European Innovation Partnership on Active and Healthy Ageing

Action Group C2

Deliverable 3: Interoperability process recommendation for EIP-AHA and for standardization

(Version 0.7)

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European Innovation Partnership on Active and Healthy Ageing

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1. Preface

The Action Group was established following an initial Call for participation in May 2012 and has proceeded as a number of parallel focused group activities aimed towards mutual learning and exchange of best practice between participants. The cooperation remains open to further participation with a shared aim of promoting the growth and take up of interoperable and independent living solutions. The participating members of the Action Group implicitly recognise that by sharing experience and best practice there is a mutual benefit in either cost saving, process improvement or skills development.

This document also benefits from the work carried out by the following undertakings:

- The Antilope FP7 project (http://www.antilope-project.eu/)
- The ReAAL FP7 project (http://www.cip-reaal.eu/)
- The BRAID FP7 project (http://www.braidproject.eu/)
- The Engaged FP7 project (http://engaged-innovation.eu/)
- A study carried out by the AAL Joint program on use case analysis

2. Introduction

The interoperability approach proposed by C2 is based on the analysis made in action C2 of EIP on AHA in 2013. The results were presented during the EIP conference of partners in November 2013[1].

The diagnosis of the C2 action is the following: the barriers for ICT solutions (fragmentation of the markets, technology push instead of user pull, business models, governance and policies, procurement and so forth…) prevent the development of the innovation ecosystem needed to create a wealth of solutions that will then be used in the market. These barriers create a vicious circle: no interoperable solutions means no critical mass which in turn means not need for standards. This circle is simply too strong to break directly.

The rationale for interoperability is that it is important to the development of the market and to the broader take-up of technology solutions to support assisted living and active and healthy ageing. There are levels of interoperability. At a basic level of interoperability elements existing in an ecosystem without adversely interfering with the intended function of each other. At the highest level of interoperability elements can communicate with each other and fully understand and use the information that they exchange.

[1] Conference of partners, November 25th, 2013
http://ec.europa.eu/research/innovation-union/index_en.cfm?section=active-healthy-ageing&pg=partners-conference-2013-programme

3. Interoperability: a Definition

This document uses the following definition of Interoperability[2]:

> *Interoperability is the ability of a system or a product to work with other systems or products without special effort on the part of the customers.*

As interoperability may cover many facets, multiple associated definitions have been provided. Annex 2 contains the glossary proposed by [Antilope]. It covers terms such as:

- Interoperability agreements
- Interoperability framework
- Interoperability governance
- Interoperability levels
- Legal interoperability
- Organizational interoperability
- Semantic interoperability
- Technical interoperability

Another perspective on interoperability is as follows:
Interoperability represents an organizational and technological approach aimed at linking the various local healthcare providers and hospitals belonging to a same region, so they can exchange and share the greatest amount of data and information. The aim is to achieve more and more integrated services, in order to make patients' life easier and contribute to reduce the loss of time and the system costs.

A definition of an interoperability model in the healthcare sector could be a model that allows us to define the procedures and the access and exchange rules of clinical-healthcare information, while establishing the rules of usage of the services between the entities, or between the different information domains that adhere to the system. A Public Body information domain is the set of network infrastructures and information systems, of data and information procedures, that, from a legal point of view, pertain to a legal entity responsible, as holder, for the security and for the protection of privacy (in the case of Italy according to the Legislative Decree June 30th, 2003 n. 196 "Code concerning the protection of personal data"). A domain is therefore composed by an Intranet and a set of Information Services and users, who operate as part of a unique responsibility on security.

Every information domain could provide services accessible both by operators internal to domain (for example ward doctors, surgery doctors, physicians who provide medical reports, doctors at the health

[2] (http://www.ieee.org/education_careers/education/standards/standards_glossary.html

department, etc.), and by users external to domains (for example, citizens as users of healthcare services). It can also take advantage of the services exposed by another entity leaving the boundaries of your domain and taking advantage of the services to support interoperability, displayed on a private Internet network connection between the domains (extranet of healthcare).
Crossing the boundaries of an information domain means to leave or enter the area from another domain, under the responsibility of a clearly identified individual, for the purposes of both security aspects and data ownership.
Interoperability among domains, therefore, is performed through the "Cooperation Domain", that is composed by the dedicated Internet, accessible only by authorised individuals, and by those services which are centrally offered to all domains for communication and data exchanges purposes.

A recent presentation on interoperability from ISO/IEC SC 25 WG 1 by Dritan Kaleshi and Ron Ambrosio can be found at http://www.slideserve.com/chandra-vaikunth/interoperability-update and a CENELEC 2010 Workshop Agreement on Interoperability in the home can be downloaded from www.shaba.eu/Files/CWA50560-2010-IFRS.pdf which provides an interesting perspective.

4. Standards and Pre-standards. Towards a Practice of Pre-standards

When it comes to research on active healthy living, one of the barriers is the disconnect between research activities and standardised activities, in terms of resources and in terms of readiness. Guidance on Standards in RTD projects is provided by CEN/CENELEC at http://www.cencenelec.eu/research/news/publications/Publications/LinkingResearch.pdf.

A research undertaking with limited resources (e.g. several person-month) may have problems in integrating the following tasks any of the following tasks: develop a standard specification; promote a standard; participate to standardization work; develop the test requirements for conformance; develop the test software for conformance; carry out the tests for conformance; adapt research and development to a standard; buy the SDK, licenses and hardware associated with a standard.

A research undertaking will specific readiness objectives will have problems in coping with standards readiness requirements. Standards are assumed to be mature, and implementations of compliant ICT solutions are supposed to be mature for deployment. For the most part standards are developed by interested industry stakeholders with public consultation through a rather formal process.

Concept of Technology Readiness

The concept of Technology Readiness Level TRL scale has been used widely in the industry. It is now also used in the Horizon 2020 programme to describe the maturity of a given technology undertaking:

- TRL1: Basic Research,
- TRL2: Technology concept,
- TRL3: Proof of Concept,
- TRL4: Lab validation,
- TRL5: Validation in relevant environment,
- TRL6: Demonstration in relevant environment,
- TRL7: Demonstration in operational environment,
- TRL8: System complete and qualified,
- TRL9: Deployment

Technology Readiness in EIP-AHA

The following categorisation can be made concerning technology undertaking carried out in the EIP-AHA community:

- Services implemented at research level (e.g. in a laboratory) are TRL4
- Services implemented at living lab but not deployed (e.g. users test the service in a lab) are TRL5
- Services implemented at living lab level and deployed (e.g. users test the service in their home) are TRL6
- Services provided to communities using established mature technology are TRL9

Technology Readiness of Complex System

The TRL of a complex system is in general directly related to the TRL of the least mature/ready subsystem. Therefore a service will have the TRL of the component with the lowest TRL.

An interesting example is when a service consists of applications and platform components (e.g. an application running on top of universAAL). The following observation can be made: it would make sense that platform components have a higher TRL than application components. It is possible to develop an application proof of concept on top of a mature platform. It is not possible to develop a mature application on top of a proof of concept platform.

