Insecurity by Obscurity: A Review of SoHo Router Literature from a Network Security Perspective

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ABSTRACT

Because of prevalent threats to SoHo based ADSL Routers, many more devices are compromised. Whilst an end-user may be at fault for not applying the appropriate security mechanisms to counter these threats, vendors should equally share the blame. This paper reveals that the lack of security related content and poor overall design could impact on end-users' interpretation and willingness to implement security controls on their ADSL router. It argues that whilst the number of threats circulating the Internet is increasing, vendors are not improving their product literature.

Keywords: ADSL router; manuals; quick start guide; network security; wireless

1. INTRODUCTION

The increasing popularity of broadband connectivity worldwide is permitting individuals to share and access a high-speed Internet connection easily. Numerous Internet Service Providers (ISPs) are shipping ADSL routers pre-configured with the client's username and password thus eliminating the difficulty faced by novice computer users in accessing the Internet. However, these pre-configured ADSL routers do not include pre-enabled security mechanisms such as firewall rule sets, wireless encryption, disablement of the Domain Host Control Protocol (DHCP), or access control lists. Whilst omitting the security mechanisms may reduce the time required to setup and use the wireless network, it does expose the end-user to many computer related threats.

Constant publicity within the Information Technology (IT) realm depicts the potential problems that end-users may face if they do not adequately secure their computer and networking products. Dlamini, Eloff and Eloff [1] detail these setbacks which may include identity or monetary fraud right through to the use of hosts in a network of botnets. Many individuals are not implementing secure methods for their computer products. However, they

often lack the expertise to understand the differences and purposes of available security methods [2, 3].

With few evident technical skills and knowledge, the end-user is not only prevented from securing their home network but is also ridiculed by publications such as the Australian Personal Computer Magazine [4]. Each month the magazine prints stories of humorous incidents between computer professionals and individuals who appear to have little understanding of their interaction with a computer system. This raises the issue of who is specifically responsible for the lack of technical understanding in the area of computer security. In the context of ADSL routers, vendors have the option of implementing high-end security by default but restricting the device's usage which in-turn makes it more cumbersome to initially operate. In actuality, the vendor manufactures the device in a manner that allows for quick plug-and-play operation but also exposes the end-user to a range of Internet based threats. Thus in order for the device to be secured, the end-user must possess reliable information and be willing to configure and secure their ADSL router.

Unfortunately poorly written documentation has been a long standing problem. Johnson [5] details how manuals for computer related products are not written to be understood by naive or novice end-users. Frequently the computer product manuals just gather dust and if they are accessed, the end-user is faced with the problem of finding information which is scattered throughout a complex document [5]. Folmer, Moynihan and Schothorst [6] depict a manual as a book of instructions that should present relevant and useful information, in an easily accessible manner. Unfortunately much computer related literature does not do this.

Schriver [7] found that only 15 percent of 201 respondents would read a manual from cover to cover, 35 percent would use the source as a reference only, and 46 percent would briefly scan through the document by stopping at interesting and appropriate headings. The remaining 4 percent would omit the product manual. That study examined the outcomes of presenting end-users with poorly designed instructions, and asking them to complete a given set of tasks. Most individuals who were unable to complete the task or locate specific content would blame themselves rather than the content or design of the manual. At the conclusion of the study, 86 percent of the participants, strongly asserted that end-users should be provided with clear and engaging standardised manuals [7]. Clearly, poor manual design can adversely affect user success. In addition, manuals should not be developed on the assumption that the end-user will always read the document from beginning to end. Instead vendors should clearly accommodate all subsets of knowledge and skill-sets by employing best practice design guidelines into all manuals.

Manuals should conform to a standard that allows end-users with varying technical competencies to use and understand a set of procedures. Wieringa, Moore and Barnes [8] suggest that a well designed manual will include an excellent set of procedures that should reduce errors, provide information on the most effective way of completing a task, and be suitable for both a skilled and novice user. Although the content must be appropriate, the quality of the formatting, presentation and style is often overlooked. Perelman, Paradis and Barret [9] and Folmer et al. [6] assert that five foundation criteria should be embedded in all high quality procedural literature.

1. A manual should use descriptive headers, an index page and a table of contents that aid in locating required information with ease.

2. Each manual should outline the reasons for its creation, the objective and the intended audience, including the required level of expertise that the literature is targeted towards.

3. A glossary should be included in a technical manual to further elaborate on uncommon terminology such as that found in computing manuals.

4. A technical manual should make use of sufficient white space to enhance presentation quality whilst at the same time should not confuse or deter the reader from the critical information.

5. Graphics should be labelled and sufficiently large so the reader can interpret the finest detail. In circumstances where the graphic is not clear, these authors suggest that multiple images should be presented to avoid confusing the reader.

