

Yours, Mine and Ours? Sharing and Use of Technology in Domestic Environments

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Abstract. Domestic technologies have been a popular area of study for ubiquitous computing researchers, however there is relatively little recent data on how families currently use and share technologies in domestic environments. This paper presents results from an empirical study of 15 families in the U.S in early 2007. We examined the types of technologies families own, including TVs, music players, phones and computers; where they were situated within the home; and the degree of shared ownership and use. Our results call attention to the prevalence of shared usage of technology in domestic environments and also suggest opportunistic spaces for ubiquitous computing technology. While not all ubiquitous computing technologies for domestic environments will be shared, the diverse ways families chose to share their computers suggest that future devices might better match how families wish to use shared technology by supporting both the shared usage model of appliances and the ability to access a personal profile.

Keywords: domestic technology, home, sharing, empirical studies, login.

1 Introduction

Domestic environments have long been a place of interest for ubiquitous computing research. In Weiser's original vision of the disappearing computer [20], Sal starts her coffee machine by talking to her alarm clock, wipes her intelligent pen over her physical newspaper to send quotes to her office, and tells her lost garage door manual to find itself. Regardless of whether one prefers Weiser's vision of the disappearing computer or ubiquitous technology that seeks to engage the user [16], homes will be involved. Research on ubiquitous technology in domestic environments has a long history including the smart home movement [1] and recent advocacy for homes that make us smart [18]. Rodden and Benford [17] outlined three key approaches to technology in domestic environments: information appliances, interactive household objects, and augmented furniture.

In this research we focus on existing usage and sharing of technology in domestic environments. A fundamental characteristic of many homes is that they have multiple inhabitants. As we begin to think about the realities of using ubiquitous computing devices in a domestic environment, we are immediately confronted with questions

about whether these devices should support sharing and personalization. For example, would Sal's alarm clock only allow her to start the coffee machine or can Sal's spouse use it as well? Does her pen only work for her or require some type of identification in order to send the scanned information to her?

We have identified two sharing models typically used by technology devices in domestic environments: an *appliance model* and a *profile model*. Technology devices that use the appliance model (e.g., TVs, refrigerators, and landline phones) allow anyone in the home to use the technology and rely on social protocols to mediate sharing of these items. In contrast, technology devices that use the profile model support multiple users on the device by asking users to identify themselves. These devices may also require the user to authenticate themselves. The profile model is typically used in workplace settings and because of this, many computers used in domestic environments, including computers running the Windows and Macintosh operating systems, support profiles. Regardless of whether a particular technology device supports the profile model or not, some households choose to purchase one device for each person, be it a music player, mobile phone, or computer. Using *individual ownership* instead of *shared ownership* attempts to avoid issues of sharing and eliminate any potential for contention by giving each person their own device.

It is perhaps tempting to think that many ubiquitous technology devices and systems could avoid issues of sharing in household settings by adopting the appliance model. Past research does suggest that families do not make use of profile options on their computers [9]. However, Grinter et al. [7] point to problems caused by the use of the appliance model by TiVos, a brand of Personal Video Recorder. TiVos have a single viewer model that does not distinguish between multiple viewers, and thus has no way to differentiate viewing data or generate personalized recommendations. The appliance model also assumes that very little personalization or privacy is needed. It seems naïve to assume that individual family members might not have some desire to customize or have information they would like to keep separate from others. Another way for ubiquitous technology solutions to avoid issues regarding sharing would be to require individual ownership. However, this approach assumes that devices are never shared which is unlikely for a variety of reasons. First, many households do not have the financial means to purchase several devices. Second, the form factor and functionality of some devices make them inappropriate for individual ownership (e.g. most families do not have individually owned toasters). While individual ownership may be appropriate for some ubiquitous devices, certainly, some will be shared.

To better understand how families currently use and share some of their technology and gain insights into sharing models that might be appropriate for future ubiquitous computing devices, we interviewed 15 families in the northwest United States (50 people total). We visited families in their homes and inquired about their current use of several different technologies including computers, TVs, phones, music devices, and game consoles. In particular, we looked at where families located these devices in their homes, how families handled ownership of the devices, and how they managed sharing of computers through use or non-use of logins and passwords.

Whether a family shares one computer or has five computers available can have a significant impact on how they manage share usage. Therefore, we interviewed families in three different groups based on level of computer ownership: families with a single computer, families with fewer computers than people, and families with an

equal or greater number of computers than members of the household. Due to our focus on sharing, we recruited households where at least one computer was used by two or more people on a weekly basis. Based on the findings of Kraut et al. [11] about the role teenagers played in motivating Internet use at home, we also selected families at different life stages to explore issues of family dynamics.

Results from our field study showed that families often shared ownership of technology placed in public living spaces, including desktop computers. The differences we observed between where computers were located compared to the other technologies we studied point to semi-private and private spaces as potentially opportunistic locations to focus on for deploying ubiquitous computing devices. Of the families we visited, eight had multiple profiles enabled on some or all of their computers, but whether or not these multiple profiles were used varied widely across the families. Families that did use multiple profiles emphasized a desire to provide family members with the ability to personalize their computing environment and organize their information, rather than a need for privacy. The willingness of several participants to use the computer logged in as other family members, particularly for quick activities, suggests that shared devices might better meet the needs of families by supporting aspects of both the appliance and profile model.

2 Related Work

Our study follows in the tradition of several studies conducted in the late 1990s that explored the use and sharing of technology in domestic environments, typically with a focus on personal computers [10,11,12,13]. More recently, Woodruff et al. [22] looked specifically at the locations and use of wireless laptops in the home and Grinter et al. [7] studied household networks. In our study, in addition to studying computers we also collected information for other technology devices including TVs, phones, and music players. We now motivate and provide context for our study by reviewing findings from previous work on the location of technology in domestic environments, sharing and contention, and the use of profiles.

