

Time, Ownership and Awareness: The Value of Contextual Locations in the Home

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Abstract. Various researchers suggest that technology embedded within the home can augment communication and coordination of home inhabitants. Our goal in this paper is to clearly delineate how households currently manage communication and coordination information; this will provide practitioners and designers with a more complete view of information in the home. Through contextual interviews, we identify five types of communicative information found in homes: reminders and alerts, awareness and scheduling, notices, visual displays, and resource coordination. We found that these information types are created and understood by home inhabitants as a function of *contextual locations* within the home. The choice of location is important to the functioning of the home, and is highly nuanced. Location helps home inhabitants understand *time*: when others need to interact with that information, *ownership*: who this information belongs to and who should receive it, and also provides them with *awareness* of the actions and locations of others. These findings resonate and further elaborate on work by others, e.g., Crabtree et al. [2,3].

1 Introduction

As computing devices become smaller, inexpensive and wirelessly interconnected, they will be embedded within our everyday environments [4,5]. In this new genre of ubiquitous computing, researchers suggest that the home can be augmented by making it more connected to other places, and more aware of its inhabitants [5,9,11]. The home can somehow display information so that people can access it anytime and anywhere. Example information includes the well-being of distant family members, schedules of home dwellers, weather forecasts, recipes, videos and music. Benefits touted for such pervasive information include increased feelings of connectedness to loved ones, better time management and more entertainment options [7,10,16].

Our own focus is in *communication and coordination information for the home*, i.e., information that people use to communicate and coordinate with household members (including themselves) and with the outside world, where the home serves as the communication center. We include within this category any communication item used within the home or taken from the home into the outside world. For example, notes, lists, newsletters, schedules, calendars, voice mail, email, snail mail, and instant messages are all pieces of home communication information.

The vast majority of households already cope with large quantities of this information, mostly through a variety of tacit mechanisms. The technological opportunity is to somehow augment the home by supplying this information for display and interaction through digital forms. Designers and researchers are even now proposing how we can do this, e.g., [7,16]. However, without a great deal of care, inappropriate designs could lead to information overload [8], ineffective uses, and mismatched audiences. Understanding how such information is currently managed in the home will help us make more educated design decisions.

Several researchers have already begun to explore various aspects of communication in the home, e.g., [1,2,3,7]. In particular, Crabtree et al's study identifies "prime sites" in the home for introducing ubiquitous technology to support communication [2,3]. They found that space in the home "...does not simply 'contain' action then, but is interwoven with action in various functional ways." [14] That is, information-related places in the home fall into three categories based on the type of activities that take place there: places where information lives, places where information is left or displayed for others and places where information is created or reworked.

Our own study, described below, uses a different method and takes place in a different culture. Yet it validates these findings: we saw the same types of places, and the same interweaving of space and action. While valuable as a replication, our results also add to this previous work in three important ways:

1. We describe what types of communication information are present in the homes we studied, for which information systems can be designed;
2. We discuss how places (sites) are initially selected and established, as well as how they are grouped throughout the home; and,
3. We extend the notion of places by investigating what the location of a piece of information tells people about it, and how this meta-data and context helps household members cope with and organize communication information. That is, information spaces are not only interwoven with action and activity, as described by Crabtree et al. [2,3,14] but they are also interwoven with *time*, *ownership* and *awareness*.

The paper unfolds by first describing how we used contextual interviews as the basis for our study. Subsequent sections summarize our interpretation of our interviews; we describe the types of communication information seen in the homes, and articulate the role locations have on information and interaction. These are illustrated by examples drawn from the study. After comparing our results to related work, we conclude with implications for future home information systems.

2 The Study

We used semi-structured contextual interviews to gain a thorough understanding of how households and individuals currently handle communication information in the home: what communication information is present and manipulated by inhabitants, and the role meta-data about each message plays in how it is handled.

Participants. We recruited and interviewed twenty-nine people (16 female, 13 male) within the context of ten different households. We intentionally selected diverse households to provide a broad range of household size, composition and demographic. Among the households we interviewed were roommates, common-law partners, divorced parents with shared custody, married parents with young children, working couples with teenagers and retired couples with adult children. Our participants included five teenagers, sixteen young-mid adults (ages 20 to 39) and eight middle-aged adults (ages 40 to 60). For pragmatic reasons, we did not interview children under the age of twelve. Homes ranged in size from small one bedroom apartments to large houses, with a wide range in between. Participants were from a wide variety of backgrounds, including students, retirees, programmers and office administrators. Most participants were at least moderately technically inclined.

Method. We used a series of semi-structured interviews that took place in each household's home context. We asked all members of the household to show us what communication information they used, and where this information was located in the home. We provided a deliberately vague and open definition of communication information so that we could see what they considered it to be. We photographed this information within their locations.

