



BSI Standards Publication

Active assisted living (AAL) use cases

National foreword

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FINAL VERSION



Active assisted living (AAL) use cases

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ACTIVE ASSISTED LIVING (AAL) USE CASES

FOREWORD

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This consolidated version of the official IEC technical specification and its amendment has been prepared for user convenience.

IEC TS 63134 edition 1.1 contains the first edition (2020-04) [documents SyCAAL/152/DTS and SyCAAL/167/RVDTS] and its amendment 1 (2022-12) [documents SyCAAL/262/DTS and SyCAAL/283/RVDTS].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 63134, which is a Technical Specification, has been prepared by IEC systems committee Active Assisted Living.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- transformed into an International Standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC SyC AAL is developing use cases for AAL system standards with a view to identify gaps in standardization.

All selected use cases have a real-world validity. The development of use cases makes it easier to define AAL categories of similar use cases and highlight their commonalities. It was then possible to extract functional requirements from the use cases and make recommendations for future standardization items related to AAL. Collecting the use cases also allowed SyC AAL to validate the proposed AAL reference model and reference architecture.

This document captures the results of a use case input process that began with the call for contributions of AAL use cases in November 2015. The current document reflects contributions and discussions by SyC AAL experts, mirror committees and liaison members. This document also contains material gathered from reports, AAL research projects and group output from the SyC AAL meetings in November 2015 (Tokyo), April 2016 (Wellington), October 2016 (Frankfurt), April 2017 (Beijing), September 2017 (Cleveland), May 2018 (Tokyo) and October 2018 (Seoul), as well as information obtained from the subsequent web calls to the meetings.

As of November 2018, a total of 45 use cases were submitted. To start the project, members of the SyC AAL user focus working group were requested to submit use cases using the IEC template. The use case submissions consisted of the title of the use case, a description and the origin of the use case. The use case template helped to group and categorize the use cases according to the identified functional requirements and needs of users. The former AAL use case template developed in SG 3 AAL was modified in order to capture also wider societal issues including security, risk and privacy, as well as looking at AAL in relation to the Internet of Things (IoT).

Experts from the following national committees, liaison organizations and research projects contributed use cases on AAL: Canada, China, Japan, Germany, Netherlands, South Korea, UK, USA, ISO IEC JTC 1 SC 41 PCHA and Continua and AALiance2.

The target audience for this document includes the following stakeholders who have an interest in the AAL system:

- AAL users and service provider personnel who can learn about AAL user needs and how to operate AAL systems;
- first responders, formal carers, etc. to understand how to respond to an AAL system emergency call;
- CE and ICT device manufacturers who want to understand AAL devices and interface and interoperability requirements;
- AAL care recipients who are interested in the usability, accessibility and performance of the AAL system;
- AAL operators to understand the system requirements;
- regulators who are responsible for developing and supervising AAL and related regulations.

ACTIVE ASSISTED LIVING (AAL) USE CASES

1 Scope

This document identifies AAL scenarios and use cases based on real-world applications and requirements. The use cases provide a practical context for considerations of interoperability and standards based on user experience. Use cases provide a context for utilizing existing standards and identifying further standardization work. User requirements have also been identified.

This document also highlights potential areas for standardization in the AAL environment to ensure safety, security, privacy, ease of operation, performance and interoperability.

Lastly, this document is a contribution to the IEC use case management repository, the purpose of which is to collect, administer, maintain, and analyse use cases.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-871, *International Electrotechnical Vocabulary – Part 871: Active assisted living (AAL)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-871 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.2 Abbreviated terms

AAL	active assisted living
ADL	activities of daily living
AMM	advanced medication monitoring
BAN	body area network
ETA	enhanced terminal accessibility
IADL	instrumental activities of daily living
IoT	Internet of Things
km	kilometres
UCMR	use case management repository

4 General

4.1 Overview

- Clause 4 provides a general overview of the structure of the document and the use case development stages.
- Clause 5 describes the AAL use case template with its annexes.
- Clause 6 provides the use case analysis based on the use case categories.
- Clause 7 presents considerations related to user requirements.
- Clause 8 is the summary of the standards gap analysis.
- Clause 9 describes the conclusions and recommendations
- Annex A includes the AAL use case template
- Annex B describes the complete representative use cases.
- Annex C contains the user requirements analysis
- Annex D contains extractions of user requirements of the 10 representative use cases.

4.2 Objectives

The intent of this document is to capture representative use cases in a consistent manner in order to categorize products, services and systems of AAL technologies in such a way to assist system developers and service providers to develop solutions that address the AAL user needs. These include user requirements of safety, security and privacy.

Use cases provide input into the development of AAL scope definition, reference architecture and conformity framework. Use cases will also be used to validate the scope and architecture.

Use cases are a common technique for gathering requirements in systems and in this case provide a better understanding of the user's needs and functional requirements of AAL systems (what, not how) as well as requirements for safety, security (cyber and physical), privacy and data protection. Use cases describe typical scenarios that an AAL user may experience when interacting with a system to achieve a goal. Use cases are a well-known tool for expressing requirements at a high level with real-life relevance.

4.3 Use case development stages

When developing AAL use cases, the following steps were considered which reflect the guidelines provided by the System Resource Group of IEC to develop the use case management repository (UCMR).

The modelling framework is needed to manage the complexity, structure the analysis, guide experts and automate the generation of a standardized textual template, as described in IEC 62559-2 and adapted to consider the people aspects of AAL.

4.4 AAL architecture model

The AAL architecture model is illustrated in Figure 1.