2.1 Location of Technology

Previous studies of technology in domestic environments have often examined the location of technology as an important aspect that helps characterizes its use. Venkatesh [19] refers to this as the *technological space* in his theoretical framework for understanding the role technology plays in social life and the diffusion of technology. One of the three models Mateas et al. [12] developed based on an ethnographic study of 10 homes in 1996 was a spatial one. They found the PC in every home they visited was located in what they termed the *work space*, rather than the *hang-out* space. Our study allows us to explore whether or not this model still holds ten years later when there are more computers in homes.

Frohlich and Kraut [9] motivate the significance of studying the position of computers in the home by observing the relationship between computer location and sharing. They note that putting computers in private spaces gives special privileges to the owner of the space and discourages sharing, while placing computers in a more

public space encourages sharing. In [9] which brings together data from 35 families drawn from their two earlier studies [10,11], Frohlich and Kraut found that 50% of computers were in public spaces like dining rooms, kitchens, and family rooms, while 26% were in semi-private spaces like a study and 24% were in private spaces such as a parent or child's bedroom. Families with more than one computer in their sample placed them in a variety of locations. In their study of 10 English households, O'Brien and Rodden [13] also found the physical configuration of the domestic environment had an influential role in how the technology was used, particularly with regards to ownership. In a 2003 study, Crabtree et al. [4] identified ecological habitats (places where communication media live), activity centres (places where media are produced), and coordinate displays (places where media is displayed) as prime sites for ubiquitous computing in domestic environments. From their study of laptop use by 34 people in 12 households, Woodruff et al. [22] developed a framework of favored places based on whether the location was open or closed and ergonomic or comfortable. They found that laptops were used in a small set of favored places (2 or 3) rather than throughout the home. The data we have collected on technology in the homes of 15 families allows us to see how the locations of computers may have changed after the passage of 10 years from many of the earlier studies [11, 12, 13] and also compare the use of laptops we saw with the findings of Woodruff et al. [22].

2.2 Sharing and Contention

In our study we focus on how households share technology. Most of the U.S. households studied in the 1995 HomeNet study [11] had a single computer (Kraut, personal communication). In the U.S. households in Boston that Frohlich et al. studied in 1997 [10], roughly three quarters of the families had second computers, mostly cast-offs for kids (Frohlich, personal communication). Due to the relatively limited number of computers, it is perhaps not surprising that Frohlich and Kraut [9] reported that "contention for computer time is a heated issue in many of the families we visited," describing fights and arbitration by parents to manage the scarce resource of computer time. In fact, the relationship between parents and children was an important theme of their research, with parents opting to regulate computer usage and internet access.

While technology adoption has greatly increased in the last ten years,¹ the challenges between individuality and collective action observed by Grinter et al. [7] suggest that sharing and contention remain interesting issues to study. In Grinter et al.'s study, iPods and TiVos were identified as causing particular challenges. iPods must be associated with a specific computer and music library which causes problems in shared usage scenarios. TiVo's appliance model does not allow personalization, which led to a competition between members in some households. With different levels of computer ownership in the families we studied, we can gauge whether contention on computers remains an issue for them. By also gathering data for other types of technologies, we can understand how the sharing methods used by families

¹ For reference, the UN's MDG Indicator of Personal computers per 100 population estimate for the United States in 1997 was 39.98 computers per 100 population and 76.22 computers for 2004, while for the United Kingdom it was 23.89 computers in 1997 and 60.02 in 2004 (<http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=607&crid=>).

for those technologies are similar or different from how they manage sharing of computers.

2.3 Profiles and Personalization

When technologies support the profile model, users have the option to create separate profiles. As Badram [2] has pointed out, logins on computers involve multiple concepts, the *identification* of the user, *verification* of the user's identity and determining whether the user has *authorization* to use the computer. While computer use in a workplace setting typically requires identification, verification and authorization, this may not be necessary in a domestic environment. Frohlich and Kraut [9] reported that most of the systems encountered in their study were not managed using multiple profiles. However, this was not without challenges, as users of the shared computer could find changes made by one user (e.g. software installed, bookmarks) to be disruptive. One reason families might choose to adopt profiles is for personalization; having separate profiles allows users of a shared computer to have their own background and easily separate their bookmarks.

In discussing a study of forced login use in hospitals, where multiple people shared several computers, Badram [2] discussed a number of problems that logins caused. These problems included disrupting the ability of the staff to work collaboratively and share computer related materials, and the ways that people circumvented the logins by having a universal login or annoyed colleagues by locking a computer so it could not be accessed by anyone else. While domestic environments are not hospitals, studies by Crabtree et al. [4, 5] and others [6, 17] highlight the stark difference between domestic environments and the office environment from which the profile model has been transplanted. One of our goals was to understand whether or not families have chosen to make use of multiple profiles, and their reasons for doing so. More generally with respect to personalizing technology in domestic environments, Randall's case study of life in a smart home [14] discusses a continuum between *personalization* of technology which may make it most useful for a particular individual, but difficult for others and *integration* where all functionalities could be used by all family members. Our investigation looks at whether families were using *personalization by profile* [14] on their home computers. By looking specifically at the use or non-use of multiple profiles we gain insight into whether the profile model fits families' needs for sharing.

3 Study Method

To gather data from families about how they use and share technology, two researchers visited each family at their home and conducted a semi-structured interview that typically lasted about 2 hours. The visits were conducted in January and February of 2007. The home visit was modeled on the method used in Grinter et al. [7] and had four components: a demographic questionnaire, sketching exercise, tour around the house, and wrap-up discussion. We visited 15 different families for a total of 50 people. We asked families to have all members present for the interview

and achieved that for 12 of the 15 families. Because of scheduling challenges, one person was missing from the three other families, in which case the family members present described the technology owned by the missing participant and their usage patterns. The families all resided in the Seattle metropolitan area in the northwest United States. Families received two pieces of software as a gratuity.

