DKE - Roadmap

GERMAN STANDARDIZATION ROADMAP

Smart Home + Building

Version 2.0

DKE
VDE DIN

Gefördert durch:

Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

VDE

Published by

VDE VERBAND DER ELEKTROTECHNIK
ELEKTRONIK INFORMATIONSTECHNIK e. V.

as the parent organization of

DKE Deutsche Kommission Elektrotechnik
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Issue date: August 2015

CONTENTS

Contents . . . 3

1 Introductory remarks . . . 8

1.1 Introduction and background to the Smart Home + Building standardization roadmap . . . 9
1.1.1 A brief look at standardization . . . 10
1.1.2 Added value from specifications . . . 10
1.1.3 Specifications with a view to the Smart Home . . . 11

2 Terms and definitions . . . 12

2.1 Smart Home . . . 12
2.2 Conformity . . . 13
2.3 Interoperability . . . 13
2.4 Smart Home Domain . . . 14
2.5 User Story . . . 14
2.6 Use Case . . . 14
2.7 Message . . . 15
2.8 Generic Use Cases . . . 15
2.9 Use Case Management Repository (UCMR) . . . 15

3 Standardization . . . 16

3.1 Standards . . . 16
3.2 Standards and specifications . . . 17
3.3 Structure of the standardization landscape . . . 18
3.3.1 DIN, CEN and ISO . . . 19
3.3.2 DKE, CENELEC and IEC . . . 19
3.3.3 Standardization mandates from the European Commission . . . 20
3.4 Standards and specifications with a view to the Smart Home . . . 20
3.4.1 Cross-cutting topic Smart Grid . . . 23
3.5 The German Standardization Roadmaps . . . 24
3.5.1 The German Standardization Roadmap on Electromobility – Version 3.0 . . . 25
3.5.2 The German Standardization Roadmap AAL – Version 2.0 . . . 26
3.5.3 The German Standardization Roadmap Industry 4.0 – Version 1.0 . . . 27
3.5.4 The German Standardization Roadmap IT Security – Version 2.0 . . . 28
3.5.5 The German Standardization Roadmap Smart City – Version 1.0 . . . 29

4 Current status and market developments for the Smart Home . . . 30

4.1 Potential growth market for the Smart Home . . . 30
4.2 A challenge – the variety of sectors and domains in the Smart Home market . . . 30

4.3 A retrospective – the development phases of the Smart Home market . . . 32
4.4 Opportunities – the Smart Home market and its customers' requirements . . . 33

4.5 Current status – market development for building automation systems . . . 35
4.5.1 Let-out areas in a building erected by investors . . . 37
4.5.2 Use of areas by the investor himself . . . 37
4.5.3 Internet of Things and Smart Tagging . . . 38

4.6 Prospects – on the way to the Smart Home mass market . . . 39
4.6.1 Moves towards standardization and consolidation on the Smart Home market . . . 39
4.6.2 Forecasts for the Smart Home market . . . 43

5 Projects related to Smart Home + Building . . . 48

5.1 Smart Home + Building Certification Programme . . . 48
5.2 GUIDED AB . . . 51
5.3 proSHAPE . . . 53
5.4 UHCI . . . 55
5.5 Safety systems in smart buildings – smoke detection with smoke/heat extractors and evacuation system . . . 57
5.6 Natural ventilation, energy management and fire and water detection in Smart Homes with connection via IP500/GPRS gateway . . . 59

6 Technologies . . . 61

6.1 Environment . . . 61

6.2 Home and Building Architecture Model (HBAM) framework . . . 61
6.2.1 Interoperability levels . . . 64
6.2.2 Application domains . . . 71
6.2.3 Integration zones . . . 75

6.3 Smart Home – from actual to specified . . . 79
6.3.1 Sensors and actuators . . . 80
6.3.2 Data created in various use cases in the Smart Home . . . 81
6.3.3 Gateways . . . 82

7 User stories and use cases . . . 83

7.1 Example of a user story . . . 83
7.2 Example use cases . . . 85

8 Safety and protection in the Smart Home + Building . . . 87

8.1 Safety of household and similar electrical appliances . . . 87

8.2 Information security in the Smart Home . . . 88
8.2.1 Communication security . . . 89

8.2.2 Communication across technology boundaries . . . 90
8.2.3 Protection profile for a Smart Meter Gateway [15] . . . 90
8.2.4 Security architecture with data protection zones . . . 92

8.3 Fire protection . . . 93

8.4 Fire detection systems . . . 93

8.5 Protection from burglary . . . 94

8.6 Intruder alarm systems . . . 94

8.7 Interoperability of safety and security systems in Smart Homes / Smart Buildings . . . 94
8.7.1 Interoperability of wireless sensor networks (WPAN) . . . 96
8.7.2 Interoperability in the wireless network on the protocol level . . . 97

9 Qualification . . . 98

9.1 Target groups . . . 99

9.2 Requirements for a Smart Building qualification model . . . 100

9.3 Best practice examples . . . 103
9.3.1 KNX qualification system . . . 103

9.4 Best practice example 2: ELKOnet qualification system . . . 104

9.5 Draft of a Smart Home qualification concept . . . 105
9.5.1 Basic skills and core disciplines . . . 105
9.5.2 Areas of specialization for experts . . . 106

10 Requirements for action and recommendations . . . 107

11 Abbreviations . . . 112

Appendix A: Technologies . . . 119

A.1 AirPlay . . . 119
A.2 BACnet . . . 119
A.3 BLE (Bluetooth Low Energy, Bluetooth LE, Bluetooth Smart) . . . 120
A.4 Bluetooth . . . 120
A.5 Connected Living Innovation Component Kit (CLICK) . . . 120
A.6 DALI . . . 123
A.7 DECT . . . 123
A.8 DECT ULE . . . 124
A.9 DLNA . . . 124
A.10 EEBus . . . 125
A.11 eNet . . . 127

A.12 EnOcean . . . 128
A.13 Ethernet . . . 128
A.14 G.hn . . . 130
A.15 HGI-Smart-Home-Task-Force und SWEX . . . 132
A.16 iBeacon . . . 132
A.17 IP500 . . . 132
A.18 KNX . . . 135
A.19 Konnektivität KNX/TP . . . 136
A.20 KNX/RF . . . 137
A.21 LCN . . . 137
A.22 LON . . . 137
A.23 M-Bus . . . 138
A.24 M2M . . . 138
A.25 NFC, RFID . . . 139
A.26 OGEMA . . . 139
A.27 openHAB . . . 140
A.28 OSGi . . . 140
A.29 SafetyLON . . . 141
A.30 TCP/IP . . . 141
A.31 UPnP . . . 142
A.32 WLAN(Wi-Fi) . . . 143
A.33 X10 (Protokoll) . . . 144
A.34 ZigBee . . . 144
A.35 Z-Wave . . . 145

Appendix B: Standards and specifications for Smart Home + Building . . . 148

B.1 Safety Domain . . . 148
B.2 Entertainment Domain . . . 152
B.3 Health/AAL/Wellbeing Domain . . . 153
B.4 Energy Management Domain . . . 155
B.5 Standards and specifications for building services and Smart Home in general . . . 157
B.6 Mandates – Smart Home . . . 164

Appendix C: Terms and Definitions [28] . . . 165

Bibliography . . . 173

Sources of the illustrations

Cover	Fololia 59595986 L - (Jack Black)
Bild 1	R. Glasberg, N. Feldner. Band 1 Studienreihe zur Heimvernetzung Konsumentennutzen und persönlicher Komfort
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Bild 3	DKE
Bild 4	DKE
Bild 5	DKE
Bild 6	VDE
Bild 7	VDE - (DKE reconstruction)
Bild 8	VDE
Bild 9	DDI
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1 Introductory remarks

The term “Smart Home” has gained currency in recent years as denoting technologies in living space and buildings where networked devices and systems improve the quality of life, security and the efficient use of energy. Alternative designations to “Smart Home” include “eHome” and “Smart Living”.

The continuing digitization and networking of almost all areas of human experience is leading in the domestic environment to changes which bring with them new opportunities for living and working at home. Smart Home is embedded in the striving for sustainable development of the infrastructure and improvement of the quality of life in an urban setting. This covers areas such as the economy, the living and working environment, the social environment, assistance in mobility and dealings with the authorities. Smart Home is concerned with the integration and use in the domestic environment of information and telecommunications technologies which facilitate new experiences and make familiar activities in entertainment, leisure, energy management, security and health more costeffective or more convenient.

The members of the Smart Home standardization consortium comprise representatives of academic institutions and industrial enterprises in the fields of home automation, heating, ventilation, air conditioning and refrigeration, lighting, consumer electronics, distributed power supply and energy management, and from other areas such as system integration or security systems. The aim of the consortium is to create and maintain an international series of standards which make the sustainable development of interoperable, safe, portable and reusable applications and services in the home environment possible.

1.1 Introduction and background to the Smart Home + Building standardization roadmap

This German standardization roadmap Smart Home + Building Version 2.0 is an update of the first standardization roadmap Smart Home + Building Version 1.0, which was published in January 2014.

The standardization roadmap Smart Home + Building is a joint project by DKE, the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE, and the companies interested and involved. The starting point for this work was a preliminary study aimed at documenting information on existing studies, projects, standards and products from the Smart Home environment. This information was structured and evaluated in consensus-based work by the parties involved.

In the Smart Home + Building project, the terms Smart Home, domain and use cases are defined. Groups of applications, such as energy management, security and AAL, are identified in this document as domains.

The standardization work followed the procedures successfully adopted in recent years at VDE|DKE, as presented in Version 2.0 of the standardization roadmap E-Energy/Smart Grids. These procedures are implemented with the use case methodology.

Standardization Roadmap E-Energy/Smart Grids 2.0

That methodology is based on uniformly defined use cases, which describe actors, processes and activities from the point of view of the task, and abstract technical details from these.

In this connection, one of DKE's central functions is the collection, coordination and processing of use cases and user stories in the Smart Home + Building environment. The objective is coordination spanning various domains of the existing activities on the subject of use cases on the national, European and international levels. These use cases are described in a standardized form and stored in the DKE Use Case Management Repository (UCMR). That database can be accessed remotely at any time, which makes it possible to work on the definition of use cases from any location. Here, the use cases are compacted to form generic use cases.

The standardization committees deduce technical requirements from the various use cases, and those technical requirements are then reflected in standards and specifications for the fields concerned. At an early stage of standardization, use cases therefore map processes and plans for implementation which are then to be put into practice.

BITKOM series of studies on home networking, volume 1, "Consumer benefit and personal convenience"

BITKOM Study series for home networking Volume 1 "Consumer use and personal comfort"

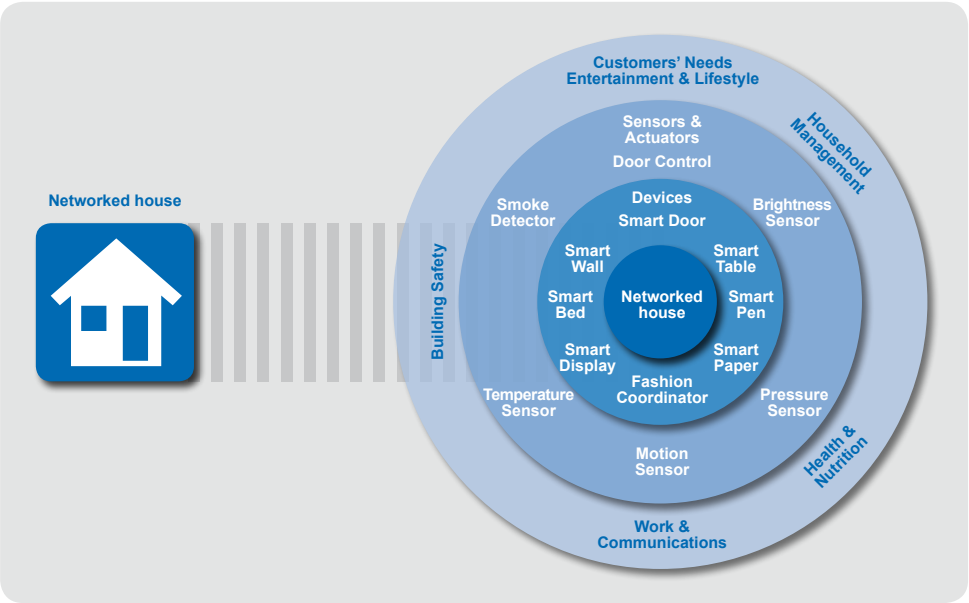

Figure 1: Example of devices in the connected home, Glasberg & Feldner, 2008

1.1.1 A brief look at standardization

Observing our own living environment precisely reveals that we come into contact with standardization on a daily basis. Our surroundings would be inconceivable without it.

Specifications provide a host of benefits, such as standardized interfaces, guaranteed interoperability of different components, fulfilment of minimum safety requirements and

1.1.2 Added value from specifications

By taking part in standardization work, companies can express their own interests, come into contact with other stakeholder groups and extend their knowledge-based lead, as they are playing an active part in defining the global language of technology.

Specifications are to be regarded as recommendations for action which can be used by everyone, making market access easier for manufacturers and providing a uniform basis for negotiations with contractual partners. They bring about increases in efficiency and savings in costs across all the areas of enterprises, and, last but not least, they increase customers' confidence in the product.

1.1.3 Specifications with a view to the Smart Home

The consortium sees standardization as a central element in the development of a Smart Home mass market. As a project plan, the standardization roadmap forms the basis of central project activities in standardization. Requirements such as ICT, hardware and software interfaces, bus systems and transmission methods, and cross-cutting topics such as IT security and usability, are examined within the context of the Smart Home + Building.

There are already some Smart Home solutions on the market, which, however, are technologically limited as they are each optimized for one particular area of application and do not permit a holistic approach. This standardization roadmap is intended to create a basis on which holistic Smart Home solutions can be made practicable. This could be a further step towards securing an international pioneering role for the German market. Compliance with international standards and specifications is therefore a must for the Smart Home + Building project.

In a first step, existing standards and specifications in the individual connection layers (hardware, software and data) are assessed. Should gaps become apparent, they are closed in cooperation between interested parties (industry, SMEs, authorities, craftspersons, customers, experts, etc.) leading to a consensus.

The accent is to be on a joint agreement which enables businesses to have reliable and future-proof access to the market. This should make Germany the leading market in the Smart Home field.

2 TERMS AND DEFINITIONS

2.1 Smart Home

A Smart Home comprises privately used indoor residential and office space (no matter whether this is owned or rented, a house or a flat, or old or new). The Smart Home is thus also an unlimited entity comprising dwellings in a correspondingly large structure (high-rise or residential block), provided that the private sphere is catered for and individual needs of the residents for safety and security, convenience and energy efficiency are fulfilled.

The Smart Building differs from this in that it is a commercially used building.

With the Smart Home, the focus is on private individuals. In contrast, with the Smart Building, the focus is on the building itself. The mechanisms for signalling should however be the same.

The following attempt at a definition is presented in Volume 1 of the BITKOM series of studies on home networking (Glasberg & Feldner, 2008):

BITKOM series of studies on home networking, volume 1, "Consumer benefit and personal convenience"

The terms connected home, electronic house, intelligent living, smart home, smart house, etc. cover a series of approaches to future life and work in private residential units. What all these terms have in common is the necessity to provide the residents with systems which satisfy their individual needs for convenience, safety and security, and energy efficiency.

A Smart Home is therefore more than a collection of individual smart devices.

1. The needs of the residents are detected by a large number of sensors and smart devices which provide for intuitive activation.

2. The information collected is processed taking account of the present condition and in anticipation of potential conditions.

3. The information collected and the interpretation based upon it are followed by an action. This is made possible by a sophisticated Connected Home Network which uses wired and wireless technology, interfaces and software, etc., to facilitate simple and reliable interaction between devices from the fields of consumer electronics (CE), information and communications technology (ICT), electrical appliances (cooker, refrigerator, etc.) and building services (alarm systems, heating and lighting control systems, etc.).

2.2 Conformity

Conformity is defined as the agreement of a system with the requirements set down in a specification. The conformity of the interfaces of a system with the corresponding interface specifications is regarded as a precondition for two or more systems allowing themselves to be connected via those interfaces and then being able to communicate with each other.

2.3 Interoperability

All investigations, studies and market reports are unanimous in their opinion that interoperability is the most important issue in the success of Smart Home solutions. Volume 3 of the BITKOM study on home networking deals with this subject as follows.

Interoperability (…) designates the ability of two or more systems to work together to perform a task by communicating through their interface. The concept of interoperability can be broken down into several levels, for instance as described in ETSI ETR 130:1994:

- Protocol interoperability
- Service interoperability
- Application interoperability
- User perceived interoperability

One of the fundamental requirements for the networked Smart Home is the interoperability of the systems involved. This presupposes that the networked components, devices or systems can exchange data without errors. This is to be implemented by means of a uniform, technologically neutral, standardized language which thus establishes interoperability between the subscribers.

2.4 Smart Home Domain

The term “domain” is used in this document to refer to a group of applications, such as security, health, entertainment or suchlike, which serves to give structure to the various smart functions. It may be that certain individual functions, such as shutter control, are used in several domains. A shutter controller, for example, serves both the domain of “security” and that of “energy”. For reasons of clarity, these aspects are located in individual domains. For standardization purposes, however, the resulting situation is that it is necessary for the standards of all domains to be fulfilled for these applications and their desired interoperability.

In the context of the Smart Home, the following domains are regarded as part of the Smart Home market::

- Energy management
- Security
- Entertainment/communications
- Health/AAL/wellbeing
- Smart Home infrastructure/automation

An example use case is presented in Figure 13 and Figure 14.

2.5 User Story

A user story is a description from the point of view of a user, normally in text form, of a general cross-domain Smart Home application.

2.6 Use Case

The user stories can be used to derive a set of the required use cases. These provide a detailed workflow description from the point of view of the actors and components of the Smart Home architecture (these will be described in a later chapter).

Several use cases are generally involved in the implementation of a user story. The relationship between user stories and use cases can be reflected in an allocation table (mapping user stories – use cases).

Use cases can be presented in connection with a text description, as a sequence of individual steps in the form of sequence diagrams.

Several use cases of the same kind are assigned to one or more domains. One such specific task (user story) is, for example, the air conditioning of a house or a room. For the air conditioning, the following use cases are then required:

- Temperature measurement, for instance for each room (implemented by sensors)
- Possible evaluation of other sensors (window opening, person detection)
- Atmosphere control (implemented by a temperature controller or ventilation controller)
- Control of heating/ventilation (implemented by connected systems or one or more actuators)

2.7 Message

The communication resulting from the use cases requires the use of corresponding messages. These form the lowest level in the implementation of use cases. The correlation between use cases and the necessary messages can be established by means of an allocation table (mapping message – use cases).

2.8 Generic Use Cases

Generic use cases are an extract from similar use cases with their device and interface characteristics generalized and reduced to the essentials. Generic use cases are the basis of gap analyses in the field of standardization.

2.9 Use Case Management Repository (UCMR)

The Use Case Management Repository is a database in which use cases, described in a standardized form, are accessible and can easily be compared. Compaction to form generic use cases takes place here.

3 STANDARDIZATION

Innovation in the development of Smart Home systems is promoted by standards and specifications. They set down framework conditions which provide all those involved with a certain degree of investment security. Standardization should take place “openly” enough to ensure sufficient space remains for the development of innovative systems which stand apart from the competition. Excessively restrictive specification could prevent future innovation.

Standards and specifications are developed on various levels (national, European and international) in various organizations. Interested parties (manufacturers, traders, universities, consumers, craft tradespeople, testing institutes, authorities, etc.) send their experts to take part in working groups at standardization organizations. The standardization work is organized and performed in those groups.

3.1 Standards

Standardization is taken to mean the planned processes and activities for creation and putting into force of rules by which products and services are made uniform.

Standardization is above all applied when the same or similar objects are used in many different contexts at various places by various groups of people. The aim of standardization is to avoid technical obstacles to use and to promote the exchange of goods and services nationally and internationally within the group of interested parties. Further consequences of standardization include rationalization, compatibility, fitness for purpose and safety in the use of products and services.

Standards are taken here to mean de jure standards, in contrast to de facto standards which are not established by official standardization work on at least the national level. Such de facto standards may also be “industry standards” and standards established by industrial stakeholder groups such as the Bluetooth protocols from Bluetooth-SIG or the IrDa protocol from the Infrared Data Association.

Companies may also create internal standards (works standards). These may be imposed on suppliers as mandatory requirements.

3.2 Standards and specifications

Standardization fundamentally means the achievement of uniformity of dimensions, types, procedures or other factors. The objective is to create common specifications and parameters (for example for tools, production or software components).

Differences between standards and specifications:

Table 1: Properties of standards and specifications

Principle	Standard	Specification
Voluntary	X	X
Public	X	
Everyone	X	(X)
Uniformity and freedom from contradiction	X	X
Relevance	X	X
Consensus	X	(X)
Orientation towards the state of the art	X	X
Orientation towards economic circumstances	X	X
Orientation towards general benefit	X	X
International	X	

For better understanding, an overview of the various standardization organizations and their interrelationships is now presented..

3.3 Structure of the standardization landscape

In the spirit of fully consensual standardization, the International Organization for Standardization, the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU) are the decisive standardization organizations on the international level. The corresponding standardization organizations responsible on the European and German national levels are the European Committee for Standardization (CEN) and German Institute for Standardization (DIN), the European Committee for Electrotechnical Standardization (CENELEC), the European Telecommunications Standards Institute (ETSI) and the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE (DKE) (see Figure 2). The various national standardization organizations are members of ISO, IEC, CEN and CENELEC.

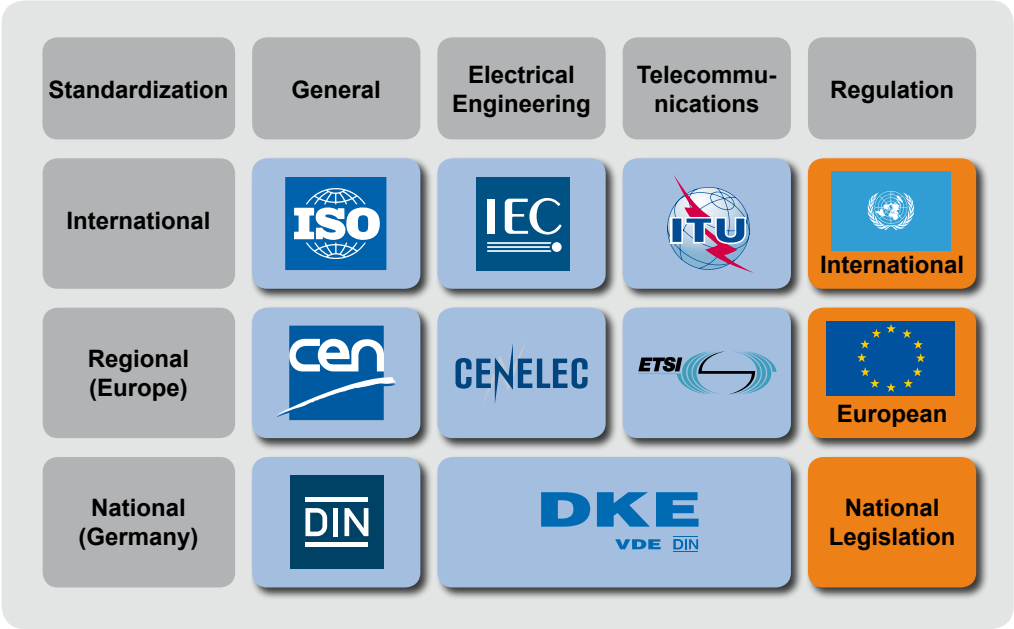

Figure 2: Fundamental elements of the standardization landscape and their relation-ships with regulatory levels

3.3.1 DIN, CEN and ISO

The German Institute for Standardization (DIN) provides all interested parties with a platform for the creation of standards and specifications as a service to industry, government and society. DIN is a private sector organization with the legal status of a non-profit association. The members of DIN are companies, associations, authorities and other institutions from industry, commerce, the craft trades and academia.

The main work of DIN is to compile consensus-based standards together with the stakeholders' representatives promptly and in a manner suitable for the market. On the basis of a contract with the German Federal Government, DIN is recognized as the national standardization body within the European and international standardization organizations.

Today, almost 90 % of the standardization work at DIN has a European and international orientation, with the members of DIN organizing the entire process of non-electrical standardization on the national level and ensuring German involvement on the European and international levels via the corresponding national committees. In that context, DIN represents the standardization interests of Germany as a member of CEN and ISO.

3.3.2 DKE, CENELEC and IEC

DKE represents the interests of the electrical engineering, electronics and IT industries in the field of international and national electrotechnical standardization work, and is funded by the German Association for Electrical, Electronic & Information Technologies (VDE). It is responsible for the standardization work which is then discussed at the corresponding European and international organizations (IEC, CENELEC and ETSI). It therefore represents German interests at both CENELEC and IEC. DKE is a modern, non-profit service organization which works to ensure the safe and rational generation, distribution and use of electricity and therefore also to contribute to public welfare.

The function of DKE is to compile and publish standards in the fields of electrical engineering, electronics and information technology. The results of DKE's electrotechnical standardization work are set down in German standards published by DIN and, where they contain safety-related provisions, they are also published as VDE specifications and are included in the VDE Specifications Code of Safety Standards.

The working panels are assigned as German mirror committees to the corresponding Technical Committees of IEC (and/or CENELEC), so that only one German committee is responsible for the entire national, European and international work and collaboration in the relevant field.

3.3.3 Standardization mandates from the European Commission

Mandates are orders from the European Commission for various purposes. In the field of standardization, mandates can be issued to the European standardization organizations for the creation of technical standards. The EU Commission uses its mandates as an expression of political intent. This is based on the idea that the standards are part of the reference system of the EU Directives.

The process of issuing mandates is governed by Directive 98/34/EEC of 22 June 1998 “laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on Information Society services” and the Vademecum on European standardization.

3.4 Standards and specifications with a view to the Smart Home

A Smart Home is a complex system which encompasses various areas such as energy, entertainment and ambient assisted living (AAL), but at the same time interacts with adjacent areas or is a part of further areas (e.g. the smart grid). As a result of the variety of domains, functions, actors and components, optimum interaction is necessary to ensure efficient and safe function of the system.

This is also reflected in the standardization of the system of a Smart Home. The standardization organizations and technical committees which are directly or indirectly concerned are called upon to work together more comprehensively and more closely. The interrelationships in complex systems like a Smart Home are however frequently so extensive that simple analyses by the individual committees concerned cannot provide adequate results. Management of requirements on a system level is required, breaking down complex interrelationships into simpler partial aspects.

Applied to standardization, this means that workflows and relationships in the Smart Home have to be broken down into individual sequences so that solutions (e.g. specifications and standards) can then be created with the aid of the responsible Technical Committees.

One way in which this work can be performed is the Use Case method. In that method, the system as a whole is modelled on the basis of a functional architecture, i.e. the system is described in terms of individual functions which interact with each other. The functional architecture is defined on the basis of the use cases which are implemented or supported by the system. Use cases also form the basis for stipulation of the requirements for the system. Furthermore, the actors which are responsible for the various functions of the system have to be identified so that they can be appropriately defined and assigned. The functional architecture, use cases, actors and requirements form the foundation for the standardization of functionality and interfaces. In complex systems, a simplified model approach which describes the main functions of a system and

its interactions independently of any particular technology is required for functional modelling.

An example workflow of the use case method is presented in Figure 3:

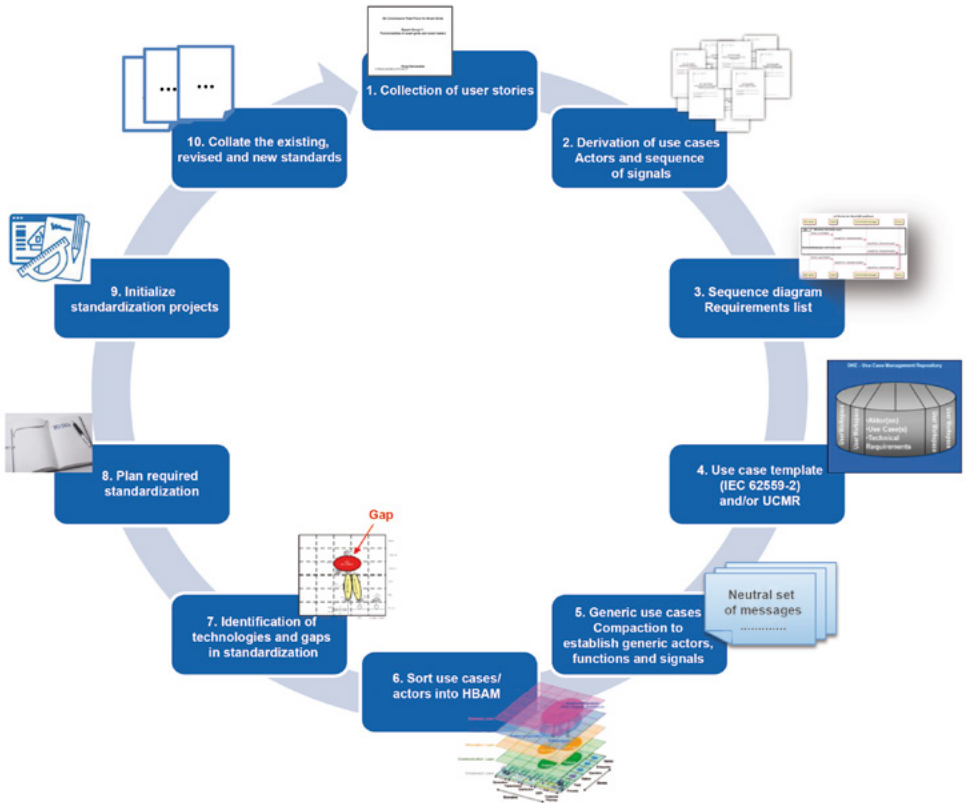

Figure 3: Sustainable standardization process for Smart Home

The use case method in the field of the smart home is being considered in the Joint Working Group DKE/GAK_STD 1711.0.2 “Use Cases”. German businesses and Smart Home initiatives are being intensively involved in this process.

In the context of the Smart Home, the following domains are considered to be an integral part of the Smart Home market:

- Security
- Entertainment/communications
- Health/AAL/wellbeing
- Smart Home infrastructure/automation
- Energy management

The existing standards and specifications, sorted by Smart Home domains, are listed in Appendix B. These lists are not to be regarded as complete; the missing standards and specifications are to be added by the time of publication of the Standardization Roadmap Smart Home 2.0, and the gaps in the standardization work identified.

The collection and processing of use cases on the basis of textual presentations of scenarios in the Smart Home environment is a central function which the specially Established Joint Working Group DKE/GAK_STD 1711.0.2 “Use Cases” is addressing. Within that working group, coordination across the Smart Home domains with existing activities on the national, European and international levels is also taking place.

The Working Group DKE/AK STD_1711.0.3 “Interoperability” deals with the analysis of the use cases collected by the “Use Cases” working group and the derivation of generic requirements for interface signals and functions for specific equipment classes. The results are contributed to specifications which are then, at the initiative of interested parties and under the leadership of DKE, transformed into VDE Application Guides. Authorization for that process is obtained by means of a public objections procedure or from a national standardization committee. Depending on the publication method chosen, the time until publication can range from a few months to a maximum of one year. The advantage of VDE Application Guides is that they can flow into European or international standardization within a relatively short time thanks to the DKE’s international network and a tried and tested decision-making process.

The further important topic of information security and data protection is dealt with in the Work-ing Group DKE/AK STD_716.0.1, which was originally established for the field of “Energy Man-agement in Buildings” and had its scope extended to cover the Smart Home as a whole in spring 2014. In this working group, five subgroups work with objectives complementing each other, and their results are intended to flow into a series of VDE Application Guides.

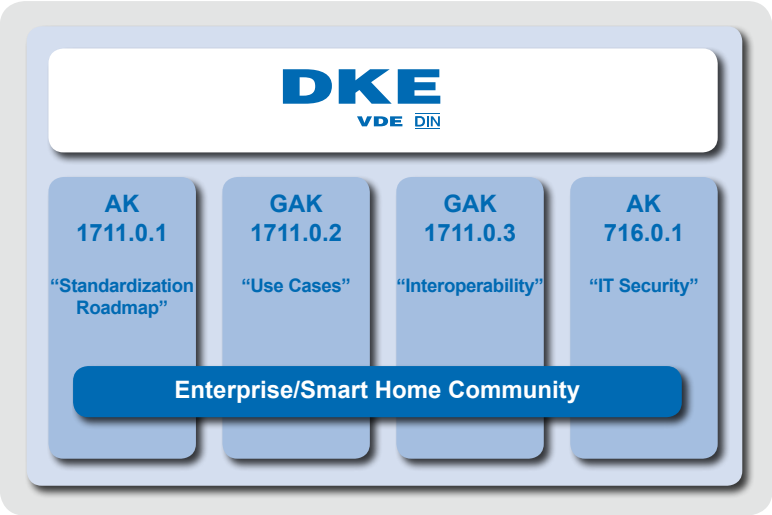

Figure 4: Overview of the DKE standardization working groups in the Smart Home + Building field

3.4.1 Cross-cutting topic Smart Grid

The DKE Steering Committee on E-Energy / Smart Grids Standardization coordinates higher level issues and activities on standardization in the field of “E-Energy / Smart Grids” in cooperation with the technical committees of DKE and DIN, and with various stakeholder groups. The standardization work proper remains the preserve of the DKE/DIN standardization committees, which, however, receive suggestions and support from the Expertise Centre.

One special focal area in the work of the Steering Committee is the energy transition and the in-tegration of energy from renewable sources. In the course of that work, Version 2.0 of the German Standardization Roadmap E-Energy / Smart Grids was compiled by the Steering Commit-tee.

Standardization Roadmap E-Energy/Smart Grids 2.0

The holistic, smart energy supply system described in the standardization roadmap, which includes the operation of active energy distribution and energy transmission networks with new ICT-based technologies for network automation, is characteristic of the Smart Grid. It also includes the central and distributed energy supply facilities from storage to the consumer, so as to achieve better networking and control of the system as a whole. The standardization roadmap describes the interplay between these different components. In addition, the ICT-based networking of the components in the electrical power network forms the essential basis for future control of the grid. In the smart energy grid of tomorrow, various segments or domains including terminal devices in industry and households come under consideration. These include:

- Energy management
- Smart meters
- Measuring point operation
- Security products
- Distribution networks
- Transmission networks
- Communications networks
- Power generators
- Storage facilities
- Aggregators
- Electromobility
- Energy markets
- Additional services (“added value services”)

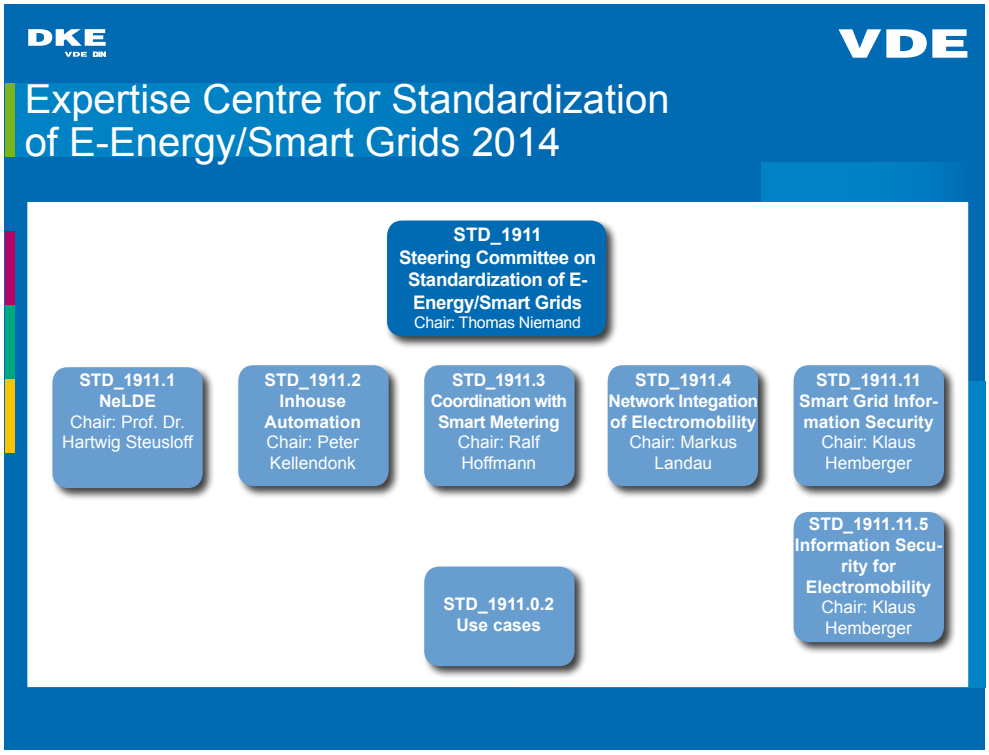

Figure 5: Structure of STD_1911 Standardization of E-Energy/Smart Grids

The DKE/DIN Steering Committee on E-Energy/Smart Grids Standardization is to take on mirroring of the IEC System Committee “Smart Energy” and be transformed into an “Excellence Cluster Smart Energy”. The basic orientation and function of being a contact in all standardization matters related to the optimization of intelligent electricity grids and then creating cross-system standards together with the additionally established DKE System Committee “Smart Energy” will be preserved.

