). See section “message semantics” for details.

The Continua Design Guidelines define a logging capability for both actors as an optional capability. When implemented, the logging is compliant with the IHE Audit Trail and Secure Authentication (ATNA) integration profile and is based on the Security Audit and Access Accountability Message XML Data Definitions for Healthcare Applications (RFC 3881), which are delivered either over BSD Syslog (RFC 3164) or over Reliable Syslog (RFC 3195).

When using the universAAL option, the use of a Virtual Private Network (VPN) is recommended.

5.2 Transaction 02: Behaviour/alarm notification sent

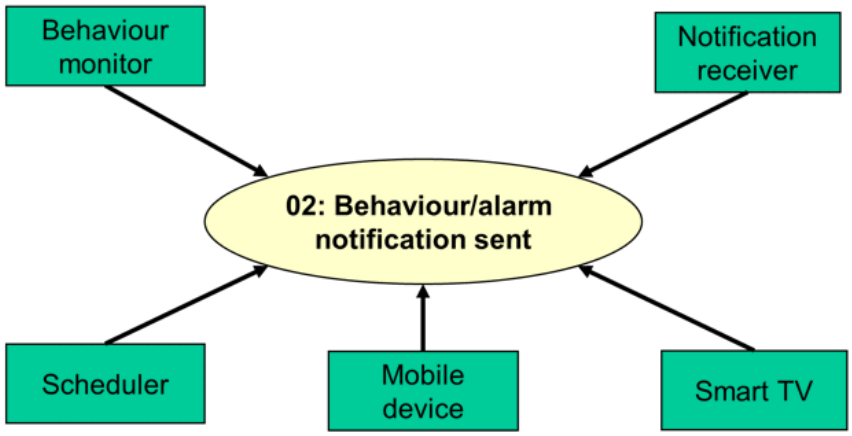
5.2.1 Scope

The Behaviour Monitor and the Scheduler use this transaction to send a notification to a Notification Receiver. The notification may either be an alarm (such as a detected fall, or the result of an “emergency” button pressed by the user), or a notification about long-term changes in behaviour patterns that indicate an increased need for support.

The notification receiver might either be a professional call centre operated by a social alarm service provider, which would be an appropriate choice for alarm messages, or an IT system operated by formal or informal carers, which would be appropriate for notifications about long-term behaviour patterns. It is expected that behaviour monitor actors are able to send notifications to different notification receivers based on routing criteria such as priority or type of event. The precise implementation of this routing mechanism is implementation dependent.

At this time, no accepted international standard for this transaction exists, and most social alarm systems are still based on analogue (modem-like) communication over telephony lines. However, a Swedish standard that very well matches the requirements of this transaction does exist and is used as the technical basis for this transaction: the “Social Care Alarm Internet Protocol” (SCAIP), in Swedish: ftSS 91100 Digitala trygghetslarm – Internetprotokoll för digitala trygghetslarm. A proposal for a new CEN Technical Committee named “Service Chain for Social Care Alarms”, which would among other tasks develop a European standard based on SCAIP, has been submitted by the Swedish Standards Institute (SIS) in June 2013 and is currently under discussion. After the availability of a European standard, this transaction might be revised to use the European standard instead of the Swedish standard.

5.2.2 Use Case Roles



use case roles

Actor: Behaviour monitor (in SCAIP this actor corresponds to an “Alarm Sender”)

Role: Sends a (low or high priority) notification about a detected event to the notification receiver.

Actor: Scheduler (in SCAIP this actor corresponds to an “Alarm Sender”)

Role: Sends a notification about an event (related to the user's medication not being taken) to the notification receiver.

Actor: Notification receiver (in SCAIP this actor corresponds to an “Alarm Receiver”)

Role: Receives a notification and reacts accordingly, either by means that are “out of bands” from the perspective of this transaction (e.g. sending somebody to visit the user), or by using the communication link that may be initiated as part of this transaction to clarify whether a physical intervention is needed.

Actor: Smart TV (in SCAIP this actor corresponds to an “Alarm Sender”)

Role: Sends an alarm raised by the user to the notification receiver.

Actor: Mobile device (in SCAIP this actor corresponds to an “Alarm Sender”)

Role: Sends an alarm raised by the user (“panic button”) to the notification receiver.

Since the behaviour monitor, scheduler, smart TV and mobile device implement the same type of interaction in this transaction, all of these actors are summarised as “notification sender” in the explanations below.

5.2.3 Referenced Standards

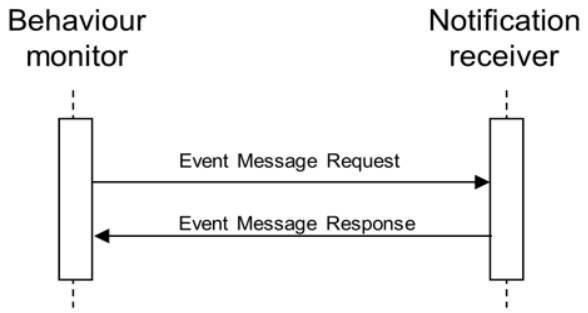
- Social Care Alarm Internet Protocol (SCAIP) Specification 2012-09-18, http://www.sis.se/PageFiles/12476/CEN-f%C3%B6rslag/c069_2013.pdf
- RFC 2617: HTTP Authentication: Basic and Digest Access Authentication, 1999
- RFC 3261: SIP: Session Initiation Protocol, 2002
- RFC 3263: Locating SIP Servers, 2002
- RFC 5246: TLS: The Transport Layer Security Protocol, Version 1.2, 2008
- RFC 6455: The Websocket Protocol, 2011
- RFC 3550: RTP: A Transport Protocol for Real-time Applications, 2003
- RFC 3711: The Secure Real-time Transport Protocol, 2004

5.2.4 Interaction Diagrams

Two different types of interactions are defined in this profile. A behaviour monitor may either only send an “event message”, or it may send an “event message” and after that, or in parallel, establish a voice or multimedia connection using a “voice or multimedia” connection. It is possible that the two interactions must be sent to different end-points. A notification sender shall be configurable to support different end-points for

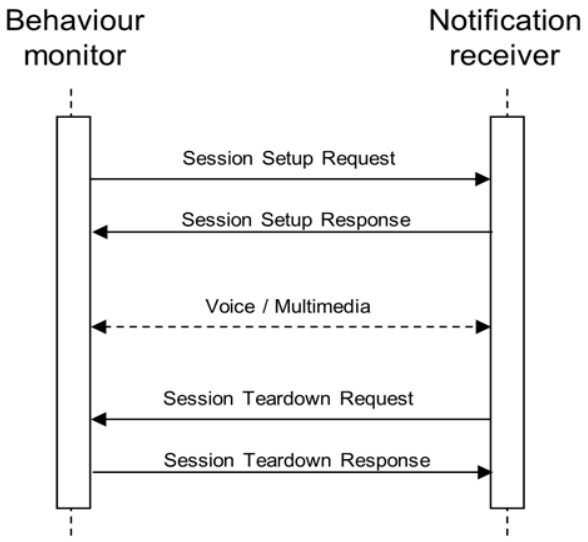
the notification receiver.

The first interaction diagram shows the “event message” interaction. Note that instead of the behaviour monitoring shown in the figure, all other notification senders could initiate the same sequence of interactions.



interaction diagram: event message

The second interaction diagram shows the “voice or multimedia” interaction. Note that instead of the behaviour monitoring shown in the figure, all other notification senders could initiate the same sequence of interactions.



interaction diagram: voice or multimedia

5.2.5 Messages

5.2.5.1 Event Message

5.2.5.1.1 Trigger Events

The notification sender initiates this transaction whenever it needs to send a notification to a Notification Receiver. The notification may either be an alarm (such as a detected fall, or the result of an “emergency” button pressed by the user), or a notification about long-term changes in behaviour patterns that indicate an increased need for support.

5.2.5.1.2 Message Semantics

Message Format

SCAIP uses an XML data structure to represent the notification, which includes among other fields an

identification of the sender, location, priority, device type from which the notification originates, status code (indicating the type of event), and some text fields with a clear-text description of the event. The XML document is transmitted using the MIME type “application/scaip+xml”. Each Event Message Request must be acknowledged by the notification receiver with an Event Message Response.

Two alternative transport protocols are specified for this interaction: either the Session Initiation Protocol (SIP) or the WebSocket protocol. The behaviour monitor can choose which protocol to use, the notification receiver must support both protocols. The WebSocket protocol is easier to implement but does not permit a voice or multimedia connection (see other message definition), which is always based on SIP.

WebSocket transport

When the WebSocket Protocol is used to transport the Event Messages, the notification sender must establish the transport connection to the notification receiver. This transport connection shall be secured with Transport Layer Security (TLS).

Before establishing the WebSocket connection, a HTTP authentication using the Digest Access Authentication Scheme according to RFC 2617 must be performed.

The WebSocket Protocol handshake will then create the WebSocket connection. This connection is then used to exchange Event Messages between the behaviour monitor and the notification receiver. The messages may be sent in any direction at any time. The WebSocket connection should not be closed by the behaviour monitor, but by the notification receiver, which may choose to initiate the closing handshake at any time.

SIP transport

When the SIP Protocol is used to transport the Event Messages, the notification sender must establish the transport connection to the notification receiver. This transport connection shall be secured with Transport Layer Security (TLS). (Note: In the SCAIP specification, SIP over TLS is only “strongly recommended”, but for the purpose of this message exchange this requirement is strengthened to a mandatory requirement in this transaction. This choice also solves the problem that SIP messages larger than 1300 bytes require transmission over a reliable transport protocol.)

Before establishing the WebSocket connection, a HTTP authentication using the Digest Access Authentication Scheme according to RFC 2617 must be performed.

The SIP handshake will then establish the SIP connection (SIP REGISTER). A SIP MESSAGE then delivers the event message as the body of the SIP MESSAGE request as an inband signalling protocol.

SIP depends on the domain name service (DNS) to resolve remote targets. It is strongly recommended that any SIP implementation used as a SIP client support RFC 3263 for service location, load sharing and failover.

5.2.5.1.3 Expected Actions

Upon receipt of the event message, the notification receiver is expected to confirm receipt using an event message response. It is furthermore expected that the notification receiver reacts according to the priority and content of the message, either by means that are “out of bands” from the perspective of this transaction (e.g. sending somebody to visit the user), or by using the communication link that may be initiated as part of this transaction to clarify whether a physical intervention is needed.

5.2.5.2 Voice or Multimedia

5.2.5.2.1 Trigger Events

The notification sender initiates this transaction when in addition to an event message sent to a notification receiver human communication between the user and the notification receiver is desired. This is useful if the behaviour monitor has a user interface that permits direct voice or video communication with the user at the time the event message is generated, and if the type of event makes human communication desirable, e.g. to verify whether there is really an emergency requiring human intervention, or to remind the user of some activity of daily living he or her has forgotten about.

The capability of performing voice or multimedia communication in addition to event messages is optional

both for the notification sender and for the notification receiver.

5.2.5.2.2 Message Semantics

The SIP Protocol is used to initiate the connection to the notification receiver by, and at the discretion of, the notification sender. This transport connection shall be secured with Transport Layer Security (TLS). (Note: In the SCAIP specification, SIP over TLS is only “strongly recommended”, but for the purpose of this message exchange this requirement is strengthened to a mandatory requirement in this transaction.)

Before establishing the WebSocket connection, a HTTP authentication using the Digest Access Authentication Scheme according to RFC 2617 must be performed.

The SIP handshake will then establish the SIP connection (SIP REGISTER). The voice or multimedia session is initiated with a SIP INVITE request. This request must be challenged by the SIP service provider (i.e. another HTTP authentication must be performed) to make sure that the notification sender is configured with the correct authentication credentials and is authorized to send SIP messages through the SIP server of the SIP service provider. The SIP session is successfully established once the notification receiver has accepted the session, sending a 200 OK acknowledged by an ACK request. The session may be terminated by any of the two actors involved.

The transmission of real-time audio or video data uses a different protocol negotiated over SIP. Any codec supported by both end-points may be used, but support for G.711alaw and G.711ulaw must be supported by both actors. It is recommended, however, that high-quality audio wideband codecs such as G.722, SILK, iSAC or Speex should also be supported, which offer superior audio quality.

The transport protocols that can be used for the transmission of real-time data are the Real-time Transport Protocol (RTP, RFC 3550) and the Secure Real-time Transport Protocol (SRTP, RFC 3711), which is an encrypted version of RTP. It is strongly recommended, but not required, to use SRTP to encrypt the media flow.

SIP depends on the domain name service (DNS) to resolve remote targets. It is strongly recommended that any SIP implementation used as a SIP client support RFC 3263 for service location, load sharing and failover.

5.2.5.2.3 Expected Actions

Once the voice or video connection is established, the person operating the notification receiver will communicate with the user of the notification sender in the context of the event message sent, and initiate actions as needed.

5.2.5.3 Protocol Requirements

Not applicable.

5.2.5.4 Actor Requirements

Not applicable.

5.2.5.5 Security Considerations

This transaction is intended to run over public networks such as the Internet. Therefore, the transmission of event messages is always secured by an encrypted TLS 1.2 connection and a HTTP authentication (using the Digest Access Authentication Scheme). It is undefined whether authentication is user-specific or the same account credentials may be used by multiple notification senders.