We recruited families that use computers frequently and had at least one computer that was shared. We were also interested in whether the number of computers in the home impacted shared usage so we recruited 5 families in each of three different groups: single computer families ($C=1$), multiple computer families ($C<P$), and computer per person families ($C\geq P$). The $C=1$ families had one shared computer, the $C<P$ families had more than one computer, but not one for each person, and the $C\geq P$ families had at least one computer for each family member (old enough to use a computer). For each of the three categories we aimed for a diversity of families. Eight of our fifteen families had teenagers (aged 13 or older) and five had adolescents (7-12 years old). The remaining two families had toddlers (0-3 years old), but data from these children were not included in our analyses since they rarely used the computer. Our families ranged from those living in large private homes to smaller apartments and included single parents, blended families with step children, and families with two working parents. While not intentional, all families primarily used personal computers running the Windows operating system, although one family had recently purchased a Macintosh.

To start our visit, similar to previous studies [e.g. 10, 12], we brought a pizza dinner to each family which served as an ice breaker. We first gathered demographic information, and then asked each member of the family to sketch a floor plan of their house. Participants then used red circular stickers to indicate the location of the computers they used. For laptops, participants indicated all locations of use. To help determine whether the computers were viewed as belonging to a particular member of the family (e.g. Mom's computer) or were associated with a particular space (e.g. living room computer) we asked participants to label the computers using the name they would use when referring to the computer when talking with others. We then gathered additional data for each computer including how long the family had owned it and the percentage of time each family member used that particular computer. Next, we had participants add TVs using yellow stickers, game systems (yellow sticker with black dot), music players including portable ones such as iPods (green stickers), and phones including mobile phones (blue stickers). Participants denoted technology they carried with them around the house, such as a mobile phone or iPod, by putting a stick figure on the diagram. If a mobile device typically stayed in a specific place while in the house (e.g., mobile phone charger), the sticker for the device was put in that location. For each TV, game system, music player, and phone, we collected additional details on who used the technology. Figure 1 shows two example sketches. While we had each participant complete their own sketch, we allowed them to interact while doing the sketches which often led to interesting discussions.

Next we took a home tour, visiting each computer indicated on the sketches. For shared computers, we asked how family members managed the sharing, including whether or not they used multiple profiles. If families made use of profiles, we

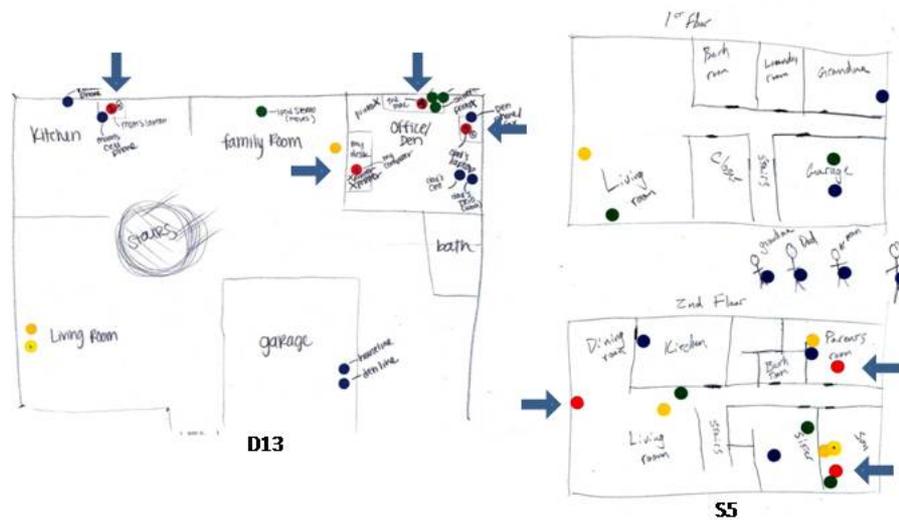


Fig. 1. Participants' sketches of their house's floor plans annotated with dots indicating different pieces of technology. The red dots (representing computers) are marked with arrows.

discussed which profiles were used, whether people might use the computer logged in as someone else, how documents were managed, and how features such as Internet bookmarks and email accounts were handled. We also inquired about the extent to which people personalized their computers. If the computer was a laptop used in multiple locations, we visited all of the locations where the computer was used, and discussed how the person chose the location to use the computer. We also took a digital picture of each computer in its primary location within the home.

We concluded our home visits with a wrap-up interview where we asked participants to describe positive aspects of their current setup and what they were planning to change. We also asked specific questions related to privacy and comfort with home guests and others using their computer(s) and additional questions about personalization of mobile phones and other devices. We analyzed our data by counting the technology present in each household and coding its location. We collected over 650 observations and quotes from participants during the interviews and used the affinity diagramming technique from [3] to derive themes.

4 Results

The interviews and sketches gave us a fascinating picture of the number and type of technology devices owned by the families. We first describe the types of technologies families owned (4.1) and where the technology was located (4.2). Section 4.3 discusses how families shared their technology, looking in particular at the use or non-use of computer profiles. Section 4.4 describes the family dynamics we observed.