The following study compares and contrasts the quality and content of current and previously released ADSL Router literature from ideal procedure manual and security perspectives. It utilises the best practice design guidelines as expressed by Perelman et al. [9] and Folmer et al. [6] as a foundation for the product literature. Further, an analysis is conducted on the recommendations and emphasis by vendors to encourage end-users to apply appropriate security safeguards to their particular product.

Attempting to configure and secure an ADSL router is not supposed to be a trivial task for the average end-user. In this study a quick-start guide was provided by all but one of the vendors in conjunction with a more comprehensive manual. The quick-start guide details a straightforward process to ensure that the network-capability of the device may operate promptly. However, the quick-start guides lacked specific literature on any topic relating to network security.

2. LITERATURE PRESENTATION IN 2005

The product literature selected for examination for 2005 incorporated products which encompassed a DSL router, a standardised Australian based modem, and 802.11 wireless network capabilities. Products that Australian Internet Services Providers sell or make available to consumers on specific 24-month contracts were selected as these are used by most consumers purchasing a broadband Internet service. Furthermore, the products chosen were based on the availability of these ADSL routers from computer retail outlets within Western Australia. Accordingly, six ADSL routers' were selected for product literature scrutiny:

- Billion 7202 [10]
- D-Link G604T Generation 1 [11]
- Motorola SBG900 [12]
- NetComm NB5PlusW [13]
- Netgear DG834G [14]
- Siemens 6520 [15]

Overall, the vendor manuals clearly did not conform to any specific publication standards. A glossary of terms is deemed crucial in computing and network related literature due to the heavy emphasis on uncommon computer terminology. Only the Motorola, NetComm, and Netgear product manuals encompassed a glossary of terms, yet these still overlooked many technical and jargon based words. To help consumers locate topics of interest swiftly, an index page is considered an efficient method by which to assist the end-user in locating desirable topics (Perelman et al., 1998, p. 143). However, in the product literature tested all vendors failed to provide anything which resembled an index page. Table 1 below presents a comparison and contrast of the design elements of the product literature examined.

Table 1 Comparison and contrast of 2005 product literature design

	Billion	D-Link	Motorola	NetComm	Netgear	Siemens
Descriptive Page Headers					✔	
Contents Page	✔	✔	✔	✔	✔	✔
Index Page						
Detailed Glossary			✔	✔	✔	
Professional Layout				✔	✔	
Large and Clear Graphics		✔		✔	✔	
Description of Graphics					✔	
Explanation of Intended Audience					✔	

NetComm and D-Link include large, clearly visible graphics which further portrayed the documentation that the vendor was discussing. In contrast, the remaining manuals presented graphics which were small and lacked detail, thus making it difficult for the reader to relate the graphic to the instruction provided. Netgear included labels (i.e. Figure 5) with each of their images which are then referred to within the body of text, unfortunately the remaining vendors fall short of making this clear distinction. With the small unclear graphic, the instruction associated with the graphic was often situated away from it or not provided at all. Hence, it appears that vendors rely on graphics to represent a series of instructions, although may further confuse or deter the reader when presented with unclear images.

A manual lacking a clear indication of the skill set required could potentially leave a novice user attempting to configure a product which requires a higher level of skill. Further to this, by outlining a clear objective, the literature should be able to detail the overall goal rather than leaving the end-user searching around for information which is not within the document. The Netgear product manual clearly outlines its objective and intended audience and suggests that the information provided should enable the end-user to both configure and, more importantly, secure the device. It also indicates that a novice to intermediate skill would be required to comprehend the product manual and in-turn to configure the ADSL router.

The information provided within the contents page will either guide the readers to the information or deter them from reading the literature. All of the product manuals included a table of contents which reflected the contents of the entire document to an advanced or technical user. However, the clarity with which this is presented for a novice user was very poor. In many circumstances, clear headings were not stated and keywords such as *security*, *securing* or *secure* were not found anywhere within the contents pages. The vendors repeatedly used words such as *installation, management, setting up* and *configuration* on the table of contents with little distinction between the different categories and thus which particular section should be consulted. In addition to the lack of headings, some vendors had chosen to include sub headings, incorporating technical words such as *firewall, LAN, DHCP, WEP, WPA, IP settings* and *port forwarding* which would mean little if anything to a novice Internet user.

Perelman et al. [9] suggest that a document must use formatting which does not deter the reader from finding the critical information within the document. The manuals for the NetComm and Netgear device made use of appropriate whitespace and paragraph layout to ensure that the information is readable. Both manuals exceed 200 pages while the others that used about 100 still cover the same amount of information. These four manuals appeared to have the information crammed together, making it difficult to understand. Topics of interest often started directly below another topic on the same page rather than

on a new page to clearly differentiate sections. There also appeared to be a correlation between having fewer pages and thus smaller text which makes the product literature appear as an academic text book rather than a user friendly manual.

