Handling of Information in the Ubiquitous House *

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ABSTRACT

In his book "delete - The Virtue of Forgetting in the Digital Age" Viktor Meyer-Schönberger analyses the consequences of constant collection of data on the Internet and the inability to control who, at what point and in which context this data is used. Furthermore he poses the question what this disability to forget, a virtue that has shaped Mans development, means for mankind, his analytical skill and social behaviour.

The theme of the book prompts us to ask what storage of data would mean in an ubiquitous world that is about to break upon us into the near future. What does the collection of data in the house-realm mean for our sensation of private sphere in the castle-notion of our homes we foster in our heads. The promise of ease of life, sustainable homes and energy efficiency will then be balanced to the trade-off with the uneasy feeling, when we realise the grade of surveillance one is exposed in our own four walls.

Ubiquitous Computing is seen here as household apparatus networked with different arts of sensors, combined with context-awareness and usability models that allow the use of intelligent buildings, in forms such as automatic light and temperature regulation. Smart houses record the habits and every-day action of its habitants, not only for functional but ideally also for analytical reasons to learn, adapt and optimize household functionality to the needs of its users. The data collected could show how often one is at home, when one usually goes to bed, the time spent working at the desk etc. But also information such as how long one stays in the toilet, were we ill in bed or having just a quiet day at home – information that, depending on the context, could be quite compromising if it becomes public. The information is stored in the assumption that the household owners are the only ones who have access to it. But in different scenarios, which to some extent already exist in the Internet world, third parties can easily get hold of private data. The degree of privacy in our home achieved through architectural measures, could be then perverted by public exposure of our inmost secretes served in digital form. The basic question arises – do we need to store such private data, and if yes in what detail and for how long?

Meyer-Schönberger discusses possible strategies of reintroducing forgetting in the digital world, concretely introducing an expiry date, as a part of meta-data connected to digital data. Apart from expiration date several other principles can be used to ensure that data is not abused outside the home-realm, such as: limiting the capacity of apparatus, so that old data is always overwritten with new data and only a small time frame being stored; encrypting data between specific apparatus, thus ensuring only a "local" interpretation of data; reinterpreting the collected data in statistical or mathematical expressions, that show general behaviour without revealing the identities, details or habits of the residents.

Keywords

Ubiquitous House, Private House, Privacy

1. INTRODUCTION

This paper will be concerned with three main subjects: architecture, the digital house and the private sphere and how they are interconnected.

The architecture of the private house has changed in the last few decenniums due to the changes in the social structure. The traditional nucleus of the society – the family with children, has become the minority in the modern western world. The typical household today in the modern western towns consists of the single or a couple without children. Yet the apartments and the houses that are available or are still built are meant for the family with children. Those who can afford to build a new house tend to choose a design that is slightly different from the traditional private house – a two story house with bedrooms on the top floor and the kitchen, study and living room on the ground floor. What these people tend to ask for was described in the exhibition "The Un-Private House" at the MoMA in 1999. In the book[16] accompanying the exhibition, Terence Riley presents several examples of the new tendencies in the modern private house, and analyses especially the changes in the notion of privacy. Whereas the traditional private house has gradually ousted the public realm from the house, Riley notes in his examples how the public has been slowly re-introduced into the modern house. Also there is a tendency to less separate rooms and more to activities that are reconciled in one larger room.

There are several points that influence these changes:

1. With the children not in the house, and thus less noise emission there is no necessity of separate rooms for different activities.

*A full version of this paper is available at `www.cetkovic.com/portfolio/docs/paperInfHandlingUbiHouse.pdf`

Skilled Art April 23+24, 2010, Guimaraes, Portugal.
ACM .

2. It has become normal to work partly or fully at home, thanks to the computer. There is no clear separation between the place of work and home.

3. With the new media, the television and radio, the telephone and especially the computer the public has entered the home.

Especially the last point of the interconnectivity with the computer has made the far-away more than ever present in the house, with the web-cam even to a public that in physical sense would never been able to fit in the home[24]. There are individuals that expose readily 24/7 their private sphere on the net, the first and quite well-known jennycam[25](Jennifer Ringley) who had a large community that consumed this sort of exhibitionism.

