



WEB BROWSER SECURITY
SOCIALY-ENGINEERED MALWARE PROTECTION
COMPARATIVE TEST RESULTS

Apple® Safari® 4
Google Chrome™ 4
Windows® Internet Explorer® 8
Mozilla® Firefox® 3.5
Opera™ 10



METHODOLOGY VERSION: 1.2
FEBRUARY 2010

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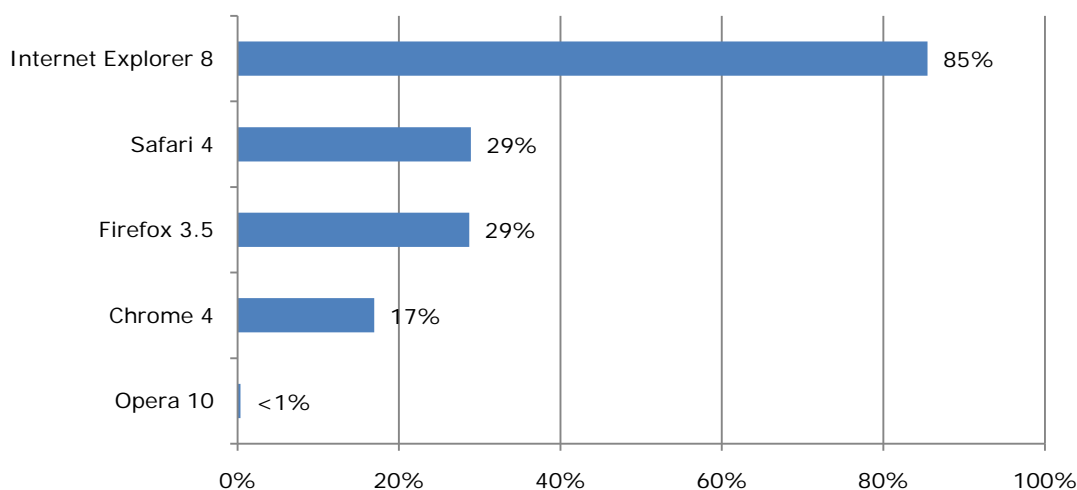
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EXECUTIVE SUMMARY

In January 2010, NSS Labs performed the third test of web browser protection against socially-engineered malware—the most common and impactful security threat facing Internet users today.¹ This report followed the same Live Testing methodology as the tests conducted in Q1 2009 and Q3 2009 (www.nsslabs.com/browser-security). This report contains empirically-validated evidence gathered during 18 days of 24 x 7 testing, performed every six hours, over 74 discrete test runs, each one adding fresh new malware URLs. Each product was updated to the most current version available at the time testing began, and allowed access to the live Internet.

Mean Block Rate for Socially-Engineered Malware



Windows Internet Explorer 8 caught 85% of the live threats, an exceptional score which surpassed the next best browser (Apple Safari 4) by a 56% margin. Internet Explorer 8 improved 4% between the Q3 2009 and Q1 2010 tests, maintaining its leadership.

Apple Safari 4 caught 29% of live threats, far fewer than Internet Explorer 8. Overall protection improved greatly from Q3 2009, with Safari providing 0.2% greater protection than Mozilla Firefox 3.5 in the current test.

Mozilla Firefox 3.5 caught 29% of live threats to put it in a statistical tie with Safari 4. Both Firefox 3.5 and Safari 4 achieved this protection while utilizing the Google Safe Browsing™ API.

Google Chrome 4 caught 17% of live threats, up 9% from the Q3 2009 test.

Opera 10 caught less than 1% of the live threats, providing virtually no protection against socially-engineered malware.

¹ Note: This study does not evaluate browser security related to vulnerabilities in plug-ins or the browsers themselves.

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1 INTRODUCTION

1.1 THE SOCIALLY-ENGINEERED MALWARE THREAT

Socially-engineered malware attacks pose a significant risk to individuals and organizations by threatening to compromise, damage, or acquire sensitive personal and corporate information; statistics from 2008 and 2009 show that this trend is increasing at a rapid rate. According to Symantec, “social engineering will be the primary attack vector” in 2010;² detecting and preventing these threats continues to be a challenge as criminals remain aggressive. Anti-virus researchers report detecting between 15,000 and 50,000 new malicious programs per day, Kaspersky Lab has even reported detecting up to “millions per month.”³

While not all of these malicious programs are used in social engineering attacks, this technique is increasingly being applied to the web to quickly distribute malware and evade traditional security programs. 53% of malware is now delivered via Internet download versus just 12% via e-mail according to statistics from Trend Micro.⁴ And, according to Microsoft, as many as 0.5% of the download requests made through Internet Explorer 8 are malicious.⁵

Criminals are taking advantage of the implied trust relationships inherent in social networking sites (Facebook®, MySpace™, LinkedIn®, etc.) and user-contributed content (blogs, Twitter™, etc.) which allow for rapid publishing and anonymity. Furthermore, the speed at which these threats are “rotated” to new locations poses a significant challenge to security vendors.

