PASSMARK®
SOFTWARE

WEBROOT®

Webroot SecureAnywhere® Internet Security with Antivirus vs. Eight Competitors

Performance Benchmarks

Windows 10

November 2021

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Revision History

Rev	Revision History	Date
Edition 1	Initial version of report	9 November 2021

References

Ref #	Document	Author	Date
1	What Really Slows Windows Down (URL)	O. Warner, The PC Spy	2006

Executive Summary

PassMark Software® conducted objective performance testing on nine (9) Antivirus products. This report presents our results and findings as a result of performance benchmark testing conducted for these products.

The aim of this benchmark was to compare the performance of Webroot SecureAnywhere Internet Security with Antivirus with eight competitor antivirus products. The testing was performed on all products using fifteen (15) performance metrics. These performance metrics are as follows:

- Scan Time
- Scheduled Scan Time
- Installation Size
- Installation Time
- Registry Keys Added
- Boot Time
- User Interface Launch Time
- Chrome Launch Time
- Memory Usage during System Idle
- Memory Usage during Initial Scan
- Browse Time
- File Copy, Move and Delete
- File Format Conversion
- File Compression and Decompression
- File Write, Open and Close

Overall Score

PassMark Software assigned every product a score depending on its ranking in each metric compared to other products in the same category. The table below shows overall scores achieved by the tested products, with a score of 100 being an ideal product achieving the highest possible score in each of the selected test metrics. Antivirus products have been ranked by their overall scores:

Product Name	Overall Score
Webroot SecureAnywhere Internet Security with Antivirus	83
Norton 360 Deluxe	67
ESET Internet Security	63
Microsoft Defender	60
AVG Internet Security	53
McAfee Total Protection	53
Trend Micro Internet Security	50
Malwarebytes Premium	40
Bitdefender Internet Security	39

Products and Versions

For all products, we have tested the full retail release of the most current and publicly available version of each Antivirus product. The names and versions of products are as follow:

Manufacturer	Product Name	Release	Product	Date Tested
Webroot Inc.	Webroot SecureAnywhere Internet Security with Antivirus	2021	9.0.31.84	October 2021
Microsoft	Microsoft Defender	2021	4.18.2109.6	October 2021
Trend Micro Inc.	Trend Micro Internet Security	2021	17.7.1130	October 2021
Bitdefender	Bitdefender Internet Security	2021	26.0.1.23	October 2021
Malwarebytes Inc.	Malwarebytes Premium	2021	4.4.9.142	October 2021
ESET, spol. s r.o.	ESET Internet Security	2021	15.0.16.0	November 2021
Avast Software s.r.o.	AVG Internet Security	2021	21.9.3208	November 2021
NortonLifeLock Inc.	Norton 360 Deluxe	2021	22.21.10.40	November 2021
McAfee, LLC	McAfee Total Protection	2021	16.0	November 2021

Performance Metrics Summary

The following list of metrics were selected to provide a detailed and realistic indication of the areas in which an Antivirus software may impact system performance for end users. Our metrics test the impact of the Antivirus software on common tasks that end-users would perform on a daily basis.

All of PassMark Software's test methods can be replicated by third parties using the same environment to obtain similar benchmark results. Detailed descriptions of the methodologies used in our tests are available as "*Appendix 2 – Methodology Description*" of this report.

Benchmark 1 – Scan Time

All Antivirus solutions have functionality designed to detect viruses and various other forms of malware by scanning files on the system. This metric measured the amount of time required to scan a set of clean files. Our sample file set comprised a total file size of 982 MB and was made up of files that would typically be found on end-user machines, such as media files, system files and Microsoft Office documents.

Benchmark 2 – Scheduled Scan Time

This metric measured the amount of time required to run a scheduled scan on the system. The scan is set for a particular time via the client user interface.

Benchmark 3 – Installation Size

In offering new features and functionality to users, Antivirus software products tend to increase in size with each new release. Although new technologies push the size limits of hard drives each year, the growing disk space requirements of common applications and the increasing popularity of large media files (such as movies, photos and music) ensure that a product's installation size will remain of interest to home users.

This metric aims to measure a product's total installation size. This metric is defined as the total disk space consumed by all new files added during a product's installation.

Benchmark 4 – Installation Time

The speed and ease of the installation process will strongly influence the user's first impression of the Antivirus software. This test measures the minimum installation time required by the Antivirus software to be fully functional and ready for use by the end user. Lower installation times represent Antivirus products which are quicker for a user to install.

Benchmark 5 – Registry Keys Added

A large registry increases a machine's use of resources. This may negatively impact system performance, especially on much older machines. This test measures the number of keys and values added to registry, after rebooting the test machines, following a successful product installation. Lower numbers mean that a product has added fewer keys during installation and had less impact on the registry.

Benchmark 6 – Boot Time

This metric measures the amount of time taken for the machine to boot into the operating system. Security software is generally launched at Windows startup, adding an additional amount of time and delaying the startup of the operating system. Shorter boot times indicate that the application has less impact on the normal operation of the machine.

Benchmark 7 – User Interface Launch Time

This metric provides an objective indication as to how responsive a security product appears to the user, by measuring the amount of time it takes for the user interface of the Antivirus software to launch from Windows. To allow for caching effects by the operating system, both the initial launch time and the subsequent launch times were measured. Our final result is an average of these two measurements.

Benchmark 8 – Chrome Launch Time

This metric is one of many methods to objectively measure how much a security product impacts on the responsiveness of the system. This metric measures the amount of time it takes to launch the user interface of Google Chrome browser. To allow for caching effects by the operating system, both the initial launch time and the subsequent launch times were measured. Our final result is an average of these two measurements.

Benchmark 9 – Memory Usage during System Idle

This metric measures the amount of memory (RAM) used by the product while the machine and Antivirus software are in an idle state. The total memory usage was calculated by identifying all Antivirus software processes and the amount of memory used by each process.

The amount of memory used while the machine is idle provides a good indication of the amount of system resources being consumed by the Antivirus software on a permanent basis. Better performing products occupy less memory while the machine is idle.

Benchmark 10 – Memory Usage during Initial Scan

This metric measures the amount of memory (RAM) used by the product during an Antivirus scan. The total memory usage was calculated by identifying all Antivirus software processes and the amount of memory used by each process during an Antivirus scan.

Benchmark 11 – Browse Time

It is common behavior for security products to scan data for malware as it is downloaded from the internet or intranet. This behavior may negatively impact browsing speed as products scan web content for malware. This metric measures the time taken to browse a set of popular websites to consecutively load from a local server in a user's browser window.

Benchmark 12 – File Copy, Move and Delete

This metric measures the amount of time taken to move, copy and delete a sample set of files. The sample file set contains several types of file formats that a Windows user would encounter in daily use. These formats include documents (e.g. Microsoft Office documents, Adobe PDF, Zip files, etc.), media formats (e.g. images, movies and music) and system files (e.g. executables, libraries, etc.).

Benchmark 13 – File Format Conversion

This test measures the amount of time taken to convert an MP3 file to a WAV and subsequently, convert the same MP3 file to a WMA format.

Benchmark 14 – File Compression and Decompression

This metric measures the amount of time taken to compress and decompress different types of files. Files formats used in this test include documents, movies and images.

Benchmark 15 – File Write, Open and Close

This benchmark was derived from Oli Warner's File I/O test at http://www.thepcspy.com (please see *Reference #1: What Really Slows Windows Down*). This metric measures the amount of time taken to write a file, then open and close that file.

Test Results

In the following charts, we have highlighted the results we obtained for Webroot SecureAnywhere Internet Security with Antivirus in green and the average in blue colors for ease of comparison.

Benchmark 1 – Scan Time

The following chart compares the average time taken to perform on-demand scan on a sample dataset with 6,166 files in it and 982 MB size in total.

Product	Time (s)
Bitdefender Internet Security	20.13
Norton 360 Deluxe	38.00
ESET Internet Security	39.00
Malwarebytes Premium	41.63
Trend Micro Internet Security	43.72
Microsoft Defender	49.63
Webroot SecureAnywhere Internet Security with Antivirus	54.50
McAfee Total Protection	79.88
Average	89.68
AVG Internet Security	440.63
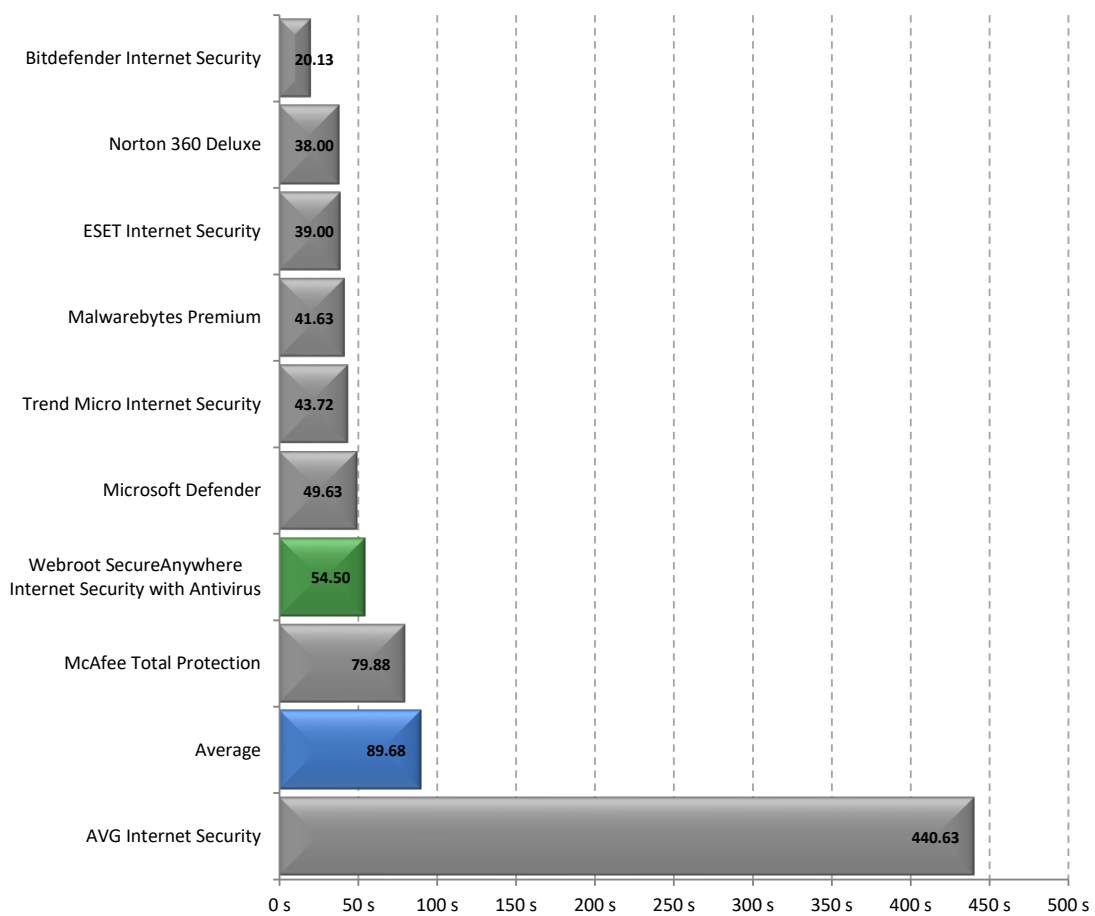
Benchmark 2 – Scheduled Scan Time

