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Guidance on Port Security

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Submitted by

Lavoiris Ballard
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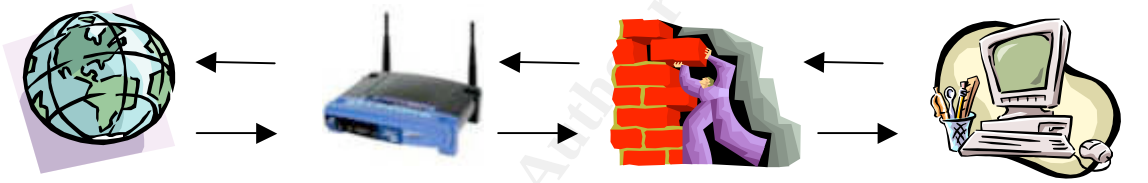
Abstract

Security is the buzzword on everyone's lips these days – from Homeland Security to airport security to computer security. Never have we been so aware of the computer vulnerabilities that are a constant threat to our privacy and peace of mind.

This paper takes a look at a very small but very important part of our computers – ports. Ports seem to be these mysteriously open holes in your computer that, without the right protections in place, can be open doors for the unscrupulous to exploit. We will take a look at some measures we can put in place to close the doors, and examine some options to block the doors once they are closed.



Internet router firewall your computer

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Guidance on Port Security

Ports seem to be these mysteriously open holes in your computer that everyone has the ability to access without your knowledge, and then do all kinds of unpleasant things to your desktop, workstation, or laptop. One way an attacker determines where your computer is vulnerable is by port scanning. Port scanning is a process in which an attacker uses a software program to 'ping' the ports on your computer in order to generate a response. If the correct response is received from the 'knock', the 'knocker' knows the port is open. Port scanning software is freely available on the internet. The vulnerabilities for all types of services are also freely available on the internet. With all this information readily available, it is easy for an attacker to scan your ports for vulnerable services. Once the vulnerable service is found, you are wide open to an attack…unless you put some protections in place.

The best way to protect your computer is to use a 'best practice', which is 'if you don't need it, don't use it!' You may ask, "How do I know if I need it?" "How do you shut them?" "Where are they?" This paper will discuss some ways to protect these very vulnerable access points into your computer.

We will begin with ports. A port is a communication interface through which any service (e.g. FTP, Telnet) or system (e.g. Oracle db listener, MS SQL) can connect and transfer 'packets' of data to and from any other computer or system on a network. Packets contain information it needs to reach its destination, as well as the data you are sending, encapsulated within it. This includes communication from one system, service, or program to another system, service or program on the same computer, or to another computer. There are many types of ports, but they can be divided into two basic types – hardware and software, or physical and logical. The focus of this discussion is the software ports on personal workstations and laptops with Microsoft Windows operating systems.

Ports have protocols assigned to them. Protocols determine how data is transported from one computer to another. The receiving computer must have the same protocol so it knows how to interpret the incoming packet. The two most common protocols are the User Datagram Protocol (UDP) and Transport Control Protocol (TCP). UDP is the simpler of the protocols, transferring data as requested by the sender, but not guaranteeing a successful delivery from point A to point B. UDP is used when a reply verifying successful delivery, from the destination host, is not required. TCP, on the other hand, is designed to ensure the transmission arrives at its destination, and is used when a connection needs to be established and delivery of data must be confirmed.

All computers are configured with certain 'well known' ports enabled for communication. There are 65,535 ports available on every computer. Don't worry, most of these ports are never used. Some ports are used for the same purpose, or service, regardless of the operating system of the computer; for

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example, the Telnet program usually communicates through port 23. Port definitions are designed to facilitate communication between computers and other types of hosts. Ports are opened or closed depending on services necessary for the normal functioning of the operating system, not the need for a secure computer.