For clarity, the following definition is used for a socially-engineered malware URL: **a web page link that directly leads to a download that delivers a malicious payload whose content type would lead to execution.** These downloads appear to be safe, like those for a screen saver application, video codec upgrade, etc., and are designed to fool the user into taking action. Security professionals also refer to these threats as “consensual” or “dangerous” downloads.

1.2 WEB BROWSER SECURITY

Modern web browsers offer an **added layer of protection** against these threats by leveraging in-the-cloud, reputation-based mechanisms to warn users. This report examines the ability of five different web browsers to protect users from socially-engineered malware.⁶ Each of the five web browsers has added security technologies to combat web-based threats. However, not all of them have taken the same approach, nor claim to stop the same breadth of attacks.⁷

Browser protection contains two main functional components. The foundation is an “in-the-cloud” reputation-based system which scours the Internet for malicious websites and categorizes content accordingly; either by adding it to a black or white list, or assigning a score (depending on the vendor’s approach). This categorization may be performed manually, automatically, or using both methods. The second functional component resides within the web browser and requests reputation

² Symantec *Reality Check* “Tech Briefs.” <http://www.symantec.com/connect/zh-hans/blogs/expect-these-security-trends-dominate-2010>

³ Kaspersky, Eugene in <http://www.examiner.com/x-11905-SF-Cybercrime-Examiner-y2009m7d17-Antimalware-expert-and-CEO-Eugene-Kaspersky-talks-about-cybercrime>.

⁴ Cruz, Macky “Most Abused Infection Vector”. *Trend Labs Malware Blog*, 7 Dec 2008. <http://blog.trendmicro.com/most-abused-infection-vector/>

⁵ <http://blogs.msdn.com/ie/archive/2009/03/25/ie8-security-part-ix-anti-malware-protection-with-ie8-smartscreen-filter.aspx>.

⁶ Exploits that install malware without the user being aware (also referred to as “clickjacking” and “drive-by downloads”) are not included in this particular study.

⁷ Phishing protection was tested separately for technical reasons and is available in a companion report.

information from the in-the-cloud systems about specific URLs and then enforces warning and blocking functions.

When results are returned that a site is “bad,” the web browser redirects the user to a warning message or page instructing that the URL is malicious. In the event that the URL links to a download, the web browser instructs the user that the content is malicious and that the download should be cancelled. Conversely, when a website is determined to be “good,” the web browser takes no action and the user is unaware that a security check was performed.

2 EFFECTIVENESS RESULTS

2.1 TEST COMPOSITION: MALICIOUS URLS

Data in this report spans a testing period of 18 days, from January 15 through February 3, 2010. All testing was performed in our lab in Austin, TX. During the course of the test, we routinely monitored connectivity to ensure the browsers could access the live Internet sites being tested, as well as their reputation services in the cloud. Throughout the course of this study, 74 discrete tests were performed (every six hours) without interruption for each of the five browsers.

The emphasis was on freshness; thus, a larger number of sites (1,756) were evaluated than were ultimately kept as part of the result set. The NSS Labs Socially-Engineered Malware Protection Comparative Test Methodology provides additional details on the URLs evaluated and used in the result set.

2.1.1 TOTAL NUMBER OF MALICIOUS URLS IN THE TEST

From an initial list of 12,000 new suspicious sites, 1,756 potentially-malicious URLs were pre-screened for inclusion in the test and were available at the time of entry into the test. These were successfully accessed by the browsers in at least one run. We removed samples that did not pass our validation criteria, including those tainted by exploits or that contained invalid samples. Of the initial 1,756 URLs, ultimately 562 URLs passed our post-validation process and are included in the final results, providing a margin of error of 4.08% with a confidence interval of 98%.

2.1.2 AVERAGE NUMBER OF MALICIOUS URLS ADDED PER DAY

On average, 95 new URLs were added to the test set per day. On certain days, however, more or fewer URLs were added to the test set as criminal activity levels fluctuated.

2.1.3 MIX OF URLS

The mixture of URLs used in the test was representative of the threats on the Internet. Care was taken not to overweight any one domain to represent more than 10% of the test set. Thus, a number of sites were pruned after reaching their limit.