The following chart compares the average time taken to run a scheduled scan on the system. Products with lower scan times are considered better performing products in this category. [1]

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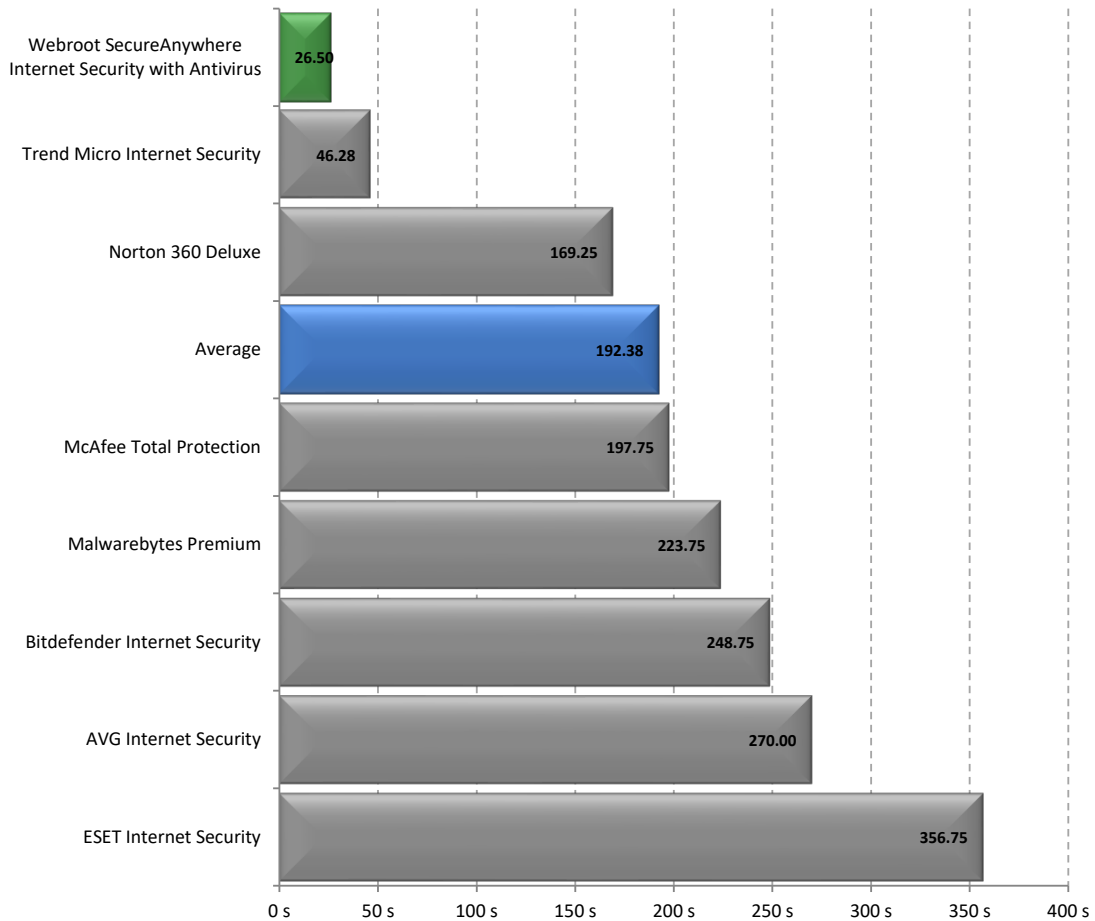
[1] Microsoft Defender was excluded from this test as the product did not have the functionality to run a scheduled scan.

Benchmark 3 – Installation Size

The following chart compares the total size of files added during the installation of Antivirus products. Products with lower installation sizes are considered better performing products in this category. [2]
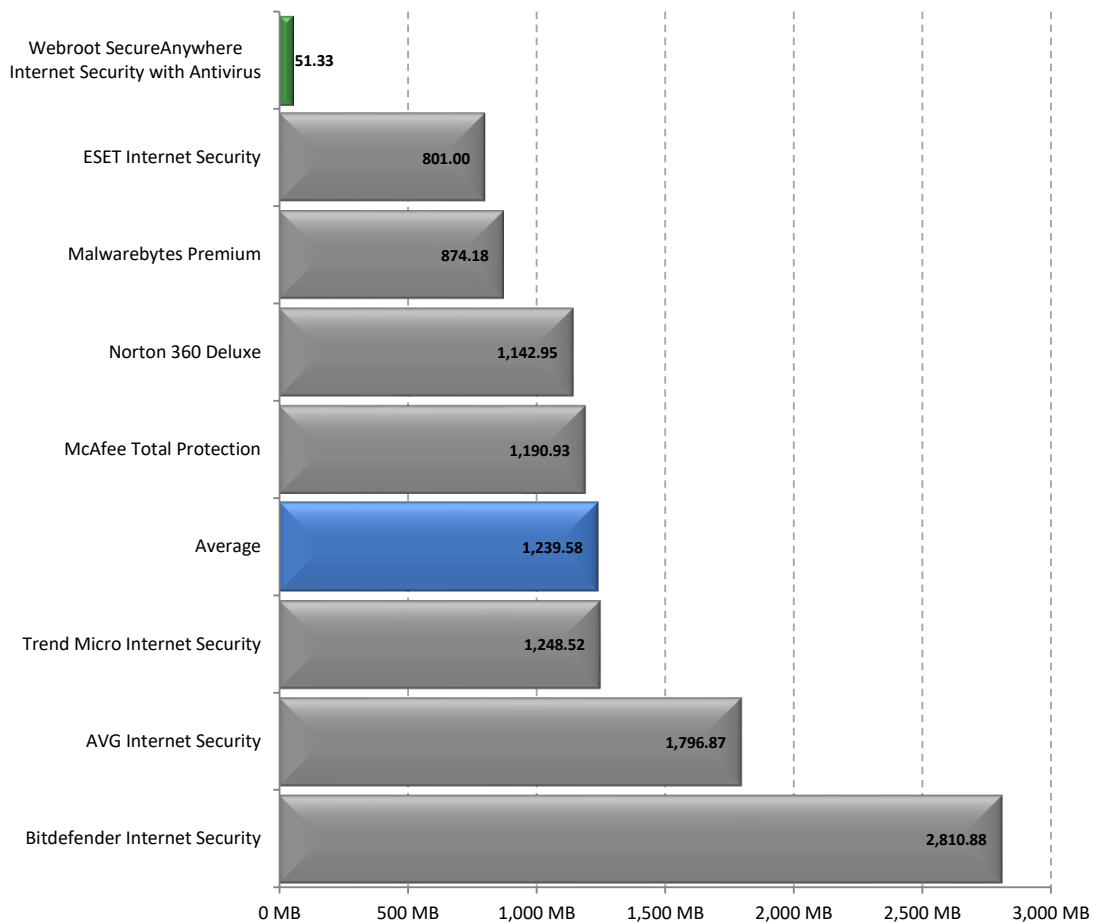
Product	Size (MB)
Webroot SecureAnywhere Internet Security with Antivirus	51.33
ESET Internet Security	801.00
Malwarebytes Premium	874.18
Norton 360 Deluxe	1,142.95
McAfee Total Protection	1,190.93
Average	1,239.58
Trend Micro Internet Security	1,248.52
AVG Internet Security	1,796.87
Bitdefender Internet Security	2,810.88

[2] Microsoft Defender was excluded from this test as it was a Windows 10 built-in software.