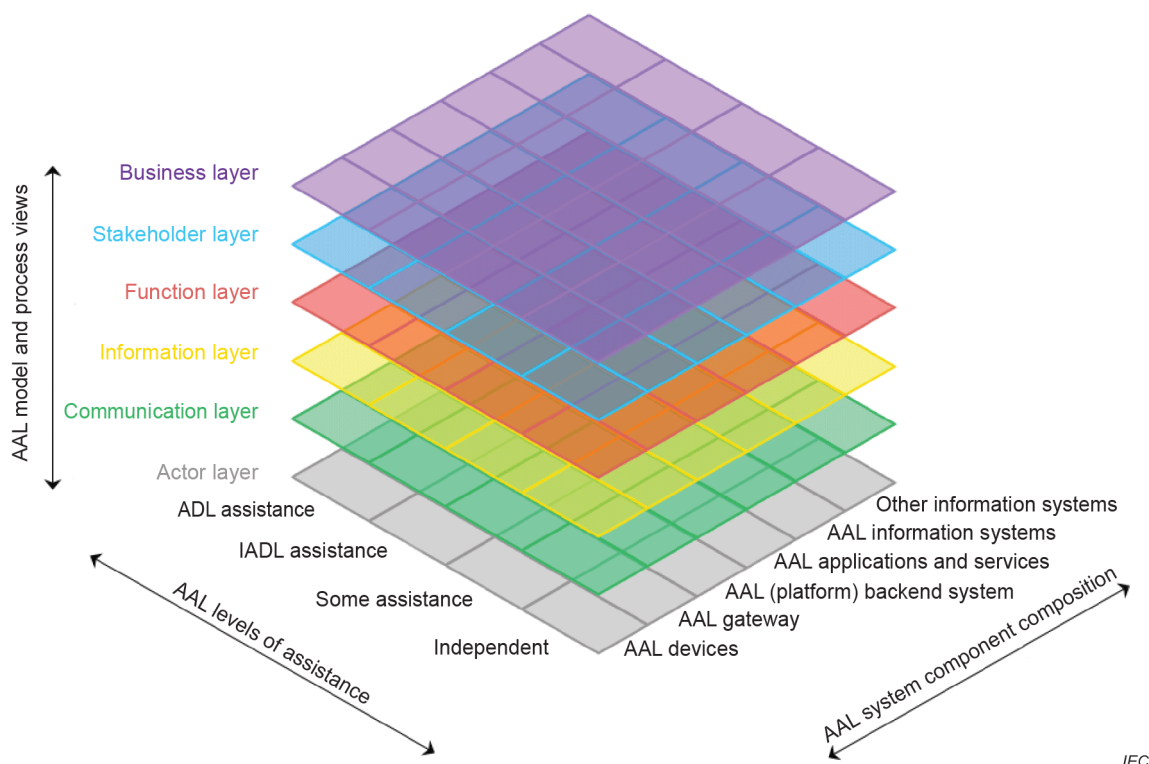


Figure 1 – AAL architecture model

The *x*-axis of Figure 1 describes AAL levels of assistance (also referred to as user domains in use cases):

- Independent (level 0)
In this user domain, AAL users are not dependent on assistive technology. AAL services are used for comfort, wellbeing, wellness, fitness, entertainment, social interaction (socialization) or security.
- Some assistance (level 1)
In this user domain, AAL users need some assistance by assistive technology. This includes some assistance at some points in time or some assistance that is continuously needed.
- IADL assistance (level 2)
In this user domain, AAL users need assistance with instrumental activities of daily living. These activities are not essential for fundamental functioning but allow an individual to live independently in a community. They include but are not limited to housework, preparing meals, taking medications as prescribed, managing money, shopping for groceries or clothing, use of telephone or other form of communication, transportation within the community.
- ADL assistance (level 3)
In this user domain, AAL users need assistance with basic self-care tasks that include but are not limited to functional mobility, bathing and showering, dressing, self-feeding, personal hygiene and grooming.

The *y*-axis of Figure 1 describes AAL system component composition, which is further described in 5.7.

The *z*-axis of Figure 1 describes AAL model and process views, defined as follows:

- Actor layer
Layer of an architecture model in which the content is derived from the use case information on actors
- Communication layer
Layer of an architecture model that describes protocols and actions for the interoperable exchange of information between the actors of a use case
- Information layer
Layer of an architecture model that describes the information that is being used and exchanged between functions, services and actors
- Function layer
Layer of an architecture model that represents the functions described in the use cases
- Stakeholder layer
Layer of an architecture model that represents the different stakeholders involved in providing the applications and services described in the use cases
- Business layer
Layer of an architecture model that represents the business models, including business

5 Definition of AAL use case template

5.1 Overview

The use case template, included in Annex A, provides sections to include a description of the use.

The intent is to have these annexes map directly into the AAL reference model and architecture model.

For easier mapping into the AAL reference model, a use case diagram and a sequence diagram are added to each use case.

5.2 Description of use case

The use case is described in a short narrative of three sentences. In addition, a long description of the use case is requested, which includes the actors and their roles as well as their task in the AAL system and relationship with the care recipient.

5.3 AAL levels of criticality

The level of criticality refers to an estimate of the severity of injury that a system could permit or inflict, either directly or indirectly, on a client, patient or operator as a result of device failures, design flaws, or simply by virtue of employing the system for its intended use.

- Major
Level of criticality is Major if a failure or latent design flaw could directly result in death or serious injury to the client, patient, or operator. The level of criticality is also Major if a failure or latent design flaw could indirectly result in death or serious injury of the client, patient or operator through incorrect or delayed information or through the action of a care provider.
- Moderate
Level of criticality is Moderate if a failure or latent design flaw could directly result in minor injury to the client, patient or operator. The level of criticality is also moderate if a failure or latent design flaw could indirectly result in minor injury to the client, patient or operator through incorrect or delayed information or through the action of a care provider.

- Minor

Level of criticality is Minor if failures or latent design flaws are unlikely to cause any injury to the client, patient or operator.

5.4 Levels of assistance (user domains)

Four levels of assistance are defined from "minimal assistance (level 0)" to "fully assisted (level 3)" that correspond with "no automation" to "full automation".

- a) Level 0: able to live independently with minimal assistance.
- b) Level 1: able to live independently but some assistance is needed periodically (part time).
- c) Level 2: assistance is needed with IADL (part time and/or full time).
- d) Level 3: assistance is needed with ADL (full time).

NOTE 1 Stages of ageing are identified in ISO/IWA 18:2016.

IADL (instrumental activities of daily living) includes, for example, the use of transportation, answering the telephone, shopping (plus cooking, housekeeping, cleaning, medication management, and monetary management), etc.

ADL (activities of daily living layer) includes the most basic human activities like walking and moving around, going up a few steps of stairs, bathing (plus eating, clothing, continence, grooming), etc.

NOTE 2 Medical assistance may be needed at any level.

NOTE 3 Annex B of the use case template is the *x*-axis of the AAL architecture model.

The key distinction between level 2 and level 3 is as follows.

- In level 3, the AAL system performs all tasks automatically without the supervision of the AAL user, so the user does not need to respond or intervene.
- In level 2, the AAL user has to perform some tasks and has to respond and supervise the AAL system which is not fully automated.

In level 1, the AAL user may perform many of the tasks himself or herself and only periodically needs assistance, whereas in level 0 the AAL user may use one or more parts of the AAL system, but is able to perform or control the remaining tasks. Level 0 has the highest level of independence.

Figure 2 presents an overview of AAL user domains.

AAL user domain				
	Level 0 Independent	Level 1 Some assistance	Level 2 Assistance with IADLs	Level 3 Assistance with ADLs
The AAL system runs	to assist the independent AAL user	under the supervision of the AAL user	automatically but requires responses from the AAL user	automatically without supervision of the AAL user
Assistance scope	Independent	Social or emergency	Social and/or health	Social and health
Health management	Self monitoring	Some external monitoring may be needed	IADL monitoring needed	ADL management needed
Activity assistance	Independent	Only for extra daily activities	Needed for instrumental activities of daily living	Needed for activities of daily living or medical support
Social life assistance	Independent	Only for extra daily activities	Needed for daily activities	Needed for daily activities

IEC

Figure 2 – Overview of AAL user domains

5.5 Use case categories

AAL use cases are categorized to align with the function layer of the AAL architecture model in order to clarify the scope and to highlight exceptional scenarios.

- Prevention and management of chronic long-term conditions:
 - Prevention, early detection and efficient management of chronic long-term conditions.
 - Provide AAL solutions for persons with identified risk factors and/or chronic conditions.
 - Improve medical prescriptions and adherence to treatment by providing accurate information to the professional.
 - Enable the wellbeing of people with chronic conditions and their communities (family, caregivers, neighbourhood, service providers, care system, etc.).
- Social interaction:
 - Enable people of all ages to be active, content and socially connected in the society, from both a societal and personal perspective, effectively contributing to their health, overall quality of life and to social inclusion.
 - Denotes all systems for social connections and networking as well as the possibility for knowledge transfer.
- Mobility:
 - Enable people's mobility (orientation and navigation) in terms of moving in the home and domestic environment.
 - Transportation and travel activities.
 - Encompasses all systems that are useful for mobile processes, e.g. mobility aid, safety and security on the move, transport or information of outdoor conditions.
- Health and wellness:
 - Better management of health and wellness.