Guiding questions. We found that people would naturally provide a four part answer when generally asked about a specific piece of communication information:

1. ***What is it?*** What is this information about, what is it related to?
2. ***Whose is it?*** Who needs to pay attention to it? Should I pay attention to it? Is it mine? Who else needs to see it?
3. ***What needs to be done with it?*** What actions need to be taken? What needs to be done with it?
4. ***When do I/others need to interact with it?*** Is it urgent? At what point in time will I/others need to interact with this information?

For example, a typical statement would be “Well, that’s a phone message (*question #1*) for my mom (*#2*), and she needs to call them back right away (*#3*) so she needs to see it when she comes home. (*#4*)”. Our goal for an interview was to understand a person’s explanation about the type of communication information, its medium, and its location. These explanations suggest what meta-data people use to help them decide how to handle the information they come across. Depending on what participants showed us and their responses, our interview questions then focused on understanding what kinds of information were present, why participants had chosen the various information locations, and when participants would typically access or interact with the information.

Analysis and Results. We analyzed interviews and observations using an open coding technique which was intended to reveal similarities and differences between participant households. In general, we found that in spite of the diversity of our par-

ticipant demographics and household compositions, there were many commonalities.

We discuss our results in the remainder of this paper. Due to lack of space, we do not provide full details of our analysis. Rather, we present our main findings and use actual examples drawn from our participants as well as related work to illustrate what we saw. The next three sections outline the specific types of communication information found in the home, identify the media used to handle each type of communication information, and investigate the fundamental role that *locations* play and how they help people cope with communication information. For simplicity, from this point forward we use the terms *communication information* and *messages* interchangeably. In Section 6 we will describe how these results and analysis confirm and extend related work. This is followed by its implications to practitioners.

3 Communication Information Types

In analyzing our data, we saw many similarities in the kinds of communication information present in the home, in spite of the diversity of the homes, their layouts, and the people within them. We found five categories of communication information in the home distinguished in terms of how the information was used or its intended purpose:

1. **Reminders and Alerts** are intended or used as a memory trigger.
2. **Awareness and Scheduling** information provides knowledge of the activities and whereabouts of household members.
3. **Visual Displays** are to be shared or admired.
4. **Notices** provide household members with information about activities or people outside the home.
5. **Resource Coordination** information is used to coordinate the sharing of common household resources.

These five categories are not mutually exclusive; a single piece of information may fall into several groupings. For example, a shared grocery list could be both a to-do list (Reminders and Alerts), and a way to coordinate sharing of duties (Resource Coordination). Finally, these categories describe and contain all of the instances of communication and coordination information we saw in our participant households. Every household we interviewed had at least one and usually many more examples of each category. The categories are discussed below in detail.

Reminders and Alerts. The most common type of information present in the home is *Reminders and Alerts*. This category includes anything intended or used as a memory trigger, e.g., to-do lists, reminder notes or emails, instant messages, or warning tags. We saw three sub-types of this information: *reminders* that remind people about things they know but may forget, *to-do* lists that contain a list of things that must be done and *alerts* that remind or inform people of critical information.

This category is highly time-sensitive. The goal of messages in this category is to convey information at the right time, whether this time is related to the urgency of the

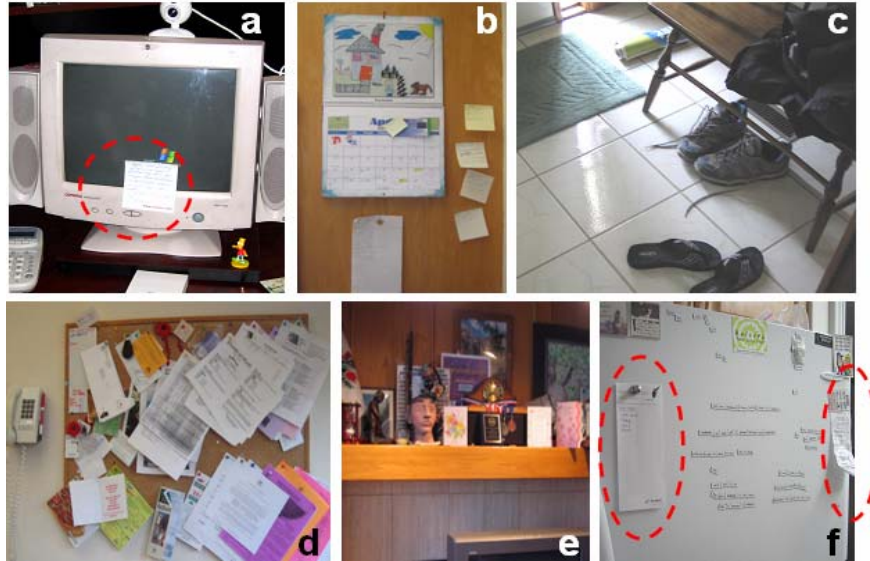


Fig. 1: Information Types

message (e.g., a reminder to call the shop right away, since it closes early), or to its relevancy (e.g., remembering to return a DVD on your way to work, or remembering what errands you need to run on the way home).