3.5 The German Standardization Roadmaps

The German standardization roadmaps which have already been compiled contain extensive and in some cases comparative descriptions of the standardization landscape.

All standardization roadmaps for downloading

3.5.1 The German Standardization Roadmap on Electromobility – Version 3.0

The German Standardization Roadmap on Electromobility – Version 3.0

Fossil energy sources represent an important aspect for people's energy supply. Their availability, for example in the form of petroleum for combustion engines, is decreasing and resulting in increasing prices. Additionally, exhaust gases produced during combustion have a negative effect on our environment. Therefore, in order to be able to sustainably meet the mobility demands of people in the future, energy must be supplied from environmentally friendly sources. Thus, the future of energy supply lies in sustainable energy sources that are politically reliable and available in the longterm, and whose ecological "footprint" is minimal. If electromobility uses these sustainable energy sources, it will help to set the course for a future worth living. By establishing cycles and processes that treat resources with care, progress will be promoted effectively while the same standard of convenience the users are used to is maintained.

To make electricity from renewable energy sources readily available for use in electric vehicles, a strategic concept for short, medium and longterm solutions to the approaching challenges is

needed. As regards electric-drive vehicles, thinking globally is first and foremost a question of key technical parameters: charging performance, charging interfaces, and battery capacity. Ultimately, functionality, price, ecological awareness and responsibility across national borders will determine the level of user acceptance. But above all, there is a need for "round tables" at which the various actors can work together to make progress, implementing this progress in standards and specifications, which can be used as a basis for further developments. Automobile manufacturers, energy suppliers, grid operators and research institutes have long realised how closely knit the electromobility network really is. The electric vehicle of the future will be a decisive element of the "smart grid". Many new interfaces are emerging which will provide an opportunity to developed existing interfaces further.

Electric vehicles open the way for new kinds of charging processes, which in particular take account of the integration of the electric vehicles in the Smart Home infrastructure. The electric vehicle of the future cold be used for energy storage, taking up surplus energy especially from domestic photovoltaic systems. Excesses and shortfalls in electricity supply could be compensated for in this way in a national smart grid. The networking of ICT (information and communications technology) systems inside and outside the home is an essential condition. Local charging stations, which can be supplemented by domestic solar carports and local storage batteries, must be integrated in such a smart grid system.

Standardization is extremely important in this context, as it strengthens the position of German industry in its European and international environment and provides security for investment. Domains such as automotive engineering, electrical and power engineering, and information and communications technology must grow together for successful electromobility and its integration in the smart home infrastructure. As these previously separate areas come together, new business relationships and added value will be created.

The German Standardization Roadmap on Electromobility Version 3.0 builds upon the first The German Standardization Roadmap on Electromobility which was published in autumn 2010. It addresses current developments in electromobility and the background conditions, and sets these in relation to current and necessary standardization activities. The German Standardiza-tion Roadmap on Electromobility reflects the common understanding of all the actors involved in electromobility. Vehicle manufacturers, the electrical industry, power suppliers and network operators, and information network providers, associations and politicians were involved in its compilation. For that reason, the German Standardization Roadmap on Electromobility repre-sents the German standardization strategy for that field.

3.5.2 The German Standardization Roadmap AAL – Version 2.0

The German Standardization Roadmap AAL

Ambient Assisted Living (AAL) is a topic which developed only a few years ago as a separate research and work area, but was then quickly taken up and promoted by numerous national and European players. AAL is characterized by its pronouncedly multidisciplinary nature and, as a result, the large number of partners from a range of different medical, technological, social and business-related areas. This also results in a large number of specifications that already exist and are applied to the individual systems today. However, the mere existence of such specifications does not necessarily live up to the specific requirements of the AAL systems and products. There is a need to look at the existing specifications to identify and select those that really offer system relevance.

The broad introduction of networked medical and support technologies depends on having safe, simple and interoperable systems which are of measurable benefit to the users. Existing gaps – especially with regard to training of qualified staff and quality assurance – have to be closed. The challenge is to bring together the various stakeholders and overcome new obstacles by creating new points of contact and interfaces. With a view to the design of interfaces between different networks and also between technical devices and systems, there is a resulting need in some cases for (systematic) standardization.

A holistic understanding and a general view of the various players must be further supported. Version 2 of the German AAL Standardization Roadmap promotes the common understanding of all those involved in the AAL environment and makes them receptive to ideas from other areas. The further developments of the German AAL Standardization Roadmap are being discussed with the working groups, standardization committees and interested groups of professionals involved, and will be pursued.

The AAL environment is also listed as one of the Smart Home domains.

Their infrastructures differ in some respects. For this reason, there has to be close cooperation between these areas. Suitable public relations measures can identify synergy effects with the

fields of smart meters and the smart home. Assistive technology generally refers to that technology which enables users to perform functions and motions which they could not perform without the technology more simply or autonomously. Sensors installed in the home can record activities and request the assistance needed. The use of networked health and smart home technologies can provide for appropriate support, assistance or maintenance of the independence of people in their domestic environments. An example of this connection between assistive technology and smart home applications is the connection of sensors to entertainment applications, for instance for control by gestures.

The networking of the health service which follows is of great social relevance, both from the viewpoint of individual citizens and from that of the German health sector, and leads to greater efficiency and quality of medical care and assists in coping with the insurers' limited budgets.

The AAL environment is however not limited to the domestic scene only, but also involves the broader surroundings of the persons concerned if they are mobile and leave the house. G. Demiris et al. describe smart homes as "Residences equipped with technology that enhances safety of patients at home and monitors their health conditions" (p.88) [G. Demiris et al., Older adults' attitudes towards and perceptions of "smart home" technologies: A pilot study, Medical Informatics 29 (2004), 87-94].

3.5.3 The German Standardization Roadmap Industry 4.0 – Version 1.0

The German Standardization Roadmap Industry 4.0

The networking of industry and the internet opens up great potential for the future. On the basis of its outstanding position in manufacturing, automation and systems technology, Germany has the opportunity to play a decisive part in shaping the impending fourth industrial revolution (after mechanization, industrialization and automation) with networked cyber-physical systems at its core. Furthermore, Germany will be able to position itself worldwide as one of the most competi-tive locations for industry and a leading supplier of factory equipment. Consensus-based stand-ards are the decisive precondition for the successful implementation of new concepts and technologies in industrial practice. The world's first standardization roadmap, "Industry 4.0", compiled by the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE (DKE), is an important step in that direction. For the first time, it provides all the players with an overview of existing relevant standards and the discernible need for standardization in the environment of Industry 4.0. In it, the standardization experts define topics such as system architecture, use cases, reference models and processes, and examine the individual aspects of implementation with a view to integration of the entire value chain in industrial production.

One central challenge is that of seamlessly linking and integrating the four dimensions of the value creation process (product, factory and technology life cycle and business process) which come together at the actual time of product manufacture and are today controlled by a multitude

of digital tools, by means of horizontal integration (real-time optimized ad-hoc value creation networks), vertical integration (business processes and technical processes) and the consistency of engineering throughout the life cycle.

The Standardization Roadmap “Industry 4.0” presents important general recommendations for action in standardization and the future standardization strategy for the following aspects: the use of harmonized standards as the basis for the Industry 4.0 landscape, the integration of national developments in international standardization, support to the established standardization committees by provision of additional experts, and training for the research and development requirements of emerging systems.

DIN and DKE have published the Standardization Roadmap Industry 4.0 as a dynamic status report and a means of supporting the impending standardization work. Comments, suggestions and additions are expressly welcomed and will contribute to the development of the document and thus also to international interoperability of the products and market acceptance of the technology.

The aim of the new version of the standardization roadmap is to assess the various topics from a current perspective and identify what has happened in standardization in the meantime, how great the need for standardization is currently seen to be by industry, and what, if anything, it should address. Starting with this examination, a prioritization of the topics is to take place, and following versions of the standardization roadmap will present the status of the time. Publication of the next version is scheduled for October 2015.

3.5.4 The German Standardization Roadmap IT Security – Version 2.0

The German Standardization Roadmap on IT Security

The aim of this roadmap is to identify areas in which a need for security solutions meets the potential for applying standardization. The roadmap is intended to assist in coordinating the standardization activities by indicating the committees in which work has already started or even been completed. The discussion in professional circles has shown that information technology can no longer be considered industry by industry, but is rather a horizontal technology which is used in all sectors. The identification of existing committees and standards is therefore the first step towards coordination. The roadmap issues recommendations as to which activities should be initiated in order to meet the demand in the identified areas. As a result of the large degree of networking which impending trends in information technology indicate, a cross-industry approach is necessary to meet the demands of the situation. In this roadmap, therefore, current cross-industry and cross-technology topics are addressed and examined in detail.

3.5.5 The German Standardization Roadmap Smart City – Version 1.0

The German Standardization Roadmap Smart City 1.0

As places of knowledge and creativity, residential areas will continue to serve as drivers of economic and social development in the future. Ongoing urbanization and the accompanying increase in social and geographic inequalities, demographic and social changes in urban communities and climate change are placing enormous demands on the planning and administrative capacities of cities. The structural crisis of local finances and widely fluctuating trade tax revenues carry great risks for the range of financial options open to cities.

Yet behind all these changes and uncertainties there are also opportunities for bringing about further synergies. These arise from linking up systems, processes and technologies to help safeguard public services and increase the quality of life in cities.

With the aid of interested experts from industry, science, various associations and German cities, the DIN and DKE organizations would like to support these efforts by issuing the German Smart City Standardization Roadmap. Its purpose is to highlight the need for standards and to serve as a strategic template for national and international standardization work in the field of smart city technology.

The standardization roadmap highlights the main activities required to create smart cities. It does not aim to examine the situation within the different areas of activity, as this is taken care of in the form of discrete standardization activities. The focus of version 1 of the standardization roadmap is on the interaction between different areas, their demarcation with regard to need for action, and the representation of the standardization activities within the areas. Examples of the approach are taken from initial projects, and the different actors are named. The present version 1 of the Standardization Roadmap is expressly not intended to be used to identify any specific need for standardization within the individual areas. The question of the actual need for standardization in the specified fields of activity remains to be clarified.

In May 2015, Version 1.1 was published as a supplement to the full version, providing an overview of current standardization work and presenting the results to date.

4 CURRENT STATUS AND MARKET DEVELOPMENTS FOR THE SMART HOME

4.1 Potential growth market for the Smart Home

Smart Home + Building opens up considerable potential for the future, from an economic, social and ecological point of view. Intelligent house and building services with integrated systems, for instance for energy management, building security or medical assistance, make homes and buildings more efficient, safer, more economical and at the same time more convenient. They are also a topic of interest to politicians and society, as they illustrate approaches to mastering global challenges in the fields of climate protection, scarcity of resources, the ageing population, health, communications and security.

In Germany in particular, there is an opportunity to use the existing expertise in network technologies and system integration strategically in developing the growth market of the Smart Home. Smart Home products and services have unfortunately not yet crossed the threshold to a mass market, although the technological conditions have been fulfilled for some time now and there has been no lack of initiative behind the development of the Smart Home market. One reason for the reticence in demand will surely have been the excessive focus on what was technically feasible instead of taking account of the actual demand and the concrete benefit to the final customer. Consumers are interested in use scenarios like, for example, the control of home electronics or the surveillance of buildings, which is why it is necessary to place the add-ed value of Smart Home applications in the foreground.

For a number of years, moreover, there have been agreements relative to safety which the various governments have enshrined in legal regulations. These include for example smoke detectors and burglar alarms. Distinctions are made in these cases as to whether a Smart Home application or a Smart Building application (professional use) is concerned.

4.2 A challenge – the variety of sectors and domains in the Smart Home market

The term “Smart Home” has now become established among the public as a synonym for the networking of intelligent components, devices and systems (“smart devices”) in privately used apartments or houses. In media presentation, distinctions are made between a series of Smart Home domains which have become established in various sectors of industry, mostly on the basis of different networking technologies and objectives. The most important domains from the present point of view are energy management, audiovisual communication and entertainment, building security and safety, and health/AAL.

In all these domains, the opportunity of mobile control by means of a tablet or smartphone means additional convenience for the user. Examples include mobile access to recorded television programmes, videos, photos and music, etc. Mobile control of fundamental functions of the home such as heating, air-conditioning or ventilation is however also possible. The optimum use

of in-house energy and fulfilment of the individual's need for security are certainly the main factors behind added value from the customer's point of view. In addition, the transformation of the energy sector towards decentralization of the energy market will create new market roles which themselves have interfaces to the Smart Home and can therefore definitely be regarded as accelerators of the market development. Increasingly, however, technical assistance systems and the concept of Ambient Assisted Living (AAL) are also being associated with the Smart Home.

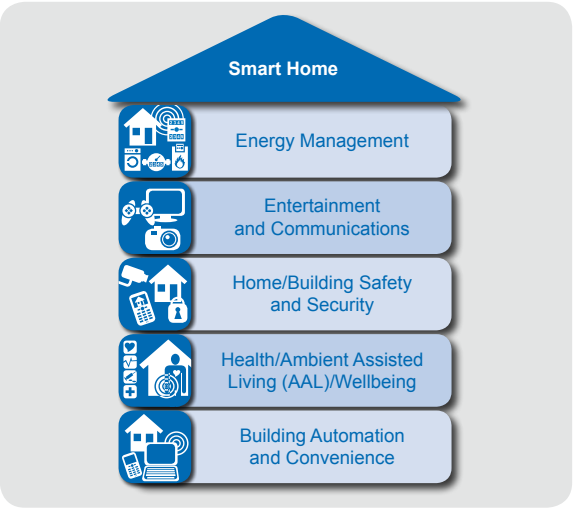

Figure 6: Smart Home domains: Energy management, Entertainment/Communications, Health/AAL/Wellbeing, Safety and Security, and Smart Home Automation/Building Automation

Research and development (R&D) in the field of ambient assisted living (AAL) deals among other topics with the development of "assistive technologies" which enable people in need of assistance or care to lead self-determined, active lives up to an old age. AAL can be regarded as a domain of the Smart Home.

Further information on the AAL Congress and Future Habitats

A study by Bitkom in cooperation with Deloitte [32] sees AAL as an important driving force behind the development of the Smart Home market, as demographic change is causing the number of people requiring nursing care to grow constantly, thus increasing the market potential of AAL. More and more old and needy people will in future be confronted with a pool of nursing staff which continues to be limited. AAL provides elderly people with an alternative means, based on smart technology, of continuing to lead their lives independently in their accustomed environment. Specific applications from the AAL field can also allow support services to function more efficiently and costs to be cut. As soon as large companies from the health, telecommunications and residential sectors are able to offer affordable AAL solutions, this Smart Home domain will be able to make a breakthrough to the mass market.

4.3 A retrospective – the development phases of the Smart Home market

The concept of the Smart Home is really nothing new: As early as the end of the 1980s, there was initial interest in Europe in intelligent networking in commercial buildings and private homes, while companies in the USA and Japan had been active as technology and market pio-neers in the previous years. In Europe, BatiBUS, EHS and EIB were created as competing Smart Home standards, on the basis of which businesses in the consumer goods and electrical industries developed specific Smart Home products. In spite of this important technology hub, however, no Smart Home mass market developed. The competition between the standards and the highly divergent business models of the consumer goods and electrical industries put a brake on the dynamism of market development.

At the turn of the millennium, the industry agreed on Konnex (KNX) as the consolidated European bus standard, and in doing so initiated a further technological surge, essentially carried forward by the idea of individual room temperature control as an energy efficiency measure. The expected transition into the mass market did not however take place, as neither private users nor commercial customers such as home builders were inclined to purchase in any great amounts.

In the light of the forecast demographic change, considerable market potential for Smart Home technologies was identified in the fields of Ambient Assisted Living (AAL) and health assistance systems at the end of the first decade of the 21st century. For various reasons, AAL also did not meet the expectations of opening the door to the Smart Home mass market.

The topic of the Smart Home is currently linked in discussions with the challenges of the energy transition. The necessity to establish smart grids is seen as an opportunity to achieve a breakthrough for Smart Home technology in the private residential sector as well. Accordingly, not only telecommunications companies and niche suppliers, but also large energy companies are represented on the market. At the same time, the increasing number of players and areas of application have diversified the market. Whereas in the past the areas for investment by the industries now involved were clearly demarcated, highly different suppliers with more and more standardization approaches are now entering the market. After years of unfulfilled forecasts and disappointed expectations, the market for Smart Home applications is still in an orientation phase. One important recognition has gained credence, namely that the Smart Home market is driven less by technologies than by the expected benefit to customers.

4.4 Opportunities – the Smart Home market and its customers' requirements

The establishment of cross-domain Smart Home solutions could be a key to the market success of Smart Home. This opinion is supported by current studies on customers' wishes and requirements [CG 2011], [DL 2013]. The combination of applications and control options across domain boundaries is regarded as a central criterion for success. In the study by Cap Gemini Consulting, 39 % of the people questioned showed interest in Smart Home products which grouped together applications across three domains of the Smart Home. And 21 % of those questioned even preferred functions which spanned four segments of the current Smart Home range. A total of 20 % still mention multiple links as an important criterion for success.

The more, then, a Smart Home product reduces the complexity of a building control system and thus increases convenience, the greater are the added value and the incentive to buy from the point of view of the customer. The study by Deloitte [DL 2013] also makes it clear that the customers' requirements will play the decisive role in the further development of the market. This finding should be taken into account in future positioning and marketing strategies. Consideration of the requirements of various segments reveals that simple installation and connectivity of different systems are still central challenges for the products on offer (cf. Figure 7).

	LUXURY	PREMIUM	MASS MARKET
Customer requirements	• Professional End2End installation • Premium product design • Intuitive and exclusive control systems • Innovative features	• Support during installation • Intuitive control systems • Flexible installation, not tied to one home • Extended scope of functions	• Simple "do it yourself" installation • Affordable, flexible solutions • Opportunities to use essential functions
Existing offers	• Sophisticated systems for device control • Elegant social alarm products • Integrated systems for energy management	• Extensive device control systems including energy solutions • Elegant social alarm products • Higher priced "do it yourself" products	• Portable, low-cost "do it yourself" solutions • Reliable social alarm systems • Basic energy management systems
Challenges	• Complex installation • Small number of qualified installation experts • Complex management of systems and 24/7 service	• Limited number of qualified installation experts • Interoperability problems • Conquering the mass market with wireless solutions	• Different standards/ interoperability problems • Little transparency with regard to existing products • No integrated or complete systems

Figure 7: Requirements, offers and challenges by segments (following Deloitte 2013)

A similar picture resulted from questioning in the context of the guideline talks of the Deutsches Dialog Institut with those companies involved in the promotional project "Certification Pro-gramme Smart Home + Building". They put the domain combination Energy management / Building technology in first place for a central role in Smart Home market development. In the next places, there followed the combinations of Energy management / Security and Security / Building technology. The companies were also asked about their experience of motivation in the purchasing of Smart Home systems. In that context, they gave maximum points to the aspect

of Convenience, followed by Cost control /Cost reduction, Security, Fun and Reduction in the eco-logical footprint.

In addition, the aspect of IT security is gaining in importance with Smart Home products. Attacks are relatively simple to mount with software tools that are widely available. Black hat hackers could already tamper relatively easily with Smart Home systems. They would meet with hardly any resistance on the part of the users, as private users are only seldom capable of administering their own systems professionally. It is therefore necessary for manufacturers to give priority not only to the connectivity of different Smart Home products and applications, but also to the issues of IT security and data protection in the light of the expected mass market.

Numerous experts expect a large market for “smart living”. According to the representative Forsa poll “DFH Trend barometer 2012” [DFH 2012] commissioned by Deutsche Fertighaus Hold-ing AG, 57 % of Germans think the integration of innovative building automation systems in new-build houses is important. More than half (51 %) of those questioned who intend to have a house built soon would be prepared to invest between 4,000 and 8,000 euros in smart building technology for more security, convenience and greater energy efficiency. 64 % of all those questioned and even 84 % of the future owners of new homes think a building technology function which provides a permanent overview of energy consumption is sensible. 39 % think an automated heating control system which is optimally adjusted to weather conditions would make their everyday life significantly easier.

Apart from functions which improve energy efficiency, future home builders also value system components which increase security and convenience on an everyday basis. According to the Forsa poll, 66 % of those questioned consider that it would make life much to very much easier if a Smart Home system automatically called the police or fire brigade on detection of a break-in or smoke. 43 % of those questioned assess it as very helpful to have automatic ventilation of the house and watering of the garden, even when they are on holiday.

The German housing industry is still adopting a wait and see strategy on the topic of the Smart Home. The background is that most of the systems on the market are proprietary solutions from individual suppliers, which can only be extended with further components from the same manufacturer. The combination of applications in different Smart Home domains is therefore impeded or indeed made impossible. With investment cycles of 10 to 15 years, the German housing industry feels under these conditions that security of investment is lacking.

In the view of the housing industry, there is a further challenge for Smart Home products in that the focus is currently above all on retrofitting existing houses. According to the German Energy Agency (DENA), only approx. 180,000 new dwellings were constructed in Germany in 2010 (against 300,000 in 2001 and up to 700,000 in the 1990s). In contrast, there are over 40 million older dwellings. In the light of these figures there is a need for systems which are specifically suitable for simple and low-cost retrofitting.

This estimation is also supported by the company survey in the course of the project "Certification Programme Smart Home + Building" funded by the Federal Ministry of Economic Affairs (BMWi):

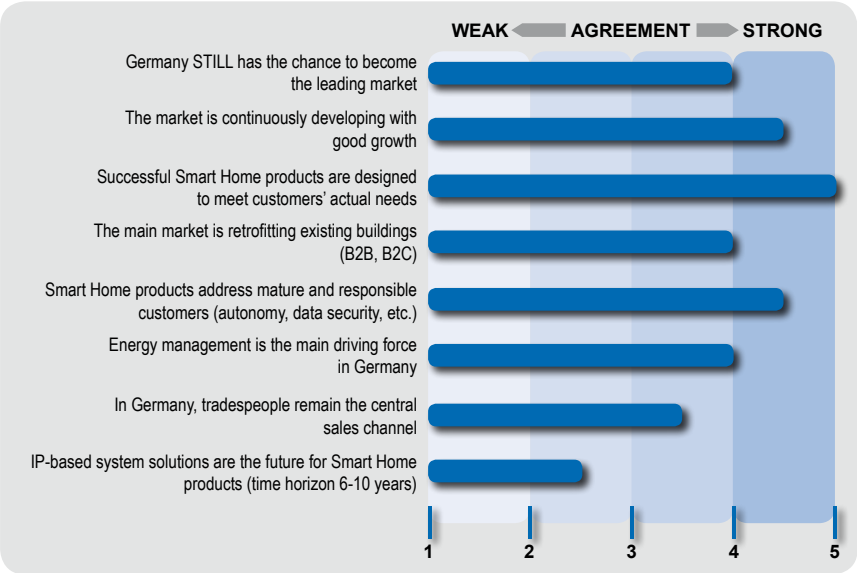

Figure 8: Estimation of the German market by 30 leading companies in the field of Smart Home + Building; original graphic by DDI on the basis of the guideline talks in the alignment procedure.

4.5 Current status – market development for building automation systems

The interaction between various disciplines and the processing of events are per se quite old wishes on the operational side. In reality, however, the wished-for and the achievable often diverge. The reasons for that do not always have to be technical ones; it also has to do with workflows in the construction industry, cost planning and the various stakeholder groups.

The different technical disciplines in buildings are planned, quoted, installed and commissioned by just as many differently organized professionals. Depending on the requirements in operation, links between disciplines in different functionalities can be useful and have a significant ef-fect on the productivity of the persons and systems in the building. As a rule, such links also open up potential for optimization in various directions.

In the context of the development of renewable sources of energy in the environment of homes and buildings, the generation and consumption of power have been brought closer together. On the other hand, industrial-scale generation and distribution of energy has been made more distant by contractual decoupling (disregarding the generation companies' closed loop control systems and their organization here).

As the users are more and more becoming not just consumers, but also producers ("prosumers") as a result of improved plant, systems and user guidance, and buildings are to be optimized in accordance with the utilization strategy (productivity of the space) while the generators and distribution facilities are controlled in response to other parameters (e.g. voltage, frequency and phase angle), it makes sense to optimize these domains individually and "guide" them by means of incentive systems, e.g. dynamic price models for capacity and energy – for both consumption and generation. Distinctions of that kind on the one hand establish clarity and a step by step procedure, without always having to call the system as a whole into question.

A further aspect is the possible complexity of the solutions. Closely linked systems become demanding in all phases of the life cycle, and require expert knowledge and experience, promoting solutions which are on the one hand expensive and on the other hand relatively inflexible. Such systems are also more sensitive to disruptions during operation, and require professional management.

These obstacles could be lowered by adopting a Building Information Modelling (BIM) approach, reducing the amount of work required for coordination. Which markets demand such integration and how it is to take place in practice remains to be seen. In the Internet of Things (IoT) approach, the components in the systems are equal in status, and therefore it is technically possible to combine them in a useful manner.

A large number of factors affect automation and control in industrial buildings. One important objective must not be lost from sight: A building, as opposed to a home, is a utilitarian structure which serves a purpose, and all services have to be concentrated on that purpose in order to maximize productivity. In contrast to homes, where the residents take direct action to assure their wellbeing, in utility buildings the result is always a compromise between all the people working in a particular zone. The objective in this case is indirectly also a kind of wellbeing – that of being productive.

What influences the market for building space – and thus also indirectly building automation?

In the market for building space there are a large number of currents which on the one hand demand automation solutions, and on the other hand take account of the changing requirements of a group of stakeholders. In this context, only the automation market itself and the requirements relevant

4.5.1 Let-out areas in a building erected by investors

Generally applicable statements:

- Landlords want to position their “product” (space for rent) attractively and sustainability labels, flexible use, opportunities for extension and the productivity of the persons / means of production using the space are important.

- Tenants are attracted by scalable and influenceable operating costs, especially when the utilization concept can and is to be mapped in the technology.

Tenants as a rule have their own operational needs and require different automation solutions, in some cases with their own provision of, for example, refrigeration and ventilation. The interaction between these “tenant solutions” and the “basic fixtures” is decisive for optimization of efficiency and productivity – especially when several tenants and their systems present a challenge to the central generation and distribution systems (owned by the investor) for, for example, hot and cold water. In this area, technology can realize tremendous gains by better strategies (interoperability). “Prosumer” modes of operation are more the province of the investor and less that of the tenant.

4.5.2 Use of areas by the investor himself

In this case, the drivers are clearer and easier to discuss than with rented properties. As the utilization concept is determined by the investor himself, the interests can flow directly into an overall solution. Unlike in former times, comparisons of costs between different buildings in similar locations and with a similar standard of fit-out are important, and value for money is playing an increasingly important role. Rooms are as a rule supplied with those services which enable them to be productive. Investment and work without benefit are avoided from the planning stage onwards. “Prosumer” concepts and integration of services are typical of this type of building automation customer.

4.5.3 Internet of Things and Smart Tagging

Why are these two hypes in particular so promising?

Internet of Things

The technology fundamentally means that sensors, actuators and other elements/automation systems can be connected direct to a standardized network (typically Ethernet-based) and are therefore in a position to take part in events without any major infrastructure. Without rules and standards, that can lead to a Tower of Babel. The experts are therefore called upon to facilitate sensible – semantic – clarity.

Approaches to rules are available in many projects on standards and agreements. All of these have common aims:

- Reduction of the possible connections to sensible combinations
- Incorporation of the spatial and/or geographical context
- As correct and rapid establishment of contact as possible with the aid of semantic information and self-curing effect on failure/restoration of the connection

Smart analyses of the behaviour of one or all subscribers can give rise to unexpected automation functions and render many rules in the systems of today obsolete, because they are self-learning.

Smart Tagging

This technology is not, in itself, new. All the manufacturers have considered it and in some cases achieved astounding things.

Let us remember VDI paper 3814. There, a very simple form of structured relationship between the most important elements of building automation (and other technical components) was documented. In principle, what we are dealing with here is a similar approach to the tagging of information with meaningful, globally standardized terms. This mechanism should of course function across and beyond linguistic and cultural borders.

What, then, is the benefit of this technology for the investor and/or the tenant?

An example:

Let us assume that all the components in a closed loop control circuit (measuring point, actuator and time program) are designated by tags with their function AND geographical location. Let us also assume that the control system has to be adapted to a change in use. In the ideal case, the signals do not have to be firmly connected, but can be located by search services and connected automatically.

That does not really sound earth-shattering, but does make changes much simpler and safer, and they can – if the infrastructure permits – be implemented during operation.

If we imagine that such mechanisms can also function across product and supplier boundaries (new standards), then it becomes really interesting.

4.6 Prospects – on the way to the Smart Home mass market

4.6.1 Moves towards standardization and consolidation on the Smart Home market

Ensuring interoperability across trades and technologies in the Smart Home is a technical challenge which many companies are facing with different strategies, either organized in various alliances and initiatives or as large individual players. The approaches can be divided into three fundamental categories:

- Individual companies with a major market presence of their own
- Alliances of companies working together on the protocol level
- Alliances of companies working together on the data model/middleware level

Apple is attempting to establish its own protocol based on Bluetooth LE and Internet Protocol (IP) for communication between accessories and iPhones/iPads, in the form of HomeKit and the HomeKit Accessory Protocol (HAP). In the light of the present large share in the global smartphone and tablet market, this proprietary approach could still be successful for Apple.
Other large companies such as Samsung, Deutsche Telekom through QIVICON, AT&T and power supplier RWE approach this issue above the protocol level and are trying to anchor their own proprietary software platforms in the market.

Other companies are grouping together in alliances and initiatives to achieve as broad a presence for their technologies on the market as possible. A distinction has to be made between alliances which work on the protocol level and those which work on the data model or middleware level.

Since its establishment in 2010, the IP500 Alliance has focused on the security applications in Smart Homes and Buildings (smoke, burglary, access control) and, since 2014, has provided a certified wireless communications platform for the users of larger sensor installations.

ZigBee, Z-Wave and EnOcean are “classical” representatives of wireless-based protocols.
Thread, founded by Google, Samsung and others, is a further alliance aiming to develop a new protocol.

A second category of alliances aims at uniformity on the data model level. This is where ontologies of technologically neutral signals and functions are created, with abstractions of devices which facilitate cross-platform communication between devices in Smart Home systems.

A number of the well-known initiatives and platforms are listed below.

Apple HomeKit

Apple initially presented the concept of home networking via its proprietary operating system iOS in 2014. Under the name of HomeKit, there was a specification for the development of apps and devices (accessories) with HomeKit capability. Communication with the devices takes place via IP (WLAN) or Bluetooth LE from the iPhone or iPad. HomeKit also provides for the incorporation of bridges to enable communication with devices using other wireless protocols such as Z-Wave. Companies which develop devices for Apple HomeKit and wish to market them must have those devices certified I the Apple “Made for iPod/iPhone/iPad” programme (Mfi).

Deutsche Telekom – QIVICON

Deutsche Telekom has been marketing the QIVICON Smart Home solution since 2013. In contrast to the other product suppliers on the market, Telekom has backed a partnership strategy right from the start. The focus is therefore not on Telekom’s own products, but those of its partners, with Telekom taking on the role of the platform supplier and marketer. QIVICON offers a gateway corresponding to the platform, to which the partners can connect their hardware and software. The advantage for the partners is they do not have to develop their own platform or gateway.

At present, QIVICON supports the protocols ZigBee and BidCos, the proprietary protocol of eQ-3. Companies wishing to connect their products to the QIVICON platform have to become partners in order to obtain the specification for the interfaces. Actual certification of the hardware and software is not then required.

EEBus-Initiative

The EEBus Initiative is a group currently comprising 53 companies which have set themselves the aim of focusing consistently on standardization to create cross-technology interoperability. The origin of the EEBus concept is in the field of smart and renewable energy. On the basis of agreed use cases, the working groups of this initiative have specified common, technologically neutral data models (“neutral messages”) which form the bridge between different networking technologies and systems. These neutral messages form the core components of the EEBus specification. The KEO software system from Kellendonk is a functioning software implementation on the basis of the EEBus specification. It has already demonstrated its functionality in an interoperability “plug fest” conducted with products from 15 different companies in March 2015.

In recent years, the EEBus Initiative has entered into strategic partnerships and cooperative ventures with a series of other initiatives. These include the alliances on networking standards like BACnet, enOcean, KNX, LonMark and ZigBee. The EEBus Initiative has been working with the Italian alliance Energy@home since the end of 2012 to arrive at a uniform data model, and with the French association AGORA to improve the connectivity of the products and components in the Smart Home.

In March 2015, the EEBus Initiative and the Open Interconnect Consortium (OIC) agreed on strategic cooperation to create the needed interoperability of electronic devices and thus decisively accelerate the development of an all-encompassing market in the Internet of Things.

IP500 Alliance e.V.

Manufacturers of Smart Home security products and systems (OEMs) came together in May 2010 to form a global alliance (www.ip500.org) with the aim of guaranteeing the interoperability of national and international communications systems relevant to security in the Smart Building environment on the basis of a wireless platform. German and international requirements (e.g. those of VdS or EN standards) have been incorporated in the IP500 ECO System. The IP500 platform therefore offers an IPv6/6LowPAN wireless based mesh network for redundant and secure connection of all smart sensors and actuators in the Smart Home or Smart Building on the basis of the dual bands in the sub GHz (720-980 MHz) and 2.4 GHz ranges. The solution is based on a complete CNX100/200 radio module and is suitable for global use (more information at www.CoreNetix.com).

Further information on IP500 Alliance e.V.

Further information on CoreNetiX

AT&T Digital Life

In 2013, AT&T launched its Digital Life product, a Smart Home solution with the focus on building security, on the American market. This product is a self-contained solution which currently does not provide for any integration with partners. AT&T uses a multitude of protocols for this product, providing five different interfaces in its gateway. Apart from IP (LAN and 3G), the sensors are connected via Z-Wave and two different proprietary protocols in the 400 and 900 MHz ranges.

Samsung – SmartThings

The Smart Home solution from SmartThings, kick-started in 2012, was taken over by Samsung in 2014. SmartThings provides a home network solution for the American market which accommodates its own components and apps and also devices and apps from third party suppliers. According to the supplier, the SmartThings platform supports around 1000 devices ad 8000 apps, some of which were developed specifically for it. SmartThings uses the two wireless protocols ZigBee and Z-Wave, and the IP interface.

Google – Nest/Dropcam

The Nest company, founded in 2010, was taken over by Google in 2014 with the aim of establishing a Smart Home strategy on its products. The system, first designed as a room thermostat, has now been expanded into a platform for other devices and services. The thermostat can now connect lamps, household devices, music systems and medical equipment. Communication between the devices is via the proprietary Nest Weave protocol. That uses both a Personal Area Network (PAN, 802.15.4) and a wireless LAN (WLAN, 802.11 b/g/n) for communication. In that way, it is ensured that critical applications such as smoke detectors can communicate with each other by radio even if the WLAN in the house fails. In the meantime, Google has founded the Thread Group to develop a new Internet of Things protocol based on IP (see below).

AllSeen Alliance

The AllSeen Alliance, founded in 2014, which brings together companies such as LG, Sharp, Haier, Panasonic, Sony, Microsoft, Bosch, Electrolux, Cisco, TP-Link and Harman, propagates the AllJoyn development framework devise by Qualcomm with the aim of promoting interoperability in the Internet of Things, especially in the areas of the smart home, smart TV, smart audio, broadband gateways and automobiles. Qualcomm has now placed its software under an open source licence, allowing the development framework to be worked on by third parties.

The AllJoyn framework facilitates the development of devices which can communicate together direct (point to point) independently of manufacturers or protocols. At present, the framework supports WiFi, Ethernet, serial and Powerline (PLC) transmission standards.

Products which comply with the AllJoyn specification can be certified. The “Design for Allseen” label is issued by the AllSeen Alliance as part of a self-certification programme.

OpenInterconnect Consortium

The OpenInterconnect Consortium was founded I 2014 by Intel, Samsung, General Electric, Cisco and MediaTek.

The technical basis of this consortium is the OpenInterconnect (OIC) framework, which was created as part of the “IoTivity Project” and is available as open source software. In contrast to the AllSeen Alliance, therefore, the common framework is not based on the ideas and preliminary work of a single manufacturer. Furthermore, OIC permits not only point to point connections, but also communications between devices via bridges and mesh routers. Otherwise, the two consortiums appear fundamentally to be pursuing the same objectives.

The OIC framework currently supports the WiFi, Bluetooth, BluetoothLE (low energy), WiFi Direct, ZigBee, Z-Wave and Ant+ transmission standards. There are plans for certification of OIC compatible products, but no details are available at present.

Thread Group

Thread Group is an initiative founded in 2014 by Yale Security, Silicon Labs, Samsung Electronics, Nest Labs, ARM, Freescale Semiconductor, Big Ass Fans and ARM. The aim was the development of Thread as a new IP based wireless network protocol. The reason behind this development was the problem that the network technologies defined under IEEE 802.15.4 – WPAN, WiFi and Bluetooth 4.x – are not interoperable, and IPv6 communication is not supported, power consumption is too high and networking no longer functions when even a single device is defective. Thread is based on tried and tested standards including IEEE 802.15.4, and consistently relies on IP communication with IETF IPv6 and 6LoWPAN.

