



Interested in learning
more about security?

SANS Institute InfoSec Reading Room

This paper is from the SANS Institute Reading Room site. Reposting is not permitted without express written permission.

What is Code Red Worm?

Code Red worm can be viewed as a new generation of Internet worm that took the Internet and security community by surprise. Now there exist a few versions of Code Red worm and each new version proves to be more malicious than the original Code Red worm. This should serve as a strong motivation for businesses and corporations alike to beef up their system's defense. Prevention is much more cost effective than cure, especially for mission critical systems. A flexible, defense-in-depth strategy that allows adaptation to t...

Copyright SANS Institute
Author Retains Full Rights

AD

DEEPARMOR®

What is Code Red Worm?

Adrian Tham

Aug 4, 2001

Internet Worm

The term Internet worm brings to mind the first notorious worm, Morris Worm. A fast self-replicating worm that crippled almost 10 percent of the computer connected to the Internet in Nov 1988[14]. This worm took advantage of exploits in Unix's sendmail, and finger daemon to propagate over the Internet. Though Morris worm could only successfully attack Sun and VAX system which run on Berkeley Unix code, it has caused great damage because these machines made up a large percentage of the Internet.

These days, most of the headlines on security breaches focus on viruses, for example Love Letter and SirCam viruses. What is a virus? A virus is a program that requires human interaction to spread itself around. A virus is usually introduced to a computer through an e-mail attachment, or from a disk inserted into a computer. A virus is different from a worm. According to RFC 1135: A worm is a program that can run independently, will consume the resources of its host from within in order to maintain itself, and can propagate a complete working version of itself on to other machines [15].

On July 13 2001, the administrators and the computer security community were given a loud wakeup call. A new worm was detected and was spreading rapidly to systems connected to the Internet. This fast replicating worm known as the 'Code Red Worm' took advantage of a flaw in Microsoft Internet Information Server (IIS) to manifest itself. This vulnerability was reported a month before Code Red worm was discovered on the Internet. Many administrators were either not aware of the vulnerabilities' existence or were not prepared for the attack. This gave rise to the mass disruption on the Internet traffic. According to CERT/CC, an estimate of more than 250,000 systems were infected in just 9 hours [2].

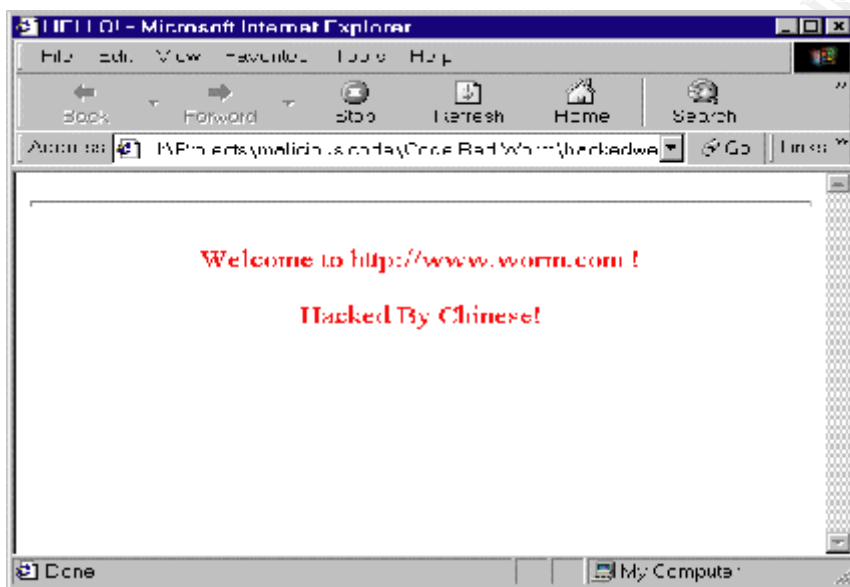
What is Code Red Worm?

"Code Red Worm", also known as I-Worm.Bady and W32/Bady.worm from Symantec Antivirus Research Center [19], is a self-replicating malicious code that exploits a known vulnerability in IIS servers. Once it has infected a system, it multiplies itself and it begins scanning random IP addresses at TCP port 80 looking for other IIS servers to infect. At the same time, the home page of infected machines will also be defaced. In addition, it does a denial of service attack on a particular IP address, previously was www.whitehouse.gov within certain timeframe, but later a variant were discovered that does not deface webpage on the infected host.

Quoted in Information Assurance Foundations discussion, vulnerabilities are the gateways by which threats manifest. Let's look at the vulnerability discovered in the IIS server, follow by the worm operation.

created. Each thread may cause another thread to be spawned causing continually thread creation to a number of 100.