Technology Readiness and Interoperability

An interoperability point is just another component of a system, and the same maturity principle applies. For instance a service A interacting with service B using an interoperability interface I will have the TRL of the lowest TRL between A, B, and I.

5. C2 Strategic Recommendations

Recommendation S1: Support Several Types of Readiness

The first recommendation of C2 is to support and enforce interoperability of independent living solutions at all level of readiness: research, living lab and market. In other words have smaller growing virtuous circles: first create a virtuous circle at research level, which then grow at innovation level (in living labs) and imposes itself in the market (as showed in Figure 1). The following table explains the readiness meaning depending on the entity making up an ICT solution (interoperability element, application component, platform component).

EIP-AHA Readiness Level	Interoperability element	Application or platform component
TRL A: Research level	Specification used by the research community, based on research level consensus.	Component developed and used at research level
TRL B: Innovation level	Specification used by living labs community based on pre-standards.	Component developed and used at living lab level
TRL C: Market level	Specification used in the market based on standards	Component developed and used at market level

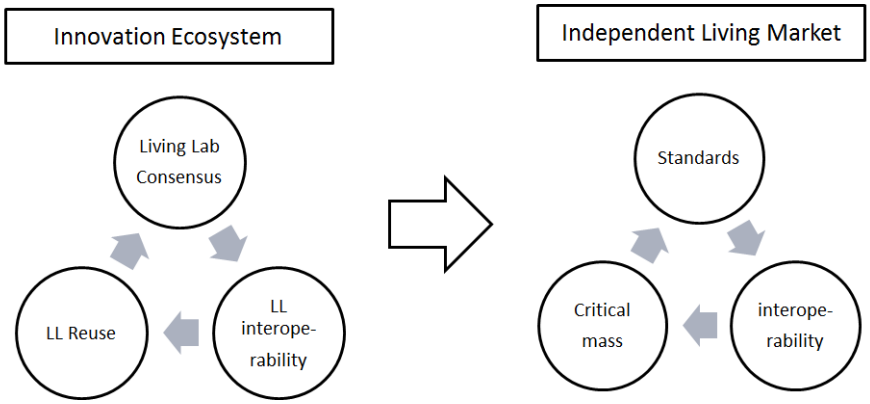


Figure 1: The Growing Interoperability Virtuous Circles

It is recommended to define three levels of readiness: the laboratory level, the living lab level, and the market level.

Recommendation S2: Use the Integration Profile Approach

Further, the C2 action recommends to *use the integration profile approach* (used successfully as an interoperability practice by Integrating the Healthcare Enterprise (IHE)[3] (see D4):

- Application domains are defined by the research community. They can be defined based on existing use case descriptions such as those elaborated by the BRAID roadmap project[4]
- Within application domains, the specification of interoperability elements result from a use case based process. The resulting interoperability elements are called *integration profiles* using the terminology employed in IHE.

Figure 2 shows an example of domain (patient care devices) and profile (implantable device – cardiac observation) from IHE. The specification of an integration profile involves the identification of roles (for instance a consumer and a producer), the specification of semantic and technical interoperability aspects. If properly identified several integration profiles can be reused to use a flexible and interoperable solution.

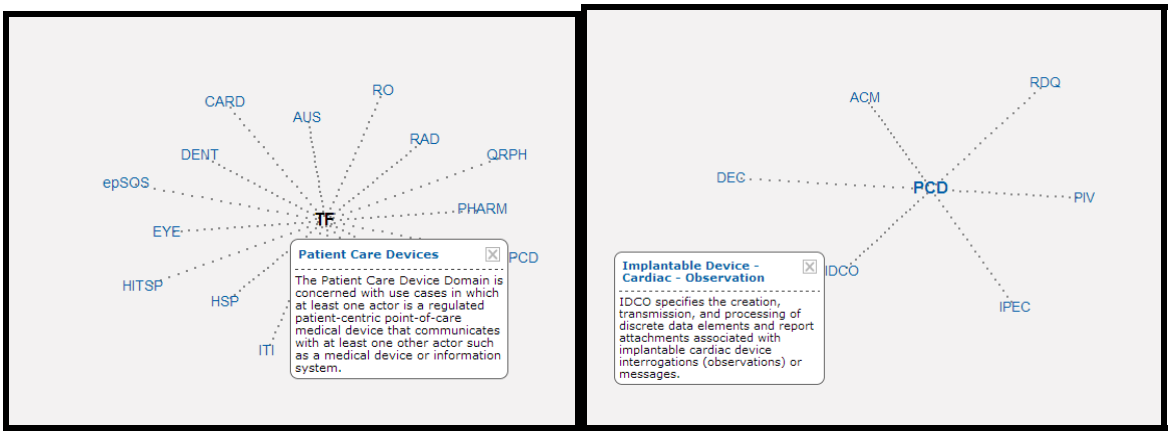


Figure 2: Example of Domains and Profiles (Courtesy of IHE)

The BRAID[5] roadmap project has produced a booklet providing a holistic roadmap perspective that covers all areas of a person's life. The roadmap is focused on four different perspectives, the "Life Settings": Independent Living, Health and Care in Life, Occupation in Life, Recreation in Life. The resulting categorization is a good starting point for the EIP-AHA community.

In parallel, the AAL joint program recently commissioned a study to review all use cases taken into account in the AAL joint program projects. It would be of interest to combine the findings of this study with to fine tune the domain categorization.

[3] www.ihe.net
[4] http://www.braidproject.eu/sites/default/files/Ageing_scenarios.pdf
[5] http://www.braidproject.eu/

Annex 1 describes an initial set of interoperability domains based on the results of the AAL study

It is recommended to use the integrating profile approach. To this end it is further recommended to start with a domain categorization based on BRAID and the AAL JP Use case study.

Recommendation S3: Build a Community

Finally, the C2 action recommends the creation of *a contributing community*. Members of this community will apply the same interoperability building practice in order to create integration profile with the three readiness levels.

Proposed interoperability practices can be based on practices used in the IHE community which include:

- Specification practice based on consensus
- Integrity testing session either remotely or in plugfest events (called connectathons in IHE)
- Use of a common repository and of associated test toolset (in the case of IHE, it is based on the Gazelle open source capability[6])

Creation of a community of integration profile contributors based on the same interoperability practice is recommended. This necessitates the availability of a common repository, an interoperability tool set and an organisation managing the common practice.

