



CONSUMER REPORT

April - June 2016



SE Labs tested a range of anti-malware (aka 'anti-virus'; aka 'endpoint security') products from a range of well-known vendors in an effort to judge which were the most effective.

Each product was exposed to the same threats, which were a mixture of targeted attacks using well-established techniques and public web-based threats that were found to be live on the internet at the time of the test.

The results indicate how effectively the products were at detecting and/or protecting against those threats in real time.



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Document version 1.0. Written 1st August 2016



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INTRODUCTION

Ransomware is a nasty category of attack that we've seen dominating the so-called 'threat landscape' in recent months. It can affect every type of computer user including home users, small businesses and even extremely large enterprises. Anyone who stores valuable data on a computer is at risk of this digital extortion racket, which encrypts data files and offers the key to recovery for a hefty price.

Over the last three months we have been monitoring the threats that affect real users and businesses. We've used many of these attacks to test systems protected by a range of different security products, including some very well-known anti-malware programs.

Because we're seeing a lot of ransomware on the internet, and because we believe that testing security products should revolve around the significant threats out there (rather than the very obscure, rare ones), there was a large amount of ransomware used in the test. We are proud to present the results of that work in this report.

While testing we noticed an interesting problem with anti-malware products and threats that damage data on the victim's system. Sometimes detecting and removing a threat can be useless, or even harmful, if it's done too late.

Stopping ransomware before it can start causing harm is crucial. And so is ensuring your data's safety. That's why, in addition to this report, we've written some guides to help. You can find these on our blog, which includes **an introduction to ransomware**, **10 ways to stay safe from ransomware** and a **guide to online backup services** that are particularly suitable for foiling ransomware.

As in our last report, we also included a series of 'targeted attacks', such as those often discussed in the press.

SE Labs uses current threat intelligence to make our tests as realistic as possible. To learn more about how we test, how we define 'threat intelligence' and how we use it to improve our tests please visit our website and follow us on Twitter.

EXECUTIVE SUMMARY

Product names

It is good practice to stay up to date with the latest version of your chosen endpoint security product. We made best efforts to ensure that each product tested was the very latest version running with the most recent updates to give the best possible outcome.

For specific build numbers, see Appendix C: Product versions on page 19.

Products tested

PRODUCT	PROTECTION ACCURACY	LEGITIMATE ACCURACY	TOTAL ACCURACY
Kaspersky Internet Security	99%	100%	100%
ESET Smart Security 9	99%	100%	100%
Norton Security	97%	96%	96%
Avast Free Antivirus	86%	100%	96%
BitDefender Internet Security 2016	82%	100%	94%
Trend Micro Internet Security 10	87%	96%	93%
Microsoft Security Essentials	71%	100%	90%
AVG AntiVirus Free Edition	63%	100%	88%
McAfee Internet Security	36%	100%	79%

Products highlighted in green were the most accurate, scoring 85 per cent or more for Total Accuracy. Those in yellow scored less than 85 but 75 or more. Products shown in red scored less than 75 per cent. For exact percentages, see 1. Total Accuracy Ratings on page 6.

- **The endpoints were effective at handling general threats from cyber criminals...**

All products were capable of handling public web-based threats such as those used by criminals to attack Windows PCs and install ransomware automatically, without having to trick a user into clicking an install button.

- **... but targeted attacks posed more of a challenge**

While most of the products were also very competent at blocking more targeted, exploit-based attacks a few were much less effective. Products with below average protection included those from AVG, Microsoft and BitDefender.

- **False positives were not an issue for most products**

With the notable exception of products from Symantec (Norton) and Trend Micro, all endpoint solutions were good at correctly classifying legitimate applications and websites. Seven out of the nine products made no mistakes at all.

- **Which products were the most effective?**

Kaspersky Lab, ESET, Symantec (Norton) and Avast products achieved the best results due to a combination of their ability to block malicious URLs, handle exploits and correctly classify legitimate applications and websites.

Simon Edwards, SE Labs, 1st August 2016

1. TOTAL ACCURACY RATINGS

Judging the effectiveness of an endpoint security product is a subtle art, and many factors are at play when assessing how well it performs. To make things easier we've combined all the different results from this report into one easy-to-understand graph.