Benchmark 4 – Installation Time

The following chart compares the minimum installation time it takes for Antivirus products to be fully functional and ready for use. Products with lower installation times are considered better performing products in this category. [3]
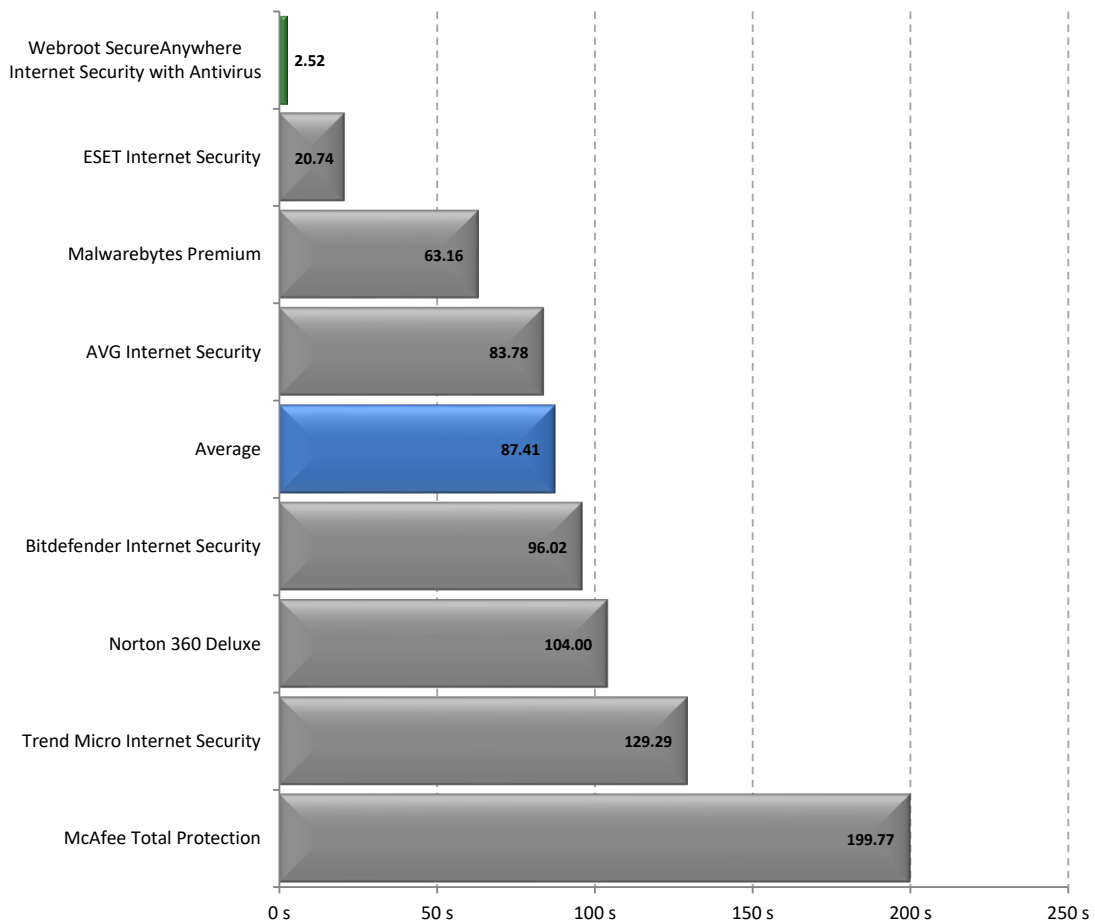
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[3] Microsoft Defender was excluded from this test as it was a Windows 10 built-in software.

Benchmark 5 – Registry Keys Added

The following chart compares the number of Registry Keys created during the security products installation. Products with lower key counts are considered better performing products in this category. [4]
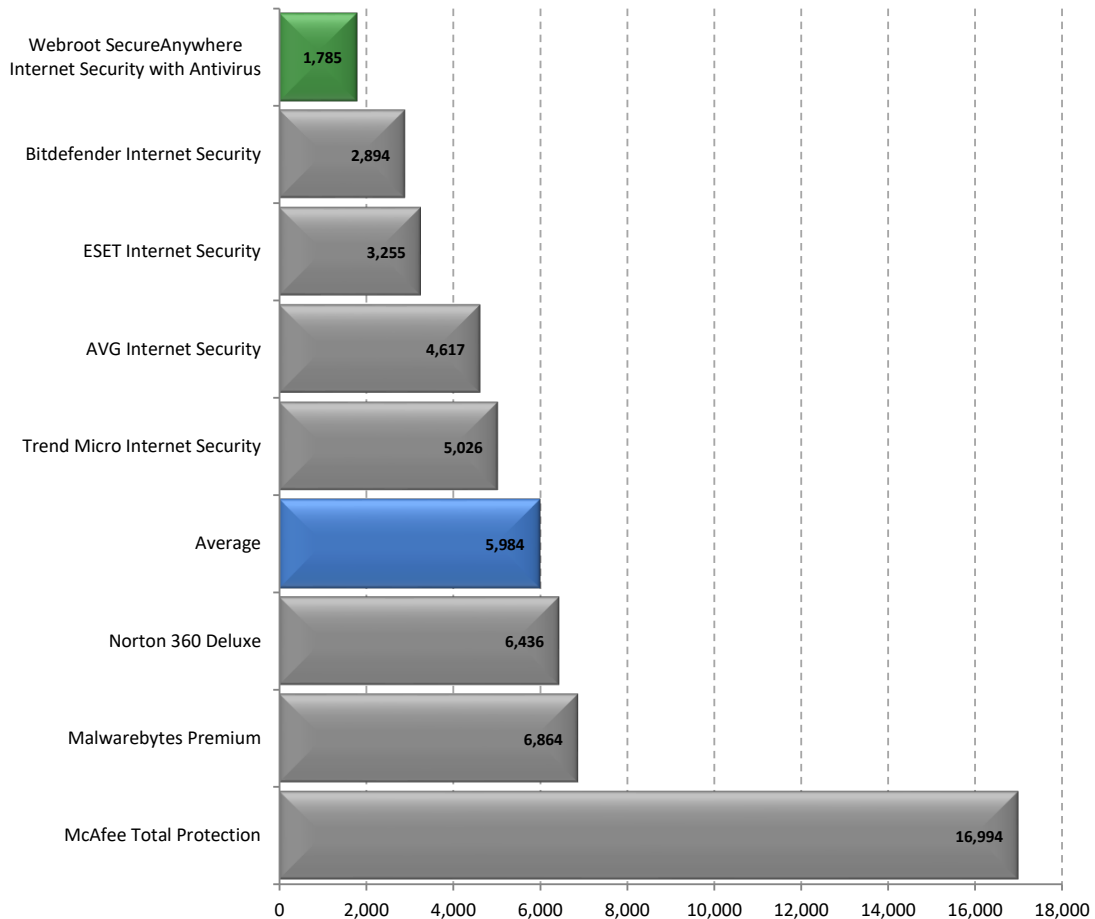
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[4] Microsoft Defender was excluded from this test as it was a Windows 10 built-in software.

Benchmark 6 – Boot Time

The following chart compares the average time taken for the system to boot (from a sample of five boots). Products with lower boot times are considered better performing products in this category.

Product	Boot Time (s)
Norton 360 Deluxe	9.22
Microsoft Defender	10.63
McAfee Total Protection	11.06
ESET Internet Security	11.22
Average	11.64
Trend Micro Internet Security	12.08
AVG Internet Security	12.26
Webroot SecureAnywhere Internet Security with Antivirus	12.33
Bitdefender Internet Security	12.52
Malwarebytes Premium	13.44
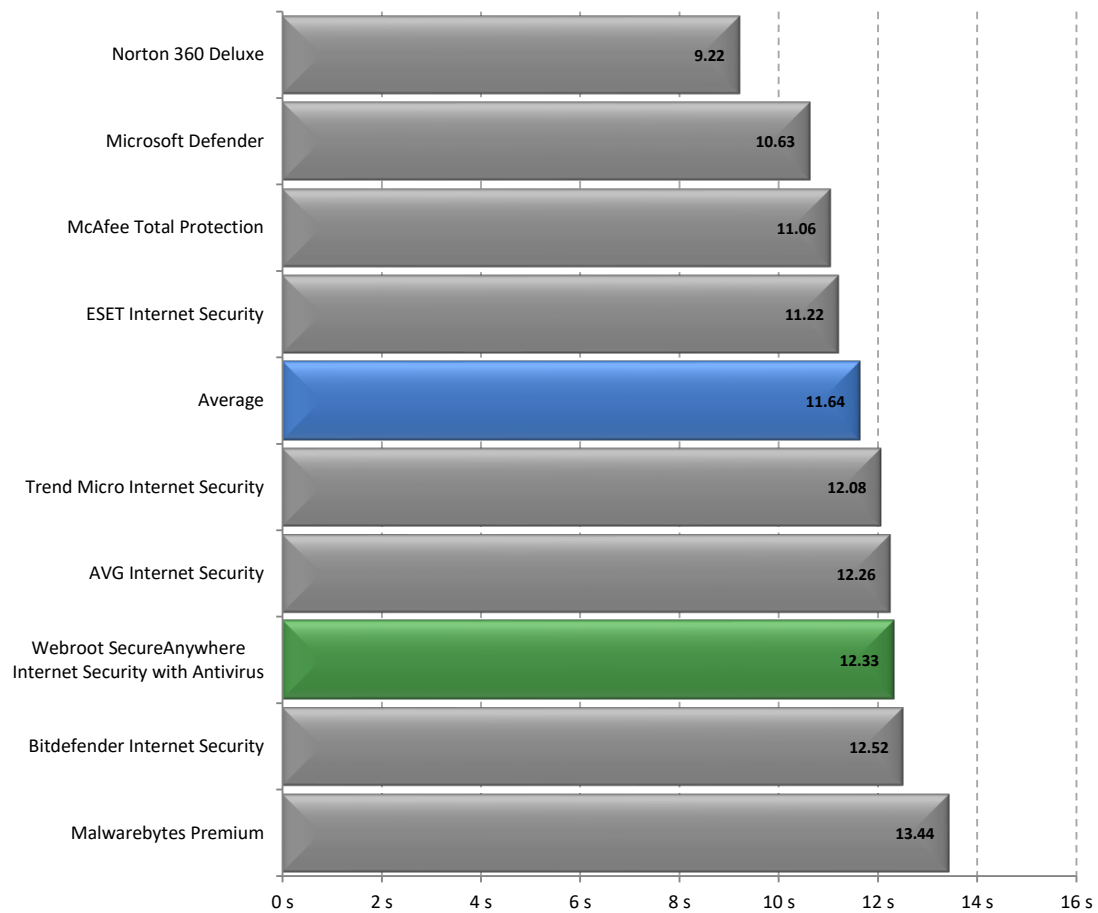
Benchmark 7 – User Interface Launch Time

The following chart compares the average time taken to launch an Antivirus product's user interface. Products with lower launch times are considered better performing products in this category.