Thread is intended to address central requirements such as low energy consumption, a high level of security, user friendliness and meshing. The two Nest products, smoke detectors and room thermostats, are the first Thread-compatible products on the market. Certification of devices is planned to start in 2015. This is to be dependent on successful testing of the quality, safety and interoperability of the device by an independent institution.

4.6.2 Forecasts for the Smart Home market

On account of the supply and demand structures, market forecasts for the Smart Home market of the future are highly divergent. A meta-study performed in 2012 by the Deutsches Dialog Institut in the course of the subsidized project “Smart Home + Building Certification Programme” evaluated 375 freely available reports, presentations, position papers and articles in trade journals on the Smart Home market of the future. Only two (!) sources took any account of the customer’s point of view. On the contrary, the starting point for the forecasts was a market estimation based on the dissemination of particular technologies or components. In practice, this means that the focus was more on forecasts concerning smart grids or smart meters, and less on the Smart Home market. Frequently, criteria which could promote a Smart Home market as infrastructure are equated with the Smart Home market itself. The resulting uncertainty concern-ing the reliability of the available forecasts is correspondingly great.

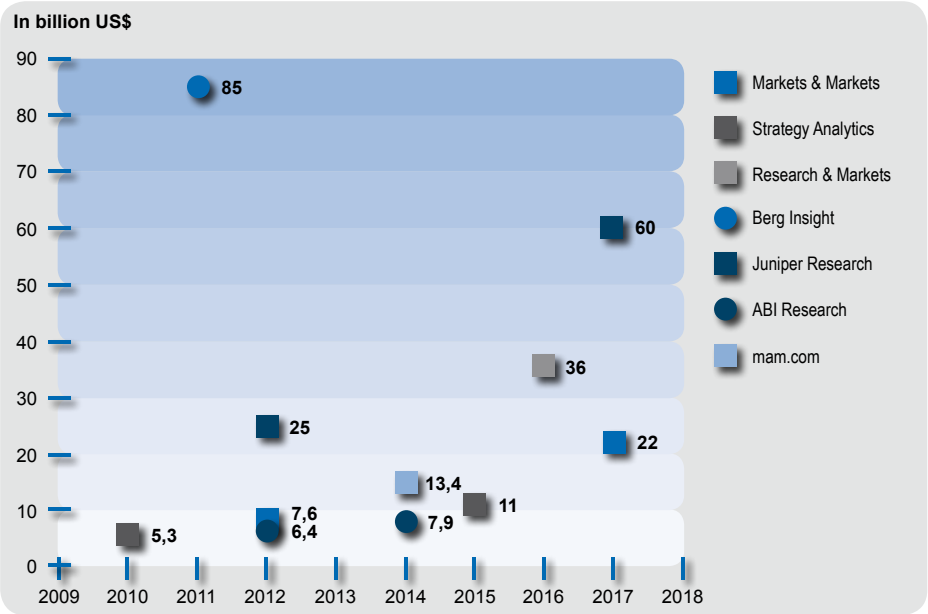

Figure 9: Home market forecasts from commercial suppliers exhibit significant differences; original graph from DDI

An examination of the Smart Home projects implemented worldwide reveals different focal areas of application. In the USA, the focus is on health and security, and in Europe more on energy management. While entertainment and lifestyle are in the foreground in China and South Korea, the topic tends to be defined in Japan by prefabrication of houses with integrated Smart Home systems. Given the closeness of this topic to the Smart City, which encompasses the Smart Home and other "smart" applications and technologies, it is useful to analyse projects of that type. Pilot projects on the Smart City are already widespread in Asia (China, Japan and South Korea) and in the Near East (United Arab Emirates).

The strong spread of figures on the international market development shown in the graph above (Figure 9) means, as mentioned, that they are not very reliable as indicators of quantity. With a reasonable cautious approximation, however, a number of conclusions can be drawn in general as to the qualitative aspects of further developments of the Smart Home market. The most decisive obstacle to dynamic market development from the present point of view is the continuing "battle of standards". The experts only forecast a reduction in the number of existing standards or a general networking of Smart Home products via IP ("all IP concepts") in the coming 5 to 10 years. The decisive step towards the start of dynamic market development may therefore be that of ensuring interoperability between the solutions in place today by means of a bridging technology. Existing stand-alone solutions for app-controlled applications may also play a supporting role in opening up the market. In the long term, the plug & play capability of Smart Home devices can lead to demand-based advantages for Smart Home companies.

The most recent market forecasts are also optimistic, but continue to reveal great differences in dynamics [BIT2014]. In a current estimation by Bitkom e.V., the market for Smart Home applications is in a decisive phase of growth. A breakthrough to mass market status is expected for 2017. Growth of around € 4 billion is forecast in Europe. The greatest dynamism is expected in the fields of cloud-based home management and health and nursing care.

From the perspective of the final customer, however, there are further fundamental requirements on which purchasing decisions are contingent, and which will be of great importance for medium and long-term success on the market. These are, for example, future proofing (upward and downward compatibility) and the modular expandability of Smart Home products, with a view for instance to system extensions for different needs in individual phases of life. The Smart Home market will therefore surely exhibit a broad product portfolio which will also reflect cultural differences for the international market. As equipping and retrofitting existing buildings will initially be of decisive importance for the development of the market, the dynamism of that process will also be significantly influenced by the pricing of retrofit package solutions for final customers and residential development companies.

The study by management consultants Deloitte has identified six critical success factors for the marketing of Smart Home systems (cf. Figure 10). Intelligent pricing is one of the decisive criteria in the market success of Smart Home products and services. Up to now, many of the price models have lacked transparency, and so final customers had difficulty in estimating the total costs. It is therefore necessary for manufacturers to move towards pricing models which have already been accepted on the market, such as all-inclusive solutions or leasing models. The actual system should reflect the customer segment to which it is addressed. In the premium segment, then, investment costs are higher and leasing models may therefore be more attractive than package offers.

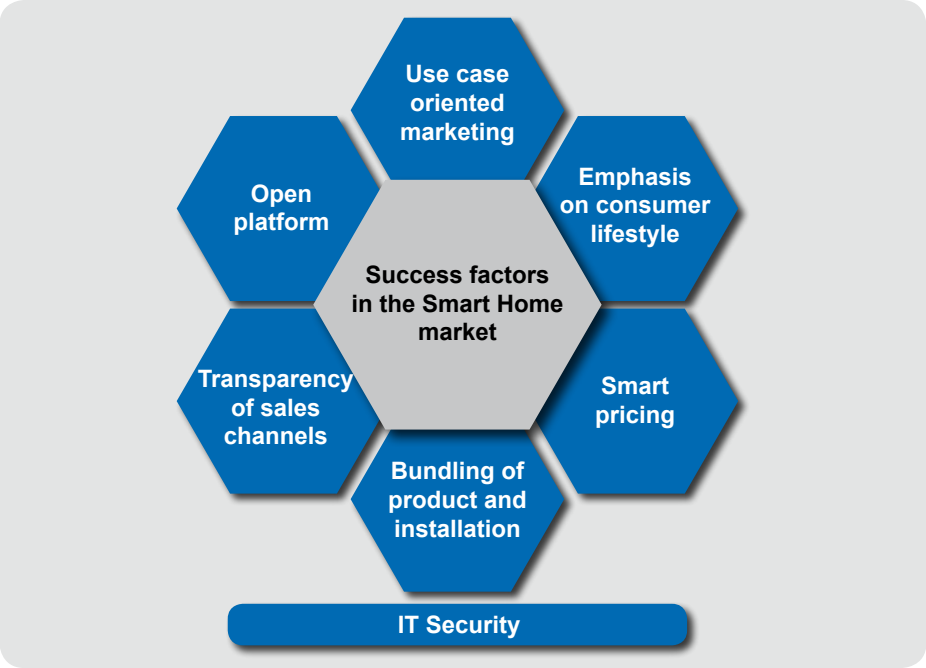

Figure 10: Success factors on the Smart Home market (following Deloitte 2013)

Furthermore, the technical variety of Smart Home systems makes it important to inform final customers of the potentials, added value and boundary conditions of the Smart Home products and services on the market. It is remarkable that, according to a survey by BITKOM e.V., 56 % of all consumers found the opportunities of home networking interesting for their own homes af-ter an initial informative meeting. Bundling of hardware and installation work therefore makes it easier for customers to decide in favour of a Smart Home solution.

For further market development, the usability and connectivity of Smart Home products and ap-plications will be decisive. A final customer facing the decision on whether or not to set up a Smart Home will first by motivated by his need to increase the comfort and convenience of his residence or to save energy. When comparing the available technical solutions, his purchasing decision will be decisively influenced by the expandability of the system, its combinability with other systems, the long-term availability of spare parts and IT security. Furthermore, it is in the interests of the final customer for the process of networking to be handlable without expert knowledge, ideally in the form of a “plug & play” solution, and for the systems of various types and functions to be controlled via an intuitively usable, integrated user interface. These re-quirements for the system rely on the partial systems involved being interoperable, i.e. it being possible for data to be exchanged without errors, and information and commands understood, correctly interpreted and implemented. The exchangeability of systems requires the use of a uniform non-proprietary and standardized language (open platform).

To summarize, it can be noted that the Smart Home market will become more dynamic whe

- interoperability and IT security are achieved by standards and ensured between Smart Home solutions,
- ease of operation is ensured,
- there is discernible added value from function and design,
- modular package solutions are available for Smart Home systems,
- the plug & play capability of the individual devices is a long-term aim,
- the investment costs for retrofitting to existing buildings are reasonable,
- the product design meets the culturally determined desires of customers, and
- transparency is established in sales channels and price models oriented towards customer segments are offered.

5 PROJECTS RELATED TO SMART HOME + BUILDING

5.1 Smart Home + Building Certification Programme

Brief description

In the “Smart Home + Building Certification Programme”, a new approach to conformity assessment for Smart Home products is to be developed. Attention is paid both to interoperability and to IT security. The aim is to offer manufacturers testing of corresponding products and the issue of a seal of quality with which market confidence in the technology offered can be strengthened. Over and above this, measures are being devised for further mobilization of the Smart Home market and a Smart Home Community covering various industries is being established.

Challenges

Smart Home products are on the way to becoming a mass market. Initial system solutions, including some from German manufacturers, have achieved market readiness. Nevertheless, final customers often hesitate to purchase a Smart Home system as they are overwhelmed by the variety of Smart Home solutions and technologies. Extendability and ease of operation of the system, and protection of privacy, are decisive criteria in consumers’ purchasing decisions. There is a need for optimization above all in cross-system interoperability and IT security. Furthermore, the cooperation between industries which is required for that purpose is not sufficient-ly ensured.

Objective

The objective of the project is to develop an open networking strategy based on generally accepted standards as a bridging technology. It is to integrate the large number of existing and successful systems and communications standards, and also to be capable of embedding the modern all-IP based systems of the present and future.

The test procedure developed in the course of this funding project is to serve as the basis for the examination and verification of technical feasibility in terms of interoperability, IT security and data protection.

Furthermore, measures for further mobilization of the Smart Home market are to be devised and a Smart Home Community covering various industries to be established.

Methods and technologies

In cross-sector cooperation, companies and stakeholder groups are identifying the technical bases of interoperability and IT security. With the use case methodology, tried and tested in the course of DKE standardization work, the technical requirements for interface signals and functions are deduced from the application scenarios provided by the companies involved.

On the basis of those requirements, DKE is compiling VDE Application Guides (VDE-AR specifications) for cross-system interoperability. These are to be promptly adopted in international standards and open standards. Furthermore, IT security scenarios are analysed and used to create standards and specifications for IT security requirements. As the technology partner in the project, the VDE Testing Institute is creating a test suite for examination of interoperability. In addition, a test platform is being established for testing of Smart Home products in terms of IT security and compliance with data protection.

Together with the companies involved, the parameters are being developed for a Smart Home ready seal which confirms successful testing of interoperability and IT security on the basis of current standards. Manufacturers of Smart Home products will in future be able to apply on a voluntary basis to the organization which is yet to be founded for issue of the seal. In addition, measures for further mobilization of the Smart Home market are being developed and published jointly with the companies involved in the project.

Figure 11: Many parts make a picture

Innovation with the Certification Programme

To date	With the Certification Programme
Manufacturers mostly only have points of orientation from their own industry or system in the development of Smart Home solutions.	Suppliers will be able to follow open standards for cross-system interoperability and IT security.
Users have no suitable aid to orientation in the selection of compatible Smart Home solutions from different suppliers.	The planned Smart Home ready seal will cre-ate transparency on the market for dealers, craftspersons and final customers. The seal will indicate which systems can be combined interoperably and with IT security. The seal offers manufacturers the opportunity to differentiate themselves on the market.
Cross-industry networking of the different stakeholders on the Smart Home market has not progressed very far.	The project will bring about an expansion of the Smart Home community, facilitating an exchange of ideas and experience between all the relevant stakeholders on the Smart Home market.

Consortium partners

VDE Verband der Elektrotechnik Informationstechnik e.V. (consortium leader), Connected Living e.V., DAI-Labor, Deutsches Dialog Institut DDI, Kellendonk Elektronik GmbH, VDE Prüf- und Zertifizierungsinstitut gGmbH.

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VDE Verband der Elektrotechnik Elektronik Informationstechnik e. V.
www.zertifizierungsprogramm-smarthome.de

5.2 GUIDED AB

Energy efficiency, convenience and security from networked and self-learning building and home technology.

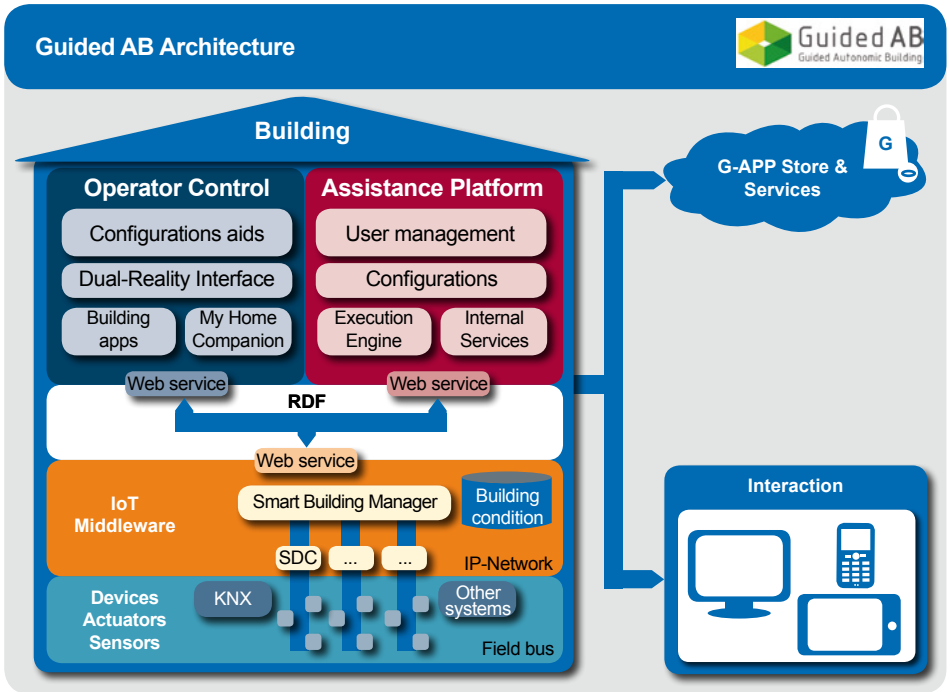

Figure 12: GUIDED AB – architecture

Brief description

The objective of GUIDED AB is to develop a new control system for building automation and home networking, which autonomously adjusts to meet the needs of users and residents. With the aid of self-learning mechanisms, use patterns are to be automatically detected and evaluated. The result to be achieved is a control system for buildings and home network components which is tailored to suit the needs of the residents and at the same time is efficient in its use of resources.

Challenges

In the smart homes and buildings of the future, electrical devices are to function autonomously and by doing so not only work independently but also use energy efficiently. Apart from monitoring, the devices are therefore to be controllable in response to tariffs. To achieve this, they are to be linked to corresponding energy management and market place systems, so that, for example, the dishwasher runs precisely when a large amount of electrical energy is available and power is thus cheapest. Resource-efficient buildings with smart control of building services will then make an important contribution to the energy transition. The technologically highly complex

systems place high demands on the internal and external networking capability of the controller components, their degrees of flexibility and their configurability.

Objective

The GUIDED AB project is aimed at researching innovative concepts for flexible building automation and home networking for smart residential buildings, and implementing them as prototypes on the basis of use cases. In that process, new approaches to systematic detection and self-learning evaluation of use patterns have to be developed and used as a basis on which to construct an intuitive and predictive controller. Existing stand-alone solutions are to be integrated in an all-encompassing system and act independently and predictively, The focus is on the ease of operation and configuration of complex building control systems, including implementation of virtual 3D models of buildings or dwellings (3D dual reality). Furthermore, sensors and actuators are to be involved, in order to create a hardware basis for the services in GUIDED AB. The aim is to develop mobile apps with which consumers can organize their domestic devices individually and have them controlled by learning systems.

Technologies

In the project, concepts are being established for self-learning services for detection and evaluation of use patterns. The project is pursuing a generic, open and expandable approach: suppliers can add further components or services to the platform and successively expand it. Together with house building experts from the project partners, use scenarios for energy efficiency, convenience, quality of life and security in private dwellings are being drawn up. Equal account is taken in that context of existing building services, for instance in remediation work, and new systems to be purchased as part of a new build home.

Use Case

Two test laboratories are being constructed for the component, integration and system tests. After trials in the test laboratories, the applications are tested in an environment close to reality and then applied in a selected residential building.

Consortium partners

Hager Electro GmbH & Co KG (consortium leader), Deutsches Forschungszentrum für Künstliche Intelligenz GmbH, FH Dortmund – Institut für Kommunikationstechnik (IKT), INTERACTIVE Software Solutions GmbH, IS Predict GmbH, QBUS eNET GmbH & Co. KG, Scheer Manage-ment GmbH.

5.3 proSHAPE

Hardware and software solutions for flexible energy supply and cost minimization.

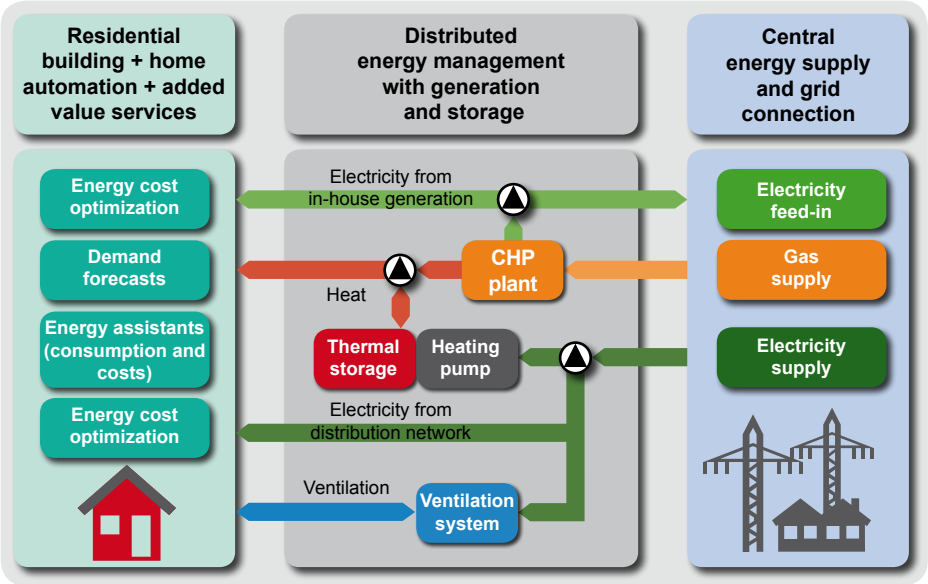

Figure 13: Approach of the proSHAPE project

Brief description

In a distributed energy management system, proSHAPE uses household-based data on current and forecast energy consumption to coordinate the power generation in the building by distributed combined heat and power units and the sale or purchase of energy. Using dynamic, price-based algorithms, the entire energy system in the smart home network can be optimized in terms of heat and electricity use.

Challenges

Distributed heat and power generation and the availability of variable electricity and gas tariffs are forcing changes in the structure and function of decentralized energy management systems. Up to now, with constant energy prices, their function has been predominantly to minimize consumption of heating energy. In future, buildings with power generation and storage facilities are to be incorporated in a distributed, future-proof energy supply system. The costs of heat and power are to be reduced with variable gas and electricity prices and the information from the buildings made usable for more flexible and distributed energy supply (e.g. in the context of virtual power plants). In the case of network bottlenecks, the building management system contributes to network stabilization by including connected power generation and energy conversion systems. On account of scaling effects in multi-storey buildings, this results in potential savings of heat and electricity which have not been exploited to date. On this basis, heating and electricity costs can be minimized for consumers in multi-storey housing, and CO2 emissions therefore reduced.

Objective

In the proSHAPE project, the existing home networking platform of the SHAPE project has been extended by functions which facilitate price-based, flexible and energy-efficient optimization of heat and power supply in multi-storey residential buildings. The project is intended above all to address the home building and energy industries as partners and service providers in the new business field of building and home networking. The development of corresponding business and billing models forms the fundamental basis for this.

Technologies

Building upon the preparatory work in the previous project, further components are to be incorporated in the energy management system. On the one hand, unit-type combined heat and power plants are to be integrated for generation of electricity and heat. Depending on demand, additional energy may be purchased from a utility, or surplus electricity sold and fed into the upstream network. On the other hand, systems for controlled ventilation are to be integrated, requiring power to drive fans. In order to compensate for the variable prices of gas, electricity and infeed of power from the CHP plant to the distribution network, the energy management system is to be expanded with agent-based added value services to optimize overall costs. These services will access tariff information transmitted in real time.

Business models are to be developed in cooperation with the energy and housing industries for the solutions created.

Use Case

The hardware and software developed are to be tested in field trials with partners from the housing and energy industries. Over 200 residential units in a district of Berlin are to be equipped with a distributed energy management system which is to provide adaptive control for a unit-type combined heat and power plant.

Consortium partners

Borderstep Institut gemeinnützige GmbH (consortium leader), DAI-Labor (TU Berlin), Dr. Riedel Automatisierungstechnik GmbH, Wohnungsbaugenossenschaft Zentrum eG, Berliner Energieagentur.

5.4 UHCI

Intuitive operator control concepts for modern interaction technologies in the Smart Home.

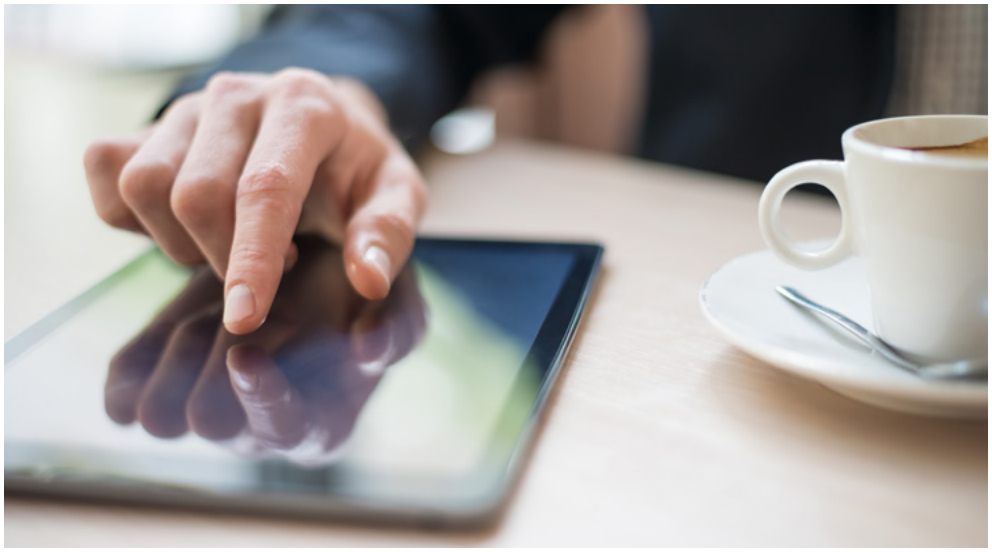

Figure 14: Mobile interaction technology in the Smart Home

Brief description

In the UHCI project, research is to be conducted into the requirements, conditions and implementation options of multimodal forms of interaction with the aid of which intuitive user interfaces with a high level of user acceptance can be developed for the various applications in the Smart Home. Open standards guarantee the compatibility between solutions from different industries and suppliers.

Challenges

The control of Smart Home applications often lacks convenience and user-friendliness. Some systems also have limitations to remote control, or have different user interfaces for mobile and stationary devices. In addition, products from different manufacturers are in many cases incompatible with each other. This frequently leads to a low level of acceptance by users, and low market penetration for the individual systems.

Objective

A test environment for interaction technologies in the Smart Home is to be created in the UHCI project. Innovative interaction technologies such as tough, gesture or voice control are to be developed, combined, examined for usability and tested in prototype application scenarios in the home environment. The aim is to develop a user interface schema with an intuitive operator

control system which is suitable for different fields of application in the Smart Home. The use of open standards is to ensure compatibility between solutions from different industries and suppliers.

Technologies

Firstly, the requirements, conditions and implementation options for an open user interface framework and corresponding usability guidelines are being researched and developed for various applications in the Smart Home. With the aid of demonstrators, several application scenarios are then to be created and modified individually for different target groups. The results of use are then to be evaluated with tools for expectation and acceptance analysis.

Use Case

Several application scenarios are to be examined in the course of the project. Interaction Anywhere is one scenario which provides users with various opportunities for interaction, depending on their whereabouts and the associated availability, through the design and implementation of multimodal interfaces (e.g. touch, voice, gesture or 3D models) for input and output devices. Playing of media outside the home is via a local cloud. In this way, for example, a scenario is implemented in which multimodal interfaces are applied to meet specific TV requirements from the project participant Loewe. A demonstrator with adaptive dialogue control based on a digital cooking assistant is also being created.

Consortium partners

Facit Research GmbH & Co. KG (consortium leader), ART+COM AG, Connected Living e.V., DAI Laboratory and Quality and Usability Laboratory of the Technical University of Berlin, Design Research Lab of UdK, DiscVision GmbH, Fraunhofer IDMT, Loewe Technologies GmbH, UMAN Universal Media Access, Networks GmbH.

5.5 Safety systems in smart buildings – smoke detection with smoke/heat ex-tractors and evacuation system

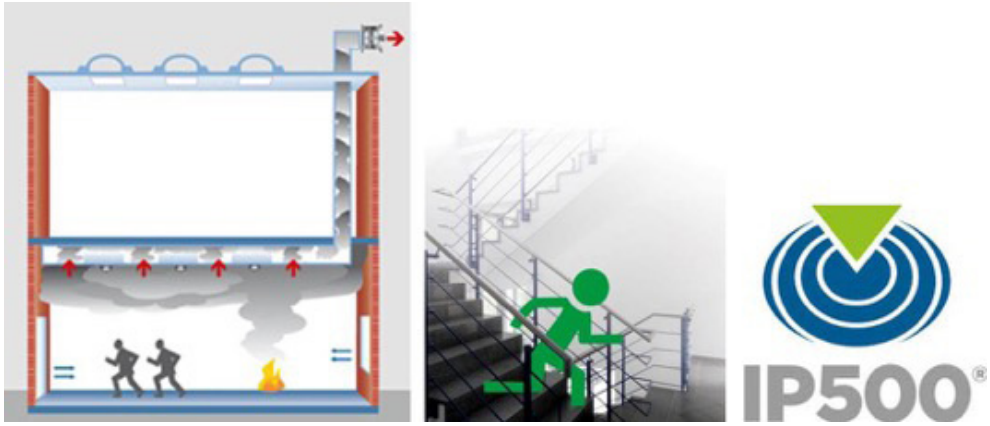

Figure 15: Lugano project

Brief description

In the Lugano project, a smoke/heat extraction system in combination with an evacuation system is defined. Smart Buildings are monitored by smoke, CO2 and temperature sensors. The sensors can also be retrofitted to buildings, and then connected via the IP500 wireless network to an in-house access point. With the flexibility of the IP500 wireless network, the sensors can be positioned at any location and therefore cover all critical areas.

If a sensor triggers an alarm, the central controller systematically activates the smoke/heat extraction system. In parallel, the evacuation signals are set and controlled in such a way that the persons present are always guided out of the danger zone by the safest and quickest route.

Challenges

Smart Buildings have a large number of sensors and actuators installed in a defined area, which is not the case in a Smart Home. The challenges to wireless networks in Smart Buildings are therefore significantly greater. The IP500 platform is designed to support a large number of sensors and actuators with a corresponding network architecture and a large range. A further challenge is location by means of “IP500 tags” which pass on their coordinates ad-hoc to the evacuation system and thus indicate an escape route safely and rapidly – for instance also for wheelchair users.

Further information on CoreNeiX

Technology

The IP500 communications platform uses the sub-GHz (868 MHz) frequency range on the physical radio level and follows the IEEE 802.154. b / 2006 standard. The IP500 wireless mod-ule is the CNX100/200 from CoreNetiX (www.CoreNetiX.com).

The networking is regulated using the IP500 network mesh technology. The transport layer is based on the IETF standard (IPv6/6LowPAN). All the fire and temperature detectors can therefore communicate with unique addresses via the IP500 router or direct with the IP500 access point. In this project, the access point routes the data from the fire detectors to the fire alarm centres and then on to the building management system which activates the evacuation systems accordingly.

Objective

The objective is to position the wireless sensors optimally in the building so that in the event of a fire alarm the appropriate smoke, heat and evacuation systems are activated immediately, ensuring an effective and rapid evacuation of persons from the danger zone. Mobile IP500 tags can supply additional location data which are then supplied to the evacuation routes through the IP500 network.

Consortium partners

IP500 Alliance (Berlin), ESSMANN GRUPPE (Bad Salzuflen), CoreNetiX (Berlin), EATON (Leamington, UK), OMRON (Tokyo, Japan), iQuest (Frankfurt).

5.6 Natural ventilation, energy management and fire and water detection in Smart Homes with connection via IP500/GPRS gateway

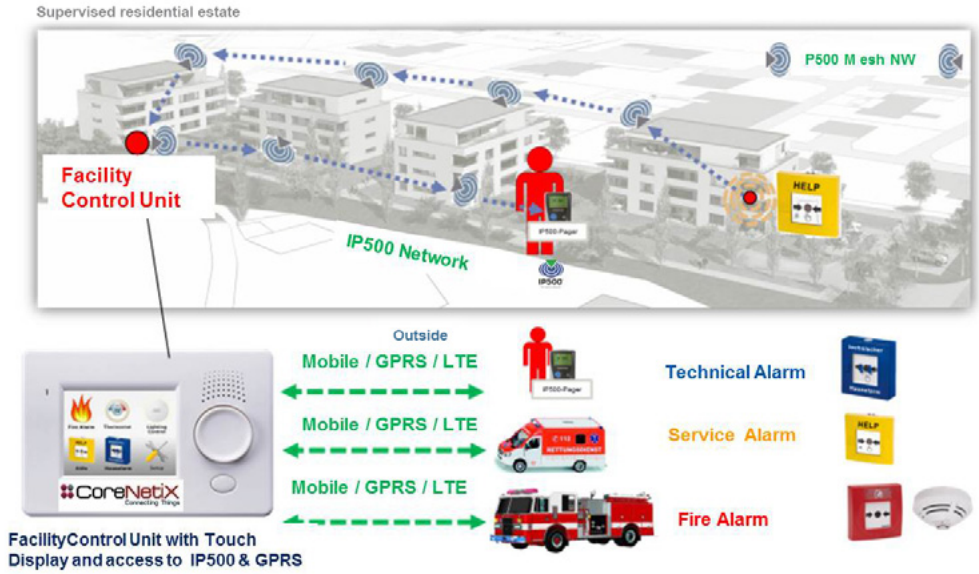

Figure 16: Smart Home project in Freiburg

Brief description

In this Smart Home project (in Freiburg, southern Germany), various sensors and actuators are being installed with wireless links (and therefore without high installation costs) in existing private households.

Connection of the fire and water sensors and of the service and alarm buttons to a GPRS gateway is effected via the IP500 wireless network. As a result, the individual sensors can be simply fitted at stipulated locations in the various households with complete interoperability. If a fire or flood is detected or assistance requested by means of the service button, this information is transmitted via the IP500 wireless network to the GPRS gateway (which is also the control station), which then sends the alarm to predetermined recipients, which can be mobile smartphones or organized emergency call centres.

Challenges

The different structures of Smart Homes and Smart Buildings present a certain challenge to wireless networking. In addition, interoperability of the desired sensors and actuators is not always given. Furthermore, the standards and directives on safety and security systems (fire and access, etc.) are becoming more and more important. Finally, these challenges can only be met by an open, jointly specified and powerful platform (as an ECO system).

Objective

With the interoperable IP500 platform and networking, existing private households can retrofit a range of sensors and services without major installation costs. This increases safety in the case of fire or flooding in private households, as early detection allows them to be stopped or rectified at an early stage.

Technology

The IP500 communications platform uses the sub-GHz (868 MHz) frequency range on the physical radio level and follows the IEEE 802.154. b / 2006 standard. The IP500 wireless module is the CNX100/200 from CoreNetiX.

The networking is regulated using the IP500 network mesh technology. The transport layer is based on the IETF standard (IPv6/6LowPAN). All the fire and water detectors can therefore communicate via the IP500 router or direct with the IP500 access point. In this project, the access point is the control panel, with corresponding operator control functions (screen). The information in the control panel is then passed on when required through the integrated GPRS gateway to mobile smartphones or cloud facilities (alarm centres).

Consortium partners

IP500 Alliance (Berlin), CoreNetiX (Berlin), Salt (Switzerland), Essmann Gruppe (Bad Salzuflen), OMRON (Japan), Gisinger Wohnungsbau & Management (Freiburg).

6 TECHNOLOGIES

6.1 Environment

The desire for a modern home creates a great demand for technology. The need for entertainment, safety, security and energy management has to be catered for by electronic devices, hardware and software.

Communication between various systems is to be facilitated by simple networking of the devices, and where necessary connection to the internet. Devices are no longer to be side-by-side stand-alone units, but rather possess common semantics to ensure the exchange of signals and information.

This interoperable communication gives rise to a host of opportunities to make the private world of the residents more comfortable and more intelligent.

The architecture of the Smart Home is described below and an introduction to the technology is provided. The detailed description of the technology is attached as an appendix.

6.2 Home and Building Architecture Model (HBAM) framework

The Home and Building Architecture Model (HBAM) framework describes the topics assigned to the end-user of a Smart Home or Smart Building from the point of view of standardization. In this view, the user is the centre of attention, and an ecosystem is constructed around that user. The HBAM does not set out requirements for IT architectures, but rather describes and models the complexity of a home or building. Furthermore, it provides a context for the various issues involved.

The ecosystem mentioned above is divided into three main aspects in order to break down that complexity. The aspect of interoperability is important, especially with regard to the end-user, and, with increasingly networked information technology and converging issues, has become a major criterion for standardization and a necessary condition for the successful placing of Smart Home products on the market. Distinctions are made between various levels of interoperability, which can be defined within a manufacturer's product portfolio or across the boundaries between manufacturers. In the HBAM framework, interoperability does not refer solely to technical matters, but also to socially relevant developments and regulatory objectives.

A further aspect of the ecosystem is the application domains in the Smart Home or Smart Building. These domains describe the established categories which can already be interlinked in their own ecosystems, but do not have any standardized access to other application domains. In a cross-domain approach, new applications can be developed with great added value for, and therefore increased acceptance by, the end-users. In the area of standardization, too, a cross-domain view is important as it breaks up vertical ways of seeing and facilitates horizontal transitions into other application domains.

The products and systems available for Smart Home or Smart Building applications may differ greatly in terms of functionality or degree of integration. The HBAM framework provides for different integration zones, so that distinctions can be made with regard to the areas of action of the products or systems, depending on their complexity. These areas of action have a very large bandwidth and represent an environmental interaction of individual products ranging up to products and systems completely incorporated in market processes.