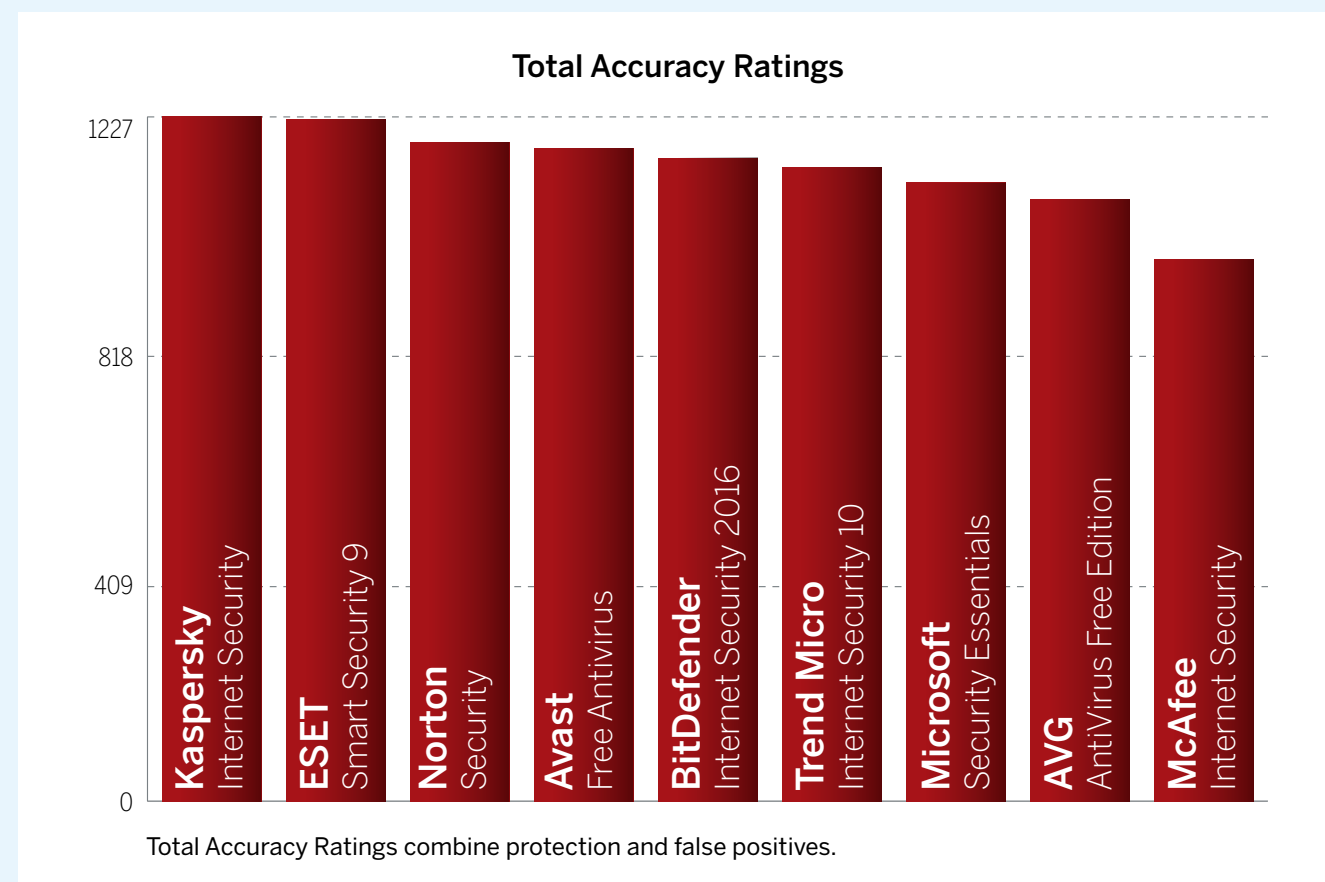
The graph below takes into account not only each product's ability to detect and protect against threats, but also its handling of non-malicious objects such as web addresses (URLs) and applications.

Not all protections, or detections for that matter, are equal. A product might completely block a URL, which prevents the threat completely before it can even start its intended series of malicious events. Alternatively, the product might allow a web-based exploit to execute but

prevent it from downloading any further code to the target. In another case malware might run on the target for a short while before its behaviour is detected and its code is deleted or moved to a safe 'quarantine' area for future analysis. We take these outcomes into account when attributing points that form final ratings.

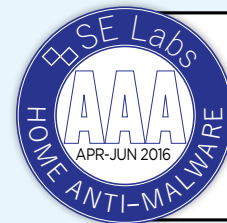
For example, a product that completely blocks a threat is rated more highly than one which allows a threat to run for a while before eventually evicting it. Products that allow all malware infections, or that block popular legitimate applications, are penalised heavily.

Categorising how a product handles legitimate objects is complex, and you can find out how we do it in 5. Legitimate Software Ratings on page 12.