2. PRIVACY ON INTERNET AND IN PUBLIC

The notion of privacy has drastically changed and especially in the realm of the Internet consequences of this change are being still examined and discussed. This paper will not go deeper into the subject of privacy on the Internet, as it is discussed in many different sources. None the less several aspects of the discussion around privacy on the Internet will be referred to in this paper, to point out in which direction the discussion around the privacy in the smart house might develop:

1. The tendency of Internet users (especially the new generation) to readily give parts of its privacy in exchange for free services (e.g. Googlemail, Facebook, MySpace). This could be on one hand interpreted as a change in attitude to privacy, i.e. a generation having nothing to hide, on the other hand it could be seen as an un-mature reaction due to little experience of the consequences what such openness can bring in the future[1].

2. There are companies harvesting information about individuals on the Internet and creating profiles of the unwary masses. A real market of information about individuals and their habits has emerged, that is bound for big money in the near future. Not only the economy is interested on such information, as to be able to place the right products with the right person at the right time, but also the governments are interested on such profiles.

3. Whatever we do on the Internet (browse, search, chat etc.), we create a digital footprint. This information combined together from different sources creates a digital profile of us, that seldom corresponds to how we see ourselves. We can rarely verify this aggregated data and it is virtually impossible to have this image of us corrected or deleted.

Even if we want to attribute these changes of privacy to something typical for the Internet, the surveillance of the public sphere has changed so much, that we cannot assume that we will disappear as individuals in the sea of masses. This just doesn't work in the digital age, as the computer allows to pinpoint each individual and follow its activity indefatigably. In England and especially in London there will be soon few places that are not covered by CCTV cameras. And as face recognition algorithms will soon reach such a level of sophistication, records of the movements of each individual in the public could be stored in a database of where we were at what time. This sort of total surveillance might seem as a large effort that might not be worthwhile creating, but thanks to mobile phones this is already a reality in certain countries. Thanks to the localisation possibilities of mobile phones, companies can track the movement of any subscriber whose phone is roaming mode. This setting allowed such interesting projects like "Real-Time Rome"[4], where MIT-Researches together with the mobile Phone Company Telefonica created maps of movements of masses in Rome during a certain time period. Certain governments prescribe that the companies store this movement data for certain time for judiciary reasons.

So the last resort of privacy, away from beady-eyed governments and companies, seems to be the private home. But will it stay so?

3. UBIQUITOUS HOUSE

The term Ubiquitous House is derived from Ubiquitous Computing and House i.e. a house whose technology is interlinked (LAN, Wireless) and communicate with each other to create a smart environment and control the different functionalities of the house. The main focus of the gadgets is the inhabitant. The scanners need to observe the inhabitants to decide in which rooms they are located in, so to control the different aspects of that space, like lighting, air condition, heating, humidity etc. This environment is intelligent in the sense that it learns from the reactions of the users to different situations and tries to adapt to the users habits.

The house of the future has already started with the appearance of the computer in the household. The most renowned mention of the beginnings of pairing of Internet and household is the Trojan Room Coffee Machine[20] at the Research Lab of the Cambridge University. It is known as the first live web cam transmission on the Internet.

As early as 1998 Alex Van Es[22] hooked up his door bell, his refrigerator, the flush of his toilet, the phone and three web-cams to the Internet and recorded the time whenever one of this apparatuses was in use, to create a statistic of his daily household use and life available to the net. Today there are many such example of information collected by scanners at buildings being published on the Internet[2].

The combination of all data collected about the inhabitants, creates a perfect digital profile of the individual. By doing his everyday customs in such an environment of total scanning the inhabitant creates a digital replica of him- or herself. Moreover analysing this data allows not only

[1]Social networks like facebook have been around for four, myspace for seven years, becoming really popular during the Web 2.0 hype five years ago. Their notion of privacy can be seen as a series of trial and error rules, where companies like facebook often try to define rules about the rights over content of the users, only to retrace such an attempt after outcries of the user community. Google had to retrace its plans to interpret user links, when it introduced buzz and taking over automatically googlemail connections in buzz – thus declaring all the users email connections to be equal to friends. See also[14].

[2]A notable example is the project from Usman Haque that mashes such sites onto the Pachube platform in an attempt to aggregate all this data for the web community.

to contribute certain habits to the individuals but also to predict behaviour. Researchers analysing social habits in social networks like Facebook were able to predict which individuals were to become couples by observing how intensely one person was observing another person through the platform[15]. The researchers could probably come to the same conclusion by observing teenagers in their everyday interaction at school with the difference that they have to create an environment where the targeted group of people can be observed and create criteria to measure such communication. Whereas on the Internet the whole communication is already digitalised and available in huge numbers, so that conclusions about human nature can be made. Social networks like Facebook, MySpace, LinkeIn etc., have become a popular source for Sociology and Social Psychology. Collecting data in the house would provide even more comprehensive measurements of homo sapiens. Combined with the digitalised thoughts, interests and discussions on the Internet the individual becomes fully transparent (german: der gläserne Mensch). We need just to consider some of the different realms of the smart home already available to understand how extensive and detailed this information is:

Kitchen: The vision of liberating the housewife from the obligations at home has continued to produce interesting fancies. Many from the Internet Fridge[12] to the refrigerated oven, are already in production. The ambient idea is that not only can we control what food we buy (ex. using the KitschenAttendant[2]) and thanks to the Internet that could be anywhere in the kitchen[13] decide what to cook with the available ingredients[5], but we can also follow what kind of nutrition we are consuming and follow the (medical-) effect on the individual. Analysing what we prefer at special occasions and what in general tells about our tastes.

Hygiene: At the bathroom and the gym the individual updates on a daily basis the personal health and allows the system to draw conclusions how the body reacts on different food and actions the individual has been exposed in the past. Even the mental health can be analysed through different indicators. Weight, pulse, blood pressure, fat indicator, temperature are values that we already consciously measure today[1]. Yet it is possible to collect all of this data without any conscious handling from our side. Additional statistical data of how often we use the toilet, how long we sleep or also what we ate can be collected for the overall image. With these data an individual becomes a measurable object. The up-side would be early prognostics of illnesses and prophylaxis through controlled exercise and food management. The down side is a society like Julie Zeh describes in her sombre book "Corpus Delicti"[26], where the individual is punished for his medical trespassing.

> "I've connected the toilet to the Internet! Every time I flush the toilet, the date, time, and the duration is now logged. This way you can see a direct connection between what's in my fridge, what I've thrown into the trash bin, (Read: What I ate) and what came out. =:)"
> Alex van Es[19]

That the smart house of the future stays isolated from the net is less likely, as part of the vision of the future house is information wherever and whenever we need it. It lays in the nature of things that this collected data will be provided to different companies for statistical, control, backup reasons etc., which means that the digital individual provides all the necessary data for targeted marketing from the industry.

Even if this data is passed anonymously, research on the Internet has shown how easily with certain cross-reference (k-anonymity) methods the owners can be reconstructed[9].

But it won't be the malicious hacker or spyware that will pass personal information to the companies. The real threat to the privacy will be the inhabitant of the smart house himself. Swapping information about their privacy for services that companies harvesting information might offer. Just like in the internet where free mail, free social networking, free chatting, free document creation and handling, free searching etc. is taken for granted in exchange for putting up with information- and user-oriented commercials.

Imagine a scenario where house-owners agree to install a fridge with an RFID-reader and connection to the Web for free, in exchange for a contract that allows the provider to refill fridge with the general articles of daily use, as soon as they get used up. That means no more milk, butter, Furthermore the fridge could have a screen or be linked to some mobile computer that suggests what food needs to be consumed due to expiration date. Also nutrition programs concerning health or diets for weight can be combined with the contents of the fridge[11].

> "This is the future! In the future all you would need to do is discard an item and the next day by supermarket delivery you receive your replacement groceries! Your credit card or bank account is automatically charged. Then all you have to do is to put your purchases away!"
> Alex van Es[19]

The companies collecting the information for the services they provide (data suppliers) offer this information on the market to data consumers that use the information on individuals for various reasons. A veritable user-information market, comparable to the financial market may emerge[6].

Privacy is precisely defined as "the quality or state of being apart from company or observation: seclusion"[3], yet the term is relative. It has evolved over centuries and depends also on cultural interpretations[10]. So does the space needed for our sense of privacy or the interpretation of private in public spaces vary from culture to culture . Winy Maas from MVRDV has said:

> "Putting the inside, even your own, on display seems a very modern topic. It might be perverse but it has similarities with the mixture of privacy and publicness these days: walking on the zebra crossing and listening to the love conversation of the neighbour who is phoning his girlfriend, the way people show their privacy on the television in order to attract attention. In such a condition the ancient limitations between privacy and publicity seem to be irrelevant."

