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Final plan for using and disseminating knowledge

Overview state of the art of 'Smart Homes'

History

Years ago, we used to dream that intelligent robots would carry out all of the every-day housework in the households of the future. Nowadays, due to the development of electronics we at least have the possibility of electronically communicate with household appliances and to interconnect them.
Such an »intelligent environment«, which can process information and independently control appliances, can make our lives much easier. In an average modern house, there are already approximately 40 micro-processors in use, with an intelligent networking which can perform functions such as, regulating optimum temperature and lighting conditions, activate sun shielding, provide for security, to automatically open the garage door upon arrival, or to choose the appropriate music for the present activity.

In public buildings (e.g. administration buildings, hotels etc.) , building automation systems, for centrally controlled lighting systems, airconditioning systems and heating systems, are already standard applications. However, such systems are still rare in private households.

Smart Homes

Smart Homes are a special application of 'smart environments', which is an interdisciplinary research field, dealing with computer science, electrical engineering, and also information and communication technologies. It integrates disciplines such as machine learning, human-machine interface, wireless networking, mobile communications, sensor networks, computing, etc..

The term »Smart Homes« describes solutions for the private households with systems and tools, which offer more flexibility, security, comfort, cost effectiveness and energy efficiency.
The first generation of Smart Homes are systems with intelligent controls (closed or open loop), based on a sophisticated software which uses a lot of sensor data (for example temperature, air velocity, humidity etc.) and finally, manual interventions for the calculation of optimal adjustments and control strategies, originally mainly focused on energy savings.
The next generation, which is in development stage, involves systems which use a type of artificial intelligence (learning software). This learning software records and analyses the user behavior, and creates user profiles for an adaptive control of the different functions.
First generation »Smart Homes« has been developed since about the year 2000, but a breakthrough has not been reached yet due to high costs and an absence of standards for the products.

Communication Systems

Generally, a smart home can be achieved through an interconnection of utility service systems and facileties management (electricity metre, alarm system, heating and light regulation etc.) together with the electrical household appliances (electric cooker, refrigerator etc.) and multi-media equipment (television, video-recording equipment, radio, central servers etc.). This interconnection is either carried out through a BUS-system or a direct wireless connection.
The automation of electrical engineering in buildings is usually set up on Bus-systems, and standardised in the European norm EN 50090 (mostly EIB (European Installation Bus), or LOB (Local Area Network).

Multi-media applications are usually integrated into IP-Networks. In doing so, various mechanical systems (e.g. house automation systems, security systems, audio and visual systems, personal computer networks) , are inter-connected with protocols such as UPnP via the IP-network. Due to security reasons, the individual networks usually remain closed-loop.

Overview Bus systems

The Bus-Systems are based on appliance control and disconnection of electricity supply.

European Installation Bus (EIB)
The EIB is an open and standardised BUS-system which was developed for installation in functional buildings. Each connected appliance receives a signal from a sensor (e.g. brightness sensor, temperature sensor etc.) and an in-built micro-processor processes the signal and converts it into orders for co-called actuators (e.g. to roll the blinds down, turn on the lights etc.).
This system works in a decentralised manner, i.e. with distributed intelligence. The EIP is generally used for the control of:

- Illumination
- Temperature
- Blinds and shutters
- Air conditioning
- Location surveillance, signalling and operation.

The European BUS installation is a standard in accordance with EN 50090 or in accordance with IS-PRO/IEC 14543-3. This standard describes how the sensors and actuators can be connected with each other and how they communicate with each other (protocol).
The actuator is the standby which controls the load (e.g. a luminaire), and which receives its orders via the EIB network, either directly from the sensor (e.g. brightness sensor) or from a central computer.

Local Operating Network (LON)
This is a Bus-system which is generally used for building automisation. The standardization is in compliance with the American codes ANSI/CEA-709 and ANSI/CEA-852, together with the Europeancode EN 14908.
In comparison to a central orientated system, whereby a central computer collects all data and transmits on all orders, this concept is is to allow the possibility of a de-centralised automisation. Information would only be needed locally, where processing would also take place.

Wireless Communication Systems

Communications systems without wiring (wireless, i.e. via radiowaves), is becoming more popular and does not require the need for often complicated laying of cables. The household appliances can be connected to a desired network (for example the internet or a local network). The most important technical systems are currently:

- ► Wireless LAN systems according to the standard of the series IEEE 802.11 as a supplement to the cable-based local networks (Local Area Networks, LAN's)
- ► Bluetooth for transmission of speach and data in the immediate vicinity
- ► Speach and data communication systems in accordance with the DECT-Standard (Digital Enhanced Cordless Telecommunications)
- ► WiMAX (Worldwide Interoperability for Microwave Access) for connection of land lines and for mobile device terminals
- ► Radio-link system for the wireless bridging of long distances between buildings
- ► ZigBee, based on IEEE 802.15.4, for sensor and control networks
- ► Infrarot-Modules in accordance with IrDA for communication and periphery equipment

► Wireless keyboard, mouse and other input devices

► UWB (Ultra-wideband) for connection of periphery equipment with high data rates.