Awards

The following products win SE Labs awards:

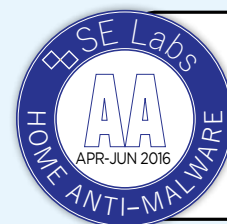


● Kaspersky Internet Security

● Norton Security

● ESET Smart Security 9

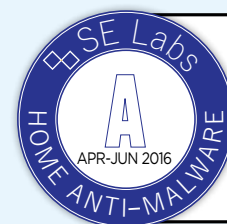
● Avast Free Antivirus



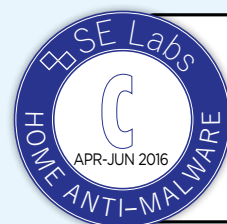
● BitDefender Internet Security 2016

● Microsoft Security Essentials

● Trend Micro Internet Security 10



● AVG AntiVirus Free Edition



● McAfee Internet Security

TOTAL ACCURACY RATINGS			
Product	Total Accuracy Rating	Total Accuracy (%)	Award
Kaspersky Internet Security	1227	100%	AAA
ESET Smart Security 9	1226	100%	AAA
Norton Security	1185	96%	AAA
Avast Free Antivirus	1175	96%	AAA
BitDefender Internet Security 2016	1157	94%	AA
Trend Micro Internet Security 10	1140	93%	AA
Microsoft Security Essentials	1113	90%	AA
AVG AntiVirus Free Edition	1083	88%	A
McAfee Internet Security	974	79%	C

2. PROTECTION RATINGS

The results below indicate how effectively the products dealt with threats. Points are earned for detecting the threat and for either blocking or neutralising it.

- Detected (+1)**
 If the product detected the threat with any degree of useful information, we award it one point.
- Blocked (+2)**
 Threats that are disallowed from even starting their malicious activities are blocked. Blocking products score two points.

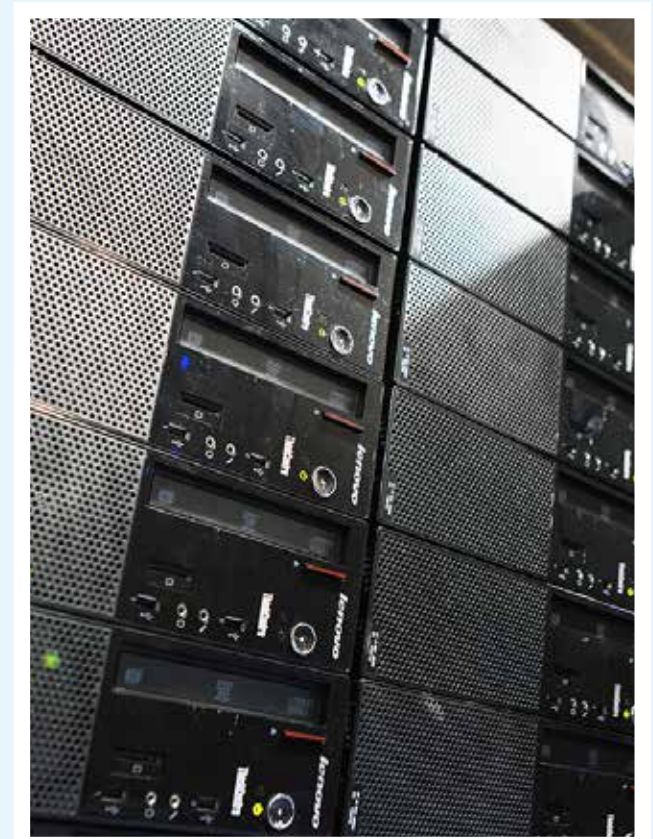
- Neutralised (+1)**
 Products that kill all running malicious processes 'neutralise' the threat and win one point.
- Complete remediation (+1)**
 If, in addition to neutralising a threat, the product removes all significant traces of the attack, it gains an additional one point.
- Compromised (-5)**
 If the threat compromised the system, the product loses five points. This loss may be reduced to four points if it manages to detect the threat (see Detected, above), as this at least alerts the user, who may now take steps to secure the system.

Rating calculations
 We calculate the protection ratings using the following formula:

$$\text{Protection rating} = (1 \times \text{number of Detected}) + (2 \times \text{number of Blocked}) + (1 \times \text{number of Neutralised}) + (1 \times \text{number of Complete remediation}) + (-5 \times \text{number of Compromised})$$

The 'Complete remediation' number relates to cases of neutralisation in which all significant traces of the attack were removed from the target. Such traces should not exist if the threat was 'Blocked' and so Blocked results imply Complete remediation.

These ratings are based on our opinion of how important these different outcomes are. You may have a different view on how seriously you treat a 'Compromise' or 'Neutralisation without complete remediation'. If you want to create your own rating system, you can use the raw data from 4. Protection Details on page 11 to roll your own set of personalised ratings.