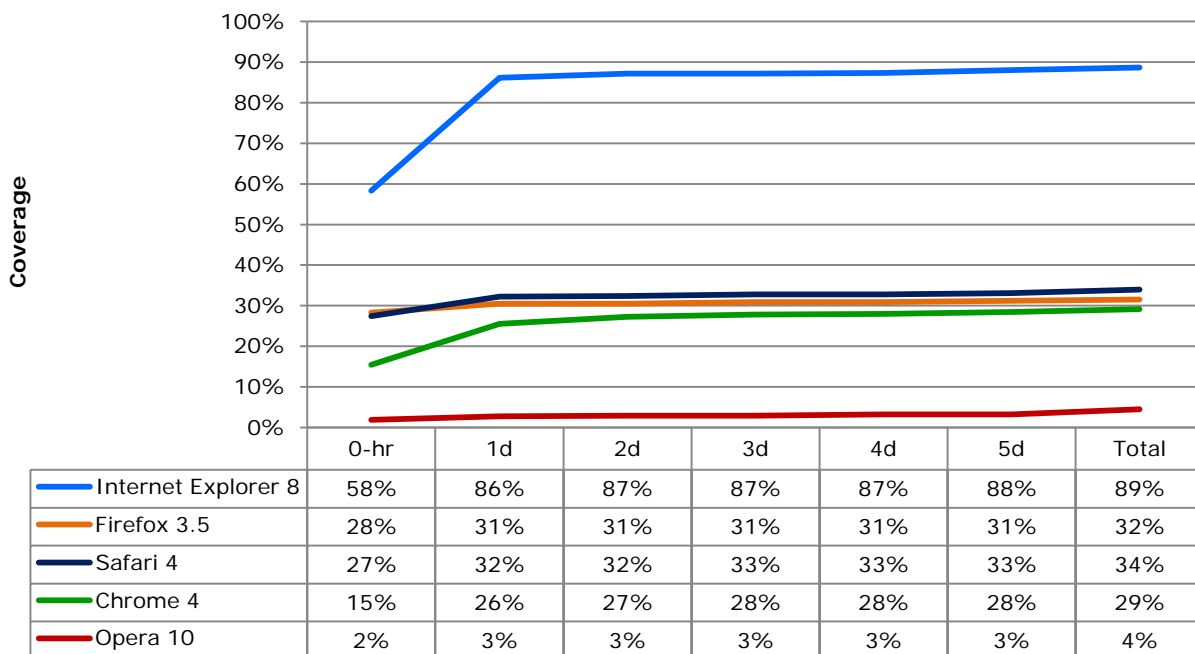
2.2 BLOCKING URLS WITH SOCIALLY-ENGINEERED MALWARE

NSS Labs assessed the browsers' ability to block malicious URLs as quickly as we found them on the Internet. We continued testing them every six hours to determine how long it took a vendor to add protection.

2.2.1 AVERAGE TIME TO BLOCK MALICIOUS SITES

The following response time graph shows how long it took the browsers under test to block the threat once it was introduced into the test cycle. Cumulative protection rates are listed for the "zero hour," and then the first five days. Final protection scores for the URL test duration are summarized under the "Total" column. Generally, at least half of a browser's total protection was achieved in the zero hour. But, Internet Explorer 8 continued to add as much as 30% of additional protection over the course of the test. Other browsers added between 2% and 14% over the course of the test.

Malware URL Response Histogram



Ultimately, the results reveal great variations in the abilities of the browsers to protect against socially-engineered malware, with Internet Explorer 8 protecting users from 55% more unique malicious URLs than its nearest competitor, Safari 4. Trends show Chrome 4, Safari 4, and Firefox 3.5 all converging at a protection rate just under 35%, indicating that while they all share the Google Safe Browser feed, there is a difference in implementation.

2.2.2 AVERAGE RESPONSE TIME TO BLOCK MALWARE

In order to protect the most people, a browser's reputation system must be both fast and accurate. The table below answers the question of how long on average a user must wait before a visited malicious site is added to the block list. It shows the average time to block a malware site once it was introduced into the test set—but *only if it was blocked during the course of the test*. Unblocked sites are not included, as there is no mathematical way to score "never."

The value of this table is in providing context for the *overall block rate*, so that if a browser blocked 100% of the malware, but it took 240 hours (10 days) to do so, it is actually providing less protection than a browser with a 70% overall block rate and an average response time of 10 hours.

