The Connected Home: from Market Barriers to Business Model Solutions

Malgorzata Ciesielska, Feng Li

RCUK Digital Economy Research Hub on Social Inclusion through the Digital Economy (SiDE), Newcastle University Business School, NE1 7RU United Kingdom
{m.ciesielska, feng.li} @nlc.ac.uk

Abstract. The market for the connected homes is still immature, and there is a considerable confusion about the possible ways of their market development. Basing on a systematic review of previous studies, we analyse nine main reasons why the connected home market has so far failed to take off. We conclude that consumer misperceptions, lack of knowledge as well as the closed system architecture by most providers are the key barriers to their large-scale development. We suggest that overcoming those barriers is possible by referring them to business model building blocks.

Keywords: connected home, smart home, market barriers, business model, interoperability, communication protocols standardisation.

1 Introduction

A connected home is a high-tech residential setting, which incorporates ICT to offer particular services to the residents for the smart assisted living. Smart and connected homes, alongside the notion of assisted living in particular, have gained a lot of attention in the last few years. This is the result of several trends: ubicomp revolution of 90s [1-3], widespread proliferation and fast adaptation of mobile technology and a steady growth rate of households with Internet access all over the world at the similar phase (worldbank.org data) mixed with ageing society- related problems, including the growing health and social-care costs [4-6]. But, the fully connected home has not yet fully emerged and we still don't recognise clear business models of how to bring connected homes and assistive technologies to the mass market.

This paper presents the results from our analysis of yet not overcome connected home market development barriers. To identify them we applied the systematic literature review method [7-8] within Thompson's ISI Web of Knowledge database in all available years (1970-2010). As an outcome, we came up with 39 papers that clearly referred to the market barriers and business challenges for connected home's solutions.

The contribution of this paper is twofold. Not only we indicate the recurring problems of the connected home market but in we clearly refer them to the areas of key business activities, in which they should be addressed. In order to do so we employ the business model perspective. Following [9-10]: we concentrate on three

business model components: Product; Infrastructure; and Customers. To be sustainable, the business has to be financially stable and credible in front of its stakeholders. This sustainability is reach by building positive customer relationship, attention to consumer needs and keeping them informed about the company's actions. At the same time the business infrastructure, its internal and external networks, has to be well thought and directed to match the product/service value proposition. Value proposition, especially the outcomes of product and services development and commercialisation, is a key to revenue generation.

2 Market Barriers

As far as at the beginning of the new millennium two industry reports [11-12] indicated that markets, technologies and supply chains of connected homes are immature and that the consumers are not only sceptical but also ignorant of technological improvements and that building industry should provide generic infrastructure. Not only the demand seems to be inactive, but what is worse the demand is unconscious, unaware of what is available on the market [13]. In addition to that, although end-users express worries about privacy issues, they haven't been so far addressed properly [14]. Moreover, the costs of switching to such technologies appeared to be to high, both in financial terms and private time and habits. In recent years a marketing strategy for the connected home concept changed back to offering single devices enabled to be connected and integrated in larger systems when necessary and configured according to particular buyer's needs. Not a wonder that at the same time construction and property industry was little enthusiastic about creating a market for a fully automated, intelligent house [13].

At this stage of the connected home market creation, the business perspective is needed. The customers have to see a clear value creation chain, which ensure the services and advantages of the smart technologies to be sustainable and justify investments in it. Suppliers, although are more successful with selling separate devices / appliances rather than offering integrated systems, they will soon meet other demand barriers. Early adopters may be happy with trying out technical novelties, but larger population expects fully usable products, not a promise of possible functions.

In the following sections we will summarise the main market-related problems of connected homes, in particular to the user-related issues, technology & supply-related issues, costs, and finally business-related issues including strategy, marketing and services.

2.1 Users Perceptions

The connected home is often seen through analogies to the futuristic, science-fiction stories and movies. The wider public is not informed about possibilities or advantages of the connected homes and often links them to visions taken from pop culture: "The Jetsons" style of living [15] or "Start Trek" [16]. On the other hand, there seem to be the lack of proper information campaign about the connected home benefits, like the ones for energy-saving, security, safety, convenience and enhancing communication

[17] and there are still a number of particular acceptance barriers, which need to be specifically addressed, like: price stability, lack of information, compatibility and possibilities of upgrades, reliability, servicing costs, and complexity in use [4].