Product	Time (ms)
Webroot SecureAnywhere Internet Security with Antivirus	126.3
AVG Internet Security	286.1
Trend Micro Internet Security	346.1
Microsoft Defender	373.5
ESET Internet Security	437.0
Average	1,030.3
McAfee Total Protection	1,100.4
Bitdefender Internet Security	1,155.8
Norton 360 Deluxe	1,679.2
Malwarebytes Premium	3,768.7
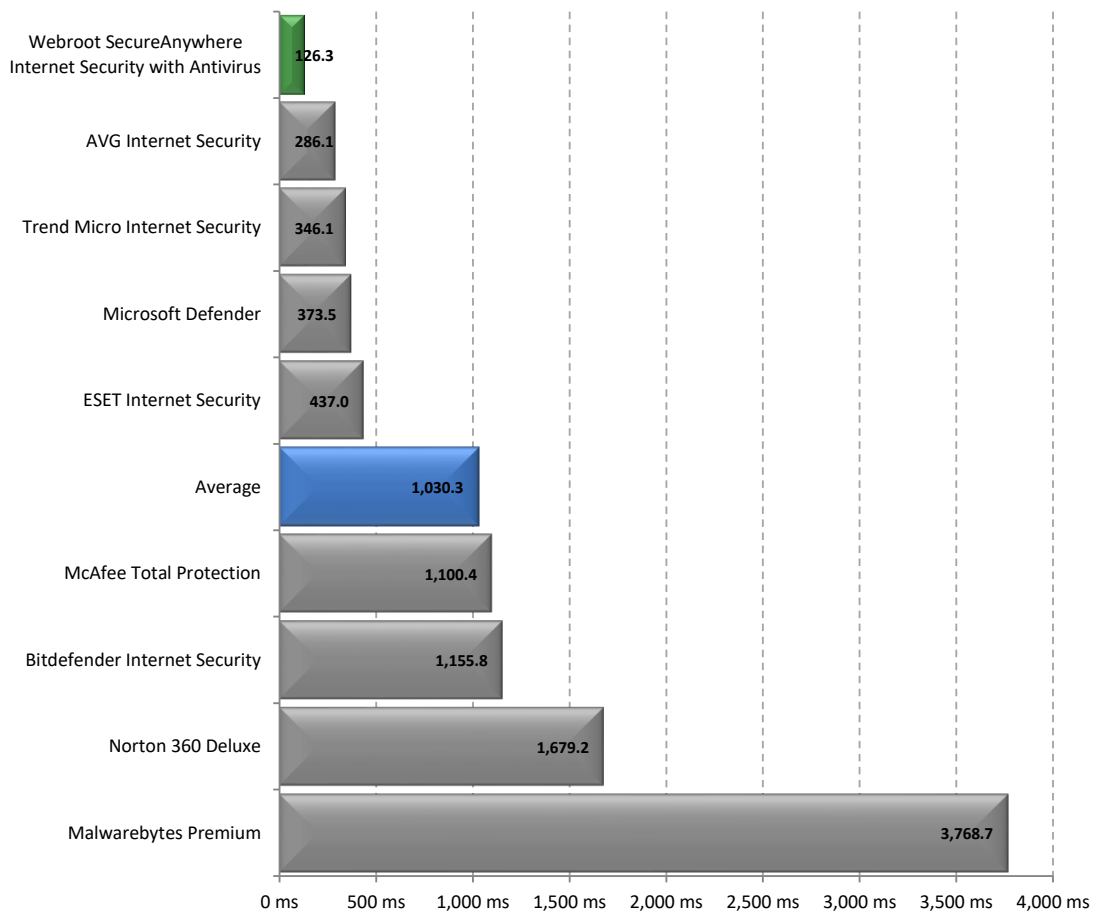
Benchmark 8 – Chrome Launch Time

The following chart compares the average launch times of Google Chrome browser after rebooting the machine for each Antivirus product we tested. Products with lower launch times are considered better performing products in this category.

Product	Launch Time (ms)
Microsoft Defender	475.7
Norton 360 Deluxe	585.1
Webroot SecureAnywhere Internet Security with Antivirus	601.6
Bitdefender Internet Security	621.0
AVG Internet Security	629.3
Malwarebytes Premium	677.5
Average	771.7
McAfee Total Protection	846.6
ESET Internet Security	1,166.0
Trend Micro Internet Security	1,342.6
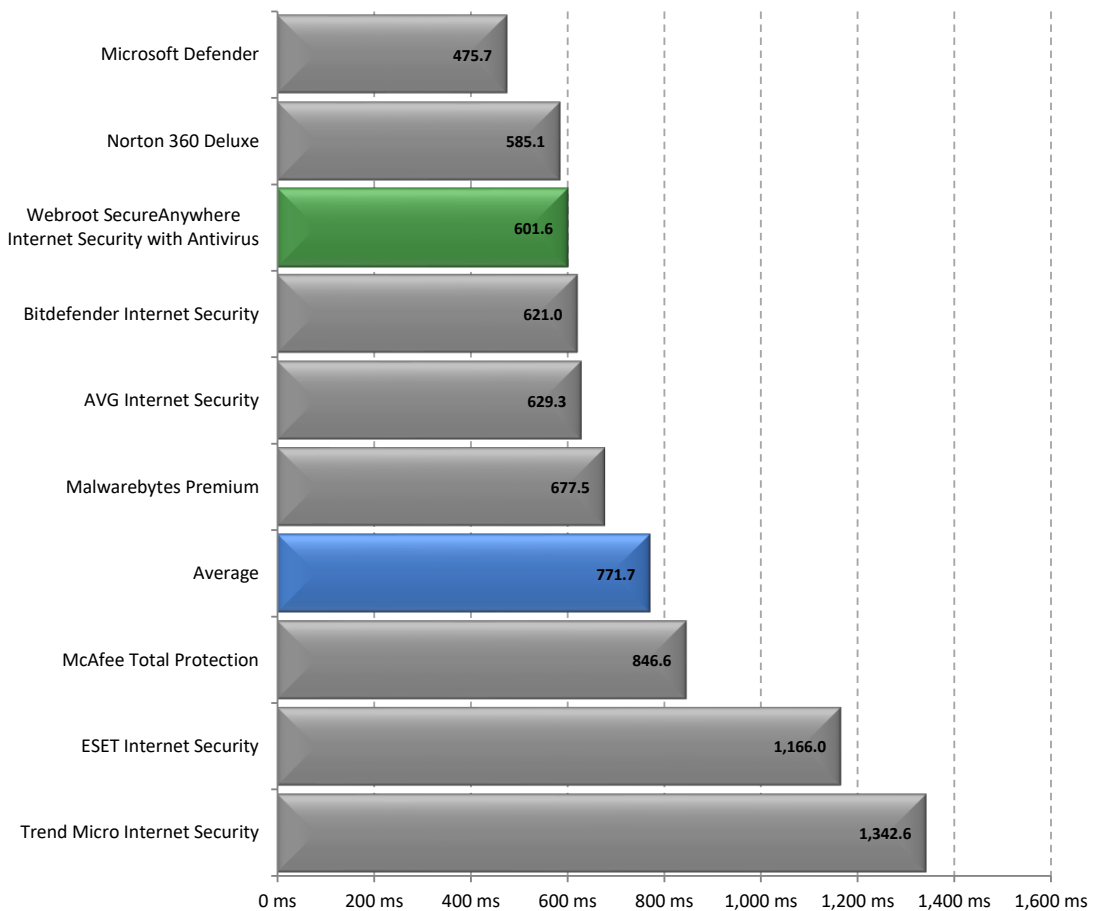
Benchmark 9 – Memory Usage during System Idle

The following chart compares the average amount of RAM in use by an Antivirus product during a period of system idle. This average is taken from a sample of ten memory snapshots taken at roughly 60 seconds apart after reboot. Products with lower idle RAM usage are considered better performing products in this category.

Product	MB
Webroot SecureAnywhere Internet Security with Antivirus	41.50
Norton 360 Deluxe	70.07
ESET Internet Security	79.69
Trend Micro Internet Security	221.94
Microsoft Defender	264.39
Average	275.67
AVG Internet Security	297.11
Malwarebytes Premium	302.00
McAfee Total Protection	336.13
Bitdefender Internet Security	868.20
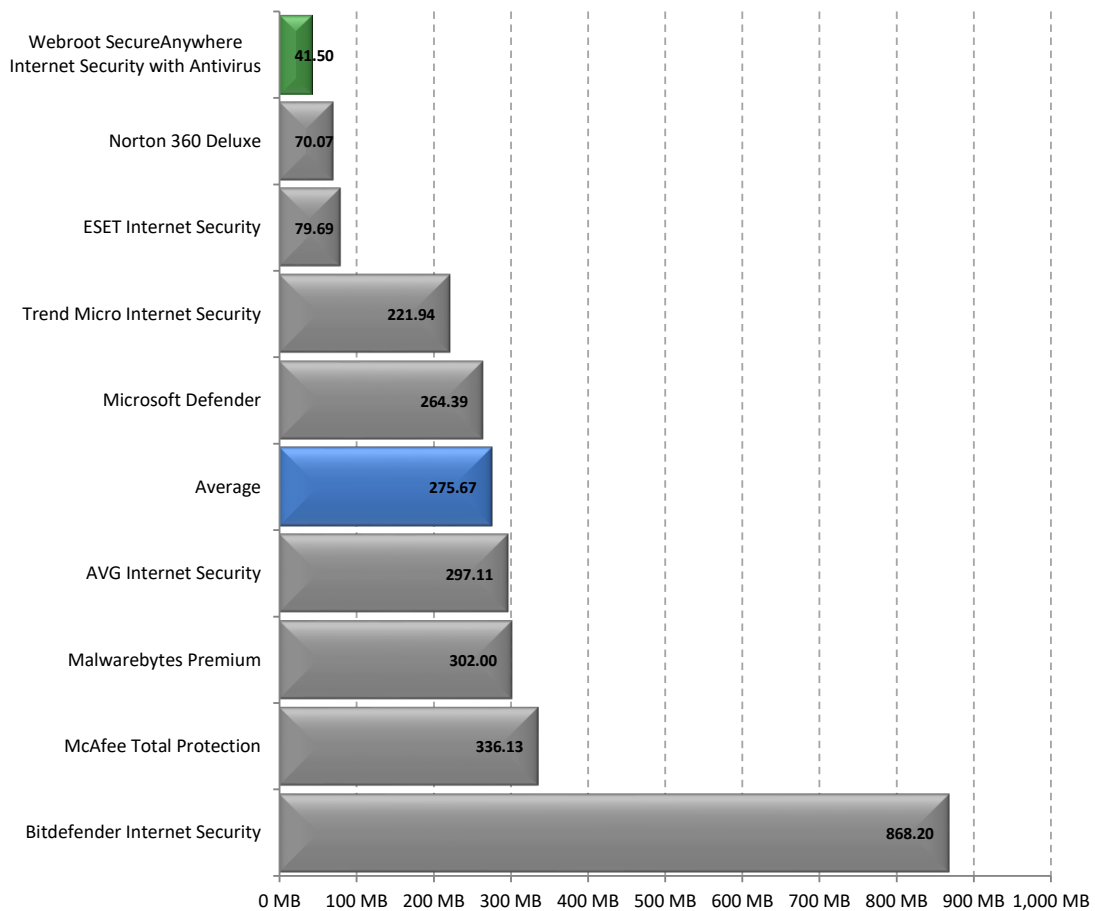
Benchmark 10 – Memory Usage during Initial Scan

The following chart compares the average amount of RAM in use by an Antivirus product during an initial scan on the system drive. The average RAM usage is obtained from a sample of ten memory snapshots taken at five seconds interval. Products that use less memory during a scan are considered better performing products in this category.