It should be noted that in the case of SIP, only point-to-point TLS encryption is performed between the SIP end-points (proxies, redirection servers) involved, although the SIP protocol guarantees that all point-to-point connections are protected using TLS in this case. Nevertheless, the SIP proxies and redirection servers must be trusted to not make unauthorised use of the information contained in the SIP message, since they are able to read the message in clear text.

In the case of voice or multimedia connections, the real-time data transport can be implemented either in an unsecure manner (using RTP) or in encrypted form using SRTP. While the latter is strongly recommended, it

is not required. Note that the key exchange of the symmetric encryption key used in SRTP takes place over the SIP handshake which, therefore, must be TLS encrypted because otherwise the key material would be exchanged in clear text.

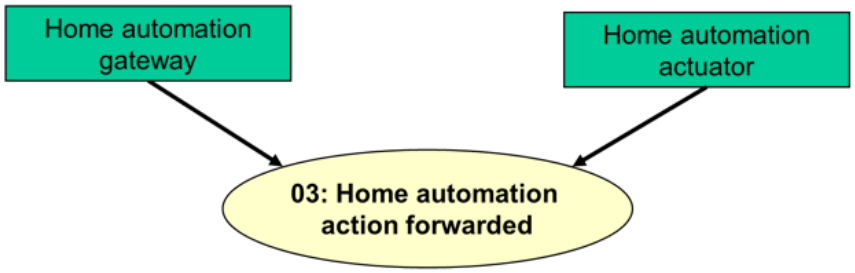
5.3 Transaction 03: Home automation action forwarded

5.3.1 Scope

A home automation gateway uses this transaction to forward an action (command) received using Transaction 04: Home automation action initiated to a home automation actuator.

This transaction may be alternatively implemented either using the KNX option using the KNX home automation field bus, or using the ZigBee option using wireless ZigBee communication.

5.3.2 Use Case Roles



use case roles

Actor: Home automation gateway

Role: Receives actions (commands) intended for a home automation actuator and forwards these over the home automation field bus.

Actor: Home automation actuator

Role: Receives and executes actions (commands) over the home automation field bus.

5.3.3 Referenced Standards

5.3.3.1.1 Standards and specifications related to the KNX option

- EN 50090-1:2011 Home and Building Electronic Systems (HBES) - Part 1: Standardization structure
- EN 50090-2-2:1996 Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General technical requirements
- EN 50090-2-2:1996/A1:2002 Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General technical requirements, Annex 1
- EN 50090-2-2:1996/A2:2007 Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General technical requirements, Annex 2
- EN 50090-2-3:2005 Home and Building Electronic Systems (HBES) - Part 2-3: System overview - General functional safety requirements for products intended to be integrated in HBES
- EN 50090-3-1:1994 Home and Building Electronic Systems (HBES) - Part 3-1: Aspects of application - Introduction to the application structure
- EN 50090-3-2:2004 Home and Building Electronic Systems (HBES) - Part 3-2: Aspects of application - User process for HBES Class 1
- EN 50090-3-2:2004 Home and Building Electronic Systems (HBES) - Part 3-2: Aspects of application - User process for HBES Class 1
- EN 50090-3-3:2009 Home and Building Electronic Systems (HBES) - Part 3-3: Aspects of application -

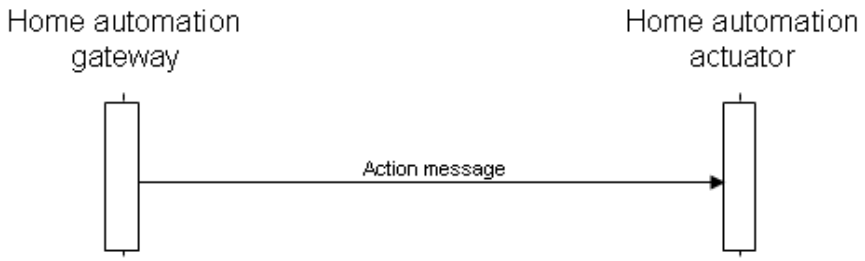
HBES Interworking model and common HBES data types

- EN 50090-4-1:2004 Home and Building Electronic Systems (HBES) - Part 4-1: Media independent layers - Application layer for HBES Class 1
- EN 50090-4-2:2004 Home and Building Electronic Systems (HBES) - Part 4-2: Media independent layers - Transport layer, network layer and general parts of data link layer for HBES Class 1
- EN 50090-4-3:2007 Home and Building Electronic Systems (HBES) - Part 4-3: Media independent layers - Communication over IP
- EN 50090-5-1:2005 Home and Building Electronic Systems (HBES) - Part 5-1: Media and media dependent layers - Power line for HBES Class 1
- EN 50090-5-2:2004 Home and Building Electronic Systems (HBES) - Part 5-2: Media and media dependent layers - Network based on HBES Class 1, Twisted Pair
- EN 50090-5-3:2006 Home and Building Electronic Systems (HBES) - Part 5-3: Media and media dependent layers - Radio frequency
- EN 50090-7-1:2004 Home and Building Electronic Systems (HBES) - Part 7-1: System management - Management procedures
- EN 50090-8:2000 Home and Building Electronic Systems (HBES) - Part 8: Conformity assessment of products
- EN 50090-9-1:2004 Home and Building Electronic Systems (HBES) - Part 9-1: Installation requirements - Generic cabling for HBES Class 1 Twisted Pair

5.3.3.1.2 Standards and specifications related to the ZigBee option

- IEEE 802.15.4: IEEE Standard for Local and metropolitan area networks – Part 15.4: Low-Rate Wireless Personal Area Networks
- ZigBee Alliance, ZigBee document 053474r17, ZigBee Specification.
- ZigBee Alliance, ZigBee document 08006r03, ZigBee PICS and Stack Profiles.
- ZigBee Alliance, ZigBee document 075123r03, ZigBee Cluster Library Specification.
- ZigBee Alliance, ZigBee document 05-3520-29, ZigBee Home Automation Public Application Profile.

5.3.4 Interaction Diagram



interaction diagram

5.3.5 Messages

5.3.5.1 KNX Option

5.3.5.1.1 Trigger Events

The transaction is initiated by the home automation gateway whenever an action (command) intended for a home automation actuator has been received using Transaction 04: Home automation action initiated.

5.3.5.1.2 Message Semantics

This message makes use of the KNX protocol. A KNX telegram (message) containing the action is sent over the bus, using a group address. The action (command) shall be encoded based on the standard datapoint types specified in the KNX standard, and, where possible, based on the functional blocks of the KNX standard. Since this transaction does not cover the set-up and configuration of the network (i.e. no peer-to-peer communication), the TPCI field of the telegram shall be set to zero.

5.3.5.1.3 Expected Actions

Upon receipt of the message, the home automation actuator executes the command (action).

Note that it is beyond the scope of this project to define, and standardise, a mapping between the KNX protocol (datapoint types and function blocks) and UPnP SensorManagement. This means that at this moment it is not possible to guarantee a common interface for actuators of the same type.

5.3.5.2 ZigBee Option

5.3.5.2.1 Trigger Events

The transaction is initiated by the home automation gateway whenever an action (command) intended for a home automation actuator has been received using Transaction 04: Home automation action initiated.

5.3.5.2.2 Message Semantics

This message makes use of the ZigBee Home Automation protocol, which is based on the ZigBee PRO (ZigBee 2007) protocol, and implements a wireless home automation network protocol over IEEE 802.15.4 personal area networks. ZigBee operates either in the 868/915 MHz (Europe/North America) or in the 2.4 GHz frequency band. For the purposes of this transaction, the 868/915 MHz shall be used.

The home automation gateway shall act as the ZigBee Coordinator of the ZigBee home automation network.

The home automation actuator shall implement one of the device types and corresponding clusters specified in the ZigBee Home Automation application profile and use its server-side clusters to receive commands from the home automation gateway.

5.3.5.2.3 Expected Actions

Upon receipt of the message, the home automation actuator executes the command (action).

Note that it is beyond the scope of this project to define, and standardise, a mapping between the ZigBee protocol (ZigBee Home Automation device clusters) and UPnP SensorManagement. This means that at this moment it is not possible to guarantee a common interface for actuators of the same type.

5.3.5.3 Protocol Requirements

Not applicable.

5.3.5.4 Actor Requirements

The KNX protocol offers multiple alternative transport protocols: a dedicated 24V twisted-pair bus (KNX/TP) with serial 9600 bit/s transmission, wireless KNX communication (KNX/RF), Powerline communication (KNX/PL) and communication over IP networks (KNXnet/IP). The home automation gateway shall support KNX/TP communication and may additionally support KNXnet/IP. For security considerations (see below), KNX/RF and KNX/PL are not permitted for this transaction. The home automation actuator shall support either KNX/TP or KNXnet/IP.

ZigBee operates either in the 868/915 MHz (Europe/North America) or in the 2.4 GHz frequency band. For the purposes of this transaction, the 868/915 MHz band shall be used with the ZigBee option.

5.3.5.5 Security Considerations

The KNX protocol does not provide any security mechanisms - neither an authentication of communicating

peers, nor an integrity protection of KNX telegrams (messages) or confidentiality of messages are provided. When used over dedicated twisted-pair cable (KNX/TP), this is usually not a problem, since physical access to the cable is only possible from within the home or apartment. However, KNX offers alternative transport protocols where the absence of security mechanisms is a problem, notably wireless KNX communication (KNX/RF), Powerline communication (KNX/PL) and communication over IP networks (KNXnet/IP). Since wireless and Powerline KNX communication may offer the possibility of malicious attacks from outside, these transports are *not permitted* for this transaction. Furthermore, the use of KNX over IP networks requires careful consideration of security requirements: KNXnet/IP over WLAN should only be used with WPA2 protected WLANs; furthermore, KNXnet/IP in LANs or WLANs connected to the public internet require a configuration that makes sure that no KNX telegrams are visible to, or can be received from, unauthorised network nodes in the public internet.

The ZigBee protocol offers built-in security features: secure communications protecting establishment and transport of cryptographic keys, ciphering frames and controlling devices. ZigBee uses symmetric 128 bit keys to implement its security features. A key can either be associated to a complete ZigBee network (in which case it is used both on IEEE 802.15.4 MAC layer and on ZigBee network/application layer), or to an individual link (on ZigBee network/application layer). The negotiation of a link key requires a common master key, which - similar to a network key - is a shared secret that must be installed in all ZigBee devices of the network. One device in the ZigBee network acts as a “trust centre” that maintains the network key and master key, and can distribute link keys to devices on the network. The address of the trust centre and the master key should be pre-loaded to the ZigBee devices prior to installation, because otherwise this information would be transmitted over the ZigBee network in unprotected form and might be recorded, and exploited, by an unauthorised eavesdropper.

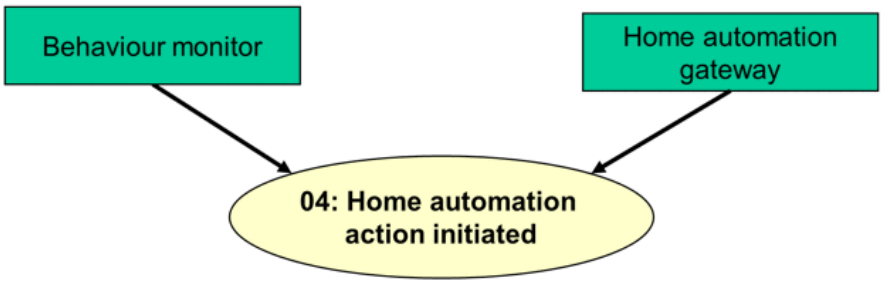
5.4 Transaction 04: Home automation action initiated

5.4.1 Scope

The behaviour monitor uses this transaction to initiate an action of a home automation actuator. The behaviour monitor sends the transaction to the home automation gateway in a format that is independent from the home automation bus implemented in the local environment, and the home automation gateway translates the command and forwards it to the home automation actuator using Transaction 03: Home automation action forwarded.

This transaction may be alternatively implemented either using the “conventional” option based on Universal Plug and Play (UPnP), or using the “universAAL” option based on the universAAL middleware, which uses semantic communication between nodes.

5.4.2 Use Case Roles



use case roles

Actor: Behaviour monitor

Role: Initiates an action of a home automation actuator by sending a message to the home automation gateway.

Actor: Home automation gateway

Role: Translates and forwards the command received from the behaviour monitor to the actuator connected

to the home automation field bus.