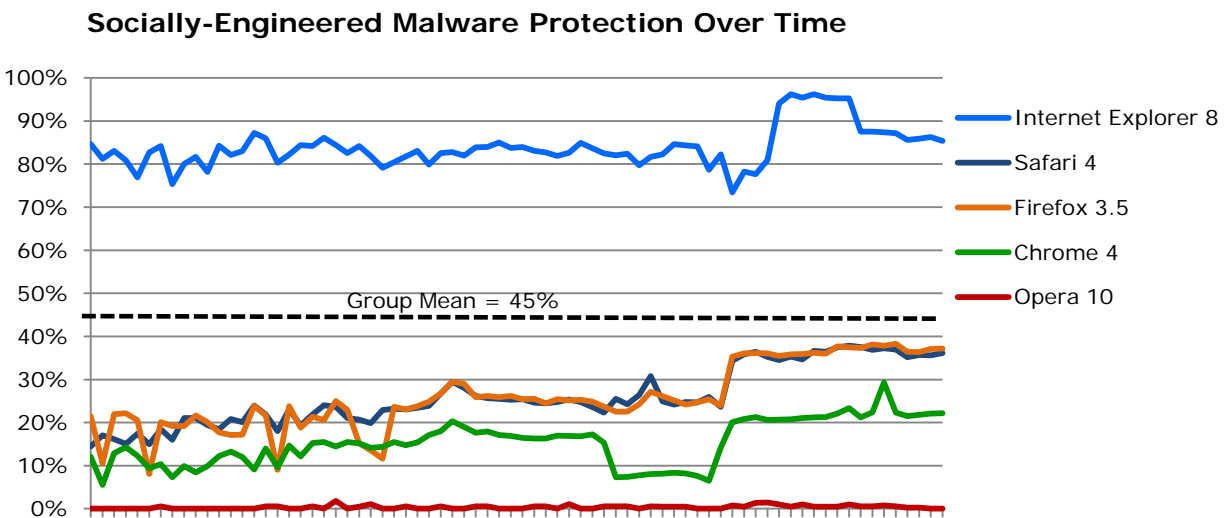
Browser	Average Add Time (Hours)
Firefox 3.5	5.7
Internet Explorer 8	6.7
Safari 4	9.0
Chrome 4	14.7
Opera 10	82.4
Mean	23.7

The mean time to block a site (if it is blocked at all) is 23.7 hours, a number artificially high due to Opera's severe lag. Thus, Firefox, Internet Explorer, Safari, and Chrome were above average at adding new blocks.

2.3 BLOCKING URLs WITH SOCIALLY-ENGINEERED MALWARE OVER TIME

The metrics for blocking individual URLs represent just one perspective. When it comes to daily usage scenarios, users are visiting a wide range of sites which may change quickly. Thus, at any given time, the available set of malicious URLs is revolving, and continuing to block these sites is a key criterion for effectiveness. Therefore, NSS Labs tested a set of live URLs every six hours. The following tables and graphs show the repeated evaluations of blocking over the course of 18 days, 74 test cycles for each of five browsers. Each score represents protection at a given point in time.

As seen on the graph, Internet Explorer demonstrated a very high level of protection. Safari and Firefox were consistent—both gained strength over time as they started blocking previously missed URLs.

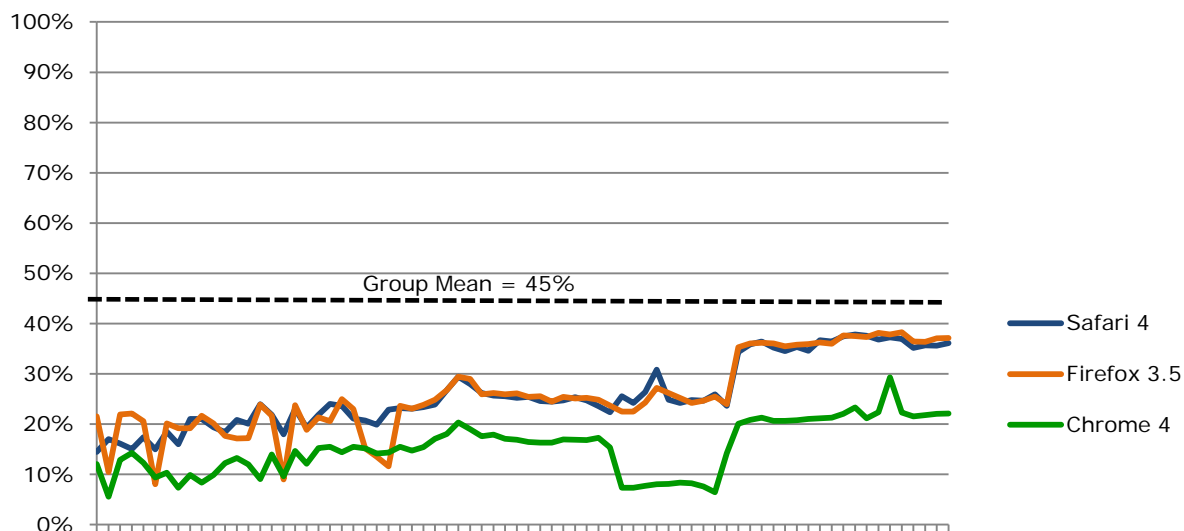


Note that the average protection percentage will deviate from the unique URL results for several reasons. First, this data includes multiple tests of a URL. So, if a URL is blocked early on, it will improve the score. If it continues to be missed, it will detract from the score. Thus, results of individual URL tests were compounded over time.