What is a well-known port? There are three categories of ports as listed below:

- Well Known Ports are those from 0 through 1023
- Registered Ports are those from 1024 through 49151
- Dynamic or Private Ports are those from 49152 through 65535[1]

Well-known ports are used to provide a known local connection for a specific service on your computer. Think of them as well known telephone numbers. If you have an emergency and you need to call for help, you know to call 911 to get the help you need. Now that is a very simplified explanation, but on a basic level, the same simple concept applies to the definition of well-known ports and services. These ports are usually reserved for use by privileged user or system root level processes and services.[1]

Registered Ports are not reserved and are available for use by the normal user. Dynamic or Private Ports are available for use by any service. The Internet Assigned Numbers Authority (IANA), who is responsible for the assignment of well known port numbers for applications and services[2], provides a list of currently registered users, which can be found at www.icann.org/general/iana-proposal-02feb00.htm#IID1.[3] Please visit the Microsoft site for Windows port assignments.[4]

Now that we have covered some basic concepts, we need to know what ports are open and/or enabled on our computer system so that we may begin to 'harden', or secure, our computer. There are several tools available to determine this, commercial and freeware. One of the free tools that is included on most operating systems is Netstat. Netstat displays open ports, ports awaiting a connection (listening) and the protocols associated with them. As you can see in Figure 1, Netstat has several options. Figure 1 shows the options for Windows XP Professional and Windows XP Home Edition; Windows 2000 and prior versions have the same options with the exception of the –o option.

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[1] "Well Known Port Numbers". http://whatis.techtarget.com/definition/0,,sid9_gci514078,00.html. August 30, 2002.
[2] "Port Numbers". http://www.iana.org/assignments/port-numbers. January 8, 2004.
[3] ICANN. "Proposal to the U.S. Government to Perform the IANA Function". 11 February 2000. URL: http://www.icann.org/general/IID1(6 Nov. 2003).
[4] Microsoft. "Port Assignments and Protocol Numbers". 2004. URL: http://www.microsoft.com/technet/treeview/default.asp?url=/technet/prodtechnol/windows2000serv/reskit/tcpip/part4/tcpappc.asp (8 Nov 2003).

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On your computer, go to the command prompt.

```
NETSTAT [-a] [-e] [-n] [-o] [-s] [-p proto] [-r] [interval]

  -a          Displays all connections and listening ports.
  -e          Displays Ethernet statistics. This may be combined with the -s option.
  -n          Displays addresses and port numbers in numerical form.
  -o          Displays the owning process ID associated with each connection.
  -p proto    Shows connections for the protocol specified by proto; proto
              may be any of: TCP, UDP, TCPv6, or UDPv6.  If used with the -s
              option to display per-protocol statistics, proto may be any of:
              IP, IPv6, ICMP, ICMPv6, TCP, TCPv6, UDP, or UDPv6.
  -r          Displays the routing table.
  -s          Displays per-protocol statistics.  By default, statistics are
              shown for IP, IPv6, ICMP, ICMPv6, TCP, TCPv6, UDP, and UDPv6;
              the -p option may be used to specify a subset of the default.
  interval    Redisplays selected statistics, pausing interval seconds
              between each display.  Press CTRL+C to stop redisplaying
              statistics.  If omitted, netstat will print the current
              configuration information once.
```

Figure 1. (Windows XP).

At the command prompt, type in '**netstat /?**'. The results should be similar to those in Figure 1 above.

Next, at the command prompt, type in '**netstat –an**' as shown below. The results should be similar to those shown in Figure 2 below.

```
C:\>netstat –an

Active Connections

  Proto  Local Address          Foreign Address        State
  TCP    0.0.0.0:80             0.0.0.0:0              LISTENING
  TCP    0.0.0.0:135            0.0.0.0:0              LISTENING
  TCP    0.0.0.0:445            0.0.0.0:0              LISTENING
  TCP    0.0.0.0:1025           0.0.0.0:0              LISTENING
  TCP    0.0.0.0:1026           0.0.0.0:0              LISTENING
  TCP    0.0.0.0:1072           0.0.0.0:0              LISTENING
  TCP    0.0.0.0:1074           0.0.0.0:0              LISTENING
  TCP    0.0.0.0:1078           0.0.0.0:0              LISTENING
  TCP    0.0.0.0:4720           0.0.0.0:0              LISTENING
  TCP    0.0.0.0:8009           0.0.0.0:0              LISTENING
  TCP    0.0.0.0:8080           0.0.0.0:0              LISTENING
  TCP    192.168.1.100:139      0.0.0.0:0              LISTENING
  TCP    192.168.1.100:1033     0.0.0.0:0              LISTENING
  UDP    0.0.0.0:445            *:*
  UDP    127.0.0.1:1027         *:*
..
```

Figure 2.