Product	MB
Webroot SecureAnywhere Internet Security with Antivirus	71.51
ESET Internet Security	186.89
Norton 360 Deluxe	187.38
AVG Internet Security	440.09
Trend Micro Internet Security	452.19
Microsoft Defender	480.76
Average	541.24
McAfee Total Protection	924.90
Bitdefender Internet Security	1,000.23
Malwarebytes Premium	1,127.18

Benchmark 11 – Browse Time

The following chart compares the average time taken for the Google Chrome browser to successively load a set of popular websites hosted on a local server. Products with lower browse times are considered better performing products in this category.

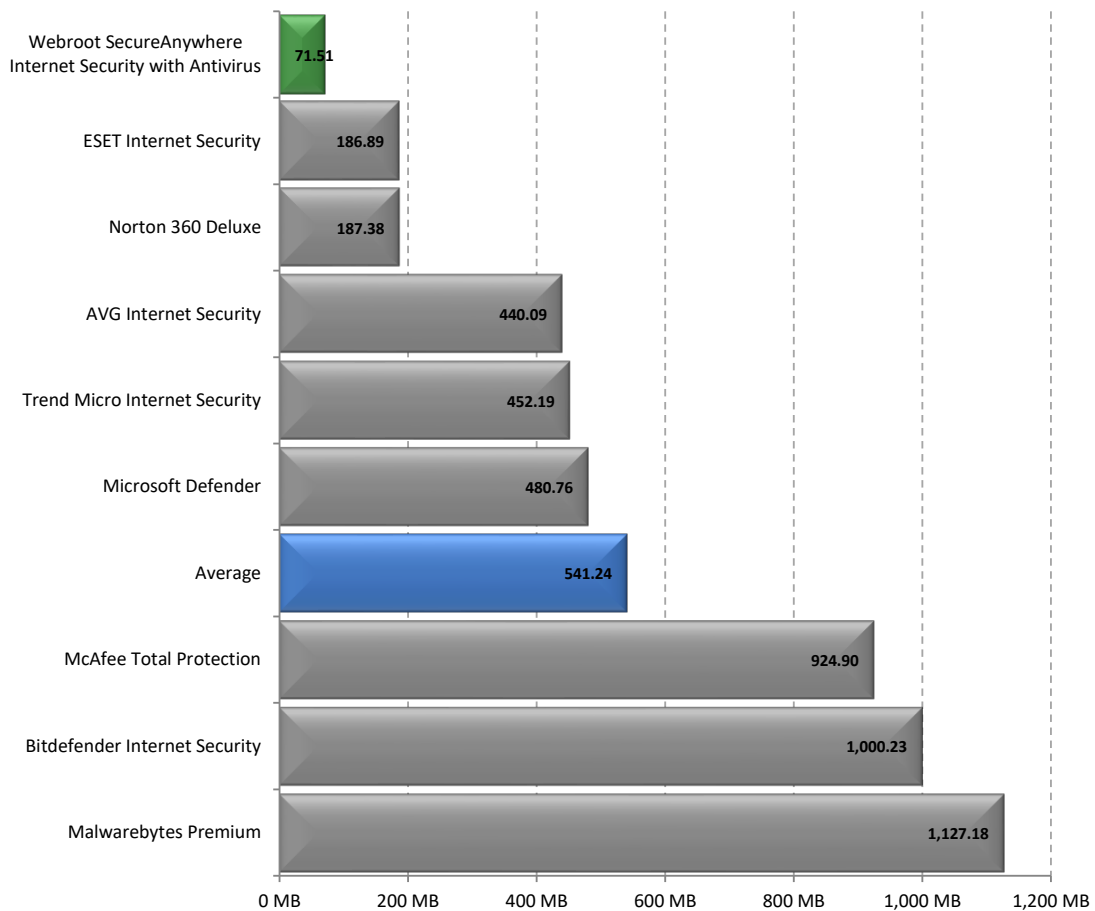| Product	Browse Time (s)
McAfee Total Protection	12.57
Webroot SecureAnywhere Internet Security with Antivirus	12.61
Malwarebytes Premium	13.14
Norton 360 Deluxe	14.55
ESET Internet Security	15.66
Trend Micro Internet Security	16.46
Microsoft Defender	16.71
Average	17.13
Bitdefender Internet Security	24.03
AVG Internet Security	28.43
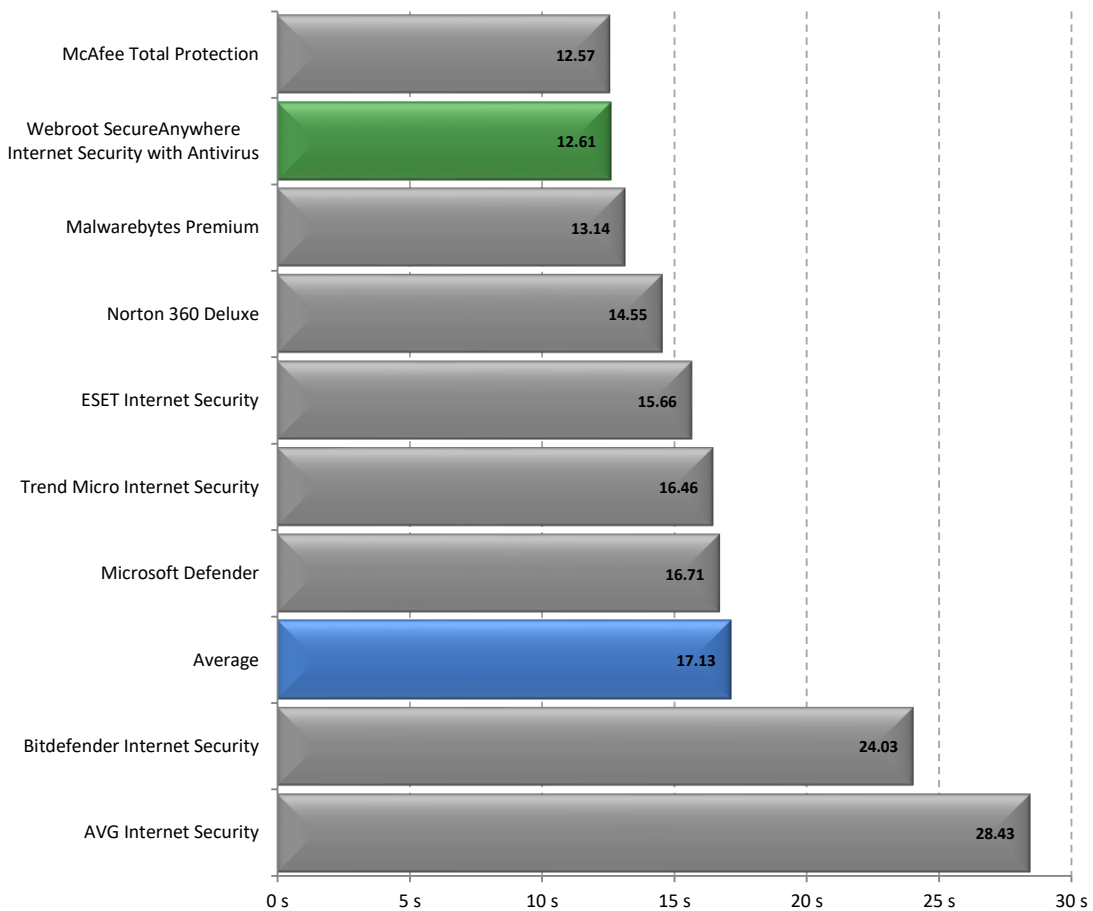
Benchmark 12 – File Copy, Move and Delete

The following chart compares the average time taken to copy, move and delete several sets of sample files for each Antivirus product tested. Products with lower times are considered better performing products in this category.