2.4 SAFE BROWSING PRODUCTS

Even though Chrome, Firefox, and Safari all use the Google Safe Browsing data feed, our testing detected different results in terms of effectiveness in blocking socially-engineered malware URLs.

Socially Engineered Malware Protection Over Time - Safe Browsing Products



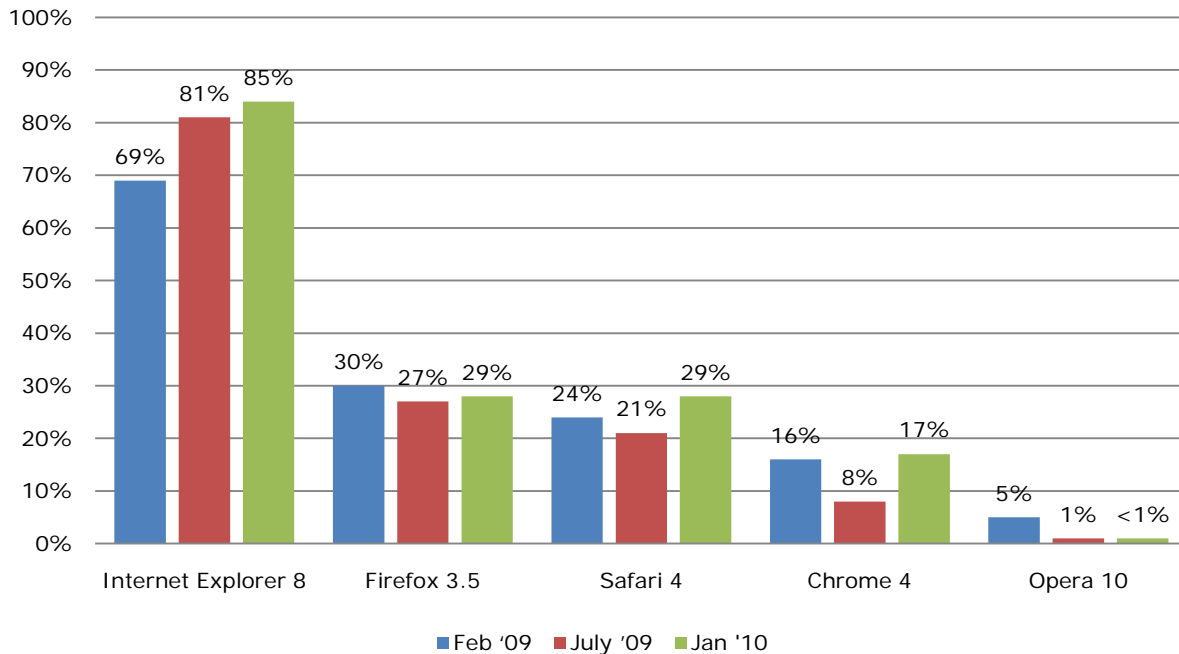
There could be any number of explanations for this variance, though no explanations were provided by the browser vendors.

Fundamentally, each browser or intermediary server may implement the API differently, calling it at different times with different parameters and determining blocks differently. Further, as an open-source project, Mozilla's implementation uses a different database structure and access method from the other two proprietary browsers. Lastly, as mentioned in Section 2.2.1 and indicated in the Malware URL Response Histogram, the Safe Browsing products' protection rates were showing signs of converging just under 35%. This supports the notion that there are operational differences between the implementations of the API, but that the block lists are the same (or very similar).

2.5 INTER-TEST CHANGES

Using the same test methodology for the Q1 2009, Q3 2009, and Q1 2010 tests allows for an easy "apples-to-apples" comparison of performance changes over time. As demonstrated by the following table, Internet Explorer 8 increased its protection by 4% since Q3 2009 and 16% since the initial Q1 2009 test.

Inter-Test Changes



With the exception of Opera (declining from the previous test to less than 1%), all of the other browsers increased protection, between 1% and 9%.

Safari 4's improved protection is now on par with Firefox 3.5. Chrome 4 nearly doubled the protection rate of Chrome 2, yet it appears that aggressive pruning (by age) prevented Chrome 4 from providing better protection.

Between the previous test and this one, all of the browser versions were upgraded to the latest available code.

- Internet Explorer 8 was upgraded from build 8.0.7100.0 to 8.0.7600.16385.
- Firefox 3.0.11 was upgraded to 3.5.7.
- Safari was upgraded from 4.0.2(530.19.1) to 4.0.4(531.21.10).
- Chrome was upgraded from 2.0.172.39 to 4.0.249.78.
- Opera was upgraded from 10.00b1 (build 1551) to 10.10 (build 1893).