6. C2 Operational Recommendations

Recommendation O1: Adopt a common interoperability framework

Use of a common interoperability framework based on Antilope is recommended

The common interoperability framework is described in section 7. Note that the Antilope framework points out that interoperability should not be limited to technological infrastructures and should push to make processes and organizations interoperable[7]. Clinical workflows merge, Human Task definitions need to be considered as a foundation of a successful process of ICT integration. This process relies on workflow standardisation (identify roles in the process, duties/rights of participants) and deployment model design. Partners involved, such as Enterprises and Clinical Operators, should first of all adhere to a common set of rules and policies (e.g. trusted Level of Assurance (LoA) in authenticating

[6] http://gazelle.ihe.net/
[7] Observations made by B3 members on interoperability

users, access policies to PHI, coding value sets etc.). These requirements should be evaluated in accordance to project purposes, state of art of systems involved in the interoperability framework, and local policies. Some tasks that need to be accomplished during the evaluation are listed below:

- Identify role of participants within the clinical workflow that need to be integrated;
- Identify boundaries/responsibilities between enterprises;
- Identify Human Tasks to be accomplished;
- Identify technologies and standards based on environmental requirements;
- Identify less impacting deployment model;

Recommendation O2: Adopt an appropriate validation approach[8]

Technical Design is useless without a strong system of regulation for vendors and partners involved in the project. Product and systems part of the interoperability framework must be tested/evaluated in order to:

- Recognise the implementation of interoperability standards: this can be addressed using tools, libraries developed/suggested by SDO organizations;
- Demonstrate interoperability with complimentary systems, and to accomplish well-defined simple use-cases. This level of evaluation requires the sharing of pre-defined data and information. The Integration Profile approach to designing the interoperability framework offers, at the right place and time, a good basis on which to support this evaluation step, the IHE Connect-a-thon (CAT). The CAT is a weeklong interoperability-testing event held in annually in Asia, Europe and North America.
- Evaluate compliance to project specifications. This process requires Local defined testing processes focused in evaluate technical compliance and verify functional usability and performances of the systems.

A process of validation of the systems reduces the time needed for deployment, reduces the risks of unexpected management of clinical workflows and provides a control mechanism in which Clinicians, Technical Operator and Manager can be involved bringing their expertise. The challenge is to apply to it to AHA taking into account the different level of readiness (as explained in recommendation S1). Diagnosing and correcting errors in deployed distributed systems can be difficult and costly.

[8] This recommendation originates from action B3

Application of an interoperability validation approach that takes advantage of the experience gained in IHE and adapt it to the readiness needs of AHA is recommended: i.e. a validation approach for the laboratory level, a validation approach for the living lab level, and a validation approach for the market level.

Recommendation O3: Build a Set of Application Integration Profiles

It is important to demonstrate to the community that it is possible to share integration profiles at different level of readiness.

It is proposed to demonstrate interoperability for an integration profile where several levels of readiness are mixed together. One particularly important application area is social alarm, which could be extended to the notion of rescue management. The resulting contributions could be the following

- At market level, social alarms capabilities from the market[9]
- At living lab level, AAL services
- At research level, more research oriented management capabilities, e.g. fall detections[10], or robotic services

Annex 1 describes the typical intended work to develop an example application integration profile in the area of behaviour monitoring (this work is based on a study of the AAL joint program).

Recommendation O4: Integrate Features from Multiple Platforms

Platforms are important elements of ICT solutions. They allow applications to focus on higher level capabilities. For instance, universAAL[11] or OpenURC[12] are two different platforms specifically designed with two different focuses, the AAL ambient system service space and the accessibility space respectively. Two interoperability issues must be addressed though. First application developers must not be locked in by using one given platform. Secondly, application developers should be able to use services and features from several platforms at the same time. This is departure from the old school of ICT thinking when computers could only run one platform. Today a smart device capability or a cloud capability can run several platforms at the same time. This is important to enable the introduction of further innovation, service resilience and reconfiguration.

The following examples of needed features could be:

[9] Social alarms are widely deployed and there is an established mature information exchange standards BS8521, but there is no mapping of this into HL7 messaging.

[10] Fall detection capabilities are already accommodated in market standards but mostly without complex causal analysis capability.

[11] http://universaal.org/

[12] http://www.openurc.org/

- API Interoperability (e.g. based on RestFUL[13] interactions)
- Semantic interoperability (e.g. based on ontology mechanisms)
- Features for user data management[14]

Definition and enforcement of an approach where applications can, at the same time, make use of services of different platforms is recommended.

Recommendation O5: Liaise with Standardisation Activities

As stated earlier, standardization is one of the 3 components of a virtuous circle (interoperability, critical mass, standardization). Therefore applying the C2 recommendations for interoperability means that standards must be preceded by pre-standards (which can be used at living lab level), which may themselves be preceded by research agreements.

Also note that in terms of readiness, it is in general expected that platform subsystems will have a readiness that is greater than the readiness of application subsystems using them. Work in standardisation for platform elements must therefore start at an earlier stage.

The importance of multi-stakeholder contribution standardization was identified by the European Commission which issued at the end of 2012 a regulation[15] calling for the creation of a multi-stakeholder platform[16]. This platform is composed of representatives of national authorities of EU Member States & EFTA countries, by the European and international ICT standardisation bodies, and by stakeholder organisations that represent industry, small and medium-sized enterprises and consumers. It recently published a rolling plan[17] for standardization which integrates the work of the C2 action group.

Liaison with MSP and integration with C2 recommendations in MSP is recommended.

[13] RESTful Web Services. Web services for the real world. Leonard Richardson, Sam Ruby. O'Reilly Media. May 2007

[14] EHR (Electronic Health Record) as infrastructure for enabling data and functional integration among different logical domains and different physical sites. This aspect is a key point for collecting data both within the healthcare and social domain. The adoption of an EHR oriented approach leads the usage of standard for coding the data collected in distributed repositories and the data retrieve service using RestFul interaction or SOA approach, depending on the use cases. PHR (Personal Health Record) as functional improvement of EHR as a way to empower patients to manage their own health. From the technical point of view, PHR is a powerful tool for gathering data (i.e. clinical, environmental, social, life style etc.) coming from the patient herself/himself provided with sensors or medical devices at home.
The healthcare system needs to open up the possibility to collect information from different providers including the possibility of receiving data from patients and ensure ubiquitous access of care. It can also facilitate the mining of large amounts of health data and data meshing following a Big Data approach. The integration of the existing platforms could be favoured by the introduction of EHR and PHR into the whole system infrastructure. Within this framework, the mobile platforms can play a key role also in the healthcare domain, (see the "Green paper on mobile health "EU 10.04.214). In this sense it is necessary to stimulate the standardization bodies to complete or adapt the standards already used for mobile application also within the Healthcare domain. IHE and HL7 are already active in this direction (see Mobile access to Health Documents MHD-IHE profile and HL7 FHIR standardization activities).

[15] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:316:0012:0033:EN:PDF

[16] http://ec.europa.eu/digital-agenda/en/european-multi-stakeholder-platform-ict-standardisation

[17] http://ec.europa.eu/digital-agenda/en/news/rolling-plan-ict-standardisation

7. EIP-AHA Common Interoperability framework

This section is a contribution directly taken from the Antilope D1.1 deliverable [Antilope].