3. LITERATURE CONTENT IN 2005

End-users may rely on vendors to specify the appropriate configuration for securing the network device. Changing the default password may be considered an essential first point to secure the ADSL router, yet the D-Link and Siemens based products made no clear assertion for the end-user to do this. While the remaining four product manuals did recommend that the end-user change the default password, only the Netgear product manual clearly defined ideal password characteristics such as length, use of numbers and symbols, and depicts the problems associated with the use of dictionary based words. While an end-user might be encouraged to change the default password of *admin,* with little guidance the outcome could see the individual utilising a password of *admin1* which provides little benefit over the default.

In relation to further security features which could be implemented on the device, none of the vendors attempt to persuade the reader to apply some sort of security through, for example, utilising wireless encryption, enabling the use of the in-built firewall, applying MAC address filtering, and disabling features such as Domain Host Control Protocol (DHCP). In general the necessity and benefits of each of the available security features were not explained clearly. In two instances the security of the device was only covered in the Appendix and at that point did not encourage the end-user to implement any particular security method.

4. LITERATURE PRESENTATION IN 2009

Four years later, the popularity and existence of ADSL routers from previous years still persists. D-Link, Netgear and Netcomm still manufacture the same, yet updated versions of their products for Small office Home office (SoHo) environments. The Siemens and Motorola network devices lost market share and as a result two new manufacturers namely TP-Link and Belkin gained a significant foothold within Australia with their reputation and market share growing stronger. The Billion ADSL routers are still on the market, yet less accessible to the consumer as it is sold by fewer retail outlets in Australia. As a comparison with previous product literature the following products were selected to be examined:

- Belkin F5D7633au4A [16]
- D-Link G604T Generation II [17]
- NetComm NB5PlusW [13]
- Netgear DG834g V5 [18]
- TP-Link TD-W8901G [19]

As the number of threats continues to increase it was expected that the vendors would have attempted to both increase the default security of their products and improve the quality of the literature. However, NetComm continues to manufacture ADSL routers for SoHo based environments, yet the literature has remained unchanged over the four year time frame. This could be considered acceptable had the product literature exceeded good design expectations. However, the vendor fails to encourage end-users to implement appropriate security on their product, as well as not meeting general publication guidelines. Table 2 below presents a comparison and contrast of the design elements of the product literature examined in 2009.

The poor quality of the supportive graphics will probably continue to frustrate the end-user. Netgear and TP-Link provided large clear graphics which permit the finest detail to be identified. Each image remains clearly labelled with a figure notation but now with an additional description. In contrast, the remaining manuals encompassed a variety of graphical formats. In some instances the graphics whilst large were not sharp and lack a clear description or label with no consistent in-text referencing to the images.

A quality manual would begin by setting a foundation for the reader of desirable knowledge and skill set to understand the information [6]. In an effort to prepare the end-user for the product information, D-Link has now included a description of the intention of the source.

> *"This user's guide provides instructions on how to install the DSL-G604T ADSL 2+ Router and use it to provide Internet access for an Ethernet/Wireless network or single computer."*

Unfortunately, in addition to this statement D-Link negates the previously beneficial statement by encouraging end-users to utilise a both simplified and non-security focused guide for their particular product.

> *"If you are using a computer with a functioning Ethernet port, the quickest and easiest way to set up the DSLG604T is to follow the instructions provided in the **Quick Installation Guide** (QIG)."*

The Quick Installation Guide which D-Link refers to does not focus on any real

security, nor does it attempt to encourage or persuade users to refer to the main manual. In comparison, Netgear as per the four year old version goes one step further in not only demonstrating to the end-user the intention but furthermore, the expected skill required to utilise the product literature.

> *"The NETGEAR® Wireless ADSL2+ Modem Router DG834G User Manual describes how to install, configure, and troubleshoot the 54 Mbps Wireless ADSL2+ Modem Router Model DG834G. The information in this manual is intended for readers with intermediate computer and Internet skills."*

As per the product literature guidelines, providing the end-user a detailed breakdown of the intention and required skill can significantly reduce frustration, where an individual may not necessarily have the expertise to configure the product. Unfortunately, one notable difference between the current and previous versions of the Netgear product literature is that it now suggests a minimum *intermediate* skill level in contrast to the previously minimum *basic* level. This may potentially deter end-users from the product literature as not everyone may encompass the skill set to effectively configure an ADSL router.