- Prevent functional decline and frailty.
- Enable assisted living and support sustainable care models.
- (Self-)management of daily life activities at home:
 - Enable assisted living and sustain persons to continue managing their daily activities in their home.
 - Live independently for longer, meaning with as little (professional) help as possible and with choice and control over the decisions, equipment and assistance.
 - Live actively in the sense of staying in charge of their own lives and participating in society the way they want.
 - Denotes all techniques and systems which help and support the user during daily life (like a managing system, a calendar or reminder or other support systems).
 - Denotes all technical support including fall detection and prevention, ambient sensors or actuators, alarm systems and localization.
 - Support care givers to give assistance.

AAL use case categories are illustrated in Figure 3.

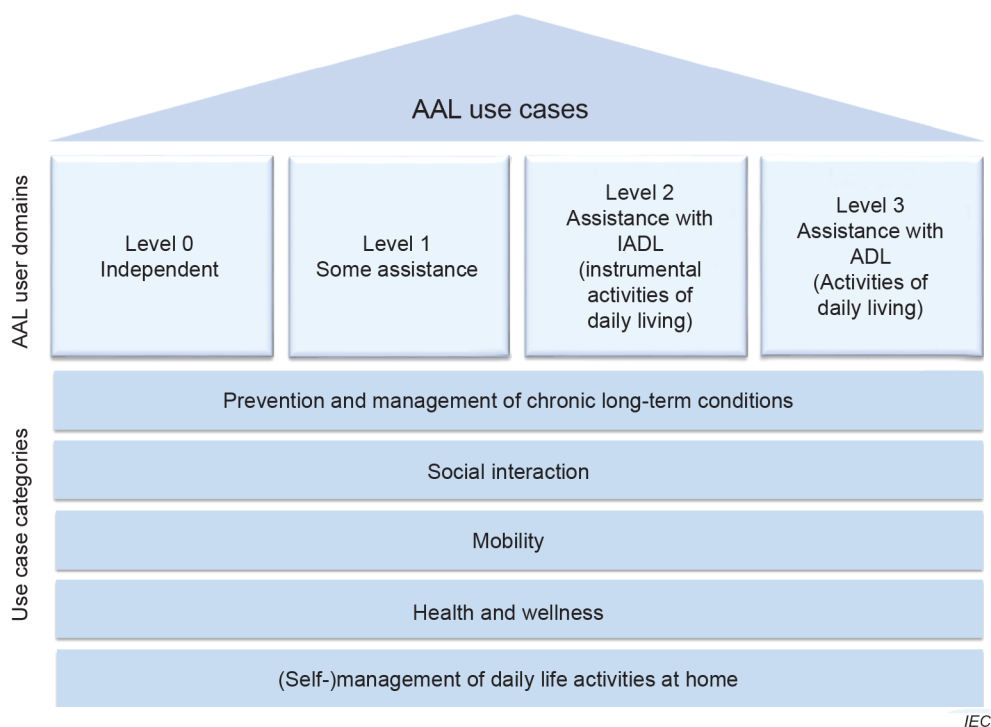


Figure 3 – AAL use case categories

5.6 Context of use

- Global

The outdoor environment including transportation – automobile, bus, train, airplane, etc.

EXAMPLE 1 Normally an uncontrolled environment in terms of weather, population, animal, etc.
- Public buildings

Includes all other relevant indoor environments that may or may not be designed for accessibility required by AAL users.

EXAMPLE 2 Including devices like the ones referred to under "home", but this can be expected to be a different selection and with a different mix of enabling functions and applications.
- Personal mobile and personal vehicle

Includes personal mobile devices that can control devices, communicate and save the information data. Personal vehicles designed for elderly and/or handicapped are included.

EXAMPLE 3 Normal cars or vehicles designed for elderly people, whether hand-operated (stability aids) or engine powered (electric bikes and scooters, ...), etc.

- Home (IEC 60050-871)

Place of residence.

EXAMPLE 4 Flat, apartment, single-family house, townhouse, sheltered housing.

NOTE Care homes, retirement homes and other facilities with nursing services are not included in this definition.

- Body and personal

Includes the body and the immediate area around the body.

EXAMPLE 5 Includes devices like sensors and actuators worn in or on the body, hand carried and personal devices typically taken along by one individual (music player, smartphone, tablet).

- Workspace

Denotes the area of the workspace outside of the home, e.g. office, factory, etc.

EXAMPLE 6 Environmental sensors and home automation sensors/actors to monitor the workplace of employees and detect dangerous situations (air pollution, gas leak).

5.7 System component composition

The system component composition is described in the AAL architecture model y-axis.

- AAL devices

Device (IEV ref 151-11-20: material element or assembly of such elements intended to perform a required function) used in an AAL service (871-01-04).

AAL gateway (IEV ref 732-01-17: A gateway is a functional unit that connects two computer networks with different network architectures and protocols)

- AAL (platform) backend system

System that houses a number of components (functionalities) in order to collect the data from AAL gateways or AAL devices over a network connection. The system may also implement components for the remote management of AAL gateway and/or AAL device (e.g. firmware update) and components for interfacing with AAL information systems and/or other information systems.

In the client-server model, the server is usually considered the backend.

Platform maybe a smartphone platform (e.g. IOS, Android), a server platform (e.g. Linux) or an IoT platform (IoT cloud service).

- AAL application and services

Program or application that interacts with the AAL users or within the network infrastructure to transmit or exchange data and information in the network

Action or function of an AAL system creating an added value for customers.

- AAL information systems

A collection of technical and human resources that provide the storage, computing, distribution, and communication for the information required by an AAL service.

- Other information systems

A collection of technical and human resources that provide the storage, computing, distribution, and communication for the information not specific to AAL services.

5.8 Actors

5.8.1 General

An actor is a 1) person, 2) technical component, or 3) organization that plays a role in one or more interactions within a use case or a combination of use cases.

An AAL user is considered a "Person Actor". There are three role categories of AAL users:

- a formal "Person Actor" user who formally applies AAL functions and services to the AAL care recipient ('Health Care Professional' e.g. a nurse);
- an informal "Person Actor" user ('AAL lay informal carer') who applies informal AAL functions and services to assist the AAL care recipient (e.g. family member) who can also be trained (e.g. through related education);
- the care recipient "Person Actor" user who, if capable, applies AAL functions and services in a self-managed manner to himself or herself (e.g. a person who self-manages his or her condition or impairment).

