

## **Background and approach to a definition of smart buildings**

**Authors: S.Millán, A. Ganah, A. García, F.J. Jiménez and O. Higuera**

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### **ABSTRACT**

There is no possibility of finding a single reference about domotics in the first half of the 20th century. The best known authors and those who have documented this discipline, set its origin in the 1970's, when the x-10 technology began to be used, but it was not until 1988 when Larousse Encyclopedia decided to include the definition of "Smart Building". Furthermore, even nowadays, there is not a single definition widely accepted, and for that reason, many other expressions, namely "Intelligent Buildings" "Domotics" "Digital Home" or "Home Automation" have appeared to describe the automated buildings and homes. The lack of a clear definition for "Smart Buildings" causes difficulty not only in the development of a common international framework to develop research in this field, but it also causes insecurity in the potential user of these buildings. Thus, the main purpose of this paper is to propose a definition of the expression "Smart Buildings" that satisfactorily describes the meaning of this discipline. To achieve this aim, a thorough review of the origin of the term itself and the historical background before the emergence of the phenomenon of domotics was conducted, followed by a critical discussion of existing definitions of the term "Smart Buildings" and other similar terms. The extent of each definition has been analyzed, inaccuracies have been discarded and commonalities have been compared. Throughout the discussion, definitions that bring the term "Smart Buildings" near to disciplines such as computer science, robotics and also telecommunications have been found.

**Keywords:** Smart Buildings, definition, Domotics, Intelligent Buildings, Home Automation.

## **1 INTRODUCTION AND METHODOLOGY**

Domotics is nowadays a 30-year-old discipline that has not defined itself yet, it has been documented that the ambiguity in the meaning of the term and services offered by Smart Buildings creates confusion between what the user expects from these buildings and what the user finally obtains [1], so that the logical consequence is the rejection of the society to these new automated services. For that reason, a clear definition could contribute to the architecture, engineering and construction industry by making the home automation services offered in the market more understandable by the customer. Furthermore, proposing a satisfactory definition of the discipline will help in setting and limiting the scope of the research in this field.

About the methodology, as the research started by documenting the evolution of Smart Building, content analysis process has been used [2]. This document and content analysis has been chosen because this is a method that can be used with either qualitative or quantitative data and it is normally represented as three main phases: preparation, organizing and reporting. Some of the more significant definitions are included in this research paper.

## 2 THE ORIGIN AND DEFINITION OF THE TERM "DOMOTICS"

**Definition 1:** *Electrical appliances give way to the real domotique: a home transformed by the use of hardware components, microprocessor equipment for connection to personal computers, teletext and the electronic directory, multifunction phones, (...) and calculators all terminals and household robots that beyond the traditional functions can handle all types of operations, like as energy costs for heating or cooking [3].*

Although there are references that explain that the first appearance of the term is due to the French professor of the Rennes University, Marc Humbert, as usual in the field of new technological terms, French dictionaries are the first to propose in 1988, of an official way, the first definition for the term "domotique".

**Definition 2:** *is the concept of housing that integrates all security automation, energy management, communications, etc [4].*

It is a rather general and unrealistic definition for the date. However, it is the first attempt to provide us with a definition to the term and reflects the desire to automate the most services offered. A group of French organizations: The FIEE, The FNB, The IFB, The FNEE, and EDF proposes, in 1988, the following definition.

**Definition 3:** *Set of services in the habitat provided by the systems that perform various functions, which can be connected together and with external communication networks . These functions include, in particular, energy conservation and management of technology, information and communication, control, comfort and security.*

This definition is almost coeval with the first definition proposed by Larousse. However, it is much more concrete and introduces a very important concept, the concept of "service". It also refers to communication networks that give unity to the overall system of home automation. Philippe Dard, technician at CSTB (Centre Scientifique et Technique du Bâtiment) proposes another definition, much deeper in the social aspects.

**Definition 4:** *Domotics is a social and technical process that uses new technologies in the habitat. This process renews questions about the nature of the habitat and the mission of the agents involved [5].*

In this last definition is interesting the nature of "process" that is given to the concept, it does not bound the technologies that are involved and recognizes the role of society and therefore the user in defining the objectives of the same.

It is not clear that Domotics can fit in the definition of science, it is rather a discipline that studies the set of systems that are capable of automate a building. A clear agreement about the etymology of the word domotics can neither be found and is often explained as (domus = house) + informatics = domotics, or as domus + robotics = domotics, or domus + tica (automatics in Greek) = domotics.

## 3 EVOLVING CONCEPT, "SMART BUILDINGS"

Automation applied to buildings is called "domotique" in France or "domótica" in Spain, but in international contexts, it is more common the English term "home automation" or the American expression "smart building/house" (see Table 1). It is known that, almost simultaneously to the birth in France of the term "Home Automation" in 1982, in 1981 was used for the first time in EEUU the term "Intelligent Building" by UTBS Cosporation (United Technology Building Systems Corporation) and "Smart Building" was a term promoted in the 1980s by a group of construction companies (NAHB) and is generally interchangeable with the term "home automation". However, as stated by M. A. Florez de la Colina, when these two last

expressions are compared, it is generally considered that "automated house" is a pre-development stage of "smart house".

Geographic Area	Europe				Asia
	EEUU	France	UK	Others	
<b>Representative references</b>	(NAHB 1980) (Gross 1998)	(Humbert 1982) (Larousse 1988) (FIEE et al. 1988) (Nouveau Dictionaire 1989) (Dard 1990)	(Derek, T. and J. Clements-Croome 1997) (Yang and Peng 2001) (Wigginton and Harris 2002)	(Dooftingh 1990, ESPRIT PROJECT) Instituto Cerdá. (1990) Flórez de la Colina, M.A. (2004) Huidobro, J.M. and R.J. Millán. (2004)	(So, A.T. et al. 1999) (Wong, J. et al. 2005) (Yiu, C. and Y. Yau 2006)
<b>Commonly used expressions</b>	Intelligent Buildings Smart Buildings/Houses Home Automation	Domotique (Domotics)	Home Automation Intelligent Buildings Smart Buildings	Home Systems Domótica (Domotics) Hogar Digital (Digital Home) Inteligencia Ambiental (Intelligent Ambient) Hogar Digital Conectado" (connected digital home")	Intelligent Building Intelligent Home
<b>Main concepts, features and functions</b>	*To employ sensors and control systems to monitor a dwelling *To provide a safer, more comfortable, and more economical dwelling *It speaks about: building structure, building systems, building services and building management.	*Use of hardware components *Connection to personal computers *Integrates all security automation, energy management, communications, etc *Application of computing to housing *Set of services in the habitat provided by the systems *Connected together and with external communication networks *Functions included: energy conservation and management of technology, information and communication, control, comfort and security *It is a social and technical process	*Intelligence applied to the building *System able to respond to individual, organisational and environmental requirement and to cope with changes *One of the main goals is to achieve efficient management of resources with minimum life-time costs of hardware and facilities	*Emphasis is on information technology *Convergence of services: entertainment, communications and the digital management of the house *A structure of independent networks *System that includes the Internet connection *Emphasizes on centralized control *Also emphasizes on the elements that provide the media access (wiring).	*Focused on user needs and the requirements of the user *It should provide advanced automatic control systems to monitor services *It should have good networking infrastructure *It should provide adequate tele-communication facilities *Automatic functions: communication automation, office automation and building management automation *Rationalisation of building administration to provide more attentive administrative services with lower cost *Environmental friendly *Space utilisation and flexibility *Image of high technology

Table 1. Comparative table of attempts to establish a definition related to Home Automation

According to Wigginton and Harris there are about 30 different definitions of intelligence related to buildings . Early definitions focused primarily on the intention of introducing new technologies at dwellings. The most recent definitions, are adding to the system the ability to "learn" and to self-adjust to the environment and to the user. It seems therefore, that indeed the aim of the terms "domotique" and "smart building" are very similar and, although today they are often explained using different connotations, they are both terms that have tried to evolve since they began to be used to encompass new developments, technologies and disciplines that each day are included in the field of automated building design.

#### 4 RELATED CONCEPTS

Additionally we must also know the existence of complementary terminology that is the result of the trade and other business initiatives. Within this complementary terminology, the expression "Digital Home" can be found. This term was defined, powered and used by Telefónica and ASIMELEC, both Spanish companies, and it emerged with a clearly differentiating and commercial will. According to Telefónica, the Digital Home is the realization of the idea of convergence of services, entertainment, communications and the digital management of the house, infrastructure and equipment (Home Networking). Another term used is "Connected Home" sponsored by Plan AVANZ@ for convergence with Europe's Information Society of the Ministry of Industry, Trade and Tourism in Spain. What this plan aims

is to encourage and facilitate the recruitment of the internet connection of households, so the background does not define any type or level of smart building. It is also very enlightening when; analyzing existing definitions related to automation in buildings, a comparison between countries or continents is made (Table 1). Through this comparison it can be detected that, not only each geographical area prefer to use certain terms over others, through the proposed definitions the emphasis on various aspects of automation can also be detected.

## 5 CONCLUSIONS

As it has been shown, there are many differences between the definitions discussed, but there are many similarities to what is meant by automation. The most significant similarities and differences are:

- Many definitions describe a set of "systems" capable of automating a home, these systems provide "services" about energy management, safety, welfare and communication. Other definitions prefer to focus on the term "services" as a proper end of home automation.
- The systems that make up the installation can be integrated through internal and external networks of communication, yet it is not a requirement that the home automation system is connected to the Internet network. Nowadays there are other ways in case remote control is required.
- It is usual to refer to the overall management and control, this control has certain ubiquity, from inside and outside the home. The concepts of "control and management" and "intelligence" alternate between the different definitions studied.
- Some definitions refer to Smart Buildings as a result of the application of certain "science" or "technology" very specifically, and some definitions refer to a "process" which reflects an evolutionary will of the term smart building.
- The role of the user and their interaction with the system is not dealt evenly in the analyzed definitions.

From these considerations, the following definition of smart building has been developed:

**Definition proposed:** The Smart Building is the one that includes a scalable set of services. This set of services is integrated into the housing and are supplied by systems that can be configured in one or more internal networks; in turn, those systems can communicate with other networks outside the home. These services perform functions related to energy saving, the technical management of facilities, information, communication, entertainment, accessibility, care, comfort ... etc. And the control of this scalable set of services can be performed from one or more points (management centres).

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