5.4.3 Referenced Standards

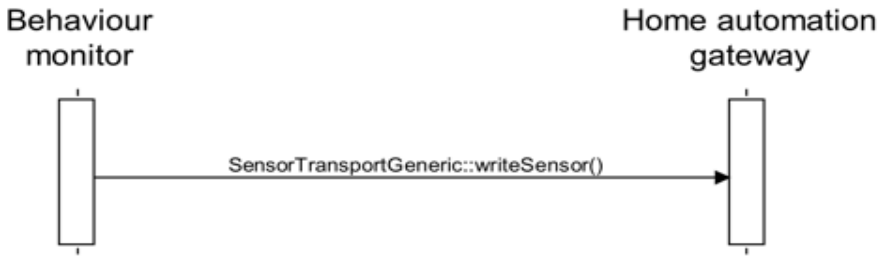
5.4.3.1.1 Standards and specifications related to the conventional option

- DeviceProtection:1 Service For UPnP Version 1.0, UPnP Forum, 2011
- RFC 2246: The TLS Protocol, Version 1.0, 1999
- SensorManagement Architecture Overview for UPnP Version 1.0, UPnP Forum, 2013
- SensorManagement Sensor DataModel Service for UPnP Version 1.0, UPnP Forum, 2013
- SensorManagement:1 Device for UPnP Version 1.0, UPnP Forum, 2013
- SensorTransportGeneric:1 Service for UPnP Version 1.0, UPnP Forum, 2013
- UPnP Device Architecture 1.0, UPnP Forum, 2008

5.4.3.1.2 Standards and specifications related to the universAAL option

- AllSeen Alliance: Introduction to the AllJoyn Framework, December 10, 2013, https://allseenalliance.org/sites/default/files/resources/intro_alljoyn_framework.pdf
- JGroups reliable messaging toolkit, http://www.jgroups.org/
- MQ Telemetry Transport (MQTT) V3.1 Protocol Specification, http://public.dhe.ibm.com/software/dw/webservices/ws-mqtt/mqtt-v3r1.html
- OWL 2 Web Ontology Language Document Overview (Second Edition). W3C Recommendation 11 December 2012, http://www.w3.org/TR/owl2-overview/
- RDF Semantics. W3C Recommendation 10 February 2004, http://www.w3.org/TR/rdf-mt/
- RDF/XML Syntax Specification (Revised). W3C Recommendation 10 February 2004, http://www.w3.org/TR/rdf-syntax-grammar/
- TURTLE: Terse RDF Triple Language. W3C Working Draft 09 August 2011, http://www.w3.org/TR/turtle/
- universAAL Reference Documentation, http://forge.universaal.org/wiki/support:Reference_Documentation
- universAAL Unified devices ontology, http://forge.universaal.org/wiki/ontologies:Devices

5.4.4 Interaction Diagram



interaction diagram

Note: This interaction diagrams shows the “conventional option”. The device discovery phase is not shown.

5.4.5 Messages

5.4.5.1 Conventional Option: UPnP SensorManagement

5.4.5.1.1 Trigger Events

The transaction is initiated by the behaviour monitor whenever an action of a home automation actuator

(such as lighting, heating/air conditioning, window opener etc.) is required due to the recognised activities of the user (e.g. because the user wants to leave the apartment, or because the system has recognised that the user is getting up at night to go to the toilet).

5.4.5.1.2 Message Semantics

This transaction makes use of the Universal Plug and Play (UPnP) protocol, and in particular of the UPnP SensorManagement specifications, which are a “standardized device control protocol” (SDCP) of the UPnP specification. The home automation gateway acts as a UPnP SensorManagement device, whereas the behaviour monitor acts as a UPnP control point. For security reasons, both actors shall also support the UPnP DeviceProtection service; see section on Security Considerations for details.

UPnP is a set of network protocols that permits devices to discover each other's presence, and to establish network services. Discovery is based on the Simple Service Discovery Protocol (SSDP), which uses HTTP over UDP. This protocol allows a device to advertise its services in the network, and it allows a control point to search for devices on the network. In both cases the control point learns about the presence of the device, its type, identifier and a URL to a service where more detailed information can be requested. This information is formatted in XML and contains, among other information, a list of services and URLs for control, eventing, and presentation. For each service, the description includes a list of the commands, or actions, to which the service responds, and parameters, or arguments, for each action; the description for a service also includes a list of variables; these variables model the state of the service at run time, and are described in terms of their data type, range, and event characteristics. Actions can be initiated by the control point by sending a control message, based on the SOAP protocol, to the device.

The home automation gateway acts as a UPnP SensorManagement device and thus supports the UPnP ConfigurationManagement service (CMS), which is used by the control point (behaviour monitor) to retrieve information about the list and hierarchy of sensors and actuators managed by the home automation gateway using the GetSupportedDatamodels(), GetSupportedParameters() and GetInstances() actions. These actions furthermore provide a list of parameters (variables) representing the status of the sensors, sensor data, and actions for actuators.

Actuator actions are initiated by the control point by calling the SensorTransportGeneric::WriteSensor() action for the UPnP SensorManagement device. The parameters to this action contain the desired new value of one or more control variables (such as the desired temperature, lighting level or on/off status) for the actuator. The control variables available, units of measure, and upper and lower limits for each setting are part of the device descriptions that were retrieved by the behaviour monitor during the discovery phase as described in the previous paragraph.

At this time, the UPnP standard only specifies device identifiers (names) for typical home automation sensors such as Motion_Sensor, Door/Window_Sensor, Smoke_Sensor, Water_Sensor, etc., but no specialisations of the SensorManagement data and service model are defined for these types of sensors. This means that at this moment it is not possible to guarantee a common interface for sensors of the same type. If is, however, beyond the scope of this project to define, and standardise, a mapping between the home automation protocols (ZigBee, KNX) and UPnP SensorManagement.

5.4.5.1.3 Expected Actions

Upon receipt of the message, the home automation gateway is expected to translate the command into a corresponding message of the home automation field bus installed in the home, and to deliver it to the addressed actuator using Transaction 03: Home automation action forwarded.

5.4.5.2 universAAL Option

5.4.5.2.1 Trigger Events

The transaction is initiated by the behaviour monitor whenever an action of a home automation actuator (such as lighting, heating/air conditioning, window opener etc.) is required due to the recognised activities of the user (e.g. because the user wants to leave the apartment, or because the system has recognised that the user is getting up at night to go to the toilet).

5.4.5.2.2 Message Semantics

universAAL is a distributed middleware that makes the distribution of messages and services transparent to the API user. For universAAL option, both actors (home automation gateway and behaviour monitor) are expected to run an instance of the universAAL middleware connected through the discovery and peering mechanisms of universAAL. This means that the actors will share three message buses: the context bus, the service bus and the user interface bus. The context bus publishes event messages describing changes in the context the system is running in (such as sensor data), the service bus is used to call services (APIs), and the user interface bus is used for messages related to user interface interactions. Messages sent over a bus can be received by software components independent from the actor they are physically located on.

The “messages” exchanged over the three buses are objects representing an instance of an ontology in RDF/OWL format each. When a message is passed between middleware platform instances, each object is serialised using TURTLE and then transmitted using a reliable transport protocol. At this time, universAAL uses JGroups for this purpose, but in the future also other communication protocols such as MQTT and AllJoyn will be supported. This means that the communication protocol is not guaranteed to be stable across all universAAL instances, but the API within the middleware platform is.

For the purposes of this transaction, actuator actions shall be communicated as service calls on the universAAL service bus. The universAAL *ont.device* ontology shall be used to represent the home automation actuator actions.

5.4.5.2.3 Expected Actions

Upon receipt of the message, the home automation gateway is expected to translate the command into a corresponding message of the home automation field bus installed in the home, and to deliver it to the addressed actuator using Transaction 03: Home automation action forwarded.

5.4.5.3 Protocol Requirements

Not applicable.

5.4.5.4 Actor Requirements

Not applicable.

5.4.5.5 Security Considerations

By default the UPnP protocol used in the “conventional option” operates without any security functions; neither an authentication of the actors nor a secure transmission (integrity, confidentiality) are performed. Furthermore, many UPnP devices assume that all systems “discoverable” within their network are trustworthy. Great care must be taken whenever such a network containing UPnP devices is connected to the public internet through a router, especially if that router implements the UPnP “Internet Gateway Device” (IGD) protocol, since these are known to be vulnerable to certain malicious attacks that may provide the attacker with a possibility to initiate commands (actions) on UPnP devices in the LAN.

Therefore, the UPnP DeviceProtection service, which is optional in the UPnP specification for SensorManagement devices, **shall** be supported by both actors in this transaction. UPnP DeviceProtection provides secure communication of all HTTP and SOAP transactions based on the Transport Layer Security (TLS) protocol, a peer authentication of the control point by the UPnP device based on the X.509 certificates exchanged during TLS connection setup, and the assignment of access rights for all services.

When using the universAAL option, the use of a Virtual Private Network (VPN) is recommended.

5.5 Transaction 05: Home automation event forwarded

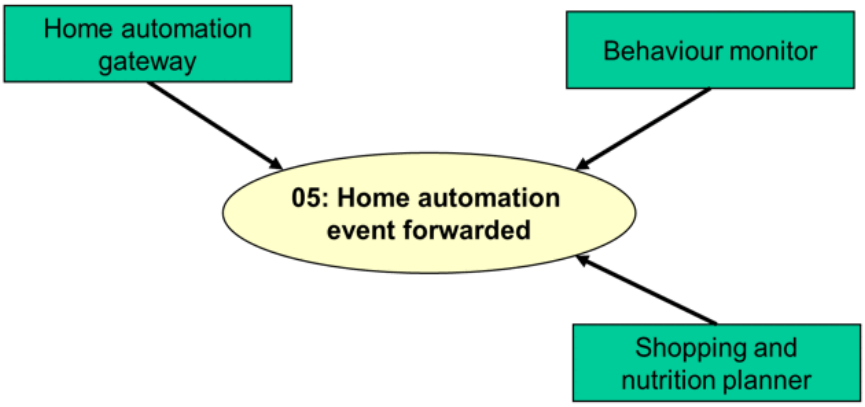
5.5.1 Scope

The home automation gateway uses this transaction to forward sensor data to a behaviour monitor and/or a shopping and nutrition planner. The sensor data has been received by the home automation gateway from a

home automation sensor using Transaction 06: Home automation event sent.

This transaction may be alternatively implemented either using the “conventional” option based on Universal Plug and Play (UPnP), or using the “universAAL” option based on the universAAL middleware, which uses semantic communication between nodes.

5.5.2 Use Case Roles



use case roles

Actor: Home automation gateway

Role: Forwards event notifications received from the home automation field bus.

Actor: Behaviour monitor

Role: Receives and processes event notifications about home automation sensor events.

Actor: Shopping and nutrition planner

Role: Receives and processes event notifications about home automation sensor events.

5.5.3 Referenced Standards

5.5.3.1.1 Standards and specifications related to the conventional option

- DataStore:1 Service for UPnP Version 1.0, UPnP Forum, 2013
- DeviceProtection:1 Service For UPnP Version 1.0, UPnP Forum, 2011
- RFC 2246: The TLS Protocol, Version 1.0, 1999
- SensorManagement Architecture Overview for UPnP Version 1.0, UPnP Forum, 2013
- SensorManagement Sensor DataModel Service for UPnP Version 1.0, UPnP Forum, 2013
- SensorManagement:1 Device for UPnP Version 1.0, UPnP Forum, 2013
- SensorTransportGeneric:1 Service for UPnP Version 1.0, UPnP Forum, 2013
- UPnP Device Architecture 1.0, UPnP Forum, 2008

5.5.3.1.2 Standards and specifications related to the universAAL option

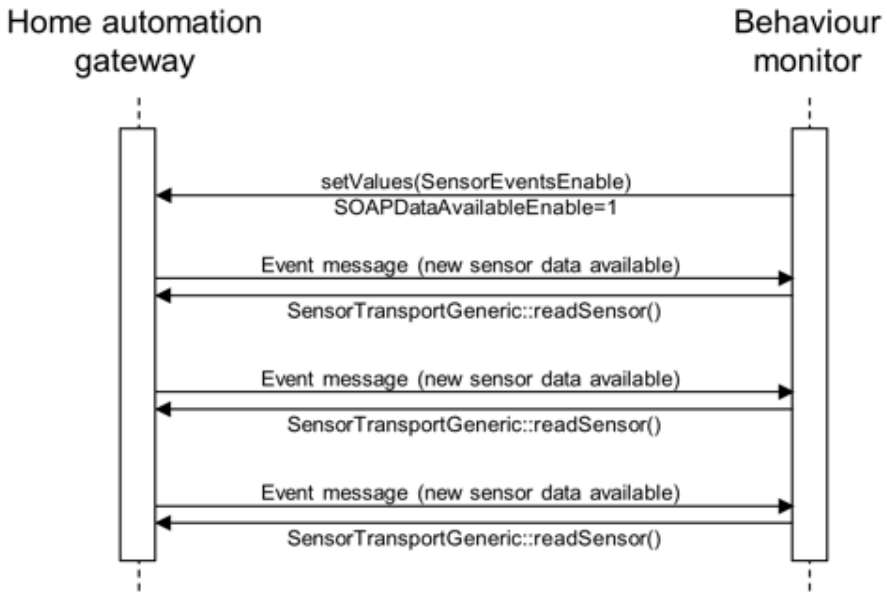
- AllSeen Alliance: Introduction to the AllJoyn Framework, December 10, 2013, https://allseenalliance.org/sites/default/files/resources/intro_alljoyn_framework.pdf
- JGroups reliable messaging toolkit, http://www.jgroups.org/
- MQ Telemetry Transport (MQTT) V3.1 Protocol Specification, http://public.dhe.ibm.com/software/dw/webservices/ws-mqtt/mqtt-v3r1.html
- OWL 2 Web Ontology Language Document Overview (Second Edition). W3C Recommendation 11 December 2012, http://www.w3.org/TR/owl2-overview/
- RDF Semantics. W3C Recommendation 10 February 2004, http://www.w3.org/TR/rdf-mt/