5.8.2 Persons

AAL user (IEC 60050-871:2018, 871-02-05) is a person who uses or benefits from AAL devices, systems or services. The AAL user may be the following persons:

- AAL care recipient is a person who receives and consumes AAL care services.
- AAL care assistant (IEC 60050-871:2018, 871-02-10) is a person providing care services to the AAL service recipient:
 - AAL formal carer is a person who provides formal personal or homemaking services to the AAL care recipient;
 - AAL informal carer is a person who provides informal (or lay) services to the AAL care recipient.
- healthcare professional (IEC 60050-871:2018, 871-02-14) is a service provider in the healthcare system who carries out training, therapy, health promotion and consultations.
AAL service provider personnel are employees, contractors and agents of an AAL service provider organization.
- AAL operator (IEC 60050-871:2018, 871-02-04) is a person handling or using, or handling and using an AAL system for the benefit of an AAL user.
- AAL technical assistant (IEC 60050-871:2018, 871-02-03) is a person supporting AAL users and AAL operators with the installation and continued support of AAL devices and systems and with technical and other advice.
- consultant for medical devices (IEC 60050-871:2018, 871-02-11) is an expert informing members of healthcare professions or the healthcare industry and of healthcare facilities about medical devices and advising them on their use.

5.8.3 Technical components

The technical components are described in 5.7.

5.8.4 Organizations

Two examples of organizations as actors are given:

The service provider (IEC 60050-871:2018, 871-02-01) may be an AAL service or healthcare service provider. The other example is a research organization that conducts research into new or modified health treatments and their efficacy.

5.8.5 Relationship between actors

Figure 4 shows the relationship between AAL actors.

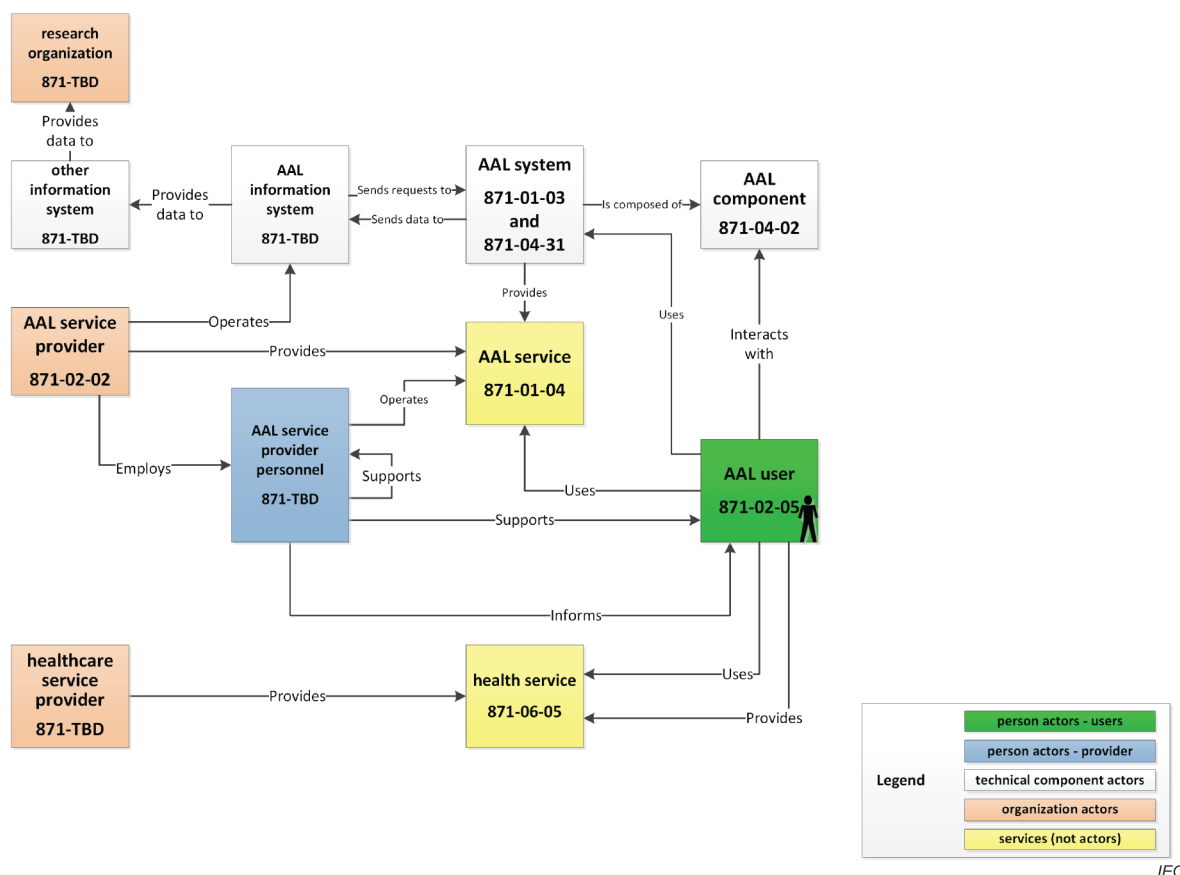


Figure 4 – Relationship between actors

6 Use case analysis

6.1 General

Subclauses 6.2 and 6.3 discuss the use case analysis based on representative use cases and the functional requirements of the AAL system. Therefore, there is an interrelation with the user's requirements as described in the use cases and the reference architecture.

6.2 Overview and representative use cases

6.2.1 General

IEC SyC AAL has collected more than 50 use cases. Titles and short descriptions of the use cases are listed in Table 1. The representative use cases are included in Annex B. An additional list of the use cases, which is regularly updated, is available under the supporting documents link: <https://www.iec.ch/sycaal/supportingdocuments>. Further use cases have been added and also the use case template has been revised (see Annex E).

NOTE 1 It is possible that relevant standards, regional laws and regulations, as well as liaisons are missing from the original use case descriptions, and are being considered in the current SyC AAL document under consideration on a use case standards inventory and mapping.

The use cases are grouped according to the categories below. The classification (see 5.5) is based on claims found in each use case.

Use case categories:

- 1) prevention and management of chronic long-term conditions;
- 2) social interactions;
- 3) mobility;
- 4) health and wellness;
- 5) (self-)management of daily life activities at home.

Table 1 – Updated titles and categories of use cases

Use case number	Title of use case	Level of criticality (major, moderate, minor)	Use case category				
			1	2	3	4	5
1	Personal health check	Moderate	X		X	X	X
2	Advanced medication monitoring (AMM)	Major	X			X	
3	Enable social interaction with care providers	Moderate	X	X		X	X
4	Social interaction with smart TV	Minor	X	X			X
5	Smart wheeled walker – Guidance to return home	Major			X		
6	Improve communication between user and equipment by ETA (enhanced terminal accessibility)	Moderate			X		
7	Healthcare in the senior citizens' welfare centre	Major				X	X
8	Personal trainer	Minor	X			X	
9	Behaviour monitoring	Major	X			X	X
10	Shopping and nutrition planner	Minor					X
11	Intelligent lighting fixtures	Major					X
12	Remote health monitoring / fall detection	Moderate	X				X
13	Telemonitoring	Major	X			X	X
14	Acquired brain injury – at-home alarm support	Major					
15	Objective remote health monitoring	Major	X			X	X
16	Query sensors and switches for status [different template]	Moderate					X
17	Remotely monitor Parkinson's patient to prevent falls and manage medication titration	Major	X			X	
18	Continuous blood glucose monitoring with remote assistance	Major	X			X	
19	Enable the upload of measurement data on the WAN interface	Major	X			X	X
20	Controlled information sharing	Major	X				X
21	Patient reported outcomes measures (PROMS)	Major	X			X	X
22	Transmitting questions and related answer response/selection, or instructional material, in a telemonitoring system via WAN-IF	Moderate	X			X	X
23	Epilepsy detection/acquired brain injury – at-home alarm support	Major	X				X
24	Fall detection functional neurological disorder – at-home alarm support	Major			X	X	X