3 CONCLUSIONS

The use of reputation systems to assist browsers in the fight against socially-engineered malware is a strong use of cloud technologies. But, not all vendor implementations and daily operations yield the same results.

It became obvious from this test and comparisons to the earlier test that Microsoft continues to make considerable improvements in adding protection from socially-engineered malware into **Internet Explorer 8** (through its SmartScreen[®] Filter technology). With a unique URL blocking score of 89% and over-time protection rating of 85%, Internet Explorer 8 was by far the best at protecting against socially-engineered malware. The 30% increase from zero-hour to 5 days of blocking suggests a far superior feedback mechanism.

Safari 4 and **Firefox 3.5** tied for second, both achieving a 29% protection rating—56% less protection than Internet Explorer 8. Statistically tied within the margin of error at 34% and 32% respectively, Safari's unique URL score was slightly better than Firefox and a considerable improvement from our last test. In addition, protection for both Safari and Firefox was more consistent than during our prior test, a sign that the operational processes for both are improved.

With a protection rating of 17%, **Chrome 4** more than doubled its 8% protection rating from our last test. And, Chrome's unique URL score of 29% was also a vast improvement. Chrome still lacks unique URL protection within the first 24 hours (15%) which ultimately suppressed its score *versus* other Safe Browsing API-related products.

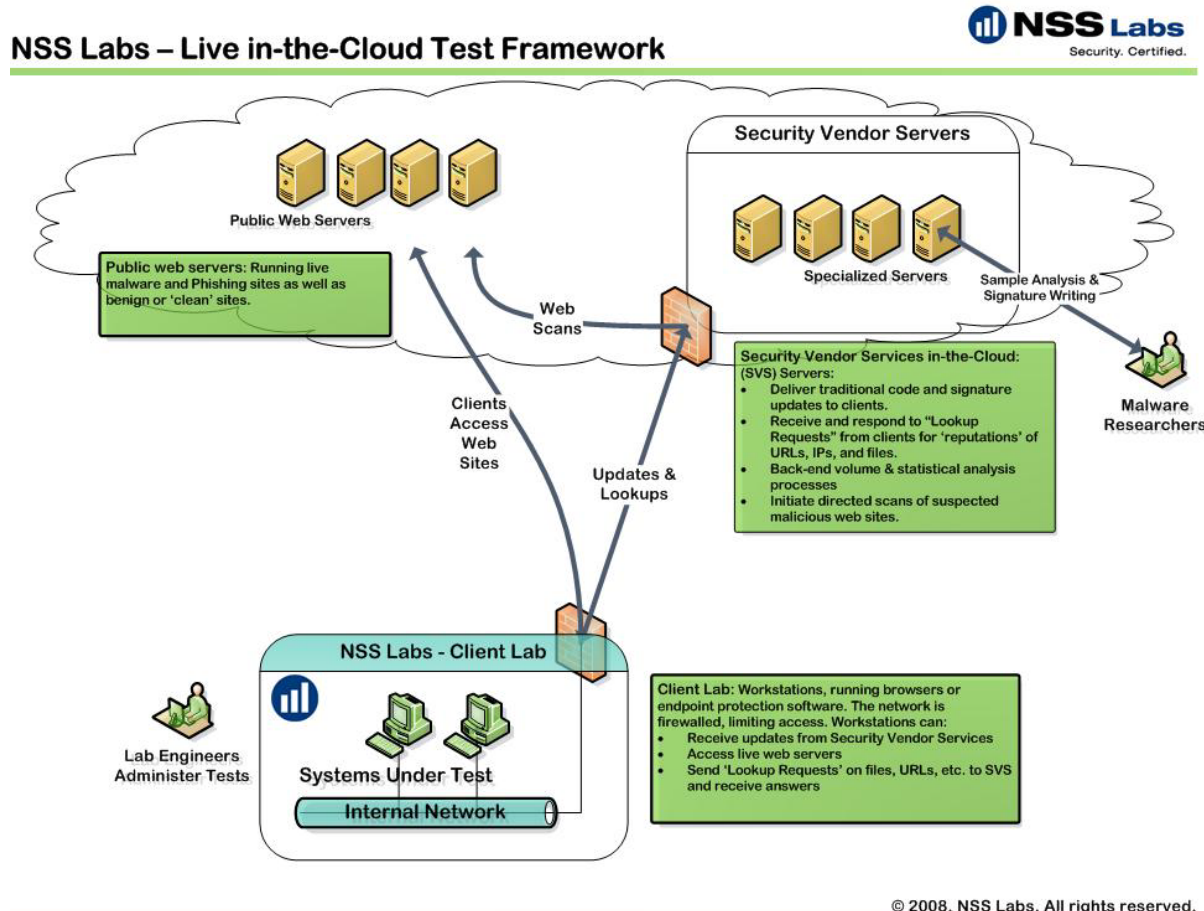
Opera 10's overall blocking rate of less than 1% was well under the margin of error and consistent with results from our last test. Once again, we double-checked the setup and manually verified a significant portion of URLs. Users should not expect any protection against socially-engineered malware from Opera 10.