- RDF/XML Syntax Specification (Revised). W3C Recommendation 10 February 2004, http://www.w3.org/TR/rdf-syntax-grammar/
- TURTLE: Terse RDF Triple Language. W3C Working Draft 09 August 2011, http://www.w3.org/TR/turtle/
- universAAL Reference Documentation, http://forge.universaal.org/wiki/support:Reference_Documentation
- universAAL Unified devices ontology, http://forge.universaal.org/wiki/ontologies:Devices

5.5.4 Interaction Diagram

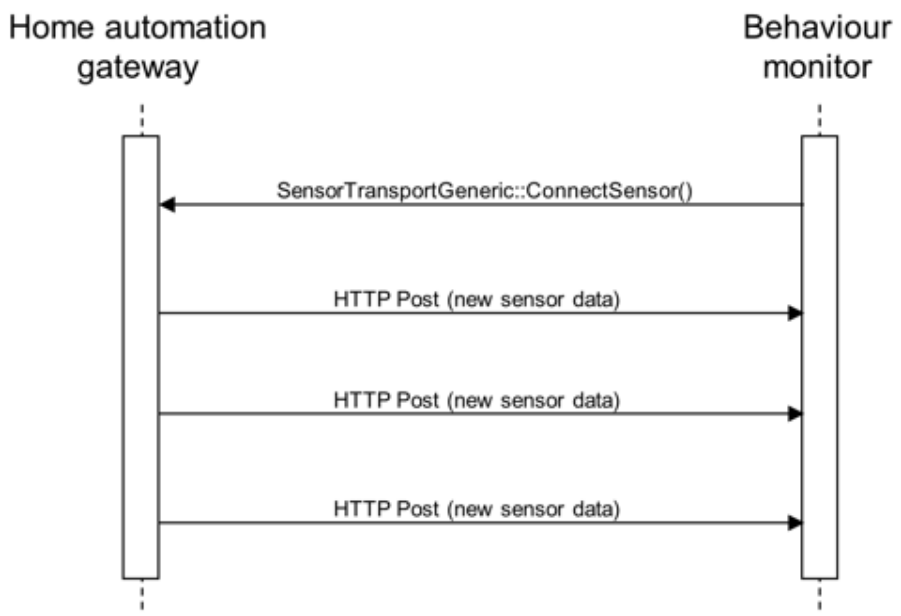
Two different types of interactions are defined in this transaction. Both are shown with a behaviour monitor as the receiver; alternatively a shopping and nutrition planner may take the same role.

The first interaction diagram below shows the event based delivery method. A behaviour monitor may request the home automation gateway, for each managed sensor, to send an event message whenever new sensor data becomes available. After receiving this event message, the behaviour monitor would explicitly retrieve the new data using a separate transaction.



interaction diagram 1: event based delivery of sensor data

The second interaction diagram shows the subscription based delivery method. Here the behaviour monitor creates a “subscription” for each sensor it is interested in, and whenever new sensor data becomes available, the home automation gateway will initiate direct delivery of the new sensor data.



interaction diagram 2: subscription based delivery of sensor data

Note: These interaction diagrams show the “conventional option”. The device discovery phase is not shown.

5.5.5 Messages

5.5.5.1 Conventional Option: UPnP SensorManagement

5.5.5.1.1 Trigger Events

The transaction is initiated by the home automation gateway whenever new sensor data has been received from a home automation sensor, in order to forward the data to the receiver (behaviour monitor or shopping and nutrition planner).

5.5.5.1.2 Message Semantics

This transaction makes use of the Universal Plug and Play (UPnP) protocol, and in particular of the UPnP SensorManagement specifications, which are a “standardized device control protocol” (SDCP) of the UPnP specification. The home automation gateway acts as a UPnP SensorManagement device, whereas the behaviour monitor or shopping and nutrition planner acts as a UPnP control point. For security reasons, both actors shall also support the UPnP DeviceProtection service; see section on Security Considerations for details.

UPnP is a set of network protocols that permits devices to discover each other's presence, and to establish network services. Discovery is based on the Simple Service Discovery Protocol (SSDP), which uses HTTP over UDP. This protocol allows a device to advertise its services in the network, and it allows a control point to search for devices on the network. In both cases the control point learns about the presence of the device, its type, identifier and a URL to a service where more detailed information can be requested. This information is formatted in XML and contains, among other information, a list of services and URLs for control, eventing, and presentation. For each service, the description includes a list of the commands, or actions, to which the service responds, and parameters, or arguments, for each action; the description for a service also includes a list of variables; these variables model the state of the service at run time, and are described in terms of their data type, range, and event characteristics. Actions can be initiated by the control point by sending a control message, based on the SOAP protocol, to the device.

The home automation gateway acts as a UPnP SensorManagement device and thus supports the UPnP ConfigurationManagement service (CMS), which is used by the control point to retrieve information about the list and hierarchy of sensors and actuators managed by the home automation gateway using the GetSupportedDatamodels(), GetSupportedParameters() and GetInstances() actions. These actions

furthermore provide a list of parameters (variables) representing the status of the sensor, sensor data, and actions for actuators.

Two alternative methods are specified in UPnP SensorManagement for the delivery of sensor data to the control point (see also interaction diagrams above). Since both methods must be supported by the UPnP device, the control point can choose to implement either, or both methods:

- *Event based delivery:* The control point can either activate the delivery of event messages whenever new data is available for one or more sensors using the SensorEventsEnable parameter. The home automation gateway will then send event messages to the control point whenever the sensor has new data available, and the control point can retrieve the data using a SOAP call to the SensorTransportGeneric::ReadSensor() action of the sensor.
- *Subscription based delivery:* Alternatively, the control point can provide a URL to which the sensor should automatically deliver data whenever new data is available, using the SensorTransportGeneric::ConnectSensor() action of the sensor. The sensor will then deliver new data to the configured URL using a HTTP POST transaction.

It should be noted that the UPnP SensorManagement specifications contain an optional extension called the DataStore service. This is a service that can be configured to receive and persistently store sensor data from any SensorManagement device; furthermore the service provides retrieval methods that allow a control point to easily access historic sensor data. For the purposes of this transaction, this service is not required, but implementers should be aware that it many cases it might be desirable to support this functionality either as part of a behaviour monitor, or as a separate network entity, because in AAL applications often historical sensor data needs to be analysed, e.g. to determine trends.

At this time, the UPnP standard only specifies device identifiers (names) for typical home automation sensors such as Motion_Sensor, Door/Window_Sensor, Smoke_Sensor, Water_Sensor, etc., but no specialisations of the SensorManagement data and service model are defined for these types of sensors. This means that at this moment it is not possible to guarantee a common interface for sensors of the same type. If is, however, beyond the scope of this project to define, and standardise, a mapping between the home automation protocols (ZigBee, KNX) and UPnP SensorManagement.

5.5.5.1.3 Expected Actions

Upon receipt of the message, the behaviour monitor is expected to integrate the received sensor data into the local knowledge base, with means not defined in this integration profile, and to make use of the data for the recognition of activities or emergencies.

Upon receipt of the message, the shopping and nutrition planner determines whether the event indicates that the user has left the apartment, and if so, cancels the reminder timeout for any active shopping reminder.

5.5.5.2 universAAL Option

5.5.5.2.1 Trigger Events

The transaction is initiated by the home automation gateway whenever new sensor data has been received from a home automation sensor, in order to forward the data to the receiver (behaviour monitor or shopping and nutrition planner).

5.5.5.2.2 Message Semantics

universAAL is a distributed middleware that makes the distribution of messages and services transparent to the API user. For universAAL option, all actors are expected to run an instance of the universAAL middleware connected through the discovery and peering mechanisms of universAAL. This means that the actors will share three message buses: the context bus, the service bus and the user interface bus. The context bus publishes event messages describing changes in the context the system is running in (such as sensor data), the service bus is used to call services (APIs), and the user interface bus is used for messages related to user interface interactions. Messages sent over a bus can be received by software components independent from the actor they are physically located on.

The “messages” exchanged over the three buses are objects representing an instance of an ontology in

RDF/OWL format each. When a message is passed between middleware platform instances, each object is serialised using TURTLE and then transmitted using a reliable transport protocol. At this time, universAAL uses JGroups for this purpose, but in the future also other communication protocols such as MQTT and AllJoyn will be supported. This means that the communication protocol is not guaranteed to be stable across all universAAL instances, but the API within the middleware platform is.

For the purposes of this transaction, sensor data shall be communicated as a sequence of events on the universAAL context bus. The universAAL *ont.device* ontology shall be used to represent the home automation sensor events.

5.5.5.2.3 Expected Actions

Upon receipt of the message, the behaviour monitor is expected to integrate the received sensor data into the local knowledge base, with means not defined in this integration profile, and to make use of the data for the recognition of activities or emergencies.

Upon receipt of the message, the shopping and nutrition planner determines whether the event indicates that the user has left the apartment, and if so, cancels the reminder timeout for any active shopping reminder.

5.5.5.3 Protocol Requirements

Not applicable.

5.5.5.4 Actor Requirements

Not applicable.

5.5.5.5 Security Considerations

By default the UPnP protocol used in the “conventional option” operates without any security functions; neither an authentication of the actors nor a secure transmission (integrity, confidentiality) are performed. Furthermore, many UPnP devices assume that all systems “discoverable” within their network are trustworthy. Great care must be taken whenever such a network containing UPnP devices is connected to the public internet through a router, especially if that router implements the UPnP “Internet Gateway Device” (IGD) protocol, since these are known to be vulnerable to certain malicious attacks that may provide the attacker with a possibility to initiate commands (actions) on UPnP devices in the LAN.

Therefore, the UPnP DeviceProtection service, which is optional in the UPnP specification for SensorManagement devices, **shall** be supported by both actors in this transaction. UPnP DeviceProtection provides secure communication of all HTTP and SOAP transactions based on the Transport Layer Security (TLS) protocol, a peer authentication of the control point by the UPnP device based on the X.509 certificates exchanged during TLS connection setup, and the assignment of access rights for all services.

When using the universAAL option, the use of a Virtual Private Network (VPN) is recommended.

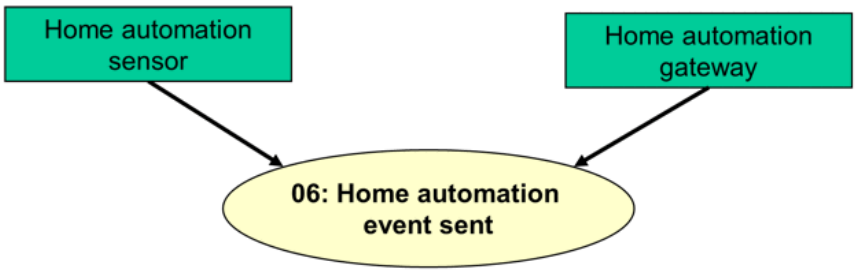
5.6 Transaction 06: Home automation event sent

5.6.1 Scope

A home automation sensor uses this transaction to transmit sensor data to a home automation gateway, which in turn will forward the sensor data using Transaction 05: Home automation event forwarded.

This transaction may be alternatively implemented either using the KNX option using the KNX home automation field bus, or using the ZigBee option using wireless ZigBee communication.

5.6.2 Use Case Roles



use case roles

Actor: Home automation sensor

Role: Sends sensor data such as a temperature measurement, metering information about electricity consumption, activity detected by a presence detector, or a switch pressed by the user.

Actor: Home automation gateway

Role: Receives and forwards event notifications about home automation sensor events.

5.6.3 Referenced Standards

5.6.3.1.1 Standards and specifications related to the KNX option

- EN 50090-1:2011 Home and Building Electronic Systems (HBES) - Part 1: Standardization structure
- EN 50090-2-2:1996 Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General technical requirements
- EN 50090-2-2:1996/A1:2002 Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General technical requirements, Annex 1
- EN 50090-2-2:1996/A2:2007 Home and Building Electronic Systems (HBES) - Part 2-2: System overview - General technical requirements, Annex 2
- EN 50090-2-3:2005 Home and Building Electronic Systems (HBES) - Part 2-3: System overview - General functional safety requirements for products intended to be integrated in HBES
- EN 50090-3-1:1994 Home and Building Electronic Systems (HBES) - Part 3-1: Aspects of application - Introduction to the application structure
- EN 50090-3-2:2004 Home and Building Electronic Systems (HBES) - Part 3-2: Aspects of application - User process for HBES Class 1
- EN 50090-3-2:2004 Home and Building Electronic Systems (HBES) - Part 3-2: Aspects of application - User process for HBES Class 1
- EN 50090-3-3:2009 Home and Building Electronic Systems (HBES) - Part 3-3: Aspects of application - HBES Interworking model and common HBES data types
- EN 50090-4-1:2004 Home and Building Electronic Systems (HBES) - Part 4-1: Media independent layers - Application layer for HBES Class 1
- EN 50090-4-2:2004 Home and Building Electronic Systems (HBES) - Part 4-2: Media independent layers - Transport layer, network layer and general parts of data link layer for HBES Class 1
- EN 50090-4-3:2007 Home and Building Electronic Systems (HBES) - Part 4-3: Media independent layers - Communication over IP
- EN 50090-5-1:2005 Home and Building Electronic Systems (HBES) - Part 5-1: Media and media dependent layers - Power line for HBES Class 1
- EN 50090-5-2:2004 Home and Building Electronic Systems (HBES) - Part 5-2: Media and media dependent layers - Network based on HBES Class 1, Twisted Pair
- EN 50090-5-3:2006 Home and Building Electronic Systems (HBES) - Part 5-3: Media and media

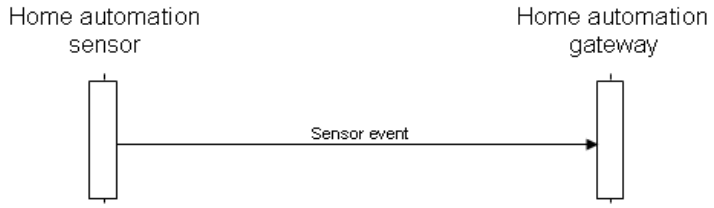
dependent layers - Radio frequency

- EN 50090-7-1:2004 Home and Building Electronic Systems (HBES) - Part 7-1: System management - Management procedures
- EN 50090-8:2000 Home and Building Electronic Systems (HBES) - Part 8: Conformity assessment of products
- EN 50090-9-1:2004 Home and Building Electronic Systems (HBES) - Part 9-1: Installation requirements - Generic cabling for HBES Class 1 Twisted Pair

5.6.3.1.2 Standards and specifications related to the ZigBee option

- IEEE 802.15.4: IEEE Standard for Local and metropolitan area networks – Part 15.4: Low-Rate Wireless Personal Area Networks
- ZigBee Alliance, ZigBee document 053474r17, ZigBee Specification.
- ZigBee Alliance, ZigBee document 08006r03, ZigBee PICS and Stack Profiles.
- ZigBee Alliance, ZigBee document 075123r03, ZigBee Cluster Library Specification.
- ZigBee Alliance, ZigBee document 05-3520-29, ZigBee Home Automation Public Application Profile.

