

A Study on Network Management Tools of Householders

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ABSTRACT

In this paper, we report on the tools that users currently rely on for their home network management, the usability problems with those tools, and some desirable features for a tool for householders. The data was collected from 25 home network users in Atlanta, USA. The results of this study provide initial clues on the practices of home network management of householders, as well as design implications for future kinds of home network management tools.

Categories and Subject Descriptors

C.2.3 [Computer-Communication Networks]: Network Operations – *network management, network monitoring*

General Terms

Management, Human Factors

Keywords

Home network, Management Tools, Usability Problems

1. INTRODUCTION

The home network has become an essential part of people's daily life. Consequently, network management has become a regular household task [5, 9]. Householders need to configure new network devices to connect them to the network, and set up infrastructure devices such as routers and wireless access points both for connectivity with their Internet Service Provider (ISP) and for connectivity within the home. They have to manage security in order to protect their networks from unwanted access, potentially configure parental controls to restrict Internet usage for their children, and diagnose and troubleshoot connectivity problems, to name but a few.

However, many householders have difficulty doing such management jobs due to the inherent complexities of the home network [2, 3]. Thus, home networking has become the focus of a growing body of work in the HCI community.

A number of researchers have reported the results of studies on the user experience of home networking. These

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include an investigation of “early adopter” home network users [4, 7], an investigation into the sources of complexity in home networking [1, 6], an investigation into the practices of building and maintaining home networks [2, 9], and an investigation of householders' perceptions of their home network [8]. All of these studies focused on user experiences and perceptions of inherent characteristics of the home network.

In this work, we focus on the user experience related to network management tools. Network management tools mediate between the users and the home network, and thus can significantly influence on the home network experience for users.

We first report data on what tools people currently use to manage their home networks. We then report what usability problems they have with those tools and what are the needs of those users who currently are most likely to undertake management of the network.

We conducted interviews with 25 home network users, ranging from users with only informal knowledge of networking to users with trained knowledge of networking. Although the results of our study are primarily qualitative, rather than quantitative—we do not claim statistical significance, for example—our results give initial clues on the current management tools and the usability problems of those tools derived from their network management experiences.

2. STUDY METHODOLOGY

2.1 Participants

We recruited 25 participants of ages ranging from 20's to 50's. We recruited the participants by word of mouth, by emails to a number of local organizations such as a university language institute and churches, and by on-site recruiting in public places such as cafes. The study was conducted in our research lab, the participants' home or workplaces, and in public places where the participants were recruited.

Our participants all had home networks, and all had had some experience with home network management experiences, although the degree of expertise varied widely among householders. Most had wireless networks in their home. All participants had one or more desktop PCs and laptops connected to their home network. About one third of the participants had other types of mobile computing devices such as a PDA, and networked game devices.

Among these 25 users, 18 were self-declared non-skilled network users (hereafter, called “non-expert users”) having just informal knowledge of networking to perform some small set of management tasks. They had obtained informal knowledge of networking from online sources as well as acquaintances such as friends and family members. A small number of users relied on product manuals or company professionals (such as a tech support line). Seven users were self-declared skilled network users (hereafter, called “expert users”) who had obtained technical knowledge from some form of formal training.

2.2 Method

We conducted an interview with each participant. For the interview, we listed a range of home network management tasks which we group into the following four categories:

- **Connectivity configuration:** this category includes the tasks associating with configuring new network devices to connect them to the network, and setting up infrastructure devices such as routers and wireless access points for connectivity with their Internet Service Provider (ISP) and for connectivity within the home.
- **Security and access control:** this includes basic security functionality to protect devices from unwanted access, as well as access controls for guest machines and parental controls for children.
- **Network monitoring:** this includes basic monitoring and assessment for the overall home network, the ability to monitor particular devices’ Internet usage, and view the overall connectivity to the Internet.
- **Troubleshooting:** this includes functionality to figure out networking problems such as connectivity and slow speed problems.

During the interview, we asked users to check the tasks in each category that they had done in their home network and to indicate the tools they had used for the tasks. We also solicited their input on those tools and asked them what they would like to see any new tools to be able to do. Each interview lasted 1 hour to 1 and 1/2 hour on average. We report our findings in the next section.

3. FINDINGS

3.1 Tools That Users Rely on

Overall, the tools that the participants mostly relied on were the tools built-into the router and the OS. Participants described a number of motivations for using these tools, chief among these were the following: 1) they did not need to install additional software themselves, 2) they had no idea what other management tools existed, and 3) they did not want to pay extra cost just for a management tool. In the rest of the section, we report the collected data per management category.

Connectivity configuration. For connectivity configuration, all 25 participants had previous experience. Figure 1 shows the distribution of the tools that users relied on for connectivity configuration, with the number of users on the left side for each tool.