Use case number	Title of use case	Level of criticality (major, moderate, minor)	Use case category				
			1	2	3	4	5
25	U-home smart solutions for the elderly care community	Major			X	X	X
26	Lifestyle reassurance management of activities of daily living (ADL)	Major	X			X	X
27	Privacy, data protection, information security related to AAL	Major	X			X	X
28	Information reliability and device and patient authenticity	Major	X			X	X
29	Building-integrated notification system	Major	X	X		X	X
30	Standardized data exchange of regular medical check-up record	Moderate	X			X	X
31	Mobility assistant	Major	X		X		X
32	Calendar service	Major				X	X
33	52-year-old with multiple health conditions – At-home medication and alarm support	Moderate	X			X	
34	Environmental health monitoring and alarms at work	Major	X			X	
35	Home alarm and service provider – example of alarm activation response	Major					X
36	One-stop emergency service using Lifetag	Major	X			X	
37	Heat stroke prevention system in home	Major					X
38	Air bag system in stairway	Major					X
39	Bathtub drowning prevention system	Major				X	
40	Overturn detection and alert system for home garden	Major					X
41	Minor user mistakes lead to undesirable results	Major					X
42	Use of general equipment leads to malfunction of the system	Major					X
43	Home assistant robot	Minor	X			X	
44	AAL exoskeleton robot	Major	X		X		X
45	AAL care service provided by trained working person	Moderate	X			X	X
46	Accessible TV with IPTV based on ITU-T H.702	Minor					X
47	Real-time communication for the disabled	Minor		X		X	X
48	Corona-blue: Smart mobile healthcare app ("Psychological Quarantine")	Minor				X	X
49	"Community Treatment Center" model for Covid-19 for mild cases	Major				X	X
50	An authentication error due to unintended interactions / face authentication system and mist spraying system	Major					X
51	An unexpected lock out of a person due to shutter closing / automatic laundry drying system and shutter system in a house	Major					X
52	An unintended collision / mobile kitchen and automatic robot cleaner	Minor					X
53	An unintended functional interference / high-performance smart speaker and automatic robot cleaner	Minor					X

Use case number	Title of use case	Level of criticality (major, moderate, minor)	Use case category				
			1	2	3	4	5
54	A fire due to unintended interferences / electric stool robot and electric heater	Major					X

NOTE 2 The use cases were renumbered after analysing and combining common use cases. The first number is the new number of the use cases after consolidation.

The distribution in Table 1 shows that many use cases fall in three categories: 1 "prevention and management of chronic long-term conditions", 4 "health and wellness" and 5 "(self)-management of daily life activities". This shows that mainly support is needed for physical conditions and daily life. Urgent and/or critical conditions are dealt with in these three categories.

Fewer use cases are claimed to be classified in the other two categories: 2 "social interaction" and 3 "mobility". The two categories should be recognized as integral part of AAL, as social interaction and mobility are indispensable factors for sustaining an independent life of the older person. Lack of mobility and social interaction could lead to negative impacts on physical strength and cognitive abilities.

The following are representative use cases for categories as described in 5.5. The complete use cases are included in Annex B. The cases were chosen based on the criteria below:

- 1) use cases that are easy to read and to grasp the scope of AAL;
- 2) two use cases for each category: one with general description and the other with a focus on specific functions.

As for category 5, (self-)management of daily life activities at home, three representative use cases are selected. This is because the category covers a wide range of situations and various use cases have been submitted. Use Case 11 is chosen as an additional representative use case as it is mentioned in an International Standard that is being developed in IEC SyC AAL: IEC 63168-1, *Cooperative multiple systems in connected home environments – Functional safety of electrical/electronic safety-related systems – AAL aspects – Part 1: General requirements for design and development*.

6.2.2 Prevention and management of chronic long-term conditions

6.2.2.1 Use case 1 personal health check

Chiyoko is a 73-year-old woman, living independently with her husband. She wears a small on-body sensor that remotely and wirelessly monitors her conditions. The detected biometric measurements including vital signs are sent to a healthcare service centre and stored there so that medical doctors can analyse the data. The doctors generate a monthly health report for Chiyoko. The reports are shared with her family chemists at a drugstore near Chiyoko's house. The chemists give advice to Chiyoko based on the health report as well as her health conditions.

In this use case, person actors are Chiyoko, medical doctors and chemists. Chiyoko is an AAL care recipient, while medical doctors and chemists are healthcare professionals. The AAL care recipient is maintaining independent living, and falls on either level 0 (independent) or level 1 (some assistance) of the AAL user domains. The data is stored in a cloud server so that other AAL actors can share it and make professional intervention when necessary.

6.2.2.2 Use case 2 advanced medication monitoring

Bernice is 84 years old and lives on her own. Her doctor has prescribed multiple medications for Bernice. She uses a medication monitoring system that reminds her when to take which medicine. The system also records her medication adherence. Her daughter, one of her informal carers, may be notified when her mother's medication non-adherence is detected.

This use case deals with level 2 (assistance with IADL) of the user domain. The advanced medication monitoring (AMM) system sends reminders to the AAL care recipient, provides physicians with information on medication and the patient's compliance, and can send notification to relevant informal carers when irregularities are detected. The AMM may be programmed by trained AAL operators.

6.2.3 Social interaction

6.2.3.1 Use case 3 social interaction with caregivers

Bernice lives on her own but has medical, physical and cognitive issues. The problems limit her mobility and it is difficult for her to visit other people to interact with and maintain connections with them. Her problems sometimes prevent attendance at regular medical appointments. She can maintain social interaction with family members, friends, and care providers through text-based interaction (E-mails, instant messaging), as well as voice and audio interaction.

This use case mainly focuses on AAL users at level 2 of the user domain, where many people have difficulty going out of their homes. In such situations, keeping social relationships becomes a challenge. Lack of social connection should be avoided as much as possible, as it could lead to depression and have further negative impacts on physical or cognitive abilities of the older person.

6.2.3.2 Use case 4 smart TV

Peter, who is 83 years old, lives alone. His son lives in a city about 200 km away. Peter uses a smart TV as a communication device to stay in contact with his family, friends, carers, medical doctors and others. He has his smartphone connected to a TV set to use the phone as a remote controller. A panic button with localization function is installed in the smartphone. When he pushes the button, a formal carer at a local nursing service will respond and make necessary arrangements. The smart TV can be used to order groceries from local supermarkets.

The AAL care recipient needs some assistance (level 1) in the area of social interaction. This is because the user's mobility is limited due to some health condition such as illness, frailty, and so on. The system helps him enjoy remote communication without physically moving to a different place to see his family and friends.

6.2.4 Mobility

6.2.4.1 Use case 5 smart wheeled walker – guidance to return home

Mrs. Appletree uses a smart wheeled walker to stabilize her walk. The device is even more helpful when she goes outside. The walker guides her not only inside her flat, but also to chosen destinations outside via her preferred routes. It can help her when she gets disoriented. The walker is like a friend with whom she can talk; it answers back, offers information and advice. It also has a reminder function, so she does not miss her appointments.

The AAL care recipient is getting forgetful, and she is at either level 1 or level 2 of the user domain. The user's mobility increases as the walker helps her not only physically but also in terms of orientation and selection of efficient routes for her. The walker is equipped with sensors and internet connection. It serves as a digital assistant to the user.