5.6.4 Interaction Diagram



interaction diagram

5.6.5 Messages

5.6.5.1 KNX Option

5.6.5.1.1 Trigger Events

The transaction is initiated by the home automation sensor whenever new sensor data needs to be transmitted. The transaction may either be sent periodically or triggered by a physical event, such as a switch being operated by the user, a presence detector detecting movement in its field of view, or a smoke detector detecting smoke.

5.6.5.1.2 Message Semantics

This message makes use of the KNX protocol. A KNX telegram (message) containing the sensor data is sent over the bus, using a group address. Sensor data shall be encoded based on the standard datapoint types specified in the KNX standard, and, where possible, based on the functional blocks of the KNX standard. Since this transaction does not cover the set-up and configuration of the network (i.e. no peer-to-peer communication), the TPCI field of the telegram shall be set to zero.

5.6.5.1.3 Expected Actions

Upon receipt of the message, the home automation gateway is expected to translate the sensor event to the UPnP SensorManagement protocol used for Transaction 05: Home automation event forwarded.

Note that it is beyond the scope of this project to define, and standardise, a mapping between the KNX protocol (datapoint types and function blocks) and UPnP SensorManagement. This means that at this moment it is not possible to guarantee a common interface for sensors of the same type.

5.6.5.2 ZigBee Option

5.6.5.2.1 Trigger Events

The transaction is initiated by the home automation sensor whenever new sensor data needs to be transmitted. The transaction may either be sent periodically or triggered by a physical event, such as a switch being operated by the user, a presence detector detecting movement in its field of view, or a smoke detector detecting smoke.

5.6.5.2.2 Message Semantics

This message makes use of the ZigBee Home Automation protocol, which is based on the ZigBee PRO (ZigBee 2007) protocol, and implements a wireless home automation network protocol over IEEE 802.15.4 personal area networks. ZigBee operates either in the 868/915 MHz (Europe/North America) or in the 2.4 GHz frequency band. For the purposes of this transaction, the 868/915 MHz shall be used.

The home automation gateway shall act as the ZigBee Coordinator of the ZigBee home automation network.

The home automation sensor shall implement one of the device types and corresponding clusters specified in the ZigBee Home Automation application profile and use its client-side clusters to deliver sensor data to the home automation gateway.

5.6.5.2.3 Expected Actions

Upon receipt of the message, the home automation gateway is expected to translate the sensor event to the UPnP SensorManagement protocol used for Transaction 05: Home automation event forwarded.

Note that it is beyond the scope of this project to define, and standardise, a mapping between the ZigBee protocol (ZigBee Home Automation device clusters) and UPnP SensorManagement. This means that at this moment it is not possible to guarantee a common interface for sensors of the same type.

5.6.5.3 Protocol Requirements

Not applicable.

5.6.5.4 Actor Requirements

The KNX protocol offers multiple alternative transport protocols: a dedicated 24V twisted-pair bus (KNX/TP) with serial 9600 bit/s transmission, wireless KNX communication (KNX/RF), Powerline communication (KNX/PL) and communication over IP networks (KNXnet/IP). The home automation gateway shall support KNX/TP communication and may additionally support KNXnet/IP. For security considerations (see below), KNX/RF and KNX/PL are not permitted for this transaction. The home automation sensor shall support either KNX/TP or KNXnet/IP.

ZigBee operates either in the 868/915 MHz (Europe/North America) or in the 2.4 GHz frequency band. For the purposes of this transaction, the 868/915 MHz band shall be used with the ZigBee option.

5.6.5.5 Security Considerations

The KNX protocol does not provide any security mechanisms - neither an authentication of communicating peers, nor an integrity protection of KNX telegrams (messages) or confidentiality of messages are provided. When used over dedicated twisted-pair cable (KNX/TP), this is usually not a problem, since physical access to the cable is only possible from within the home or apartment. However, KNX offers alternative transport protocols where the absence of security mechanisms is a problem, notably wireless KNX communication (KNX/RF), Powerline communication (KNX/PL) and communication over IP networks (KNXnet/IP). Since wireless and Powerline KNX communication may offer the possibility of malicious attacks from outside, these transports are *not permitted* for this transaction. Furthermore, the use of KNX over IP networks requires careful consideration of security requirements: KNXnet/IP over WLAN should only be used with WPA2 protected WLANs; furthermore, KNXnet/IP in LANs or WLANs connected to the public internet require a configuration that makes sure that no KNX telegrams are visible to, or can be received from, unauthorised network nodes in the public internet.

The ZigBee protocol offers built-in security features: secure communications protecting establishment and transport of cryptographic keys, ciphering frames and controlling devices. ZigBee uses symmetric 128 bit keys to implement its security features. A key can either be associated to a complete ZigBee network (in which case it is used both on IEEE 802.15.4 MAC layer and on ZigBee network/application layer), or to an individual link (on ZigBee network/application layer). The negotiation of a link key requires a common master key, which - similar to a network key - is a shared secret that must be installed in all ZigBee devices of the network. One device in the ZigBee network acts as a “trust centre” that maintains the network key and master key, and can distribute link keys to devices on the network. The address of the trust centre and the master key should be pre-loaded to the ZigBee devices prior to installation, because otherwise this information would be transmitted over the ZigBee network in unprotected form and might be recorded, and exploited, by an unauthorised eavesdropper.

5.7 Transaction 07: Localization event sent

5.7.1 Scope

This transaction is used by an indoor localization sensor, i.e. a device such as a floor mat that provides information about the location of the user within the apartment, to provide a new location for the user to the behaviour monitor.

Real-time locating systems (RTLS) are widely used in logistics, but the standards established in this field (e.g. ISO/IEC 24730) assume that an object or a person to be tracked always to carries a wireless tag device that can be located and provides location and identity information - a scenario that does not translate well to AAL scenarios where the position of the user within the apartment needs to be tracked at all times of day, independent of clothing, and where the identity of the person located by the system may not always be clear.

Despite an extensive search, no standard defining a communication protocol suitable for this use case could be identified. The authors, therefore, propose a web service based communication protocol that could be the starting point for a standardisation activity. The following design principles have been adopted from existing work in this field (such as the NMEA 0183 standard for the exchange of GPS location data over a serial line in the maritime field, the GPS Exchange Format (GPX) as a file format for location data, and the specifications of the AALOA “EvAAL” competition for indoor locating systems):

- Location data should be expressed in a format compliant with GPS positioning data (i.e. as latitude and longitude using the WGS 84 geodetic datum). While this may seem “unnatural” for indoor location information at first, it significantly simplifies the fusion of indoor and outdoor location information, the development of navigation systems for pedestrians supporting outdoor and indoor navigation, and the use of geolocation services and map services such as Google Maps or OpenStreetMap, which are all based on WGS 84. Furthermore, GPS coordinates are usually given as degrees, minutes, and up to 6 digits of fractional minutes, which allows for a precision of a position better than 2mm in each direction, which is more than sufficient for indoor use.
- Location data should always be accompanied by a timestamp representing the time of measurement.
- There are several information items that may or may not be available depending on the type of locating system, such as the identity of the user (or more generally an identifier remaining constant for one person moving in the apartment), the user's bearing and speed of movement, height information (which would be useful for indoor navigation in a multi-floor building), accuracy information for the position, or a list of identifiers for well-defined spaces (rooms, areas) in the apartment. Optional elements are used to transfer this information if available.
- Since GPX is a widely used extensible file format for storing localization data, the web service call shall be based on the GPX 1.1 schema.

5.7.2 Use Case Roles

use case roles

Actor: Indoor localization sensor

Role: Locates a person in the apartment and sends a localization event.

Actor: Behaviour monitor

Role: Receives localization events and processes them to determine user activities and identify possible emergency situations (such as fall events or the user leaving the home while the cooker is switched on).

5.7.3 Referenced Standards

- GPS Exchange Format (GPX) 1.1 Schema Documentation, http://www.topografix.com/GPX/1/1/
- Office of GEOINT Sciences: World Geodetic System 1984 (WGS 84)
- RFC 2246: The TLS Protocol, Version 1.0, 1999.
- W3C, SOAP Version 1.2 Part 1: Messaging Framework (Second Edition), W3C Recommendation 27 April 2007
- W3C, Web Services Addressing 1.0 - Core, W3C Recommendation 9 May 2006
- WS-I, Web Services Interoperability (WS-I) Basic Profile Version 1.1, 2006.
- WS-I, Web Services Interoperability (WS-I) Basic Security Profile Version 1.0, 2007.

5.7.4 Interaction Diagram

interaction diagram

5.7.5 Messages

5.7.5.1 Conventional option: localization event

5.7.5.1.1 Trigger Events

This message is triggered by the indoor localization sensor whenever it measures a new position for the (or one) user within the apartment.

5.7.5.1.2 Message Semantics

The transport protocol used to deliver the message is a Web Service call based on the definitions of the

"Web Services for IHE Transactions" (IHE IT-I Technical Framework, Volume 2x, Annex V). This is a SOAP 1.2 message taking into account the WS-I Basic Profile 1.1. Note that this transport protocol is compatible to the one used in Transaction 01: BAN parameter forwarded (conventional option).

The message may optionally be protected in compliance with the WS-I Basic Security Profile 1.0, making use of a Transport Layer Security (TLS) 1.0 secure "channel". AES encryption as described in RFC 3268 must be supported.

Below a sample message is shown. The full specifications of the GPX 1.1 format on which this message is based are available from http://www.topografix.com/GPX/1/1.

```
<soapenv:Envelope xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope">
  <soapenv:Header xmlns:wsa="http://www.w3.org/2005/08/addressing">
    <wsa:To soapenv:mustUnderstand="true">http://hostname/localization_event_service</wsa:To>
    <wsa:From soapenv:mustUnderstand="true">
      <wsa:Address>http://www.w3.org/2005/08/addressing/anonymous</wsa:Address>
    </wsa:From>
    <wsa:MessageID soapenv:mustUnderstand="true">urn:uuid:5e1b0ef0-73c5-11e3-981f-
0800200c9a66</wsa:MessageID>
    <wsa:Action soapenv:mustUnderstand="true">urn:uuid:c6711c60-73c5-11e3-981f-
0800200c9a66</wsa:Action>
  </soapenv:Header>
  <soapenv:Body>
    <LocalizationEvent xmlns="http://www.topografix.com/GPX/1/1">
      <-- See GPX 1.1 definition of wptType -->
      <wpt lat="47.634528" lon="-112.323897">
        <ele>15.75</ele>
        <time>2013-12-20T12:15:27Z</time>
        <extensions>
          <-- optional extensions: userid, bearing, speed, space identifiers -->
          <userid>14587</userid>
          <bearing>180.0</bearing>
          <speed>0.73</speed>
          <spaceid>in_bedroom</spaceid>
          <spaceid>in_bed</spaceid>
        </extensions>
      </wpt>
    </LocalizationEvent>
  </soapenv:Body>
</soapenv:Envelope>
```

5.7.5.1.3 Expected Actions

The behaviour monitor is expected to integrate the localization data into the local knowledge base, with means not defined in this integration profile, and to make use of the data for the recognition of activities or emergencies.

5.7.5.2 universAAL Option: localization event

5.7.5.2.1 Trigger Events

This message is triggered by the indoor localization sensor whenever it measures a new position for the (or one) user within the apartment.

5.7.5.2.2 Message Semantics

universAAL is a distributed middleware that makes the distribution of messages and services transparent to the API user. For universAAL option, both actors (BAN gateway and behaviour monitor) are expected to run

an instance of the universAAL middleware connected through the discovery and peering mechanisms of universAAL. This means that the actors will share three message buses: the context bus, the service bus and the user interface bus. The context bus publishes event messages describing changes in the context the system is running in (such as sensor data), the service bus is used to call services (APIs), and the user interface bus is used for messages related to user interface interactions. Messages sent over a bus can be received by software components independent from the actor they are physically located on.

The “messages” exchanged over the three buses are objects representing an instance of an ontology in RDF/OWL format each. When a message is passed between middleware platform instances, each object is serialised using TURTLE and then transmitted using a reliable transport protocol. At this time, universAAL uses JGroups for this purpose, but in the future also other communication protocols such as MQTT and AllJoyn will be supported. This means that the communication protocol is not guaranteed to be stable across all universAAL instances, but the API within the middleware platform is.

For the purposes of this transaction, localization data shall be communicated as a sequence of events on the universAAL context bus.

5.7.5.2.3 Expected Actions

The behaviour monitor is expected to integrate the localization data into the local knowledge base, with means not defined in this integration profile, and to make use of the data for the recognition of activities or emergencies.

5.7.5.3 Protocol Requirements

Not applicable.

5.7.5.4 Actor Requirements

Not applicable.

5.7.5.5 Security Considerations

The message may optionally be protected in compliance with the WS-I Basic Security Profile 1.0, making use of a Transport Layer Security (TLS) 1.0 secure “channel”. AES encryption as described in RFC 3268 must be supported.

When using the universAAL option, the use of a Virtual Private Network (VPN) is recommended.

5.8 Transaction 08: Appliance status queried/updated

5.8.1 Scope

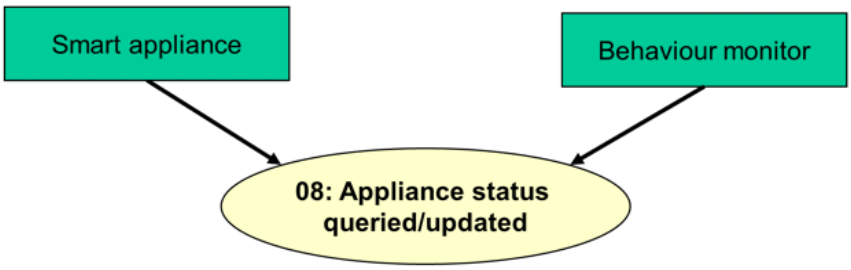
This transaction describes the communication between a smart appliance (i.e. a “white good” that supports network communication) and the behaviour monitor.

The standard that has been chosen for this transaction is the CECED Home Appliances Interoperating Network (CHAIN) defined by the CECED organisation (Conseil Européen de la Construction d'appareils Domestiques). The application layer protocol (“Application Interworking Specification”, AIS) of this standard has been published as EN 50523, whereas the transport protocol is based on Powerline communication (EN 50065-1). The following types of appliances are defined and supported by this standard:

- Combi
- Air conditioner
- Dishwasher
- Tumble dryer
- Washer dryer
- Washing machine
- Gas oven

- Gas cook top
- Hobs
- Hood
- Microwave oven
- Electrical oven
- Range cooker
- Steam oven
- Induction hobs
- Refrigerator freezer
- Freezer
- Refrigerator

5.8.2 Use Case Roles



use case roles

Actor: Smart appliance

Role: Reports its status and receives and executes commands.

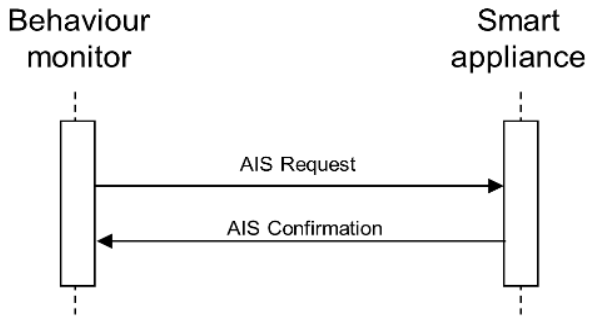
Actor: Behaviour monitor

Role: Uses status updates from smart appliances as an additional source of sensor data for the recognition of activities of daily living and issues commands for example when a dangerous situation has been detected or the user wants to switch “everything off” before leaving the home.

5.8.3 Referenced Standards

- EN 50523-1:2009 Household appliances interworking - Part 1: Functional specification
- EN 50523-2:2009 Household appliances interworking - Part 2: Data structures
- EN 50065-1:2011 Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz - Part 1: General requirements, frequency bands and electromagnetic disturbances

5.8.4 Interaction Diagram



interaction diagram

5.8.5 Messages

5.8.5.1 AIS Request

5.8.5.1.1 Trigger Events

In most circumstances communication is initiated by the behaviour monitor by sending a request to an individual smart appliance, or by sending a broadcast message to the network of smart appliances. This may happen when the behaviour monitor wants to query the status of an appliance, or issue a command to an appliance (in particular, to switch it to a mode of operation that is safe when the user leaves the home). Event report messages may, however, be initiated by a smart appliance when a reportable event occurs.

5.8.5.1.2 Message Semantics

The following message types are defined in the Application Interworking Specification and may be sent as part of this transaction, with the exception of “Proprietary Command”, which is explicitly forbidden:

- Execution of a command
- Washing Parameters
- Cooking Parameters
- Refrigeration Parameters
- Air Conditioning Parameters
- Start Time
- Finish Time
- Device Status
- Remaining Time
- Current Phase
- White Goods Device Set Temperature
- White Goods Device Displayed Temperature
- White Goods Device Current Temperature
- White Goods Device Set Humidity
- White Goods Device Displayed Humidity
- White Goods Device Current Humidity
- Normal Events
- Alert Events
- Reduction
- Extended Identification Request + Index

- Basic Identification Request
- Request Diagnosis Data
- Diagnosis Data
- Time
- Date
- Proprietary Command (Unspecified Data)

The semantics of the messages is defined in EN 50523-1 and EN 50523-2.

5.8.5.1.3 Expected Actions

Upon receipt of the request message, the smart appliance responds with a confirmation message containing the status of the command or the requested data. Note that the protocol also defines group messages and broadcast messages (such as date/time updates) that do not require confirmation.

5.8.5.2 Protocol Requirements

Each device in a smart appliance network is assigned two addresses: the “domain address”, which defines a logical network (only devices with the same domain address can interact with each other) and the “link address” which addresses a device within a logical network. Details of the assignment of addresses and the “plug-and-play” configuration of the smart appliance network are defined in EN 50523-1. Within the logical network, the behaviour monitor acts as the (single) master and the smart appliances act as slaves to this master.

5.8.5.3 Actor Requirements

Not applicable.

5.8.5.4 Security Considerations

One limitation of the use of powerline communications (PLC) is that the communication may well reach beyond the limits of one apartment or house, i.e. it might be possible to read messages, or even to send commands, from an environment outside the control of the user.

5.9 Transaction 09: Video stream

5.9.1 Scope

Some assistive systems use optical sensors (cameras operating in the visible light or infrared spectrum) to implement behaviour monitoring, i.e. detecting a person's position, activities of daily living, and emergencies such as a fall event. In such architectures, one or more optical sensors will be connected to the behaviour monitor, which applies video analysis techniques to the continuous stream of video data.

Video sensors differ from classical home automation sensors in that they require a relatively high bandwidth that is not offered by most home automation networks. Therefore, a different network is needed for the optical sensors. This transaction makes use of the ONVIF specifications, a set of publicly available specifications developed and maintained by the Open Network Video Interface Forum (ONVIF). The ONVIF specifications define a set of protocols that enable interoperability between TCP/IP network based physical security products (i.e., surveillance cameras and related devices), based on internet standards such as web services, RTP streaming, and standard video codecs such as motion JPEG, MPEG-4, and H.264.

5.9.2 Use Case Roles

use case roles

Actor: Optical sensor

Role: Sends a video stream, and optionally also an audio stream. In ONVIF terms, this actor is an ONVIF Device.

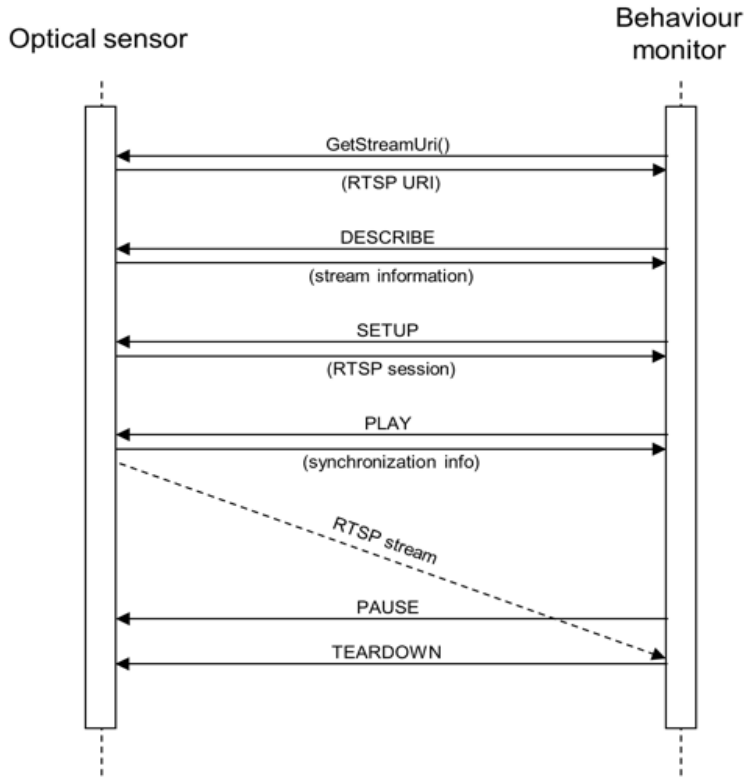
Actor: Behaviour monitor

Role: Receives a video stream, and optionally also an audio stream, and applies image/signal processing techniques to derive behaviour monitoring information. In ONVIF terms, this actor is an ONVIF Client.

5.9.3 Referenced Standards

- ISO/IEC 10918-1:1994 Information technology – Digital compression and coding of continuous-tone still images: Requirements and guidelines (JPEG)
- ISO/IEC 14496-10:2012 Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding (H.264)
- ISO/IEC 14496-2:2004 Information technology – Coding of audio-visual objects – Part 2: Visual (MPEG 4)
- ISO/IEC 14496-3:2005 Information technology – Coding of audio-visual objects – Part 3: Audio (AAC)
- ITU-T Recommendation G.711:1988: Pulse code modulation (PCM) of voice frequencies
- ITU-T Recommendation G.711:1990: 40, 32, 24, 16 Kbit/S Adaptive Differential Pulse Code Modulation (ADPCM)
- OASIS: Web Services Dynamic Discovery (WS-Discovery) Version 1.1, 2009
- ONVIF Core Specification, Version 2.4.1 (2013)
- ONVIF Media Service Specification, Version 2.4 (2013)
- ONVIF Profile Policy, Version 1.0 (2011)
- ONVIF PTZ Service Specification, Version 2.4.1 (2013)
- ONVIF Streaming Specification, Version 2.4.1 (2013)
- RFC 2246: The TLS Protocol, Version 1.0, 1999
- RFC 2326: Real Time Streaming Protocol (RTSP), 1998
- RFC 3268: Advanced Encryption Standard (AES) Ciphersuites for Transport Layer Security (TLS), 2002
- RFC 3550: RTP: A Transport Protocol for Real-Time Applications, 2003
- WS-I: Basic Profile Version 2.0, 2010

5.9.4 Interaction Diagram



interaction diagram

Source: ONVIF Streaming Specification, p. 16, Fig. 7.

5.9.5 Messages

5.9.5.1 Video Stream

5.9.5.1.1 Trigger Events

The video streaming is initiated by the behaviour monitor. The streaming may either be continuous (“always on”), or be triggered by presence information derived for example from information received via Transaction 05: Home automation event forwarded (motion detector, presence detector, or light barrier on the door), or via Transaction 07: Localization event sent.

Note that the ONVIF specifications contain an eventing mechanism that may allow an optical sensor with built-in motion detector to send an event message to the behaviour monitor and thus trigger the transmission of video data; however, as these specifications are relatively vague related to the types of events that may be transmitted in the current version of the ONVIF specs, this type of communication is not further detailed in this transaction.

5.9.5.1.2 Message Semantics

The ONVIF specifications offer plug-and-play interoperability between ONVIF devices (i.e. the optical sensor actor) and clients (the behaviour monitor). Device discovery is based on WS-Discovery, with ONVIF specific extensions. Once the client has discovered a device, the capabilities of the device can be queried using Web Service calls. The Web Services as such are specified by ONVIF, and the protocol is based on SOAP over HTTP using the Web Services Interoperability Organization (WS-I) basic profile 2.0 recommendations.

The optical sensor actor shall implement the “ONVIF Profile S” as an ONVIF device, which specifies the services required for a device that sends video data over an IP network to a client. Optional features for an

ONVIF device in this profile are the transmission of audio data, and the control of Pan, Tilt and Zoom functions (PTZ) if offered by the sensor. The mandatory functionality of an ONVIF device compliant to Profile S includes support for the ONVIF media service, and the ONVIF streaming service. The media service allows the client to retrieve a list of supported media profiles, and to select one media profile supported by the device. Media profiles are pre-defined configurations for the device, including the settings for audio source, video source, audio and video encoders used, and PTZ control if supported. The client can furthermore retrieve the URI under which the live streaming of video data can be initiated. Optionally, the media service may permit the client to request, and retrieve snapshots (still image frames) from the camera in JPEG format.

The streaming of video and audio data as such takes place using the Real-time Transport Protocol (RTP), with two possible transport options:

- RTP over UDP (low protocol overhead, no security, LAN only)
- RTP with media control using the Real-time Streaming Protocol (RTSP) and the Real-time Control Protocol (RTCP) over HTTP, which may be secured with Transport Layer Security (TLS) if supported by the device. This protocol is suitable for firewall traversal.

Several video codecs are available for video streaming: Motion JPEG (required capability), MPEG-4 with simple profile or advanced simple profile, or H.264 with baseline, main, extended, or high profile. Audio data, if supported, is encoded using G.711 uLaw (required capability if audio is supported), G.726 or AAC.

The behaviour monitor actor shall implement the “ONVIF Profile S” as an ONVIF client, which specifies the functions needed to configure, request, and control streaming of video data over an IP network from an ONVIF device compliant to the Profile S.

5.9.5.1.3 Expected Actions

The behaviour monitor processes the video stream (and optionally the audio stream, if present) using image and signal processing techniques to derive information about the presence of a user, the activities of daily living performed, and possible emergencies such as a fall event. The video stream may also be used to distinguish multiple persons in the apartment. The type of processing used, and the information derived by the behaviour monitor are not further restricted or specified in this transaction.

It should be noted that there is a relationship between this transaction and Transaction 02: Behaviour/alarm notification sent, which optionally also supports audio and video transmission, in this case between the user and the receiver of a notification, such as an informal or formal carer. Since the SCAIP protocol used in Transaction 02 also uses RTP to transport audio and video data, it might be possible for the behaviour monitor to use an optical sensor that also supports audio as the audiovisual input to a multimedia session with a notification receiver. However, there are differences: Connection set-up uses ONVIF web service calls in this transaction and the Session Initiation Protocol (SIP) in transaction 02, audio is optional in this transaction whereas video is optional in transaction 02, and a secure transmission is based on RTP over HTTPS in this transaction, versus SRTP (Secure RTP) with SIP key exchange in transaction 02. Furthermore, the SCAIP specification used in transaction 02 does not mention the use of RTSP and RTCP, which are both used in this transaction. Therefore, the use of an optical sensor of this transaction as a source of audio and video for transaction 02 will require the behaviour monitor to implement some gateway functionality that is beyond the scope of this transaction.

5.9.5.2 Protocol Requirements

Not applicable.

5.9.5.3 Actor Requirements

Not applicable.

5.9.5.4 Security Considerations

Video data showing the activities of the user in the home must be considered highly sensitive, and must be protected appropriately. The ONVIF specifications support a number of options for protecting the

communication between devices (cameras) and clients, but most of these are optional.

As a minimum level of security, access to the web service interfaces offered by a device is limited to authenticated users based on user name and password (or a hashed password) transmitted using WS-Security. The management of user names, access rights and passwords is a function of the ONVIF protocol. Unfortunately, ONVIF does not guarantee that passwords are never transmitted in clear text over an unencrypted connection.

ONVIF recommends that all devices and clients should support the TLS protocol, but this support is optional. Furthermore, TLS can either be used with AES encryption, or in an unencrypted mode only offering peer authentication and message integrity. TLS, if supported, is used for all TCP based communication, but not for the streaming of video data using RTP over UDP.

Therefore, this transaction must either be executed over a network that is appropriately protected (e.g. cabled LAN limited to the apartment, a Virtual Private Network (VPN), or a WPA2-protected WLAN), or - preferably - both actors should support TLS and use AES encrypted connections both for the web service interactions, and for the streaming of video data, which requires the use of the RTP with RTSP/RTCP over HTTP transport option instead of RTP over UDP (see above).

5.10 Transaction 10: BAN parameter sent

5.10.1 Scope

The Body Area Sensor uses this transaction to send measurements to the BAN Gateway, which will in turn forward the data to another actor, e.g. to a behaviour monitor, using another communication protocol with wider range.

For this transaction, three alternative communication stacks are defined in compliance with the Continua Design Guidelines: Bluetooth Health Device Profile (wireless), Bluetooth Low Energy (wireless, low energy usage), USB (wired).

The following types of body area sensors are defined:

- Pulse Oximeter
- Blood Pressure Monitor (LE)
- Thermometer (LE)
- Weighing Scale
- Glucose Meter
- Basic 1-3 Lead ECG
- Heart Rate Sensor (LE)
- Cardiovascular Fitness
- Strength Fitness
- Adherence Monitor
- Peak Flow Meter
- Activity Hub

Out of these types of sensors, only the Blood Pressure Monitor, Thermometer and Heart Rate Sensor can use the Bluetooth Low Energy option at this time, since only for these sensor types the corresponding profile and service definitions for use with Bluetooth Low Energy have been defined by the Bluetooth SIG.

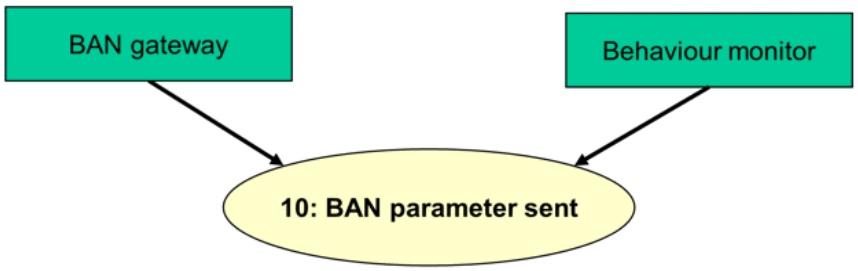
The Activity Hub sensor type can be used to implement a number of additional sensors:

- Fall Sensor
- Motion Sensor
- Enuresis Sensor
- Contact Closure Sensor
- Switch Sensor

- Medication Dosing Sensor
- Water Sensor
- Smoke Sensor
- Property Exit Sensor
- Ambient Temperature Sensor
- Usage Sensor
- Personal Emergency Response (PERS) Sensor
- CO Sensor
- Gas Sensor
- Body Composition Analyzer

Note that for certain sensor types such as Smoke Sensors, other transport protocols than the ones defined in this transactions would be more useful; this transaction is deliberately limited to Body Area Networks. Nevertheless, no restriction of the permitted type of body area sensors is defined, since the Continua Design Guidelines also permit all these types to be used with the body area network protocols defined in this transaction.

5.10.2 Use Case Roles



use case roles

Actor: Body area sensor (in Continua this is a “PAN Device”)

Role: Measures vital parameter or activity data and sends it to the BAN gateway over the body area network.

Actor: BAN gateway (in Continua this is a “Application Hosting Device”, AHD)

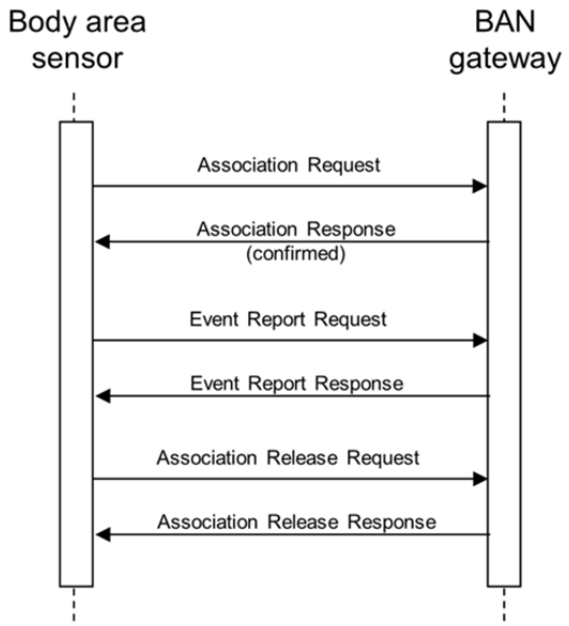
Role: Receives sensor data from the body area network.

5.10.3 Referenced Standards

- Continua Health Alliance: Continua Design Guidelines, Version 2012
- Bluetooth Core Specification, Version 4.0, 2010
- Bluetooth Health Device Profile, Version 1.0
- Bluetooth Health Thermometer Profile & Service, Version 1.0
- Bluetooth Heart Rate Profile & Service, Version 1.0,
- Bluetooth Device Information Service, Version 1.0
- Bluetooth Blood Pressure Profile & Service, Version 1.0
- Bluetooth Personal Health Devices Transcoding Whitepaper, Version 1.1
- IEEE Std 11073-10406:2011 Health informatics – Personal health device communication – Part 10406: Device specialization – Basic electrocardiograph (ECG) (1- to 3-lead ECG)
- IEEE Std 11073-10420:2010 Health informatics – Personal health device communication – Part 10420: Device specialization – Body composition analyzer

- ISO/IEEE 11073-10101:2004 Health informatics – Point-of-care medical device communication – Part 10101: Nomenclature
- ISO/IEEE 11073-10404:2010 Health informatics – Personal health device communication – Part 10404: Device specialization – Pulse oximeter
- ISO/IEEE 11073-10407:2010 Health informatics – Personal health device communication – Part 10407: Device specialization – Blood pressure monitor
- ISO/IEEE 11073-10408:2010 Health informatics – Personal health device communication – Part 10408: Device specialization – Thermometer
- ISO/IEEE 11073-10415:2010 Health informatics – Personal health device communication – Part 10415: Device specialization – Weighing scale
- ISO/IEEE 11073-10417:2010 Health informatics – Personal health device communication – Part 10417: Device specialization – Glucose meter
- ISO/IEEE 11073-10421:2010 Health informatics – Personal health device communication – Part 10421: Device specialization – Peak expiratory flow monitor (peak flow)
- ISO/IEEE 11073-10441:2008 Health Informatics – Personal health device communication - Part 10441: Device specialization–Cardiovascular fitness and activity monitor
- ISO/IEEE 11073-10442:2008 Health Informatics – Personal health device communication - Part 10442: Device specialization - Strength fitness equipment
- ISO/IEEE 11073-10471:2008 Health informatics – Personal health device communication – Part 10471: Device specialization - Independent living activity hub
- ISO/IEEE 11073-10472:2010 Health Informatics – Personal health device communication – Part 10472: Device specialization – Medication monitor
- ISO/IEEE 11073-20601:2008 Health informatics – Personal health device communication – Part 20601: Application profile – Optimized exchange protocol
- ISO/IEEE 11073-20601a:2010 Health informatics – Personal health device communication – Part 20601: Application profile – Optimized exchange protocol - Amendment 1
- Universal Serial Bus Device Class Definition for Personal Healthcare Devices, Release 1.0, November 8, 2007, USB Implementers Forum
- Errata for “USB Device Class Definition for Personal Healthcare Devices, Release 1.0, November 8, 2007” as of February 15, 2008, USB Implementers Forum

5.10.4 Interaction Diagram



interaction diagram

Note: This interaction diagram shows the message exchange for the Bluetooth HDP and USB options. The Bluetooth pairing process is not shown. Since associations may be kept open over a longer time, the association negotiation (Association Request/Response and Association Release Request/Response) shown in the diagram will not typically proceed and succeed every single transmission of sensor data.

5.10.5 Messages

5.10.5.1 Bluetooth HDP Option: Agent-initiated measurement data transmission

5.10.5.1.1 Trigger Events

The transmission is initiated by the body area sensor whenever it determines that newly generated measurements warrant a transmission to the BAN gateway. This may be the case after every single measurement, or after a certain number of measurements or a timeout.

5.10.5.1.2 Message Semantics

Before messages can be exchanged on application layer, a Bluetooth pairing between the body area sensor and the BAN gateway is required. The Continua Design Guidelines specify that this pairing must remain active until manually changed by the user, even if the devices are switched off or batteries are exchanged. The transport layer for this option is based on the Bluetooth Health Device Profile (HDP) specification.

The message exchange on application layer is a bidirectional transmission of messages, as shown in the interaction diagram, based on ISO/IEEE 11073-20601:2008 and ISO/IEEE 11073-20601a:2010, and the device specialisation for the given sensor type, which defines the data structure for each type of sensor. The protocol supports the negotiation of a network association between “agent” (body area sensor) and “manager” (BAN gateway), the exchange of configuration information, and the transmission of measurements. According to the Continua Design Guidelines, transmission of sensor data must always be initiated by the agent using an Event Report Request message, and never by the Manager (which would use an Action Request message instead).

5.10.5.1.3 Expected Actions

Upon receipt of the Event Report Request message, the BAN gateway is expected to return an Event Report Response message to confirm receipt. Furthermore the BAN gateway is expected to temporarily store the

sensor data and at its own discretion forward it to another receiver either immediately or once a sufficient number of measurements has been received.

5.10.5.2 Bluetooth LE Option: sensor data transmission

5.10.5.2.1 Trigger Events

The transmission is initiated by the body area sensor whenever it determines that newly generated measurements warrant a transmission to the BAN gateway. This may be the case after every single measurement, or after a certain number of measurements or a timeout.

5.10.5.2.2 Message Semantics

Before messages can be exchanged on application layer, a Bluetooth pairing between the body area sensor and the BAN gateway is required. The Continua Design Guidelines specify that this pairing must remain active until manually changed by the user, even if the devices are switched off or batteries are exchanged. The transport layer for this option is based on the Bluetooth Low Energy (LE) profile, which is part of the Bluetooth 4.0 Core Specification.