Table 1. Technology owned by each family

Family Id.	C = 1					C < P					C ≥ P					Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Teens	N	N	N	N	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	
People	2	2	2	3	4	3	4	4	4	6	2	3	3	4	4	50
Game Consoles	1	1	1	0	1	1	1	0	0	2	4	1	1	0	0	14
TVs	1	2	1	2	4	3	4	4	2	2	3	2	5	5	3	43
Music Players	2	2	4	7	7	11	8	6	3	6	4	6	8	5	6	85
Stereo*	1	2	3	4	5	9	6	4	3	5	3	4	1	4	2	56
Mobile	1	0	1	3	2	2	2	2	0	1	1	2	7	1	4	29
Phones	3	3	4	4	7	10	8	9	4	6	4	4	11	9	13	99
Landline	2	1	3	2	3	7	4	5	2	2	3	2	7	5	9	57
Mobile	1	2	1	2	4	3	4	4	2	4	1	2	4	4	4	42
Computers	1	1	1	1	1	2	3	3	3	3	3	3	4	4	8	41
Desktop	1	1	1	1	1	2	1	3	3	1	1	1	2	2	2	23
Laptop	0	0	0	0	0	0	2	0	0	2	2	2	2	2	6	18
Wireless	N	N	Y	N	N	Y	Y	N	Y	Y	N	Y	Y	Y	Y	9

* different families had different perceptions about what was considered to be a stereo (i.e. alarm clocks).

4.1 Technology in Homes

Table 1 shows the technology owned by each family, with families grouped based on their level of computer ownership. All of the families had a high-speed Internet connection and 9 families had a wireless network running in their house², which included 6 of the 7 families with laptops. Four of the 6 families who did not have wireless were single computer families.

Most families with game consoles (PS2, Xbox, etc.) clearly adopted a *shared ownership* approach for them. Eight families each had 1 console, while Family 11 had four consoles for two people. In Family 10, one of the sons also had a Nintendo DS used only by him, but all family members that played games shared their Xbox. For TVs, the raw numbers begin to suggest a move toward *individual ownership*, with 8 of the 15 families having the same number or more TVs than family members. However, families reported considerable shared use, telling us that 37 of the 43 TVs were at least occasionally watched by everyone. Mobile music players and phones are where we truly observed *individual ownership*. Mobile music players were always attributed to a particular individual when described to us (e.g. “Matt’s iPod”, “my iPod”), similarly each mobile phone was owned by an individual and was referred to using the person’s name. Mobile phones were quite popular, 40 participants had a mobile phone and two of the fathers (F4³, F13) had two mobile phones. The 10 people

² For reference, the PEW Internet & American Live survey in 2006 reported that 42% of American homes had a broadband connection ([http://www.pewinternet.org/pdfs/ PIP_Wireless.Use.pdf](http://www.pewinternet.org/pdfs/PIP_Wireless.Use.pdf)) and 19% of internet users had wireless networks at home ([http://www.pewinternet.org/pdfs/ PIP_Wireless.Use.pdf](http://www.pewinternet.org/pdfs/PIP_Wireless.Use.pdf)).

³ Using the convention of [11], individuals are identified using their family role and id. For example, F4 is the father in Family 4 and D9b is the second daughter of Family 9.

without mobile phones included M3, who refused to carry a phone saying “[I] just don’t want people to be able to reach me,” and the 9 children under twelve.

Since we sampled specifically for different levels of computer ownership and some shared usage, we saw families with both completely shared ownership of computers and more individualized ownership, which we discuss further in Section 4.3. One interesting type of usage we observed was *specialized individual ownership* in Family 15 (8 computers for 4 people) and Family 13 (7 iPods for 3 people). For example, F15 uses each of his three laptops for different things, one is for daily work, another for presentations (called “the Beast”), and the third for international travel, while D13 keeps her three iPods in different locations including her bathroom and gym bag.

We found the number of laptops present in the different groups interesting. The C=1 families had no laptops, while 4 of the 14 computers (29%) in the C < P families were laptops, and 14 of the 22 computers (64%) in the C ≥ P families were laptops. Certainly families with more computers had a higher percentage of laptops, but this did not mean that all recently purchased computers were laptops. Both Families 6 and 13 had purchased desktop computers within the month before our visit. M6 told us she bought a desktop because she had never had a laptop and her perception was that they were not as powerful and not as good. She liked the solidness of the desktop.

4.2 Locations of Technology

Examining the participant’s sketches, it is clear that technology was pervasive throughout the homes we visited. For each computer we coded its primary location of use as being either public or private (proposed in [9]) based on whether the space was accessible and used by all household members. Mobile devices (e.g. laptops, ipods, mobile phones) were coded according to their primary location of use. If the device was carried around with the person, it was coded as being in a private space. Table 2 gives a detailed breakdown of the locations of technology within the home.

Technology in Public Spaces. Public spaces were defined as areas in the home that were accessible to everyone in the family such as living rooms, dining rooms, kitchens, and home offices. TVs, game consoles, music players, phones, and computers were all common in public spaces within the home. In total, 50% of the technologies we examined were located in a public space. We also examined whether the public locations were completely public (i.e. accessible to everyone in the family) or were semi-private (i.e. controlled by certain people in the family but available to everyone such as a home office) and compared this to previous results [9]. In our study, 20% of the computers were located in completely public spaces (compared to 50% in [9]) while 39% were located in semi-private areas (compared to 26% in [9]). Computer locations differed slightly from locations of other technology with very few families reporting any computer use in the kitchen, and no one reporting use in a garage or bathroom. In contrast, seven families (1,5,6,7,13,14,15) indicated using other technology such as TVs, phones, and stereos in the garage or bathroom.