Product	Time (s)
Microsoft Defender	3.11
McAfee Total Protection	3.44
AVG Internet Security	4.09
Norton 360 Deluxe	4.24
Webroot SecureAnywhere Internet Security with Antivirus	4.35
Average	4.36
Malwarebytes Premium	4.85
Trend Micro Internet Security	4.87
Bitdefender Internet Security	5.09
ESET Internet Security	5.23
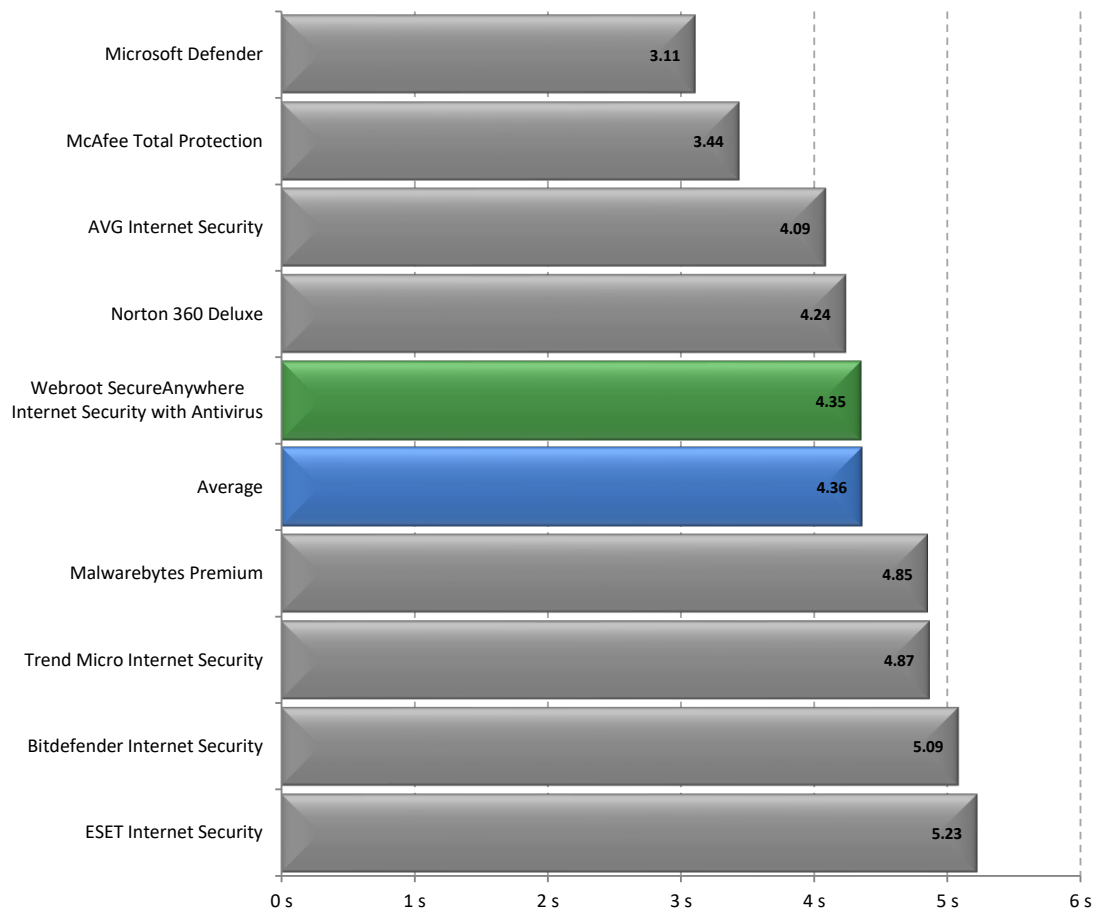
Benchmark 13 – File Format Conversion

The following chart compares the average time it takes for five sample files to be converted from one file format to another (MP3 ↔ WMA, MP3 ↔ WAV) for each security product tested. Products with lower times are considered better performing products in this category.

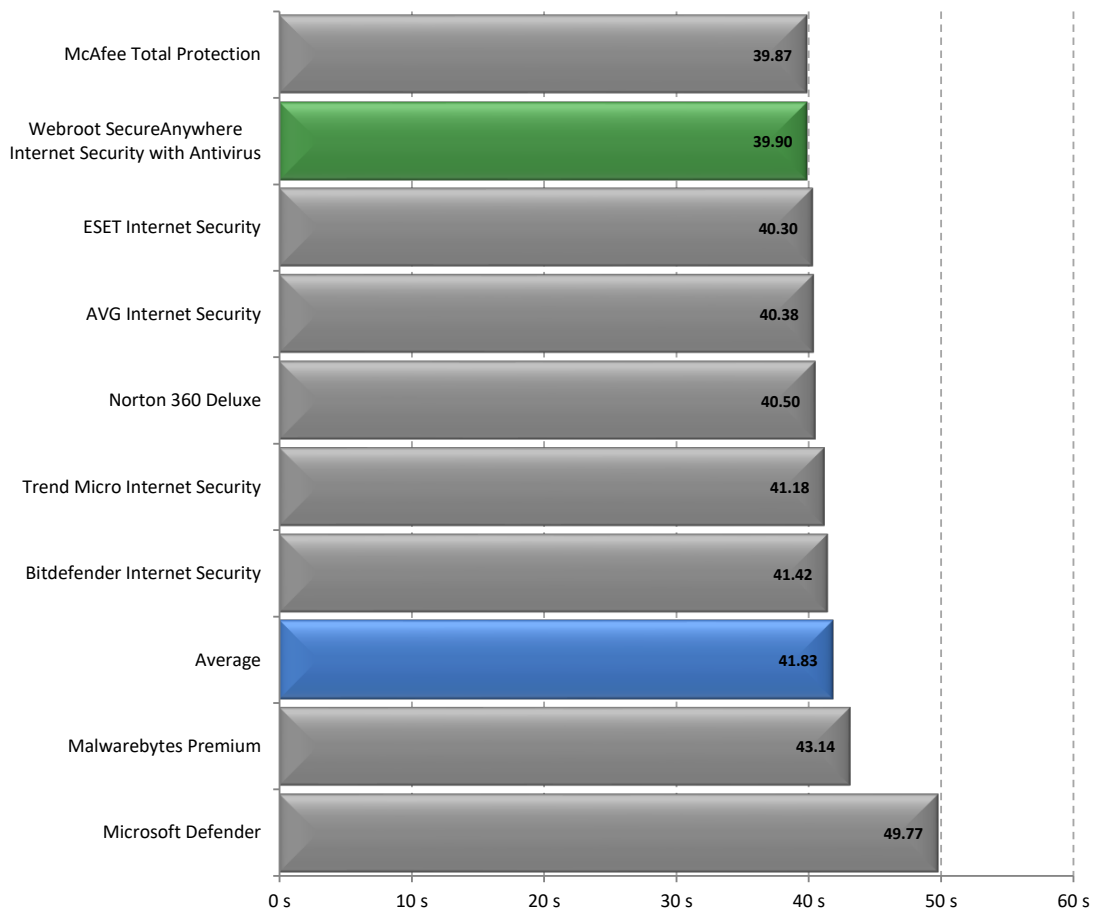| Product	Time (s)
Microsoft Defender	50.34
ESET Internet Security	50.75
Webroot SecureAnywhere Internet Security with Antivirus	52.35
Average	52.57
Norton 360 Deluxe	52.62
AVG Internet Security	52.82
Trend Micro Internet Security	53.14
McAfee Total Protection	53.23
Bitdefender Internet Security	53.94
Malwarebytes Premium	53.99
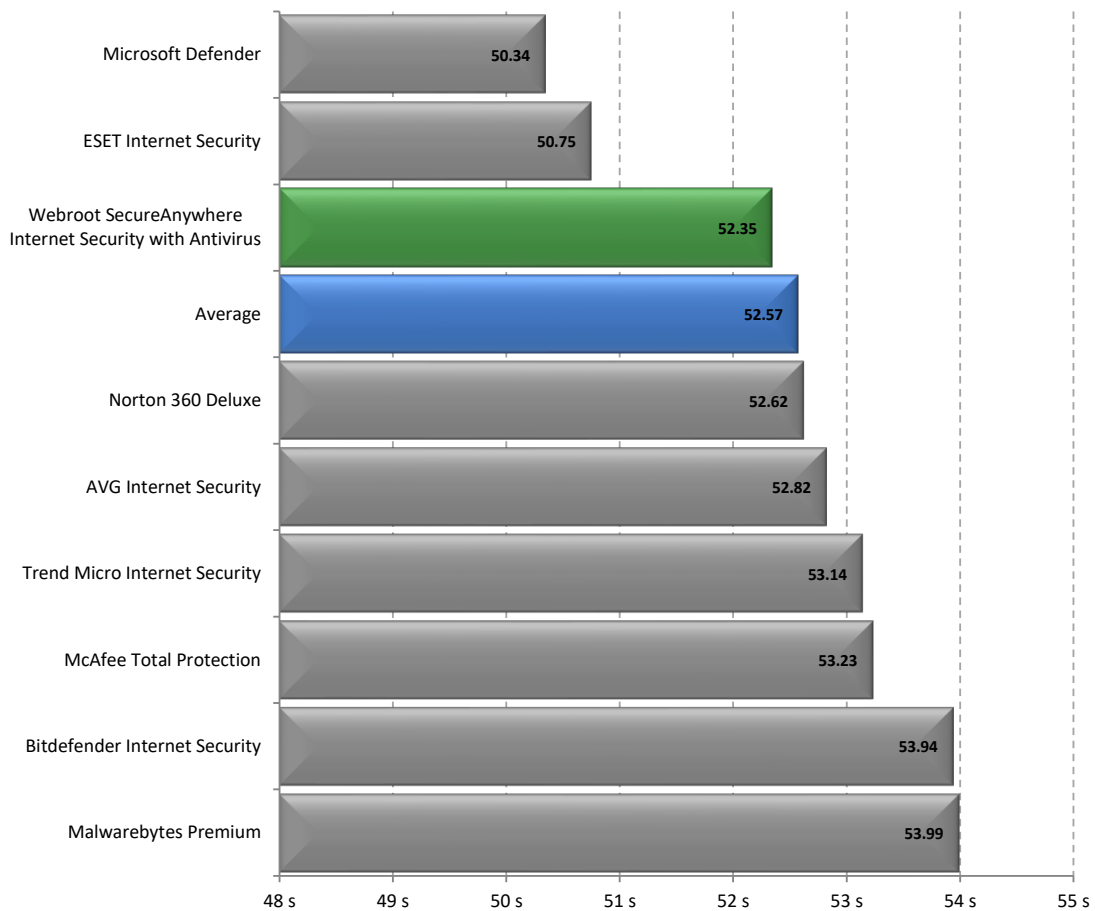
Benchmark 14 – File Compression and Decompression

The following chart compares the average time it takes for sample files to be compressed and decompressed for each security product tested. Products with lower times are considered better performing products in this category.