We have learned through habits and tradition passed over centuries how to use the architecture, furniture and other means to shield our privacy from outside and make ourselves at ease. The possibility of letting ourselves go comes from the knowledge that no one sees what we do. Nor do the traces we leave during the time we stay home reveal what we did. Only the style we pick our furniture, leave a mess or

choose the decoration says something about us and usually we choose to do so to make a statement, in the same way we choose our clothes as a means to project ourselves. We have learned that during day we can let light in and air without exposing our home too much, and that in the night we need to turn of the light or close the curtains to protect the sphere from prying eyes. In Arabic countries there are screens on windows, for example Mashrabiyas in Egypt, that block the views from outside but allow the inhabitants to look through the screens outside, at the same time allowing the air-current to flow through and shading the inside from the sun. We know how to use these elements and intuitively know when our private sphere is exposed to the outside and when not.

The question is how the individual will (re)act on the intrusion of the private sphere in the smart house. Or to put it more extreme – will there be any privacy in the ubiquitous house?

Will there be architectural consequences such as recreating separate spaces where the privacy is kept away from sensors and other registering data. Maybe "surveyed areas" have to be distinguishable, so people know when they are being registered by what sensor. The artist group "made" are renown for painting surfaces in public areas which are surveyed by CCTV cameras, so that public recognises scanned areas and allows them to choose if they wish to be registered or if they want to stay out[17]. How annoying the realisation of being observed can be, is shown in the installation "Access" of Marie Sester[18], where a spot-light follows an individual while he or she is moving in the exhibition. The original idea of Marc Weiser about "ubiquitous computing", was that the computers and scanners will disappear out our sight and our consciousness[23], just like the electro motor is not visible for us in the every day household. Maybe for this reason the most of the experimental "houses of the future" look from the architectural point of view as if they have been built in the late 80's. But more and more projects insist that the new gadgets become apparent and the architecture reacts or interacts with them[7].

Or will the inhabitant simply pull out the plug when he or she is in the need of privacy. And who will guarantee that even then there is nothing being registered.

> "The whole experience made me realize that the coffeepot perhaps has one last lesson to teach us, one which could, even now, start another new trend. Putting content on the Web is no longer news, it's expected. No organization can get any column inches by starting a Web server. You want to know the secret of getting attention these days? Switch it off."
> Staford-Fraser[21]

The technical possibilities are already being examined. As described in "delete" there are technologies that allow declaring a time space how long data is to be valid, and make further reading of this information after a certain date impossible[8]. In the same direction would be the notion of reducing the memory of gadgets so to store only a certain amount of data before overwriting it. One could code all data and allow only gadgets that share certain keys to exchange and interpret data. But it is also clear that looking at the evolution on the Internet, the answer is not simply a technological solution but is also a question of changing our state of mind about privacy and our attitude towards sharing data.

4. CONCLUSION

The goal of this paper is to create an awareness of the notion of privacy in the digital houses. The smart house, the ubiquitous house is supposed to be our home of the future. The technology will bring us many conveniences in our every day life at home. It will help the old and the disabled to manage their every-day life at home without difficulties or worries. But it will bring also challenges. This technology is linked in a net and its potential is a consequence of this ability to interconnect and the sum of all the services. Its adaptability comes from observing and learning i.e. out of an endless memory and analytical power. If we take the experiences from the evolution of the Internet and project them into the concept of the ubiquitous house, the consequences for our current understanding of privacy would be radical. With business as usual, either the house of the future wouldn't be any more the retreat into privacy or privacy as we know it will disappear. If we want to avoid this, the evolution of the concept ubiquitous house cannot be left over to an uncontrolled and uncoordinated set of initiatives and developments but must be coordinated and thoroughly discussed before accepted as reality.

5. REFERENCES

[1] Central Laboratory: Result - Intelligent Toilet | Daiwa House. http://www.daiwahouse.co.jp/lab/en/result/result11.html. [Online; accessed 19 Aug 2009].

[2] KitchenAttendant - The Tool for Today's Modern Kitchen. http://www.kitchenattendant.com/index.cfm. [Online; accessed 4 Apr 2010].

[3] Privacy - definition and more from the free Merriam-Webster dictionary. http://www.merriam-webster.com/dictionary/privacy. [Online; accessed 3 Apr 2010].

[4] Real Time Rome. http://senseable.mit.edu/realtimerome/. [Online; accessed 7 Nov 2009].

[5] Word spy - fridge googling. http://www.wordspy.com/words/fridgeGoogling.asp. [Online; accessed 9 Apr 2010].

[6] M. Bauer, B. Fabian, M. Fischmann, and S. Gürses. Emerging markets for rfid traces. *Arxiv preprint cs/0606018*, pages 1–19, 2006.

[7] M. Böhlen and H. Frei. A house for the computer for the 21st century. http://www.realtechsupport.org/new_works/hc21.html, Oct. 2006. [Online; accessed 19 Apr 2010].