An example of this category is visible in Figure 1a. Here, a mother wanted to remind her son that he is to put dinner in the oven when he arrives home from school. She placed this note on the son's computer monitor because there is some urgency to it. To foreshadow the role of locations, she knows that her son will see this at the right time, as his routine on coming home is to go to his computer to check his email. An example of an alert is a post-it note stuck on a container of food in the fridge, alerting a roommate with allergies to the presence of nuts. It is an alert as the roommate needs to see the message before she considers eating it.

Awareness and Scheduling. The second most common type of communication information present in homes concerns Awareness and Scheduling. *Awareness information* is used to maintain an understanding of the presence and activities of household members. For example, this information is used to know who is currently home. *Scheduling information* includes items such as one's calendar activities or time schedule, for example, what time someone will be returning to the house. Both awareness and schedule information involve knowing details about the day-to-day routines of household members.

While Awareness and Scheduling information is not as time sensitive as Reminders and Alerts, it is critical to the smooth functioning and micro-coordination of the household and the comfort of its inhabitants. Their goal is to provide people with knowledge of the whereabouts and activities of others. For example, we saw that this information is particularly important for families with children, where parents need to coordinate who drives the children to their various activities. A more mundane exam-

ple is knowing or deciding when dinner will be served. While some of this information is left explicitly (e.g., as a note in a central common location such as the kitchen table), others are left implicitly through routine actions and gathered peripherally (e.g., the presence or absence of cars or shoes).

Figure 1b illustrates a common scheduling artifact, a family calendar. On this calendar, events for members of the household are explicitly written down so that they are not missed or forgotten. Using the example above, this may include a ride schedule so parents know who needs to be picked up and where. Figure 1c shows an entryway to the house where guests leave their shoes, and how the presence or absence of shoes acts as an implicit awareness message. Since members of this household enter through the garage, they know that shoes in the front entrance means that guests are present in the home; they may even be able to identify guests from their shoes.

Visual Displays. Household members often set up information to be shared, noticed and/or admired. Examples include the display of birthday cards, postcards, pictures, awards, or children's artwork. We call this category of information Visual Displays.

As an example, Figure 1e shows a mantle in a family room containing pictures, birthday cards, awards and medals, as well as children's artwork and souvenirs. These are all pieces of infrequently updated information that the family wishes to display in a public location, where it attracts the attention and comments of both household members and guests. Other examples include awards on the mantle, postcards on the fridge door, birthday cards on the hall table, and funny comics in the computer room.

Notices The goal of Notices is to provide household members with information about activities or contacts outside the home. The most common example of this category are phone messages. Notices also include newsletters, forms or notices from school, letters, etc. This information may be very time sensitive (e.g., a school notice that needs to be signed right away, or an urgent phone message) or not at all (e.g., the latest church bulletin). The defining characteristic of a notice is that it comes from something outside the home.

For example, Figure 1d shows a family bulletin board covered in notices and newsletters from work, school and children's activities. Phone messages can be seen in the top left hand corner of the board. This information keeps the family aware of what is happening with their outside activities and contacts. As with Visual Displays, this category of information is often shared between home members and publicly displayed; however, its content is more practical and more frequently updated .

Resource Coordination. The final category is Resource Coordination. This category includes any information used to manage the sharing of a common resource. For example, Resource Coordination items may include contact information, financial data, charts for sharing chores, bills to be split among roommates, or notes on food that is not to be eaten by others. Items from this category are less common, but still present in every home.

An example is shown in Figure 1f. On the left of the fridge door is a shopping list, while on the right side there is a receipt for the most recent grocery purchases. This information is used by two roommates to coordinate the sharing of groceries.

In summary, understanding the five types of information is the 1st step to knowing how to handle a particular piece of information. Information type is part of the answer to our first question: ‘*what is it?*’ We will see that this is not enough: other factors come into play to help people understand information and how it should be handled.

Information Media. People choose many different kinds of paper-based and electronic media to communicate these five information types. When people have a choice of mediums to use, we found that the information type did not usually determine the medium selected for a message. Instead, the selection of medium was based on the convenience and comfort level of the medium for the sender and recipient.