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In response to the netstat command, we see a display telling us the protocol used, the local address the port is assigned to, the address the port is communicating with (foreign address), and the status of the port. Note that in this listing, no ports are communicating. There are other port states other than those listed here. For more information, please visit Microsoft's Product documentation pages.

Now, if you open a web browser and connect to www.yahoo.com, then execute the netstat command again, you will see something like the listing in Figure 3 below. Notice that the local address, your computer, has new ports open to accommodate the request for communication with Yahoo! You are communicating using the IP (internet protocol) addresses listed via port 80. Port 80 is a well-known port assigned http, hypertext transfer protocol, for internet use. Also note the state of the port has changed from 'listening' to 'established'.

```
Proto  Local Address          Foreign Address        State
TCP    192.168.1.51:3830      143.166.83.231:80      ESTABLISHED
TCP    192.168.1.51:3831      143.166.83.231:80      ESTABLISHED
TCP    192.168.1.51:3832      143.166.224.238:80     ESTABLISHED
TCP    192.168.1.51:3833      143.166.224.238:80     ESTABLISHED
TCP    192.168.1.51:3834      143.166.83.38:80       ESTABLISHED
```

Figure 3.

A more comprehensive program for displaying port information is Fport. Fport is a free tool developed by Foundstone that will list the same information Netstat does, as well as additional information about the service running on the port. FPort lists the Pid (Process ID) of the service and the path of the service. The Pid is the number the operating system has assigned to the process.

```
F:\Tools\Fport-2.0>fport
FPort v2.0 - TCP/IP Process to Port Mapper
Copyright 2000 by Foundstone, Inc.
http://www.foundstone.com

Pid      Process        Port    Proto   Path
1348     KHost       -> 80      TCP     C:\WINNT\kdx\KHost.exe

440      svchost     -> 135     TCP     C:\WINNT\system32\svchost.exe
8        System      -> 139     TCP
8        System      -> 445     TCP
136      MSTask      -> 1025    TCP     C:\WINNT\system32\MSTask.exe
```

Figure 4.

Okay, we have determined how to find the ports and the services running on them. Let's look at how to stop the services running on these ports.

To see a list of the services running on your Windows 2000 computer, go to **Start-Control Panel-Services**; on a Windows XP computer, go to **Start-Control Panel-Administrative Tools-Services**. You will see a listing of all the services running

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on your computer, the Status of the service, and the Startup Type (see Figure 5 below). The Status will have 'Started' if the service is running. Startup Type should have one of three states – Automatic, which indicates the service is started upon boot up, Manual, which indicates the service will not automatically start, but must be started by you, and Disabled, which prevents the service from being started by anyone other than an authorized user, usually a systems administrator. Find the services you wish to stop, and follow the procedures as indicated. Both operating systems have a couple of options for stopping a service.

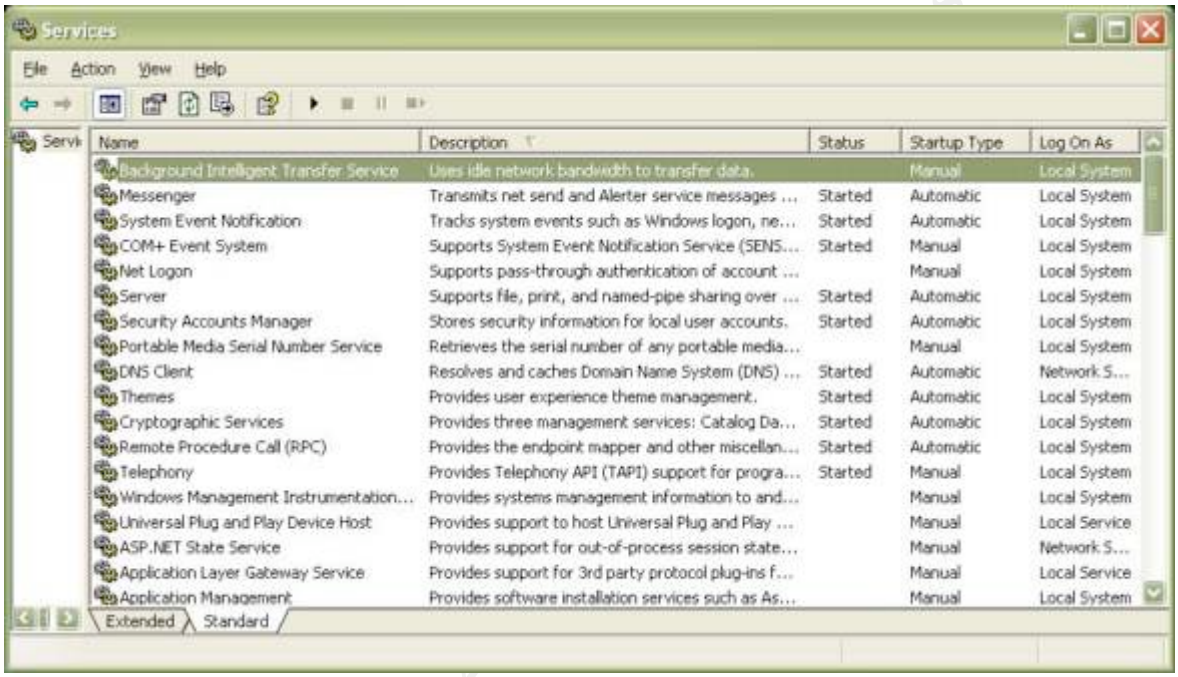

Figure 5.

You may have noticed that if you shut down any of the services listed as using the ports in figures 2 or 3, and then rerun the Netstat or Fport command again, that port will no longer be listed as being in use.

As you start to investigate the services running on your computer, pay particular attention to those that allow any 'remote' processing or logging in to your computer. Some remote processes will allow outsiders to log in to your computer without you know and remove or deposit unwanted programs. For example telnet will allow anyone able to gain access to execute any command on your computer as if they are on your computer. Not a good thing. For those services you determine should not be running, disable them. To do this, in the services window, right-click on the name of the service you wish to disable. A small window will pop up; click **Properties**. In the middle of the properties window in a drop down box labeled 'Startup type:'. Click the small arrow on the drop down box; select 'Disable'. Click 'Apply'.

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A good source of information on the services running on Microsoft operating systems is the Microsoft technical library, www.microsoft.com/technet. Please be careful and do a little research before disabling services. I highly recommend you look some of them up before shutting them down.

An additional layer of security is provided on your computer through a process call TCP/IP filtering. TCP/IP filtering allows you to select which ports to allow incoming traffic through. This option only blocks incoming traffic; outgoing traffic is not blocked. To access this option, on your Windows 2000 or Windows XP computer, go to your local network settings. Right-click on **Local Area Connection**; click on **Properties**. Scroll down until you see Internet Protocol (TCP/IP) in the windowpane; select it by clicking on it once to highlight it. Click on the **Properties** button immediately below the window. Once the Internet Protocol window appears, click on the **Advanced** tab in the lower right-hand corner. Next, click on the **Options** tab. Select TCP/IP Filtering in the window, and then click **Properties**. You should a display as shown below in Figure 6.

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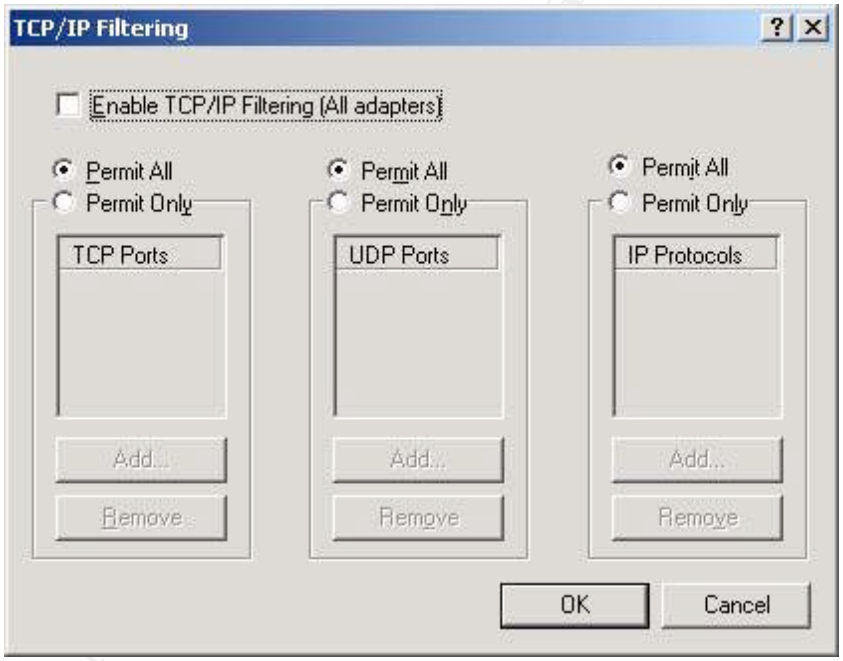

Figure 6.

At first glance it appears as if this computer is set to permit all incoming traffic. Note that the Enable TCP/IP Filtering checkbox at the top of the panel has not been checked.

To change these options, select '**Permit Only**', and then click **Add**. According to Microsoft, the following rules apply:

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> **Permit Only**. If you want to allow only selected TCP or UDP traffic, click **Permit Only**, click **Add**, and then type the appropriate port in the **Add Filter** dialog box.
>
> If you want to block all UDP or TCP traffic, click **Permit Only**, but do not add any port numbers in the **UDP Ports** or **TCP Port** column. You cannot block UDP or TCP traffic by selecting **Permit Only** for **IP Protocols** and excluding IP protocols 6 and 17.
>
> Note that you cannot block ICMP messages, even if you select **Permit Only** in the **IP Protocols** column and you do not include IP protocol 1. [5]

When you have completed the configuration, don't forget to check the box at the top to enable TCP/IP filtering.

You've closed all unneeded ports and disabled all unnecessary services. Now, how do you protect those ports and services that must be open and running from attack? This is where a personal firewall and a router come into play.

Firewalls can prevent inbound and outbound traffic. Firewalls can be hardware, software, or a combination of both. A personal firewall protects your computer by installing filtering software to screen incoming and outgoing requests, whether for connection to the internet or another computer. It alerts you when programs on your computer need access to the internet, and lets you determine whether you want to allow them to access the internet. The alerts can be turned off.

There are several highly-recommended firewalls available today. Among them are McAfee Personal Firewall Plus, Norton AntiVirus, BlackICE and ZoneAlarm. ZoneAlarm, Outpost and Kerio are free for your use. If you are not familiar with firewall software and would like to try one, I recommend ZoneAlarm's free firewall. You just download it, answer a few questions, and let it run. It will alert you to all internet activity (the alerts can be turned off), and it keeps a log of all activity.

If you prefer, there is a more in depth configuration of ZoneAlarm. During the install process, one of the last screens you will see is the one in Figure 7 below. It allows you to set the access permissions to the internet for every program on your computer. If you already know the programs and where to find them on your computer, then by all means go through this process; otherwise, this can become very tedious.

Windows XP has incorporated an Internet Connection Firewall (ICF) for intrusion detection; Windows 2000 does not have this capability. ICF and other personal firewall products are mutually exclusive, so please do not enable this facility and

[5] Microsoft. "HOW TO: Configure TCP/IP Filtering in Windows 2000". May 23, 2003. URL: http://support.microsoft.com/default.aspx?kbid=309798 (Nov 2003).

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install a separate firewall product. For information on how to configure ICF, please go to the following link: http://windows.about.com/cs/howtos/ht/configureicf.htm.[6]

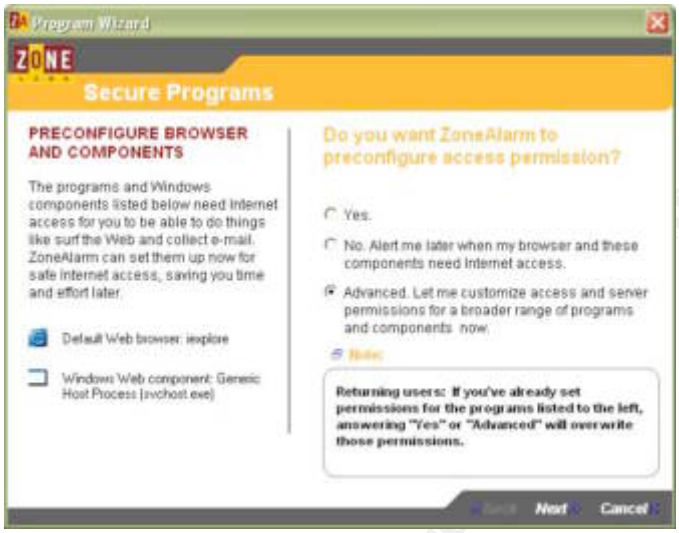

Figure 7.

Routers 'route' traffic through networks, and are excellent for internet sharing on a home or small business network. Many routers have a built-in firewall for an added layer of protection from inbound traffic. The router/firewall is placed between your computer and your external internet connection. Most of them are already configured to block traffic to your computer, and can easily be reconfigured through your web browser. I recommend a Linksys cable/DSL router. They are readily available at any computer store. They are easy to install and come with easy to use software that automates the configuration process. If you run into trouble, Linksys' technical support is excellent.

Some would suggest that if you have a router with a built-in firewall installed that you no longer need a software firewall. My suggestion would be to install both, and monitor the software firewall logs. If the logs don't record any intrusions that were blocked, then you may safely uninstall the firewall software and rely solely on the router firewall.

A more advanced topic on port protection is port mapping, port forwarding or port redirection. Port mapping is a technique that allows you to re-map a service to a port other than its well-known port assignment. How does this process protect your computer? Suppose you want to open the FTP port, 25, on your home computer so you can connect to it from your laptop computer remotely (please don't do this; it's only an example). FTP is typically assigned to port 25. Since you don't want everyone to be able to gain access to your computer, you map the service to another port greater than 1023, say 2525. Now if someone runs a port

[6] Douglas Ludens. "How to Configure Windows XP Internet Connection Firewall". URL: http://windows.about.com/cs/howtos/ht/configureicf.htm (Dec 2003).

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scan against your computer, it will appear as if port 25 is closed. Port mapping is for inbound traffic only, and can be a bit complicated to configure. Instructions are available for port mapping through the use of the Internet Connection Service (ICS) for Windows 2000[7] and Windows XP[8] on Microsoft's and other technical websites.

Layers of security are the best defense against attackers. In addition to the measures discussed here, may I suggest you install antivirus software on your computer? Be careful of answering email and downloading or executing files from unknown addressees. Antivirus software can be configured to scan incoming email attachments for trojans, worms and other malicious software, as well as performing periodic scans on files already on your computer. For all the measures discussed here, one infected email can undo all the defenses you have put into place. Norton Antivirus or McAfee's VirusScan is an excellent choice.

We have discussed ports, what they are, and the different types of ports. We have discussed tools you can use to display ports, their protocols, IP addresses, states and the services that are running on them. We have discovered how to list the services running on your computer and how to disable them if necessary. We have ventured into a couple of advanced topics, TCP/IP filtering and port remapping. We have discussed firewall options. And lastly we have mentioned antivirus software as an additional 'defense-in-depth' measure to protect your computer and it's valuable information. Ports are a necessary component for the successful operation of your computer and network. Protecting them is a very important step in implementing your security measures.

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[7] Microsoft. "To configure Internet connection sharing for applications and services". 28 February 2000. URL: http://www.microsoft.com/windows2000/en/professional/help/default.asp?url=/windows2000/en/professional/help/howto_share_conn_config.htm (February 2004).

[8] Microsoft. "HOW TO: Configure Internet Connection Sharing in Windows XP". 30 October 2003. URL: http://support.microsoft.com/default.aspx?scid=kb;en-us;Q306126&sd=tech (February 2004).

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7. Foundstone. “Free Tools”. 2003-2004. URL: http://www.foundstone.com. (January 2004).

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