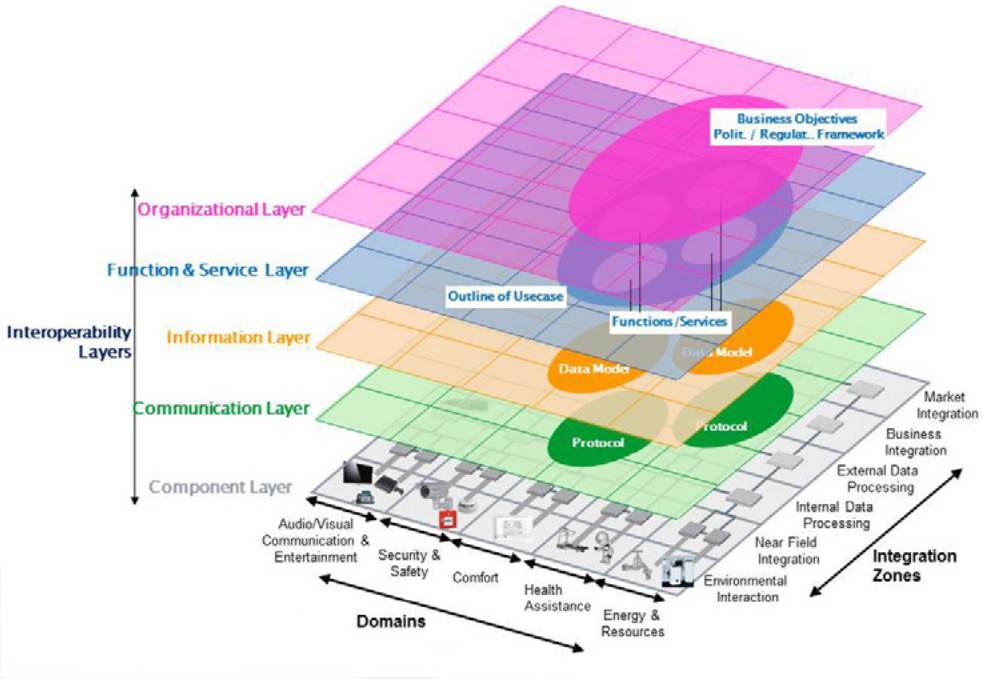

Figure 17: Home and Building Architecture Model (HBAM) framework

The concept of this three-dimensional representation goes back to the highly successful Smart Grid Architecture Model (SGAM), which was developed by standardization experts on the European level in the Smart Grid Coordination Group (SG-CG). As it was developed for the field of energy (electricity), it had to be adapted to meet the modelling requirements for smart homes and buildings.

The application domains in a Smart Home do not correspond to linear value creation as used in the SGAM. In addition, the perspective of the HBAM is that of the end-user, and therefore the SGAM domain view can only partially be applied. The aim was to put all the areas of application relevant to the end-user into a context from the standardization point of view and to describe a holistic scenario. Electricity is also a fundamental and highly important subject with regard to smart homes and buildings. For smart and networked applications, however, interfaces to other domains have to be defined and used.

The HBAM framework is based on a systemic modelling approach. This is not an attempt to fully map the complexity of individual domains, but rather to describe the interfaces of a system

which are required for it to interact with other application domains. A system may have any degree of complexity, depending on the product and application domain. Depending on the integration zone or interoperability level, transitions to other applications can be defined for that system. It is therefore important to remember that the modelling approach adopted here does not result in a full and complete description. In the multimedia field, for example, there are already networked applications which do not facilitate direct links with other application domains. If these loosely coupled systems are to be linked together, there is a need for interfaces which functionally remove the complexity of the corresponding application domains.

The edges of the individual segments of the application domains, the interoperability levels and the integration zones form the interfaces between these subsystems. A subsystem can extend over several areas, which then also illustrates its complexity. With complex building automation systems, for example, data modelling and communications technology are highly interdependent. Decoupling of data storage would allow any kind of communications technology to be used and interoperability to be established on the information level even if that is not possible on the communications level.

For a more precise consideration of the available products and systems, it is necessary to examine the HBAM framework in greater detail. In the “Energy & Resources” application domain, for example, various topics for the end-user are grouped together. Classically, this area of applications includes the relevant methods of heating and the issues concerning energy from renewable sources which are part of the energy transition. Other topics concerning natural resources, such as water supply or waste disposal, are grouped together in this complex. It becomes recognizable here that the complexity of the “Energy & Resources” topics in homes and buildings is much too great for it to be completely described in a modelling approach. Therefore, only the aspect of “Access to the End-User”, which as a partial aspect of the “Customer Premises” domain for power supply in the SGAM also falls within the “Energy & Resources” application area of the HBAM framework, is described.

As in the case of the energy industry, the entertainment and health sectors also have their own ecosystems with individual value chains. These are also not defined in this modelling approach, which concentrates only on the transition to the end-users in homes and buildings and the interfaces required in each case.

6.2.1 Interoperability levels

The interoperability levels were derived from the Groupwise Architecture Council - Interoperability Stack. A component level, which models both physical and logical components (e.g. software modules) has been added to that stack. Virtualization is an extremely important aspect which has been integrated in the level concept. Even if most of the devices and systems in homes and buildings are nowadays controlled by software, there is increasing decoupling of the logical control from its physical implementation. The influence of internet services (e.g. cloud applications) is leading to networked software applications no longer being dependent in their actions on the local environment of the physical devices. Here, various internet-based software service models (e.g. SAAS – software as a service) have become established and are gaining importance in the context of smart homes and buildings. The technical components can be mapped on the levels of components, communications and information. The service functionality and its de-scription, in contrast, is part of the “Use Cases and Services” level.

As a result of the change of perspective between the HBAM framework and the SGAM, the level definitions have been slightly adjusted. As already mentioned, software modules are also mapped on the component level, and services on the use case level. Furthermore, the organizing level of directives and regulations to be complied with is described as the Organization Level. This does not merely concern the mapping of business models, but also of the standards which are relevant to end-users, such as those aimed at preserving data protection.

Component level

The component level describes all the logical and physical elements. As already mentioned, the latter covers devices which the user can see and touch. They could be a DVD player, a heat pump, a blood pressure measuring instrument or a smartphone. Each product has specific re-quirements which are defined from the relevant application domains. The standards already de-veloped for these devices are not limited to product safety issues (for instance EMC), but also take account of how the products are used.

Over and above this, there are increasingly software platforms which enable customized soft-ware to be loaded onto a device to make it individually usable by the end-user. For this purpo-se, software development environments such as SDKs from Android or Smart TVs have been formed, offering interfaces to devices for third party suppliers. These can be used to give the end-user additional value from new applications.

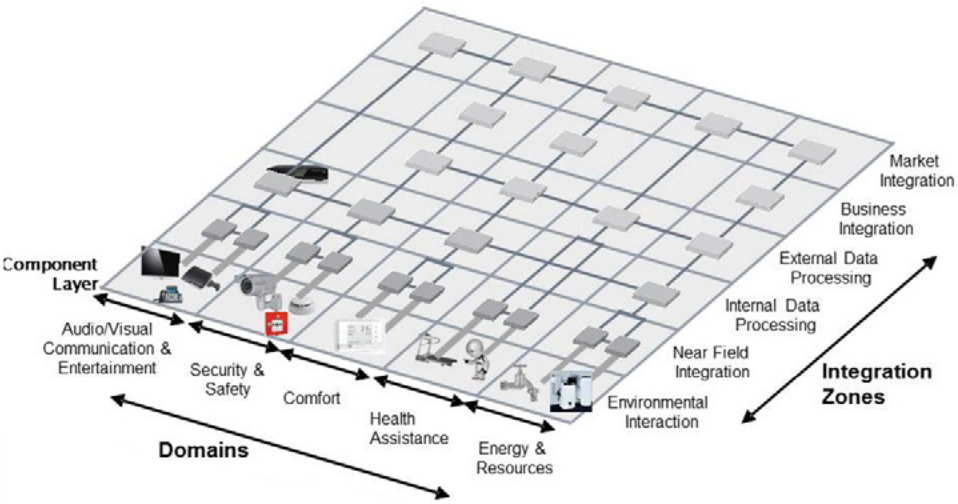

Figure 18: Component level

Communications level

The communications level comprises all layers of communications with regard to their interoperability. There is an established layer model which was defined as a standard by OSI as early as 1994, and which divides the requirements for an exchange of information by technical means into seven layers. Communications protocols can be classified in this system, and in some cases also reflect user-specific requirements.

Like the component level, the communications level is not flat. It maps a large number of different protocols which have become established for various areas of application. For a closer consideration of the various implementations of protocols, a more detailed examination of the OSI layer model is therefore required.

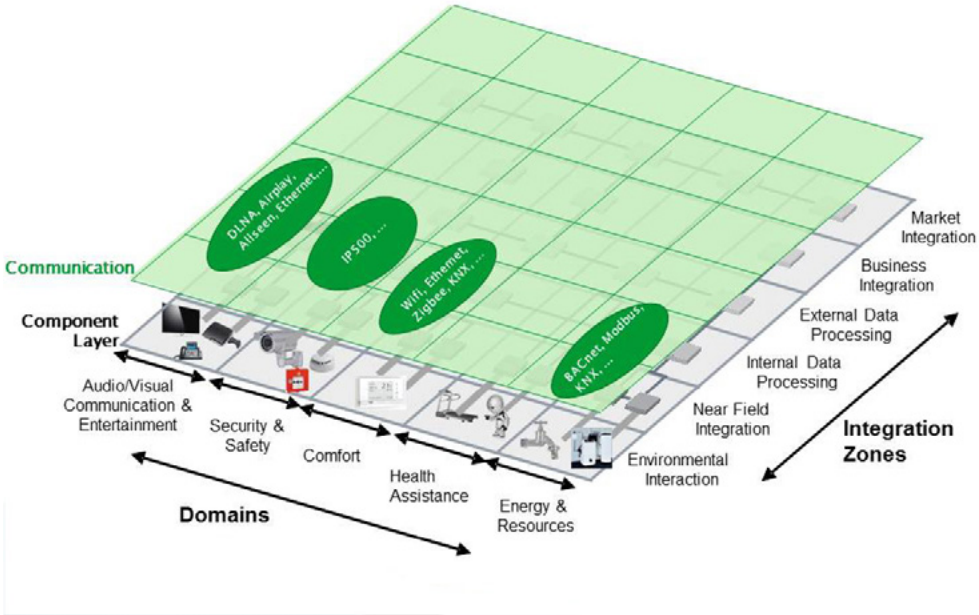

Figure 19: Communications level

Information level

The information level describes data models and meta-information which can be used for applications in a smart home or building. This requires a distinction between data and communication, in order to establish interoperability with regard to the content of applications. In the multimedia field, various encoding standards (e.g. MPEG) have been created, and are independent of both their use and the method of data transfer. Flows of video data can therefore be distribut-ed and played independently of specific applications or communications technologies.

This is the third technical possibility to establish interoperability in the home or building on the basis of the existing information.

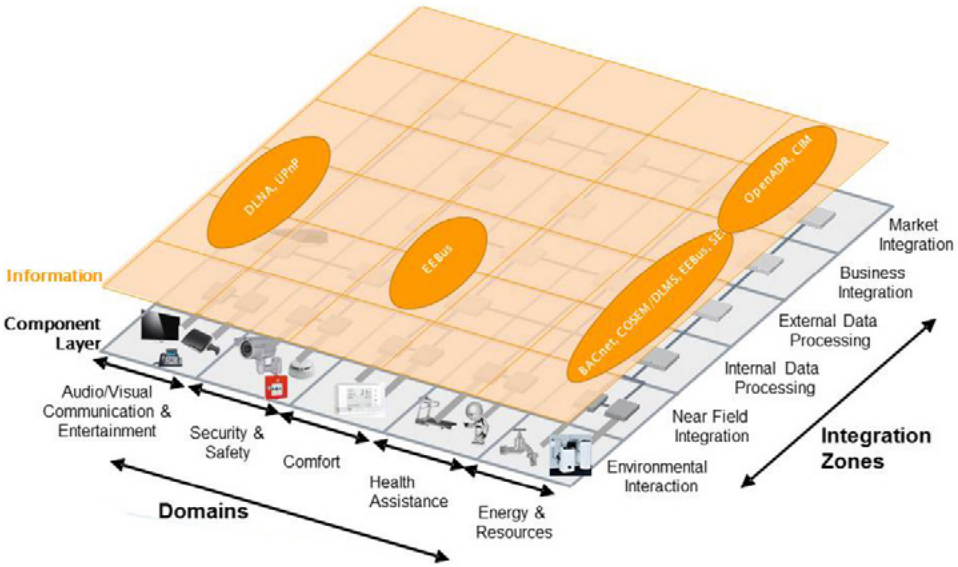

Figure 20: Information level

Use cases and services level

As the first primarily non-technical level, the use cases and services level describes use cases which appear appropriate for interoperability of different products and systems. The use case methodology is relatively new in standardization, and is intended to reflect a snapshot of the ideas and approaches on which the standards for interfaces can be defined.

Functionalities which transcend the boundaries of application domains do in particular become very complex very quickly, as vertically established standards often fail to offer any appropriate interfaces. Making a breakthrough here with a practical implementation is often associated with a large amount of development work, even if the functionality eventually achieved may initially appear to be minor.

In order to define as suitable interfaces as possible for these cross-domain use cases, there is a need for a collection of various scenarios. Those scenarios can be used to deduce requirements which permit a corresponding functional decoupling and satisfy general rather than individual points of view. A standard has been developed on the international level for this purpose, intended to facilitate a stocktaking of these use cases with a template for the energy field (IEC 62559).

Technical implementation then requires a specific architecture which can then be incorporated as an abstract in the HBAM. A functional architecture model for smart electricity meters, for ex-ample, was published as early as 2011, and all the smart meters in Europe are to comply with that standard. There are of course specific national implementations, which are nevertheless based on the European standard. In this area, standardized interfaces will promote individual competition and facilitate sustainable business models.

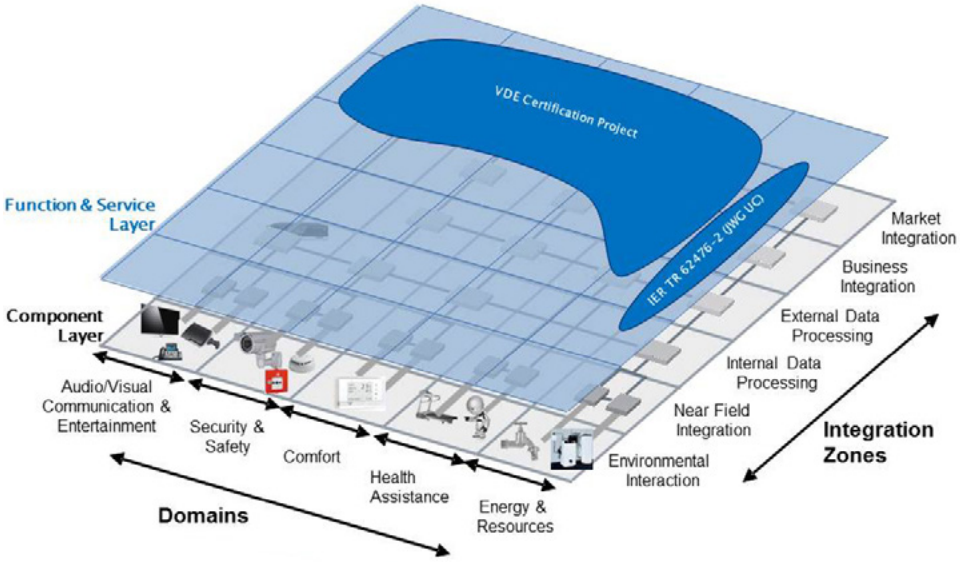

Figure 21: Use cases and services level

Organization level

The organizational interoperability level covers social and economic conditions for the technical systems in smart homes and buildings. Entrepreneurial viewpoints are not in the primary focus with regard to the development of an ecosystem around the end-user. Business models in which the end-users can, where appropriate, be involved must be possible. Here, however, the social questions concerning standardization and sustainable development are in the foreground.

An ageing society and the implementation of the energy transition while taking account of the in-terests of end-users require a generally valid organization level. This can describe technical guidelines from VDE or requirements from the European standardization organizations. Espe-cially if Germany wishes to develop into the leading market for smart homes and buildings, the incorporation of the technical systems in local or regional ways of life is of decisive importance.

In the area of data protection there are global standards, and regional requirements have to be observed in their implementation. Data protection in practice has to comply with the European and national regulations, which will not be identical in all respects to those elsewhere in the world. It must therefore also be ensured in the case of standards such as ISO 80001 that ac-count is taken of political background conditions.

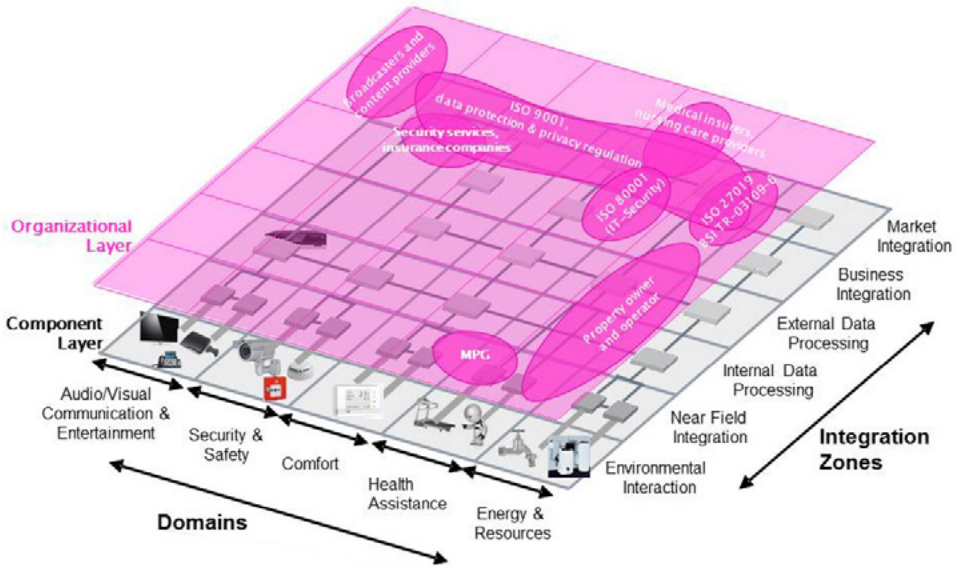

Figure 22: Organization level

Summary of interoperability levels

See Table 2 for an overview of the interoperability levels in the HBAM framework.

Table 2: Overview of the HBAM interoperability levels

Interoperability levels	Description
Component level	This level describes all logical and physical units which make smart homes and buildings possible for the end-user. This comprises software modules and applications, and hardware which is necessary to provide a service.
Communications level	Communications are a fundamental part of interoperability. This level describes OSI layers 1 (physical layer) to 7 (application layer), and thus all aspects of communications. This includes both local communication and, depending on the degree of integration, wide area communication.
Information level	For end-to-end interoperability, it is important for data storage and modelling of information to be kept separate from the applications and communications. The data to be transmitted must be independent of communications standards, and the applications for processing the data must be decoupled.
Use cases and services level	Use cases which describe an actual condition at a single point in time and scenarios for the future conceived in the present are required to describe functionalities and services. These use cases can be used to firm up the architecture descriptions for the various application domains, so as to provide suitable interfaces for horizontal interoperability on at least one of the three technical levels.
Organization level	This level does not necessarily describe technical aspects. Regu-latory and other socially relevant developments can be referenced here, and this level is not limited to economic considerations. The development of the ecosystem should be oriented towards the benefit of the end-user and therefore follow a sustainable approach.

6.2.2 Application domains

The application domains of the HBAM framework stand for themselves and have no direct interdependency. It is not assumed that all these application domains have to be implemented in a home or building to fulfil the criteria of a Smart Building. Depending on the end-user's requirements and needs, the focus is set individually and the solution arrived at will cover one or more application domains.

For intelligent energy applications in which the aim is the efficient use of resources, the "Customer Premises" domain from the Smart Grid work on SGAM overlaps with the "Energy & Resources" application domain of HBAM. The latter is more broadly defined and includes not only electricity, but also water and gas supplies. It is therefore important that the use cases under consideration from Smart Grid work for intelligent power supply run together for end-users in this domain.

Each application domain, on close consideration, can be divided into further partial domains. All energy and resource topics overlap from the point of view of the consumer, and are therefore grouped together in a single application domain. This approach reduces complexity and frees the HBAM modelling from the need to describe partial domains. The objective is a structured description of the various areas and their overlapping interfaces. Similarly to the energy sector, the application domain for health support only includes a description of the end-user's interface with a completely independent ecosystem of health and nursing services in the context of homes and buildings. That ecosystem is highly complex and cannot be described in the application domain of the HBAM. The same applies to the application domain of the entertainment industry and the workflows of the music and film industries which do not have to concern the end-user when listening to music or watching films.

The application domains thus constitute loosely connected systems which can be more closely connected if that results in added value for the end-user. The interoperability levels then permit technical coupling via the component level, communications level and/or information level. On the component level, one could envisage control via an app on a smartphone, with which the television picture can be transmitted or the heating system controlled. One could also imagine a multifunctional button to increase convenience and control both lighting and heating. If these two systems share a common communications infrastructure, interoperability of the two applications can be achieved on the communications level. In the case of different applications and communications infrastructures, common data storage in a database with a uniform data format can result in interoperability of different application domains. A wireless switch could be connected to a database via Bluetooth, for example, to act via WiFi to control the heating system. In that case, the application domains are different on the component level and the communications level, and interoperability of the two systems is effected on the information level.

Energy and resource domain

Environmental aspects are grouped together in the “Energy & Resources” application domain. This includes energy matters such as gas and electricity, and also waste management and water supply. This application domain groups all issues in homes and buildings which are primarily concerned with energy and resources. Intelligent heating applications and systems with optimized consumption in distributed power supply systems can be mapped in this application domain.

Health-supporting domain

This application domain groups together the health-supporting services for the end-user. In the light of demographic change and the need for home nursing, extended services can be established in the Smart Home and Building. Building regulations such as barrier-free construction or the desire of elderly people to stay in their familiar environment are increasingly exerting an influence on the infrastructure of buildings.

As already mentioned in the introduction to application domains, this application domain only represents the interface to the health services and makes no attempt to map them in their totality. The performance of health services requires separate description and definition to provide answers to the questions of the future and its specific requirements.

Convenience domain

In a Smart Home or Building, applications to increase comfort and convenience are especially important. By means of automation and the individualization of workflows, the perceived level of convenience can be significantly increased. That includes applications for smart lighting control or control of shutters, and is demarcated from the more general concept of convenience by its involvement with concrete applications.

Applications in all domains should be convenient to use under the given conditions In this respect, this domain is concerned with specific applications to increase comfort and convenience in the home.

Security and safety domain

The safety and security of a building can be considerably increased by fire protection systems or products and other systems designed to monitor safe operations. The increasing complexity of the products and systems installed in homes and buildings raises increased demands for the safe operation of the building as a whole. This should not have any effect on the product safety defined by standards for those products. On the contrary, the applications concerned here are intended to ensure the safe operation of a home or building and its protection.

Protection from burglary is a concrete application in this domain, as are systems for protection from vandalism. The specific security of information technology is not limited to this application domain. IT security has to be implemented by every application in the relevant domains and levels. The requirements to be fulfilled are diverse and must be described in relation to the context. As a result, what is concerned here is the primary objective of concrete applications, with data protection and IT security applicable to the entire HBAM framework.

From a regulatory point of view, and in the objectives of applications in this domain, there may be different perspectives. Fire detectors, for example, only recently became compulsory in private houses, whereas there have been extremely strict regulations on them in commercial buildings (offices, production workshops and so on) for many years now. In the objective of protection, there are also differences between private dwellings and commercial buildings. While protection of persons is in the focus with private buildings, protection of investment and compliance with the applicable regulations are the aims for the operators of commercial property. The access systems used, for example, differ greatly on account of the highly different requirements.

Audiovisual communications and entertainment domain

Integrated communications applications, with which audio and video communications are possible, are grouped together in the entertainment applications domain. It also contains the classical entertainment media such as film and music, for which smart televisions have more and more interfaces and services available. Games consoles, which are no longer limited to games alone, but now constitute multimedia servers, are also included in this application domain for end-users.

Summary of HBAM domains

Table 3 below shows the domains with significant effects on people's individual lives.

Table 3: Overview of the HBAM framework domains

Domains	Description
Energy and resources	This application domain groups environmental issues and energy topics in homes and buildings together from an end-user's point of view. This domain mirrors the work on power supply in the "Customer Premises" domain of the SGAM framework.
Health support	All applications supporting the end-user with regard to health are grouped together in this domain. It includes nursing care in the home and other measures which can be adopted in the domestic environment.
Convenience	Individualization and increased convenience by automation are essential components of the Smart Home and Building. These are grouped together in the Convenience application domain.
Safety and security	Protection of a home or building is of special importance and requires special systems and applications. Even though the requirements for private dwellings differ greatly from those of commercial properties, both aspects are grouped together in this application domain.
Audiovisual communications and entertainment	Smart televisions are becoming more and more popular, and are increasingly also incorporating communications applications. This application domain covers the products and systems assigned to entertainment and communications.

6.2.3 Integration zones

The concept of the area of impact or integration zone was introduced as an abstraction of the complexity of products and systems. Depending on the application domain and interoperability level, products and systems have a corresponding area of activity, and systems can be defined in that way. A system does not have to be assignable to one integration zone or application do-main only. On the contrary, it will normally be the case that complex systems extend over several zones and levels. The concept of structuring within the HBAM framework is intended to assist in providing indications of interfaces, so that smart solutions can be classified according to their complexity and function and rendered interoperable.

The integration zone may be physical or logical. Fundamentally, it describes the flow of data from smart systems in the home or building. By interaction with the environment, data are collected or displayed or, quite generally, used. Integration of these data can lead up to market integration, in which data are incorporated in market processes. In this way of data use, there are various requirements which have to be fulfilled. These are highly dependent on their context, which is why segmentation into six zones from data collection to incorporation in market workflows has taken place.

Depending on the application domain, there will be specific hardware and software (component level), different communications technologies and also different data models for the presentation of information in the different integration zones. With the integration zones, assignment is not predominantly geographical or spatial. The focus is on functional structuring, and therefore assignment by location only takes place in a second step when a concrete architecture is applied to this abstract modelling.

An allocation of system boundaries can then take place on the basis of this classification. A concrete architecture then specifies the interfaces of the zones, levels and applications. The requirements which are applied to the zones are described from a systemic point of view in this model. For example, the collection of measurement data for smart meters and the assignment of the integration zone for measured data acquisition are stipulated by regulations. Smart meters provide an interface for the integration of this system in a more complex system, which is not the case with simple meters without interfaces for further information processing.

Environmental interaction

The “environmental interaction” zone is the area with the least complexity. In this zone, for example, data on functions are detected by sensors. This data collection can take the form of the recording of speech, the operation of a switch or the measurement of temperature or power consumption. This zone covers both the collection of data and the implementation of data by interaction with the environment.

Near field integration

Switches which turn a lamp on or off by responding to signals also constitute an interaction with the environment. The display of a video on a television set or a mobile terminal unit would also be an environmental interaction of a TV set, although not for data collection, but rather for output or use of data.

Internal data processing

The “internal data processing” zone refers to a systemic observation in which a distinction has to be made between internal and external views. This definition then depends on the actual implementation of the application domains.

In principle, the internal data processing zone is defined as that area in which the end-user has access to and control of the various issues. That is the case in the implementation of smart meters in Germany, up to and including the smart meter gateway. Distinctions then have to be made between different topics and standardization projects, which are to be mapped on the corresponding levels. They may be regulatory requirements from the organization level or data models from the information level, or application or communications technologies from the other technical levels.

External data processing

As a counterpart to internal data processing, the integration zone concept provides for a transition to system-related external data processing. The details are not defined, but this area is no longer within the direct area of influence of the end-user.

In the case of applications in the entertainment domain, it may be a video uploaded via a platform and in an area accessible to the user but requiring services from an external supplier. Other examples can be found in cloud services where user-specific data are managed and stored.

In most cases, the integration zone transition from internal to external data processing is represented by the connection to a wide area network. This does not have to be the publicly accessible internet, but in general a wide area connection with which a self-contained and functioning system can be linked with other systems.

In the case of a distributed energy network, it may be the connection of a microgrid or a smart meter to the head end system of the distribution network operator. The functionalities of the systems concerned here differ greatly, but they are able to ensure their basic functionality even without external system links.

Enterprise integration

The connection and integration of information in business processes is described in the next integration zone. Here, data are not only used and stored by the end-user, but are also available to the enterprise for further processing. This process requires mutual consent and should be defined accordingly in a Service Level Agreement. As that is primarily organizational in nature, this requirement is assigned to the organization level. There are also clear requirements for enterprises with regard to the use of data from end-users, which have to be complied with in this connection. No distinction is made here between or restriction imposed on provision of data for a consideration or free of charge.

Energy service providers can, for example, evaluate information from their customers and bundle it for further use. A service based on aggregated anonymized information and with the consent of the end-user is conceivable. This could facilitate optimization of the enterprise's internal workflows on the basis of the information provided.

This zone therefore describes the incorporation of the data and information generated by devices in entrepreneurial workflows for further processing. The purpose of the processing must be determined individually and may vary in different application domains.

Market integration

The integration of data in market processes constitutes the most complex integration zone. Here, the area of impact of the information processed is extended to other market participants and is not limited to the private or corporate context.

One example is the direct marketing of renewables-based power generation facilities from a certain size upwards, as stipulated in the German Renewable Energy Act. The electricity gener-ated and the necessary information are then connected to market processes.

Summary of integration zones

Table 4 below shows a summary of the six integration zones in the HBAM framework.

Table 4: Overview of the integration zones in the HBAM framework

Zones (integration lev-els)	Description
Environmental interaction	This integration zone describes the data collection and implementation which takes place in direct interaction with the vicinity.
Near field integration	The connection of sensors, actuators, displays, etc. is grouped together in this zone. It is primarily concerned with interfaces for the exchange of data.
Internal data processing	The internal data processing zone demarcates a system, which may have different natures depending on the application domain and use case, from other systems. A perspective directed into the system is described here.
External data processing	In contrast to internal data processing, the external data processing zone describes the link between a system and other systems. This covers access to a system from the outside, without making any specific requirements concerning the actors or defining any particular relationship between the actors.
Enterprise integration	The integration of information in entrepreneurial workflows defines an entrepreneurial relationship between the actors concerned. The business relationship on which this is based does not have to be remunerative, but may also involve alternative concepts.
Market integration	Acting with information for provision of further services defines a complex relationship between the parties involved. As with enterprise integration, this link with the marketplace does not have to have a financial basis, but can be based on barter or other systems.

6.3 Smart Home – from actual to specified

Currently, technical stand-alone solutions which already provide smart functions can be found in many homes. Many of these stand-alone solutions, such as alarm systems, are also intrinsically integrated. There are also increasingly smart stand-alone solutions to be found in the areas of heating, photovoltaics or blinds. As these systems do not as yet communicate with each other and are often not equipped with the technical integration interfaces, they do not have the necessary Smart Home architecture.

Figure 23 below shows how these stand-alone solutions exist side by side. They do not use the same cable infrastructure, nor do they have the same central control facilities.

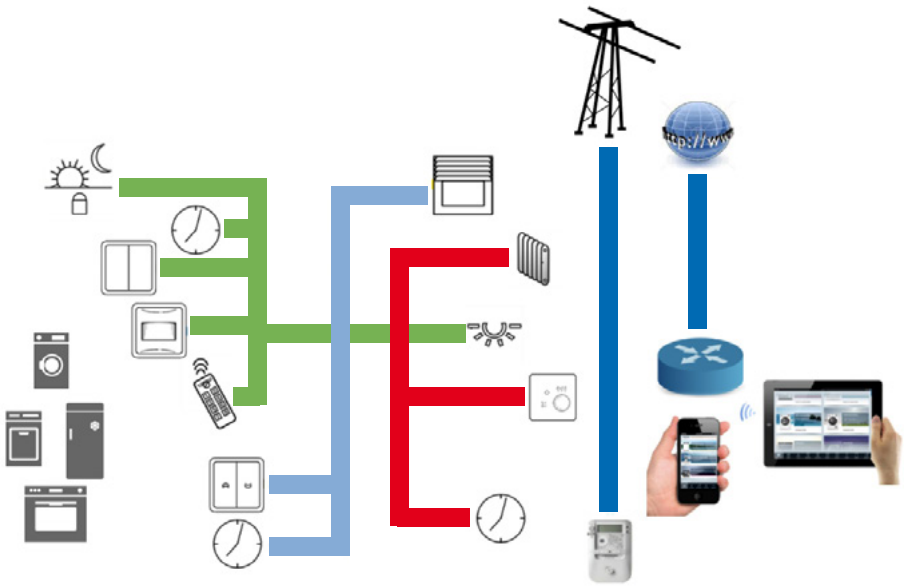

Figure 23: Architecture of stand-alone solutions – the actual situation

A real Smart Home, in contrast, requires the integration and interoperability of all the existing systems. All the sensors, actuators and control centres are then connected by an installation bus and integrated by means of a coordinated software platform (a framework such as OSGi and EEBus). The actuators are also connected to the power supply. Figure 24 provides an overview of what a Smart Home architecture looks like (= specified).

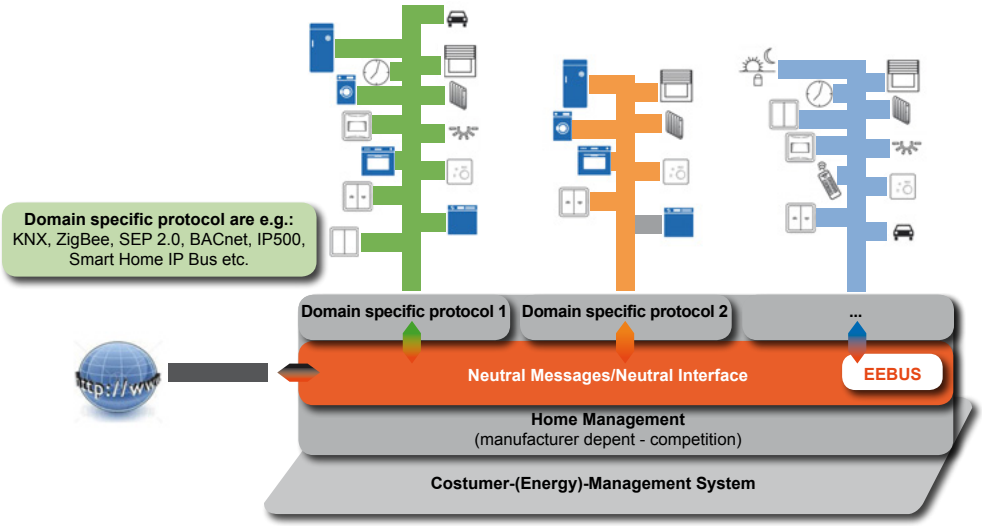

Figure 24: Fundamental architecture of a Smart Home – the specified situation

Figure 24 – the fundamental architecture of a Smart Home – shows an example of a modern topology implemented in a Smart Home. The systems installed, such as KNX / LON / LCN / ZigBee /… are merely examples standing for any bus system, and are also not intended to represent any particular transmission media such as radio, cable or powerline, etc.

This example is merely intended to make it clear that there will be an opportunity in future to link entire systems and thus facilitate bidirectional communication. The applications mentioned, such as domestic appliances, motor cars, inverters, heat pumps and shutters do not at present share their information through the systems stated, as the systems for these applications have for the most part not yet been stipulated.

6.3.1 Sensors and actuators

The interaction between sensors and actuators is a fundamental condition for Smart Home solutions.

Sensors are the first technical component at the start of the measuring chain. They are metrological instruments and detect chemical or physical variables such as temperature, humidity, brightness and pressure. They can be fitted with a microprocessor which consumes a small amount of energy. Such microprocessors are broadly referred to as smart sensors, as they possess a certain intelligence, enabling them to detect the desired variable and convert the information directly at the measuring point into a suitable form for processing on a higher level.

The counterparts of the sensors are actuators. These perform actions in response to electrical signals. They are classified as drive systems. Actuators convert electrical signals into mechanical

work or other physical variables. These drive elements can be found, for example, in door or window actuators.

Sensors and actuators can communicate, for example, via bus systems such as KNX and LON. These systems facilitate an exchange of commands and information within private residences in accordance with a set of rules.

6.3.2 Data created in various use cases in the Smart Home

Various user types and application scenarios which create their own specific data and therefore require a corresponding data throughput in the home network can be identified. Figure 25 below represents eight different areas of the Smart Home and their typical data volumes.

Application scenario	Home electronics	Telecommu-nications	Energy supply	Security and safety	Convenience	Household appliances	Electro-mobility	Smart Metering
Examples of devices	IPTV, television, video, photos, audio, games console	Telephone, smartphone, tablet, notebook, PC	Distributed power genera-tion facilities, HVAC, energy management systems, electri-cal and thermal storage, Smart Meters	Door, window, smoke alarm, sensors for intrusion, access, presence	Lighting, temperature, presence, door, window	Washing machine, dryer, dishwasher, refrigerator, deep freezer	Electric vehicle, electric scooter, pedelec	Electricity, gas, heat, water, Smart Meter Gateway
Data volume	High (Mbit/s)	Medium (kBit/s)	Medium (kBit/s)	Low (kBit/s)	Low (kBit/s)	Low (kBit/s)	Low (kBit/s)	Low (Mbit/s)
Security	Low	High	High	High	Low	Medium	Medium	High
Availability	Low	Medium	High	High	Medium	Medium	Medium	High
Power con-sumption (communica-tions node)	High	Medium	Medium	Low	Low	Low	Low	Low
Regulated	No	No	No	Yes (partly)	No	No	No	Yes
Owner	Home owner/ tenant	Home owner/ tenant	Home owner/ tenant, possibly utility	Home owner/ tenant, possibly operator	Home owner/ tenant	Home owner/ tenant	Home owner/ tenant	Utility

Figure 25: Data volume from different Smart Home areas

The pure data communication by the building automation components (control centre, sensors and actuators) requires only a very small volume of data.

6.3.3 Gateways

In the classical sense, a gateway in home automation connects different systems. The individual systems are not necessarily interoperable in themselves. For that reason, gateways are used to connect the different systems via middleware, so that as a rule information and signals can be exchanged bidirectionally. The variety of technology has led to gateways with more than two bus systems being available in recent years.