Placement of information also plays a large role; the affordances of where the message needs to be placed will determine the media used. If (say) a note needs to be left at the family computer, appropriate media choices could include a sticky note (for sticking on the monitor), or typing a note into an opened text editor on the display.

The medium by itself rarely helps household members answer any of our guiding questions. The answer to these questions, and the ability to cope quickly with the information, is provided by richer means—*contextual locations*—as described next.

4 Contextual Locations

Every household we looked at had a set of key locations (places) that inhabitants used for displaying, interacting, organizing and coping with communication information. We found that these places within the home were more than they initially seem to be. No matter what the answers were to *what is it*, *who is it for*, *when do they need it* or *what needs to be done* for a given piece of information, when we asked people “How do you know?” they would almost always reply with some variation of “Well, because it is on the fridge” or “...in the doorway” or “...on her placemat”. *People use placement to filter and manage communication information in their homes.*

These places provide household members with important meta-data about the communication information located there. This meta-data includes **time** information, **ownership** information and **awareness** information. Places are what enable people to answer our guiding questions for each message: *whose is it*, *what needs to be done with it*, and *when do I/others need to interact with it*. In this way, space is interwoven not only with action [14], but also with this rich context and meta-data about the messages placed there. We call these places **Contextual Locations**, since they provide the information in them with context, and therefore richer meaning.

We will first describe how places for information are initially selected. We then describe the ways these chosen contextual locations afford time, ownership and awareness to the information placed there.

Location Placement in the Home. We consider locations to include any place where communication information was placed. These could be static (e.g., the kitchen table)

or dynamic (e.g., a day planner carried in a purse). The number of locations in a home varied widely. One participant household had only four locations they used for communication information, while another had 23 separate locations. The average number of locations per household was just over 15; in fact, 60% of our households had between 13 and 17 locations.

The number of distinct communication information locations per household appears to be determined by two separate factors. The first is the house size: we found that the larger the house, the more locations present. The smallest home we studied had the fewest locations and the largest had the most. The second factor is the number of independent adults in the household. The presence of children does increase the number of locations, but not as significantly as the presence of another adult. For example, a household consisting of a divorced mother and her 15 year old son had far fewer locations than a similar sized home inhabited by two adult roommates. However, couples tended to have fewer locations than two unmarried friends or roommates, because they typically had very entwined lives.

The number and placement of these locations is part of the home ecology, where it is a shared household understanding that develops over time. To illustrate, one participant household contained a group of roommates living together for only a few weeks. While each had a good understanding of places for their individual information, the shared locations were not yet well formed or understood. Insufficient time had passed for them to evolve their meaning and uses of these locations.

Through their everyday routines, households implicitly select locations in order to provide answers to the four information questions. These locations develop social meaning over time, and become a strong shared language in the home. People rely on their knowledge of home routines (their own and those of others) as well as the placement of main traffic paths and common areas to find suitable places for information.

Pathways and routines. Information locations tend to group themselves along pathways through the house [2], for instance the path from the front door to the kitchen. Since these are routes most of the household will pass through over the course of the day, they are chosen as places to leave the information people need to or want to see. Part of this is derived from familiarity, where people know the routines of other household members—what they do when they come home, where they go, where they leave things like keys or purses—and using this knowledge in deciding where to leave messages. As Tolmie et al. [15] found “Routines are resources for action, and knowledge of others’ routines can be resources for interaction.”

In one of our households, the teenage son enters through the front door, passes through the kitchen, and then goes down to the basement. Parents leave notes for him on the kitchen counter since he has to pass by it on his way to the basement stairs. Knowledge of his routine, as well as the pathway he takes from the entrance way to the basement, meant that this was the logical place for this information. *Households use their knowledge of routines and pathways to select information placement.*

Once these locations are established however, they themselves become an element in daily routines. For example, many of our participants would describe locations they would explicitly check for information as part of their routine upon arriving home. These would include locations such as the answering machine or the kitchen table. *Information locations may create or establish new routines.*

Clusters. Areas also tend to be grouped. One communication area will normally cause other ones to form nearby, since it is often convenient to have different kinds of communication information in close proximity. We call these location groupings *clusters*. For example, if the kitchen counter is used to organize newsletters, other locations such as the family message board will usually be nearby. Clusters are most often present in common, frequently visited areas of the house, such as the kitchen, family room, entrance way, etc.