6.2.4.2 Use case 6 communication between user and equipment by ETA (enhanced terminal accessibility), 'VISIT to JAPAN'

Bob, a 70-year-old British man, recently travelled to Japan. He had had enhanced terminal accessibility (ETA) installed on his smartphone. So even in a foreign country, Bob was able to enjoy his stay to the fullest: he could easily spot a ticket-vending machine by checking a map on his smartphone. He could get prepaid ticket-data smoothly from the ticketing machine into his smartphone. When he wanted to eat something, he obtained restaurant information by downloading menus, the language of which was automatically translated to English by ETA. Information relating to his specific allergy was automatically provided as well.

ETA is useful for AAL care recipients who need some assistance in the area of communication. ETA is helpful in communication both with other people and equipment. Adding personal information on users' special needs (e.g. allergy) improves accessibility of the man-machine interface.

6.2.5 Health & wellness

6.2.5.1 Use case 7 intelligent apartment for the elderly

Konrad lives in an intelligent apartment equipped with a tele-monitoring system that helps him monitor his biometric data. Routine monitoring ranges from health checks to house security. An intelligent drug cabinet monitors medication adherence as well. In the case of irregularities, alarms go off and inform both his family and the head office of the living quarters. A short response time is guaranteed through an excellent organizational infrastructure.

The user needs assistance with IADL in many areas of daily life. In the intelligent apartment, where his activities are monitored, he can manage his appointments, home security, etc. Household chores are also managed by the staff at the apartment house. He can consult with healthcare professionals via video conferencing.

Many actors appear in this use case: AAL users along with AAL care recipient, AAL service providers, and various kinds of devices, etc. This is because the setting (intelligent apartment for the elderly) comprehensively takes care of all kinds of daily life activities of senior citizens.

6.2.5.2 Use case 8 personal trainer

Frieda is getting a little weaker these days. It has become harder for her to be active during the day. Housework tasks are sometimes a big burden for her. Her doctor gave her a little wearable device that tracks her physical activity, along with a small box. Her son connected the box to her PC at home. The box shows videos that give tips to simplify household tasks and daily activities. It also suggests tailored workout training for her. A few months later, Frieda found herself fitter and safer when she performs her daily activities.

The user gets some hints to make household tasks easier for her. At the same time, regular exercise helps her stay fit. A body activity sensor collects data and the AAL application determines appropriate activities and exercises for the user. As it is difficult for the AAL care recipient to set the device herself, an informal carer, her son, comes in to help her.

6.2.6 (Self-)management of daily life activities at home

6.2.6.1 Use case 9 behaviour monitoring

Jane is 85 years old and suffers from mild cognitive impairments. She uses an AAL system which detects potentially dangerous situations for her and changes in her behaviour patterns. For example, if Jane leaves a pan on the stove in the kitchen unattended for a certain period of time, the system notifies her by displaying a message on the TV, which she is likely to be watching. Should she ever fall at home and not be able to get up, then the system automatically notifies an emergency call service. When her daily activity patterns changes, a notification will be sent to her daughter so that she can look for appropriate support.

The AAL care recipient maintains independent living though she is getting forgetful and needs reminder and notification assistance for some of the daily activities. This AAL care recipient falls on the category of either level 1 or level 2 of the user domains. Sometimes she fails to do what is necessary to keep herself and her residence safe and secure. Various sensors are utilized to monitor home safety and the user's body movement, so that formal and informal carers can respond to the situation and/or change.

6.2.6.2 Use case 10 shopping and nutrition planner

Michael is 72 years old and lives alone. He suffers from mild cognitive impairment and often has problems with healthy diet and related shopping tasks. That's why his son installed a new shopping assistant on Michael's smart TV and mobile phone. Michael can use the system for organizing his shopping list. For example, the assistant recommends him to add more fruits to his shopping list. He can use the system for online ordering, too. The items he bought are delivered to his home. The system also knows that the stock of sparkling water is running out and adds some bottles to the shopping cart as well.

The AAL care recipient lives alone but needs assistance in managing a healthy diet, as well as doing grocery shopping. His son, an informal carer, installed a system that helps the AAL care recipient assemble shopping lists, as well as arranging on-line shopping with door-to-door delivery service. Connected with intelligent storage system, it can report low stock of certain foodstuffs; for example, an intelligent fridge. It can also be connected with a home automation infrastructure to issue reminders if the user has assembled a shopping list but failed to actually go shopping.

6.2.6.3 Use Case 11 intelligent lighting system

Takuji, 68, doesn't see well in dark places. He sometimes visits his son Mamoru's house, which has an intelligent lighting system installed. After dark, the light automatically turns on when the sensor of the system detects human presence. The residents can also control On/Off via their smartphone, and the conventional switch on the wall is used only secondarily. One day, the sensor somehow didn't work when Takuji went upstairs. Because it was getting dark, Takuji wanted to turn on the light. He used the normal On/Off switch on the wall, but it did not work. He was at a loss. It is very difficult for him to go downstairs safely without lighting. His grandson Shota downstairs could not fix the problem either, because he didn't have a smartphone. They had to call Mamoru, who operated the system remotely using an App on his smartphone.

This use case presents a possible problem that AAL users could encounter when a system does not work properly. The problem would be especially serious for those who are not familiar with the operation. In this use case, the system automatically determines operation based on the information from the sensors and the user does not know how he can choose different operation manually. Operation options available in such situations should be considered beforehand. Visualization of the system status would be also helpful for the users.

6.3 Functionalities that appear in each use case

Various types of functionalities are found in the collected use cases. The elements are sorted into five groupings with ten sub-groupings (see Table 2).

- General

Use cases 18, 19, 25, 26, 27, 29 deal with the management of information and data. They should be taken into consideration and be applied to other individual use cases as much as possible.
- Monitoring

The functionality mainly covers two kinds of monitoring: emergency (fall, fire, etc.) and long-term health issues (vital signs, medication adherence, etc.). Consultation is also included in this functionality as part of monitoring process.
- Communication support

This functionality covers various types of communication: communication with people such as family members, friends, medical staff, etc. Transactions and interaction with systems (e.g. smart shopping) are also included in this functionality.

- Activity support

This functionality deals with miscellaneous activities ranging from activities such as exercise and games, and also smart home management such as use of lighting systems. Reminder function (excepting medication-related matters) is also included in this functionality.

- Mobility support

Factors in this functionality aim at facilitating and assisting mobility of AAL care recipients, in terms of both movement and orientation.