While music players and phones were common in public spaces, it partially depended on whether the technology was stationary or mobile. Landline phones and stereos were primarily found in public locations (67% and 57% respectively). In contrast, while mobile phones and music players were used occasionally in public

Table 2. Where technology was located in the home: public (e.g., living room, family room, study) or private (e.g., bedrooms, carried with the person)

		Public	Private	Total
TV		26 (60%)	17 (40%)	43
Games		6 (43%)	8 (57%)	14
Music	Stereo	32 (57%)	24 (43%)	56
	Mobile	7 (24%)	22 (76%)	29
Phones	Landline	38 (67%)	19 (34%)	57
	Mobile	7 (17%)	35 (83%)	42
Computer	Desktop	17 (74%)	6 (26%)	23
	Laptop	7 (39%)	11 (61%)	18
TOTAL		140 (50%)	142 (50%)	282

spaces, they were primarily carried around with the person or kept in a bedroom (phones 83%, mobile music players 76%). For computers, 59% were located in a public space with the majority of those being desktop computers (17/24). Overall, desktop computers were significantly more likely to be located in public spaces (74%) than private spaces ($t_{14}=2.22$, $p=.044$). Similar to what Mateas et al. [12] observed, these computers were often placed in sections of the public space designated as *work spaces*, typically on a desk (termed an *ergonomic* place by Woodruff et al. [22]). For example, M3 commented she “likes that it [the desktop computer] is in that case [a large furniture cabinet] so we can close it off and it doesn’t look like a junky office and keeps kids out of it.”

Many of our participants expressed positive comments about having the computers in a public living area. People liked the *togetherness* of the public space, e.g. “Even when we are both doing separate things, we are together” (M2), “I like the fact that the computer is in the open because it encourages conversation” (M5). Also, many parents indicated that they liked having the computers in a public space to keep an eye on the children’s activities, e.g. “we decided to put the computer in the living room so we know what everyone is doing on it” (M5). Similar to [9], several parents clearly stated that they would not have computers and Internet in the children’s bedrooms: “the kids want the computers upstairs but it’s not going to happen!” (M8). Although many of our families liked having the computer in a public space, some family members indicated problems resulting from this approach. In particular, noises from the fan, alerts, or others’ usage, as well as light and motion from screensavers can be distracting to other activities in the room.

Of the 24 computers located in public spaces, 16 were kept on the majority of time (11 on all the time, 5 turned off at night) making them available for walk-up use. Desktops were more likely to be left on compared to laptops (14 and 2 respectively). The remaining 8 computers were off unless being used (3 desktops, 5 laptops).

Technology in Private Spaces. We considered spaces to be private when individuals or a group such as parents had primary control over the space (i.e. bedroom). Technologies that people always carried with them throughout the house were also considered to be in a private space. This does not include mobile devices that had a

primary location within the home (e.g. a mobile phone that typically stayed in the kitchen instead of with its owner). TVs, game consoles, music players, phones, and computers were common in private spaces within the home. As mentioned previously, 50% of all the technologies discussed in our study were located in private spaces. For computers, 41% were in private spaces (6/23 desktop computers and 11/18 laptops) which is higher than the 24% reported in earlier work [9]. The computers found in private spaces were more likely to be laptops with 11 of the 17 computers being laptops.

We found a roughly even split between technology in adults' versus children's bedrooms (of the technology identified as being in bedrooms, 50% of non-computer technologies and 57% of computers were located in adults' bedrooms). However, laptops were more common in parents' bedrooms (7) as compared to children's bedrooms (1), while desktop computers were more common in children's bedrooms (5) as compared to parents' bedrooms (1). Many of the desktop computers found in children's bedrooms were hand-me-down computers. Not surprisingly, mobile phones and music players were the most common technologies that people carried around and used throughout the home. In our discussions about these devices, it was clear that these were very personal devices and were rarely shared with others in the family. This is different from many of the other technologies in the home, which were much more likely to be shared.

Computers found in private spaces were often turned off when not in use (11/17). Whether or not these computers were laptops was also a factor, 10/11 laptops were turned off when not in use (or put in sleep mode) compared to 1/6 desktop computers.

Laptop Usage. As Woodruff et al. [22] noted, laptops are particularly interesting because they can be moved to different places in domestic environments. Eighteen families in our study had laptops (none from the C=1 group, 3/5 from the C<P group, and all families in the C≥P group). In our study, nine of the 18 laptops (5 from Family 15, and one from each of Families 7,11,12,13) were used primarily in a single location (home office or bedroom), while the other 9 laptops were used in multiple locations throughout the home. Three laptops were considered highly mobile because their owners, three daughters (ages 11, 12, 21) used the laptops extensively, taking them wherever they went in the home (D14a, D14b, D15b). One mother stated, "if it was waterproof, she'd be in the shower with it!" (M14). This exceedingly mobile use seems to be different than usage of laptops in a few favored places observed in Woodruff et al. [22], which we did observe for our adult participants and one 17-year old male (S7), all of whom had individualized ownership of a laptop⁴. The reasons our participants moved between their favored places are similar to those discussed in Woodruff et al. [22] and included where others were in the house; other activities going on; and affordances of the environment.

4.3 Sharing

We observed a large amount of sharing across the technologies we examined. Technology located in public areas was generally shared. All TVs, stereos, and

⁴ When coding the locations of technology, laptops with a few favored places were coded according to their primary location of use (which was between 70-100% of the time).

landline phones in public spaces were shared by everyone in the family and “place based” names were primarily used when describing the technology (e.g. the one in the garage; the TV in Mom and Dad’s bedroom). Computers in public spaces were also generally shared, with the exception of those owned by Family 15 (who had 8 computers) who had *specialized individual ownership*. For the remaining 14 families, 16 of the 18 computers in public areas were shared by multiple members of the family. While Family 15 did not have any computers that family members took turns using, M15’s desktop computer was referred to as “the computer” and left on so that everyone in the family could look at and add to the main family calendar which was kept in Outlook (M15 was typically the only person who added calendar events).

Technologies located in private areas, had a lower amount of shared usage. The TVs, stereos, and landline phones found in bedrooms were primarily used by the owner(s) of the bedroom with the exception of TVs in parents’ bedrooms, which were often used by several members of the family. As mentioned previously, mobile music players and mobile phones had very little sharing. Computers in private spaces also had much less shared usage, with only 6/17 computers being shared. In three of these cases, it was younger children using the computer in their parent’s bedroom (D1, S11 (2 computers)). In one case Family 4 had the family computer in one of the daughter’s bedrooms (D4) and the remaining two cases involved family members (D13, M14) borrowing a laptop and taking it out into a public space to use it.