Neighborhoods. Communication media and technology such as phones and computers also attract communication information. Since this technology is less portable, information typically comes to them. Since locations group together as we described above, clusters will often form around these areas. We call these technology centered clusters *neighborhoods*. For example, for obvious reasons phone messages usually go next to the phone. Calendars are also usually near the phone, so that people can check their schedules when making plans with others. Other types of information, such as school newsletters, are needed near the calendar as it augments its information. This creates an information neighborhood around the phone. *Information locations tend to group themselves so that relevant information and technology is nearby.*

Location Attributes and Proximity. The attributes of a location affect both how suitable it is for information display and the kinds of information left or placed there. For instance, it would make very little sense to organize school handouts by pinning them up on the wall in the bedroom. Information would not be at hand when it was needed, and important events or letters might get missed. It is much more likely that these handouts will be stacked in piles on the kitchen counter, because it's flat, and they can be moved around easily. As a common, frequently visited place, the kitchen counter is a location where everyone who needs this information can get at it.

There is also the issue of relevance—information related to something needs to be near it, so the media will be chosen to adapt to the location, as discussed earlier. Phone messages will often be left on sticky notes near the wall phone; shopping lists on the fridge will be magnetic, etc. *Places in the home will be repurposed as information locations to meet people's need for organization.*

Visibility versus Practicality. The fitness of a location for communication often dominates other seemingly more practical factors. For example, it may be more practical to put new information in a location that has the space for it instead of an already heavily used information-crowded location. But this is not done. For example, there may be ample space in the basement for school handouts or church newsletters, but because the basement is not a commonly frequented place, information might be missed. Instead, it is added to the already busy central bulletin board. While it takes up much needed space, competes for attention, and gets in the way, it is more easily accessed. A second example would be placing a DVD that needs to be returned on the first stair leading down to the entryway as all household members will see it (and perhaps trip over it) as they go by, even though it might be less hazardous to leave it



Fig. 2: Urgent message from a mother to her teenage son.



Fig. 3: Envelopes to be mailed are placed here with keys

by the TV. *Location has such great value in terms of providing organization and relevance that it overrides more practical considerations.*

5 Time, Ownership and Awareness

The above location attributes and groupings described how people choose locations to communicate with members of their household, where these locations become part of the household's shared language. Next, we will see how this choice of location adds valuable information to each message, where it provides meta-data regarding *time, ownership and awareness*.

5.1 Time

One primary way locations add information is in timing, where time attributes—urgency, relevance, when it needs to be seen or used, the dynamics of the information—are all conveyed by the location in which the information is placed. This helps people answer the question *when do I/others need to interact with this information*.

Urgency and relevance. There is a definite correlation between location choice, and when information will be needed or when it should be seen. One of the most frequently stated reasons for location choice by our participants was the need for the information to be seen at a certain time. This time could be when one eats breakfast, or leaves the house in the morning, or sits down to watch TV. People use their knowledge of the routines of themselves and others to know where to put information so that it is seen in a timely way.

Household members use this knowledge to convey urgency in a message, to make sure information is at hand when needed and to provide a type of priority system for themselves and others. For example, messages from a mother to her teenage son were usually left near the computer upstairs, where the mother knew it would be seen at some point. However, as seen in Figure 2 and previously mentioned, she would place urgent notes on the TV screen instead, as she knew her son would surely see it as

soon as he returned home, since the first thing he does after school is watch TV.

This information also works for recipients of information. Household members know when there may be messages for them at certain locations. For instance, upon arriving home from school or work, people typically have a set of places they will check either implicitly or explicitly for information. If there is nothing in these locations, they assume there is nothing they need to address.

As another example, the placement of information is very frequently used to create timely Reminders. Figure 3 shows how household members leave things that need to be mailed with one person's wallet and keys (e.g., the letter tucked into the wallet), itself a part of the key rack neighborhood, so that he sees them when he picks up his keys to leave in the morning. This type of reminder, done by leaving things where they will be noticed at the right time, was common to all households. *Locations provide a vital means for people to convey time-related relevance and urgency.*



Fig. 4: Information dynamics

Information dynamics. We also found that information will change location over time as its dynamics change. This includes relevance to other messages, whether or not actions associated with that information have been taken, whether the message is still useful, and its temporality (e.g., is it a new message or an old one).

We saw that as information becomes less relevant or is dealt with, it is often moved to a new location. For example, when bills first arrive in the home, they are usually sorted and left for the person who pays them. This person will then open them, and move them to a second location, for example, the computer, in order to remember to pay them online. Once the bills have been paid, they move it to a third location for storage, a filing cabinet for example. This is true of much information that moves through the home—postcards and pictures may be placed in one location until everyone has looked at them, then in another place for long term storage or display.