Table 2 – Categories and functionalities of use cases

Functionalities		Use case number				
		Use case category				
		1	2	3	4	5
General (Data protection, privacy, etc.)		18, 19, 25, 26, 27, 29				
Monitoring	Emergency	9 , 12, 23, 31, 33, 34	4	25, 31	7 , 9 , 13, 24, 25, 31, 34, 36, 39	4 , 7 , 9 , 12, 13, 23, 25, 31, 35, 40, 42
	Vital data, activity level, etc.	1 , 8 , 9 , 12, 15, 17, 18, 21, 31		1, 25, 31	1 , 7 , 8 , 9 , 13, 25, 31	1 , 7 , 8 , 9 , 12, 13, 15, 21, 25, 31, 42, 45
	Medication	2 , 17, 33			2 , 7 , 32, 45	2 , 7 , 32
	Consultation	1, 13, 25, 31, 45	4	1, 25, 31	1 , 2 , 4 , 7 , 25, 31	4 , 13, 31, 45
Communication support	General	1 , 3 , 33	3 , 4 , 29	1 , 6 , 25	1 , 3 , 7 , 25, 39, 43	1 , 3 , 4 , 7 , 25, 45
	Transactions	10	4	6 , 10		4 , 10
Activity support	Reminders	2 , 7 , 29, 33	29	5	2 , 5 , 7 , 25, 29, 32	5 , 7 , 10 , 25, 29, 32
	Miscellaneous	7 , 8 , 9		5	5 , 8 , 9 , 32, 43	5 , 7 , 8 , 9 , 10 , 11 , 32, 37, 38, 41
Movement support	Disorientation			5	5 , 31, 36	5 , 10 , 35
	Walking support	31, 44		5 , 31, 44	5 , 31	5 , 31, 38, 44
Representative use cases are shown in bold.						

7 Considerations of user requirements

7.1 General

Based on the previous use case analysis, the major user requirements are identified. AAL users may or may not be professionally trained in the use of AAL systems. As a result, AAL systems should be designed and implemented with the interaction of the needs, preferences and capabilities of the actors (persons, technical and organizational) and the context of use (environments) in mind.

For demonstrating the user requirements of AAL use cases, SyC AAL has developed Figure 5. There is no hierarchical structure of user requirements; the user requirements should be considered on an equal basis. The user requirements are interconnected; however, the technical implementation of each requirement is independent.

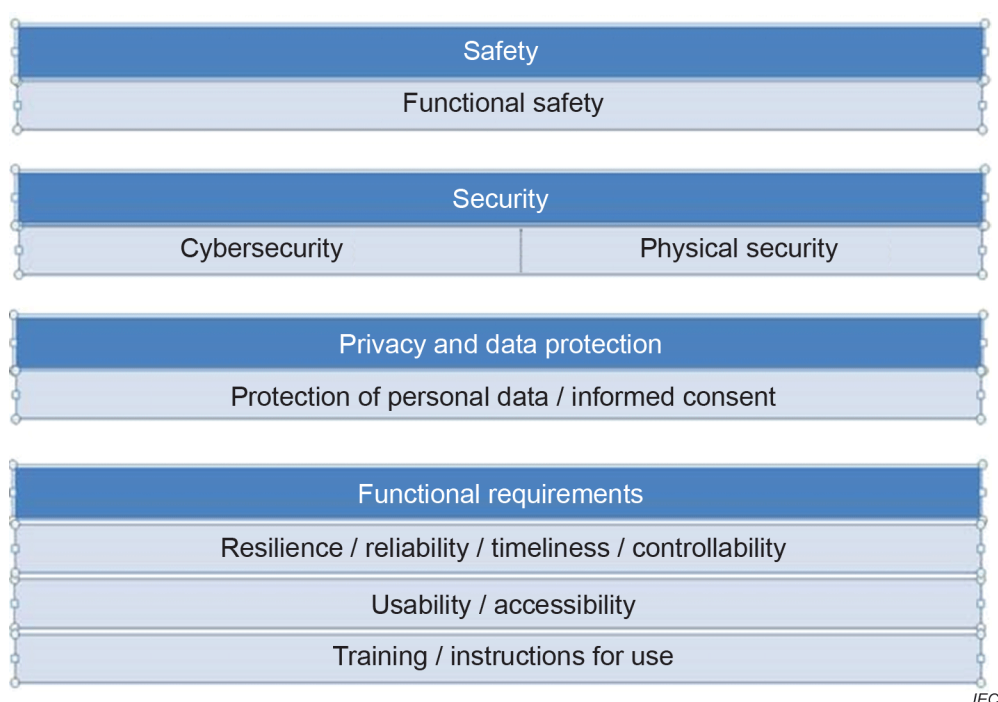


Figure 5 – Overview of user requirements

According to ISO/IEC 30141, the characteristics of IoT systems comprise trustworthiness, architecture and functional characteristics. Trustworthiness is defined as the degree of confidence a stakeholder has that the system performs as expected with characteristics including:

- safety;
- security;
- privacy and data protection;
- functional requirements;

Additional characteristics for AAL systems were identified which are of operational and functional nature of the AAL system.

- usability, see also ISO 9241-11:2018;

It is important that the AAL user has an understanding of how the AAL system operates. AAL systems should be designed so that each category of AAL user understands the part or parts of the system in which they interact. All aspects of usability, including effectiveness, efficiency and user satisfaction, can either increase or decrease safety.

NOTE See also the dialogue principles as defined in ISO 9241-110:2006.

- accessibility, see also ISO/IEC 29138-1.

7.2 Definition of user requirements

7.2.1 General

The AAL use cases were classified according to the care recipient viewpoint (see 6.3) and use case categories (see 5.5). Similar to the AAL architecture model, SyC AAL mapped the AAL use case classification by use case categories (x -axis), care recipient viewpoint (y -axis) and user requirements (z -axis). Figure 6 aims to provide a three-dimensional view of user requirements, use case categories and user's viewpoint. The user requirements are extracted from Figure 5. For easier reading, only some user requirements are placed on the z -axis.

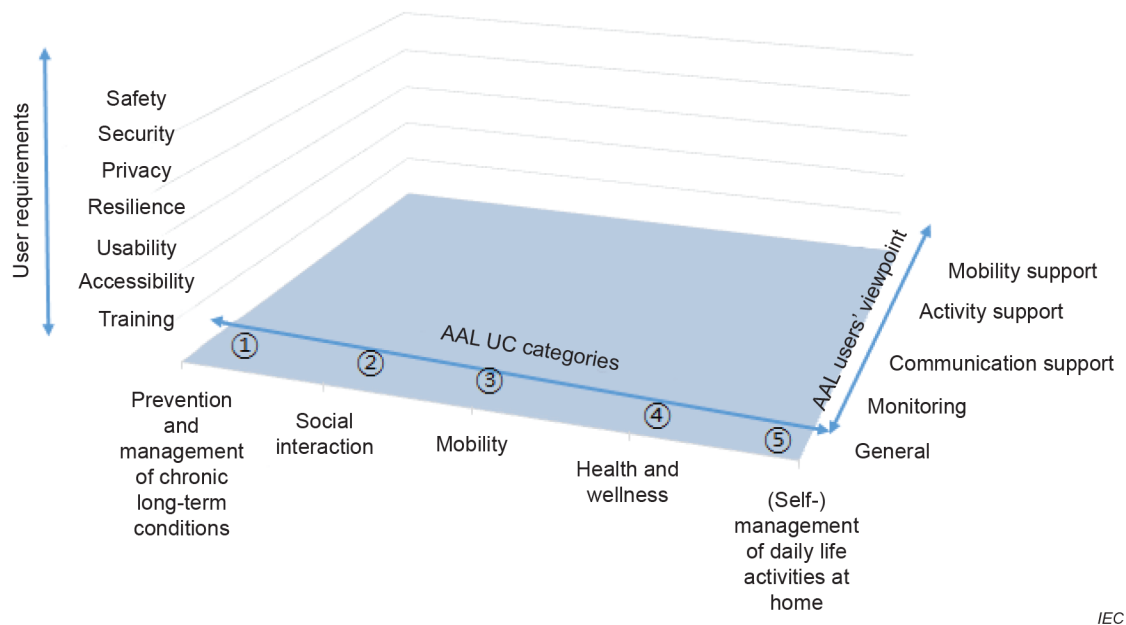


Figure 6 – AAL use case classification

7.2.2 Safety

Safety, as user requirements has implications for the design, development and operation of AAL products, services and systems.