While a glossary of terms would be considered essential in computing literature, only Belkin has succeeded in including this in their manual. Unfortunately, the words are not in alphabetical order hence present a puzzling avenue for locating a word. Netgear which previously provided a detailed glossary of terms has removed this from their current product literature. While this has scaled the overall size of the document from 268 pages to just over 170, end-users may still access an online glossary of terms through the Netgear website – unfortunately providing little usefulness if the end-user is not actually able to configure their device properly to access the Internet.

Netgear is still ahead of its competitors in terms of its table of contents and overall formatting. It has redefined its headings and now incorporates a distinctive section for security related content. In contrast, the remaining manuals appear to still utilise repetitive headings such as *setup* and *configuration* even though on closer examination they are evidently different sections. Netgear has included a clear header and footer on each page which permits the reader to easily distinguish sections and sub-sections. New topics begin on new pages and text appears large and vivid. Unfortunately, the remaining vendors fail to incorporate such techniques and appear to have adopted lower standards than in 2005. This makes these manuals difficult to follow and utilise to its full potential.

In terms of an index page – this feature is continually overlooked by vendors and is yet to be seen in a product manual as an easy approach to finding

relevant information on a given topic. In addition, as there is no index page, and the table of contents page is poorly written, an end-user would potentially have to read the entire manual in order to locate a desirable section. This contradicts rationale human behaviour as Schriver [7] clearly identified that only 15 percent of individuals in his study would actually read through an entire manual.

Table 2 Comparison and contrast of 2009 product literature design

	Belkin	D-Link	NetComm	Netgear	TP-Link
Descriptive Page Headers				✔	
Contents Page	✔	✔	✔	✔	✔
Index Page					
Detailed Glossary	✔		✔		
Professional Layout			✔	✔	✔
Large and Clear Graphics		✔	✔	✔	✔
Description of Graphics				✔	✔
Explanation of Intended Audience		✔		✔	

5. LITERATURE CONTENT IN 2009

Vendors are continually failing in persuading and guiding end-users to implement effective security. Simple techniques such as changing default passwords or implementing basic security settings are still overlooked in product literature. Belkin has encouraged that end-users change their default password. Throughout the product literature however, the ways in which this is achieved conflicts as the two quotes below from the product manual show. An end-user may interpret the initial quote as optional. In contrast, the second quote does encourage the end-user to change their password thus varying levels of assertion exist.

> "*The Router ships with NO password entered. If you wish to add a password for more security, you can set a password from your Router's web-based user interface.*"

> "*It is strongly recommended that you change the password to your own for increased security.*"

There has been very little improvement from vendors through their product

13

literature in encouraging end-users to implement security. In terms of firewall rule sets, MAC address filtering or wireless security, Belkin is the only vendor actively encouraging security implementation. TP-Link details that by default no security has been implemented and encourages use of the default security settings to avoid adversely affecting the router's performance. Conversely, Belkin has taken a strong role in encouragement of appropriate security by clearly differentiating between WEP and WPA or Hex and ASCII keys, and explaining how the use of increased key lengths will strengthen the overall security of the wireless network. Detailed examples are provided in both graphical and text format of MAC filtering and positioning the router in an appropriate manner.

6. CONCLUSION

The current quality of ADSL router literature poses numerous problems for the end-user. From a psychological perspective the end-user could be driven away from the information in the product manuals particularly where text is crammed and graphics are unclear. As ADSL routers implement little or no security by default, vendors should be actively attracting end-users to the product literature to ensure security is implemented. However, had the product literature been developed in a way that engaged the end-user, lack of encouragement and explanation from the vendors would still be a problem.

With the lack of standardisation, and common requirements such as an index and glossary page, both home users and businesses may be running insecure wireless networks and computers. Thus home users who have less time, and no access to corporate resources such as trained IT staff, could in-turn be at a greater security risk than their business counterparts. This analysis portrays areas in which end-users may face difficulty when attempting to secure their ADSL router. Whilst individuals may not always utilise product literature when attempting to configure their device, those who do may find the task frustrating. The usability of the ADSL router itself may encompass its own set of problems which has been omitted from the research problem domain in this particular discussion.

From the product literature examined over a four year period, there is not a single manual which could be considered *ideal*. Whilst the Netgear literature appears to be as close to ideal as possible in relation to publication standards, it is far from adequate when encouraging and explaining the key areas of security that the end-user should implement. In contrast, the Belkin product literature provides valuable information relating to security and a clear and precise explanation of the benefits and problems associated with using a particular security mechanism. However, the manner in which the information is presented may simply deter the end-user from ever attempting to utilise the product manual.

This discussion has set a foundation from which further research may be conducted particularly on the impacts to a specific audience. As the manual should be considered an indispensible source of information, it would be beneficial to study the impacts that the previous and current literature have, and in-turn use the information to form an ideal product literature standard for the purpose of network security in a SoHo environment.

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