2.2 Poor Understanding of User Needs

According to Paul Liao - the president of Panasonic technologies - in the past 30 years progress in technology led to many new products, but its success depends on consumers' expectations, which are steadily growing [18]. In other words customers always expect even further improved performance, decreased costs, miniaturisation, etc. The fact that the technology-oriented approach had failed to provide significant understanding of domestic consumers' expectations was noticed first in 1995 [15]. But similar critics of the innovation industrially driven can be found also in more recent studies [4, 11, 19-20]**.** It seems that ubicom revolution hasn't managed to produce true user-oriented value in the connected home area.

2.3 Data Security and Privacy Issues

There are several security and privacy issue that haven't so far been resolved. This includes authentication and authorisation [21], a need for low-cost, high-quality and excellent security services [22], dependability problems of reliability, availability, security, and manageability [23] or a need for identifying of security mechanisms needed to ensure privacy [24-25]. Once the monitoring systems are installed, the technical possibilities of monitoring are always available. "It could be argued that the ethical pitfalls in monitoring people's movements within their home, or recording the frequency of using the toilet or regularity of eating, counteract the advantages of various smart home technologies for providing independence" (14, p. 17). Therefore, privacy should be a central design issue in its own right with a particular focus in the design areas of capture of data, construction, accessibility and purpose. The key problems lay in disembodiment of the collected data from the context and dissociation from one's actions. The solution is better control and feedback [14].

2.4 Lack of Effective Marketing Message

There is very little PR or marketing strategies aiming at informing the potential customers about the possibilities and advantages of the connected home technologies as well as to dispel doubts about safety, security and other technology-related issues. The problems of lack of the proper marketing communication were raised from the beginning of the 90s [26] and this situation continued over the next two decades [12, 13, 19, 27].

2.5 Lack of Installation, Maintenance Services and Skills

The large reports on connected homes at the turn of the 1990s indicated the obvious

lack of skills among the builders who were supposed to fit the smart technologies in the buildings [11-12, 29]. Similarly [30] and [20] emphasise that still most potential users don't have enough technical skills to install and maintain their connected home systems on their own. Without infrastructure solutions, it may be very difficult to provide smart home installations outside the DIY niche.

2.6 The Costs of Devices and Installations

The customers are interested in connected home solutions but are unwilling to pay the current prices [17, 31-33]. From a house developer perspective, the full range of intelligent technologies would add min +5% to the new home costs [17] or an average about £1400 per room [11]. Because the relatively high initial investment form the consumer is still necessary [12, 34], those costs make the connected home targeted at middle and upper income groups while it stays unreachable for others who could possible benefit form it, like the disabled or the elderly [4].

2.7 The Old Housing Stocks and Retro-adaptation Problems

The large old house stock, in particular in Europe, is another obstacle to the consumer up-take of connected home technology [34]. It is calculated that networking an old building is more expensive than doing it during the new construction works [4]. Therefore, the full retro-fit to existing building is considered improbable on the wide scale due to financial and disruption costs [12,19].

2.8 The Supply: Pessimistic About the Market, Poorly Developed Distribution Channels

The connected home undertaking requires involvement of various specialists originating from retail, transport, services, installation, house-building and software industries and their collaboration has to be properly managed. That is why we believe that the future of the connected home market will depend on the system integrators [4]. Possibly, the slow development of the connected home market reflects the lack of the genuine successful business case in this area. It seems that not only building industry is caught in the concept of constantly futuristic market but also consumer electronic industry considers it as undefined future opportunity [36].

2.9 Lack of Common Standards and Therefore Difficulties in Integrating Different Systems

Huang et al. [37, p. 619] "hypothesize that the utility of input appliances will be greatly increased if they too were 'infrastructure enabled". But they still aren't. The problem is in the lack of common standards, which concerns many issues primarily related to: communication protocols and control [4, 11, 19, 26, 28, 29, 38, 40-46] but also standardisation of testing and diagnostic tools [24].