Profiles. One focus for our study was investigating the use (or non-use) of profiles on computers. Windows and Macintosh operating systems support multiple profiles with a feature called ‘user accounts.’ In both systems, multiple user accounts can be created and each account has its own context including a separate default document structure. Both systems support fast user switching, which allows switching between different accounts without logging off and keeps the other accounts active in the background. We observed three different types of profile use on the computers in the families we studied: having a single profile (7 Families, 4 with teens), having multiple profiles configured, but using only one (4 families, 1 with teens) and regularly using multiple profiles (5 families, 4 with teens). Note that family 8 fell into two categories, all of their computers had multiple profiles, but on two of the computers they only used a single profile. No usage differences were found between the groups representing level of computer adoption, however, the existence of teens in the family seemed to increase the likelihood that separate profiles would be configured and used, unless the teenagers had a computer of their own they could use.

Single Profile. Seven families chose to share a single profile (4,9,10,11,13,14,15) on their computer(s). Convenience and ease of use were common reasons expressed by families. Comments included: “It’s more convenient, I’m all about easy” (D10), “You can start using it right away” (M12⁵), “It’s a hassle to log in and log off all the time” (M14). Related to the possible use of profiles for privacy and security, some families suggested there was no reason, for example, F11 said “Nothing on there. No need for security”. Others felt that they could control and monitor what their children were

⁵ Family 12 had multiple logins enabled, but choose to share one account. This comment is related to the use of a single profile.

doing more easily when they shared one profile. One mother (M10) explained that they used to have multiple profiles (a year ago), but when the kids started using passwords, she was not happy about it and the family switched to share a single profile.

While participants viewed shared profiles as being simpler, it was not without its disadvantages. First, individual customization was not possible, so everyone would have to be comfortable with choices made by members of the group, such as the background someone chooses to put on. Second, many computer applications have convenience features which save default data to facilitate usage, however, with multiple users, the correct data may not be loaded (i.e., default login information). This was particularly problematic for web browsers which have many convenience features. Family 12 had an interesting work-around to resolve this issue. Although they shared a profile, the desktop had icons for two different instances of their browser (Opera). Each instance was personalized for one of the parents, allowing them to have quick access to their favorites without cluttering up their spouse's list.

Have Multiple / Use One. Four families had multiple profiles enabled, but chose to share a single profile (1,3,8,12). Several families commented that this was because someone else set up their computer or that they had initially envisioned that they would use multiple profiles, but ended up using just one. Some families had a separate administrator profile set up, but it was rarely used. Other families commented that they shifted to sharing a single profile because of specific things set up on one profile (e.g. Internet access) or problems with other profiles. D8a explained that she and her sister used the same login because it gets Internet and IM. Family 5 (who had shifted to use multiple profiles) commented, "When it was dialup, mom's setup was used because it was the easiest (and remembered the password)" (F5).

Four families (10,11,13,15) indicated that they used to have multiple profiles set up on their computer(s), but they switched to only have one profile. Some commented that multiple profiles were "a pain" (D10) or "drove [them] nuts" (M15) so they removed them. In other cases, as new computers were brought into the home, their usage patterns changed. D13 commented that as they gravitated towards individual computers, the need for multiple profiles was less critical. Similarly, D15a explained that they used to have multiple profiles, but took them off now that everyone has their own computer. She said: "It's one less hassle to not have to login."

Multiple Profiles. Five families chose to use multiple profiles (2,5,6,7,8). Interestingly, none of the $C \geq P$ families used multiple profiles. Personalization and organization were common reasons expressed for utilizing multiple profiles. Families explained that profiles enabled them to personalize their environment, including backgrounds, screensavers, and favorites. For example, "Carol can do her own thing, I can do my own thing. We can set up our screens differently and have different backgrounds" (M6). Personalizing backgrounds was popular in our study, with 29 of the 41 computers having custom backgrounds. Families in our study also indicated that individual profiles enabled each person in the family to have their own things on their own profile which some felt was more organized and made it easier to find information. Comments included: "I have all my stuff" (F2), and "His stuff doesn't

get in the way” (M2). Some of our participants also commented that individual profiles can provide a sense of identity, “Feels like it’s yours” (M5).

Families also indicated disadvantages of having multiple profiles. Six families, who either currently or previously used multiple profiles, expressed confusion about the file structure when using multiple profiles (3,5,6,12,13,15). They had trouble finding shared documents such as digital pictures and remembering which profile certain files were stored under. Additionally, there was some frustration expressed that logging on and off was slow. When asked whether they utilized fast user switching, several families commented that they did utilize it sometimes, but that it often caused the computer to run slow, or were frustrated by notifications (e.g. AIM instant messenger and other pop-ups) that were still received from other profiles.

We asked families using multiple profiles how they handled logging off. Only Family 8 indicated that they logged off after using the computer. In Family 5, most of the family members did not bother logging off, so the typical log-in procedure required logging off the previous person first. In families 6 & 7, both mothers did not tend to log off while other family members did. S7 referred to this as “bad computer etiquette.” S7 indicated that one of the reasons why he and his sister try to log off is because their mom has been known to talk to their friends on IM. Family 2 explained that the computer is always logged into the mother’s account and if her spouse wants to access his account, he has to first log her out (he always logs himself off when he is done). Family members also told us that they would sometimes use the computer in someone else’s profile. This was particularly common if the participant had something quick to do, they would just go ahead and use the active profile.