The growing requirements with regard to the networking of different domains in overall systems will continue to justify the existence of classical, stationary gateways. Above all the networking of the smart meter world with the world of energy management or classical home automation through a smart meter gateway will give rise to new requirements for the implemented interfaces and security systems (WAN / M-BUS / HAN CLS (cf. BSI TR3109)). In addition, the connection to a WAN will also more and more frequently require gateways to adopt additional router functionalities. In this way, the systems and technologies which have to date been primarily local are opening themselves up to the outside world (internet).

7 USER STORIES AND USE CASES

The following format has been adopted for the description of user stories and use cases:

A user story is a purely textual description of a Smart Home application, which generally spans more than one domain, from the point of view of the user. A user story can be broken down into several, less complex, use cases. Use cases are described from the points of view of different actors, e.g. user, system, device or function. The following information is compiled from the use cases in the form of sequence diagrams: definition and derivation of the functions and data, communication partners and flow direction (cf. TR 62746-2).

7.1 Example of a user story

A user story may exist as a purely textual description. For a clearer presentation of the sequence of individual steps from the perspectives of the actors, a tabular form can be advantageous. A template has been created, into which the user story is entered together with additional information.

The following user story, “Flexible start of a washing machine” is an example of this method of presentation.

Table 5: Example user story, “Flexible start of a washing machine”

Identification	
Name	Flexible start of a washing machine
Identity no. User Story	US_1
Definition	
Initiating actor	SD (washing machine)
Precondition	There is a connection to the CM. The service provider platform is active and has electricity prices available.
Postcondition	The current electricity prices are stored on the home service platform.

Functionality		
	Customer Manager (CM)	**Smart Device (SD) (in this case a washing machine)**
Process sequence		The user prepares the washing machine (puts the washing in and loads washing powder) and • selects the desired washing program, • sets the finish time (e.g. 8 p.m.), • sets optimization parameters if applicable (e.g. best tariff, environmental aspects, etc.), and • switches the machine to standby.
		The washing machine informs the CM of • the start of a new program, • the preselected latest completion time, • the selected incentive variable (e.g. electricity price), and • the expected energy consumption and the duration of the washing process
	The CM determines the sequence plan on the basis of the information available: • The selected optimization parameters • Tariff information • Energy profiles of the provider • The expected energy consumption of other washing machines • The expected energy consumption of the requesting washing machine The CM sends the calculated start time to the washing machine.	
		Washing machine starts.

Alternative process sequences

The user stories enable the expert to describe the functional relationships of a concrete use case in his own language without being held up by the obstacles of a formal template. The use case author extracts information from the rather inhomogeneous user stories, including a set of roles and actors which are used jointly as the basis of the use cases. In this way, mapping of zone-specific actor's names (e.g. market actor's name, legal actor's name, etc.) to logical actors takes place.

7.2 Example use cases

The example, "Flexible start of a washing machine" presented in section 7.1 can be divided into use cases. These can be presented in the form of sequence diagrams, with the individual communication steps between the actors shown as labelled arrows.

The use cases derived from this user story are shown below in the form of sequence diagrams as examples.

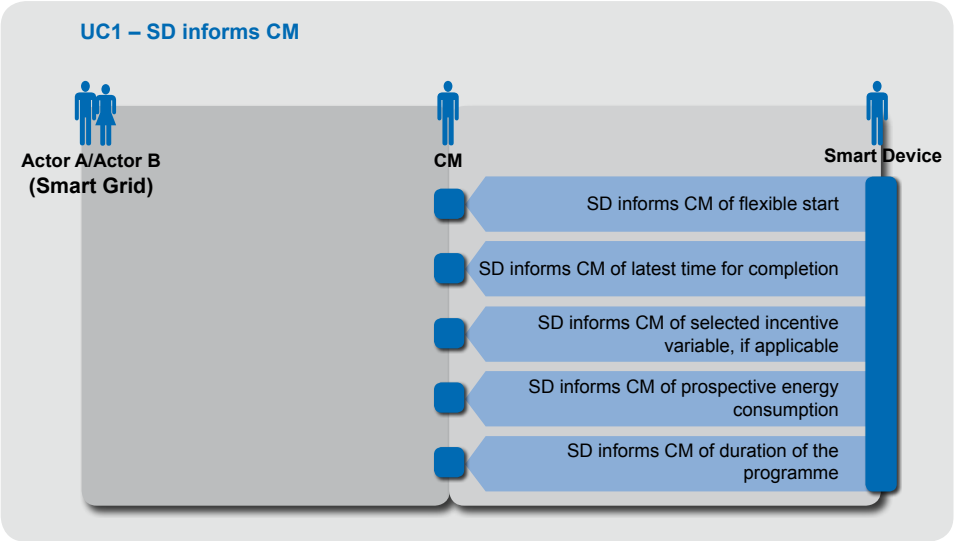

Figure 26: Use case 1 – SD informs CM

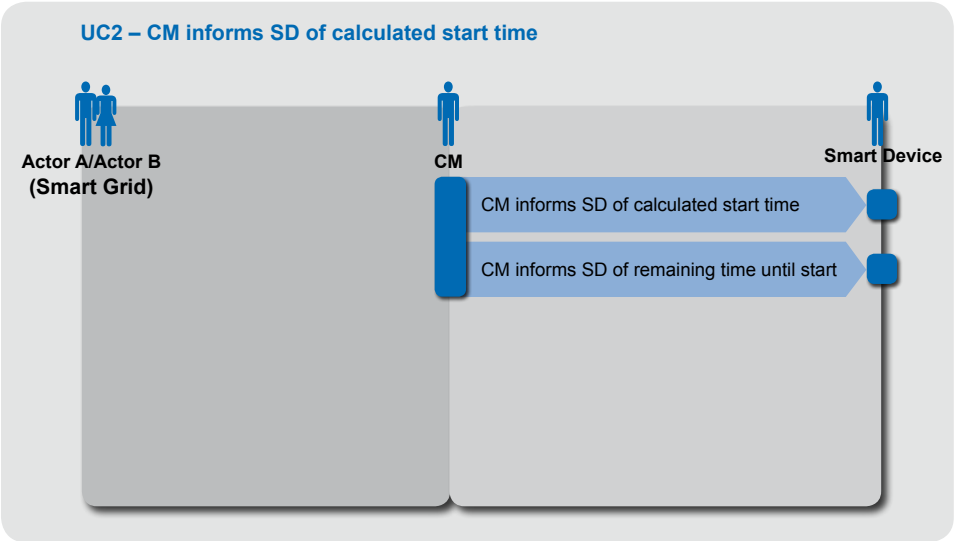

Figure 27: Use case 2 – CM informs SD of the calculated start time

The use cases are also used to identify the data exchanged between actors and the necessity of confidentiality, availability (quality of service) and integrity (authenticity and nonrepudiability) as provided for by the data protection and data security requirements is stated.

8 SAFETY AND PROTECTION IN THE SMART HOME + BUILDING

The consciousness of safety in the Smart Home is increasing, both among users and on the market. A distinction must be made between functional safety and IT security. Functional safety refers here, as the term indicates, to the safe and reliable execution of the functionalities of the various use cases, while IT security is more concerned with the protection of data and defence against attack from outside. The two areas partly merge when, for example, a critical functionality is to be performed in a network. As a result of increasing networking, a holistic consideration of this complex of issues and an interoperable safety and security concept are essential for the Smart Home of the future.

8.1 Safety of household and similar electrical appliances

DIN EN 60335-1 (VDE 0700-1), “Household and similar electrical appliances - Safety - Part 1: General requirements (IEC 60335-1:2010, modified)” sets down requirements, among others, on functional safety arrangements for household and similar electrical appliances which use programmable safety-related electronic circuits (PECs).

It is generally assumed that all components associated with the functional safety of an appliance will fail at some time during the life of the appliance.

The requirements in section 19, together with those in sections 20, 22, 24 and 32 of Part 2 of the IEC/EN 60335 series, form the functional safety plan referred to in IEC/EN 61508 which must be covered by the design of the appliance. The tests associated with the sections cited constitute the validation procedure by which the equipment design is to be assessed.

Programmable electronic components which use software with functions that are covered by section 19 and sections 20, 22, 24 and 32 of Part 2 must be designed in such a way that they fulfil the requirements listed in Table R.1 of IEC/EN 60335-1. For certain hazardous equipment functions, it may also be necessary to have software which fulfils the requirements of Table R.2.

The conditions for the software development and the testing process have been taken from IEC/EN 61508 and adapted to suit the requirements of the IEC/EN 60335 series of standards.

IEC/TC 61 publishes the latest issue of a guidance document concerning functional safety of appliances using programmable electronic circuits at irregular intervals. Its contents are reproduced in a national appendix to DIN EN 60335-1 (VDE 0700-1). On the national German level, the topic is dealt with in DKE/AK 511.0.4, “Functional safety aspects of electronic circuits and telecontrol (including Smart Grids) in household and similar electrical appliances”.

8.2 Information security in the Smart Home

A Smart Home comprises privately used indoor residential and office space (no matter whether this is owned or rented, a house or a flat, or old or new). The Smart Home is thus also an unlimited entity comprising dwellings in a correspondingly large structure (high-rise or residential block), provided that the private sphere is catered for and individual needs of the residents for safety and security, convenience and energy efficiency are fulfilled. The Smart Building differs from this in that it is a commercially used building. With the Smart Home, the focus is on private individuals. In contrast, with the Smart Building, the focus is on the building itself. The mechanisms for signalling should however be the same.

Consciousness of the issue of security is also increasing in the Smart Home context: security in the collection, storage, processing and transmission of data and information is a fundamental condition of modern and future-proof Smart Home systems – above all with regard to their market acceptance. The functional and non-functional requirements from the individual Smart Home areas such as safety, convenience, home automation, air conditioning, heating and ventilation, energy management, telemedicine or ambient assisted living (AAL) are therefore being identified and collated in cooperation with the responsible standardization committees. Account is to be taken of the requirements on all levels of a Smart Home system, from an individual sensor to a cloud management system.

For standardization, this results in the challenge of creating an extensively interoperable and secure overall system from the many different technologies and stand-alone solutions, facilitating a broad range of use cases from the viewpoints of end-users, manufacturers and service providers. The interoperability of the different technologies in the Smart Home is to be established by middleware/gateway functionality. The WAN interface of this gateway is of special im-portance with regard to IT security, as it has to provide a secure way for local devices to com-municate via the WAN.

Existing standards (e.g. IEC 62351 and IEC 27002/27019 from the Smart Grid domain and the results from the SGIS) should be taken into account in the security considerations. Special at-tention is also to be paid to the German and European data protection requirements, as data on presence, diagnoses and even TV viewing habits can be sensitive information.

The aim is to develop uniform security requirements and standards for all the products and application areas in the Smart Home, so as to adequately counteract the dangers resulting from an increasingly networked and interoperable world of applications.

The requirements for the selected security mechanisms for communication inside and outside the Smart Home reflect the fundamental aims of information security. These are confidentiality, integrity and availability, with differentiated views of the various use cases. Personal data, for example, have relatively high confidentiality requirements, while for data relevant to safety the focus has to be on integrity and availability.

8.2.1 Communication security

A partial aspect of information security in the Smart Home is communication security, which defines the requirements for all measures and systems which organize the transmission of data between any two devices. Communication security can refer both to encryption of the transmission channel and to the reliability of transmission. There are a series of standards and specifications for the encryption of the transmission channel: TLS is mostly used to secure IP connections. Securing of the connection by TLS 1.2 with Perfect Forward Secrecy is recommended by the BSI [22]. AES-128 is in widespread use as an encryption method and is also used for encryption in many wireless technologies. With TLS 1.2, AES-128 is also mostly used for symmetrical encryption. For narrow band systems, AES-128 should be operated in a mode which does not require padding. The reliability of communication must take account of the following aspects:

- Susceptibility to disturbance of communication by desired participants
- Susceptibility to disturbance of communication by undesired participants
- Measures to transmit information on disturbance of a transmission channel
- Measures to detect and signal the interruption of a communications link

Depending on the security level and the area of application, appropriate measures are to be taken and described in the course of further development of the standards for the Smart Home.

In particular, results already obtained from standardization in the fields of professional fire protection and burglary prevention, and the energy and automation sectors, are to be observed and adapted (fine specification and profiling).

The security concept should also include the topic of data economy, according to the maxim that data which are not transmitted cannot be misused. Suitable recommendations could be compiled in this respect and taken into account in the various use cases. This issue can be pursued at the interfaces with corresponding filters. With certain devices, the user should also be given the opportunity to switch between different data economy modes (e.g. none, unidirectional or bidirectional WAN communication).

It will be a further challenge to standardization to establish sufficient security for use cases in which the focus is on small sensors and devices. For cost reasons, these frequently do not have enough computing power for asymmetrical processes or secure hardware, for example for the saving of private keys from a PKI. In most cases, there is also no facility for input of pre-shared keys, as savings were made in the past in the area of security for reasons of cost and user-friendliness. Standardization will have to resolve these issues if end-to-end security is to be implemented.

8.2.2 Communication across technology boundaries

As already mentioned, the establishment of interoperability is one of the most important aims of standardization, and decisive for the success of the Smart Home. A secure “transmission bridge” in the form of middleware or a gateway has to be implemented to overcome the technology boundaries between the individual stand-alone systems and ensure secure transfer of data between the technology domains. In the course of the security examination, the different communications technologies have to be qualified for particular security levels. The bridge between WAN and LAN, especially, has to be handled with great care in standardization, so as to protect the local network from attacks via the WAN interface. Connection to a cloud or a service provider, and remote access by the user to his home via the internet are examples of use cases in which the WAN interface requires a special degree of security.

8.2.3 Protection profile for a Smart Meter Gateway [15]

The increasing feed-in of energy from renewable sources confronts future energy supply systems with very great challenges. On the one hand, the feed-in of energy from renewables takes place at unpredictable times, and on the other hand energy consumption can lead to considerable peak loads at certain times of the day.

According to the European Union, this situation is to be remedied in future by smart grids which provide for more flexible and at the same time more secure energy supply. In the course of the establishment of such smart grids, smart metering systems are to be used at the consumers’ premises. By using these, consumers will have greater transparency concerning their own energy consumption and the opportunity to reduce energy costs by controlling electricity consump-tion.

As personal consumption data are processed and collected in metering systems and there are potentially negative feedback effects on the security of energy supply, the requirements for data protection and data security are high. Attacks by hackers on smart metering systems such as have been reported in the USA and newer hazards such as the Stuxnet malware clearly illustrate the necessity of secure solutions for the introduction of smart metering systems in Germa-ny.

In the implementation of its energy strategy, the federal government is planning a step by step introduction of smart connections to the energy grid for consumers and producers. The share of renewable sources in electricity generation is to rise to at least 35 % by 2020 and at least 80 % by 2050.

Against the background of possible threats, the federal government considers legally binding requirements for the security architecture of smart grids to be necessary, in order to ensure that data protection and data security are ensured right from the start. The BSI was mandated by the

Federal Ministry of Economic Affairs and Technology in September 2010 to create a protection profile (PP) and thereafter a technical directive (TR) for the communications unit of a smart metering system (Smart Meter Gateway), in order to ensure a uniform technical standard of security for all market players. The protection profile and the technical directive are enshrined in the Energy Industry Act (EnWG) and in the energy package which was passed by the German parliament on 30 June 2011. Since the start of 2011, the BSI has, in close cooperation with the Federal Commissioner for Data Protection and Freedom of Information (BfDI), the Physikalisch-Technische Bundesanstalt (PTB) and the Federal Network Agency (BnetzA) produced a draft of a "Protection Profile for the Gateway of a Smart Metering System". In several comments sessions, associations from the fields of telecommunications, energy, information technology, housing and consumer protection have been able to make extensive comments on the protection profile and thus play a decisive part in its development. In the field of standardization, various committees have been established at DKE to harmonize the national regulatory requirements of the technical directive with international standardization activities, both from the metrological point of view and in the area of energy management in the Smart Home. In addition, there are approaches in the standardization field to using the smart meter gateway as a secure interface in properties allowing added value services from the Smart Home domain (e.g. AAL) to be transacted.

8.2.4 Security architecture with data protection zones

Many of the data which are processed and stored in homes are personal or can be related to persons. In order to avoid undesired conclusions being drawn about the behaviour of residents, a data protection strategy in the Smart Home is essential. The principle of “privacy by design” must be a fundament objective ensuring confidentiality. This is both required by law and necessary to ensure acceptance by users.

To reduce the complexity of security considerations, it is proposed that the security architecture be divided into data protection zones. In private residences – especially rented flats – the responsibility for operational management will not always rest with the user. A distinction between users and those responsible for data protection is therefore necessary.

The data protection zones may be the following:

- Room
- Apartment
- Building (residential or commercial, etc.)
- Areas of enterprises with protection requirements for cloud services (including data storage and processing of personal data)
- Application software modules inside a device

Communication between data protection zones is routed through secure channels. For each protection zone there is a Responsible Operator who ensures, for example, availability and data protection. For a dwelling, this can be the owner, an appointed third party or the resident. The ambient conditions which are to be assumed for the purposes of a risk analysis can be described for each data protection zone.

The aim of this architecture concept is to facilitate both private cloud operations and the use of apps on devices when the requirements for separation have been sufficiently implemented and verified.

8.3 Fire protection

Apart from the security and protection of data, the safety of the users and the inventories inside buildings have to be ensured.

The fire protection regulations valid in Germany are to be complied with in accordance with the Building Codes of the German federal states and the European Construction Products Directive.

Fire safety in the Smart Home can be increased by the incorporation of smart fire detector and fire extinguisher systems and the use of construction products with high level classifications in terms of fire behaviour (e.g. cables with improved behaviour in the case of fire).

8.4 Fire detection systems

In order to ensure that persons in private households are protected from fire, the fire detection system must be an integral part of the safety concept. It is to be an alarm system which detects fire, smoke and heat at an early stage. If events are triggered by one or more fire detectors, these are received and evaluated by the system via a wired or wireless network, and further protective measures are initiated.

According to DIN 14675, “Fire detection and fire alarm systems - Design and operation”, April 2012, (section 5.1, Protection goals), the fire detection system must achieve at least the following objectives:

- Detection of fires as they arise
- Rapid information and alarm to the people concerned
- Automatic activation of fire protection and operating facilities
- Rapid alarming of the fire brigade or other organizations providing assistance
- Clear location of the hazardous area and indication thereof
- Compliance with the following standards and guidelines in planning, design, installation and maintenance:
  - DIN 14675:2012-04 – Fire detection and fire alarm systems - Design and operation
  - VdS 2095:2010-05 – VdS Guidelines for automatic fire detection and fire alarm systems - Planning and Installation
  - DIN VDE 0833-2 VDE 0833-2:2009-06 – Alarm systems for fire, intrusion and hold up - Part 2: Requirements for fire alarm systems

8.5 Protection from burglary

Private residences gain in security from networking. The large number of sensors in the household can simulate a variety of scenarios, such as the presence of the residents.

Time-dependent control of shutters can thus protect homes from burglars.

8.6 Intruder alarm systems

An intruder alarm system uses sensors to monitor persons and property. Further functions include evaluating hazard messages and issuing signals. The purpose is to detect and report break-ins.

The following standards and guidelines are to be followed in planning, design, installation and maintenance:

- DIN EN 50131-1 VDE 0830-2-1:2010-02 – Alarm systems - Intrusion and hold-up systems - Part 1: System requirements
- VdS 2311:2010-11 – VdS Guidelines for intruder alarm systems – Planning and installation

8.7 Interoperability of safety and security systems in Smart Homes / Smart Buildings

An extensive safety and security system for Smart Homes or Smart Buildings ideally consists of different types of sensor whose functionalities complement each other. This increases security in the building, as for example motion, temperature, CO2 or smoke sensors cover the individual areas in the building and provide information to the alarm centre when a relevant incident occurs.

The interoperability of such different sensors and actuators in a safety and security system is dependent on the communications platforms on the physical and protocol levels. That concerns Smart Homes and Smart Buildings equally, although the networks in Smart Buildings are much larger (hundreds of sensors) and the sensor systems are more complex.

THE GERMAN STANDARDIZATION ROADMAP SMART HOME + BUILDING – VERSION 2.0 59

Reliable and secure communication across technological boundaries is fundamentally effected via gateways. Interoperability on the same level (e.g. the product/device level) can only be ensured when the manufacturers of the sensors and actuators use the same communications platform. If there is a wireless solution for safety and security systems, the IP500 Wireless Personal Area

Platform (WPAN) is used for large buildings (e.g. office buildings, trade fair halls, factories or large sports stadiums) – see the following diagram of the platform.

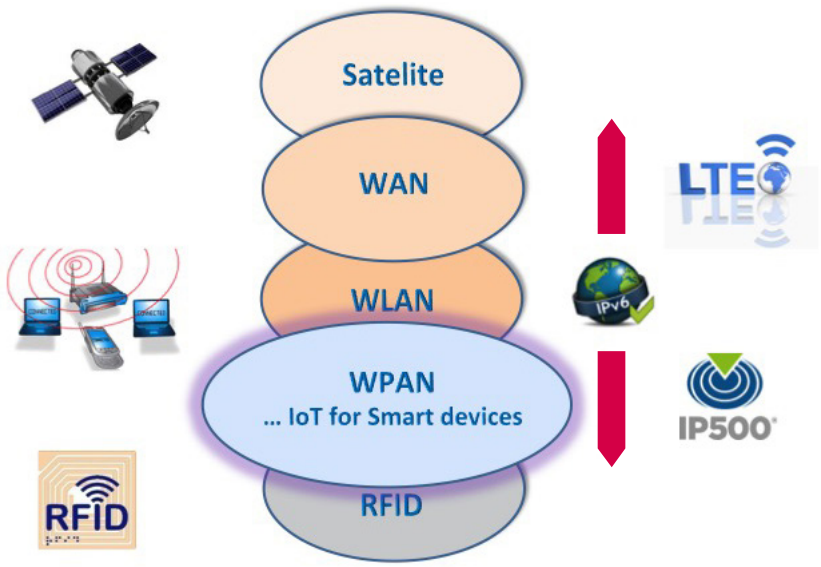

Figure 28: IP500 platform

The IP500 platform ensures stable and reliable communication for the safety and security products (fire, access or evacuation) in the wireless network, as does use of the suitable frequency ranges (sub-GHz and out-of-band) to IEEE and ETSI standards, and the use of IPv6-based protocols in harmony with EN 5425 or VdS Guidelines.

With this interoperability, safety and security systems can communicate reliably via wireless networks and thus form the platform for the Internet of Things market for Smart Homes and Smart Buildings.

8.7.1 Interoperability of wireless sensor networks (WPAN)

Wireless sensors have the great advantage that they can be fitted very simply at a wide range of locations in a building. Installation costs for sensor products can thus for the greatest part be avoided. The IP500 access points (A) or router (R) (see diagram below) merely have to be connected to the local IT network via an Ethernet socket, as is also the case with a WLAN. If the information from the sensors is to be communicated immediately from the IP500 network through the WAN, GPRS gateways are installed and pass the data into the cloud, for instance to mobile smartphones or alarm centres. In the case of safety and security systems, however, there are also other factors which provide greater redundancy, immunity to interference and availability for the wireless network and thus also the products relevant to safety or security (nodes (N) or actuators (F)). With the flexible network technology based on a mesh topology, a high transmission reliability of the nodes in the IP500 network is also guaranteed. That is enormously important, above all when one network component fails and the information has to be transmitted to the access point along a different route.

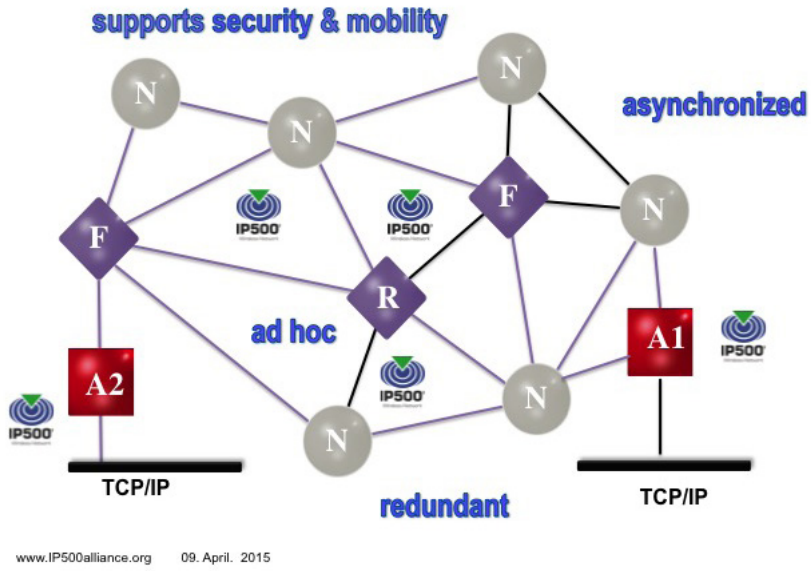

Figure 29: IP500 mesh network topology

The jointly used IP500 platform on the sensor/product level ensures interoperability in the entire wireless network. As a result of the opportunity to have more than one access point (A1 and A2 in the diagram), the use of the IP500 network services provide for a high level of redundancy in the network. Direct connection of the access points to the IT network in the building or home is possible using IPv6/6LowPAN protocols.

In addition, the IP500 access point provides the opportunity to communicate on AT command level with proprietary or standard systems which are already installed. Finally, then, the entire network is mapped in the higher level Building Management System (BMS).

8.7.2 Interoperability in the wireless network on the protocol level

On the basis of a jointly used physical (wireless) communications level and the transmission level of the mesh and network topology of the IP500 platform, a variety of protocols are supported. For Smart Buildings, the protocol “BACnet over IP” is used, and is becoming more and more widespread across the globe. For applications in Smart Homes, the KNX protocol is supported. However, different protocols such as M-BUS, ECHOnet, etc. will also be supported in future. This is then effected via the IP500 access point as a gateway, on the basis of AT commands.

9 QUALIFICATION

A high-quality Smart Building system groups together a wide variety of functions, technologies, industries and actors with highly divergent origins.

In the light of the highly individual customer wishes for the networking of devices and services in buildings, they are obliged to a completely new extent to work together and agree upon technical and organizational interfaces.

Apart from a large number of technical problems still to be solved, the systematic initial and further training of people at all the stages of the Smart Home / Smart Building value chain constitute a special challenge. For the current players on the building market have up to now only been prepared by their professional training for narrow segments of Smart Building integration – if at all.

If training is left to chance, it can be assumed that “half-educated” players will create Smart Home solutions which fail to satisfy or even frustrate customers’ wishes.

It would then take many valuable years for this promising field of business to overcome the undesirable evolutionary step with frustrated customers, survival of the fittest on the free market and a new start. A further impediment is that the rate of innovation in building has proven to be very slow. New construction and renovation cycles occupy several decades. Willingness to make a new start after an unsatisfactory implementation will as a rule only set in after several years.

It is therefore of great economic importance to all the market participants for a Smart Building qualification system to put the actors rapidly and comprehensively in a position to provide integrative advice for, offer, design, implement and support Smart Home solutions.

9.1 Target groups

For the purposes of Smart Building qualification, distinctions can be made between the following major target groups with an influence on successful implementation:

- Employees of manufacturers and service providers (sales, support, service, etc.)
- Planners and designers
- Civil engineers
- Tradespeople
- Architects
- Wholesalers and retailers
- Housing industry

vHome owners and users

These target groups differ considerably in terms of qualification with regard to

- their core industry,
- their previous education and training,
- their familiarity with technology,
- their ability to study privately,
- their requirements for a breadth of subjects, and
- their requirements for subject depth

9.2 Requirements for a Smart Building qualification model

Against the background stated above, the requirements for a Smart Building qualification model can be summarized as follows:

A suitable Smart Building qualification system for employees is characterized by:	Explanatory notes
Step by step introduction	With a view to the pressing demands for expertise from the current players on the Smart Building market, qualification is to be introduced in the following steps: Step 1: Qualification for employees Step 2: Incorporation of relevant topics in apprenticeships/ university courses
Structuring in • **"Basic seminars for all"** **and** • **"Specialist seminars" to be selected**	With the enormous breadth of subject matter and the variety of technical solutions, it rapidly becomes clear that it will hardly be possible to educate individual players in all the relevant topics in any depth. It is not realistic for the implementation of complex Smart Home projects to be a service "from one pair of hands". It is important to structure the course materials in basic expertise and core disciplines, with a selection of specializations.
Modular structure	The further training of employees must dovetail with the operational requirements of their companies. Courses taking up several weeks would place too great a strain on firms, both in terms of time and money.
Decentralized venues with several alternative dates each year	Entrepreneurs are more willing to register employees for courses when they do not involve being there on the day before or travelling a long distance. Furthermore, times at which there is space in the order book are popular for training. Flexibility of dates is therefore also important to businesses.

Option of lateral entry for individuals, depending on prior knowledge	A qualification system will hardly gain acceptance if it forces participants to attend courses for which they have already acquired the know-how elsewhere. A good Smart Home qualification system for employees is therefore open in its recognition of previous qualifications and courses outside its own system.
Integration of manufacturers' courses	The more proprietary the content of further training courses and the shorter the innovation cycles, the more the training centres have to do and invest in bringing hardware, software and training staff up to date. By recognizing and sensibly deploying training courses organized by manufacturers, the training concept remains up to date. The manufacturers, for their part, require basic knowledge as a condition for participation in their events and thus concentrate their work for the training organization on their product specifications.
Meaningful qualifications	Further education and training is only taken on when its benefit to the participant and the firm is clear. The qualification certificate must distinguish between broad training and in-depth training.
Promotionally effective certificates for the business	Entrepreneurs are more likely to send their employees to courses when the firm and its customers can present the additional expertise obtained as an effective method of advertising.
Recognition and promotion by as many im-portant market players as possible	Professional training gains when as many participants as possible reach agreement on standard training modules. The results are greater market penetration, a large-scale regional coverage with a large selection of dates, low distance barriers, and continuous updating of high-quality course contents. Manufacturers and professional associations are called upon to point in the same direction.

Integrated e-learning and blended learning concepts	Many subjects can be learned independently of a particular location. It is however important for learners not to be left alone. The integration of (digestible) self-study phases with regular meetings and online conferences places higher demands on the participants, trainers and training centres, but helps to reduce absence from work and keep travelling costs low. Pure e-learning approaches in which the students are left to their own devices have not been very successful in the past, and should only be used in selected areas.
Central body bearing responsibility	A further training system must incorporate technical developments and market changes at an early stage. If the updating and development is left to individual trainers or individual training centres, the comparability of qualifications will rapidly be undermined. In various contexts it has proven successful to establish a body which is responsible for the further development of course con-cepts and subject matter, and the organization of train-the-trainer events. In the best practice examples (see below) these are the KNX Organization for KNX and the ELKOnet experts committee for the expert/specialist course concepts. Alternatively, such a body can ensure the quality of training by means of central examination directives. In this way, the training services providers can be left to fill out the courses (similarly to apprenticeship examinations, etc.).

9.3 Best practice examples

9.3.1 KNX qualification system

With its present market success, KNX, as one of the few non-proprietary systems can serve, with its predecessor EIB, as a model for implementation of a qualification system. Competitors in the market for installation equipment grouped together under the roof of the EIB Association and adopted not only certification rules for EIB products, but also certification rules for EIB training centres and EIB training courses, ensuring that invitations to tender stipulated the demonstration of qualified EIB personnel for the award of contracts. In 1999, the procedure was taken over without restriction in the KNX standard, in which EIB, BatiBus and EHSA were merged.

Manufacturers offer their own training courses, but require demonstration of attendance at an EIB basic course in a certified training centre as a condition for participation. Sound qualifications were recognized from the start as a decisive key to the success of a system, and firmly anchored in that process. The quality of training is ensured by the stipulation of examination regulations and their monitoring at training centres.

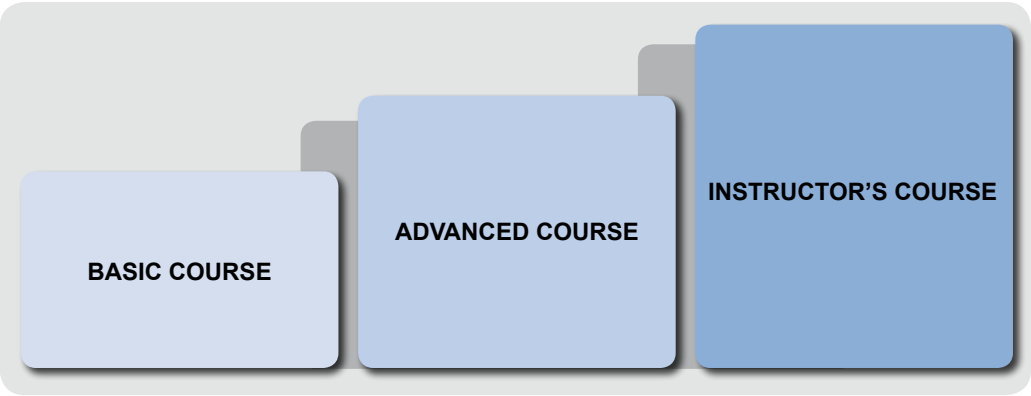

Figure 30: Qualification system of the KNX Association – firmly anchored in the standard right from the start (picture: Sassmannshausen)

9.4 Best practice example 2: ELKOnet qualification system

In the ELKOnet association of training centres, further training for employees is available in a modular form. The modules cover durations of between one and five days. For each training module called up and passed, the student receives an entry in his Skillcard.

When all the modules of the mandatory area have been passed, the title of “Specialist (ELKOnet) in ….” is awarded.

If further optional training is pursued, the title of “Expert in ….” Is awarded.

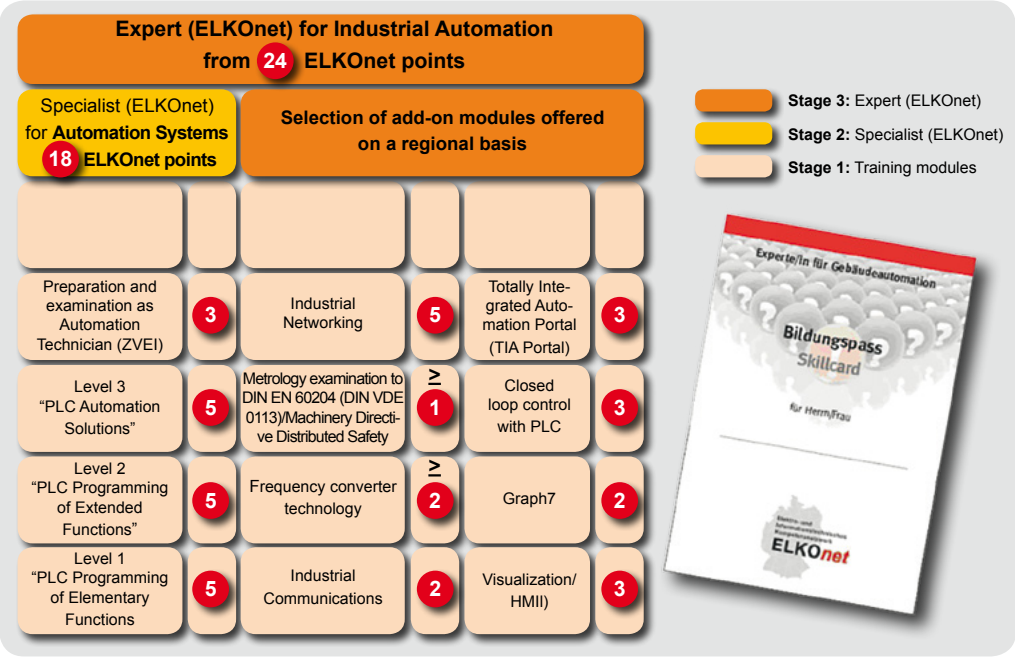

Figure 31: ELKOnet qualification using the example of industrial automation (source: ELKOnet)

Figure 31 illustrates the ELKOnet qualification process with the example of industrial automation. When the modules in the left-hand column (mandatory area) have been completed, a qualification as “Specialist (ELKOnet) in Automation Technology” is achieved. Further training leads to the qualification as an “Expert in Automation Technology” (source: ELKOnet).

Many modules lead to the award of a certificate.

If a firm can demonstrate that it employs a specialist or expert, that firm receives the right to use the title “Specialist contractor for …” or “Expert contractor for …”.

The modules are harmonized and can be obtained from all ELKOnet locations. Comparable know-how obtained from manufacturers’ seminars is also recognized.