For the realisation of Use Cases, many aspects have to be taken into account, such as legislation and guidelines, contracts and agreements, a shared workflow layout, semantic and syntactic choices, the healthcare ICT systems involved, safety and privacy issues, and the technical infrastructure. For a successful implementation of interoperability, all these aspects have to be taken into consideration. A shared 'model' for these interoperability levels is introduced. This model can be adopted by all stakeholders and participants (policy- and decision makers, IT architects and managers, information analysts, healthcare professionals, software vendors, technicians etc.). The refined interoperability model should:

- Provide an overview of the different levels of interoperability
- Be understandable for all stakeholders involved in interoperability discussions - technical terms should be avoided.
- Show the relationship between the different levels of interoperability
- Show examples of the different parts, within the schema
- Show the stakeholders involved in the different levels of interoperability
- Build upon existing interoperability models

Keeping in mind the requirements stated above, the interoperability model introduced here is a synthesis of a number of interoperability architecture models, such as described by the EIF model, CALLIOPE, HITCH, TOGAF, HL7 SAIF, and others. For the purpose of the Antilope project, a model is introduced that is both simple, and shows all high-level aspects of interoperability. Figure 3 shows a schema of the interoperability model:

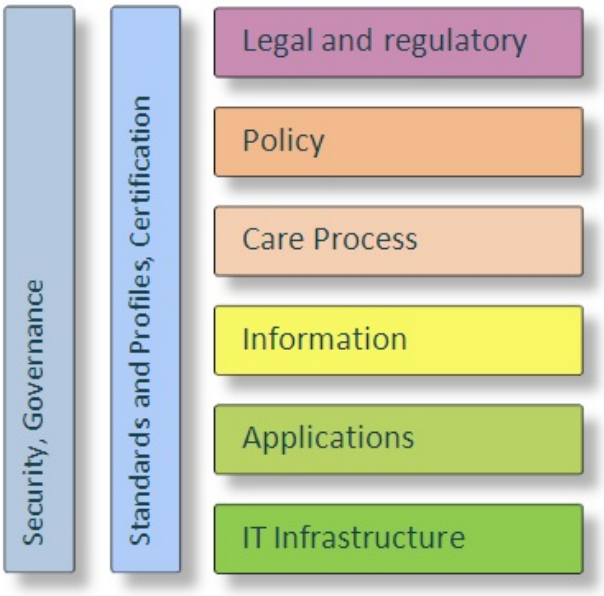


Figure 3: Refined Interoperability Model

In the following table, the different interoperability levels are explained in more detail.

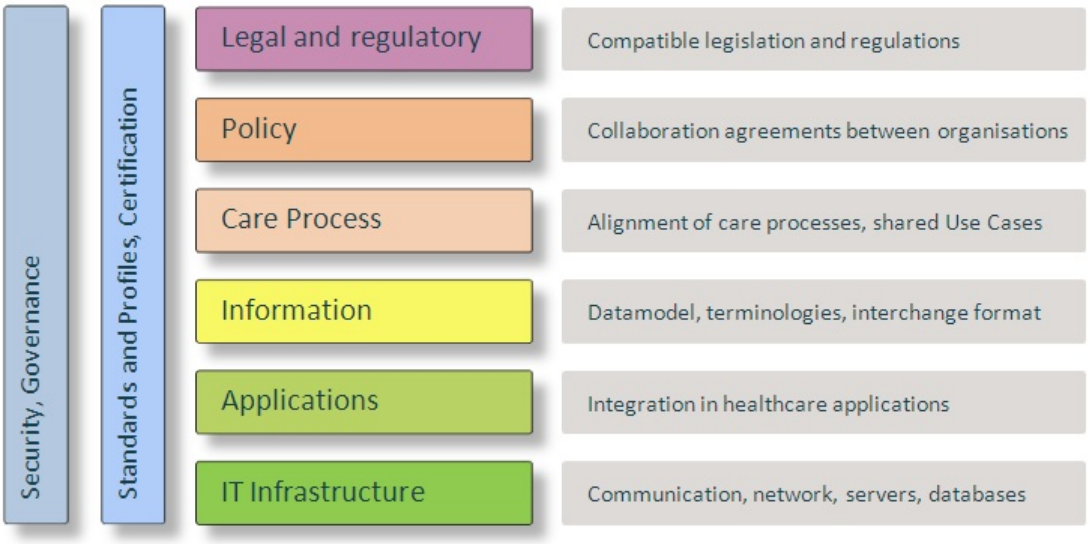
Legal and regulatory	On this level, compatible legislation and regulatory guidelines define the boundaries for interoperability across borders, but also within a country of region.
Policy	On this level, contracts and agreements between organisations have to be made. Trust and responsibilities between the organisations are formalized on the Policy level.
Care process	After the organisations have agreed to work together, specific care processes are analysed and aligned, resulting in integrated care pathways and shared workflows. This level handles the tracking and management of the workflow processes
Information	This level represents all aspects of the data model, coding and terminology, and the formatting of the medium for transportation of the information.
Applications	On this level, import and export of messages and documents is handled. A standardised

	export of interoperability information and integration of imported information into the core healthcare information system is handled on this level.
IT Infrastructure	The generic communication and network protocols and standards, the storage, backup, and the database engines are on this level. It contains all the “generic” interoperability standards and protocols.

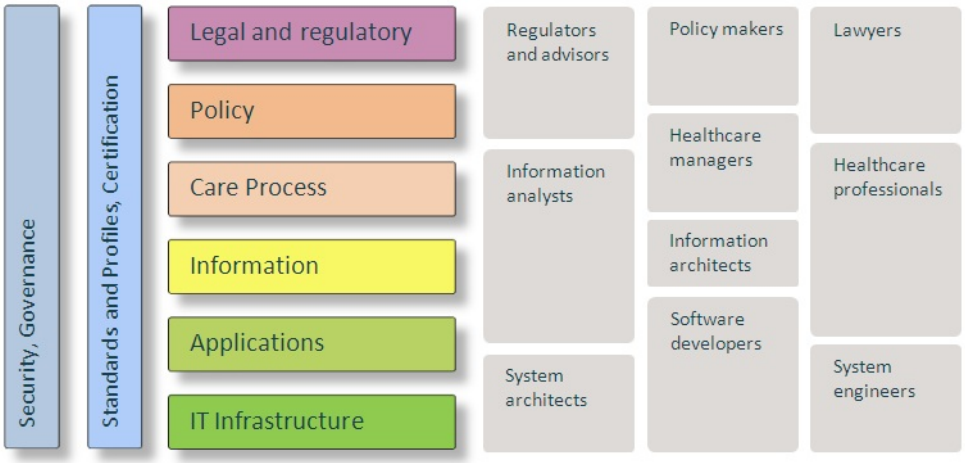
For interoperability to work, some aspects are relevant for all interoperability levels. These are shown in vertical bars. These “cross-level” aspects are divided into two bars that represent the following aspects:

- Security, Governance
  - Security: privacy, Integrity, Authentication, Authorisation, Encryption
  - Governance: maintaining, updating and validating all elements of interoperability
- Profiles and Standards, Certification
  - Profiles and Standards are used in all levels of interoperability. They are the foundation upon which interoperability is built. Certification and quality labelling make sure that the requirements of the Profiles and Standards are met, and that they are implemented correctly at the project level.