The AAL system should be responsive and spot risky behaviour and hazardous situations and intervene in a timely manner.

AAL components should meet the applicable conformance testing standards and regulations to ensure that these are safe to operate by AAL users. As the environmental conditions (e.g. temperature, humidity, mechanical stress, electromagnetic interference, mains power reliability, etc.) may be uncontrolled in certain contexts of use AAL components should be chosen to ensure that they operate properly in these cases.

The context of use (environments) should be evaluated to ensure that AAL users are capable of performing daily tasks safely.

AAL systems should be designed to be as low risk as possible. Design considerations should take into account the physical, sensory, cognitive and emotional state of the AAL user – including those users who are at risk of being excluded, for example due to a disability or who are vulnerable – and the environmental conditions of the context of use.

Functional safety (IEC 60050-351:2013, 351-57-06) is part of the overall safety that depends on functional and physical units operating correctly in response to their inputs. It means keeping residual risk to user, operator, and environment to an acceptable level.

7.2.3 Security

Security is defined freedom from unacceptable risk to the physical units considered from the outside (IEC 60050-351:2013, 351-57-07).

Data security (cybersecurity) means should be incorporated into AAL systems in order to reduce the risk of AAL system failure or compromised functionality. According to Regulation (EU) 526/2013, on Information and Communication Technology cybersecurity certification ("Cybersecurity Act"), cybersecurity comprises all activities necessary to protect network and information systems, their users, and affected persons from cyber threats.

7.2.4 Privacy and data protection

Privacy of personal data regulations are in place globally. AAL systems should comply with the applicable regulations to protect the personal data of AAL users.

ISO/IEC 24775-2:2014, 3.1.45 defines privacy as the right of an entity (normally an individual or an organization), acting on its own behalf, to determine the degree to which the confidentiality of their private information is maintained.

According to Art. 4 of the General Data Protection Regulation, personal data means any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.

Consent, as defined in the General Data Protection Regulation, of the AAL care recipient means any freely given, specific, informed and unambiguous indication of the data subject's wishes by which he or she, by a statement or by a clear affirmative action, signifies agreement to the processing of personal data relating to him or her.

7.2.5 Functional requirements

According to ISO/IEC 30141, reliability and resilience should make the AAL system robust in the face of environmental disruptions, human errors, system faults and attacks.

Timeliness and controllability are additional characteristics important for AAL systems. Timeliness in the sense of a system's response to a user's input could be subsumed under the dialogue principle "controllability", see 4.7 in ISO 9241-110:2006. A dialogue is controllable when the user is able to initiate and control the direction and pace of the interaction until the point at which the goal has been met. The requirement of "timeliness" is a requirement that is not directly related to the user, whereas "controllability" is from a user-centric point of view.

Additional important characteristics for AAL systems were identified which are of operational and functional nature of the AAL system.

- Usability, see also the dialogue principles as defined in ISO 9241-110:2006.
It is important that the AAL user has an understanding of how the AAL system operates. AAL systems should be designed so that each category of AAL user understands the part or parts of the system in which they interact. All aspects of usability, including effectiveness, efficiency and user satisfaction, can either increase or decrease safety.
- Accessibility, see also ISO/IEC 29138-1.

Each context of use should be evaluated to determine the physical, sensory and cognitive accessibility needs of each category of AAL user. In particular, design considerations and accommodations should take into account possible impairments regarding the human functions described in Clause 7 of ISO/IEC Guide 71:2014, and ISO/IEC 29138-1.

- Training and instructions for use.

Training is critical to the safe operation of an AAL system. Training should be developed for the three role categories of AAL users in the appropriate context of use. Training materials should be accessible in compatible formats.

The instructions for use for the untrained AAL user should be simple to read and easily understood. The instructions for use for the trained AAL user can contain additional AAL system information required for the setup, troubleshooting, and maintenance of the AAL system. Instructions for use should contain information identifying the organization to contact in case of any issues or questions. Instructions should be made accessible by using accessible formats that are available on accessible systems in accessible environments.

8 Summary of standards gap analysis

IEC SyC AAL has developed an inventory of standards and directives covering electric safety, EMC, sustainability, usability, data protection, privacy and security among other areas. The relevant technical committees have also been identified.

SyC AAL is in the process of identifying the relevant standards and directives for each use case including where these fit into the architecture model layers.

SyC AAL invites the national mirror committees, technical committees in liaison and liaison bodies to review the information to determine the accuracy and completeness of the inventory.

SyC AAL also invites national mirror committees, technical committees in liaison and liaison bodies to review identified standards for any potential gaps in applying these to a typical SyC AAL user and the SyC AAL environment of use as described below.

SyC AAL care recipients are aged or disabled members of the population with related issues such as lack of mobility, vision and/or hearing problems, lack of muscle strength, memory and cognitive issues. SyC AAL operators are usually family member caregivers that can be under stress owing to caring for the SyC AAL user. SyC AAL users may have a limited education or not be a native language speaker. As a result, devices and systems need to be designed with easy-to-understand instructions and user interfaces.

The SyC AAL environment is uncontrolled in terms of temperature, humidity, ambient lighting, noise, unreliable AC mains connection and could be susceptible to power outages. In which case, devices and systems need to be designed to take into account the limitations of the SyC AAL user and for operation in an uncontrolled environment of use.

9 Conclusions and recommendations

The process for developing use cases for AAL systems was presented in this document. Input to use cases are the AAL system architecture, AAL user needs and the context (environment) of use.

Use cases for AAL systems are based on real world situations and the outcome of these is to identify products, services and systems of AAL technologies in such a way as to assist system developers and service providers to develop solutions that address the AAL user's needs.

Owing to the complexity of AAL systems (diverse user population, different levels of assistance required, wide context of use; and education levels of users), AAL system components must be

designed to meet the usability needs of users as well as to operate in uncontrolled environmental conditions.

Another outcome from the use cases is to identify standards, directives, and regulations required to develop a compliant AAL system in terms of safety, security (cyber and physical), privacy and data protection as well as functional requirements.

IEC SyC AAL encourages national mirror committees, technical committees in liaison and liaison bodies to review the standards, directives, and regulations inventory to identify any gaps in these that would need to be filled in order for AAL system components to meet the needs of the AAL user.

Annex A (informative)

AAL use case template (version 1.10)

A.1 Level of criticality (see 5.3)

Major	Moderate	Minor

A.2 Name of use case

ID	Name of Use Case	AAL Levels of assistance Level 0: independent Level 1: some assistance Level 2: assistance with IADL Level 3: assistance with ADL See 5.4

A.3 AAL function and service layer

AAL Function and Service Layer (=Use Case Categories) See 5.5	Context of use See 5.6

A.4 AAL system component composition

AAL system components See 5.7

A.5 Version management

Changes / Version	Date	Name Author(s) or Committee	Approval Status draft, for comments, for voting, final