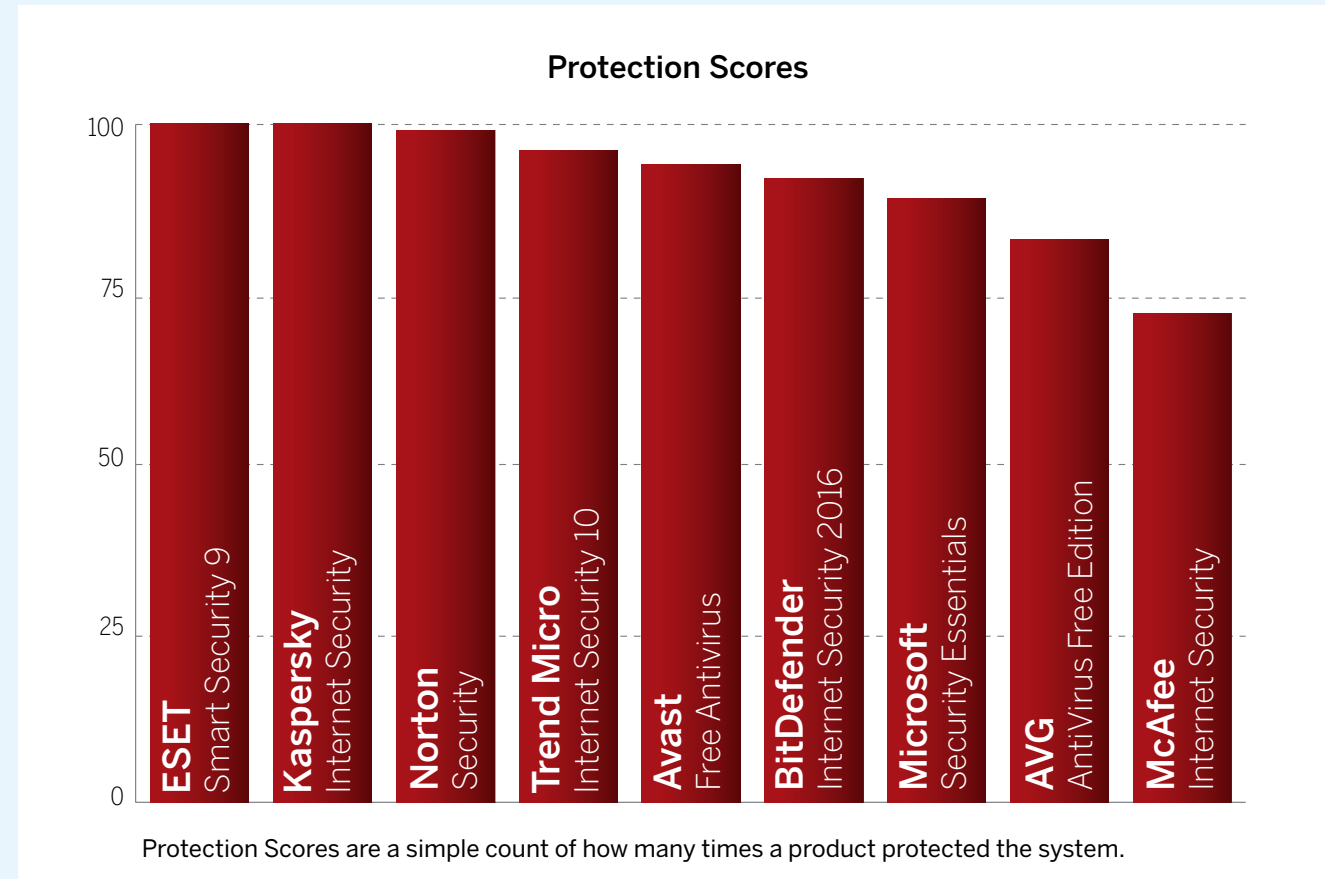
PROTECTION RATINGS		
Product	Protection Rating	Protection Rating (%)
Kaspersky Internet Security	397	99%
ESET Smart Security 9	396	99%
Norton Security	387	97%
Trend Micro Internet Security 10	346	87%
Avast Free Antivirus	345	86%
BitDefender Internet Security 2016	327	82%
Microsoft Security Essentials	283	71%
AVG AntiVirus Free Edition	253	63%
McAfee Internet Security	144	36%

Average: 80%

3. PROTECTION SCORES

This graph shows the overall level of protection, making no distinction between neutralised and blocked incidents.

For each product we add Blocked and Neutralised cases together to make one simple tally.