3. The next 99 threads attempt to exploit more systems by targeting random IP addresses, if the date is before 20th of the month.
4. The 100th thread of the worm code defaces the web server's homepage if the system's default language is US English. Firstly, the thread sleeps for 2 hours and then hooks a function which response to HTTP requests. That link is then pointed to worm code that produces the web page as shown below. The changes in the home page is not done by changing the home page in the physical disk files, but is done by the code in the memory. This hook lasts for 10 hours and is then removed.



5. If the date is between the 20th and 28th, the active threads then attempt a Denial of Service attack on a particular IP address 198.137.240.91 (once was www.whitehouse.gov) by sending a large amount of junk data, 98,304 packets.
6. If the date is greater than 28th, the worm's threads are directed into an infinite sleep.

Detail analysis of the worm can be found in the following locations:

- URL: <http://www.eeye.com/html/Research/Advisories/AL20010717.html>
- URL: <http://www.securityportal.com/research/virus/profiles/codered.html>

Reported in Handler's Diary [9], second variant of the CODE RED worm has been captured within a short period after the first was released in the Internet. The differences are:

1. It uses Time-based randomness to select a list of target IP addresses;
2. Web page defacement has been disabled.

These changes have made the worm more effective in spreading since it does not restrict itself to a set of IP addresses. And also target user might not be aware that its IIS is under attack because there is no physical view on the infected IIS server that the worm is present.

A new version of Code Red worm known as Code Red II was discovered on 4 Aug 2001, uses the same "buffer overflow" exploit to propagate to other web servers. According to eEye Digest Security, Code Red II has a different payload than the original worm [6].

1. It creates a back door process on the infected machine by copying a command shell 'CMD.exe' to an externally accessible location,
2. It also leaves a trojan 'explorer.exe' on the root directory,
3. Its propagation rate has also increased tremendously. If the system is a Chinese IIS server, the worm creates 600 threads and attempts to spread for 48 hours. If the system is a non-Chinese IIS, the worm creates 300 threads and attempts to spread for 24 hours. After the infection-spreading interval, the system is forcibly rebooted. The reboot flushes the memory resident worm, and leaves the backdoors and the explorer.exe trojan in place.

Mitigations

Online advises on how to remove the vulnerability are available in many security sources such as Digital Island, National Infrastructure Protection Center, Symantec, CERT[®] Advisory, SecurityPortal.com.

Generally using a standard anti-virus program may not be an effective solution to detect and remove this worm because the worm exists only in memory on a system and it does not write to disk. There are some free tools available on the Internet to check if the IIS is vulnerable. Such examples would be the program called "FixCodeRed" from Symantec that warns of vulnerable systems and scan memory to detect traces of the Code Red worm. Another such program "CodeRed Scanner" from eEye Digital Security .

A normal system reboot will remove the worm and restore the system. However, due to the large number of infected systems and the fact that they may attack the same list of IP addresses again, there is a high chance that a system will be re-infected as soon as it reboots. An effective way of removing the threat is to locate the causes of the vulnerability. The following is a suggestion to protect the system

1. Disable .ida, .idq, and for all other script mappings that are not explicitly required by IIS and
2. Patch the .ida processor.

If the system does not require the index server, .ida processing should be disabled. CIAC Bulletin L-117 has defined the steps to test a server on whether the .ida processing is enabled [2]. TruSecure, Alert- TSA-01-020 [22] lists the steps to remove the script mapping for .ida, .idq, and for all other script mappings that are not explicitly required in IIS. One must aware that disabling .ida should be a temporary solution until the patch can

be installed. This is because future additional Windows's component installation could possibly reactivate the .ida.

Apply the MS IIS patch to remove the Code Red problem -
Windows NT version 4.0:

URL: <http://www.microsoft.com/Downloads/Release.asp?ReleaseID=30800>

Windows 2000 Professional, Server and Advanced Server:

URL: <http://www.microsoft.com/Downloads/Release.asp?ReleaseID=30833>

Step-by-step instructions for these actions are posted at URL:

<http://www.digitalisland.net/codered>

Additional information about the patch, its installation, and the vulnerability is available at follow URL:

<http://www.microsoft.com/technet/treeview/default.asp?url=/technet/security/bulletin/MS01-033.asp>.