As early as 1987 the New Scientist reported that “Philips, Thorn-EMI, Thompson. Siemens, GEC, Mullard and Electrolux decided that their next big market would be the “intelligent home” [38]. Ten years after, Barlow & Gann [4] enumerate several “standards” existing on the market in 1998 in the US NHBA: Smart House and EIA: CEBus, in Europe LON Users Club, EHS Association, EIB Association, BatiBUS Club, in Japan: TRON house and EIAJ: HBS. The 90s are described as the time of “battle for dominance” over the concept of the connected home and in particular the standardisation attempts [46, 47]. While the connected home moved towards consumer electronic market and revealed its multi-paradigm setting and open character, the actors kept referring to it in the system paradigm with tight coordination of innovation processes. The trials of integrating some of those standards were to a large extend unsuccessful and still the easiest and fully open ones X10, ZigBee and XBee are also the most popular for connected home DIY.

Currently the most known and widely applied consumer electronic communication standard is UPnP with DLNA certificate. The Digital Living Network Alliance consists of over 200 companies who seek to create new products that are compatible by using open standards and widely available industry specifications. The promote members are companies like Access, AT&T, AWOX, Broadcom, CableLabs, CISCO, Direct TV, DOLBY, DTS, Ericsson, HP, Huawei, Intel, LG Electronics, Microsoft, Motorola, Nokia, Panasonic, Pioneer, Qualcomm, Rovi, Samsung, SHARP, SONY, Technicolor, Toshiba, and Verizon. Although UPnP/DLNA is developed by a group of companies, it doesn’t mean that their products are all compatible. On contrary, the standard has various implementations, which creates burdens for it to work properly. It is enough to follow any Internet forum describing the issues concerning UPnP problems or look at the projects like Rygel/GUPnP to realise that different UPnP/DLNA hardware is not interoperable. Some companies, like Microsoft seem to have a purposeful strategy of making their devices inoperable with some of their competitors. At the end of the day, what was supposed to be automatic and easy, is in fact just an unfulfilled promise. Moreover, the industry consortium restricts the type of formats supported by UPnP/DVLA, which results in the often error messages like “Unsupported format” or “Data is corrupted” which makes this standard even less useful. Not surprising that many involved companied do not even inform their customers that their products are adopting UPnP/DVLA standards [30].