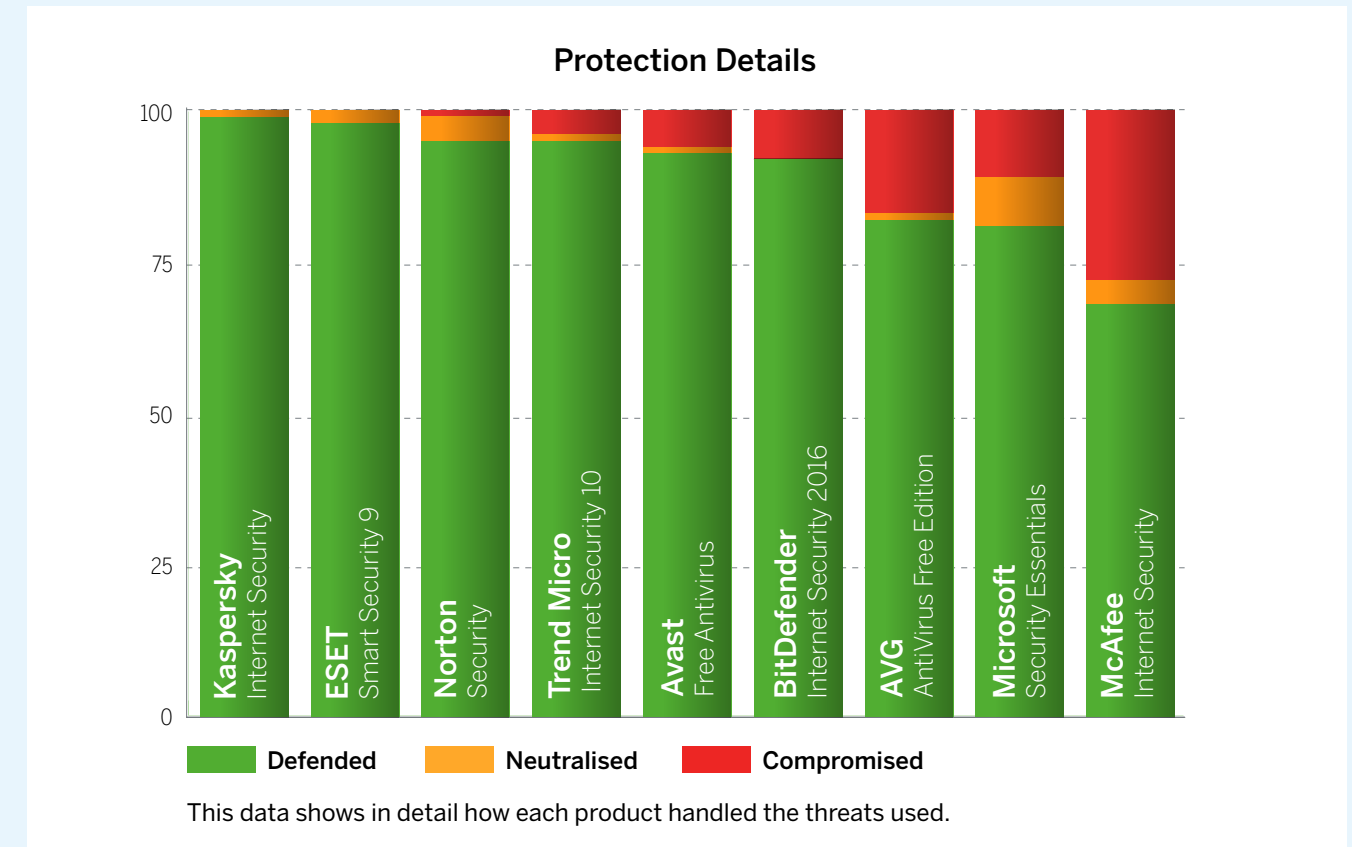
PROTECTION SCORES	
Product	Protection Score
ESET Smart Security 9	100
Kaspersky Internet Security	100
Norton Security	99
Trend Micro Internet Security 10	96
Avast Free Antivirus	94
BitDefender Internet Security 2016	92
Microsoft Security Essentials	89
AVG AntiVirus Free Edition	83
McAfee Internet Security	72

4. PROTECTION DETAILS

These results break down how each product handled threats into some detail. You can see how many detected a threat and the levels of protection provided.

Products can also provide protection even if they don't detect certain threats. Some threats abort on detecting specific endpoint protection software.