We distinguish the results between non-expert users and expert users to highlight the relationship between the tools that the users use and their knowledge level of networking.

We also noticed that users used multiple tools for a task. Therefore, in our results, the users of one tool are not exclusive with the users of other tools. That is, if a user used two tools for a task, this user was counted for both tools.

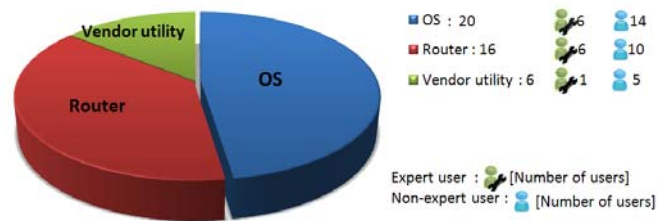


Figure 1. Tools that users rely on for connectivity configuration

As seen in Figure 1, most of the participants relied on their router’s firmware interface and tools built into the OS of their computing devices, for instance Linksys router’s interface, and Windows or Mac network connection wizards. They used the router mostly for wireless network settings and address assignments, while they used the tools built-into the OS for adding their computing devices to the network. However, six participants (mainly non-expert users), used utility software provided by their device vendors, such as Intel.

One of the main reasons that our participants used built-in tools was that they did not need to install additional software themselves. However, they mentioned that those tools, especially the ones in the router, provided too many unused low-level networking options for configuration (e.g. the DHCP address change option was known to and used by only a small number of users) and used terminology unfamiliar even to expert users.

Security and access control. Many of our participants were active in managing security and access control. Most of them used one or more of three classes of tools: either OS-level tools, router-level tools, or commercial firewall software. Figure 2 shows the results.

The most commonly used tool for our participants was commercial security software including ZoneAlarm, Norton, and McAfee. Especially, a considerable number of non-expert users relied on commercial security software.

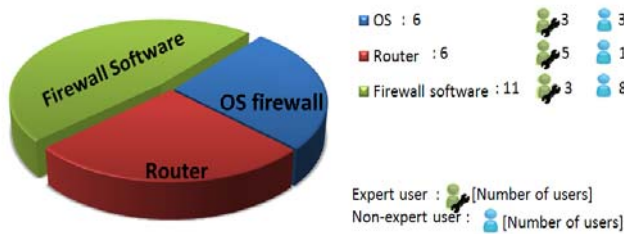


Figure 2. Tools that users rely on for security and access control

They used these tools mainly for protecting their PCs from external attacks and unwanted access.

Another ways that the users restricted access was by using firewall software on their individual PCs and the router. Six users used firewall software built into their OS, and six users used the firewall built into the router.

However, there was some distinction between non-expert users and expert users. While non-expert users tended to rely more on firewall software built into the OS than on firewalls built into the router, expert users tended to rely more on the latter than on the former. Expert users, who seems to understand the hierarchical topology of the home network, mentioned that controlling access at the router is more efficient than controlling access at every individual device in the network

Aside from the tools, there were many non-expert users who had concerns related to access control, but could not actively enable or manage access control because of lack of knowledge about how to do so. Especially for users having children, Internet and websites access control was their most serious management concern. For instance, one participant was in the need of website access control for her 11 year-old daughter, but did not know how to do access control. Instead, she relied on “physical” forms of access control, such as watching over her daughter while her daughter used the computer. Another participant, a mother of three children, was not knowledgably about how to restrict Internet access for her children’s computer. Her solution was to put a family desktop computer inside her room so that she could ensure that her children would not use it late at night, and only use it for school purposes, and sometimes educational games.

Network monitoring. For network monitoring, users checked on the network speed of an individual device in various ways. Figure 3 shows the result.

Like their approach to connectivity configuration and security and access control, a considerable number of users checked on the network speed through the tools built-into OS and the router. At the same time, a considerable number of users also used other approaches as well. Six users checked the network speed of their individual devices through information that network applications provide. For

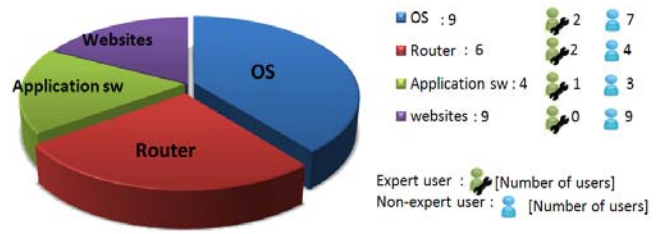


Figure 3. Tools that users rely on for network monitoring

instance, they checked file download speeds through file download programs and video streaming applications. Six users used websites (e.g. speakeasy.net) that provided a network speed checking service in order to test their individual computing devices.

However, most non-expert users had never checked the whole network status and speed before because they did not know how to do so. The tools above usually allowed them to check on the status and speed of only individual computers. Therefore, they complained that there was no explicit way to monitor the whole network performance or to detect where network speed bottlenecks come from. They expressed a desire for an easy way to see at a glance what is going on in the whole network.

Troubleshooting. For troubleshooting, the users in the study relied mostly on tools built into the OS and the router as well. On the other hand, a considerable number of non-expert users tended to just depend on very simple physical actions such as resetting, unplugging, and replugging of devices. Then for further help, they called their ISP, device vendor, or other people that they know such as friends and family members. Figure 4 shows the result.

Although many householders used tools built into the OS, they complained that it was hard to detect what caused a problem at first glance with those tools. One novice users

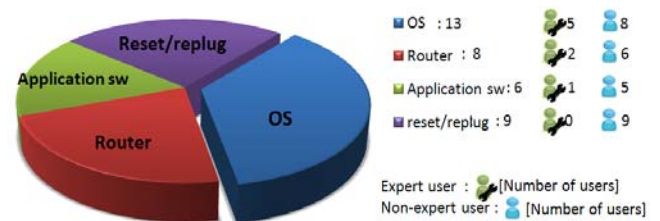


Figure 4. Tools that users rely on for troubleshooting

expressed his desire to be able to troubleshoot easily, saying, “I just want to get a simple, direct indication about network problems and solutions.” She expected a simple message like, ‘Your router is off.’, instead of the multiple steps that she needed to follow to diagnose network problems.

3.2 Usability Problems of the Tools

This section describes usability problems of the tools commonly mentioned by our participants in the study. Although the findings do not cover every possible usability problem, they will give insight into overall usability problems experienced by householders, as well as design implications for a new kind of management tool.

Hard-to-understand and hard-to-use tools. This was the most mentioned problem by the study participants. Many non-expert users emphasized it in statements such as the following: “(To use those tools) you have to have technical knowledge. If you don’t, you have to spend a lot of time to learn it.”

Existing tools, especially tools built into the OS and the router, require users to have the sophisticated technical knowledge of networking. However, many non-expert users in our study did not have such sophisticated technical knowledge of networking. For instance, there were a considerable number of users who did not understand fairly basic concepts such as what IP addresses are (needless to say MAC addresses). Many of them also had no knowledge about wireless network encryption nor how it works.

The participants also mentioned that these tools unnecessarily expose too many low-level technical options that they neither want to have nor want to understand. For example, most users except a very small number of users did not understand—nor want to have to understand—settings such as DHCP parameters (e.g. the IP address range of client devices) provided by the router. One expert user pointed that there were too many wireless security options in the tools, and that whether he wanted to or not, he had to look at them and choose one. This user did not care what kind of wireless security options existed, only whether his home network was secure or not.

In summary, the study participants strongly expressed their desire of easy-to-understand and easy-to-use tools in their statements such as the following: “Everything in the tool should be easy to see, understand, and use.” and “Making the home network (tool) easier will allow less educated people to use computing/networking technologies more easily.”

These kinds of comments confirmed the need for a home network management tool that is easy enough to use for such home network users without requiring too much underlying technical networking knowledge.

Hard-to-find tools. This was also often mentioned by many users. They complained that they had no idea what tools they needed to run or how to get to those tools to perform specific tasks. Since tools often support some aspects of network management, the users had to run different tools for different management tasks.

Some users addressed the usability problem of getting to the built-in router tool. To get to the tool built into the

router, users usually have to know the IP address of the router on the browser, something not familiar to many users. Furthermore, different routers have different default IP addresses. For instance, Linksys routers usually use 192.168.1.1 as their default IP address, and DLINK routers use 192.168.0.1.

The problem of tool accessibility suggests that it would be good to provide users with an all-in-one network management tool that supports all network management tasks at one time, tool that can be accessed easily by ordinary users.

Inconsistent user interface of management tools. The study participants also commonly mentioned problems with inconsistent user interface among management tools. This is because tools are different from vendor to vendor, from device to device, from OS to OS, and from task to task. Although the vendor, device, and OS inconsistencies may not be solved by one management tool, we believe the task to task inconsistencies can be alleviated by providing an all-in-one management environment.

No visual map of the home network. The lack of any visual depiction of the network in existing tools was an issue for the participants as well, especially when they confronted networking problems such as disconnection and slow speed. Many users pointed that the router and the OS tools do not provide any graphical information about the network topology and status, and thus they had no easy ways to check the speed of the whole home network or individual devices. This suggests that there should be a visual map for users to oversee the whole network as well as the individual devices. Several users also suggested that, for the purpose of privacy, it would be helpful to see which devices are communicating with which devices in the home network.