Product	Time (s)
McAfee Total Protection	39.87
Webroot SecureAnywhere Internet Security with Antivirus	39.90
ESET Internet Security	40.30
AVG Internet Security	40.38
Norton 360 Deluxe	40.50
Trend Micro Internet Security	41.18
Bitdefender Internet Security	41.42
Average	41.83
Malwarebytes Premium	43.14
Microsoft Defender	49.77

Benchmark 15 – File Write, Open and Close

The following chart compares the average time it takes for a file to be written to the hard drive then opened and closed 180,000 times. Products with lower times are considered better performing products in this category.
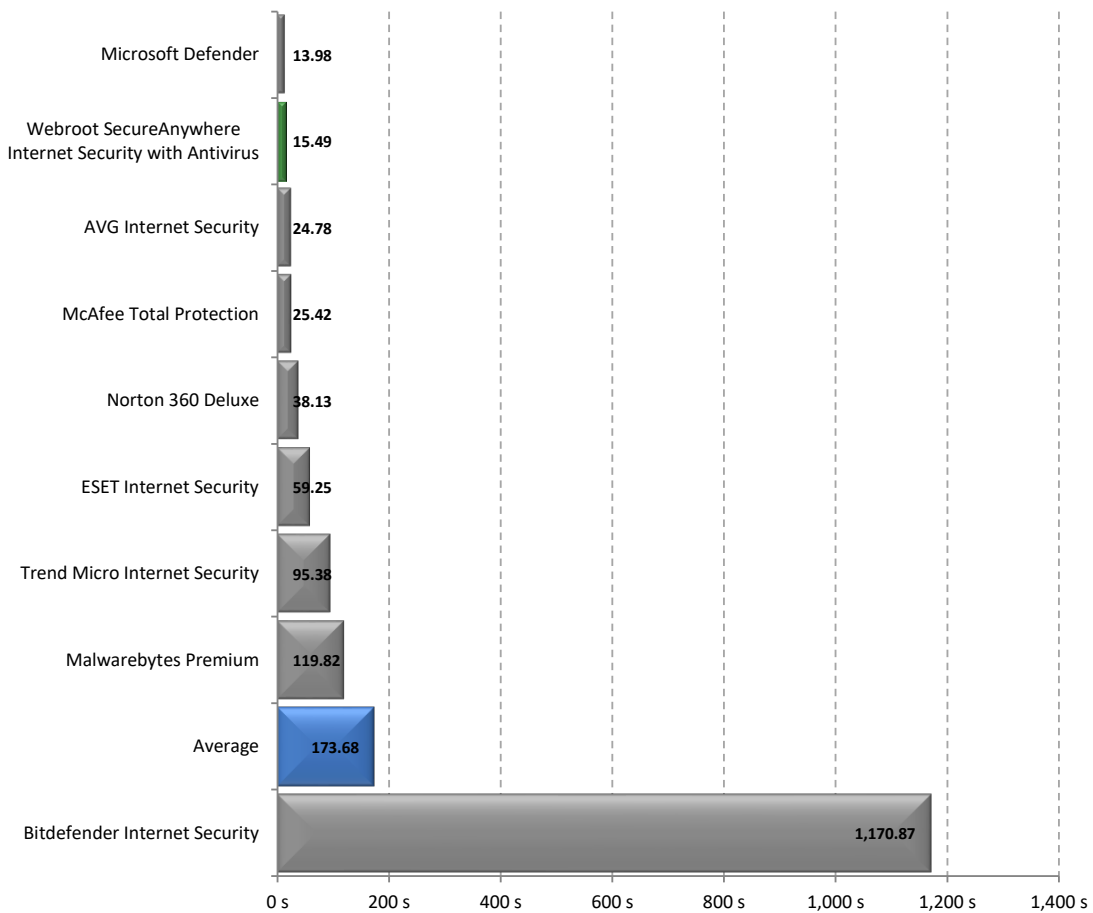
Disclaimer and Disclosure

This report only covers versions of products that were available at the time of testing. The tested versions are as noted in the "Products and Versions" section of this report. The products we have tested are not an exhaustive list of all products available in these very competitive product categories.

Disclaimer of Liability

While every effort has been made to ensure that the information presented in this report is accurate, PassMark Software Pty Ltd assumes no responsibility for errors, omissions, or out-of-date information and shall not be liable in any manner whatsoever for direct, indirect, incidental, consequential, or punitive damages resulting from the availability of, use of, access of, or inability to use this information.

Disclosure

Webroot Inc. funded the production of this report. The list of products tested and the metrics included in the report were selected by Webroot.

Trademarks

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Appendix 1 – Test Environment

PassMark Software set up the test environment with the following hardware specifications:

Testing Machine

Model:	Lenovo H50W-50 i5
CPU:	Intel Core i5-4460 CPU @ 3.20GHz
Video Card:	NVIDIA GeForce GT 705
RAM:	8GB DDR3 RAM
Main Boot Drive:	Samsung SSD 850 PRO 512GB
2nd Drive:	Samsung SSD 850 PRO 512GB
3rd Drive:	Seagate HDD 1TB (7200 RPM)
Network:	1Gbps (Connected via Gigabit Ethernet cable)
O/S:	Windows 10 Pro Version 2004 (OS Build 19041.508)

For network tests, PassMark Software used a server with the following specifications:

Testing Server

Motherboard:	Intel S1200BTL Server Motherboard
CPU:	Intel Xeon E3-1220 V2 @ 3.10 GHz
Video Card:	Intel Integrated Graphics Card
RAM:	8GB (2x4GB) ECC RAM, 1333 MHz
Hard Drive:	SSD 128GB
Network:	1Gbps (Connected via Gigabit Ethernet cable)
O/S:	Windows Server 2012 Standard

Appendix 2 – Methodology Description

Windows 10 Image Creation

A bootable version of Macrium Reflect (backup and cloning software) was used to create a "clean" baseline image prior to testing. Our aim was to create a baseline image with the smallest possible footprint and reduce the possibility of variation caused by external operating system factors.

The baseline image was restored prior to testing of each different product. This process ensures that we install and test all products on the same, "clean" machine.

The steps taken to create the base Windows 10 image were as follows:

1. Installation and activation of **Windows 10 Pro** Edition.
2. Remove Windows login password.
3. Change User Account Control settings to "Never Notify".
4. Disable *SysMain* to ensure consistent results.
5. Install *HTTP Watch* for Browse Time testing.
6. Install *Windows Assessment and Deployment Kit* for Boot Time testing.
7. Install OSForensics for testing (Installation Size) purposes.
8. Install Windows Updates.
9. Disable Windows Automatic Updates.
10. Create a baseline system image using Macrium Reflect.

Benchmark 1 – Scan Time

This benchmark measures the time it takes for Antivirus product to scan a set of sample files. The sample used was identical in all cases and contained a mixture of system files and Office files. In total there were 6166 files whose combined size was 982 MB. A breakdown of the file types and numbers in the sample dataset is as follows:

File Format	Number	Total Size	File Format	Number	Total Size
DLL	2589	490 MB	FRA	3	880 KB
EXE	694	101 MB	IQY	3	830 bytes
SYS	332	23.3 MB	ISP	3	601 bytes
GIF	302	567 KB	ITA	3	930 KB
DOC	281	64.2 MB	MB	3	4.36 MB
WMF	185	1.78 MB	MML	3	771 KB
PNG	149	1.93 MB	MMW	3	946 KB
HTM/HTML	126	946 KB	NLD	3	1.11 MB
CAT	111	7.25 MB	RAR	3	1.91 MB
NLS	80	6.63 MB	ROM	3	54.1 KB
JPG	70	1.09 MB	SIG	3	19.8 KB
INI	59	1.76 MB	SVE	3	993 KB
ICO	58	58.2 KB	TTF	3	580 KB
MOF	43	6.12 MB	ACS	2	3.8 MB
AX	39	4.48 MB	C	2	28.5 KB
XLS	38	3.62 MB	CMD	2	1.6 KB
CFG	36	141 KB	LO_	2	128 KB

POT	36	2.37 MB	LXA	2	1.19 MB
IME	35	5 MB	MAP	2	3.72 KB
DRV	31	1.19 MB	MDB	2	516 KB
TXT	31	366 KB	MMF	2	1.92 KB
CHM	30	6.28 MB	MSI	2	1.65 MB
OCX	30	6.12 MB	NT	2	4.16 KB
CPL	29	4.42 MB	OBE	2	13.9 KB
MFL	29	2.62 MB	ODC	2	386 bytes
INF	26	1.54 MB	POL	2	488 bytes
TLB	25	2.17 MB	RLL	2	112 KB
DOT	24	1.55 MB	TAB	2	160 KB
HLP	22	3.44 MB	TSK	2	2.25 KB
IMD	20	18 MB	XLA	2	79 KB
PY	20	79.2 KB	ACL	1	37 KB
[NO EXTENSION]	19	3.29 MB	BMP	1	234 KB
MSC	18	752 KB	BTR	1	1.25 MB
VBS	18	838 KB	BUD	1	93 KB
XML	18	574 KB	CHK	1	8 KB
RTF	16	62.1 MB	CHS	1	1.65 KB
ECF	15	15.6 KB	CHT	1	1.65 KB
INC	15	27.3 KB	CNV	1	52 KB
COM	14	282 KB	CPI	1	124 KB
DAT	14	1.83 MB	DATA	1	5.99 MB
LOG	14	4.53 MB	DB	1	17.5 KB
TSP	14	1.22 MB	DBL	1	2.13 KB
XSL	14	44.3 KB	DHS	1	138 bytes
H	12	56.5 KB	DICT	1	18 KB
TBL	13	606 KB	DIZ	1	428 bytes
AW	12	2.59 MB	DLS	1	3.28 MB
FAE	12	1.02 MB	DPC	1	414 bytes
JS	12	429 KB	ENG	1	751 bytes
SCR	12	2.5 MB	GRA	1	182 KB
VSD	12	1.67 MB	HOL	1	269 KB
ZIP	11	25.2 MB	HTC	1	28 KB
[HIDDEN FILES]	11	-	HXX	1	6.55 KB
PNF	10	1 MB	ICS	1	375 bytes
ACM	9	836 KB	IMG	1	66.2 KB
ICM	9	192 KB	JPN	1	2.01 KB
LEX	9	10.3 MB	KOR	1	2 KB
PPT	9	4.46 MB	LOCAL	1	0 bytes
MANIFEST	8	5.96 KB	MOD	1	2.03 KB
UCE	8	240 KB	MST	1	3.99 MB
ACG	7	780 KB	NVU	1	2.74 KB
OLB	7	1.34 MB	OPS	1	2.26 KB
WAV	7	5.03 MB	PAT	1	42 bytes
WIZ	7	1.11 MB	PRF	1	6.62 KB
BIN	6	25 MB	PRO	1	20.7 KB
GPD	6	112 KB	RAM	1	64 bytes
CNT	5	4.15 KB	RAT	1	3.09 KB
DUN	5	2.46 KB	RSP	1	4.19 KB
MPP	5	1.83 MB	SCF	1	75 bytes
PIP	5	12.5 KB	SDB	1	1.03 MB
SAM	5	305 KB	SDF	1	888 bytes

ADM	4	1.64 MB		SLL	1	471 KB
BAT	4	22.4 KB		SPD	1	1.6 MB
CPX	4	6.46 KB		SQL	1	748 KB
FON	4	61.3 KB		SVG	1	77.5 KB
SCP	4	8.53 KB		THA	1	697 bytes
SEP	4	6.79 KB		TPL	1	10.5 KB
CSS	3	11.4 KB		TRM	1	4 KB
DEU	3	1.45 MB		VXD	1	81 bytes
DTD	3	22.6 KB		WMA	1	2.5 MB
ENU	3	999 KB		WMV	1	649 KB
ESN	3	815 KB		WSC	1	39.5 KB
				Total	**6166**	**982 MB**

This scan was run by right clicking the dataset folder and choosing the "Scan Now" option. To record the scan time, we have used product's built-in scan timer or reporting system. Where this was not possible, scan times were measured manually with a stopwatch.