[8] R. Geambasu, T. Kohno, A. A. Levy, and H. M. Levy. Vanish: Increasing Data Privacy with Self-Destructing Data. In *Proceedings of the USENIX Security Symposium*, Montreal, Canada, 2009.

[9] S. Gürses, J. Jahnke, C. Obry, A. Onabajo, T. Santen, and M. Price. Eliciting confidentiality requirements in practice. In *Proceedings of the 2005 conference of the Centre for Advanced Studies on Collaborative research*, pages 101–116, Toronto, Ontario, Canada, 2005. IBM Press.

[10] E. T. Hall. *The Hidden Dimension*. Doubleday & Co., Garden City N.Y., 1966.
[11] S. Luo, J. S. Jin, and J. Li. A smart fridge with an ability to enhance health and enable better nutrition. *International Journal of Multimedia and Ubiquitous Engineering*, 4(2):69–79, Apr. 2009.
[12] R. MacManus. Internet Fridges: State of the Market. http://www.readwriteweb.com/archives/internet_fridges.php, Juli 2009. [Online; accessed 9 Apr 2010].
[13] R. MacManus. Why The iPad May Save The Internet Fridge. http://www.readwriteweb.com/archives/ipad_internet_fridge.php, Feb. 2010. [Online; accessed 10 Apr 2010].
[14] V. Mayer-Schonberger. *Delete: The Virtue of Forgetting in the Digital Age*. Princeton University Press, September 2009.
[15] E. Molgen. Freedom In the Cloud, Februar 2010.
[16] T. Riley. *The Un-Private House*. The Museum of Modern Art. Harry N. Abrams, New York, Juli 1999.
[17] F. Roost. Der neue Times Square: Null Toleranz. *arch+*, 152, 153:104–109, Oktober 2000.
[18] M. Sester. ACCESS Project. http://www.accessproject.net/, 2002. [Online; accessed 12 Apr 2008].
[19] R. Simanowski. Webtagebücher. http://www.brown.edu/Research/dichtung-digital/Simanowski/10-Juli-99/brief_03d.htm, July 1999. [Online; accessed 2 Apr 2010].
[20] Q. Stafford-Fraser. Trojan Room Coffee Pot Biography. http://www.cl.cam.ac.uk/coffee/qsf/coffee.html. [Online; accessed 10 Apr 2010].
[21] Q. Stafford-Fraser. When convenience was the mother of invention. http://www.cl.cam.ac.uk/coffee/qsf/cacm200107.html. [Online; accessed 10 Apr 2010].
[22] A. Van Es. Icepick.com - A wired house. http://www.icepick.com/. [Online; accessed 2 Apr 2010].
[23] M. Weiser. The computer in the 21st Century. *Scientific American*, 265(3):p94–95,98–102,104, 1991.
[24] Wikipedia. Chatroulette - Wikipedia, the free encyclopedia. [Online; accessed 17 Apr 2010].
[25] Wikipedia. Jennifer Ringley - Wikipedia, the free encyclopedia. [Online; accessed 4 Apr 2010].
[26] J. Zeh. *Corpus Delicti: Ein Prozess*. Schöffling, 5. edition, Februar 2009.

APPENDIX

A. TERMINOLOGY

A.1 Ambient Intelligence

In computing, ambient intelligence (AmI) refers to electronic environments that are sensitive and responsive to the presence of people . In an ambient intelligence world, devices work in concert to support people in carrying out their everyday life activities, tasks and rituals in easy, natural way using information and intelligence that is hidden in the network connecting these devices. As these devices grow smaller, more connected and more integrated into our environment, the technology disappears into our surroundings until only the user interface remains perceivable by users.

A.2 Building Automation

Refers to industrial uses of automatic or semi-automatic control of lighting, doors and windows, heating, ventilation and air conditioning, and security and surveillance systems.

A.3 Digital Home

A residence with devices that are connected through a computer network.

A.4 Smart Home

(domotics, home automation) designates an emerging practice of increased automation of household appliances and features in residential dwellings, particularly through electronic means that allow for things impracticable, overly expensive or simply not possible in recent past decades. The techniques employed include those listed in building automation as well as the control of home entertainment systems, houseplant watering, pet feeding, changing the ambiance "scenes" for different events (such as dinners or parties), and the use of domestic robots.

A.5 Ubiquitous Computing

Ubiquitous computing (ubicomp) is a post-desktop model of human-computer interaction in which information processing has been thoroughly integrated into everyday objects and activities.