With regard to wireless communications systems, the information is transmitted via electromagnetic waves (radio waves or infrared). As there is no physical protection of the transmission medium (as with a cable, for example), the corresponding risks must be taken into account:

- Fluctuating quality of transmission
- Wiretapping
- Manipulation by another.

Standards for ‚Smart Homes'

KNX is a standardised (EN 50090,ISO/IEC 14543), OSI-based network communications protocol for intelligent buildings (Home and Building Electronic Systems, HBES). KNX is the successor to, and convergence of, three previous standards: the European Home Systems Protocol (EHS), BatiBUS, and the European Installation Bus (EIB). The KNX standard is administered by the Konnex Association.

The standard is based on the communication stack of EIB but enlarged with the physical layers, configuration modes and application experience of BatiBUS and EHS.

KNX defines several physical communication media:

- Twisted pair wiring (inherited from the BatiBUS and EIB Instabus standards)
- Powerline networking (inherited from EIB and EHS - similar to that used by X10)
- Radio
- Infrared
- Ethernet (also known as EIBnet/IP or KNXnet/IP)

KNX is designed to be independent of any particular hardware platform. A KNX Device Network can be controlled by anything from an 8-bit microcontroller to a PC, according to the needs of a particular implementation. The most common form of installation is over twisted pair medium.

In some parts of the world KNX now competes with Clipsal C-Bus (protocol).

Contents of EN 50090:

- EN 50090-2-1:1994 : System overview-Architecture
- EN 50090-3-1:1994 : Aspectsof application-Introductionto the application structure
- EN 50090-3-2:1995 : Aspectsof application-User process
- EN 50090-3-2:2004 : Aspectsof application-User process forHBES Class1
- EN 50090-4-1:2004 : Media independent layers-Application layer for HBES Class1
- EN 50090-4-2:2004 : Media independent layers–Transport layer, network layerand general partsof datalink layer forHBES Class1
- EN 50090-5-1:2005 : Media and media dependent layers-Power line forHBES Class1
- EN 50090-5-2:2004 : Media and media dependent layers-Network basedon HBES Class1, TwistedPair
- EN 50090-7-1:2004 : System management-Management procedures

Demonstration Projects

The following demonstration projects have been performed, or are currently being carried out:

SmartHouse
CENELEC and IPv6 Forum launched the SMARTHOUSE project, supported by the EU commission as part of the eEurope 2005 initiative, to develop a SMARTHOUSE Code of Practice, which was completed and published in 2005. The general scope of the SmartHouse project was to develop ~~grow~~ and sustain the inter-operability of systems, services and devices for the SmartHouse which would ensure that the European Citizen has access to increased functionality, accessibility, reliability and security that a Smart House, with open architecture, would deliver in an expanding broadband infrastructure throughout Europe.
The “Code of Practice” is an overview of all actuators, systems, networks, applications and services involved in the SmartHouse, specifying functionalities, methodologies, recommended standards and working practices that would ensure inter-operability and interactivity of multiple products, applications and services in and to the SmartHouse. It recommends and references in detail all of the appropriate standards in this field.
(SmartHouse Code of Practice – CWA 50487)

Cooltown (HP)
People, rooms and objects would receive a Web-presence and be connected together via a network of all mobile and local communication equipment. For example, the data from a biometric watch, which a person is wearing, would be registered and in the event of a heart attack , the emergency services would be notified.

Homelab (Philips)
The project HomeLED / Philips represents the vision of a intelligent house for the 21st Century, and was opened in April 2002. It serves as a research platform and test environment for building automatisation, networking and multi-media electronics.

InHaus-Projekt (Fraunhofer)
This project focuses on the integration of household appliances.

Contact addresses

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Association "Intelligentes Wohnen Austria"

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Section ‚Intelligentes Wohnen im G-N-I (Gebäude-Netzwerk-Institut)‘
Research Institute ‚**CEESAR‘** (Hochschule Luzern, CH), research project ‚**iHomeLab‘**.

Comments/Conclusion from the AAL point of view:

There is a huge market demand for »Smart Homes« in the fields of ambient assisted living.
So far, intelligent or smart homes have been focusing on building services (heating, cooling, air conditioning, lighting, sun-blinds), household appliances (electric cooker, refrigerator, etc.) and multimedia (telephone, audio and video, TV, etc.), i.e. more on technological data processing. The integration of the humans, by using the occupants data (physiological indicators, life style parameters, movement and location, etc.) to assist in their comfort, health and safety has not really been taken into consideration. The conclusion is, that these two fields (Smart Homes and AAL) should be integrated much more in future.