Two extra model representations are presented. These provide extra information about the different aspects of interoperability. The first one shows the alignments that are necessary on the different levels of interoperability:


Security, Governance
Standards and Profiles, Certification
Legal and regulatory
Compatible legislation and regulations
Policy
Collaboration agreements between organisations
Care Process
Alignment of care processes, shared Use Cases
Information
Datamodel, terminologies, interchange format
Applications
Integration in healthcare applications
IT Infrastructure
Communication, network, servers, databases

The second representation shows the stakeholders that are involved in the different levels of interoperability:



Annex 1: EIP-AHA Common Interoperability Profiles/Use Cases

1. Introduction

This annex is a contribution directly taken from the AAL-JP D2 “AAL Use Cases and Integration Profiles” [AALJPD2].

2. The AAL-JP Analysis of Use Cases

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

2.1 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.

User-centric keywords

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

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

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

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

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.

Technical keywords

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

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.

2.2 Some Results from the Analysis

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.)

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 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

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.

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	3

	combined with ADL recognition (behaviour monitoring).	
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 look back at past activities.	1
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.

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.

3 Example of Application: Behaviour Monitoring

3.1 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).

3.2 Representative Uses Case

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 section 4.3 Example Application Integration ProfilesA1.4

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.				

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.

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

General Remarks

None.

4 Process of Defining Integration Profiles

The following text is taken from the AALJP D2 “AAL Use Cases and Integration Profiles” [AALJPD2].

4.1 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).

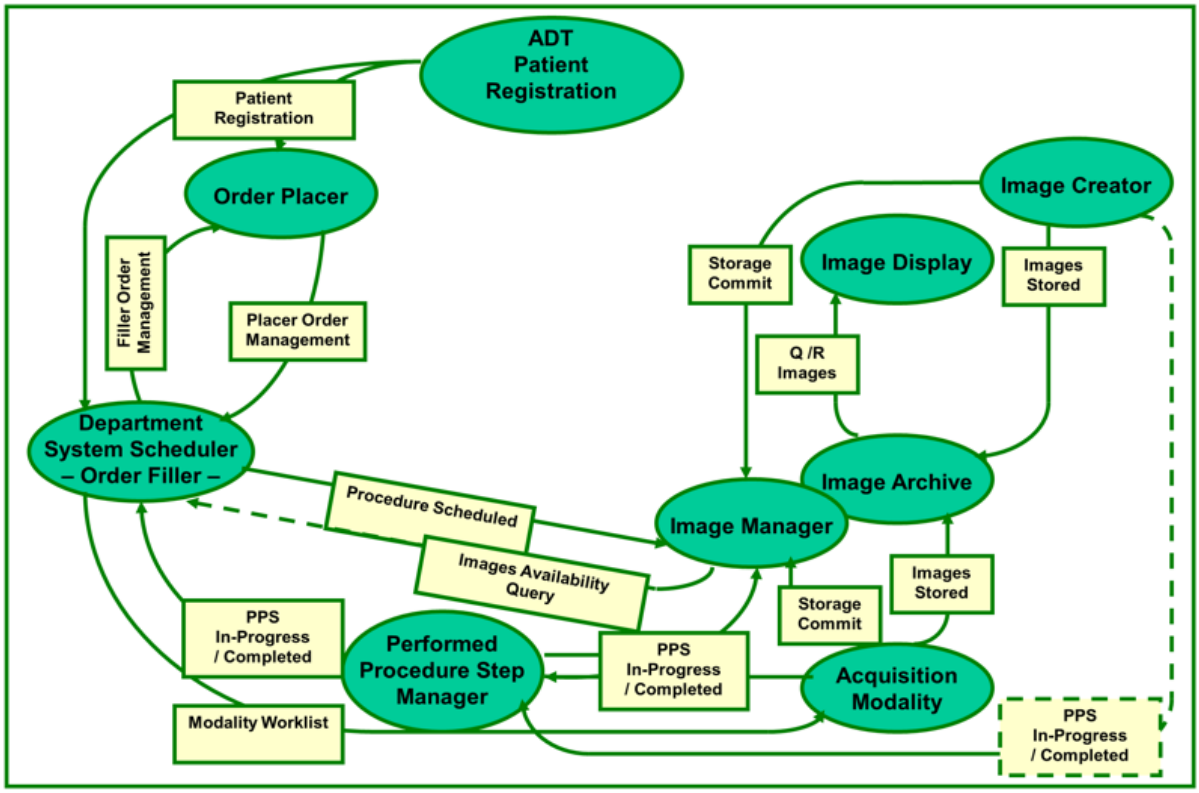


Figure 1: IHE-Style Actor/Transaction Diagram (Source: IHE Radiology Technical Framework)

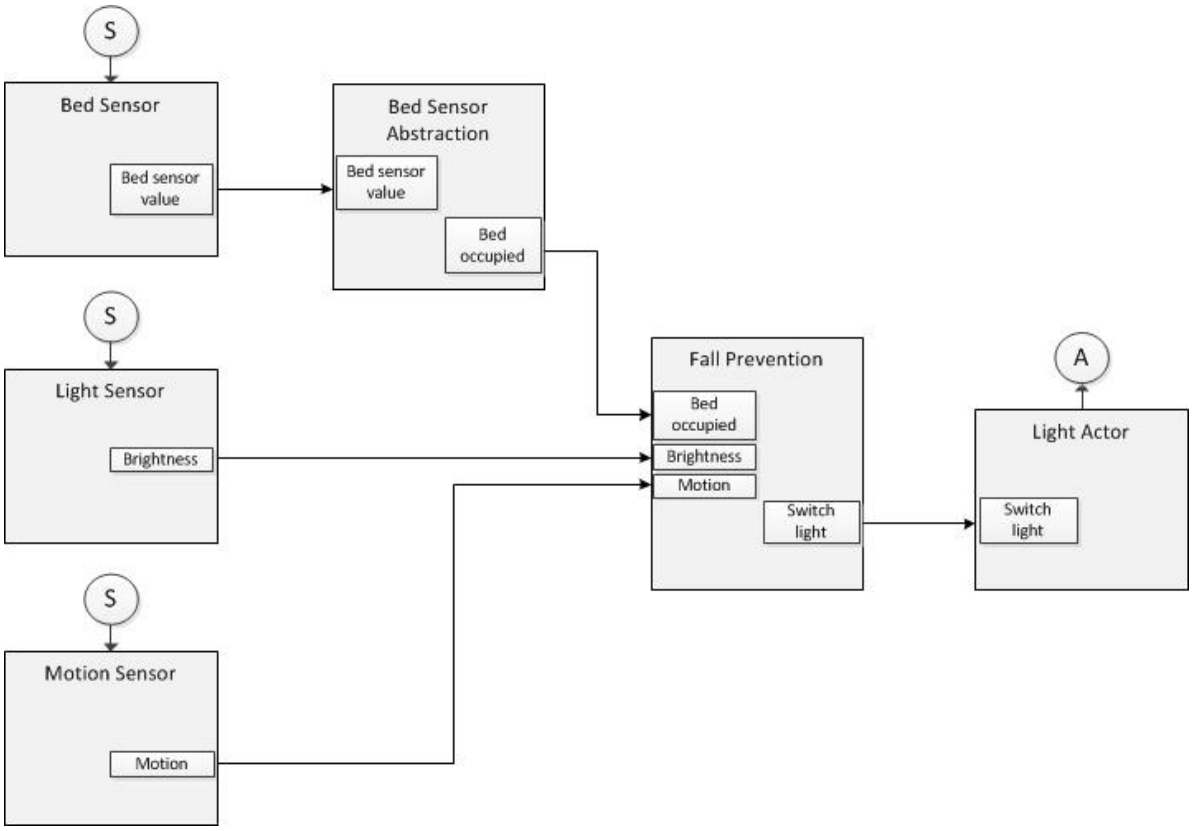


Figure 2: RAALI-Style Function Block Diagram (Source: RAALI Project [WBK+2013])

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.