Products sometimes detect more threats than they



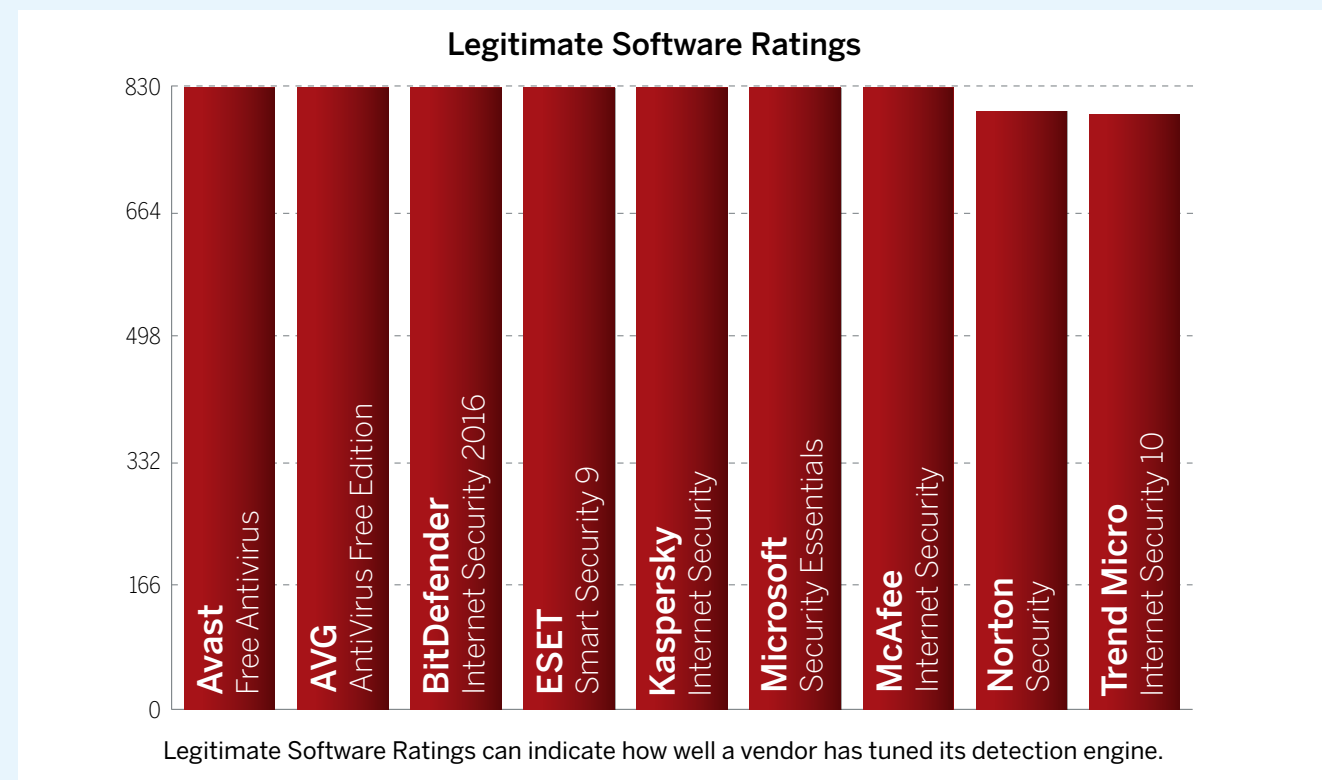
PROTECTION DETAILS					
Product	Detected	Blocked	Neutralised	Compromised	Protected
Kaspersky Internet Security	99	99	1	0	100
ESET Smart Security 9	100	98	2	0	100
Norton Security	100	95	4	1	99
Trend Micro Internet Security 10	80	95	1	4	96
Avast Free Antivirus	94	93	1	6	94
BitDefender Internet Security 2016	91	92	0	8	92
AVG AntiVirus Free Edition	90	82	1	17	83
Microsoft Security Essentials	81	81	8	11	89
McAfee Internet Security	72	68	4	28	72

5. LEGITIMATE SOFTWARE RATINGS

These ratings indicate how accurately the products classify legitimate applications and URLs, while also taking into account the interactions that each product has with the user. Ideally a product will either not classify a legitimate object or will classify it as safe. In neither case should it bother the user.

We also take into account the prevalence (popularity) of the applications and websites used in this part of the test, applying stricter penalties for when products misclassify very popular software and sites.

To understand how we calculate these ratings, see 5.3 Accuracy ratings on page 15.



LEGITIMATE SOFTWARE RATINGS		
Product	Legitimate Accuracy Rating	Legitimate Accuracy (%)
Avast Free Antivirus	830	100%
AVG AntiVirus Free Edition	830	100%
BitDefender Internet Security 2016	830	100%
ESET Smart Security	830	100%
Kaspersky Internet Security	830	100%
McAfee Internet Security	830	100%
Microsoft Security Essentials	830	100%
Norton Security	798	96%
Trend Micro Internet Security 10	794	96%

5.1 Interaction Ratings

It's crucial that anti-malware endpoint products not only stop – or at least detect – threats, but that they allow legitimate applications to install and run without misclassifying them as malware. Such an error is known as a 'false positive' (FP).

In reality, genuine false positives are quite rare in testing. In our experience it is unusual for a legitimate application to be classified as "malware". More often it will be classified as "unknown", "suspicious" or "unwanted" (or terms that mean much the same thing).

We use a subtle system of rating an endpoint's approach to legitimate objects which takes into account how it

classifies the application and how it presents that information to the user. Sometimes the endpoint software will pass the buck and demand that the user decide if the application is safe or not. In such cases the product may make a recommendation to allow or block. In other cases, the product will make no recommendation, which is possibly even less helpful.