Contention. Although we recruited families that had at least one shared computer, our participants reported very little contention over computers. This is in sharp contrast to previous research which indicated heavy contention over family computers [9]. Two families (6,13) mentioned that there used to be contention over the computer, but now that there are more computers available (one family bought a new computer and the other’s daughters moved away to college), this no longer seems to be a problem. The few comments we did receive from families regarding contention indicated only mild concern (“sometimes I have to get off the computer for mom” (D10)) or pointed out a priority or sharing scheme for the computers (“Vanessa gets first crack at the desktop because she doesn’t have a laptop” (S7)). Families that had multiple computers often indicated that they would use one of the other computers if the main one was tied up.

4.4 Family Dynamics

The high degree of trust that existed within the families was clear during our study. Several families indicated that they share many technologies in their homes (e.g., M5 said “we pretty much share everything”). In our study, only four families (3,6,8,9) were using passwords on shared machines. Three of these families (6,8,9) indicated that the passwords were a mechanism to limit the children’s access to the computer while Family 3 explained that the password was used in case outsiders hacked into their system (both people in the family knew the password). None of the families in our study discussed using passwords to maintain their personal privacy nor did anyone indicate that this was a concern, e.g. “Never tried a password. I don’t see a

reason unless you want different backgrounds” (D13). In terms of multiple profiles, none of our families expressed privacy as a reason for why they would want or need multiple profiles. While talking with us as a group might have limited their candor, the file organization used by families and the fact that people in families with multiple profiles did not always log off supports our observation that privacy was not a large concern for family members.

While families did not feel a need to protect their privacy from others in the family, similar to [9], many parents did express concern over controlling or monitoring their children’s computer and Internet activities. This included limiting the amount of time children were allowed to be on the computer or on the Internet, limiting what web sites they could visit and what information they were allowed to download, determining which computer they were allowed to use, and limiting or preventing certain activities such as IM or chat. For some families, this control or supervision was a way to protect their children from inappropriate activities. For others, the concern was related to a fear that the children would inadvertently download a virus.

While computer administration and technical support issues were not the focus of our study, similar to [7] and [15] we also saw that families typically had a ‘technology czar’ (proposed by [15]) who managed the family’s technology. While our sample of 15 families is not broadly representative, and skews toward upper middle class families comfortable with technology, we found a roughly equal division across gender for which family member was the technology czar. This was surprising given previous research [e.g. 21] on gendered use of computers.

5 Discussion

The results we have presented offer a picture of technology use and sharing in domestic environments in the U.S. which designers of ubiquitous technology can use to inform their decisions on what types of spaces and sharing models may be most appropriate for the technology they are building. In this section, we describe some of the themes that emerged from our investigation that we found most compelling.

Opportunistic Places for Ubiquitous Computing in Domestic Environments.

Ubiquitous computing devices proposed for domestic environments are frequently designed to be used in public spaces such as kitchens or living rooms, often in what Mateas et al. [12] termed the *hang-out* spaces. For example, the devices cited by Rodden and Benford [17] include Internet fridges, augmented household notice boards, cups, and garden furniture. Taylor et al. [18] describe augmented magnets, message boards, and clocks. While we do not disagree with the appeal of public spaces as locations of interest for ubiquitous devices, we feel that our study suggests other spaces within domestic environments that may also be appropriate and opportunistic to focus on.

The amount of technology in private and semi-private spaces, suggests to us that these spaces may be a more receptive environment for additional technology than public spaces. One reason for this might be that more private spaces may have fewer aesthetic concerns than public spaces, for example around power cords, noise levels, or furniture style. While certainly we do not advocate creating ugly prototypes,

pragmatically during the development and field testing of novel ubiquitous devices, deployment in a private space with less rigid aesthetic concerns might mean the difference between use and feedback on a prototype or it being stuffed in a closet when visitors arrive. Semi-private spaces, such as offices, already include the coordinate displays, ecological habitats and activity centres that Crabtree et al. [4] identified as prime site for ubiquitous computing, and many also contain considerable amounts of computer and non-computer technology. Other public spaces that might be of interest include bathrooms and garages where we were surprised that many of our participants reported having phones and music players. Our intent is not to say that kitchen and living room spaces are uninteresting, merely to point out that since these other environments are conducive to having technology, they might be opportunistic locations to consider for ubiquitous computing devices.

Yours, Mine, and Ours. In the beginning of the paper we identified two sharing models, appliance and profile. We found it interesting that for quick activities like checking a web page, participants would often go ahead and use the active profile even if it was not theirs. While this opportunistic use may be related to time delays when switching users (and future research could explore this further), the treatment of the computer as an information appliance (e.g. for looking at the family calendar or getting directions) and use of the active profile without switching suggests to us the potential for technology devices that support a mixed profile model.

A mixed profile model would incorporate aspects of the appliance model, essentially a single profile shared by everyone, and the profile model that requires a particular profile be active. For example, imagine Sal's alarm clock generally runs in appliance mode allowing anyone to use it to start the coffee maker. But Sal can activate her personal profile, perhaps by saying her name or touching a particular button to identify herself, at which point asking for traffic information would give information about the route to her office rather than her spouse's commute. After a period of inaction, the alarm clock would revert to the shared alarm clock appliance. Given that we saw that many of the computers in public spaces were relegated to a 'work space', a mixed sharing profile, which would better support awareness and quick interactions, might help computers earn a place in the family 'hang-out' space. For example, one can imagine a computer that functioned by default as an awareness appliance, showing information customized for the household, but allowed people to easily transition to longer interactions in their own profile.

Personalization not Privacy. During the study we focused on how families manage sharing of their technology, particularly their computers. We saw more families utilizing multiple profiles than we expected (5 of 15 families), especially given previous research [e.g., 9], although we still observed that many family members were relatively unconcerned about privacy within the family. The password use we did observe was typically used to control access to resources such as the Internet, rather than to keep information private.