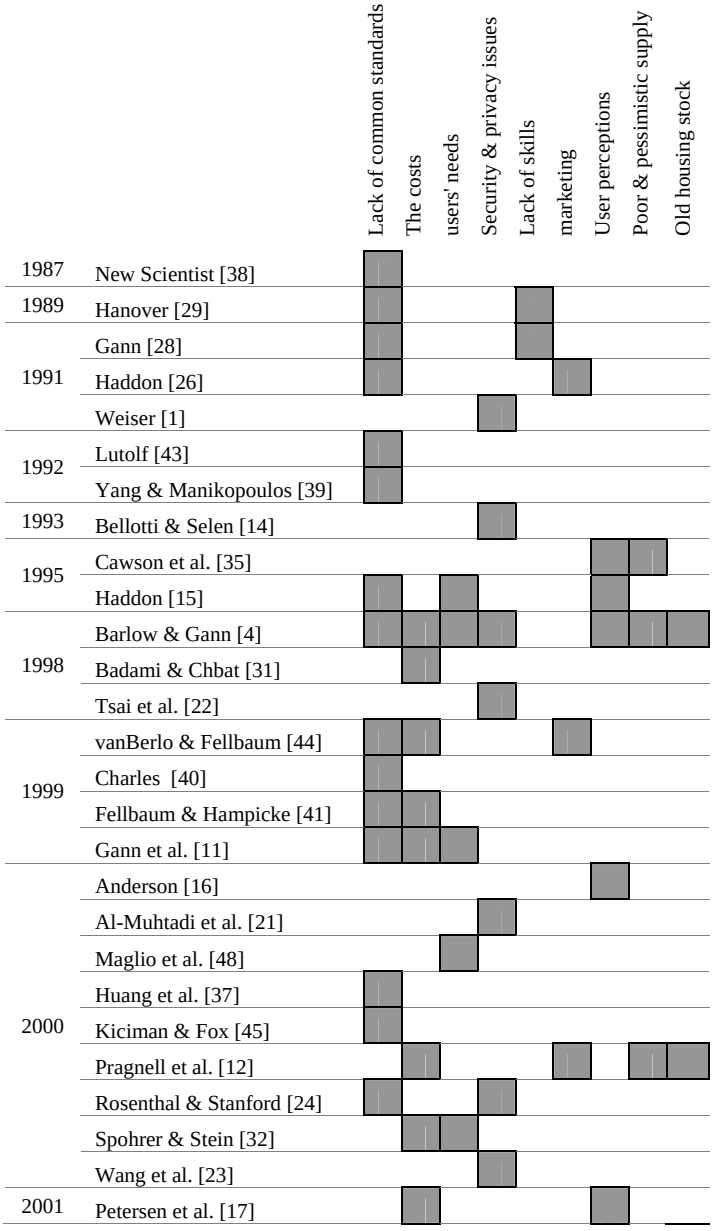
The contradictory, sand-alone strategy is represented by Apple - a notable non-member of Digital Living Network Alliance with its own technology. Apple products are known to operate well among each other and with most other manufacturers’ devices, for instance printers via Bonjour protocol. At the same time Apple standards are not fully open, and probably services like video transmission will be still available just in one direction, from others devices to Apple devices. On contrary to UPnP/DLNA, Apple’s devices do what the manufacturer promise to.

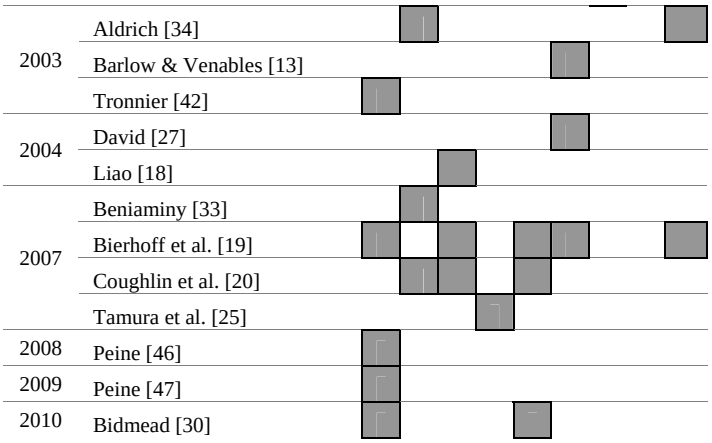
3 Market barriers and business model challenges

The reviewed literature mentioning the key barriers of the connected home market

can be classified into nine groups of problems (Table 1 below). But our aim was not only to create the list of existing market barriers for development of connected homes, but also to relate them to the key elements of a business model. Business model is an analytical way of looking at entrepreneurial endeavour by focusing on the value propositions, ways of generating profits and necessary facilities and arrangements.

Table 1. Key market-development barriers





3.1 Customer Relationship Management

First, there are several serious problems with customer relationship management. On the one hand users tend to have futuristic, partly unrealistic connotations. On the other hand they lack of knowledge about the available technology and there are issues about the proper product classification and guarantee. For instance, within the assisted living technologies people seem to look for either products like medical devices where their reliability is guaranteed by the law. All of those problems should be addressed by the proper CRM, which so far was mostly neglected by the industry.

3.2 Connected Home Innovation and Commercialisation

Second, the price and affordability for different market segments, including non-financial costs of panopticon independency and stigma stays unsolved. For instance, the elderly are looking for more generic products that are not designed for “old” or sick” but just for “younger or more healthy older adults seeking to simply age-in-place.” [20 p.1813]. Also matters of security and privacy are not clear to the end-users.