If a product allows an application to install and run with no user interaction, or with simply a brief notification that the application is likely to be safe, it has achieved an optimum result. Anything else is a Non-Optimal Classification/Action (NOCA). We think that measuring NOCAs is more useful than counting the rarer FPs.

	None (allowed)	Click to allow (default allow)	Click to allow/block (no recommendation)	Click to block (default block)	None (blocked)	
Object is safe	2	1.5	1			A
Object is unknown	2	1	0.5	0	-0.5	B
Object is not classified	2	0.5	0	-0.5	-1	C
Object is suspicious	0.5	0	-0.5	-1	-1.5	D
Object is unwanted	0	-0.5	-1	-1.5	-2	E
Object is malicious				-2	-2	F
	1	2	3	4	5	

Products that do not bother users and classify most applications correctly earn more points than those that ask questions and condemn legitimate applications.

COUNT OF INTERACTION		
Product	Click to block (default block)	None (allowed)
Avast Free Antivirus		100
AVG AntiVirus Free Edition		100
BitDefender Internet Security 2016		100
ESET Smart Security 9		100
Kaspersky Internet Security		100
McAfee Internet Security		100
Microsoft Security Essentials		100
Norton Security	2	98
Trend Micro Internet Security 10	2	98

5.2 Prevalence ratings

There is a significant difference between an endpoint product blocking a popular application such as the latest version of Microsoft Word and condemning a rare Iranian dating toolbar for Internet Explorer 6. One is very popular all over the world and its detection as malware (or something less serious but still suspicious) is a big deal. Conversely, the outdated toolbar won't have had a comparably large user base even when it was new. Detecting this application as malware may be wrong, but it is less impactful in the overall scheme of things.

With this in mind, we collected applications of varying popularity and sorted them into five separate categories, as follows:

1. Very high impact
2. High impact
3. Medium impact
4. Low impact
5. Very low impact

Incorrectly handling any legitimate application will invoke penalties, but classifying Microsoft Word as malware and blocking it without any way for the user to override this will bring far greater penalties than doing the same for an ancient niche toolbar. In order to calculate these relative penalties, we assigned each impact category with a rating modifier, as shown in the following table.

LEGITIMATE SOFTWARE PREVALENCE RATING MODIFIERS	
Impact category	Rating modifier
Very high impact	5
High impact	4
Medium impact	3
Low impact	2
Very low impact	1

Applications were downloaded and installed during the test, but third-party download sites were avoided and original developers' URLs were used where possible. Download sites will sometimes bundle additional components into applications' install files, which may correctly cause anti-malware products to flag adware. We remove adware from the test set because it is often unclear how desirable this type of code is.

The prevalence for each application and URL is estimated using metrics such as third-party download sites and the data from Alexa.com's global traffic ranking system.

5.3 Accuracy ratings

We calculate legitimate software accuracy ratings by multiplying together the interaction and prevalence ratings for each download and installation:

Accuracy rating = Interaction rating x Prevalence rating

If a product allowed one legitimate, Medium impact application to install with zero interaction with the user, then its Accuracy rating would be calculated like this:

Accuracy rating = 2 x 3 = 6

This same calculation is made for each legitimate application/site in the test and the results are summed and used to populate the graph and table shown under 5. Legitimate Software Ratings on page 12.

5.4 Distribution of impact categories

Endpoint products that were most accurate in handling legitimate objects achieved the highest ratings. If all objects were of the highest prevalence, the maximum possible rating would be 1,000 (100 incidents x (2 interaction rating x 5 prevalence rating)).

In this test there was a range of applications with different levels of prevalence. The table below shows the frequency:

LEGITIMATE SOFTWARE CATEGORY FREQUENCY	
Prevalence Rating	Frequency
Very high impact	50
High impact	29
Medium impact	11
Low impact	6
Very low impact	4
Grand total	100



6. CONCLUSIONS

Attacks in this test included infected websites available to the general public, including sites that automatically attack visitors and attempt to infect them without any social engineering or other interaction. Some of these attacks were powered by criminals using exploit kits. Other sites relied on users being fooled into installing the malware. We also included targeted attacks, which were exploit-based attempts to gain remote control of the target systems.

Kaspersky Internet Security was able to fend off the exploit-based targeted attacks fully, while also blocking all but one of the public web attacks. It neutralised the one remaining attack and handled legitimate applications and websites without error.

ESET Smart Security also protected against all of the public web-based threats and targeted attacks. It blocked 98 per cent of the threats and neutralised the remaining two. This software was also entirely effective when handling legitimate objects.

Norton Security was just as effective as the above products when protecting the endpoint from targeted

attacks and blocked many of the public threats, although it neutralised four threats and was compromised once. It did not fare quite so well when encountering legitimate objects, blocking two applications.