Browsers provide a layer of protection against socially-engineered malware, in addition to endpoint protection products; as this report shows, not all are created equal. Users should ensure that they are running the latest version available of their browser, with the latest browser and operating system updates at all times. Those protection mechanisms should not be considered a replacement for anti-virus programs. Look for upcoming tests of endpoint protection products from NSS Labs in Q1 2010.

4 TEST ENVIRONMENT

NSS Labs has created a complex test environment and methodology to assess the protective capabilities of Internet browsers under the most real-world conditions possible, while also maintaining control and verification of the procedures.

For this browser security test, NSS Labs created a “live” test lab environment in order to duplicate user experiences under real-world conditions.



4.1 CLIENT HOST DESCRIPTION

All tested browser software was installed on identical virtual machines with the following specifications:

- Microsoft Windows 7
- 1GB RAM
- 20GB hard drive

Browser machines were tested prior to and during the test to ensure proper functioning. Browsers were given full access to the Internet so they could visit the actual live sites.

4.2 THE TESTED BROWSERS

The browsers, or products under test, were obtained independently by NSS Labs. Generally-available software releases were used in all cases. Each product was updated to the most current version available at the time testing began. The following is a current list of the web browsers that were tested:

- Google Chrome v4.0.249.78(36714)
- Windows Internet Explorer 8 (build 8.0.7600.16385)
- Mozilla Firefox v3.5.7
- Opera v10.10 (build 1893)
- Safari v4.0.4(531.21.10)

Once testing began, the product version was frozen in order to preserve the integrity of the test. This test relied upon Internet access for the reputation systems and access to live content. Generally, there is a configurable separation between software updates and database or signature updates, to draw analogies from anti-virus, intrusion prevention, and general software practices.

4.3 NETWORK DESCRIPTION

The browsers were tested for their ability to protect the client in “connected” use cases. Thus, our tests consider and analyze the effectiveness browser protection in NSS Labs’ real-world, live Internet testing harness.

The host system has one network interface card (NIC) and is connected to the network via a 1Gb switch port. The NSS Labs test network is a multi-gigabit infrastructure based around Cisco® Catalyst® 6500-series switches (with both fiber and copper gigabit interfaces).

For the purposes of this test, NSS Labs utilized up to 30 desktop systems each running a web browser—six each per web browser (five browser types). Results were recorded into a MySQL database.

5 APPENDIX B: TEST PROCEDURES

The purpose of the test was to determine how well the tested web browsers protect users from the most important malware threat on the Internet today. A key aspect was the timing. Given the rapid rate and aggressiveness with which criminals propagate and manipulate the malicious websites, a key objective was to ensure that the “freshest” sites possible were included in the test.

NSS Labs has developed a unique proprietary “Live Testing” harness and methodology. On an ongoing basis, NSS Labs collects web-based threats from a variety of sources, including partners and our own servers. Potential threats are vetted algorithmically before being inserted into our test queue. Threats are being inserted and vetted continually. Unique in this procedure is that NSS Labs validates the samples before and after the test. Actual testing of the threats proceeded every six hours and starts with validation of the site’s existence and conformance to the test definition.

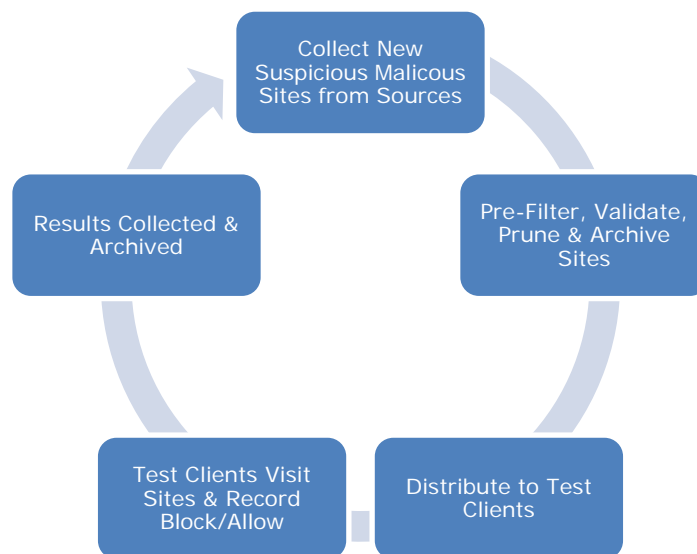
All tests were executed in a highly controlled manner, and results were meticulously recorded and archived at each interval of the test.