So, rather than using profiles to ensure privacy, the primary motivation we heard from our participants was personalization. Participants were not concerned that other family members might have access to their documents and in fact wanted easy visibility of each others' documents since people reported forgetting which profiles

they had been in when they saved a document. The depth to which the environment changed when participants switched profiles led to considerable confusion among our participants. We instead propose treating the desire for multiple profiles more like providing different *skins* for the computer, much like one might buy a decorative face plate for a mobile phone or an attractive case for a music player. This approach would change the physical appearance as well as some of the preferences and history for different profiles, but would not require a complete context switch of the entire environment, and would more closely match the experience our participants desired.

6 Concluding Remarks

In this study we have examined the locations and sharing of technologies in 15 homes in the northwestern United States. Clearly the results we have presented must be interpreted with regard to the culture in which they were collected, and our results are most applicable for those developing ubiquitous technologies for domestic environments in the United States or countries with similar cultures and levels of technology adoption.

By examining how families share technology, including their use of profiles on shared computers, our aim is to call attention to the prevalence of shared technology in domestic environments and raise awareness of the importance of considering shared usage. While not all ubiquitous computing technologies will necessarily be shared, developers need to consider whether or not the technology they are developing should support sharing or if it would be more appropriate to require individual ownership. While we have proposed some possible ways that technologies might mix features of the appliance and profile models to better match the ways in which we observed participants using their technology, we see this research as one part of a continuing conversation about how technology functions with respect to sharing in domestic environments. Certainly there are many interesting scenarios left to explore. For example, how devices might support multiple active profiles to record collaborative use of computers or recognize that two people are watching a television program and would both like it added to their personal history. We look forward to continued experimentation with technologies in domestic environments, and hope that in 2017 researchers are not observing that ubiquitous technologies in the home need to better match the ways families share them.

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References

1. Aldrich, F.: Smart Homes: Past, Present and Future. In: Harper, R. (ed.) Inside the Smart Home, pp. 17–39. Springer, Heidelberg (2003)
2. Bardram, J.: The trouble with login: on usability and computer security in ubiquitous computing. In: Personal Ubiquitous Computing, vol. 9, pp. 357–367. Springer, London (2005)
3. Beyler, H., Holzblatt, K.: Contextual Design. Morgan Kaufman (1998)

4. Crabtree, A., Rodden, T., Hemmings, T., Benford, S.: Finding a Place for UbiComp in the Home. In: Proc. Ubicomp 2003, pp. 208–226. Springer, Heidelberg (2003)
5. Crabtree, A., Rodden, T.: Domestic Routines and Design for the Home. *JCSCW* 13(2), 191–220 (2004)
6. Davidoff, S., Lee, M., Yiu, C., Zimmerman, J., Dey, A.: Principles of Smart Home Control. In: Proc. Ubicomp 2006, pp. 19–34. Springer, Heidelberg (2006)
7. Grinter, R., Edwards, W., Newman, M., Ducheneaut, N.: The Work to Make a Home Network Work. In: Proc. ECSCW 2005, pp. 469–488. Springer, Heidelberg (2005)
8. Hamill, L.: Time as a Rare Commodity in Home Life. In: Harper, R. (ed.) *Inside the Smart Home*, pp. 63–78. Springer, Heidelberg (2003)
9. Frohlich, D., Kraut, R.: The Social Context of Home Computing. In: Harper, R. (ed.) *Inside the Smart Home*, pp. 127–162. Springer, Heidelberg (2003)
10. Frohlich, D., Dray, S., Silverman, A.: Breaking Up is Hard to Do: Family Perspectives on the Future of the Home PC. *Int. J. Human-Computer Studies* 54, 701–724 (2001)
11. Kraut, R., Scherlis, W., Mukhopadhyay, T., Manning, J., Kiesler, S.: HomeNet: A Field Trial of Residential Internet Services. In: Proc. CHI 1996, pp. 284–291. ACM Press, New York (1996)
12. Mateas, M., Salvador, T., Scholtz, J., Sorensen, D.: Engineering Ethnography in the Home. In: Companion Proc. CHI 1996, pp. 283–284. ACM Press, New York (1996)
13. O’Brien, J., Rodden, T.: Interactive Systems in Domestic Environments. In: Proc. DIS 1997, pp. 247–259. ACM Press, New York (1997)
14. Randall, D.: Living Inside a Smart Home: A Case Study. In: Harper, R. (ed.) *Inside the Smart Home*, pp. 227–246. Springer, Heidelberg (2003)
15. Rode, J., Toye, E., Blackwell, A.: The Domestic Economy: a Broader Unit of Analysis for End User Programming. In: Proc. CHI 2005, pp. 1757–1760. ACM Press, New York (2005)
16. Rogers, Y.: Moving on from Weiser’s Vision of Calm Computing: Engaging UbiComp Experiences. In: Proc. Ubicomp 2006, pp. 404–421. Springer, Heidelberg (2006)
17. Rodden, T., Benford, S.: The evolution of buildings and implications for the design of ubiquitous domestic environments. In: Proc. CHI 2003, pp. 9–16. ACM Press, New York (2003)
18. Taylor, A., Harper, R., Swan, L., Izadi, S., Sellen, A., Perry, M.: Homes that make us smart. In: *Personal Ubiquitous Computing*, Springer, Heidelberg (2006)
19. Venkatesh, A.: Computers and other Interactive Technologies for the Home. *Communications of the ACM* 29(12), 7–54 (1996)
20. Weiser, M.: The computer for the 21st century. *Scientific American*, 94–104 (1991)
21. Wheelock, J.: Personal computers, gender and an institutional model of the household. In: Silverstone, R., Hirsch, E. (eds.) *Consuming Technologies Media and Information in Domestic Spaces*, Routledge, London, pp. 97–112 (1992)
22. Woodruff, A., Anderson, K., Mainwaring, S., Aipperspach, R.: Portable, But Not Mobile: A Study of Wireless in the Home. In: Proc. Pervasive 2007, pp. 216–233. Springer, Heidelberg (2006)