9.5 Draft of a Smart Home qualification concept

Starting from the ideas presented above, a Smart Home qualification could be structured as follows:

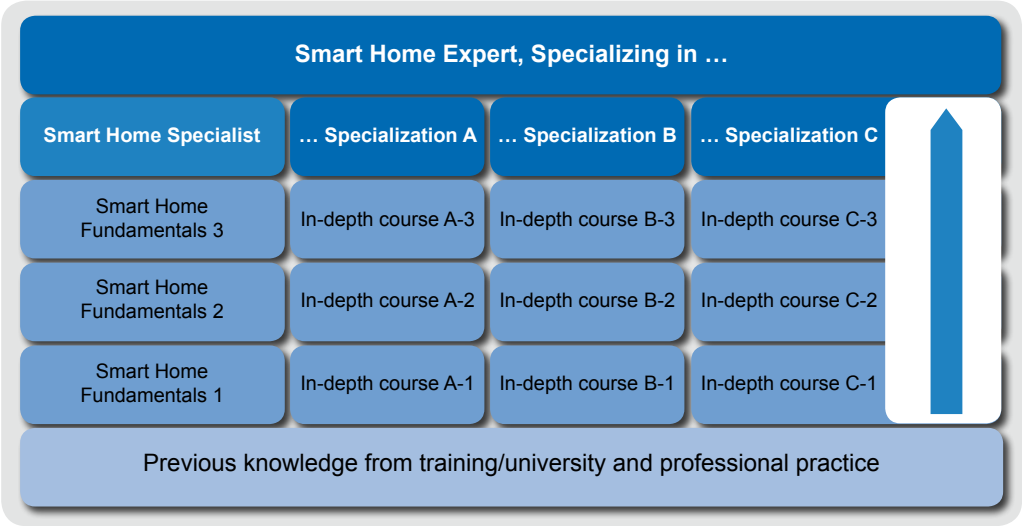

Figure 32: Specialist columns

To simplify presentation, the term Smart Home has been used throughout. The system for Smart Buildings would be exactly the same.

9.5.1 Basic skills and core disciplines

The following topics come into consideration from the present point of view as the fundamental subjects in the specialist columns (see Figure 32):

- General overview of Smart Home/Smart Building
- Users and their requirements; benefits
- Significance of the energy transition and the ageing population
- Smart Home implementation means teamwork: Who does what with the Smart Home?
- Basic knowledge of building automation
- Transmission media and their properties
- Basic knowledge of data network technology
- Overview of systems and their properties
- Applicable standards, regulations and provisions
- etc.

9.5.2 Areas of specialization for experts

The specialization skills are intended on the one hand to provide sufficient room to accommodate as many main fields of activity as possible, but on the other hand the number of specializations should preserve clarity for the market partners. A breakdown by main fields of business or by sectors of industry appears appropriate, e.g.:

- Smart Home Expert, specialization in electrical engineering
- Smart Home Expert, specialization in heating, air conditioning and ventilation
- Smart Home Expert, specialization in household appliances
- Smart Home Expert, specialization in entertainment electronics
- Smart Home Expert, specialization in AAL
- Smart Home Expert, specialization in security systems
- Smart Home Expert, specialization in Smart Home planning
- etc.

10 REQUIREMENTS FOR ACTION AND RECOMMENDATIONS

Progressive digitization and networking have in the past triggered off a series of paradigm shifts: letter post and telephone are being increasingly replaced by email, smartphones and social media. Tablets are becoming an alternative to the personal computer. The press, radio, TV and home electronics are facing increasing competition from internet-based services. These transitions are being facilitated and accelerated technically by the broadband expansion of the internet and the mobile telephony networks. It is therefore consistent for the paradigm “living in a home” to be undergo a dramatic change as a result of the networking of devices and components in the house and with the outside world. This is then the Smart Home, a basis for cloud services and smart services. This transition depends on the interplay of suitable technologies and flexible platforms, and the willingness of the end-users to put up with and take part in this paradigm shift.

In technical and technological terms, everything necessary to create Smart Home solutions suitable for the mass market appears to have been in place for years, but the Smart Home is still at the start of its first period of expansion. In the meantime, further technologies and platforms have been added, and new alliances on the Smart Home and Internet of Things have formed worldwide. There is no longer any doubt that Germany is an important and growing market for Smart Home solutions, and German companies lead the field in many segments. The increasing pressure of competition on the international level too, and the formation of a multitude of initiatives for various integration platforms and ecosystems illustrate this trend. Energy management and health assistance systems are, from today’s point of view, the Smart Home segments with the greatest market potential. This potential could be exploited if, for example, it were possible to extend the criteria for governmental subsidies such as those under the terms of the German Reconstruction Loan Corporation (KfW) to Smart Home systems. For that pur-pose, a suitable reference system would have to be defined, permitting the derivation of the necessary performance requirements. As an example of a similar procedure, reference could be made to thermal insulation of buildings: for the granting of a KfW loan, insulation requirements which are more stringent than those of a reference building have to be fulfilled.

In the light of the variety of available networking technologies and platforms, interested end-users often feel more confused and unsettled than well informed. Quite rightly, they expect the selected system to provide the necessary future-proofing, which, however, in the light of the increasing competitiveness on the market, cannot in any way be guaranteed. In addition, the information security and data protection expected during the operation of a system appear still not to be guaranteed. Networking and configuration of the systems in many cases overtax the technical skills of the customers, and tradespeople are often unable to provide them with the necessary advice and support for the maintenance or expansion of their systems. In practice, it has become apparent that a Smart Home system once successfully configured is only seldom re-configured, even in the case of a significant change of use, because end-users are reluctant to bear the costs or cannot find any suitable tradespeople to perform that task. A mass market cannot form in this way.

Flexibility of the system, interoperability across system and technology boundaries, information security and data protection are the central requirements which Smart Home solutions will have to fulfil in future if they are to be sustainably successful in the impending mass market.

In recent years, a series of alliances and initiatives have been formed and have agreed on common, non-proprietary protocol standards. Others have focused on integration platforms for Smart Home applications or, extensively, on the implementation of services in the realm of the Internet of Things. It is remarkable that all these stakeholder groups have recognized that their success is decisively dependent on interoperability across the borders of technologies or protocols. By abstraction of device properties and with the aid of standardized application program ming interfaces, it is to be made considerably easier for software developers to implement attractive Smart Home applications.

As in the past the variety of network technologies finally ruined a breakthrough into the mass market, the variety of open integration platforms now threatens to construct a similar obstacle. For this reason, it is important to harmonize the data models on which these platforms are based, to bring about the necessary convergence of the platforms, and to achieve interoperability up to the semantic level. A first step in this direction was a European funding project on Smart Appliances, in which it was possible to derive an all-encompassing, generally valid data reference model (ontology) from a variety of data models in different platforms; this became known as SAREF. The SAREF ontology is itself a possible starting point for the creation of a standard for semantic interoperability.

To summarize, the above statements can be described as three recommendation clusters:

- Promotion of market developments by systems of incentives (e.g. subsidized loans)
- Greater involvement of the craft trades by professional development (training)
- Harmonization of the work on interoperability of systems (sustainability)

In order to achieve market leadership in the field of Smart Home + Building for Germany in the face of international competition and further expand it, and in order to keep the technological development and the value creation in Germany, the developments and the underlying interests will have to be systematically developed and concerted at an early stage. For the successful positioning of German industry in this context it is important to include the favourable effects of standardization in this development process from the very start and to exploit them in full.

There are a large number of competing suppliers with different approaches to smart building automation. The building automation systems which have been developed are complex systems whose use means greater convenience, higher energy efficiency and significantly improved security. The European suppliers are well positioned with a large range of functioning systems and economically usable components.

Nevertheless, all the market players have been waiting for over 10 years for the great breakthrough on the mass market. Smart Home solutions continue to be regarded by consumers as

luxury goods for wealthy homeowners. All the market players agree that the lack of standards and specifications, lacking convergence and the lack of a presentation of the benefits have obstructed that breakthrough for over 10 years. For that reason, the consortium regards this standardization roadmap as an essential component in a market development strategy.

At the time of writing, the following standardization roadmaps have been compiled by VDE|DKE and are being put into practice:

- Standardization Roadmap AAL 2.0
- Standardization Roadmap Electromobility 3.0
- Standardization Roadmap E-Energy/Smart Grids 2.0
- Standardization Roadmap Mobile Diagnostic Systems 1.1
- Standardization Roadmap IT Security 2.0
- Standardization Roadmap Industry 4.0, Version 2

The methodology in this Standardization Roadmap Smart Home + Building 2.0 also directs activities towards the desired functionalities and use cases which are to define a complex system. The procedure must cross the boundaries between domains. In contrast to the use cases of the Smart Grid, the use cases of a Smart Home system have already been quite extensively defined in recent years. Nevertheless, the integration of e-mobility and e-energy/ smart grids topics in the Smart Home system will require adjustment and also new use cases.

Figure 33 below shows the workflow of the use case methodology, and its application as required by the issue at hand is recommended.

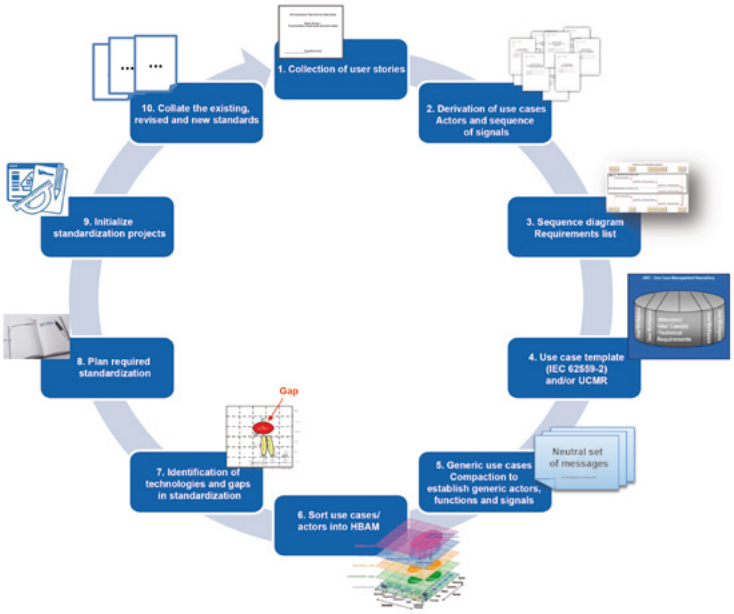

Figure 33: Sustainable process of standardization

With a jointly agreed domain description and a detailed stipulation of the use cases on the function, information, communications and component levels, this methodology achieves integration of the various bodies involved in standardization. It is concerned with the definition of requirements for applications, the reduction of complexity, the establishment of consensus and the creation of a common understanding.

Attention to the many different partial systems and domains in the Smart Home with the corresponding professional groups is to be promoted.

It is recommended that German enterprises and the various Smart Home stakeholder groups with their extensive experience be intensively involved in the process.

Similarly to the procedure with the Standardization Roadmap on E-Energy/Smart Grids 2.0, it is recommended that all interested parties be involved by the establishment of an openly accessible web portal.

There are already many international and national standards in the field of building automation, which have to be taken into account. Implementation of this aspect requires cooperation on the national and international levels. In that context, the focus of standardization must be on the establishment of interoperability and the creation of an ergonomic user interface.

If one considers the focal areas of research for the EU Commission, it becomes apparent that the various standardization activities on “AAL”, “E-Energy/Smart Grids”, “Electromobility” and also “Smart Home” are networked under the rubric of “Smart Cities” and in some cases are to be merged. In this way, the use of common infrastructures in the Smart Home, the use of comparable approaches and similar methods and standards will create links between Smart Home systems, smart metering installations, energy management gateways, AAL systems and electromobility solutions.

11 ABBREVIATIONS

Abbreviation/Acronym	Meaning
AAL	Ambient Assisted Living
AES	Alarmempfangsstellen (alarm receiving points)
AG	Arbeitsgruppe (Working Group)
ANSI	American National Standards Institute
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
BACnet	Building Automation and Control Networks
BIBBs	BACnet interoperability building blocks
BMBF	German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung)
BMU	German Federal Ministry for the Environment, Nature Conservation and Reactor Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit)
BMWi	German Federal Ministry of Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie)
BSI	Federal Office for Information Security (Bundesamt für Sicherheit in der Informatik)
CCD	Continuity of Care Document
CCR	Continuity of Care Record
CD-R	Compact Disc – Recordable
CDA	Clinical Document Architecture
CE	Consumer Electronics
CECED	Conseil Européen de la Construction d'Appareils Domestiques
CEPT	European Conference of Postal and Telecommunications
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CHAIN	CECED Home Appliances Interoperating Network

Abbreviation/Acronym	Meaning
CL	CLICK
CLICK	Connected Living Innovation Component Kit
CORBA	Common Object Request Broker Architecture
CSMA/CD	Carrier Sense Multiple Access/Collision Detection
CWMP	CPE WAN Management Protocol (TR-069)
DAI-Labor	Distributed Artificial Intelligence Laboratory
DECT	Digital Enhanced Cordless Telecommunications
DICOM	Digital Imaging and Communications in Medicine
DIN	German Institute for Standardization (Deutsches Institut für Normung e.V.)
DKE	German Commission for Electrical, Electronic & Information Technologies of DIN and VDE) (Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE)
DLNA	Digital Living Network Alliance
DPWS	Devices Profile for Web Services
DSL	Digital Subscriber Line
DVB	Digital Video Broadcasting
DVB-C	Digital Video Broadcasting – Cable
DVB-J	Digital Video Broadcasting – Java
DVB-S	Digital Video Broadcasting – Satellite
DVB-T	Digital Video Broadcasting – Terrestrial
ebXML	Electronic Business using eXtensible Markup Language
EC	European Community
eCall	Emergency call
ECG	Electrocardiography
EDGE	Enhanced Data Rates for GSM Evolution

Abbreviation/Acronym	Meaning
EHRcom	Electronic Data Interchange for Administration, Commerce and Transport
EEC	European Economic Community
EHRcom	Electronic Health Record Communication
EHS	European Home System
EIA	Electronic Industries Alliance
EIB	European Installation Bus
EMC	Electromagnetic Compatibility
EMG	Energie Management Gateway
EN	Europäische Norm
EPG	Electronic Program Guide
ES	ETSI Standard
ETS	ETSI Technical Specification
ETSI	European Telecommunications Standards Institute
EVG	Electronic ballast (Elektronische Vorschaltgeräte)
FTP	File Transfer Protocol
GFSK	Gaussian Frequency Shift Keying
GSM	Global System for Mobile Communications
HANs	Home Area Networks
HBES	Home and Building Electronic Systems
HGI	Home Gateway Initiative
HL7	Health Level Seven
http	Hypertext Transfer Protocol
HVACR	Heating, ventilation, air conditioning and refrigeration
ICF	International Classification of Functioning, Disability and Health
ICT	International Classification of Functioning, Disability and Health

Abbreviation/Acronym	Meaning
IDL	CORBA Interface Definition Language
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IP500	Internet Protocol 500
IrDA	Infrared Data Association
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JTC	Joint Technical Committee
JVM	Java Virtual Machine
KNX	„Konnex“ (kein Akronym)
LAN	Local Area Network
LLCP	Logical Link Control Protocol
LON	Local Operating Network
LR-WPAN	Low-Rate Wireless Personal Area Network
LTE	Long Term Evolution
M2M	Machine-to-Machine
MAC	Medium Access Control
M-Bus	Metering Bus
MHP	Multimedia Home Platform
NAS	Network Attached Storage
NDEF	NFC Data Exchange Format
NFC	Near Field Communication
OASIS	Organization for the Advancement of Structured Information Standards

Abbreviation/Acronym	Meaning
OEMG	Open Energy Management Gateway
OMG	Object Management Group
OSGi	Open Service Gateway Initiative
PDA	Personal Digital Assistant
PHMR	Personal Healthcare Monitoring Report
PHY	Physical Layer
PICS	Protocol Implementation Conformance Statement
PID	Patient Information Segment
PLC	Powerline Communication
PnP	Plug and Play
ProfiBus	Process FieldBus
RF	Radio Frequency
SDK	Software Development Kit
SG	Strategic Group
SGB	German Social Code (Sozialgesetzbuch)
SIP	Session Initiation Protocol
SMG	Smart-Meter-Gateway
SMTP	Simple Mail Transfer Protocol
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SSL	Secure Socket Layer
SWEX	Software Execution Environment Task Force
TC	Technical Committee
TCP/IP	Transmission Control Protocol/Internet Protocol
TIA	Telecommunications Industry Association

Abbreviation/Acronym	Meaning
TLS	Transport Layer Security
TP	Twisted Pair
TU	Technische Universität
UMTS	Universal Mobile Telecommunications System
UPnP	Universal Plug and Play
URC	Universal Remote Console
USB	Universal Serial Bus
VDE	Association for Electrical, Electronic & Information Technologies (Verband der Elektrotechnik Elektronik Informationstechnik)
VDI	Association of German Engineers (Verein Deutscher Ingenieure)
VPN	Virtual Privat Network
WAN	Wide Area Network
WAVE	Wireless Access in Vehicular Environments
WG	Working Group
WHO	World Health Organization
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Area Network
WS	Web-Services-Specification
WSDL	Web Services Description Language
XD*	(Oberbegriff für XDS, XDR und XDM)
XDM	Cross-enterprise Document Media Interchange
XDR	Cross-enterprise Document Reliable Interchange
XDS	Cross-Enterprise Document Sharing
XML	Extensible Markup Language
XPHR	Exchange of Personal Health Record Content
ZAP	ZigBee Application Profiles

APPENDIX A: TECHNOLOGIES

The technologies described in this appendix represent a non-exhaustive list of the existing frameworks and communications systems in the Smart Home field.

A.1 AirPlay

AirPlay is a collection of protocols by Apple for the transmission of audiovisual content. Audio, photos, videos and screen contents can be streamed using the http live streaming protocol. With the aid of AirPlay, split screens can also be implemented. Originally reserved for Apple's own products, the AirPlay protocol stack can now be licensed by other hardware and software manufacturers.

AirPlay is based on IP and uses a series of further internet standards such as http, XML, RTP, RTSP and SDP. AirPlay uses Bonjour (Apple's implementation of Zeroconf) to locate devices and services with AirPlay capability. Controllers can divert streams from servers to display units or players and control them remotely. AirPlay servers use http digest authentication to secure the contents. Encryption via AES and exchange of keys on the basis of HTTPS provide for additional security. http cookie implements a simple DRM system.

AirPlay can be regarded as a parallel development to UPnP-AV and DLNA.

A.2 BACnet

BACnet (Building Automation and Control Networks) is a network protocol for building automation. It was developed under the auspices of ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers). The aim is the creation of a uniform non-proprietary standard for data communication in the field of building automation. BACnet has been implemented as ANSI/ASHRAE standard 135 and as ISO standard 16484-5.

Interoperability of devices from various manufacturers is achieved by the use of standardized BACnet interoperability building blocks. These blocks define which services and procedures have to be supported to implement particular requirements of the system.

DIN EN ISO 16484-5:2013-09 defines services for communication between the devices, for purposes including joint data use, alarm and event processing, processing of value changes and device and network management. The standard defines object types for the various data, for example for device objects, analogue inputs, digital inputs, analogue outputs and digital out-puts.

The BACnet protocol consists of four layers, which in the case of BACnet/IP have the following structure:

Application Layer (layer 7, application), Network Layer (layers 6, 5, 4, 3, networking), Virtual MAC Layer (VMAC) (layer 2, security; for BACnet MAC addresses with more than 6 bytes ZigBee, IPv6) and BACnet Virtual Link Layer (BVLL) (layers 2, 1, security and bit transmission).

Apart from BACnet/IP, the following alternatives are provided for the two bottom layers: Point to point via RS-232, Master-slave/Token-passing via RS-485, ARCNET, Ethernet, LonTalk and ZigBee.

A.3 BLE (Bluetooth Low energy, Bluetooth LE, Bluetooth Smart)

BLE is part of the Bluetooth standard version 4.0 and defines the technical availability of ultra low power, i.e. very low energy consumption with reduced transmission range (approx. 10 m) in comparison with normal Bluetooth. BLE is optional rather than mandatory for Bluetooth 4.0 products. The main applications are linked devices which exchange small quantities of data at regular intervals, such as wearables and fitness trackers.

A.4 Bluetooth

Bluetooth is an industrial standard (IEEE 802.15.1) for wireless communication, originally developed by Ericsson in the 1990s. As Bluetooth uses the licence-free ISM band (2.402 GHz to 2.48 GHz), the technology can be used worldwide without permits. As Bluetooth communications can be susceptible to interference from technologies such as WLAN, a frequency hopping system is used to reduce disturbances. The frequency band is divided into 79 steps at 1 MHz intervals, which are changed approx. 1600 times per second. From version 2.0 onwards, Bluetooth achieves a maximum transmission rate of 2.1 Mbit/s. In class 1, a range of around 100 m is achieved with a maximum power of 100 mW. [24]

A.5 Connected Living Innovation Component Kit (CLICK)

Das Connected Living Innovation Component Kit (CLICK) (Bild 34) ist eine Entwicklung des DAI-Labor (Distributed Artifical Intelligence Laboratory) der TU Berlin im Kontext des Innovationszentrums Connected Living.

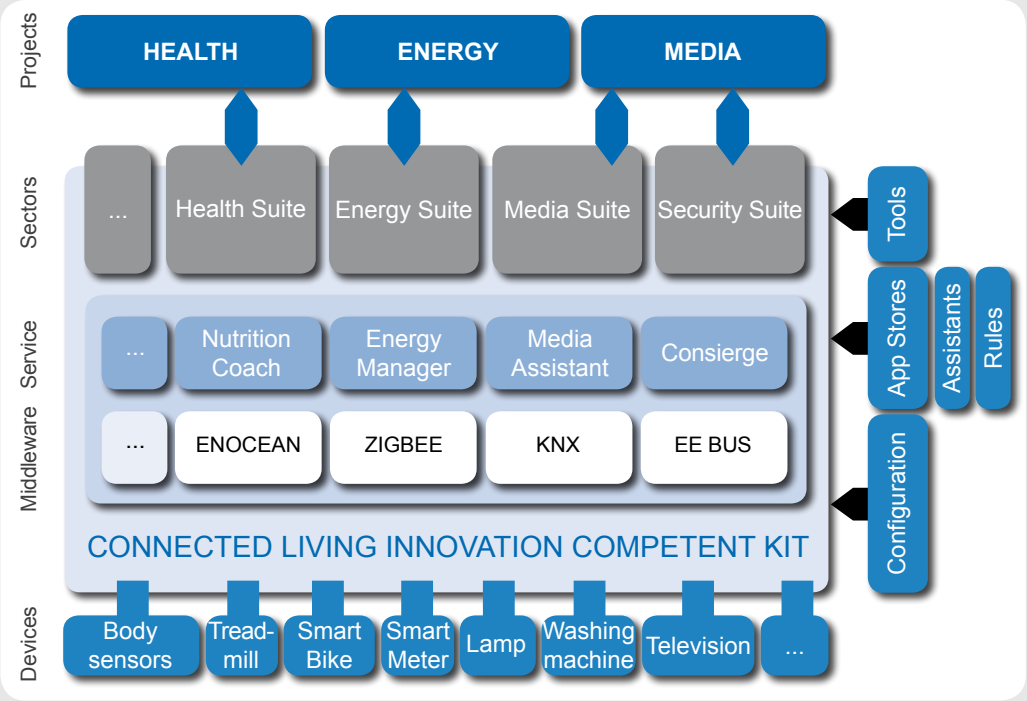

Figure 34: Connected Living Innovation Component Kit (CLICK) [25]

Its aim is to create an open, interoperable Smart Home Platform. For that purpose, CLICK makes a toolbox with various components available for various target groups such as installers, developers, users and providers (Figure 35). These tools provide simple access to all the functions of the home network, and make it easier to operate.

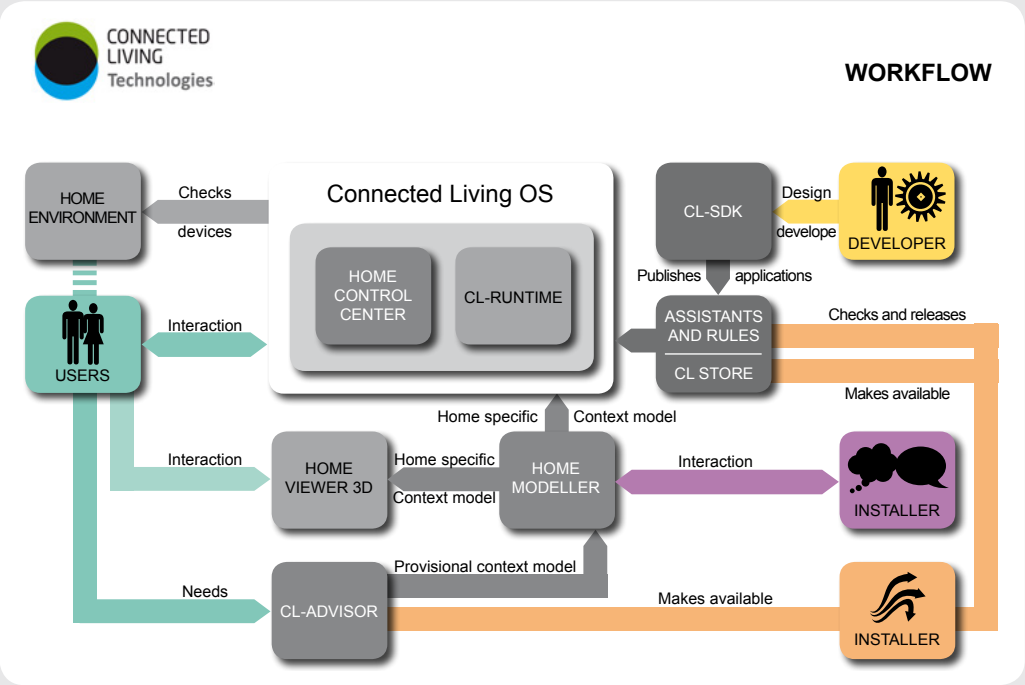

Figure 35: Connected Living workflow [25]

The **Connected Living Advisor** helps the user to plan a customized Smart Home system based on his own ideas and objectives, and indicates what steps are necessary for installation of the system.

The **Connected Living Home Modelling Tool** facilitates configuration of the home environment for the Connected Living assistant. In a first step, the spaces in the dwelling are defined with the home modeller. The configuration of the networked devices and their protocols follows in a second step.

The **Connected Living Home Use Rule Editor** allows the user to create and monitor smart automation rules for the networked home environment. The editor is part of the Connected Living home control centre and is based on the same intuitive interaction concept. With user-friendly interaction techniques such as drag & drop, clear and comprehensible rules for automation of recurrent processes can rapidly be established.

In the form of the **Connected Living Software Development Kit (SDK)**, developers are provided with a guided introduction to programming of assistants for the Connected Living system. By entering a few details at the start of the development, a customized project is launched with a simple assistant whose functionality and interaction design can be expanded at any time. The Connected Living SDK has an integrated connection with the Connected Living Store, and so the user's customized assistant can also be published with only a few clicks.

The **Connected Living Store** constitutes a central platform of the provision of assistants and rules. Developers can upload their newly created assistants and rules direct from the Connected Living SDK to the Connected Living Store, where the assistants and rules are installed fully automatically.

The store contains a smart media assistant and a cooking assistant, and also the Smart Home Energy Assistant (SHEA) which facilitates monitoring and optimization of the household's energy consumption in the form of electricity, space heating and hot water, and the associated costs and greenhouse gas emissions.

The **Connected Living Home Control Centre** provides the user with a central access point to the networked home environment. A clearly structured user interface presents the connected devices and offers intuitive configuration and control options. Apart from the devices, the home control centre also shows the installed Connected Living assistants – the added value services for the home environment.

With the bundling of CLICK to form a Connected Living system, the technological basis of the Connected Living project has been sustainably strengthened. Future Connected Living projects will benefit from these tools and software packages.

A.6 DALI

DALI stands for "Digital Addressable Lighting Interface" and is a control protocol for lighting systems based on IEC standards. The lighting systems have to be equipped with a DALI interface. Communication is based on the DALI protocol and covers the exchange of information and control messages. Each connected device is controlled via its DALI address. The bidirectional exchange of information enables both the condition of a luminaire to be controlled and its status to be polled. A DALI controller can control up to 64 devices, and can be used in building automation as a subsystem via DALI gateways.

A.7 DECT

DECT stands for "Digital Enhanced Cordless Telecommunications", and was originally developed for cordless phones. DECT is a promising standard for control and security systems based on smartphones. It is a standard used worldwide, available in 110 countries. Frequencies around 1.9 GHz are used for radio transmissions, and modulation is by Gaussian Frequency Shift Keying (GFSK).

With the distributed structure of DECT and the implemented automatic organization of the radio channels, DECT systems are highly suitable for the establishment of small-scale cellular radio networks. Large numbers of subscribers are also possible when several base stations are used, with a change of base station taking place automatically within a multi-cell wireless network by forwarding to a different cell.

A.8 DECT ULE

ULE stands for “Ultra Low Energy”, and is a new, extremely energy-saving wireless standard. ULE is based on the long-established and reliable DECT standard.

Like DECT, ULE also operates in its own exclusive frequency ranges (1,880 – 1,900 MHz), thus avoiding interference with other common wireless technologies (such as WLAN or Bluetooth).

With ULE, the DECT standard which is now used in millions of systems now has totally new applications in the areas of home automation, security and air conditioning. Analysts see great potential for growth in the new markets for home and building automation, as the technology has a number of advantages over its competitors:

- Range of radio waves up to 50 m within buildings and up to 300 m outside
- Security from standard encryption and authentication
- Exclusive frequency range worldwide (110 countries)
- Extremely low power consumption in the microampere range
- Open, non-proprietary standard
- Conformity assessment ensures interoperability of devices from different suppliers
- The international industrial association “ULE Alliance”, based in Bern, was founded and started work in 2013 to launch and popularize the ULE technology worldwide. The members are well-known product manufacturers and semiconductor suppliers.

A.9 DLNA

Digital Living Network Alliance (DLNA) is an industrial association which has launched a certification programme for multimedia devices in the home. Various manufacturers (Samsung, Sony, Intel, Panasonic, Microsoft, HP and others) have come together in the association to develop guidelines for the interaction between multimedia equipment. The aim of the conformity as-sessment is to establish a non-proprietary definition of functionalities which can be used on var-ious multimedia devices (see Figure 36). The certification programme draws on general stand-ards such as http, Internet Protocol (IP), JPG, MPG and others for the presentation of pictures, video and audio. These technologies are themselves subject to their own standardization pro-cedures by various international bodies.

DLNA is therefore neither a technology nor a standard in the classical sense. DLNA defines guidelines which are necessary for conformity assessment.

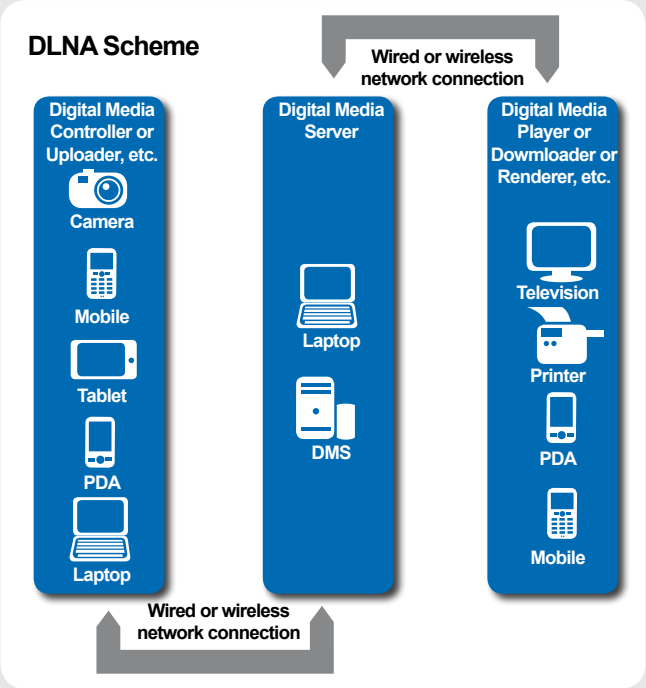

Figure 36: DLNA schematic [26]

A.10 EEBus

EEBus beschreibt ein offenes, standardisiertes und konsensorientiertes Vernetzungskonzept. Startend mit der Verbindung von Smart Grid und Smart Consumern, entwickelt sich der Ansatz über Smart Home und Smart Building zu einem ganzheitlichen Konzept für nahezu alle Smart Devices. Der EEBus kann dabei als Framework für einen Customer Manager (CM) zur Überbrückung der Lücke zwischen High-Level (Energie) Management Systemen und Low-Level Kommunikationstechnologien betrachtet werden. Er bietet eine einheitliche Schnittstelle für die Einbeziehung von Geräten mit unterschiedlichen Kommunikationstechnologien.

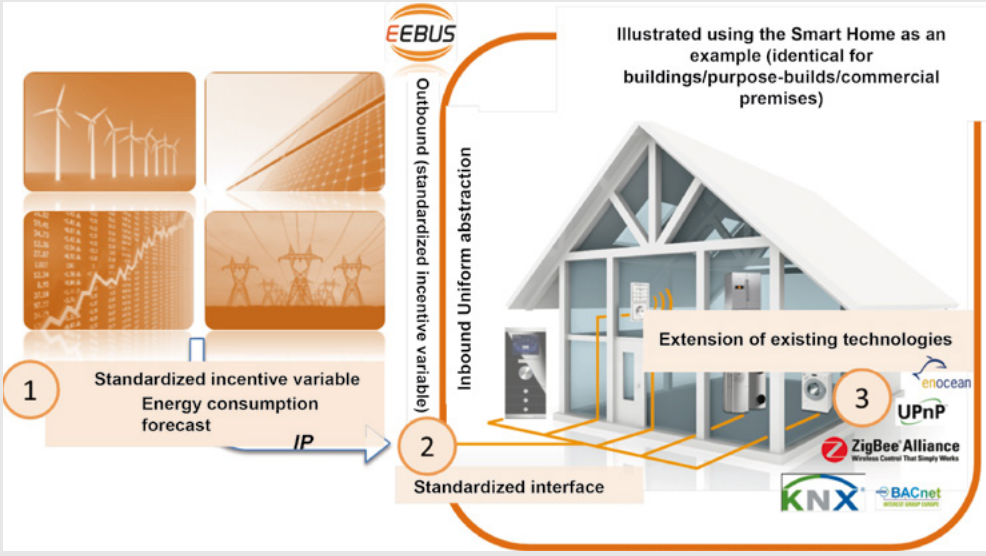

Figure 37: The EEBus concept [27]

In the EEBus concept, the Customer Manager has the function of implementing commands and forwarding them to the devices, and coordinating their actions (e.g. ensuring that high energy prices transmitted through the WAN lead to switching off or dimming of devices in the household or the use of energy profiles to save power). Its standard also covers those functional areas which are relevant but do not yet exist, such as power measurement, load management and price information. This requires standardized descriptions which indicate the way in which a terminal device can take part in energy management. In addition, the standardization work by the EEBus Initiative also covers requirements for application-specific interoperable communications. These and the additions to the corresponding standards which they necessitate are being pursued in consultation with the organizations involved (e.g. KNX Association).
This will achieve a connectivity of devices from different manufacturers and with different interfaces, which are typically installed in networks. One fundamental assumption in the concept is that there is generally no direct connection between the WAN and the devices in a home or building.
EEBus acts as middleware supporting the bidirectional exchange of control and measurement data between household appliances and power supply utilities. Expansion to incorporate further established standards ensures the interoperability of devices with standardized interfaces.
EEBus can be used in many applications and in different fields. The functions which have been created against the background of energy management use cases can also be applied in other areas, such as building automation or convenience and security. In the final analysis, switching devices on and off in response to energy needs is no different in its implementation than classical building automation. The difference is in the motivation for the action: in energy management it takes place in response to macro-economic necessities, and in building automation as a result of a desire on the part of the user.

EEBus does not have a firm set of device types, but rather uses a set of characteristics to describe devices. This approach has the advantage of great flexibility in the definition of devices. Any combinations of characteristics can thus be supported.

It should be noted that with EEBus a distinction can be made between pure data models for communication and actual implementations. The data models and interfaces are completely independent of the implementation, meaning that EEBus could also be implemented in JAVA or any other programming language.

A.11 eNet

eNet is a radio system for Smart Home applications. The proprietary system was developed by GIRA and JUNG in cooperation with INSTA. The system functions bidirectionally, so that sensors and actuators can exchange commands and status information. A frequency of 868.3 MHz (ISM band) is used, and the transmission rate is 16.384 kBit/s.

The selected modulation method is FSK on the basis of the Manchester encoding. The topology is freely selectable and up to 250 subscribers per installation can be included. An eNet server is available for the system, with the aid of which extensive visualization via a browser in HTML5 (on a PC, tablet or smartphone) is possible.

Fundamentally, however, the organizational form is decentralized and the transmitting cycle is only 0.1 %/h. Connection of sensors and actuators takes place with simple teach-in mechanisms, and extensive parameterization for customization (e.g. time clocks, links, scenes, presence simulation, etc.) of the system is possible using the eNet server.

Furthermore, there is an opportunity to parameterize and service the system via the WAN or control it remotely (LTE, UMTS, GSM, etc.).

The range of the system is standard for radio systems, at around 100 m in the open and 30 m in buildings. There is however the opportunity in this system to extend the range with repeaters. With the possible number of subscribers, up to 1000 individual channels and 100 scenes can be implemented. The sensors are supplied with power by batteries and/or by energy harvesting technology. Depending on the transmitting frequency, the battery life is between 2 and 8 years, as the transmission power is 25 mW / < 0.1 %.

A special feature of this system is the ease of putting it into service, during which changes can be made at any time without feedback effects between simple assignment using programming keys and convenient PC configuration. This freedom is available from the smallest application to full utilization of system capacity. eNet devices are available for flush mounting, surface moun-

ting, rail mounting or recessed mounting in suspended ceilings.All the devices comply with VDE and ESHG standards, and it is recommended to have them installed by a specialist electrician.

eNet permits integral planning for all applications (lighting, shutters, gates/doors, etc.).