Some of the Internet devices listen on port 80 may be vulnerable to the attack or denial of services due to port scan. Cisco has made patches available to remedy this vulnerability at URL: <http://www.cisco.com/warp/public/707/cisco-code-red-worm-pub.shtml>

Conclusion

Code Red worm can be viewed as a new generation of Internet worm that took the Internet and security community by surprise. The last such attention-grabbing worm was detected 13 years back, known as the Morris worm. Now there exist a few versions of Code Red worm and each new version proves to be more malicious than the original Code Red worm. This should serve as a strong motivation for businesses and corporations alike to beef up their system's defense. Prevention is much more cost effective than cure, especially for mission critical systems. In order to build up a bullet proof system, I would look into 3 basic concern: 1) Corporate security policies 2) Security professionals practices 3) Tools to enforce security protection.

When a company adopts certain software, it is unlikely to have a 100% guarantee that the software is free of flaws. Reason being that the software may contain inherent flaws that were not identified at the time it is released to the market. Proactively identifying security loopholes and enforcing the effective and timely patching of the flaws is a prerequisite to ensure the security of the system. Microsoft provides Internet Information Services checklist for the IIS users to find the available security fixes available at following location:

IIS4.0 – URL: <http://www.microsoft.com/technet/itsolutions/security/tools/iischk.asp>

IIS5.0 – URL: <http://www.microsoft.com/technet/itsolutions/security/tools/iis5chk.asp>

It is important for security professional to keep themselves abreast of the latest information on new available patches released by the vendors, and what is happenings on in the security community. One way to stay current is to subscribe to security bulletins and newsletters to obtain the latest information and issues faced by other professionals on the field.

Patching this IIS vulnerability is definitely not good enough, as new worms would seek out different ways to access systems and networks. A flexible, defense-in-depth strategy that allows adaptation to the dynamic environment plus well-defined policies and procedures are required to keep the system secured. It is helpful to devise a continuous lifecycle security plan that will update security policy, practices and supporting tools to secure systems and information against future attacks.

Security Bulletins

Computer Incidents Advisory Center

URL: <http://www.ciac.org/ciac/CIACHome.html>

CERT[®] Coordination Center (CERT/CC)

URL: <http://www.cert.org/nav/index.html>

Microsoft Security Notification Service

URL: <http://www.microsoft.com/security/>

SANS Institute NewsBites

URL: <http://www.sans.org/newlook/digests/newsbites.htm>

SANS Emergency Incident Handler – Incident.org

URL: <http://www.incidents.org/>

Security Portal

URL: <http://www.securityportal.com>

References

[1] Computer Incident Advisory Center, L-098: Microsoft Index Server ISAPI Extension buffer Overflow

URL: <http://www.ciac.org/ciac/bulletins/l-098.shtml>

[2] Computer Incident Advisory Center, L-117: The Code Red Worm, July 19, 2001.

URL: <http://www.ciac.org/ciac/bulletins/l-117.shtml>

[3] CERT Advisory, CA-2001-19 “Code Red” Worm Exploiting Buffer Overfolw In IIS Indexing Service DLL, July 20, 2001.

URL: <http://www.cert.org/advisories/CA-2001-19.html>

[4] Cisco, Cisco Security Advisory: “Code Red” Worm – Customer Impact, July 20, 2001.

URL: <http://www.cisco.com/warp/public/707/cisco-code-red-worm-pub.shtml>

[5] Digital Island, Code Red Worm InfoSec Bulletin

URL: <http://www.digitalisland.net/codered/>

- [6] eEye Digital Security, CodeRedII Worm Analysis, Aug 4, 2001
URL: <http://www.eeye.com/html/advisories/coderedII.zip>
- [7] eEye Digital Security, .ida "Code Red" Worm, July 19, 2001.
URL: <http://www.eeye.com/html/Research/Advisories/AL20010717.html>
- [8] eEye Digital Security, MS IIS Remote buffer overflow (SYSTEM Level Access), June 18, 2001.
URL: <http://www.eeye.com/html/Research/Advisories/AD20010618.html>
- [9] Handler's Diary, CodeRed II, Aug 6, 2001
URL: http://www.incidents.org/react/code_redII.php
- [10] HarshTruth, Major Alert!!! Code Red Worm, June 18, 2001
URL: <http://www.harshtruth.com/warnings.html>
- [11] Microsoft, Unchecked Buffer in Index Server ISAPI Extension Could Enable Web Server Compromise, June 18, 2001.
URL: <http://www.microsoft.com/technet/security/bulletin/MS01-033.asp>
- [12] Microsoft, Hotfix for Windows NT 4.0
URL: <http://www.microsoft.com/Downloads/Release.asp?ReleaseID=30833>
- [13] Microsoft, Windows 2000 Professional, Server and Advanced Server patch:
URL: <http://www.microsoft.com/Downloads/Release.asp?ReleaseID=30800>
- [14] Sullivan, Bob, MSNBC "Remembering the Net Crash of '88"
URL: <http://www.msnbc.com/news/209745.asp>
- [15] Network Working Group, The Helminthisasis of the Internet, December 1989
URL: <http://www.worm.net/rfc1135.txt>
- [16] National Infrastructure Protection Center, Ida Code Red Worm, 17 July 2001
URL: <http://www.nipc.gov/warnings/alerts/2001/01-016.htm>
- [17] SecurityPortal
URL: <http://www.securityportal.com/research/virus/profiles/codered.html>
- [18] SANS, Securing IIS Against Code Red, Jason Fossen.
URL: <http://www.digitalisland.net/codered/>
- [19] Symantec, CodeRed Worm, July 31, 2001.
URL: <http://www.sarc.com/avcenter/venc/data/codered.worm.html>