For example, in one household, members left phone messages as sticky notes on the outside of a cupboard door above the main household phone (Fig. 4a). After dealing with a message, the member may throw it out. However, if the member needs to keep the message, e.g., contact information that one did not wish to lose, it was placed on the inside of the cupboard door for a kind of longer term common archive (Fig. 4b). The household knows that messages on the inside of the door were there for storage, while those on the outside still needed to be dealt with. *In this way, locations provide a sense of the dynamics of the information.*



Fig. 5: Spatial Ownership

5.2 Ownership

One of the most important and most pervasive ways in which we saw location used was to implicitly or explicitly attach ownership to information. Not all information within the home is relevant to all members, so households use locations to define who information belongs to. This allows people to not only manage complexity, but to answer the questions *whose information is this* and *what needs to be done with it*.

Spaces. Each location within the home has an owner—this could be either the person who the space explicitly belongs to (e.g., a child’s bedroom) or an implicit ownership (e.g., Mom always works in that spot at the kitchen table, so it has become her spot). The knowledge of who a space belongs to is used to not only decide where to leave messages, but also gives members an understanding of which messages belong to them, and which information they are expected to act upon. Ownership of the space implies ownership of information and who is expected to assume responsibility for it.

We found four main subtypes of location ownership within homes: public spaces, public subset spaces, personal spaces, and private spaces. *Public spaces* are those owned by everyone in the home. For example, the main house phone or the fridge door are usually considered public spaces, and messages affixed or near it may be for anyone. Figure 5a shows a fridge door used as a public space, where everyone can see it, place items on it, and interact with those items.

Public subset spaces are those that are public, but only to a subset of household members. Couples within a mixed household or parents in a family home typically have public subset spaces: spaces that are public and shared by them, but that do not belong to others in the home. Figure 5b shows a desk shared by parents in one of our participant homes. The parents leave a shared calendar for each other to see and use, but they know that their two adult sons do not look at, write on or otherwise interact with it. The sons know that this calendar is just for their parents because it is located in their parents’ space. However, if they have events that they want their parents to note, they may leave a note for them with the calendar.

The other two types of spaces belong to individuals, where information within them are understood to be for the owner only. The first type is *personal spaces*: pub-

licly visible spaces intended for only one individual. These could be the door to a bedroom, a placemat at the kitchen table, etc. Other members of the house will leave information in these places for the owner, and the owner will leave information there for themselves. Figure 5c shows one person's 'personal placemat' containing items placed there by that person for their own use. Yet because it is publicly accessible, others may leave things for this person to see and act upon.

The final type is *private spaces*, intended for only one individual and not publicly visible or usable by others, e.g., day timers, purses, bedroom bulletin boards etc. The information left in private spaces by its owner is usually personal reminders, personal scheduling and contact information. Its owner typically does not expect others to see information in these locations, such as the personal agenda of one household member illustrated in Figure 5d.

Knowing who the space belongs to gives household members a quick way to understand whether or not the information located there is something they should pay attention to. It also helps them decide where to leave information that others need to be aware of or take action on. *Spatial ownership (implicit or explicit) indicates or implies information ownership or information action responsibility.*

Spatial ownership may also vary by time or activity. For instance, O'Brien et al. [13] found that users of a technology would often 'own' or control the space around it. For example, someone watching TV in the living room temporarily controls that space, and may displace other activities taking place in that room, such as a noisy board game, or someone wishing to study. We found that if this shift in ownership is routine, information placement may become a part of it. In Figure 2, we saw our earlier example of a mother leaving an urgent note for her son on the screen because she knows that he will watch TV soon after he gets home from school. He owns the TV space at this specific time, so notes needing to be seen at that time and pertaining to him will be left there. He also knows that notes stuck on the TV screen at this time are his. *Spatial ownership may have routine variations based on time and activity.*

Visibility and privacy. We also found that the visibility of the different locations within the home implies not only information ownership but also the privacy level of the message. Information that household members don't need or necessarily want others to see will be placed in locations that are less visible and therefore more private. Information to be shared with others (e.g., awards, pictures, messages to all) is put in the highly visible and publicly accessible locations. Household members use this in order to protect their own privacy and to protect that of others when it is needed. For example, a husband may leave a message for his wife from the doctor tucked in her purse, rather than on the kitchen table where their houseguest may see it. They use this knowledge to know when information has been placed somewhere for sharing, or when this information is more personal and sensitive. *The visibility of the location of a piece of information implies its privacy level.*

Actions. The location of a piece of information implicitly attaches intended or expected actions to it. Often information is placed in a certain location so that a member of the household will know they are expected to do something with it. This was also observed by Crabtree et al. [2] Using previously mentioned examples, this may be a

letter to be mailed placed by car keys, or a stack of bills to be paid placed by the computer.

Seeing a message in a certain location lets people know what they are expected to do with it. This may be a simple reminder to oneself, as in the example of a person putting a video to be returned by the door, so they can see it as they leave and infer that it is ready to be returned. This is one direct way space is interwoven with action, as in Crabtree et al's Coordinate Displays [2, 3].

Location ownership indicates responsibility for these actions. People will place information for others in locations that "belong" to that person as a request for action. For example, a child may place a school notice for their parent to sign on the parent's desk. Personal reminders are often left in personal or even private locations. Action triggers placed in public areas, such as the DVD return example above, can be taken care of by any household member. *The location of information implies intended actions and responsibility for those actions.*

5.3 Awareness

Finally, locations include meta-data for communication information by providing awareness information for family members. Awareness information for home inhabitants is very important to people for scheduling, coordination and comfort, as described by Neustaedter et al. [12].

Presence The presence or absence of an object from its routine location provides information, especially awareness information. For instance, many of our participants mentioned knowing whether or not someone was home by the presence or absence of their cars in the garage or on the street. What shoes were in the entry way or what keys were on the key rack was also frequently cited as a way of knowing who was around, including whether or not guests were there.

Figure 6 shows how one of the participant households evolved a particularly rich system for handling awareness information. Each member of the household would wear different colored slippers while in the main floor of the house, as it was tiled and cold on bare feet. These slippers would be left in the main entryway (Fig. 6a) when the wearer was not in, or at the foot of the stairs when they were upstairs in the carpeted area of the home (Fig. 6b). In this way, family members always knew who was home, and their general location in the house. *The presence of an object in a routine location can provide information to household members.*

Monitoring The above assignment of actions through locations combined with the information gathered through the presence or absence of artifacts also works as a form of internal monitoring. Household members know whether others have completed their tasks because they can see what information is present in which locations.



Fig. 6: Slippers indicate presence and location.

This is discussed by several previous authors, e.g. [6,7,15]. Harper et al. [6] calls this workflow control or workflow management. While the home is definitely not as work oriented as the office, there are still jobs that must be done to keep the household running smoothly. One example is a wife seeing that her husband hasn't paid the bills yet since they're still in a pile on the corner of the desk, instead of being filed. She knows he's been busy, so she takes on the job of paying them herself. He then knows she has done this because the bills have been moved. A second example, as described in [6], is parents placing their teenager's cell phone bill in the doorway to his bedroom to make sure he sees it. Once they know he's been home and has therefore seen it, they can then ask if he has paid it – he has become accountable for it because they know he has to have seen it. *Household members use locations to monitor and help each other.*

6 Confirming and Extending Related Work

The findings of our study confirm and extend what others have seen. The most relevant related work is by Crabtree et al. [2, 3], whose publications motivated us to find out more about the value of locations in the home.

Our approach and Crabtree et al's differed. We used contextual interviews as opposed to participant logs; we studied different household types, and we were working with North American families rather than British ones. In spite of these methodological and participant differences, we found that the concept of contextual location we observed in our households goes hand in hand with the three activity places described by Crabtree et al. [2, 3]. Our idea of ownership and how it is exploited extends their idea of *coordinate displays*, i.e., places where information is left for others. Our idea of clusters and neighborhoods are particular ways that their *ecological habitats* (places where information lives) are formed and used. Their notion of *activity centres* (places where information is created or worked with) are another way of describing the act of manipulating information within these locations. All are enhanced by our explanation of why people choose to leave things in certain places. Thus, part of our work confirms their findings. This confirmation is very valuable to practitioners in that it validates and adds richness to Crabtree et al's results and generalizes the work to a broader audience.

However, we stress that we have built upon Crabtree et al's previous work in three significant ways. First, we identified the types of communication information present in the home, as described above, i.e., reminders and alerts, awareness and scheduling, notices, visual displays, and resource coordination. While they show instances of these in their examples, we classify them as generalizable categories that developers can design for.

Second, we describe how these places are initially selected by the household (clusters, neighborhoods, pathways and routines), and how they are distributed through the home not only in space but in time. This is important as designers can now not only determine what types of places should contain ubiquitous computing technology, but also where these places could be located within the home.

Finally, Crabtree's notion of space being interwoven with action [2,3,14] is ex-

tended by *contextual locations* to describe space as being interwoven with not only action and activity, but also with time, ownership and awareness. Our work looks to explain why inhabitants would select one coordinate display (for instance) over another coordinate display, and what these choices mean. This provides a more complete picture of the management of communication information in the home.

We have also confirmed and added richness and nuance to other related work concerning the specific ways such locations help us. Hindus et al. [7] and Harper et al. [6] described how the presence or absence of articles in specific locations, (e.g., a bill to be paid) is used by family members to monitor and help each other complete the tasks needed to keep the household running smoothly.

7 Practitioner Implications and Design Opportunities

Our work is intended to provide a more complete view of home communication information management than has previously been reported. Our study found that communication in the home involves a rich and highly nuanced use of information, routines, and locations. All findings have implications for the design of ubiquitous or context-aware technologies for augmenting communication and coordination in the home, and for practitioners who are looking to better understand the home environment.

Existing Communication Technology. Our results point towards problems or weaknesses in existing technologies. Although email has many advantages over regular paper-mail, it has trouble replacing it because it does not provide the same physical affordances seen in our examples [6]. Other current communication technologies, such as electronic messaging, file and reminder systems also do not currently have the location affordances needed to fully replace physical ones. For example, while there are many commercial reminder programs available and in use, they do not include the location meta-data that home users need, and thus are poor replacements for (say) the scribbled note left with car keys or atop shoes. Filing systems on personal computers are impoverished as locations. A person may file something in a folder, and then quickly forget where it is. And since a person cannot flick through digital files to look for a picture on a handout she remembers, or know that it is in the stack near the coffee maker, it is hard to quickly re-find it.

Of course, electronic systems can contain the same raw information, and provide many advantages over paper based systems: distribution over a network, searching and sorting capabilities, etc. Yet none have the meta-data we saw in contextual locations readily available. There is no way of attaching urgency, relevance or awareness information to these types of electronic messages. Exploiting ownership is difficult, as ownership boundaries are rigid and access is often limited by passwords. This loses the richness of visible locations, be they personal or shared, as well as the ability to monitor other household acts for awareness. Thus the benefits gained by integrating current technology into home communication are currently tempored or minimized by their inability to use or replace the physical affordances of locations.

Design and Research Opportunities. Given the richness of existing practices of communication within the home, design of appropriate technologies appears daunting. For example, it is hard to imagine technology that can replace the richness and flexibility of the sticky note, with its ability to be conveniently placed at any location. Yet opportunities abound. The types of communication information we identified can help designers target areas where the most value can be received from new systems, and what kinds of information these new systems could integrate.

Knowing the value of locations will provide designers with new uses and goals for current technology. For example, a movable projector system as described by Intille et al. [10] could easily be used to display electronic messages in location-appropriate places. This kind of system would allow designers to go beyond physical world functionality, for instance by adding in the ability to place messages appropriately in particular home locations from work. It could even be an extension of a current instant messaging application. Another possibility includes the integration of displays and sensors into already meaningful home locations, so that electronic messages could be automatically displayed in appropriate locations. Messages could even migrate if, for instance, a person for whom there is an urgent message is sensed near a different display than the one initially chosen for the message. These ‘smart’ messages thus know about contextual locations and exploit routines and understandings already in place.

The Value of Location. It is now obvious that having all information available through some kind of monolithic computer application accessed through a conventional display misses all the nuances of location placement. People will not know where the information is, will not know what they have to deal with at the moment, and will not be reminded at appropriate times. Locations are used on such a large scale within the home that they cannot be ignored. It is key to how people deal with the ever-growing information pool they have available to them. Locations need to be valued not just as a place in which to work with or to display information, but also as a spatial means of providing it with context, value, and interaction opportunities. This means that if and when designers look at integrating technology systems into the home, they need to provide this meta-data either through physical locations, or through some kind of digital replacement. As home inhabitants add meaning when they select the locations over time, locations cannot be hardwired into the home except in obvious cases, e.g., the fridge door or the telephone as a likely neighborhood.

Obviously locations are not the only solution for design dilemmas; however, they do provide a very rich, intuitive way for people to cope with information. People already understand the semantics of location within the home. It would be more difficult to move into a design that did not support this very natural tendency, especially in the home environment where people are resistant to change and to technology.

8 Conclusion

We offer four main research contributions from the results of our study that adds understanding to how people currently handle communication information in the

home. First, we validate Crabtree et al's assertion [2,3,14] that information spaces in the home are interwoven with action and function. Second, we identified five types of communication information in the home. Third, we discussed how information places within the home are chosen, distributed and selected. Finally, we articulate our concept of *contextual locations*: the vital role that location plays in providing meta-data to household members that allow them to easily decide how to handle communication information. This meta-data, related to *time*, *ownership* and *awareness*, allows people to quickly deal with the vast quantities of information present in the home.

Our results are significant for they offer designers and practitioners a more complete picture of information management and routines in the home. We hope that our work will sensitize designers to the compelling implications that locations have for the design of future home information systems. We offer design avenues for communication information and have shown that it is important for future home information systems to either support locations or provide additional meta-data that locations typically provide. We have laid a foundation of knowledge which clearly suggests what will not work and should inspire methods that do work. Our own future research directions will focus on using our study results to design ambient and interactive devices to support communication information in the home.

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