A.12 EnOcean

EnOcean is a wireless communications technology for home and building automation. With the use of energy harvesting methods, suitable components such as sensors and light switches can be operated without external power supplies or batteries.

The basic principle of energy harvesting is that energy is produced in mechanical or thermal processes, and can then be used for transmission of radio signals.

The development of this technology is being driven ahead by the EnOcean Alliance, founded by a group of companies in 2008. The companies involved come from Europe and the USA (including EnOcean GmbH based in Oberhaching near Munich, Texas Instruments and MK Electric). EnOcean is primarily controlled by Siemens.

The EnOcean technology is not as yet standardized. It can be made available under licence from the EnOcean Alliance. The EnOcean Alliance is aiming at international standardization, especially for wireless monitoring and control in the field of building automation.

The EnOcean protocol consists of six layers of the OSI reference model, and the session layer is not defined.

A.13 Ethernet

Ethernet was originally designed for cable-based data networks (LANs), and specifies both the software and the hardware components. Data are transmitted in the form of frames, and transmission speeds from 10 Mbit/s and 100 Mbit/s (Fast Ethernet) through 1 Gbit/s (Gigabit Ethernet) up to 100 Gbit/s are achieved (see Table 6). The Ethernet technology is fundamentally that of IEEE 802.3 standard, and specifies the physical layer and the data link layer of the OSI model (layers 1 and 2). The standards of the DIN EN 50173 series specify the requirements for symmetrical copper and optical fibre cabling to support Ethernet (and other LAN types).

Ethernet is the most widely used technology for local data networks and supports the use of network protocols such as TCP/IP. Each network participant is unequivocally designated by a MAC address, a 48 bit identifier code. It is ensured in this way that all the systems in the data network have different addresses.

Table 6: Performance characteristics of selected Ethernet variants

Ethernet [variants]	Gross data transmission rate [bit/s]	Max. range [m]	Transmission medium [type]
100 Base-TX	100 Mbit/s	100	Symmetrical copper cable CAT5
100 Base-FX	100 Mbit/s	400/2000	Multimode/Single mode glass fibre cable
1000 Base-T/TX	1 Gbit/s	100	Symmetrical copper cable CAT5e/CAT6
1000 Base-SX/LX	1 Gbit/s	550/2000	Multimode/Single mode glass fibre cable
1 Gbase-T	10 Gbit/s	100	Symmetrical copper cable CAT6A/CAT7
10 Gbase-LX4	10 Gbit/s	300/10000	Multimode/Single mode glass fibre cable

A.14 G.hn

Under the working title of G.hn, ITU-T has been working since 2009 on compiling recommendations for data transfer in the home. In the meantime, these have been adopted as ITU G.9960 (Architecture and Physical Layer), G.9961 (Data Link Layer) and further Recommendations. G.hn facilitates data rates of up to one Gbit/s, not only via media such as coaxial cable, twisted pair copper cable or power lines, but also via optical transmission lines. With its universal orientation, the technology offers significant potential for future-proof new installations, and especially for the use of existing infrastructure. G.hn is therefore also referred to as Gigabit Home Net-working.

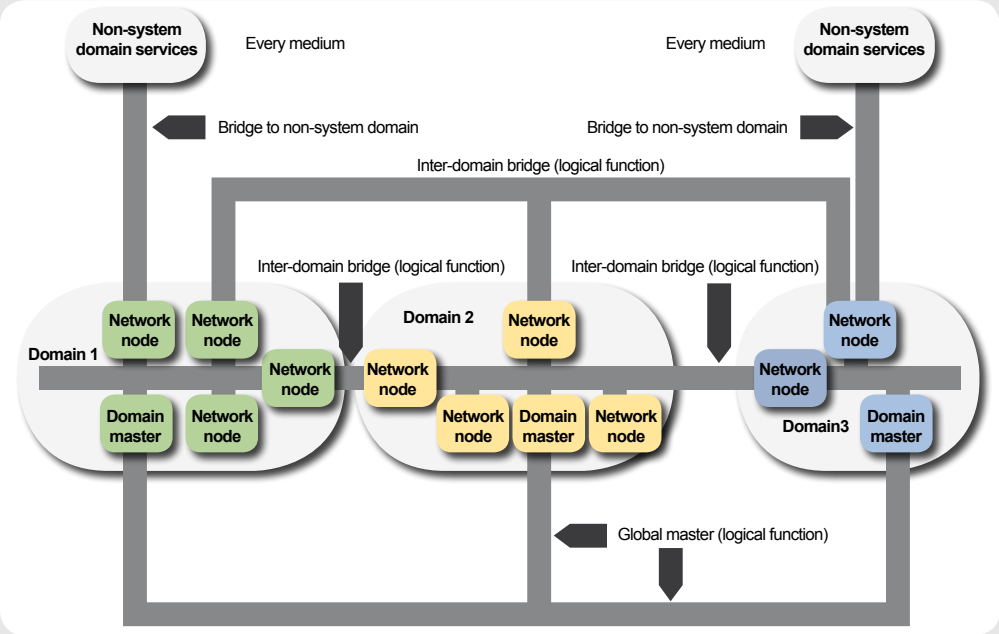

Figure 38: G.hn

A G.hn network consists of a maximum of 250 nodes which are connected by a medium. These are grouped together to form a domain and coordinated by a domain master. An extract from the architecture is shown in Figure 38. Media access is via TDMA and is optimized by the master by the variable assignment of time slots. The exchange of information can take place directly (P2P, P2MP for multicast) and indirectly via a further node. In centralized mode, all communications are implemented through the domain master. If a G.hn node has several interfaces it can belong to several domains and not only act as the bridge between various media, but also establish the connection to other networks such as internet or WLAN.

The end-to-end encryption based on AES-128 provides for security in the home network. Furthermore, authentication to ITU-T X.1035 and key management are supported. Priority and parameter-based QoS, detection of neighbouring networks and reduction of interference ensure optimized performance with energy-efficient operation. G.hn complies with the Code of Conduct of the European Union. G.hn has been expanded with TR-069 for remote maintenance via IP networks.

G.hn uses Orthogonal Frequency Division Multiplex (OFDM) modulation. With its variable parameters, OFDM can be optimally adapted to suit all media, ambient conditions and national regulations. A comparison of selected parameters can be found in Table 7.

Table 7: Transmission profiles

Medium	Bandwidth/MHz	Carrier number	Carrier spacing/kHz
Coaxial cable	50, 100	256, 512	195,3125
Telephone line	50, 100	1024, 2048	48,828125
Power line	25, 50, 100	1024, 2048, 4096	24,4140625
Optical	100, 200	512, 1024	195,3125

For coaxial lines, apart from the basic band, additional ranges of 350-2850 MHz are defined for 50-200 MHz bandwidth. In the form of G.hn lite, there is a low complexity profile available for power lines at 25 MHz. Notches in the spectrum take account of requirements for EMC, etc. In return, the number or capacity of the carriers is reduced. The Quadrature Amplitude Modulation (QAM) used for the individual carriers can be adjusted by selection of high or lower variants to accommodate these restrictions and match the linearity and signal to noise ratio of the channel. G.hn supports 4096-QAM with up to 12 bits per carrier.

The G.hn activities of ITU are supported by the Homegrid Forum (http://www.homegridforum.org).

A.15 HGI Smart Home Task Force and SWEX

The Home Gateway Initiative (HGI) focuses on description of the architecture and interfaces for modular access technologies between broadband and home networks (home gateways). This description takes the form of requirements which are to be regarded as de facto standards for home gateways. The core of the standards is the bridge between WAN, LAN and WLAN (Home Gateway Technical Requirements: Residential Profile). Furthermore, requirements are specified for the Remote Management QoS and its testability. A further important standard is the definition of a modular Software Execution Environment (SWEX) which makes the home gateway an execution instance for software which is loadable in runtime. Once a year, test events are organized for which HGI members are invited to demonstrate the compliance of their products.

In the Smart Home context, the HGI Smart Home Task Force is working on the expansion of the HGI architecture to facilitate the connection of further network technologies to the home gateway, the provision of a Device Abstraction Layer for technology-independent control of devices in the home environment by applications, services and user interfaces, and the implementation of M2M communication (ETSI M2M). In that way, HGI intends to upgrade the home gateway for the domains of Home Energy Management (HEM), Ambient Assisted Living/eHealth, Alarms and Security, Comfort and Media / NG Communications. The SWEX will take on the Device Abstraction Layer in its architecture and extend the SWEX compliance tests.

A.16 iBeacon

iBeacon was introduced by Apple as a proprietary standard in 2013, in order to facilitate navigation in enclosed spaces. iBeacon is based on Bluetooth Low Energy, and is implemented for iOS7 and above, and for the present Android devices. iBeacon enables devices with Bluetooth switched on to determine their approximate position in the room on the basis of short signals from permanently installed transmitters, and to provide functions specific to that location on the basis of the transmitter's UUID.

A.17 IP500

IP500 is a wireless standard for smart devices in buildings, with a special focus on security and reliability. The IP500 Alliance, which has defined and developed the standard, is composed of international market leaders in the fields of fire protection, access control and alarm systems.

The IP500 standard is not only a communications protocol, but also a holistic solution. In order to comply with standards relevant to safety such as DIN EN 54-25 or DIN EN 50131-5-3 and VdS certification requirements, special actions have been taken on all levels of communication to implement reliable, robust, secure and energy-efficient communications.

On the network level, various network services on Deployment, Session Key Management, BACnet Management, Monitoring etc. ensure that all devices communicate with one another securely and interoperably, and that only permissible devices may take part in communications. All communications are necessarily encrypted, with AES128 in wireless networks and Ipsec in wired networks. All network services can be hosted on any devices outside the wireless network. Asynchronous meshing is used as the network topology (see Figure 39), in order on the one hand to increase reliability and on the other hand to minimize the cost of communications.

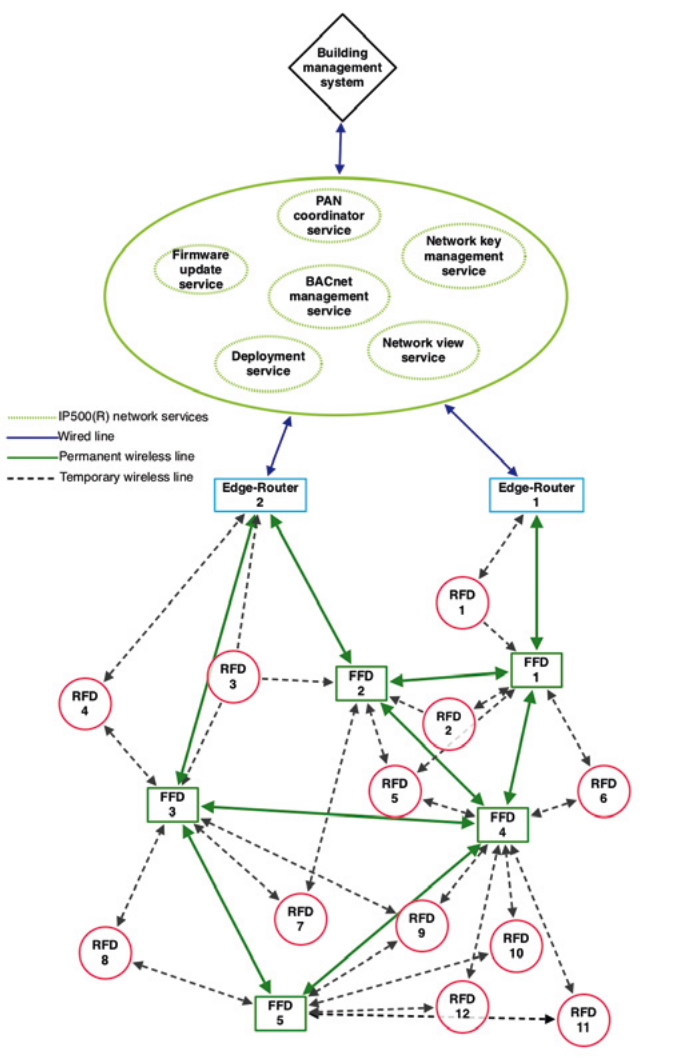

Figure 39: Example of a meshed IP500® network structure with network services

IP500 combines several internationally recognized standards and adds mechanisms which serve the aims of the IP500 Alliance. The IP500 standard is based on IEEE 802.15.4-2006 with O-QPSK modulation. The IEEE standard operates in sub-GHz frequency bands which are specified for short range devices (SRDs) and differ from region to region. The IP500 standard provides not only the highest performance (data rate) but also the greatest penetration and therefore range within buildings. Stipulation of a single type of modulation ensures interoperability on the radio level. IEEE 802.15.4 also defines the participants in the wireless network, Reduced Function Devices (RFD), Full Function Devices (FFD) and Edge Routers (ER). The latter serve as a management instance and provide for the transition into other networks, such as LANs.

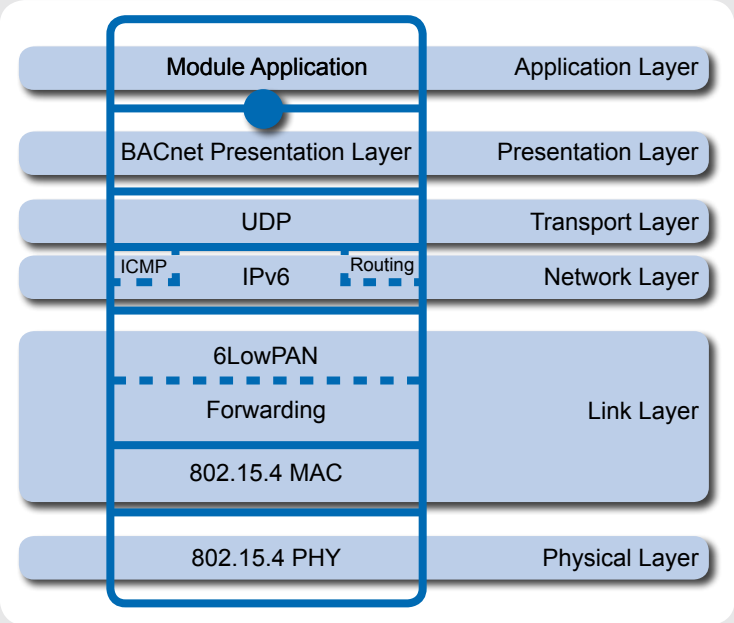

Figure 40: IP500® Module Protocol Stack

IP500 uses IPv6 (see Figure 40), and is therefore future-proof. Each device has its own IPv6 address which provides for unique identification. To optimize communication in wireless networks, 6LowPAN is used, above all reducing the data generated by IPv6 to a minimum in order to optimize transmission capacities.

On the application level, BACnet is implemented on each module. All device information has to be encoded in BACnet. The exchange of information and control of devices take place by means of BACnet Services. The BACnet Management Module in the network services starts communication centrally and ensures that all devices can be transparently integrated in the BACnet installation.

In order to make communications within BACnet interoperable, the IP500 Alliance has defined an interoperability specification which stipulates mandatory functions and optional features to be incorporated in BACnet. This information is then non-proprietary and therefore fully available to all manufacturers. Furthermore, each device can receive any further BACnet information so that manufacturers can implement additional features.

The IP500 standard therefore provides a turnkey solution for manufacturers of building automation products who wish to connect their products in an IP500 wireless network fully interoperably without any major development work.

A.18 KNX

The KNX standard was developed in 2002 on the technical basis of the EIB bus system (European Installation Bus, INSTABUS since 1990), EHS (European Home Systems) and BatiBUS, and fulfils

- European standards (CENELEC EN 50090 and CEN EN 13321-1),
- International standards (ISO/IEC 14543-3),
- Chinese standards (GB/Z 20965) and
- US standards (ANSI/ASHRAE 135).

In this way, KNX is compatible with EIB devices. The communications protocol used by KNX is open and may therefore be used by third party suppliers. KNX was developed to facilitate connection of all the important systems in building services. Planning can then be conducted integrally, encompassing all systems. All manufacturers have to have their devices certified so that all devices are mutually compatible.

The KNX system consists of bus devices (sensors and actuators) and a bus which connects all the devices for message traffic. Sensors detect physical variables, convert them into messages (telegrams) and send the messages through the bus. The actuators convert the messages received into actions. It has now however become normal for most of the bus devices to have the properties of both sensors and actuators. The KNX standard specifies the following transmission media: Twisted Pair (TP), Powerline (PLC), Radio Frequency (RF) and also IP/Ethernet (KNX/netIP).

No central controller is required, as the control logic is stored in the bus devices (multi-master system). The topology for installation of an EIB/KNX system was designed in such a way that the system can be used both for single applications and for complex building control systems.

The facility for adding a “building server” as a bus device allows even extremely complex closed loop control systems to be established.

The topology of KNX divides the bus into line segments, lines and areas. Up to 64 bus devices can be connected to one line segment. Line repeaters can be used to add 3 further line segments. That is then the maximum extent of a line. Line couplers can be used to connect up to 15 lines to form an area. Area couplers allow up to 15 areas to be connected together. This results in a theoretical maximum number of 57,600 bus devices.

The bus devices are programmed by means of software which first permits allocation of a bus device to its place in the bus topology (area, line, …). The Engineering Tool Software (ETS) is the same for all of the over 300 manufacturers of bus devices. These manufacturers now supply over 7,000 certified product groups. In addition, a second assignment can provide information on the physical location of the bus device (building elevation, floor, office, etc.). The control of sensors/actuators can also be defined. This concept produces a highly flexible system suitable for complex applications.

A.19 Connectivity KNX/TP

For the field of KNX / TP, there are already a large number of gateways available with which a high level of connectivity is or will be possible.

Gateways are available for the following systems:

- BACNet
- DMX
- DALI
- M-BUS
- Various PLC gateways
- SMI
- TCP/IP
- ISDN
- UPnP
- OPC
- EEBus/Connected Living, in preparation

A.20 KNX/RF

KNX/RF has extended the open KNX standard to provide an opportunity to control components by radio. The information is transmitted in FSK modulation at a frequency of 868.3 MHz. The transmission power is 1-25 mW. KNX/RF supports devices which can only transmit and devices which can both send and receive data. As devices which can only transmit data do not have to be active all the time, they can be implemented in an energy-efficient manner and may only need a battery for power supply. Devices which have to be ready to receive data at any time must as a rule have a power pack.

The data rate is max. 16.4 kBit/s with a range of 100 m (in the open) and 30 m (in buildings). The maximum number of devices is 57,600. Meshed networks are not possible. Project planning is also in this case performed with the ETS.

A.21 LCN

The company name LCN stands for “Local Control Network”. The bus system consists of LCN modules which are connected together by 4-wire lines, forming a distributed network. The modules are connected to the power supply lines of the individual devices and can thus collect data on energy consumption. Together with PE, live and neutral conductors, a further conductor is available which, together with the neutral wire, is used for data transmission.

When fitted with appropriate add-ons, the modules can function as sensors or actuators, and can be connected in line, star or tree topologies. Up to 250 devices per segment are possible, and up to 120 segments can be grouped together. Programming by PC or laptop can take place at any module via an LCN coupler. A gateway provides for connection to a local network or the internet.

A.22 LON

LON (Local Operating Network) is a standardized field bus which is mainly used in building automation. The LON technology was developed by the Echelon Corporation and has been implemented as an international standard since 2008 in the 14908 series. LON technology is promoted and organized by LonMark International. The LON concept is based on the approach of distributed automation, ensuring that information is processed locally wherever possible. The central element of the hardware is the Neuron chip, which contains three 8-bit processors for the functions of Media Access CPU (connection to the network), Network CPU (encoding and decoding) and Applications CPU (user software). For unequivocal identification in the network, each Neuron chip has a unique ID number (48 bits).The LON Talk protocol defines layers 2 to 7. For the lowest layer 1, various transceivers, for example radio and powerline, are available. In

order to ensure communication with devices from different manufacturers, Standard Network Variables Types are stipulated. LON can be incorporated in gateways via the OSGi framework.

A.23 M-Bus

The M-Bus is a standardized field bus for the collection of consumption data, and functions either with cable or by radio. Cable transmission is serial through a two-wire line which is protected against polarity reversal, by means of which the connected meters (slaves) can also be supplied.

One station in the bus system is stipulated as the master. Data transmission from the master to the slaves is by modulation of the supply voltage (24 V / 36 V), while transmission to the master is effected by modulation of the power consumption of the slaves. The maximum data transfer rate is 9600 Baud. No particular topology is specified for the cabling. Up to 250 meters per segment can be connected. Larger systems can also be constructed when repeaters are used.

A.24 M2M

Machine to Machine (M2M) is a broad umbrella term for a series of technologies which enable devices to communicate directly end-to-end, devices to be directly remote controlled by applications or management software, or devices to communicate by themselves with remote applications. The network technologies and communications protocols used are not specified in detail.

The origins of M2M can be traced back to applications in computer network automation, such as telemetry applications or industrial control systems. With the appearance of mobile radio networks, M2M became easier to implement, and it can be used at short notice or temporarily and permits mobile or mobility-supporting applications. Typical applications can be found in the fields of health monitoring, tracking of persons, goods or vehicles, measured value acquisition from a wide range of sensor networks, industrial automation or Ambient Assisted Living.

The challenges for M2M in the home context are the automatic deployment and location of de-vices in the home network and regulated and secure communications with the outside world. That means in particular that communications protocols and standard interfaces have to be used and in some cases created, making manual configuration superfluous and permitting communication through home gateways (see also HGI: M2M Reference Point). ETSI has also passed a series of specifications on requirements, architecture, security and management of M2M communications, and in that context devoted closer attention to eHealth, Smart Energy and automotive applications.

A.25 NFC, RFID

Near Field Communication (NFC) is a collection of standards for wireless transmission of data across short distances (a few centimetres) and at a maximum transmission rate of 424 kBit/s. This technology is used, for instance, in the pairing of devices, for authentication and in mobile payment systems. NFC is based on Radio Frequency Identification (RFID) standards and, as a point to point network type, fulfils the criteria for a Personal Area Network (PAN).

Although NFC has a range of only a few centimetres, it is specialized in secure data transmission and represents an extension of RFID.

A.26 OGEMA

OGEMA (Open Energy Management Gateway) is an open software platform for energy management applications. The standard is publicly accessible as the OGEMA Application Programming Interface (API); all developers and manufacturers can implement their ideas on automated and more efficient use of energy with the aid of software on the gateway platform.

The OGEMA framework represents a kind of operating system for energy management, which enables it to execute software applications from various sources on a gateway computer. Furthermore, with the installation of corresponding software drivers, all the systems for home and building automation can in principle be incorporated. The applications and communications drivers are connected by data models which are defined in the OGEMA specification. The OGEMA gateway acts as a firewall between the public and private communications systems and contains an extensive rights management and monitoring system which limits access to the applications and drivers to the extent required and by doing so creates transparency for the users and gains their confidence and trust.

Examples of applications which can be installed on the framework include creation of running schedules and control of household consumers such as electric water heaters, dishwashers, etc., to make use of low price phases in the variable tariffs of the future, and optimizing the station service consumption of PV systems. The connection of distributed generation facilities and flexible loads in a virtual power plant is also possible. Other applications in office buildings, heating, air-conditioning and ventilation can be adjusted to suit the use of the premises. The suitability of the framework for these kinds of energy management applications has been demonstrated in a series of Smart Grid field tests, and valuable findings made for their future development.

The Java-based API of the OGEMA framework with example source code is published on the OGEMA Alliance website. The licence for OGEMA reference implementation allows the framework to be used for commercial applications and drivers without restriction. Certification is re-quired if the OGEMA logo is to be used.

A.27 openHAB

openHAB (Open Home Automation Bus) is a vendor-neutral, protocol-agnostic open source hardware and software platform which integrates different bus systems, devices and communications protocols through so-called “bindings”.

The basis of openHAB is the OSGi-based runtime environment, which is expanded by the bindings required in the form of OSGi bundles. Communication, which is independent of manufacturer or technology, takes place via the openHAB Event Bus, which allows commands to be sent and received, and status updates to be obtained. The “item repository” retains the current states of the devices for access via user interfaces. The openHAB runtime is supplemented by the automation logic, which also functions at the item repository and performs the definition and monitoring of automation rules.

There are currently around 40 bus system, device, protocol and service bindings which range from support for individual luminaires through KNX or Bluetooth to cloud services such as Drop-box or Google Calendar. There are also clients available for web browsers, Android or iOS. openHAB is rounded off by the “openHAB Designer” which assists in configuration of the runtime environment.

A.28 OSGi

OSGi (Open Services Gateway Initiative) is a specification for a Java-based software platform which enables applications and services to be modulized (bundles), and dynamically deployed and updated during runtime. The specification is maintained by the OSGi Alliance, an industry consortium consisting of over 150 large and small businesses, and it is currently in its fifth published version.

The core specification is supplemented by the OSGi Compendium, which specifies further useful extensions to the core functionality to standardize the handling of issues such as logging, remote access and administration, various network technologies, configuration, and so on.

There are various commercial, open source and differently featured implementations of the specification (OSGi frameworks) which are used in a variety of application domains, including the automotive industry, building automation, residential (home) gateways, mobile devices, or also as integrated development environments.

In the Smart Home field, the OSGi Residential Expert Group deals with the creation and updating of specifications for functionalities and interfaces which benefit the handling of devices and

the networks encountered in the home environment, including for instance a device abstraction layer or resource monitoring and management. The ZigBee API is specified for communication by OSGi applications with ZigBee devices. The UPnP standard is already supported in the core.

A.29 SafetyLON

SafetyLON makes the properties and benefits of LON usable for safety-oriented applications in building automation. LON is used in various industrial applications, but predominantly in building automation applications, ranging from small to very large buildings, including residential buildings. SafetyLON complies with the SIL 3 standard of IEC 61508, and therefore constitutes a system with which technical systems which can present hazards to people, the environment or assets can be operated.

The SafetyLON protocol has a variable data length of up to 228 bytes (EIA 709 / EN 14908). The residual error probability per event is less than 10-9. The entire sent message is only processed when the data integrity of the relevant part of the message has been confirmed in both safety chips and the address has been found to be correct.

The SafetyLON hardware uses a 1oo2 (one out of two) structure, consisting of an EIA 709 chip as the standard LON communications processor and two safety chips. The integrity of the I/O hardware is constantly tested, and in this way it is ensured that the hardware is functioning correctly when a secure message is sent or received or when a secure input or output is used.

Specific commissioning and parameterization methods, based on the standard tools from Echelon, are used for SafetyLON.

A.30 TCP/IP

TCP/IP is a family of network products on which communication in the internet is based. The abbreviation standards for Transmission Control Protocol/Internet Protocol.

TCP/IP forms a framework for computer network protocols. Communication between subscribers in the network is facilitated by defined network protocols. These stipulate how the data are formatted, transmitted, forwarded and received.

TCP/IP makes communication between any participants in the network possible.

The Transmission Control Protocol handles data flow control for communication, is responsible for data security, and determines the action to be taken on loss of data.

Under TCP, the data flow is split up and provided with a header. The individual data packets are then reassembled correctly at the receiver.

The Internet Protocol regulates the addressing and relaying of the data packets in the network. Each device in the network has its individual IP address. In IPv4, this consists of 4 bytes, which are separated by dots. In IPv6 there are 16 bytes, in which 2 bytes are represented by 4 hexadecimal numbers and the 8 x 2 bytes are separated by colons.

The TCP/IP protocol consists of the following four layers:

- **Application Layer:** This covers various protocols such as the Hypertext Transfer Protocol (http) for transmission of data in the network, the File Transfer Protocol (FTP) for transmission of files via IP networks between the server and client, and the Simple Mail Transfer Protocol (SMTP) for sending of emails.
- **Transport Layer:** The Transport Layer supports the Transmission Control Protocol (TCP).
- **Network Layer:** The Network Layer regulates the correct delivery of the data packets as ad dressed by IP, and has a decisive influence on the routing.
- **Data Link Layer:** Among other functions, the Data Link Layer stipulates channel access mechanisms. These are required for the transmission of the data packets with IP addresses.

A.31 UpnP

Universal Plug & Play (UPnP) is a collection of standards from the UPnP Forum for description of network-capable devices and the protocols for their control. The UPnP world consists of devices which offer their services and control points, user interfaces or other programs which use those services. Building on established internet standards such as IP, UDP, TCP, http, SOAP and XML, protocols for the location of devices and their services in the home network (SSDP – Simple Service Discovery Protocol), for monitoring and control of the devices (SOAP – Simple Object Access Protocol) and for sending of change notifications ("eventing" with the aid of General Event Notification Architecture – GENA) are defined.

The standards are essentially independent of manufacturers, application domains or physical transmission media, but define mechanisms for extension. Standard device types define necessary services from those devices and are constantly developed by the UPnP Forum Working Committees. The most widespread standards to date are those for audio and video equipment (UPnP AV Architecture), both for devices that provide multimedia content and those that display

or play that content. Other organizations such as DLNA base their standards on the UPnP Device Architecture and UPnP AV.

The work of the following Working Committees is especially interesting for the Smart Home market:

- **E-Health & Sensors Working Committee (EHS):** works on data models and interfaces of sensors for interoperability with health information systems.
- **Home Energy Management and Smart Grid (HEMS):** revises and expands existing and new device specifications and protocols to enable them for the development of Smart Grid applications. Apart from the technical standards, the work also focuses on strategic and marketing aspects.
- **Home Automation and Security Working Committee (AUTOMATION):** has developed standards for device types such as security cameras, lighting systems, shutters, heating, ventilation and air conditioning systems. Further specifications for home security systems and for the control of power generation systems are pending.

Selected UPnP standards have been adopted by the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC) and published as part of the ISO/IEC 29341 x series of standards.

A.32 WLAN(Wi-Fi)

WLAN (Wireless Local Area Network) is the designation of a local wireless network which complies with the IEEE 802.11 standard and is notable for high data rates and data security, and in relation to WPAN higher transmission power and correspondingly greater range (see Table 8). WiFi certification ensures interoperability between all IEEE 802.11-based devices.

The OFDM modulation method is used for the wireless transmission of data. Frequencies around 2.4 GHz or in the range of approx. 5.2 – 5.7 GHz are used for communication. The max-imum gross transmission rates range from 11 Mbit/s (Standard 802.11b) through 54 Mbit/s (802.11 a, g and h) to 600 Mbit/s (802.11n).

As the radio transmission can be read by third parties, encryption of the data is necessary. This is specified in the security standard IEEE 802.11i, and a high degree of security is achieved by AES encryption.

Depending on the area of application and the hardware installed, WLAN systems can be operated in different modes. In the infrastructure mode, a wireless access point or a wireless router coordinates the clients, while in ad hoc mode all devices are peers, allowing local networks with a small number of devices to be established relatively simply.

Table 8: Data throughput and ranges of various WLAN standards

WLAN [variants]	Gross data transmission rate [bit/s]	Typical data throughput [bit/s]	Range under laboratory conditions [m]
802.11	2 Mbit/s	1 Mbit/s	≤ 100 m
802.11a	54 Mbit/s	23 Mbit/s	≤ 120 m
802.11b	11 Mbit/s	4 Mbit/s	≤ 140 m
802.11g	54 Mbit/s	20 Mbit/s	≤ 140 m
802.11n	300 – 600 Mbit/s	120 – 300 Mbit/s	≤ 250 m

A.33 X10 X10 (protocol)

X10 is a power line based home networking protocol which, for example, enables simple switching processes to be performed through the existing home installation by remote control. Communication is by means of control signals at 120 kHz, which – to avoid interference such as occurs with leading edge dimmers – are only transmitted during the mains voltage zeroes. There are also wireless systems for X10.

A.34 ZigBee

ZigBee is a standard for wireless networks which was developed by the ZigBee Alliance and is based on the IEEE 802.15.4 standard. ZigBee is especially interesting for home and energy management because it supports the corresponding application profiles for communication be-tween high level devices. These profiles are ZigBee Home Automation and ZigBee Smart Ener-gy.

ZigBee is designed for short range radio communication (up to 100 m) and works in the ISM frequency band (Industrial, Scientific and Medical band) and in the sub-GHz range. The data rate is in the range of 20 to 250 kBit/s.

Low-cost implementation means that ZigBee is widespread in wireless control and monitoring applications.

The ZigBee protocol defined by the ZigBee Alliance deals with the upper layers of the transmission protocol, while the two lower layers are defined by IEEE 802.15.4.

The ZigBee protocol consists of the following layers:

- **Application Layer:** The main functions of the application layer are locating devices and defining the roles of devices within the network, and stipulating the services supported. It manages the mapping table for the connection between two devices with the corresponding services and enquiries, and the forwarding of messages between devices. The complete description of a device with all characteristics and properties can be found there.
- **Network Layer:** The network layer regulates the structure and adaptation of the network and the allocation of network addresses, and is responsible for the security of the frames to be transmitted and the routing of frames in the network.
- **IEEE 802.15.4 Data Link Layer:** The data link layer controls channel access and regulates data transmission and synchronization.
- **IEEE 802.15.4 Physical Layer:** The following frequency ranges can be set by the physical layer: 868 MHz for the European area, 915 MHz for the USA and Australia, and the ISM frequency of 2.4 GHz for worldwide operation.

A.35 Z-Wave

Z-Wave is a wireless communications standard which was designed especially for home automation and energy management. The standard was developed by the Z-Wave Alliance and the Danish company Zen-Sys, which was taken over by Sigma Designs in 2008.

The Alliance includes many well-known manufacturers who are predominantly interested in product and protocol standardization.

Z-Wave is not an open standard, but manufacturer-related. That means that only Sigma Designs implements the stack, which avoids compatibility problems but rules out open access.

Z-Wave works in the ISM band in the area around 900 MHz (868.42 MHz in Europe and 908.42 MHz in the USA) and uses Gaussian FSK for modulation. It is designed for semi-duplex operation and for reliable transmission of short messages from a central node to other nodes in the network. The system was developed for short ranges. In the open, these extend to approx. 200 m, while they are typically around 30 m in buildings.

The transmission rate, at 9.6 kBit/s or 40 kBit/s, is significantly below the maximum achievable data rate of ZigBee.

The Z-Wave protocol consists of the following five layers:

- **Application Layer:** The application layer controls the implementation of commands and responses in the command classes on which communication in the Z-Wave network is based.
- **Routing Layer:** The routing layer serves to monitor the network topology and update the routing list, and regulates the routing of frames between the nodes.
- **Transport Layer:** The transport layer regulates the exchange of data and the return of signals between nodes, and employs parity checks and acknowledgements to ensure secure and error-free data transfer.
- **MAC Layer:** The MAC layer regulates channel access by monitoring of the frequency band used, and is responsible for avoiding packet collisions.
- **Physical Layer:** The ISM band around 900 MHz is used (868.42 MHz in Europe). The type of modulation is Gaussian Frequency Shift Keying (GFSK).

Distinctions are made between the following frames for the transmission of commands in the network:

- **Singlecast Frame:** Transmission to a particular node, where acknowledgement is possible.
- **Acknowledgement Frame:** Acknowledgement only or no acknowledgement.
- **Multicast Frame:** Transmission to several nodes.
- **Broadcast Frame:** Transmission to all nodes in the network.

APPENDIX B: STANDARDS AND SPECIFICATIONS FOR SMART HOME + BUILDING

The standards and specifications listed in this Appendix are sorted by the applicable Smart Home domains. These lists are not to be regarded as exhaustive; it is an aim of standardization activities to close the gaps, and additions to existing standards are always part of that work.

B.1 Safety Domain

The existing standards in the field of alarm and surveillance systems include, but are not limited to, the following:

Table 9: Standards – Alarm and surveillance systems

National standard	Title
DIN VDE V 0826-1; VDE V 0826-1:2013-09	Surveillance systems - Part 1: Hazard warning system for use in residential buildings, apartments and rooms with similar purposes - Planning, installation, operation, maintenance, devices and system requirements
DIN EN 50136-1 (VDE 0830-5-1):2012-08	Alarm systems - Alarm transmission systems and equipment - Part 1: General requirements for alarm transmission systems
DIN EN 50134-3 (VDE 0830-4-3):2012-11	Alarm systems - Social alarm systems - Part 3: Local unit and controller

Alarm systems - Social alarm systems - Part 3: Local unit and controller

Table 10: Standards in the field of intrusion

National standard	Title
DIN EN 50130-4 (VDE 0830-1-4):2015-04	Alarm systems - Part 4: Electromagnetic compatibility - Product family standard: Immunity requirements for components of fire, intruder, hold up, CCTV, access control and social alarm systems
DIN EN 50130-5 (VDE 0830-1-5):2012-02	Alarm systems - Part 5: Environmental test methods
DIN EN 50131-1 (VDE 0830-2-1):2010-02	Alarm systems - Intrusion and hold-up systems - Part 1: System requirements
DIN CLC/TS 50131-7 (VDE V 0830-2-7):2011-06	Alarm systems - Intrusion and hold-up systems - Part 7: Application guidelines
E DIN EN 50131-9 (VDE 0830-2-9):2010-06	Alarm systems - Intrusion and hold-up systems - Part 9: Alarm verification - Methods and principles
DIN EN 50131-10 (VDE 0830-2-10):2015-03	Alarm systems - Intrusion and hold-up systems - Part 10: Applica-tion specific requirements for Supervised Premises Transceiver (SPT)
DIN CLC/TS 50131-11 (VDE V 0830-2-11):2013-05	Alarm systems - Intrusion and hold-up systems - Part 11: Hold-up devices
DIN EN 50131-6 (VDE 0830-2-6):2015-03	Alarm systems - Intrusion and hold-up systems - Part 6: Power supplies
DIN EN 50131-4 (VDE 0830-2-4):2010-02	Alarm systems - Intrusion and hold-up systems - Part 4: Warning devices
DIN EN 50131-5-3 (VDE 0830-2-5-3):2009-06	Alarm systems - Intrusion and hold-up systems - Part 5-3: Requirements for interconnections equipment using radio frequency techniques
DIN CLC/TS 50131-5-4 (VDE V 0830-2-5-4):2013-05	Alarm systems - Intrusion and hold-up systems - Part 5-4: System compatibility testing for I&HAS equipments located in supervised premises
DIN EN 50131-3 (VDE 0830-2-3):2010-02	Alarm systems - Intrusion and hold-up systems - Part 3: Control and indicating equipment
DIN CLC/TS 50398 (VDE V 0830-6-398):2010-04	Alarm systems - Combined and integrated alarm systems - General requirements

DIN EN 50131-2-2 (VDE 0830-2-2-2):2008-09	Alarm systems - Intrusion and hold-up systems - Part 2-2: Intrusion detectors - Passive infrared detectors
DIN EN 50131-2-3 (VDE 0830-2-2-3):2009-05	Alarm systems - Intrusion and hold-up systems - Part 2-3: Requirements for microwave detectors
DIN EN 50131-2-4 (VDE 0830-2-2-4):2008-10	Alarm systems - Intrusion and hold-up systems - Part 2-4: Requirements for combined passive infrared and microwave detectors
DIN EN 50131-2-5 (VDE 0830-2-2-5):2009-05	Alarm systems - Intrusion and hold-up systems - Part 2-5: Requirements for combined passive infrared and ultrasonic detectors
DIN EN 50131-2-6 (VDE 0830-2-2-6):2009-05	Alarm systems - Intrusion and hold-up systems - Part 2-6: Opening contacts (magnetic)
DIN EN 50131-2-7-1 (VDE 0830-2-2-71):2014-10	Alarm systems - Intrusion and hold-up systems - Part 2-7-1: Intrusion detectors - Glass break detectors (acoustic)
E DIN EN 50131-2-7-2 (VDE 0830-2-2-72):2014-10	Alarm systems - Intrusion and hold-up systems - Part 2-7-2: Intrusion detectors - Glass break detectors (passive)
E DIN EN 50131-2-7-3 (VDE 0830-2-2-73):2014-10	Alarm systems - Intrusion and hold-up systems - Part 2-7-3: Intrusion detectors - Glass break detectors (active)
DIN EN 50132-5-2 (VDE 0830-7-5-2):2012-11	Alarm systems - CCTV surveillance systems for use in security applications - Part 5-2: IP Video Transmission Protocols
DIN EN 50132-5-3 (VDE 0830-7-5-3):2013-02	Alarm systems - CCTV surveillance systems for use in security applications - Part 5-3: Video transmission - Analogue and digital video transmission
DIN EN 50132-5-1 (VDE 0830-7-5-1):2012-11	Alarm systems - CCTV surveillance systems for use in security applications - Part 5-1: Video transmission - General video transmission performance requirements
DIN EN 62676-1-1 (VDE 0830-7-5-11):2014-11	Video surveillance systems for use in security applications - Part 1-1: System requirements - General (IEC 62676-1-1:2013)
DIN EN 62676-2-1 (VDE 0830-7-5-21):2014-11	Video surveillance systems for use in security applications - Part 2-1: Video transmission protocols - General requirements (IEC 62676-2-1:2013)
DIN EN 62676-2-2 (VDE 0830-7-5-22):2014-11	Video surveillance systems for use in security applications - Part 2-2: Video transmission protocols - IP interoperability implementation based on HTTP and REST services (IEC 62676-2-2:2013)

DIN EN 62676-2-3 (VDE 0830-7-5-23):2014-11	Video surveillance systems for use in security applications - Part 2-3: Video transmission protocols - IP interoperability implementation based on Web services (IEC 62676-2-3:2013)
DIN EN 62676-1-2 (VDE 0830-7-5-12):2014-11	Video surveillance systems for use in security applications - Part 1-2: System requirements - Performance requirements for video transmission (IEC 62676-1-2:2013)
DIN EN 50136-2 (VDE 0830-5-2):2014-08	Alarm systems - Alarm transmission systems and equipment - Part 2: Requirements for Supervised Premises Transceiver (SPT)
DIN EN 50136-1 (VDE 0830-5-1):2012-08	Alarm systems - Alarm transmission systems and equipment - Part 1: General requirements for alarm transmission systems
DIN EN 50136-3 (VDE 0830-5-3):2014-08	Alarm systems - Alarm transmission systems and equipment - Part 3: Requirements for Receiving Centre Transceiver (RCT)
DIN CLC/TS 50136-4 (VDE V 0830-5-4):2005-07	Alarm systems - Alarm transmission systems and equipment - Part 4: Annunciation equipment used in alarm receiving centres
DIN CLC/TS 50136-7 (VDE V 0830-5-7):2005-07	Alarm systems - Alarm transmission systems and equipment - Part 7: Application guidelines

B.2 Entertainment Domain

The existing standards in the field of entertainment include, but are not limited to, the following:

Table 11: Standards – Entertainment

National standard	Title
DIN EN 62481-1:2014-09	Digital living network alliance (DLNA) home networked device interoperability guidelines - Part 1: Architecture and protocols (IEC 62481-1:2013); English version EN 62481-1:2014
DIN EN 62481-2:2015-03	Digital living network alliance (DLNA) home networked device interoperability guidelines - Part 2: DLNA media formats (IEC 62481-2:2013); English version EN 62481-2:2014
DIN EN 62481-3:2015-01	Digital living network alliance (DLNA) home networked device interoperability guidelines - Part 3: Link protection (IEC 62481-3:2013); English version EN 62481-3:2014
DIN EN 60065 (VDE 0860)):2012-07	Audio, video and similar electronic apparatus - Safety requirements
DIN EN 55013 (VDE 0872-13):2013-11	Sound and television broadcast receivers and associated equipment - Radio disturbance characteristics - Limits and methods of measurement
DIN EN 55020 (VDE 0872-20):2007-09	Sound and television broadcast receivers and associated equipment - Immunity characteristics - Limits and methods of measurement
DIN EN 61305-x	Household high-fidelity audio equipment and systems - Methods of measuring and specifying the performance

B.3 Health/AAL/Wellbeing Domain

The existing standards in the field of medicine include, but are not limited to, the following:

Table 12: Standards – Medical equipment

National standard	Title
DIN EN 60601-1-2 (VDE 0750-1-2):2011-07	Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral standard: Electromagnetic disturbances - Requirements and tests (IEC 60601-1-2:2014)
DIN EN 60601-1-11 (VDE 0750-1-11):2011-03	Medical electrical equipment - Part 1-11: General requirements for basic safety and essential performance - Collateral Standard: Requirements for medical electrical equipment and medical electrical systems used in the home healthcare environment (IEC 60601-1-11:2015)

Existing standards from medical technology which are taken into account in AAL activities:

Table 13: Standards on medical technology taken into account in AAL activities

National standard	Title
DIN EN 80001-1 (VDE 0756-1):2011-11	Application of risk management for IT-networks incorporating medical devices - Part 1: Roles, responsibilities and activities (IEC 80001-1:2010)
DIN EN 60601-1-2 (VDE 0750-1-2):2007-12	Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral standard: Electromagnetic disturbances - Requirements and tests (IEC 60601-1-2:2014)
DIN EN 60601-1-11 (VDE 0750-1-11):2014-9	Medical electrical equipment - Part 1-11: General requirements for basic safety and essential performance - Collateral Standard: Re-quirements for medical electrical equipment and medical electrical systems used in the home healthcare environment (IEC 60601-1-11:2015)

Existing standards in the field of social alarms which are taken into account in AAL activities:

Table 14: Standards on social alarms taken into account in AAL activities

National standard	Title
DIN VDE 0833 (VDE 0833)	Alarm systems for fire, intrusion and hold-up
DIN VDE 0834 (VDE 0834)	Call systems in hospitals, nursing homes and similar institutions
DIN VDE 0826 (VDE 0826)	Surveillance systems
DIN EN 50134 (VDE 0830)	Alarm systems - Social alarm systems

Existing Application Guides

Table 15: Application Guides – AAL

Application Guide	Title
VDE-AR-E 2757-1 :2013-05	Ambient Assisted Living (AAL) – Terms and definitions
VDE-AR-E 2757-2:2011-08	Staying at home service - Requirements for suppliers of combined services
VDE-AR-E 2757-3:2012-01	Staying at home service - Criteria for the selection and installation of AAL components
VDE-AR-E 2757-4:2012-01	Staying at home service - Quality criteria for providers, services and products of Ambient Assisted Living (AAL)
VDE-AR-M 3756-1:2009-10	Quality management for telemonitoring in medical applications

B.4 Energy Management Domain

Smart Metering

DLMS – Device Language Message Specification

DLMS is an international series of standards which is administered by the International Electrotechnical Commission (IEC) and covers automatic meter reading with end-users. The specification is developed by the DLMS User Association, an international consortium of companies with over 60 members and the Working Groups IEC/TC 57 WG 09, IEC/TC 13 WG 14 and CEN/TC 294 WG 2.

DLMS defines various transmission protocols and “communications objects” for electricity, gas, water and heating meters and makes stipulations for the application level. This layering in accordance with the OSI model fundamentally permits transmission via any network transmission protocols.

DLMS also provides for connection of meters using the M-Bus protocol. All in all, therefore, the standard is suitable for local communications, communications with meters (primary level) and remote transmission of consumption data (tertiary level).

Meters are already available from various manufacturers. The standards in this context are as follows:

National standard	Title
DIN EN 61334-4-41:1997-09	Distribution automation using distribution line carrier systems - Part 4: Data communication protocols; Section 41: Application protocols; Distribution line message specification (IEC 61334-4-41:1996)
DIN EN 61334-6:2001-05	Distribution automation using distribution line carrier systems - Part 6: A-XDR encoding rule (IEC 61334-6:2000)
DIN EN 62056-21:2003-01	Electricity metering - Data exchange for meter reading, tariff and load control - Part 21: Direct local data exchange (IEC 62056-21:2002)
E DIN EN 62056-3-1 (VDE 0418-6-3-1):2014-12	Electricity metering data exchange - The DLMS/COSEM suite - Part 3-1: Use of local area networks on twisted pair with carrier signalling (IEC 62056-3-1:2013)

DIN EN 62056-42:2003-01	Electricity metering - Data exchange for meter reading, tariff and load control - Part 42: Physical layer services and procedures for connection-oriented asynchronous data exchange (IEC 62056-42:2002)
DIN EN 62056-46:2007-08	Electricity metering - Data exchange for meter reading, tariff and load control - Part 46: Data link layer using HDLC-protocol (IEC 62056-46:2002 + A1:2006)
DIN EN 62056-47:2007-06	Electricity metering - Data exchange for meter reading, tariff and load control - Part 47: COSEM transport layers for IPv4 networks (IEC 62056-47:2006)
DIN EN 62056-5-3:2014-09	Electricity metering data exchange - The DLMS/COSEM suite - Part 5-3: DLMS/COSEM application layer (IEC 62056-5-3:2013); English version EN 62056-5-3:2014
E DIN EN 62056-6-1:2014-10	Electricity metering data exchange - The DLMS/COSEM suite - Part 6-1: Object Identification System (OBIS) (IEC 62056-6-1:2013); English version EN 62056-6-1:2013
E DIN EN 62056-6-2:2014-10	Electricity metering data exchange - The DLMS/COSEM suite - Part 6-2: COSEM interface classes (IEC 62056-6-2:2013); English version EN 62056-6-2:2013
DIN EN 61334-6:2001-05	Distribution automation using distribution line carrier systems - Part 6: A-XDR encoding rule (IEC 61334-6:2000)

B.5 Standards and specifications for building services and Smart Home in general

The existing standards in the field of interoperability include, but are not limited to, the following:

Table 17: Standards – Interoperability

National standard	Title
DIN EN 62676-2-2 (VDE 0830-7-5-22):2014-11	Video surveillance systems for use in security applications - Part 2-2: Video transmission protocols - IP interoperability implementation based on HTTP and REST services (IEC 62676-2-2:2013)
DIN EN 62676-2-3 (VDE 0830-7-5-23):2014-11	Video surveillance systems for use in security applications - Part 2-3: Video transmission protocols - IP interoperability implementation based on Web services (IEC 62676-2-3:2013)
DIN EN 62457	Multimedia home networks - Home network communication protocol over IP for multimedia household appliances (IEC 62457:2007)
DIN EN 62481-3:2015-01	Digital living network alliance (DLNA) home networked device interoperability guidelines - Part 3: Link protection (IEC 62481-3:2013); English version EN 62481-3:2014
International standard	**Title**
ISO/IEC 14543-x-y	The standards of the ISO/IEC 14543-x-y series support competing products on the market and establish interoperability between the various parts of the series (“x”).
ISO/IEC 18012-1:2004-02	Information technology – Home electronic system – Guidelines for product interoperability – Part 1: Introduction

The existing standards in the field of point to point connections and networks include, but are not limited to, the following:

Table 18: Standards – Point to point connections and networks

National standard	Title
DIN EN 50173-4 (VDE 0800-173-4):2013-04	Information technology - Generic cabling systems - Part 4: Homes
DIN EN 50173-4 Supplement 1:2011-06	Information technology - Implementation of BCT applications using cabling in accordance with EN 50173-4
DIN EN 50173-4 Supplement 2 (VDE 0800-173-4 Supplement 2):2013-04	Information technology - Generic cabling systems - Part 4: Homes; Supplement 2: Home cabling infrastructures up to 50 m in length to support simultaneous and non-simultaneous provision of applications
DIN EN 50288	Multielement metallic cables used in analogue and digital communication and control
DIN EN 60794	Optical fibre cables
DIN EN 60603-7 (VDE 0627-603-7:2012-08): 2012-08	Connectors for electronic equipment - Part 7: Detail specification for 8-way, unshielded, free and fixed connectors (IEC 60603-7:2008 + A1:2011)
DIN EN 50174-1 (VDE 0800-174-1):2015-02	Information technology - Cabling installation - Part 1: Installation specification and quality assurance
DIN EN 50174-2 (VDE 0800-174-2):2015-02	Information technology - Cabling installation - Part 2: Installation planning and practices inside buildings
DIN EN 50174-3 (VDE 0800-174-3):2014-05	Information technology - Cabling installation - Part 3: Installation planning and practices outside buildings

The existing standards in the field of home electronic systems (HES) include, but are not limited to, the following:

Table 19: Standards – Home Electronic Systems

International standard	Title
ISO/IEC TR 14543-4:2002	Information technology – Home Electronic System (HES) architec-ture – Part 4: Home and building automation in a mixed-use building
ISO/IEC 14543-2-1:2006	Information technology – Home Electronic Systems (HES) architecture – Part 2-1: Introduction and device modularity
ISO/IEC 14543-3-2:2006	Information technology – Home Electronic Systems (HES) architecture – Part 3-2: Communication layers – Transport, network and general parts of data link layer for network based control of HES Class 1
ISO/IEC 14543-3-3:2007	Information technology – Home electronic system (HES) architecture – Part 3-3: User process for network based control of HES Class 1
ISO/IEC 14543-3-4:2007	Information technology – Home electronic system (HES) architecture – Part 3-4: System management – Management procedures for network based control of HES Class 1
ISO/IEC 14543-3-5:2007	Information technology – Home electronic system (HES) architecture – Part 3-5: Media and media dependent layers – Power line for network based control of HES Class 1
ISO/IEC 14543-3-6:2007	Information technology – Home electronic system (HES) architecture – Part 3-6: Media and media dependent layers – Network based on HES Class 1, twisted pair
ISO/IEC 14543-3-7:2007	Information technology – Home electronic system (HES) architecture – Part 3-7: Media and media dependent layers – Radio frequency for network based control of HES Class 1
ISO/IEC 14543-5-1:2010	IInformation technology – Home electronic system (HES) architecture – Part 5-1: Intelligent grouping and resource sharing for Class 2 and Class 3 – Core protocol
ISO/IEC 14543-5-4:2010	Information technology – Home electronic system (HES) architecture – Part 5-4: Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Device validation

ISO/IEC 14543-4-2:2008	Information technology – Home electronic system (HES) architecture – Part 4-2: Communication layers – Transport, network and general parts of data link layer for network enhanced control devices of HES Class 1
ISO/IEC 14543-4-1:2008	Information technology – Home electronic system (HES) architecture – Part 4-1: Communication layers – Application layer for network enhanced control devices of HES Class 1
ISO/IEC 14543-5-3:2012	Information technology – Home electronic system (HES) architecture – Part 5-3: Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Basic application
ISO/IEC 14543-5-21:2012	Information technology – Home electronic system (HES) architecture – Part 5-21: Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Application profile – AV profile
ISO/IEC 14543-5-5:2012	Information technology – Home electronic system (HES) architecture – Part 5-5: Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Device type
ISO/IEC 14543-5-22:2010	Information technology – Home electronic system (HES) architecture – Part 5-22: Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Application profile – File profile
ISO/IEC 14543-5-6:2012	Information technology – Home electronic system (HES) architecture – Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Part 5-6: Service type
ISO/IEC 14543-3-10	Information technology – Home Electronic Systems (HES) architecture – Part 3-10: Wireless Short-Packet (WSP) protocol optimized for energy harvesting – Architecture and lower layer protocols

The existing standards in the field of Home and Building Electronic Systems include, but are not limited to, the following:

Table 20: Standards – Home and Building Electronic Systems

National standard	Title
DIN EN 50090-1 (VDE 0829-1):2011-12	Home and Building Electronic Systems (HBES) - Part 1: Standardization structure
DIN EN 50090-3-1:1995-04	Home and Building Electronic Systems (HBES) - Part 3-1: Aspects of application; introduction to the application structure
DIN EN 50090-3-2:2004-09	Home and Building Electronic Systems (HBES) - Part 3-2: Aspects of application - User process for HBES Class 1
DIN EN 50090-3-3:2009-09	Home and Building Electronic Systems (HBES) - Part 3-3: Aspects of application - HBES Interworking model and common HBES data types; English version EN 50090-3-3:2009
DIN EN 50090-4-1:2004-06	Home and Building Electronic Systems (HBES) - Part 4-1: Media independent layers - Application layer for HBES Class 1
DIN EN 50090-4-2:2004-07	Home and Building Electronic Systems (HBES) - Part 4-2: Media independent layers - Transport layer, network layer and general parts of data link layer for HBES Class 1
DIN EN 50090-4-3 (VDE 0829-4-3):2015-02	Home and Building Electronic Systems (HBES) - Part 4-3: Media independent layers - Communication over IP (EN 13321-2)
DIN EN 50090-5-1:2005-06	Home and Building Electronic Systems (HBES) - Part 5-1: Media and media dependent layers - Power line for HBES Class 1
DIN EN 50090-5-2:2004-09	Home and Building Electronic Systems (HBES) - Part 5-2: Media and media dependent layers - Network based on HBES Class 1, Twisted Pair
DIN EN 50090-5-3:2007-06	Home and Building Electronic Systems (HBES) - Part 5-3: Media and media dependent layers - Radio Frequency for HBES Class 1
DIN EN 50090-7-1:2004-09	Home and Building Electronic Systems (HBES) - Part 7-1: System management - Management procedures

DIN EN 50090-8 (VDE 0829-8):2001-04	Home and Building Electronic Systems (HBES) - Part 8: Conformity assessment of products
DIN EN 50090-9-1 (VDE 0829-9-1):2004-11	Home and Building Electronic Systems (HBES) - Part 9-1: Installation requirements - Generic cabling for HBES Class 1 Twisted Pair
DIN EN 50491-2 (VDE 0849-2):2011-01	General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 2: Environmental conditions
DIN EN 50491-3 (VDE 0849-3):2010-03	General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 3: Electrical safety requirements
DIN EN 50491-4-1 (VDE 0849-4-1):2012-11: 2012-11	General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 4-1: General functional safety requirements for products intended to be integrated in Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS)
DIN EN 50491-5-1 (VDE 0849-5-1):2010-11	General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 5-1: EMC requirements, conditions and test set-up
DIN EN 50491-5-2 (VDE 0849-5-2):2010-11	General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 5-2: EMC requirements for HBES/BACS used in residential, commercial and light industry environment
DIN EN 50491-5-3 (VDE 0849-5-3):2010-11	General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 5-3: EMC requirements for HBES/BACS used in industry environment
DIN EN 50491-6-1 (VDE 0849-6-1):2014-10	General requirements for Home and Building Electronic Sys-tems (HBES) and Building Automation and Control Sys-tems (BACS) - Part 6-1: HBES installations - Installation and plan-ning

B.6 Mandates – Smart Home

There is no separate mandate for the field of “Smart Home + Building” as yet, but some of the areas involved have already been addressed in previous mandates.

Examples of these include the following:

- M/490 Standardization mandate to support European Smart Grid deployment (final report: http://www.cenelec.eu/aboutcenelec/whatwedo/technologysectors/smartgrids.html)
- M/487 Standardization mandate in the field of security standards (security and interoperability)
- M/480 Standardisation mandate for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (2010/31/EU)
- M/468 Standardisation concerning the charging of electric vehicles
- M/441 Standardisation Mandate in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability (Smart Metering)
- M/403 Standardisation mandate in the field of Information and Communication Technologies
- M/331 Standardisation mandate in support of digital TV and interactive services

APPENDIX C: TERMS AND DEFINITIONS

Term	Definition
Specific to Smart Home	
Smart Home	A Smart Home is an intelligent network of components, devices and systems in a flat, a house or an office with a central control unit, a mobile human-machine interface and an interface with a Wide Area Network (WAN) for remote control from the outside and for remote maintenance.
Smart Home Domain	In the light of the variety of possible networks in a building, these are conveniently divided into Smart Home domains such as Energy Management, Entertainment, Safety/Security, Health/AAL and Building Automation.
User Story	A user story is a description in purely textual form of a Smart Home application which usually spans several domains, from the point of view of the user.
Use Case	A use case is a specific application or workflow from the point of view of an “actor”, which can be a human being, system, device or function. A user story as defined above can be represented formally as one or more use cases grouped together.
Use Case Repository	A use case repository is a database in which use cases, described in standardized form, are accessible and their comparability is made easier. The compaction by which generic use cases are established takes place there.
Use Case Sequence Diagram	A sequence diagram is the graphical representation of functions and data, communication partners and flow directions in a use case.
Smart Home System Architecture	A Smart Home architecture is a logical arrangement of the functions in hardware or software which are necessary to implement a Smart Home as defined above. It is proprietary when it is only suitable for the products or systems from a single company or group of companies. It is open when it is based on standards and specifications and permits competing means of establishing compatibility and developing.

System Architecture in the European Mandate M/490	M/490 is the standardization mandate for Smart Grids. In the course of that work, the interface to the home and the necessary system architecture for energy and load management in the home were defined. This architecture is also suitable for applications in the non-energy domains.
Interoperability	Interoperability is a fundamental requirement for the networked components, devices or systems in a Smart Home. The European Telecommunications Standards Institute (ETSI) defines interoperability as the ability of systems, devices, applications or components to function together, and to exchange and use resources and information. An ETSI report differentiates between types of interoperability as follows: protocol interoperability, service interoperability, application interoperability and interoperability from the user's point of view.
Protocol/Interface Interoperability	In the case of interoperability from the protocol or interface point of view, the focus is on the communications interface between the distributed systems or components, all of the aspects of which (protocol, data, services, etc.) are defined. The form in which this is made available to an application – directly or encapsulated in the form of software function blocks – is not necessarily stipulated here. Each of the distributed systems (or components) can therefore have a completely different internal architecture and nevertheless be interoperable.
Application Interoperability	In the case of interoperability from the application point of view, communication in distributed systems is as a rule encapsulated by software function libraries which are made available to the application in the form of a stable and well defined API. If various systems can be addressed by that API, it is known as middleware. The middleware used ensures that all the communications interfaces involved (protocol, data and services) are well defined and can be used in a uniform manner.
Information Security	Information security primarily ensures the confidentiality, integrity and availability of information during collection, storage, pro-cessing, transmission and output. As a secondary objective, information security provides evidence of authenticity and origin, and ensures the privacy of information or communications. Information security ensures that information is protected, violations of security are detected, and rapid reaction to security incidents is possible. The information security measures are suitable for maintaining data protection.

Data security	The aim of data security in Smart Home devices is the technical implementation of measures for data protection to protect the personal rights of individuals.
Plug & Play	The plug & play capability of a device can be divided into four technical phases: *Addressing*, i.e. the device has a unique address *Discovery*, i.e. the device makes itself known in the network *Description*, i.e. the capabilities of the device are known in the network *Control*, i.e. the capabilities of the device can be used from the outside Plug & Play requirements must be defined from the market point of view, as the breadth of possible plug & play functionalities in the Smart Home is very large.
Standardization	
Standardization	Standardization is the systematic achievement of uniformity of material and non-material objects performed jointly in consensus by interested groups, for the benefit of the general public. (DIN 820-3:2010-07)
Specification	Specification is the stipulation of technical rules without necessarily involving all the interested parties and without any obligation to involve the public. In the German standardization strategy, specification work is distinguished from standardization, which is based on a full consensus. A specification contains the results of that work and reflects the state of the art. If public objection proceedings have been performed, it can adopt the status of the “generally accepted state of the art”. Specifications include, for example, the VDE Application Guides and DIN SPECs.
VDE Application Guide	A VDE Application Guide is a specification as defined above. It is the result of specification work which groups findings together with recommendations and requirements for specific areas of application. The VDE Application Guides are compiled by DKE Working Groups or other VDE committees, and are part of the VDE Regulations.

White Paper on Standardization	The White Paper is a compilation of the currently valid standards and specifications and the technologies used in the Smart Home field, and is the point of departure for a standardization roadmap.
Standardization Roadmap Smart Home + Building	The Standardization Roadmap Smart Home + Building is based on the White Paper and describes the activities required to close gaps in standardization which have become apparent from the user stories and use cases considered relevant to the customers.
Vademecum on European Standardization	The Vademecum compiles key documents from the European Commission on European standardisation policy and related practice. It provides guidance without having legal status.
Inspection and Conformity Assessment	
Tests and Inspection - Definition	A test is the examination of the characteristics of a device or system on the basis of defined requirements. Inspection is a sequence of defined tests in accordance with a set of standardized requirements which is classified as complete.
Tests and Inspection - Requirements	Inspections and tests in the field of Smart Home are performed on the basis of requirements which are to be individually defined and agreed. Together with compliance with specifications, interface standards and safety requirements, the interoperability of components, devices and systems must be ensured. For Smart Home as a networked system with an internet connection, additional account has to be taken of information and data security, functional safety and data protection.

Tests and Inspection - Procedures	Interoperability: A standardized test suite runs through the use cases developed from user stories on the devices or systems to be inspected. A test interface is used to test the conformity and interoperability of communications processes (protocol, data and services). Information and data security: The required security and protection measures in the devices and systems are tested and assessed in a test procedure based on security standards. The inspection methods include document checks, visual examination, laboratory tests and weakness tests.
Conformity Assessment	Conformity assessment is defined in the international standard ISO/IEC 17000:2004, “Conformity assessment - Vocabulary and general principles” as a “demonstration that specified requirements relating to a product, process, system, person or body are fulfilled”. Conformity assessment is of special importance in Europe in the regulated area in the assessment of products for compliance with the requirements of an EU Directive. EU Directives under the terms of Article 95 of the EC Treaty for the Internal Market set out minimum safety requirements for numerous products which have to be fulfilled by the manufacturer. Manufacturers have to demonstrate by means of a conformity assessment procedure that they have complied with the fundamental safety requirements set down in the Directive or Directives. The conformity assessment procedure must be performed by the manufacturer for each product before it is first put on the market. At the end, the manufacturer issues an EC Declaration of Conformity for the product, declaring that the product conforms with the requirements of the relevant Directive(s). Only in the sector of medical products is there the special requirement that not only the product safety has to be demonstrated, but also the medical and technical performance of the medical products as stated by the manufacturer as a medical indication in the product literature including advertising.

Certification	Certification is a process by which compliance with certain requirements is demonstrated. Certification is part of the process of conformity assessment. Certification is often issued with a time limit by independent certification bodies such as DQS, TÜV VDE or DEKRA, and monitored against either independent or proprietary standards.
Certification platform	A certification platform is the totality of resources and regulations which are necessary to arrive at the performance of inspection and certification on the basis of stipulated criteria.
Certification programme	A certification programme contains a set of rules to facilitate in-spections and certifications on the basis of previously defined criteria.
Certification process	A process (as part of a certification programme) which a component, device or system has to pass in order to be certified and obtain a certification mark.
Certification mark/ Test mark	Graphical or textual marks on products, machines or vehicles which indicate conformity with certain safety or quality criteria are known as certification marks or test marks. Depending on the object concerned, they are applied after a single test or recurrent tests. Certification marks are an integral part of the designation of goods. They are applied as required by law or voluntarily by the manufacturer. One of the best known certification marks in Germany is the TÜV sticker applied to motor vehicles following the statutory inspection, or the GS mark for “tested safety”.
Standardization Organizations	
CEN http://www.cen.eu/	The European Committee for Standardization is a private, non-profit organization whose mission it is to promote European industry in global trading, ensure the wellbeing of citizens and promote environmental protection. This is to be done with the aid of an efficient infrastructure for the development, management and distribution of coherent standards and specifications throughout Europe which are accessible to all interested parties. CEN is one of the three major standardization organizations in Europe.

CENELEC http://www.cenelec.eu/	The European Committee for Electrotechnical Standardization is one of the three major standardization organizations in Europe. CENELEC is responsible for European standardization in the field of electrical engineering. Together with ETSI (standardization in the field of telecommunications) and CEN (standardization in all other technical areas), CENELEC forms the European system of technical standardization.
ETSI http://www.etsi.org/	The European Telecommunications Standards Institute is one of the three major standardization organizations in Europe. ETSI is a non-profit institute aimed at creating uniform specifications for telecommunications in Europe. It was founded at the initiative of the European Commission in 1988. The institute has 655 members from over 50 countries, including network operators, service providers, governmental organizations, users and manufacturers. It is based in Sophia Antipolis near Nice in France.
ISO http://www.iso.org/	The International Organization for Standardization is the international association of standardization organizations and compiles international standards in all areas with the exception of electronics and electrical engineering, for which the International Electrotechnical Commission (IEC) is responsible, and telecommunications, for which the International Telecommunication Union (ITU) is responsible. Together, these three organizations make up the World Standards Cooperation (WSC).
IEC http://www.iec.ch/	The International Electrotechnical Commission is an international standardization organization based in Geneva and responsible for standards in the electrical and electronics fields. Some standards are developed jointly with ISO.
IEEE http://www.ieee.org/	The Institute of Electrical and Electronics Engineers is a global professional association of engineers in the electrical and IT fields, based in New York City. It organizes conferences, publishes various professional journals, and forms committees for the standardization of technologies, hardware and software.

LITERATURHINWEISE

[1] The German Standardization Roadmap E-Energy/Smart Grids - Version 2 [online]. Avail-able at https://www.vde.com/en/dke/std/documents/nr_smart%20grid_v2_en.pdf

[2] R. Glasberg, N. Feldner. Band 1 Studienreihe zur Heimvernetzung Konsumentennutzen und persönlicher Komfort. Ergebnisse der Arbeitsgruppe 8 “Service- und verbraucher-freundliche IT” zum dritten nationalen IT-Gipfel 2008 [online]. Available at https://www.bitkom.org/Publikationen/2008/Leitfaden/BITKOM-Studie-Konsumentennutzen-und-persoenlicher-Komfort/Studie_Konsumentennutzen.pdf

[3] The German Standardization Roadmap AAL - Version 2 [online]. Available at https://www.vde.com/en/dke/std/documents/nr_aal_en_v2.pdf

[4] Apel, R. (Siemens), Benze, J. (T-S), Baumeister, J. (BSH), Harner, A. (DKE), Kellendonk, P. (Kellendonk), et al. Standardization Roadmap E-Energy/Smart Grids 2.0, (p. 85), 2012

[5] The German Standardization Roadmap Electromobility Version 3 [online]. Available at https://www.vde.com/en/dke/std/documents/rm%20emobility_v3_en.pdf

[6] VDE [online]. Available at http://www.vde.com/de/Technik/fs/seiten/fs.aspx#funktionalesicherheit

[7] DIN EN 61508-1 (VDE 0803-1):2011-02, Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements (IEC 61508-1:2010)

[8] DIN EN 61508-7 (VDE 0803-7): 2011-02, Functional safety of electri-cal/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures (IEC 61508-7:2010)

[9] DKE: Muss bei der funktionalen Sicherheit auch die IT-Sicherheit beachtet werden? http://www.dke.de/de/DKE-Arbeit/MitteilungenzurNormungsarbeit/2011/Seiten/Erreichungderfunktionalen Sicherheit.aspx

[10] DDIN V 820-120:1994-10, Standardization - Guidelines For The Inclusion Of Safety Aspects In Standards

[11] IEC Guide 104:2010-08, The preparation of safety publications and the use of basic safety publications and group safety publications

[12] DIN EN 60950-1 (VDE 0805-1):2011-01, Information technology equipment - Safety - Part 1: General requirements (IEC 60950-1:2005, modified + Cor.:2006 + A1:2009, modified); German version EN 60950-1:2006 + A11:2009 + A1:2010

[13] E DIN EN 62368-1 (VDE 0868-1):2012-02, Audio/video, information and communication technology equipment - Part 1: Safety requirements (IEC 62368-1:2014, modified + Cor.:2015)

[14] DIN EN 61010-1 (VDE 0411-1):2011-07, Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements (IEC 61010-1:2010 + Cor.:2011)

[15] DIN EN 61508-4 (VDE 0803-4): 2011-02, Functional safety of electri-cal/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations (IEC 61508-4:2010); German version EN 61508-4:2010

[16] IIEC/TR 62380:2004-08, Reliability data handbook – Universal model for reliability prediction of electronics components, PCBs and equipment.

[17] DIN EN 61508-7 (VDE 0803-7): 2011-02, Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures (IEC 61508-7:2010); German version EN 61508-7:2010

[18] DIN EN 61508-3 (VDE 0803-3): 2011-02, Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements (IEC 61508-3:2010); German version EN 61508-3:2010

[19] DIN EN 61508-2 (VDE 0803-2):2011-02, Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems (IEC 61508-2:2010); German version EN 61508-2:2010

[20] DIN EN 61508-5 (VDE 0803-5):2011-02, Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 5: Examples of methods for the determination of safety integrity levels (IEC 61508-5:2010); German version EN 61508-5:2010

[21] ISO 26262 (series):2011-11, Road vehicles – Functional safety.

[22] Source: Bundesamt für Sicherheit in der Informationstechnik, BSI https://www.bsi.bund.de/DE/Presse/Pressemitteilungen/Presse2013/BSI_veroeffentlicht_Mindeststandard_fuer_verschluesselte_Internetverbindungen_08102013.html Last accessed on 04.03.2015

[23] Apel, R. (Siemens), Benze, J. (T-S), Baumeister, J. (BSH), Harner, A. (DKE), Kellendonk, P. (Kellendonk), et al. Standardization Roadmap E-Energy/Smart Grids 2.0, (p. 85), 2012

[24] [Wikimedia Foundation Inc. 2008g] (Brucke et al., 2008)

[25] From presentation: CLICK_Beitrag_Smarte_Technik__Connected_Technologies_ home_Connected_Living; available at http://www.connected-living.org/

[26] Wikipedia; Michael Pophal; available at https://de.wikipedia.org/w/index.php?title=Datei:DLNA_new.svg&filetimestamp=20110119010747; last accessed on 17.10.2013

[27] Blänkner, M., Kellendonk G. Zertifizierungsprogramm Smart Home Building Architekturen/Technologien, 2012

[28] Dialogplattform Smart Home; available at https://www.dialogplattform-smarthome.de/portal.htm“ \l „about“ https://www.dialogplattform-smarthome.de/portal.htm#about; last accessed on 18.10.2013

[29] The German Standardization Roadmap IT Security – Version 2. Available at https://www.vde.com/en/dke/std/documents/rm_it-security_v2_en.pdf
[30] The German Standardization Roadmap Smart City Version 1.0 (full version). Available at https://www.vde.com/en/dke/std/documents/nr_smart%20city_en_version%201.0.pdf
[31] The German Standardization Roadmap Smart City Version 1.1 (update), Available at https://www.vde.com/en/dke/std/documents/nr_smartcity_en_v1.1.pdf
[32] BITKOM, Deloitte; Nationaler IT Gipfel: Vor dem Boom: Marktaussichten für Smart Home, Fokusgruppe Connected Home des Nationalen IT Gipfels. Available at https://www.bitkom. org/Publikationen/2014/Studien/Marktaussichten-für-Smart-Home/141023_Marktaussichten_SmartHome.pdf
[33] The German Standardization Roadmap Industry 4.0 – Version 2. Available at https://www.vde.com/en/dke/std/Documents/RM_Industrie%2040_V2_EN.pdf

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