Unusable manual or instructions of tools. Manuals were too difficult to use, according to some study users, because they contained too many technical words that were not understandable or helpful. For instance, one user mentioned a poor router instruction guide, saying, “When I bought a router and brought it home, I did not know what to do. I plugged the router in but then had no idea what I should do next?” Another user expressed a wish for an instructional video kit that would explain how to create a home network. One non-expert user suggested the use of figures or animation to help users build and manage the home network. This suggests that more understandable forms of help and instructions should be created for users.

3.3 Other Desirable Features of a Management Tool

In addition to addressing the usability problems noted above, our participants also noted a number of other features that they perceived as desirable.

Universal accessibility was the commonly mentioned concern for the study participants. They wanted to have the management system accessible with any computing devices in the home network (from any laptop for instance).

Such desire for universal accessibility implies that many PC-based tools, which are installed and running on individual PCs, may not be the best option for several reasons. First, the PC-based tools can not provide users with universal access. To access those tools, users need to go to the devices in which the tools are installed. Second, the PC-based tools cannot get a full picture of the network without extra coordination overhead. To get a full picture of the network, the PC-based tools need to collect necessary information about devices other than the device that runs the tool from either the router or other devices.

With regard to a holistic environment that can support a variety of network management tasks (versus requiring separate tools per task) most users barring some expert users absolutely preferred a holistic environment. The reasons for such a preference were the following: 1) A holistic system simplifies management tasks by using one program in one place; 2) It provides a consistent look and interface, thus requiring less time for users to learn than those of multiple management tools with different looks and interfaces; 3) It allows users to recognize all available network settings and options at a glance and thus gets rid of chances to miss some management tasks. One expert user preferred a separate, specific tool.

Finally, several users emphasized that they did not want to be required to install extra software installation on a computer or on a computing device. They also did not want to have to incur any extra cost for a management system. This suggests that it would be better to provide users with management tools that are built-into networking devices.

4. CONCLUSION AND RESEARCH DIRECTION

Our study results show that householders currently rely mainly on the tools built into the OS and the router to perform management tasks in their home, despite the widely perceived usability problems of these tools, not least of which is the relatively sophisticated level of technical knowledge required in order to use them effectively.

Therefore, we need to investigate more easy-to-use network management tools for them. All of our participants except one expressed a strong eagerness to self manage their home network if they were given easy-to-use network management tools. This indicates that users have the desire to manage their networks themselves (as opposed to relying on external help sources), but that the tools are not yet available that can support their needs.

There have been some recent systems, from both academia and industry, that have started to investigate usable tools for householders. For instance, Cisco introduced a total home network management solution, Network Magic [12]. This tool allows householders to perform a set of household-oriented tasks with much more user-friendly GUI while hiding many technical details of networking. Our group have also developed interactive management tools, ICEbox [10] and Eden [11], to help householders self-configure and self-manage their home networks.

5. REFERENCES

- [1] Bly, S., Schilit, B., McDonald, D. W., Rosario, B., and Saint-Hilaire, Y. (2006). Broken expectations in the digital home. In CHI '06 Extended Abstracts on Human Factors in Computing Systems (CHI '06), 568-573.
- [2] Chetty, M., Sung, J., and Grinter, R. E. How Smart Homes Learn: The Evolution of the Networked Home and Household. Ubicomp 2007, 127-144.
- [3] Edwards, W. K. and Grinter, R. E. At Home with Ubiquitous Computing: Seven Challenges, Ubicomp 2001.
- [4] Franzke, M. and McClard, A. Winona Gets Wired: Technical Difficulties in the Home. CACM 39 (12), 1996, 64-66.
- [5] Grinter, R. E. et al. 2009. The Ins and Outs of Home Networking: The Case for Useful and Usable Domestic Networking. ACM ToCHI, 16(2) (June 2009), 1-28.
- [6] Grinter, R. E. and Edwards, W. K. The Work to Make a Home Network Work, In Proc. ECSCW'05, 2005.
- [7] Kiesler, S., Lundmark, V., Zdaniuk, B., Kraut, R. E. Troubles with the Internet: The Dynamics of Help at Home. Human Computer Interaction, 15(4), 2000.
- [8] Poole, E., Chetty, M., Grinter, R. E., and Edwards, W. K. More Than Meets the Eye: Transforming the User Experience of Home Network Management. Proceedings of ACM DIS 2008, 25-27.
- [9] Tolmie, P., Crabtree, A., Rodden, T., Greenhalgh, C., and Benford, S. 2007. Making the home network at home: Digital housekeeping. In Proc. ECSCW 2007, 331-350.
- [10] Yang, J. and Edwards, W. K. ICEbox: Toward Easy-to-Use Home Networking. INTERACT 2007, 197-210.
- [11] Yang, J. 2009. Eden: An Interactive Home Network Management System, Ph.D Dissertation, Georgia Tech.
- [12] <http://purenetworks.com/>