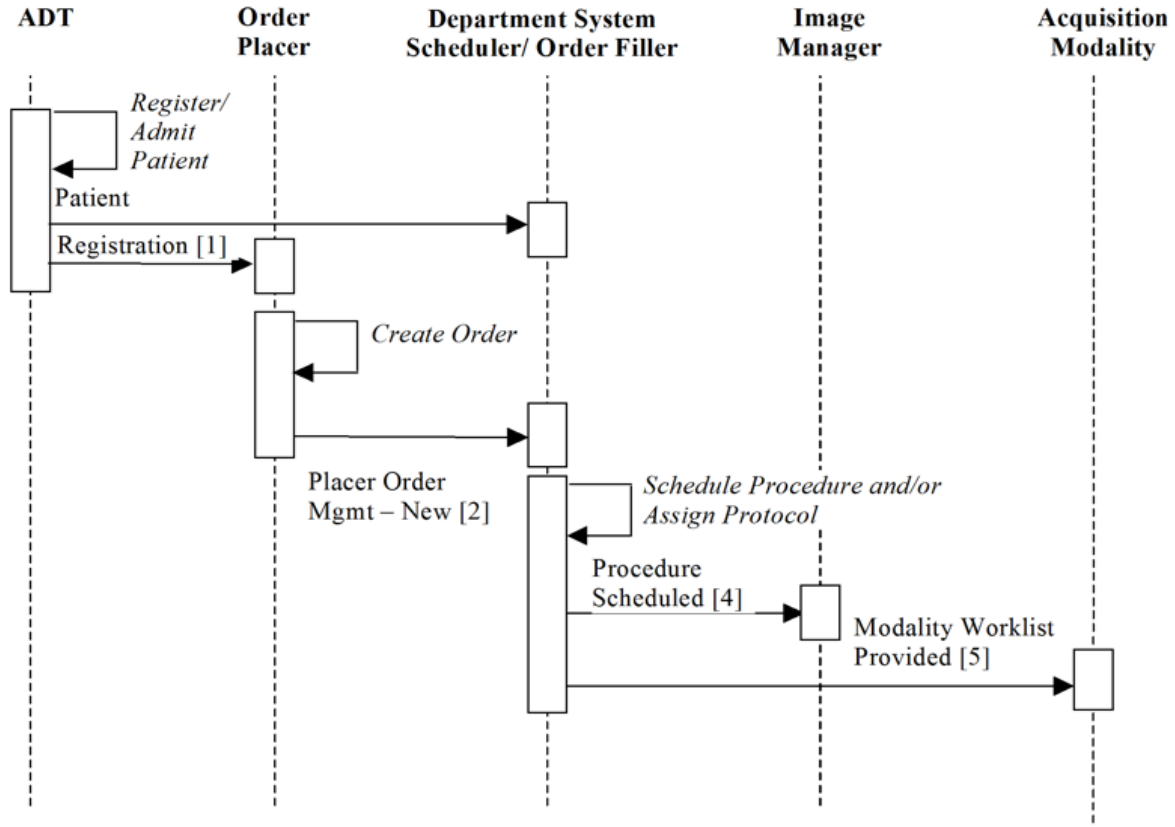


Figure 3: IHE-Style Sequence Diagram (Source: IHE Radiology Technical Framework)

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).

4.2 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[18] (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.g. 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.

4.3 Example Application Integration Profiles

Example Application Integration Profile: Behaviour Monitoring

This example application integration profile is taken from the AALJP D2 “AAL Use Cases and Integration Profiles” [AALJPD2].

Rationale

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.

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

[18] Strictly these are ad-hoc. de-facto rather than de-jure standards established by groups of cooperating industrialists and not supported by any particular SDO.

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.

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

Actors, Transactions and Options

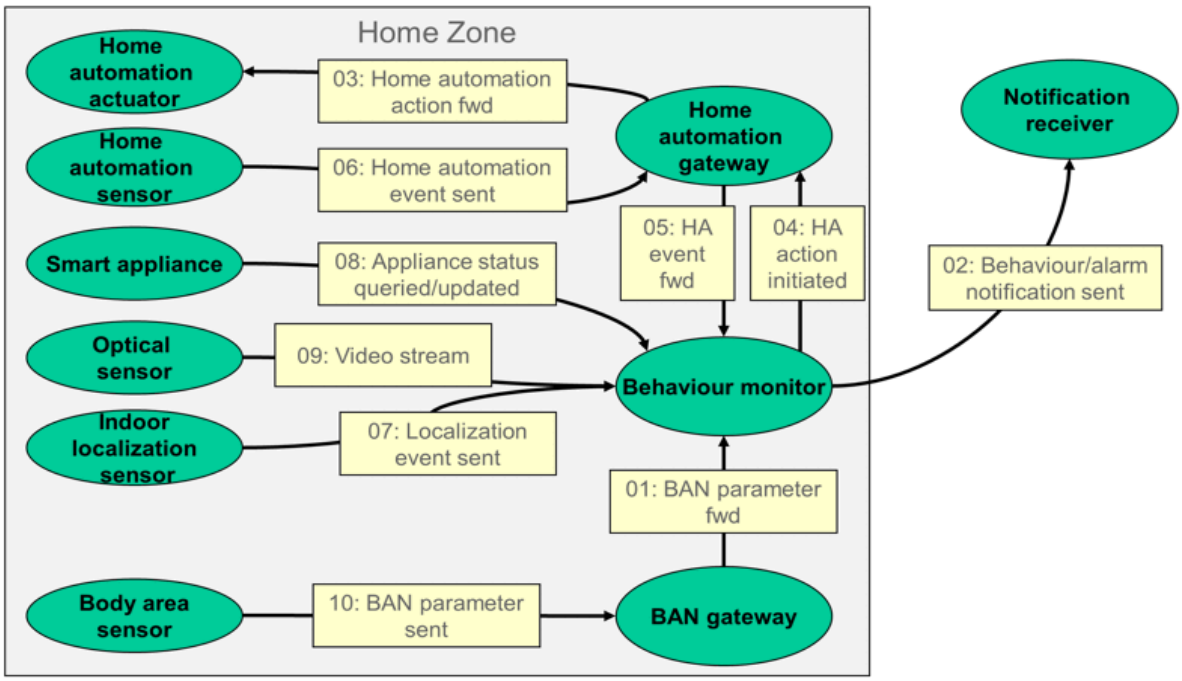


Figure 4: Behaviour Monitoring: Actors and Transactions

Actor Descriptions:

- BAN gateway: A component carried by the user such as a smartphone that receives vital parameters or accelerometry 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 power lines. 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.