For each product, five samples were taken with the machine rebooted before each sample to clear any caching effects by the operating systems. In the past, many products have shown a substantial difference between the initial scan time (first scan) and subsequent scan times (scans 2 to 5). We believe this behavior is due to products themselves caching recently scanned files. As a result of this mechanism, we have averaged the four subsequent scan times to obtain an average subsequent scan time. Our final result for this test is an average of the subsequent scan average and the initial scan time.

Benchmark 2 – Scheduled Scan Time

This test measures the time required by the Antivirus software to complete a scheduled scan on the system. The default scan options were used and the scan was scheduled to run at the next convenient time. C:\ Drive was selected for scanning when the Antivirus software asked to select a scan target. The scan was run three times with a reboot between each run to remove potential caching effects. The result is calculated as a weighted average with a 50% weighting on the initial scan and a 50% weighting on the subsequent scans. Where this option is not available or the scheduling appears to be unreliable, the product is omitted from the metric, and given the lowest score for this metric.

Benchmark 3 – Installation Size

OSForensics software was used to create the initial and post-installation disk signatures for each product. These disk signatures record the number of files and directories, and complete details of all files on the drive (including file name, file size, checksum, etc.) at the time of the signature is taken.

The initial disk signature was taken immediately prior to installation of the product. A subsequent disk signature was taken immediately following a system reboot after product installation and updates. Then we compared the two signatures and calculated the total disk space consumed by files that were new, modified, and deleted during product installation. Our result for this metric is the sum of total new and modified size.

Benchmark 4 – Installation Time

This test measures the minimum Installation Time a product requires to be fully functional and ready for use by the end user. Installation time can usually be divided in three major phases:

- The **Extraction and Setup phase** consists of file extraction, the EULA prompt, product activation and user configurable options for installation.

- The **File Copy phase** occurs when the product is being installed; usually this phase is indicated by a progress bar.

- The **Post-Installation phase** is any part of the installation that occurs after the File Copy phase. This phase varies widely between products; the time recorded in this phase may include a required reboot to finalize the installation or include the time the program takes to become idle in the system tray.

To reduce the impact of disk drive variables, each product was copied to the local disk before initializing installation. Each step of the installation process was manually timed with a stopwatch and recorded in as much detail as possible. Where input was required by the end user, the stopwatch was paused and the input noted in the raw results in parenthesis after the phase description.

Where possible, all requests by products to pre-scan or post-install scan were declined or skipped. Where it was not possible to skip a scan, the time to scan was included as part of the installation time. Where an optional component of the installation formed a reasonable part of the functionality of the software, it was also installed (e.g. website link checking software as part of an Antivirus product).

Installation time includes the time taken by the product installer to download components required in the installation. This may include mandatory updates or the delivery of the application itself from a download manager. We have noted in our results where a product has downloaded components for product installation.

We have excluded product activation times due to network variability in contacting vendor servers or time taken in account creation.

Benchmark 5 – Registry Keys Added

This test measures the number of keys and values added to registry, after rebooting the test machine following a successful product installation. The test was conducted using *OSForensics* software to count the number of keys added under HKEY_LOCAL_MACHINE and HKEY_USERS. The *OSForensics* Signatures feature was used to take a snapshot of the Windows Registry before and after installation of Antivirus products, and the signatures were compared so that the new keys can be identified.

Benchmark 6 – Boot Time

PassMark Software used the *Windows Performance Toolkit* (as part of the Windows Assessment and Deployment Kit obtainable from the Microsoft Website) tool to run this test.

The test was executed as an individual assessment via the Windows Assessment Console. The network connection was disabled to avoid interruption. The final result is taken as the total boot duration excluding BIOS load time.

Benchmark 7 – User Interface Launch Time

The launch time of a product's user interface was taken using *AppTimer*. For each product tested, we obtained a total of fifteen samples from five sets of three UI launches, with a reboot before each set to clear caching effects by the operating system. When compiling the results, the first of each set was separated out so that there was a set of values for the initial launch after reboot and a set for subsequent launches.

We have averaged the subsequent launch times to obtain an average subsequent launch time. Our final result for this test is an average of the subsequent launch average and the initial launch time.

In some cases, *AppTimer* did not correctly record the time taken for UI launch. For instance, some applications would open their window and look like they were ready, but then continued to be unresponsive. Where the measurement from *AppTimer* appeared inaccurate, we have taken the time manually with a stopwatch.

Benchmark 8 – Chrome Launch Time

The average launch time of Chrome interface was taken using *AppTimer*. This test was practically identical to the User Interface launch time test. For each product tested, we obtained a total of fifteen samples from five sets of three Chrome launches, with a reboot before each set to clear caching effects by the operating system. When compiling the results, the first of each set was separated out so that there was a set of values for the initial launch after reboot and a set for subsequent launches.

For this test, we have used *Google Chrome (Version 95)* as our test browser.

We have averaged the subsequent launch times to obtain an average subsequent launch time. Our final result for this test is an average of the subsequent launch average and the initial launch time.

Benchmark 9 – Memory Usage during System Idle

The *PerfLog++* utility was used to record process memory usage on the system at boot, and then every minute for another fifteen minutes after. This was done only once per product and resulted in a total of 15 samples. The first sample taken at boot is discarded.

The *PerfLog++* utility records memory usage of all processes, not just those of the anti-malware product. As a result of this, an anti-malware product's processes needed to be isolated from all other running system processes. To isolate relevant process, we used a program called *Process Explorer* which was run immediately upon the completion of memory usage logging by *PerfLog++*.

Benchmark 10 – Memory Usage during Initial Scan

The *PerfLog++* utility was used to record memory usage on the system while a malware scan is in progress. Please refer to the metric "**Memory Usage during System Idle**" above for a description of the *PerfLog++* utility and an explanation of the method by which memory usage is calculated.

As some products cache scan locations, we take reasonable precautions to ensure that the Antivirus software does not scan the C:\ drive at any point before conducting this test. A manual scan on the C:\ drive is initiated at the same time as the *PerfLog++* utility, enabling *PerfLog++* to record memory usage for 60 seconds at five second intervals.

Benchmark 11 – Browse Time

We used JavaScript to load a list of 108 'popular' websites consecutively from a local server. Front pages of high traffic websites were used in this test including shopping, social, news, finance and reference websites.

On each page of the sample data, a few lines of JavaScript were added to execute the JavaScript that loads the next website. Then the start and end times were recorded to get the final result.

For this test, we have used *Google Chrome (Version 95)*.

The Browse Time test was executed five times and our final result was an average of these five samples.

Benchmark 12 – File Copy, Move and Delete

This test measures the amount of time required for the system to copy, move and delete samples of files in various file formats. A breakdown of the file types and numbers in the sample dataset is as follows:

File Format	Number	Total Size
DOC	24	91.6 MB
DOCX	12	48.8 MB
PPT	9	126 MB
PPTX	9	74.4 MB
XLS	12	51.5 MB
XLSX	12	14.6 MB
PDF	219	323 MB
JPG	1045	135 MB
GIF	27	82.4 MB
PNG	5	483 KB
MOV	7	54.7 MB
RM	1	5.39 MB
AVI	24	130 MB
WMV	5	43.9 MB
MP3	84	356 MB
EXE	38	5.62 MB
DLL	208	56.6 MB
AX	2	36 KB
CPL	4	4.02 MB
CPX	4	8.56 KB
DRV	20	302 KB
ICO	2	210 KB
MSC	2	81.2 KB
NT	2	3.28 KB
ROM	4	71.4 KB
SRC	4	4.28 MB
SYS	4	88.12 KB
TLB	6	264 KB
TSK	2	2.24 KB
UCE	2	44.8 KB
Total	**1800**	**1.57 GB**

This test was conducted five times to obtain the average time to copy, move and delete the sample files, with the test machine rebooted between each sample to remove potential caching effects.

Benchmark 13 – File Format Conversion

This test measures the time it takes to convert five (5) different MP3 files into WAV files and subsequently, convert the same MP3 samples into a WMA files. The total size of the files was 24.6 MB.

To encode the MP3 into another format, we used an application called *ffmpeg.exe*. The format conversion process was timed using *CommandTimer.exe*.

This test was conducted five times to obtain the average conversion speed between these formats, with the test machine rebooted between each sample to remove potential caching effects.

Benchmark 14 – File Compression and Decompression

This test measures the amount of time required to compress and decompress a sample set of files. *CommandTimer.exe* tool recorded the amount of time required for *7zip.exe* to compress the files into a *.zip and subsequently decompress the created *.zip file.

A breakdown of the file types and numbers in the sample dataset is as follows:

File Type	Number	Total Size
Document Files	78	97.9 MB
Image Files	1073	113 MB
Video Files	65	568 MB
Total	**1216**	**783 MB**

This test was conducted five times to obtain the average file compression and decompression speed, with the test machine rebooted between each sample to remove potential caching effects.

Benchmark 15 – File Write, Open and Close

This benchmark was derived from Oli Warner's File I/O test at http://www.thepcspy.com (please see *Reference #1: What Really Slows Windows Down*).

For this test, we developed *OpenClose.exe*, an application that looped writing a small file to disk, then opening and closing that file. *CommandTimer.exe* was used to time how long the process took to complete 180,000 cycles.

This test was conducted five times to obtain the average file writing, opening and closing speed, with the test machine rebooted between each sample to remove potential caching effects.