[20] Symantec, Symantec Enterprise Security Solutions protect against the Microsoft Windows IIS Index Server ISAPI System-level Remote Access Buffer Overflow, June 20, 2001.

URL: http://www.sarc.com/avcenter/security/Content/2001_06_20a.html

[21] Symantec, CodeRed.v3, Aug7, 2001.

URL: <http://www.sarc.com/avcenter/venc/data/codered.v3.html>

[22] TruSecure Alert- TSA-01-020 IIS Index Server Worm, 17 July 2001.

URL: http://www.trusecure.com/html/tspub/hypeorhot/rxalerts/tsa01020_cid115.shtml

© SANS Institute 2001, Author retains full rights



Upcoming SANS Training

[Click Here for a full list of all Upcoming SANS Events by Location](#)

SANS Security East 2018	New Orleans, LAUS	Jan 08, 2018 - Jan 13, 2018	Live Event
SANS Amsterdam January 2018	Amsterdam, NL	Jan 15, 2018 - Jan 20, 2018	Live Event
Northern VA Winter - Reston 2018	Reston, VAUS	Jan 15, 2018 - Jan 20, 2018	Live Event
SEC599: Defeat Advanced Adversaries	San Francisco, CAUS	Jan 15, 2018 - Jan 20, 2018	Live Event
SANS Dubai 2018	Dubai, AE	Jan 27, 2018 - Feb 01, 2018	Live Event
SANS Las Vegas 2018	Las Vegas, NVUS	Jan 28, 2018 - Feb 02, 2018	Live Event
Cyber Threat Intelligence Summit & Training 2018	Bethesda, MDUS	Jan 29, 2018 - Feb 05, 2018	Live Event
SANS Miami 2018	Miami, FLUS	Jan 29, 2018 - Feb 03, 2018	Live Event
SANS Scottsdale 2018	Scottsdale, AZUS	Feb 05, 2018 - Feb 10, 2018	Live Event
SANS London February 2018	London, GB	Feb 05, 2018 - Feb 10, 2018	Live Event
SANS Southern California- Anaheim 2018	Anaheim, CAUS	Feb 12, 2018 - Feb 17, 2018	Live Event
SANS Secure India 2018	Bangalore, IN	Feb 12, 2018 - Feb 17, 2018	Live Event
SANS Dallas 2018	Dallas, TXUS	Feb 19, 2018 - Feb 24, 2018	Live Event
SANS Brussels February 2018	Brussels, BE	Feb 19, 2018 - Feb 24, 2018	Live Event
SANS Secure Japan 2018	Tokyo, JP	Feb 19, 2018 - Mar 03, 2018	Live Event
Cloud Security Summit & Training 2018	San Diego, CAUS	Feb 19, 2018 - Feb 26, 2018	Live Event
SANS New York City Winter 2018	New York, NYUS	Feb 26, 2018 - Mar 03, 2018	Live Event
CyberThreat Summit 2018	London, GB	Feb 27, 2018 - Feb 28, 2018	Live Event
SANS London March 2018	London, GB	Mar 05, 2018 - Mar 10, 2018	Live Event
SANS San Francisco Spring 2018	San Francisco, CAUS	Mar 12, 2018 - Mar 17, 2018	Live Event
SANS Secure Osaka 2018	Osaka, JP	Mar 12, 2018 - Mar 17, 2018	Live Event
SANS Secure Singapore 2018	Singapore, SG	Mar 12, 2018 - Mar 24, 2018	Live Event
SANS Paris March 2018	Paris, FR	Mar 12, 2018 - Mar 17, 2018	Live Event
SANS SEC460: Enterprise Threat Beta	OnlineCAUS	Jan 08, 2018 - Jan 13, 2018	Live Event
SANS OnDemand	Books & MP3s OnlyUS	Anytime	Self Paced