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.

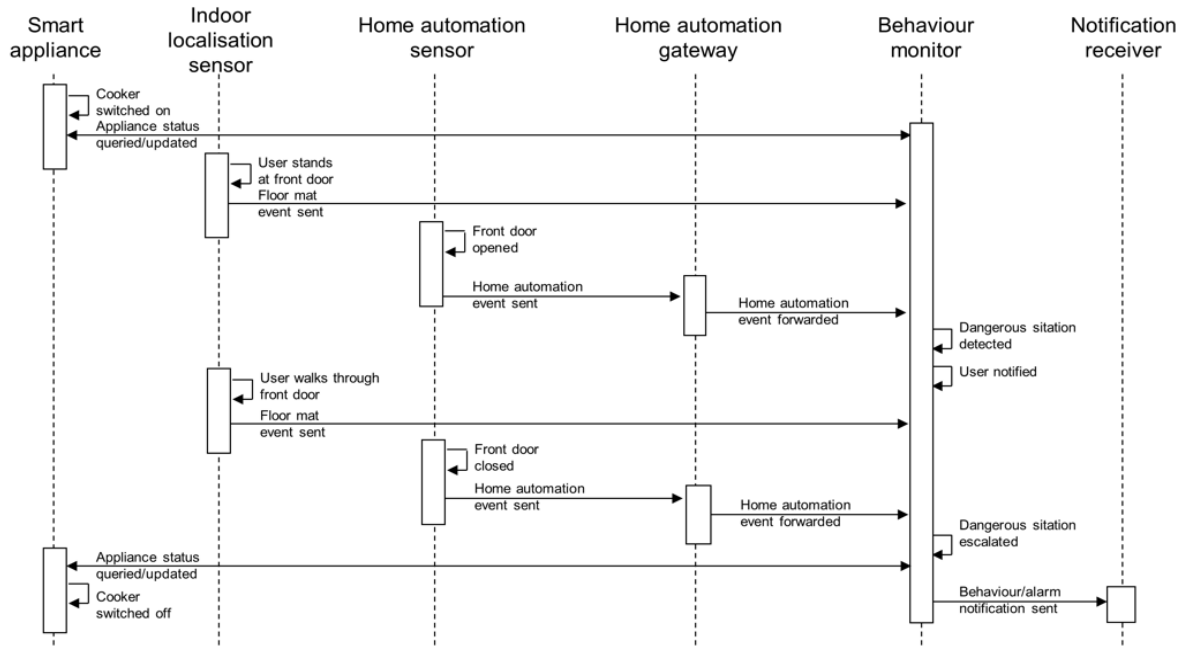
High level process and data flow

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:

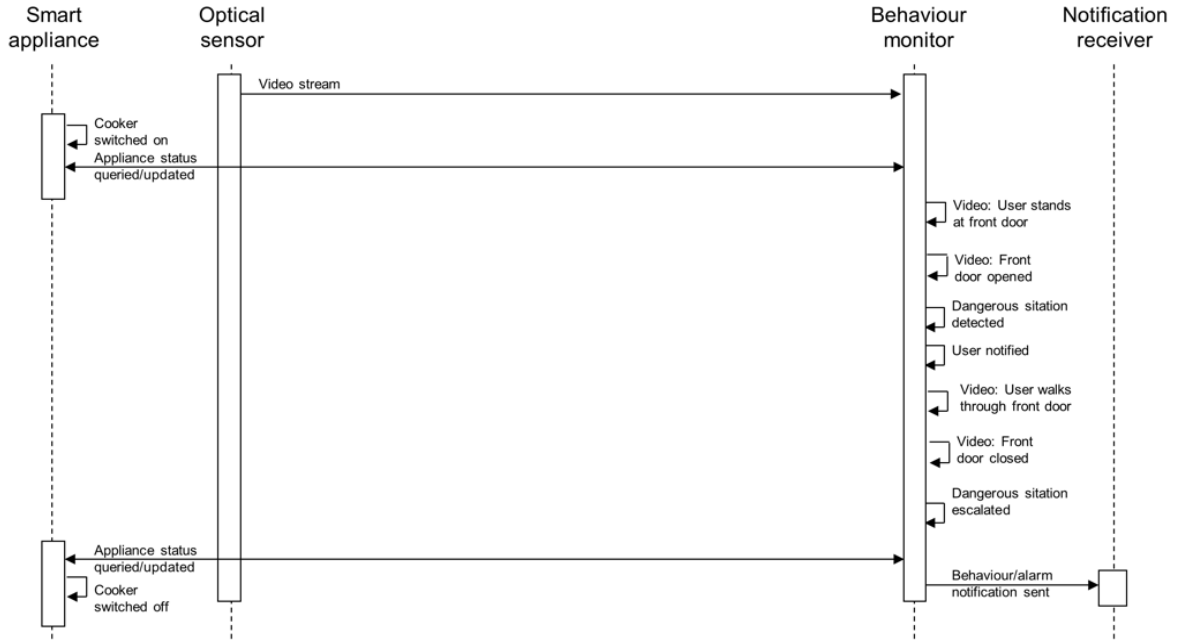


High level process flow - example 1: dangerous situation detected using home automation sensors

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.