5.1 TEST DURATION

NSS Labs’ browser test was performed continuously (24 x 7) for 18 days. Throughout the duration of the test, new URLs were added as they were discovered.

5.1.1 TEST FREQUENCY

Over the course of the test, each URL is run through the test harness every six hours. Regardless of success or failure, NSS Labs continues to attempt to download a malware sample with the web browser for the duration of the test.



5.2 SAMPLE SETS FOR MALWARE URLS

Freshness of malware sites is a key attribute of this type of test. In order to utilize the freshest most representative URLs, NSS Labs receives a broad range of samples from a number of different sources.

5.2.1 SOURCES

First, NSS Labs operates its own network of spam traps and honeypots. These e-mail accounts with high-volume traffic yield thousands of unique e-mails, and several hundred unique URLs per day. NSS Labs' continuously growing archive of malware and viruses contains gigabytes of confirmed samples. In addition, NSS Labs maintains relationships with other independent security researchers, networks, and security companies, which provide access to URLs and malicious content. Sample sets contain malicious URLs distributed via: e-mail, instant messaging, social networks, and malicious websites. No content was used from the tested parties.

Exploits containing malware payloads (exploits plus malware), also known as "clickjacking" or "drive-by downloads" were excluded from the test. Every effort was made to consider submissions that reflect a real-world distribution of malware—categorically, geographically, and by platform.

In addition, NSS Labs maintains a collection of "clean URLs" which includes sites from Yahoo, Amazon, Microsoft, Google, NSS Labs, major banks, and others. Periodically, clean URLs were run through the system to verify that the browsers were not over-blocking.

5.3 CATALOG URLs

New sites were added to the URL consideration set as soon as possible. The date and time each sample is introduced is noted. Most sources were automatically and immediately inserted, while some methods require manual handling and can be processed in under 30 minutes. All items in the consideration set were cataloged with a unique NSS Labs ID, regardless of their validity. This enabled us to track effectiveness of sample sources.

5.4 CONFIRM SAMPLE PRESENCE OF URLS

Time is of the essence since the test objective is to test the effectiveness against the freshest possible malware sites. Given the nature of the feeds and the velocity of change, it is not possible to validate each site in depth before the test, since the sites could quickly disappear. Thus, each of the test items was given a cursory review to verify it was present and accessible on the live Internet.

In order to be included in the execution set, URLs must be live during the test iteration. At the beginning of each test cycle, the availability of the URL is confirmed by ensuring that the site can be reached and is active, such that a non-404 web page is returned.

This validation occurred within minutes of receiving the samples from our sources. **Note:** These classifications are further validated after the test and URLs were reclassified and/or removed accordingly.

5.4.1 ARCHIVE ACTIVE URL CONTENT

The active URL content was downloaded and saved to an archive server with a unique NSS ID number. This enables NSS Labs to preserve the URL content for control and validation purposes.

5.5 DYNAMICALLY EXECUTE EACH URL

A client automation utility requests each of the URLs deemed "present" based upon results of the test described in Section 5.4 via each of the web browsers in the test. NSS Labs records whether or not the malware was allowed to be downloaded and if the download attempt triggered a warning from the browser's malware protection.

5.5.1 SCORING AND RECORDING THE RESULTS

The resulting response is recorded as either “Allowed” or “Blocked and Warned.”

- **Success:** NSS Labs defines success based upon a web browser *successfully* preventing malware from being downloaded and *correctly* issuing a warning.
- **Failure:** NSS Labs defines a failure based upon a web browser *failing* to prevent the malware from being downloaded and *failing* to issue a warning.

5.6 PRUNING

Throughout the test, lab engineers review and prune out non-conforming URLs and content from the test execution set. For example, a URL that was classified as malware that has been replaced by the web host with a generic splash page will be removed from the test.

If a URL sample becomes unavailable for download during the course of the test, the sample will be removed from the test collection for that iteration. NSS Labs continually verifies each sample's presence (availability for download) and adds/removes each sample from the test set accordingly. Should a malware sample be unavailable for a test iteration and then become available again for a subsequent iteration, it will be added back into the test collection. Unavailable samples are not included in calculations of success or failure by a web browser.

5.7 POST-TEST VALIDATION

Post-test validation enables NSS Labs to reclassify and even remove samples which were either not malicious or not available before the test started. NSS Labs used two different commercial sandboxes to prune and validate the malware (Sunbelt's CWSandbox and Norman[®] Analyzer). Further validation was done using proprietary tools, system instrumentation, and code analysis as needed.

6 APPENDIX C: TEST INFRASTRUCTURE

Special thanks go to our test infrastructure partners who provide much of the equipment, software, and support that make this testing possible:

