Why should home networking be complicated?

Abbas Moallem, Ph.D

NETGEAR
350 East Plumeria Drive
San Jose, CA 95134, USA
Abbas.moallem@NETGEAR.COM

ABSTRACT

In today’s life, an Internet connection in a home can be considered a utility like a telephone or even to some degree electricity. Not having an efficient home network is like having just one electrical outlet in the whole house versus having outlets throughout the house and being able to plug in all your appliances at once any time you want. Networking devices from wireless routers to storage, to digital media receivers and so on, are more and more available on the market and their speed and quality of reception constantly improves. Despite these hardware improvements, the software parts that enable users to interact and manage the extended functionalities of these devices are still very complicated and out of reach for average home users.

In the competitive market of networking device manufacturing companies, limited resources are allocated to improve the ease of use of the user interfaces (UIs) where users interact with the devices on a daily basis.

This paper presents the main issues in home network software usability, based on survey results and empirical observation, and describes a new generation of task-based user interfaces for NETGEAR devices, enabling home networking users to easily set up and interact with their devices.

Keywords: Home Networking, Routers User Interface, Smart Appliances, Smart Network usability, NETGEAR

1 INTRODUCTION

With the speedy expansion of the Internet and Internet-based technologies in homes, an Internet connection became a basic utility, like electricity, gas or water. According to the website internetworkworldstats.com, 78.3% of the US population is Internet users. Users are not just satisfied with having their computer connected to the Internet. They need wireless connections at home for their computer devices,
and a cross-access connection that lets them, view, modify, and control their computer devices. Users also need to control and monitor or solve problems when they are away from home. They equally want an uninterrupted Internet connection for smart phones or Wi-Fi connections from public places and through their preferred providers. Satisfying user needs depends on three main hardware factors.

- High-speed Internet connection at the provider level.
- Reliable and high-speed router to provide fast and expanded coverage.
- Device inter-connectivity and discoverability in a network.

To appropriately configure and manage the network devices, and problem-solve the issues, users need to first install hardware correctly, and use the user interfaces of each devices to configure, set, and manage their network.

Not long ago, the Internet connection was limited to one or more computers at home. Now, gradually within a “smart home” (Cheng & Kunz, 2009) a multitude of computerized devices are interconnected and interacting with each other. Users should be able to not only configure them but also monitor them daily and interact with them and more importantly, problem-solve network issues.

Despite a tremendous progress in hardware: from cable modems, router, media devices and so on, improvements in the usability of their software is still very primitive. It is commonly agreed upon among users that managing home networks is a tedious, difficult task that is out of reach for most users with limited networking experience.

An important body of research points out a variety of usability issues for home networking technologies. In a recent article Edwards et al. conclude that “Network usability problems run deep because the technology was originally developed for research labs and enterprise networks and does not account for the unique characteristics of the home: lack of professional administrators, deep heterogeneity, and expectations of privacy” (Edwards, 2011). The issues that seemed to be related to this lack of ease in this technology include: user interfaces are built for advanced users with IT backgrounds, heterogeneity in users, home networking configuration, and problem-solving of home network issues. For example, Grinter et al. (2005), note that home users are often unable to verbally articulate accurate information about their networks or even have a different mental model of their network based on their level of expertise.

Poole, E.S. et al. (2009) have found that home users drew on a variety of resources to conceptualize their home networks. This study suggests that they need to be offered drawings that exhibit properties associated with network education or training, on some schemes such the physical layout or routines of the home as methods of organizing the network. Alternately, when troubleshooting the networking problem, home users would like to pinpoint locations of malfunctioning devices.

Expansion of the smart home concept should also benefit older adults. Older adults seem to have an overall positive attitude towards this technology. Usage of health monitoring sensors, or security devices in the home to enhance their lives is a good example of how people benefit from this technology (Demiris G. et al, 2009). However the ease of use of these applications is crucial for successful usage by
older adults.

Home network devices should make it easy to add computers, or any other smart appliances to the home network, and establish interaction by offering users an easy to use and intuitive method of centralized management and monitoring of the devices.

The results of a survey on home wireless usage reveals that currently 22% of people surveyed bought their wireless router based on speed, followed by 17% for low price, and 1% for ease of use. However, when participants were asked about purchasing a new wireless router, speed remained the top factor and increased in importance to 37%, while ease of use moved up to the second priority with 17% (TMC News, 2011).

Consequently, making home networking smart is not achievable unless the usability of the devices (software and hardware) along with their configurations is extensively improved and accessible to not only expert users but all types of users.

2 DESIGNING SMART NETWORKS ACCESSIBLE TO ALL

If you have a home networking device, the chances are you have experienced a variety of home networking user interfaces. You might even have asked someone with technical knowledge to help you with installing, connecting, and configuring the device that you acquired or had problems with. This might have happened for any type of device from a Wi-Fi router to more advanced devices such as storage, security systems, and interactive TV or sound systems.

The poor usability of the user interfaces (UIs) is not observable only on one or two brands of products. A simple comparison among the most common brands on the market reveals that all brands suffer to some degrees from the same usability issues.

2.1 Terminology

Table [1] shows the 26 common terms used in configuration and setting of major Wi-Fi router brands.

<table>
<thead>
<tr>
<th>Table 1: Labeling terms used in most router user interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEP, WPA-PSK [TKIP], WPA-PSK, WPA2-PSK [AES], WPA-PSK [TKIP] + WPA2-PSK [AES], WPA/WPA2 Enterprise, Passphrase, Enable SSID Broadcast, Channel, Guest Network, IP Address, IP Subnet Mask, Gateway IP Address, DNS Servers, Primary DNS, Secondary DNS, Router MAC Address, Domain Names, Internet IP Address, Static IP Address, IP Subnet Mask, Media Server, HTTP, HTTP (via internet), FTP (via internet), USB Settings, IPv6, Router, Modem, DSL Modem, Cable Modem</td>
</tr>
</tbody>
</table>

In a survey, I asked a group of potential users the meaning of the 26 (Table 1) most common terms in home networking. These terms are often used as field labels in router UIs. Forty-three participants (mostly college students and former graduate students in software engineering, human factors, and psychology) completed an online survey (19 male, 24 female, 45% under age 25, 41% age 25 to 45, 45% with formal education of college, 39% graduate schools, and finally 86% of participants own a router at home). The results show that a very small percentage of people
know the meaning of the terms used in these devices’ user interfaces (UIs). Many users do not understand even the more common terms shown in Table 2, such as DSL modem or IP address. For example, 43% of participants are not sure of the meaning of “Passphrase,” “DNS Servers” 41%, WEP “48%” or even router “9%.”

<table>
<thead>
<tr>
<th>Term</th>
<th>Not sure at all</th>
<th>Know what it means but not sure</th>
<th>Definition Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router</td>
<td>9%</td>
<td>34%</td>
<td>27%</td>
</tr>
<tr>
<td>Modem</td>
<td>2%</td>
<td>41%</td>
<td>57%</td>
</tr>
<tr>
<td>DSL Modem</td>
<td>9%</td>
<td>48%</td>
<td>43%</td>
</tr>
<tr>
<td>Cable Modem</td>
<td>11%</td>
<td>43%</td>
<td>45%</td>
</tr>
<tr>
<td>WEP</td>
<td>48%</td>
<td>16%</td>
<td>36%</td>
</tr>
<tr>
<td>WPA-PSK [TKIP]</td>
<td>57%</td>
<td>2%</td>
<td>41%</td>
</tr>
<tr>
<td>Passphrase</td>
<td>43%</td>
<td>20%</td>
<td>36%</td>
</tr>
<tr>
<td>IP Address</td>
<td>9%</td>
<td>39%</td>
<td>52%</td>
</tr>
<tr>
<td>DNS Servers</td>
<td>41%</td>
<td>20%</td>
<td>39%</td>
</tr>
<tr>
<td>Router MAC Address</td>
<td>36%</td>
<td>27%</td>
<td>36%</td>
</tr>
<tr>
<td>Domain Name</td>
<td>11%</td>
<td>39%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Table 2: Understandability of selected networking terminologies used in field labeling of router UIs

Considering that this survey was conducted out of the context of the UI, and the number of respondents was limited (43 participants), it is hard to draw a global conclusion. However, empirical observations that support this data indicate to what extent users are unfamiliar with all terms used. Knowledge of the terms and their meaning requires education, training and reading of many pages of documentation and online help, which is another hard task for the average user. To underline this unfamiliarity with the terms, the readers of this article can check to see if they are familiar with these terms.

2.2 User Interfaces

Comparison of the user interfaces of four major brands of devices illustrated the similarity of the design among the different brands. Basic screens of router interfaces for these brands are shown in Figure 1a, b, d and d). A quick review of the screens, despite some differences in color palette or layout, reveals that the UIs are built using the same terminologies. Each UI displays a number of parameters requiring users to understand them and set or configure them without knowing the context, what the settings do, and the relationship among the parameters. All four UIs evaluated use a feature-based design approach targeted to advanced IT users.

Figures 1.a to 1.d show the main page UIs of the four router brands. The field labels and terminology seem very similar if not identical.

2.3 Design Constraints

Designing better and more user-centered interfaces for home networking devices requires a good understanding of the main existing constraints. The most problematic constraints in designing the user interfaces (UIs) seem to be the diversity of computer networking and applications that users use.
I asked a group of networking experts to rate and explain the score that they give to the usability of the networking technology. Eight experts participated in this survey. On the question of, “To your opinion, and based on your knowledge of home networking technology, How would you rate the usability of your home networking product (1 lowest, 10 highest)? Usability is defined as the effectiveness, efficiency, and satisfaction with which users can achieve tasks in a particular environment of a product,” experts gave an average score of 8 to the usability of networking products. When they were asked to explain the score, a variety of reasons were indicated (Table 3). This data, although not enough in terms of the number of participants, reveals that even the experts think that the usability of these devices needs more improvement.

**Commentary**

- Usability is very important. . . the product with rich features but with bad usability, I will still give low rating for such product.
- My rating is based on my family usage to keep wireless connections with an AP.
- To perform some functions requires making changes in multiple areas of Setup.
- I think usability is the most important part of a product.
- The current home products today could be significantly improved so that they are more intuitive to operate. The test that I use at home is to test usability of a product around a range of users including my 6 year old daughter and my 75 year old mother. In most cases today, both have difficulty working with home products. On the other hand, both can easily use Apple IOS devices.
- Had to stop using my XXXX router when I went to Uverse. AT&T provides a gateway. The XXXX router cannot coexist on the same home network as the gateway.
- Common sense.
- There are missing features that I'd like to have and they are not easily accessible without buying a new device.
- Average Score given by participant for usability is 8/10
3. DESIGN CONCEPTS

In an attempt to extensively enhance usability of the home networking device user interfaces (UIs), NETGEAR aimed to make common tasks in installing, configuring, and monitoring the network easy for the average home user according to each user’s needs.

To achieve this goal I classified usability needs in two categories: hardware and software usability. In terms of software usability, the following concepts were identified:

- Users’ needs are different. All users don’t need all the functionalities offered by devices. Consequently, the device functionalities should be scalable. The interface should not complicate the task of average users who need to complete only a few basic tasks.
- The UI should use common and easy to understand terminology and avoid complex and technical language.
- The UI should offer a task-based interface in terms of what users want to achieve rather than a combination of a variety of features or parameters.
- Users should be able to install, configure, and monitor their network devices in the shortest time possible.
- The UI should let users install, set and monitor the application with the least number of navigation clicks.
- The UI should be appealing and not distracting when users have the application open for long period of time.
- The UI should be built with fewest objects, simplest behavior, general rules, and terminology, and should be consistent.
- The UI should use the most common paradigm that users are familiar with to reduce learning and remembering of the design pattern.

4. USER EXPERIENCE ARCHITECTURE

The main usability problems observed in home networking might be related to the following areas:

- Selecting the proper device that matches the user’s specific needs.
- Installing the hardware according the instructions provided by the manufacturer.
- Installing the software and early configuration.
- Monitoring, managing, and adjusting settings for the device.

The users’ challenges start from the moment that they purchase and try to install the hardware and its related software. As an example, we can just look at the first step, meaning the sequence of the hardware connections when users have a cable provider. Most routers require users to:

- Unplug the modem (remove the modem batteries and unplug the modem’s power cord).
- Wait a few minutes.
Connect the router to the modem and computer then plug it in to an electrical outlet and wait for the wizard. (This sequence is provided on documentation or on the installation CD, which from the user perspective is the same).

Although there are valid technical reasons to follow this sequence, users get quite confused. They often try to do this task over and over and blame themselves, assuming that they have made a mistake in the sequence, while the issues might be something else. In one router brand, to prevent errors a big orange sticker was placed on the router to prevent the wrong sequencing (Figure 2). Figure 3 shows one of the early steps in configuration, the security setting, for one major router brand. Despite all the issues in product selection and installation usability, this paper will focus on monitoring, managing and settings the device, meaning tasks that require the use of software and occur after the hardware is installed.

4.1 Home Networking Devices User Interfaces

Comparison of the several home networking device brands illustrates that most, if not all of them, target advanced users with some networking IT knowledge. Despite some effort to provide a more basic user interface for average home users (Example: NETGEAR Genie-Netgear.com (2012), it is still hard to claim that the average home users will have a smooth user experience when installing home networking appliances.

All the major brand home networking appliances use a complex feature-oriented rudimentary user interface (UI) design. Figure 4 shows the UI for a D-Link router setup page. Among other things, we notice a tremendous amount of text, very technical terminology, complex labeling and difficult navigation. The situation is not very different from one product to another among major brands.

4.2 A Different Way of Designing for Home Networking Devices: NETGEAR Smart Network Case

NETGEAR is a worldwide provider of networking products built on a variety of technologies such as wireless, Ethernet, and Powerline. With a wide variety of devices that offer different functionalities within the networking context, usability improvement at all product levels is quite challenging.
However, with customers’ needs for more user-friendly products, the usability improvement at all level product levels is desired at NETGEAR. In an effort to create a new way of approaching the networking tasks for all users, NETGEAR aimed to make home networking accessible to average home users who do not have advanced knowledge in IT. Although it is understood that the average home user might not need all the features offered in a product, reducing the features is out of question since the appliances should continue to offer advanced setup features for expert users.

To achieve this goal, the new initiative architecture was based on a unified user interface using a cloud based technology. This architecture helps users perform the basic tasks with ease while still allowing advanced users to log in to the device UI and perform advanced configuration and monitoring.

This approach, named “NETGEAR Smart Network,” is an intelligent network that optimizes the applications that users run, enhances the performance of their connected devices, and makes those devices easier to connect and use. The network can be personalized and customized based on the devices that users need, what they do, and the type of network traffic they run.

After users connect and install their NETGEAR device, they are invited to create an account. Upon sign in and login, the web application recognizes all the devices owned and registered by the user and the system displays all the available information for each device. Users then can install the different apps, which are task-based entities, on each selected device. The available apps are offered through an NETGEAR Apps Store method that is familiar to users. The Smart Network also allows developers to create new applications.

All apps acquired by the user are saved on the cloud whenever a device connects to the Internet. Users can update them and change the configuration from anywhere. For example, a user can log in to NETGEAR Smart Network from anywhere with Internet connection and change or monitor activities in his/her home network, access a webcam, connect to the home network, or change printer settings.

### 4.3 Design Elements

When users log in, they can immediately click any device on their home network without additional navigation. All available information about the device is displayed in a device widget. Each device widget identifies a physical device. Users can also customize their owned devices with user friendly names.

In one navigational click (My Apps Tab) users can view all the applications they own. Each App Widget displays the app and the device on which it is installed including the dynamic information about the app. Clicking on the app opens the app pages where easy to understand screens and the UI help the user manage changes or perform tasks. (Figures 5 and 6)

This common way of doing the same tasks on all devices, an easy-to-understand terminologies, and consistency of the UI object provides a user-centric approach to all devices.
4.4 User Interface Simplicity

With user interface simplicity in two widgets (device and app), one-click navigation, understandable terminologies, a limited number of terms used in the UI, and simple visual design, users are empowered to perform tasks with least IT skills. With advanced information visualization techniques, users can easily understand what is performed and status of the system.

Before and After

Figure 7 and 8 show the functionality offered through the NETGEAR traditional UI and the same functionality though the app in the NETGEAR Smart Network UI. The usage of appealing visualization, easy to understand, task-based terminology and advanced UI design technique not only make user tasks easy, but also visually appealing and fun.
5. CONCLUSION

Today’s market is not about focusing on more features and functionalities. We are going toward a situation where comparable products often offer the same functionality. The example of the mobile smart phone illustrates that despite the complex functionalities among smart phones, people prefer the phone that is easy to use and easy to operate rather than one that offers more functionalities. This philosophy is applicable to all types of technology. With the expansion of smart home appliances, success will go to the home networking enterprises that offer an easier to use product, satisfying the most common users.

ACKNOWLEDGMENTS

The author would like to acknowledge my colleagues Ye Zhang for reviewing this paper and his valuable input and Betsy Miller for editing this article.

REFERENCES


Edwards, W. K. 2011, Before building the network or its components, first understand the home and the behavior of its human inhabitants. June 2011, vol. 54, no. 6, communications of the ACM.


Poole E.S., Chetty M., Grinter R.E. and Edwards W. K., 20XX, More Than Meets the Eye: Transforming the User Experience of Home Network Management GVU Center, School of Interactive Computing, Georgia Institute of Technology, Atlanta, GA, USA.