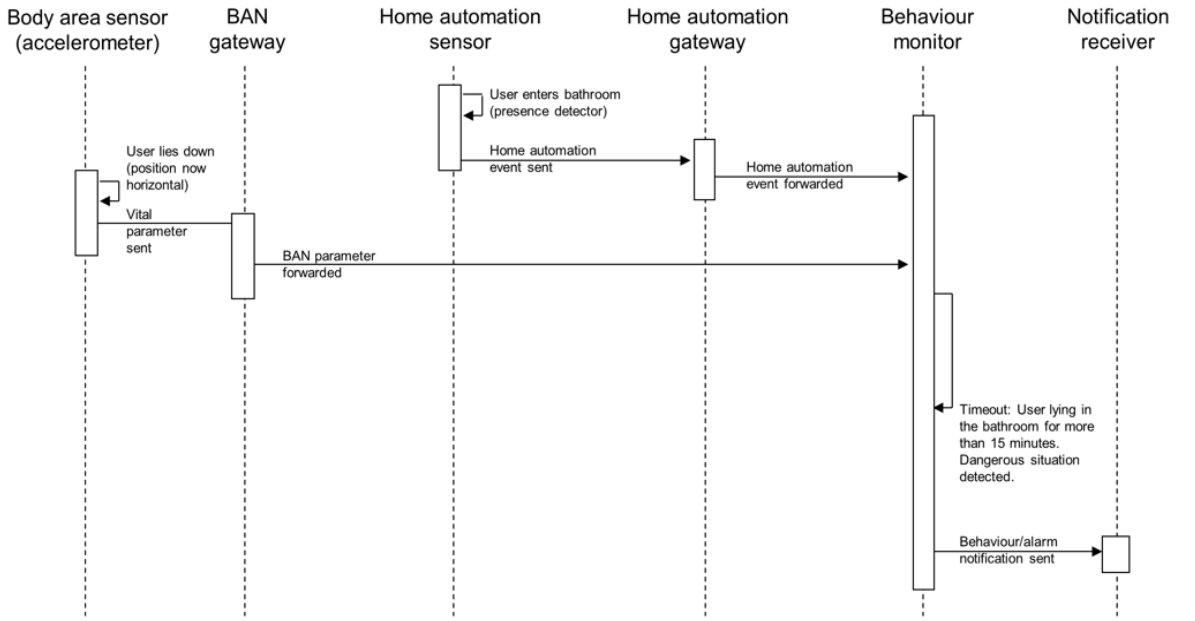
The second sequence diagram below shows the same sequence of events, but in this case in a system that uses video streams (i.e. cameras in the different rooms) instead of home automation actors and floor mats to detect the location and activities of the user. Here most events occur internally within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

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 implementer 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.

Annex 2: Glossary of terms

The following glossary of terms is a contribution from [Antilope]

Concept	Description	Source
(Base) Standard	"As defined in European legislation (Article 1, paragraph 6, of Directive 98/34/EC), a standard is a technical specification approved by a recognised standardisation body for repeated or continuous application, with which compliance is not compulsory and which is one of the following: - international standard: a standard adopted by an international standardisation organisation and made available to the public, - European standard: a standard adopted by a European standardisation body and made available to the public, - national standard: a standard adopted by a national standardisation body and made available to the public."	Generic EIF
Certification	"Based on ISO 9001:2000 (or ISO 9001:2008) and ISO 14001:2004, certification could be defined as an independent accredited external body issuing written assurance (the "certificate") that it has audited and verified that the product or software conforms to the specified requirements."	HITCH D6.4 Final Report
eHealth Interoperability project	"An eHealth interoperability project, taking place in a EU cross border, national, regional, or local context."	Mandate 403 study
Interoperability	The ability of disparate and diverse organisations to interact towards mutually beneficial and agreed common goals, involving the sharing of information and knowledge between the organisations, through the business processes they support, by means of the exchange of data between their respective ICT systems.	Generic EIF
Interoperability	ISO/IEC 2382-01 - The capability to communicate, execute programs, or transfer data among various functional	*see:* http://jtc1sc36.org/

	units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units-.	doc/36N0646.pdf
Interoperability Agreements	"Written interoperability agreements are concrete and binding documents which set out the precise obligations of two parties cooperating across an 'interface' to achieve interoperability."	Generic EIF
Interoperability Framework	"An interoperability framework is an agreed approach to interoperability for organisations that wish to work together towards the joint delivery of public services. Within its scope of applicability, it specifies a set of common elements such as vocabulary, concepts, principles, policies, guidelines, recommendations, standards, specifications and practices."	Generic EIF
Interoperability Governance	"Interoperability governance covers the ownership, definition, development, maintenance, monitoring, promoting and implementing of interoperability frameworks in the context of multiple organisations working together to provide services. It is a high-level function providing leadership, organisational structures and processes to ensure that the interoperability frameworks sustain and extend the organisations' strategies and objectives."	Generic EIF
Interoperability Levels	"The interoperability levels classify interoperability concerns according to who/what is concerned and cover, within a given political context, legal, organisational, semantic and technical interoperability."	Generic EIF
Legal Interoperability	"Align legislation so that exchanged data is accorded proper legal weight"	Generic EIF
Memorandum of Understanding	"A bilateral or multilateral written agreement between two organisations which sets out a number of areas and means by which they will cooperate, collaborate or otherwise assist one another. The exact nature of these activities depends on the nature of the two organisations, the domain of activity in question, and the scope of the cooperation envisaged."	Generic EIF

Organisational Interoperability	"Coordinate processes in which different organisations achieve a previously agreed and mutual beneficial goal"	Generic EIF
Profile Development Organisation (PDO)	"An organisation developing profiles is called a Profile Development Organisation (PDO)."	ISO TR 28380-1 IHE Global Standards Adoption
Semantic Interoperability	"Precise meaning of exchanged information which is preserved and understood by all parties"	Generic EIF
Service Level Agreement	"A formalised agreement between two cooperating entities; typically, a service provider and a user. The agreement is expressed in the form of a written, negotiated contract. Typically, such agreements define specific metrics (Key Performance Indicators — KPIs) for measuring the performance of the service provider (which in total define the 'service level'), and document binding commitments defined as the attainment of specific targets for certain KPIs, plus associated actions such as corrective measures."	Generic EIF
Standards developing organisation (SDO)	"A chartered organisation tasked with producing standards and specifications, according to specific, strictly defined requirements, procedures and rules. Standards developing organisations include: - recognised standardisation bodies such as international standardisation committees such as the International Organisation for Standardisation (ISO), *International Telecommunication Union (ITU)*, the three European Standard Organisations: the European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC) or the European Telecommunications Standards Institute (ETSI); - fora and consortia initiatives for standardisation such as the Organisation for the Advancement of Structured Information Standards (OASIS), the World Wide Web Consortium (W3C) or the Internet Engineering Task Force (IETF), *International Health Terminology Standards Development Organisation*	Generic EIF *(italic: addition of study team)*

	(IHTSDO)."	
Technical Interoperability	"Discuss technical issues involved in linking computer systems and services"	Generic EIF
Technical specifications: profile and guideline	"A technical specification means a document that prescribes technical requirements to be fulfilled by a product, process, service or system" (Regulation of European Standardisation). *In the study, profile (term used by IHE) and guideline (term used by Continua) are technical specifications that identify* "a consistent set of chosen options from a base standard or from a set of base standards, in order to provide a given function in a given environment" (ETSI standard ETS 300 406). *Profiling is usually conducted in order to achieve interoperability between different products and implementations as a profile aims to harmonise all systems implementing it to use the same standards and contents.*	Regulation of European Standardisation ETSI standard ETS 300 406 *(italic: addition of study team)*
Use case	"A textual and graphical depiction of the actors and operations that address information exchange in the context of a set of specific tasks for a workflow performed by different systems or devices." (ISO TR 28380-1 IHE Global Standards Adoption) *In the context of our study, a use case can be trigged by a business event (i.e., a business / high-level use case) or by a technical event (i.e., a technical use case). One high-level use case can (re)use one or more technical use cases.*	ISO TR 28380-1 IHE Global Standards Adoption *(italic: addition of study team)*
Use Case (high-level, Antilope)	A functional description of a process, as seen from the end user's point of view. It describes interactions between the actors in the process, in a non-technical way.	Antilope

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