Unlike the Bluetooth HDP option, the Bluetooth LE option does not use the ISO/IEEE 11073 protocol for data exchange on message level. Instead, the following specifications are used, which are all based on the Bluetooth Generic Attribute Profile (GATT), which is defined in Part G of the Bluetooth 4.0 Core Specification:

- Bluetooth Device Information Service, Version 1.0
- Bluetooth Health Thermometer Profile & Service, Version 1.0
- Bluetooth Heart Rate Profile & Service, Version 1.0,
- Bluetooth Blood Pressure Profile & Service, Version 1.0

The data types of the information exchanged, however, is compatible to the ISO/IEEE 11073 family of standards, in particular the nomenclature and domain model. The mapping from ISO/IEEE 11073 to Bluetooth Low Energy is defined in the “Bluetooth Personal Health Devices Transcoding Whitepaper”, Version 1.1 or later, which is a normative document for implementations compliant with the Continua Design Guidelines.

5.10.5.2.3 Expected Actions

Upon receipt of sensor data, the BAN gateway is expected to temporarily store the sensor data and at its own discretion forward it to another receiver either immediately or once a sufficient number of measurements has been received.

5.10.5.3 USB Option: Agent-initiated measurement data transmission

5.10.5.3.1 Trigger Events

The transmission is initiated by the body area sensor whenever it determines that newly generated measurements warrant a transmission to the BAN gateway. This may be the case after every single measurement, or after a certain number of measurements or a timeout.

5.10.5.3.2 Message Semantics

The message semantics for this option are the same as for the Bluetooth HDP Option, but instead of Bluetooth HDP a cabled connection is used, based on the USB Personal Healthcare Device Class v1.0 specification plus the 2008 errata.

The Continua Design Guidelines require that USB 1.1 “low speed” data rate never be used; permitted data rates are USB 1.1 “full speed” and USB 2.0 “high speed”.

5.10.5.3.3 Expected Actions

Upon receipt of the Event Report Request message, the BAN gateway is expected to return an Event Report

Response message to confirm receipt. Furthermore the BAN gateway is expected to temporarily store the sensor data and at its own discretion forward it to another receiver either immediately or once a sufficient number of measurements has been received.

5.10.5.4 Protocol Requirements

Not applicable.

5.10.5.5 Actor Requirements

Not applicable.

5.10.5.6 Security Considerations

For a cable-based USB connection, no further security mechanisms are used since it is assumed that the cable (as part of the body area network) is sufficiently secure against unauthorized eavesdropping.

The Bluetooth protocol makes use of “frequency hopping” 1600 times per second to make eavesdropping difficult.

The Bluetooth Health Device Profile furthermore mandates that all communication is always encrypted on link layer. This is done using the “E0” stream cipher built into the Bluetooth protocol, normally with 128 bit key length. It should be noted that cryptanalysis of this cipher has made significant progress in the last years, so that the cipher must be considered as relatively weak.

The Bluetooth Low Energy option is based on the BT Generic Attribute Profile, which makes use of 128 bit AES encryption.

5.11 Transaction 11: Calendar updated

Not defined in this project.

5.12 Transaction 12: Weather queried

Not defined in this project.

5.13 Transaction 13: Activity suggestion queried

Not defined in this project.

5.14 Transaction 14: Medication dispensed

Not defined in this project.

5.15 Transaction 15: ADL performed

Not defined in this project.

5.16 Transaction 16: Remote control event sent

Not defined in this project.

5.17 Transaction 17: Remote display

Not defined in this project.

5.18 Transaction 18: Video conference performed

Not defined in this project.

5.19 Transaction 19: Chat performed

Not defined in this project.

5.20 Transaction 20: Game played

Not defined in this project.

5.21 Transaction 21: Storage threshold notification sent

Not defined in this project.

5.22 Transaction 22: Shopping list sent

Not defined in this project.

5.23 Transaction 23: Shopping reminder sent

Not defined in this project.

5.24 Transaction 24: Shopping order sent

Not defined in this project.

5.25 Transaction 25: PHR extract exported

5.25.1 Scope

The Personal health record (PHR) uses this transaction to forward healthcare monitoring information to another electronic health record (EHR). The sensor data can be received by a BAN Gateway using the “BAN parameter forwarded” transaction, directly from a Body Area Sensor using the “BAN parameter sent” transaction, or by direct input (manual or document import) in the PHR. This transaction focuses on the reporting of a snapshot of health information over some period of time.

5.25.2 Use Case Roles

Use case roles

Actor: Personal health record (in Continua this is a “Health Reporting Network Device”)

Role: Sends (forwards) sensor data received over the WAN (Continua: “HRN Sender”).

Actor: Electronic health record (in Continua this is also “Health Reporting Network Device”)

Role: Receives sensor data from personal health record (Continua: “HRN Receiver”).

5.25.3 Referenced Standards

5.25.3.1.1 Standards and specifications

- Continua Health Alliance: Continua Design Guidelines, Version 2012
- IHE Patient Identifier Cross-reference (PIX) profile
- IHE IT Infrastructure (ITI) Technical Framework Volume 2 Appendix V, Revision 6.0. Available at: http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol2x_FT_2009-08-10.pdf
- WS-I Basic Profile Version 1.1. Available at: http://www.ws-i.org/Profiles/BasicProfile-1.1.html
- WS-I Basic Security Profile Version 1.0. Available at: http://www.ws-i.org/Profiles/BasicSecurityProfile-1.0.html
- Web Services Security: SAML Token Profile 1.1. Available at http://www.oasis-open.org/committees/download.php/16768/wss-v1.1-spec-os-SAMLTokenProfile.pdf
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- For IHE XDR and IHE XDM profiles see the ?IHE IT Infrastructure (ITI)Technical Framework Volume 1 (ITI TF-1)Integration Profiles Revision 6.0 – Final Text August 10, 2009 And the IHE IT Infrastructure (ITI) Technical Framework Supplement 2009-2010, Cross-Enterprise Document Reliable Interchange (XDR) Trial Implementation Supplement, Version – Release 4.0 August 10, 2009. Available at: http://www.ihe.net/Technical_Framework/index.cfm#IT, also at http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol1_FT_2009-08-10-2.pdf
- For IHE PIX and PDQ profile see ?IHE IT Infrastructure (ITI) Technical Framework Volume 1 (ITI TF-1) Integration Profiles Revision 6.0 – Final Text August 10, 2009? and ?IHE IT Infrastructure (ITI) Technical Framework Volume 2b (ITI TF-1) Integration Profiles Revision 6.0 – Final Text August 10, 2009?. Available at: http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol1_FT_2009-08-10-2.pdf and http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol2b_FT_2009-08-10.pdf
- PIX feed and PDQ using HL7 v3. Available at: http://www.ihe.net/Technical_Framework/upload/IHE_ITI_Suppl_PIX_PDQ_HL7v3_Rev2-1_TI_2010-08-10.pdf
- HL7 Implementation Guide for Clinical Document Architecture, Release 2: Consent Directives, Release 1, Draft Standard for Trial Use, HL7, January 2011. Available at: http://www.hl7.org/documentcenter/public/standards/dstu/CDAR2_IG%20_CONSENTDIR_DSTU_2011JAN.pdf
- For IHE XUA profile see ?IHE IT Infrastructure (ITI) Technical Framework Volume 1 (ITI TF-1) Integration Profiles Revision 6.0 – Final Text August 10, 2009? and ?IHE IT Infrastructure (ITI) Technical Framework Volume 2b (ITI TF-1) Integration Profiles Revision 6.0 – Final Text August 10, 2009 Available at: http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol1_FT_2009-08-10-2.pdf and http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_6-0_Vol2b_FT_2009-08-10.pdf
- IHE Technical Framework Supplement – Cross-Enterprise User Assertion – Attribute Extension (XUA++), Supplement for Trial Implementation, Published 2010-08-10. Available at: http://www.ihe.net/Technical_Framework/upload/IHE_ITI_Suppl_XUA-_Rev1-1_TI_2010-08-10.pdf
- IHE Technical Framework Supplement – Document Digital Signature (DSG), Trial Implementation Supplement, August 10, 2009. Available at: http://www.ihe.net/Technical_Framework/upload/IHE_ITI_TF_Supplement_Digital_Signature-2009-08-10.pdf
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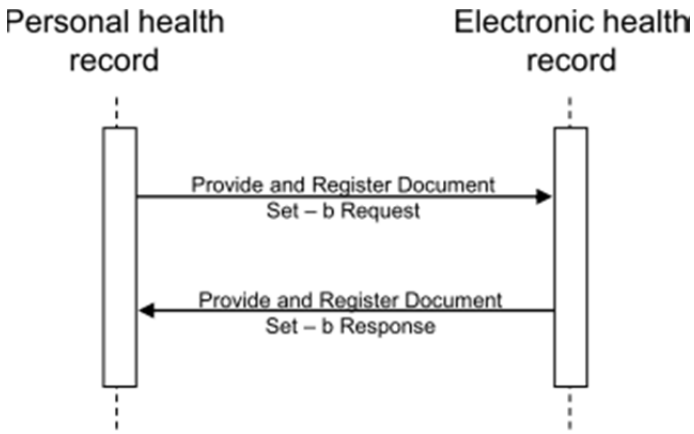
- HL7 Implementation Guide: CDA Release 2 – Continuity of Care Document (CCD). A CDA implementation of ASTM E2369-05. Health Level 7. 1 April 2007. Available at: http://www.hl7.org/Library/General/HL7_CCD_final.zip.
- SNOMED CT (Systematized Nomenclature of Medicine–Clinical Terms). International Health Terminology Standards Development Organization. Latest. Available at: http://www.ihtsdo.org/.
- The Unified Code for Units of Measure, Gunther Schadow, Clement J. McDonald, 1998-2008. Available at: http://aurora.regenstrief.org/~ucum/ucum.html.
- IETF RFC 2119, Key words for use in RFCs to Indicate Requirement Levels, S. Bradner, March 1997.
- HL7 Implementation Guide for CDA Release 2: Personal Healthcare Monitoring Report, DSTU Release 1.1 http://www.hl7.org/documentcenter/public/standards/dstu/CDAR2_IG_PHMRPTS_R1.1_DSTU_2010OCT.zip

5.25.4 Interaction Diagram



Provide and register document transaction

Note: This interaction diagram shows the IHE provide and register document set.b transaction.

5.25.5 Messages

5.25.5.1.1 Trigger Events

The transmission is initiated by the Personal health record whenever a user decides to share health information or gave his permission to share health information periodically in an automated way, in order to forward the data to the electronic health record.

5.25.5.1.2 Message Semantics

This message is based on the “HRN Interface” of the Continua Design Guidelines, which specify the transmission of a Patient identity information with an HL7v2.31 and HL7v2.5 message. HRN Senders like the personal health record must implement the IHE Patient Identity Feed transaction (PIX) in order to provide the necessary information for cross-referencing. This cross-referencing must then be performed from a Patient Identifier Cross-reference Manager either within the destination‘s domain of control, or shared between the Sending and Receiving entities.

Identity information is used together with the transport protocols defined in the IHE IT Infrastructure Framework (IHE ITI-TF-1, ITI-TF-2a, ITI-TF-2b, and ITI-TF-2x), and in the Continua Design Guidelines. For the direct secure communication of patient health data between care-givers, the IHE XDR (Cross-Enterprise Document Reliable interchange) profile utilizes standards such as SOAP 1.2 and MTOM. Health information may be transmitted through the public internet, when the HRN sender and receiver are not in the same network. The profile also allows to set up a virtual private network to transmit the information.

The Continua design guideline distinguish between direct HRN Messaging via IHE XDR profile and indirect Messaging via IHE Cross Enterprise Document Sharing over Media (XDM) profile. The direct messaging profile is used when the PHR communicates directly (without any intermediate systems) over the internet with the EHR. XDR uses HTTP, SOAP 1.2, ebXML and MTOM as specified in the XDS.b guidelines.

The indirect communication method is used when health data is transferred over email or by using offline media such as USB-sticks or CD-ROMs as specified in the IHE XDM profile. XDR and XDM using the same set of metadata and the same IHE transactions (Provide and register document set.b) to describe the contents of the payload. Continua and IHE specifying that the payload is compressed as a ZIP file.

As XDR and XDM are content agnostic both, structured CDA-documents and non-structured documents like MS-Word files or images are possible for the transmission. Continua chose the Personal Healthcare Monitoring Report (PHMR) as CDA template for the transmission of structured data. The PHMR is based on the Continuity of Care Document (CDD) which is based on the HL7 Clinical Document Architecture which is based on the Clinical Document Architecture (CDA).

5.25.5.2 Protocol Requirements

Not applicable.

5.25.5.3 Actor Requirements

Not applicable.

5.25.5.4 Security Considerations

The Continua Design guideline references the use of the IHE mechanisms for transport security (Mainly TLS, IHE ATNA). To ensure document integrity the IHE Document Digital Signature (DSG) profile is referenced. Consent management at the continua profile is based on HL7 CDA R2 Consent Directive to capture patient consent in a CDA consent document. This document can also shared via the IHE XDR, XDS or XDM profiles. Consent enforcement is implemented by the IHE Document Encryption Profile (DEN) which specifies the encryption and decryption of the payload via symmetric and asymmetric technologies.

5.26 Transaction 26: PHR updated

Not defined in this project.

6 Literature

Reference	Full citation
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