Avast was the strongest free product in the test. It was compromised six times but blocked most of the targeted attacks and all of the web-based drive-by attacks. It was, however, perfect when handling legitimate applications and websites.

McAfee Internet Security was the least effective product in this test. Although it stopped most of the targeted and drive-by attacks, it failed to block half of the malware downloaded directly onto the system it was protecting. It's excellent handling of legitimate software was good enough to help it achieve a C rating, though.

The products from **Kaspersky Lab**, **ESET**, **Symantec (Norton)** and **Avast** all win AAA awards for their strong overall performance. Those from **BitDefender**, **Trend Micro** and **Microsoft** achieved solid AA awards, while **AVG's** product is awarded an A.

APPENDICES

APPENDIX A: TERMS USED

TERM	MEANING
Compromised	The attack succeeded, resulting in malware running unhindered on the target. In the case of a targeted attack, the attacker was able to take remote control of the system and carry out a variety of tasks without hindrance.
Blocked	The attack was prevented from making any changes to the target.
False positive	When a security product misclassifies a legitimate application or website as being malicious it generates a 'false positive'.
Neutralised	The exploit or malware payload ran on the target but was subsequently removed.
Complete remediation	If a security product removes all significant traces of an attack it has achieved complete remediation.
Target	The test system that is protected by a security product.
Threat	A program or sequence of interactions with the target that is designed to take some level of unauthorised control of that target.
Update	Security vendors provide information to their products in an effort to keep abreast of the latest threats. These updates may be downloaded in bulk as one or more files, or requested individually and live over the internet.

APPENDIX B: FAQs

A **full methodology** for this test is available from our website.

- The products chosen for this test were selected by SE Labs.
- The test was not sponsored. This means that no security vendor has control over the report's content or its publication.
- The test was conducted between the 15th April 2016 and the 22nd June 2016.
- All products had full internet access and were confirmed to have access to any required or recommended back-end systems. This was confirmed, where possible, using the Anti-Malware Testing Standards Organization (AMTSO) [Cloud Lookup Features Setting Check](#).
- Malicious URLs and legitimate applications and URLs were independently located and verified by SE Labs.
- Targeted attacks were selected and verified by SE Labs. They were created and managed by Metasploit Framework Edition using default settings. The choice of exploits was advised by public information about ongoing attacks. One notable source was the [2016 Data Breach Investigations Report](#) from Verizon
- Malicious and legitimate data was provided to partner organisations once the full test was complete.
- SE Labs conducted this endpoint security testing on physical PCs, not virtual machines.

Q I am a security vendor. How can I include my product in your test?

A Please contact us at info@SELabs.uk. We will be happy to arrange a phone call to discuss our methodology and the suitability of your product for inclusion.

Q I am a security vendor. Does it cost money to have my product tested?

A We do not charge directly for testing products in public tests. We do charge for private tests.

Q What is a partner organisation? Can I become one to gain access to the threat data used in your tests?

A Partner organisations support our tests by paying for access to test data after each test has completed but before publication. Partners can dispute results and use our award logos for marketing purposes. We do not share data on one partner with other partners. We do not currently partner with organisations that do not engage in our testing.

Q So you don't share threat data with test participants before the test starts?

A No, this would bias the test and make the results unfair and unrealistic.

Q I am a security vendor and you tested my product without permission. May I access the threat data to verify that your results are accurate?

A We are willing to share small subsets of data with non-partner participants at our discretion. A small administration fee is applicable.

APPENDIX C: PRODUCT VERSIONS

A product's update mechanism may upgrade the software to a new version automatically so the version used at the start of the test may be different to that used at the end.

PRODUCT VERSIONS		
Vendor	Product	Build
Avast	Free Antivirus	11.2.2261
AVG	AntiVirus Free Edition	16.81.7640
BitDefender	Internet Security 2016	20.0.28.1478
ESET	Smart Security 8	9.0.381.0
Kaspersky	Internet Security	15.0.2.361 (e)
McAfee	Internet Security	14.0.9042, MAVAS 18.0.9019, MPF 15.0.9009
Microsoft	Security Essentials	4.8.204.0
Norton	Security	22.6.0.142
Trend Micro	Internet Security 10	10.0.1265

APPENDIX D: ATTACK TYPES

The table below shows how each product protected against the different types of attacks used in the test.

ATTACK TYPES				
Product	Targeted attack	Web Download	Web Drive-by	Protected (Total)
ESET Smart Security 9	25	20	55	100
Kaspersky Internet Security	25	20	55	100
Norton Security	25	19	55	99
Trend Micro Internet Security 10	24	18	54	96
Avast Free Antivirus	21	18	55	94
BitDefender Internet Security 2016	18	19	55	92
Microsoft Security Essentials	17	17	55	89
AVG AntiVirus Free Edition	16	19	48	83
McAfee Internet Security	20	10	42	72