Although from the industry point of view often high prices for the connected home systems are justified by the cost of innovation, there is little explanation of the value to the end users. But the question of price is more complicated and refers to the other important issue who will pay for the connected home technology, especially assisted living one: the elderly or sick themselves, the families, the government? Careful stakeholder analysis would help in creating sustainable business models able to commercialise successfully smart technologies for connected home.

3.3 Infrastructure management

Finally, the pessimism on the supply side with high costs of house retro-adaptation and lack of technical skills makes infrastructure management difficult. But this indicates on more major choice, which lies across the sections of Customer Relationship Management, product/service innovation and commercialisation and infrastructure management and therefore can be understood as a main connected home business model variable: the lack of common standards. Therefore on the supply side, there is an important choice to be made between open and closed business models with in results implicate different modes of cooperation and different phases of market development. So far, neither quasi-open strategy of Microsoft nor the closed strategy of Apple was able to help gaining significant competitive advantage.

4 Conclusions

The most commonly mentioned market barriers for connected homes are: user perceptions, poor understanding of users needs, security issues, lack of effective marketing, installation and maintenance skills, costs, old housing stock, pessimism in the industry, and lack of common communication standards and data formats. However, they seem to be considered as an explanation why the technology didn't reach the mass-market rather than the set of problems that must be solved. Therefore, our analysis shows that the market-development issues were raised for many years, and still fail to be properly addressed. One of the reasons for this situation is lack of business-oriented framework, and considerations in terms of models of value creation. We predict that the future success of the connected home approach will depend critically on the widespread adoption of the "webs" [49] and platform strategy [50] based on common standard and increasing returns. But this has wider consequences, as without the common standards; the mass market is unlikely to take off. However, the interoperability contradicts the monopolistic and/or lock-in strategies pursued by some of the significant players from the building or the home electronics industries. Many of them are currently adopting a wait-and-see strategy, risking that their competitors may come up with new killer applications or new modes of cooperation [51].

Acknowledgement
This project is part of Social inclusion through the digital economy hub financed by Research Council.

References

1. WEISER, M. 1991. The Computer of 21st Century. Scientific American, 265/3: 94-104
2. WEISER, M. 1993a. SOME COMPUTER-SCIENCE ISSUES IN UBIQUITOUS COMPUTING. Communications of the Acm, 36, 75-84.
3. WEISER, M. 1993b. UBIQUITOUS COMPUTING. Computer, 26, 71-72.

4. BARLOW, J. & GANN, D. 1998. "A changing sense of place: are integrated IT systems reshaping the home?" Electronic Working Paper Series, Science Policy Research Unit (SPRU): University of Sussex, Paper No 18.
5. BECKER, S.A. & WEBBE, F.M. 2008. The Potential of Hand-held Assistive Technology to Improve Safety for Elder Adults Aging in Place. In: Henriksen K, Battles JB, Keyes MA, et al. (eds) Advances in Patient Safety: New Directions and Alternative Approaches (Vol. 4: Technology and Medication Safety). Rockville (MD): Agency for Healthcare Research and Quality (US); available at: http://www.ncbi.nlm.nih.gov/books/NBK43759/#advances-becker_3.s1
6. MYNATT, E. D., ESSA, I. & ROGERS, W. 2000. Increasing the opportunities for aging in place. Cuu 2000 Conference Proceedings, 65-71.
7. TRANFILED, D., DENYER, D., SMART, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. British Journal of Management 14 (3), 207-222.
8. LEE, R. 2009. Social capital and business and management: Setting a research agenda International Journal of Management Reviews. Volume 11, Issue 3, 247–273
9. OSTERWALDER, A. & PIGNEUR, Y. 2002. An e-Business Model Ontology for Modeling e-Business. 15th Bled Electronic Commerce Conference e-Reality: Constructing the e-Economy, Bled (Slovenia), June 17-19.
10. LI, F. 2007. What Is E-Business? How the Internet Transforms Organizations. Blackwell Publishing
11. Gann, D., Barlow, J., Venables, T.: Digital futures: Making Homes Smarter. The Joseph Rowntree Foundation, York (1999)
12. PRAGNELL, M., SPENCE, L., MOORE, R.:The Market Potential for Smart Homes. Joseph Rowntree Foundation, York (2000)
13. BARLOW, J. AND VENABLES, T. 2003. Smart home, Dumb Suppliers? The future of Smart Home Markets HARPER, R. (ED.) Inside the smart home. London: Springer-Verlag, 247-262
14. BELLOTTI, V. & SELLEN, A. 1993. DESIGN FOR PRIVACY IN UBIQUITOUS COMPUTING ENVIRONMENTS. Proceedings of the Third European Conference on Computer-Supported Cooperative Work (Ecscw 93), 77-92.
15. HADDON, L.G. 1995. Home automation: Research issues Paper presented at the second EMTEL workshop: 'The European Telecom User'. Nov 10-11th, 1995, Amsterdam
16. ANDERSON, M.K. 2000. Becoming Your Own Hospital. Wired news. Retrieved 1/09/2010, available at: http://www.wired.com/science/discoveries/news/2000/11/40120
17. PETERSEN, T.; P. WILLIAMS & A. MILLS 2001. Analysis of the value of home automation systems Facilities. vol. 19, no 13/14: 522-530
18. LIAO, P. 2004. Taking ideas from life to create life. in: Bernabe y Varela (de), F.G. "Connected Homes. Thought Leaders. Essays from Innovators" Cisco Systems, 50-55
19. BIERHOFF, I., VAN BERLO, A., ABASCAL, J., ALLEN, B., CIVIT, A., FELLBAUM, K., KEMPPAINEN, E., BITTERMAN, N., FREITAS, D., AND KRISTIANSSON, K. 2007. Smart home environment. In: Roe, P.R.W. (ed.)

Towards an inclusive future: Impact and wider potential of information and communication technologies, 110- 156 available at: http://www.tiresias.org/cost219ter/inclusive_future/

20. COUGHLIN, J. F., D'AMBROSIO, L. A., REIMER, B. & PRATT, M. R. 2007. Older adult perceptions of smart home technologies: Implications for research, policy & market innovations in healthcare. 2007 Annual International Conference of the Ieee Engineering in Medicine and Biology Society, Vols 1-16, 1810-1815.
21. AL-MUHTADI, J., ANAND, M., MICKUNAS, M. D. & CAMPBELL, R. 2000. Secure Smart Homes using Jini and UIUCSESAME. 16th Annual Computer Security Applications Conference, Proceedings, 77-85.
22. TSAI, S. M., YANG, P. C., WU, S. S. & SUN, S. S. 1998. A Service of Home Security System on Intelligent Network. Ieee Transactions on Consumer Electronics, 44, 1360-1366. *I3E2011* 13
23. WANG, Y. M., RUSSELL, W., ARORA, A., XU, J. & JAGANNATHAN, R. K. 2000. Towards dependable home networking: An experience report. Dsn 2000: International Conference on Dependable Systems and Networks, Proceedings, 43-48.
24. ROSENTHAL, L. & STANFORD, V. 2000. NIST Smart Space: Pervasive computing initiative. Ieee 9th International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises, Proceedings, 6-11.
25. TAMURA, T., KAWARADA, A., NAMBU, M., TSUKADA, A., SASAKI, K. & YAMAKOSHI, K. 2007. E-Healthcare at an Experimental Welfare Techno House in Japan Open Med Inform J. 2007; 1: 1–7
26. HADDON, L. G. 1991. THE INTELLIGENT HOME. Investment, Procurement and Performance in Construction, 340-347.
27. DAVID, S. 2004. Consumers take the lead. In: Bernabe y Varela (de), F.G. Connected Homes. Thought Leaders. Essays from Innovators" Cisco Systems, 44-49
28. GANN, M.D. 1991. The Diffusion of Intelligent Building Technologies. In: Venmore-Rowland, P., P. Brandon & T. Mole (eds.) INVESTMENT, PROCUREMENT AND PERFORMANCE IN CONSTRUCTION: 328-334
29. HANOVER, G. 1989. NETWORKING THE INTELLIGENT HOME. Ieee Spectrum, 26, 48-49.
30. BIDMEAD, C. 2010. WTF is... DLNA? Hardware, accessed 18 Oct 2010 [Online] available at: http://www.reghardware.com/2010/10/18/wtf_is_dlna/
31. BADAMI, V. V. & CHBAT, N. W. 1998. Home appliances get smart. Ieee Spectrum, 35, 36-43.
32. SPOHRER, J. & STEIN, M. 2000. User experience in the pervasive computing age. Ieee Multimedia, 7, 12-17.
33. BENIAMINY, I. 2007. Smart Scheduling For Smart Meters professional technology & business smart appliance everyone Pipeline & Gas Journal, Sept 2007, 32-34
34. ALDRICH, F.K. 2003. Smart Homes: Past, Present and Future. in HARPER, R. (ed.) Inside the smart home. London: Springer-Verlag, 17-40.
35. CAWSON, A., L. HADDON, I. MILES 1995. The Shape of Things to Consume. Chapter 3. Home automation. Available at:

http://www2.lse.ac.uk/media@lse/whosWho/AcademicStaff/LeslieHaddon/ShapeofThings.pdf
36. CRAUMER, M. 2002. The sputtering R&D machine. Harvard Business Review, 80, 25+.
37. HUANG, A. C., LING, B. C., BARTON, J. J. & FOX, A. 2000. Running the Web backwards: appliance data services. Computer Networks-the International Journal of Computer and Telecommunications Networking, 33, 619-631.
38. 1987. EUROPEAN COMPANIES SET THE STANDARD FOR SMART HOMES. New Scientist, 113, 31-31.
39. YANG, J. & MANIKOPOULOS, C. N. 1992. ROUTER CONNECTED PHYSICAL MEDIA IN NETWORKING THE INTELLIGENT HOME. Ieee Transactions on Consumer Electronics, 38, 30-35.
40. CHARLES, J. 1999. Ubiquitous computing uncorked. Ieee Software, 16, 97-99.
41. FELLBAUM, K. & HAMPICKE, M. 1999. Integration of smart home components into existing residences. Assistive Technology on the Threshold of the New Millennium, 6, 497-501.
42. TRONNIER, H. 2003. CENELEC Work Shop - SMart House, Final report. Euronom, Kronberg. Available at http://www.cenelec.eu/Cenelec/Technical+work/CENELEC+Workshop/Ongoing+Workshops/Smart+House.htm
43. LUTOLF, R. 1992. SMART HOME CONCEPT AND THE INTEGRATION OF ENERGY METERS INTO A HOME BASED SYSTEM. Seventh International Conference on Metering Apparatus and Tariffs for Electricity Supply, 367, 277-278.
44. VAN BERLO, A. & FELLBAUM, K. 1999. Smart home technology: Useful applications for older people. Assistive Technology on the Threshold of the New Millennium, 6, 508-512.
45. KICIMAN, E. & FOX, A. 2000. Using dynamic mediation to integrate COTS entities in a ubiquitous computing environment. Handheld and Ubiquitous Computing, Proceedings, 1927, 211-226.
46. PEINE, A. 2008. Technological paradigms and complex technical systems - The case of Smart Homes. Research Policy, 37, 508-529.
47. PEINE, A. 2009. Understanding the dynamics of technological configurations: A conceptual framework and the case of Smart Homes. Technological Forecasting and Social Change, 76, 396-409.
48. MAGLIO, P. P., MATLOCK, T., CAMPBELL, C. S., ZHAI, S. M. & SMITH, B. A. 2000. Gaze and speech in attentive user interfaces. Advances in Multimodal Interfaces - Icmi 2000, Proceedings, 1948, 1-7. *I3E2011*
49. HAGEL III, J. 1996. Spider versus spider, Mckinsey Quarterly, 1996(1), 4-19.
50. CUSUMANO, M.A. 2010. Staying power - six enduring principles for managing strategy and innovation in an uncertain world. Oxford University Press
51. SANDSTRÖM, G. 2009. Smart homes and User Values - Long-term evaluation of IT-services Residential and Single Family Dwellings PhD Thesis. Introduction. Royal Institute of Technology, Stockholm