

Advanced Security Test Report

Broadcom

Carbon Black Cloud



ONLINE REPORT

SE LABS tested **Broadcom Carbon Black Cloud** against a range of ransomware attacks designed to extort victims.

These attacks were realistic, using the same tactics and techniques as those used against victims in recent months.

Target systems, protected by **Carbon Black Cloud**, were attacked by testers acting in the same way as we observe ransomware groups to behave.

Attacks were initiated from the start of the attack chain, using phishing email links and attachments, as just two examples. Each attack was run from the very start to its obvious conclusion, which means attempting to steal, encrypt and destroy sensitive data on the target systems.

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Introduction



CEO
Simon Edwards

If you spot a detail in this report that you don't understand, or would like to discuss, please contact us. 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 [LinkedIn](#).

Ransomware vs. Endpoint Security

Results from the largest public ransomware test

Ransomware is the most visible, most easily understood cyber threat affecting businesses today. Paralysed computer systems mean stalled business and loss of earnings. On top of that, a ransom demand provides a clear, countable value to a threat. A demand for "one million dollars!" is easier to quantify than the possible leak of intellectual property to a competitor.

One reason why ransomware is so 'popular' is that the attackers don't have to produce their own. They outsource the production of ransomware to others, who provide Ransomware as a Service (RAAS). Attackers then usually trick targets into running it, or at least into providing a route for the attackers to run it for them. Artificial intelligence systems make the creation of such social engineering attacks easier, cheaper and more effective than ever before.

Given the global interest and terror around ransomware, we have created a comprehensive test that shows how effective security products are when faced with the whole range of threats posed by ransomware itself and the criminal groups operating in the shadows.

In this report we have taken two main approaches to assessing how well products can detect and protect against ransomware.

Ransomware Deep Attacks

For the first part of this test, we analysed the common tactics of ransomware gangs and created two custom gangs that use a wider variety of methods. In all cases we run the attack from the very start, including attempting to access targets with stolen credentials or other means. We then move through the system and sometimes the network, before deploying the ransomware as the final payload.

In the first two attacks for each group, we gain access and deploy ransomware onto the target immediately. In the third, fourth and fifth attacks we move through the network and deploy ransomware on a target deeper into the network.

The ransomware payloads used in this part of the report were known files from all of the families listed in **Attack Details** on page 8.

This test shows a product's ability to track the movement of the attacker through the entire attack chain. We disable the product's protection features and rely on its detection mode for this part of the test. The results demonstrate how incident response teams can use the product to gain visibility on ransomware attacks.

Ransomware Direct Attacks

The second part of the test takes a wide distribution of known malware and adds variations designed to evade detection. We've listed the ransomware families used in **Attack Details** on page 8. We sent each of these ransomware payloads directly to target systems using realistic techniques, such as through email social engineering attacks. This is a full but short attack chain. In this part of the test, we ensure any protection features are enabled in the product.

If products can detect and protect against the known version of each of these files, all well and good. But if they also detect and block each ransomware's two variations then we can conclude that the protection available is more proactive than simply reacting to yesterday's unlucky victims.

Executive Summary

We tested **Carbon Black Cloud** against a wide range of ransomware attacks. These included recent, prevalent ransomware payloads alongside new, never-before-seen variations.

We examined the product's abilities to:

- Detect and protect against known ransomware
- Detect and protect against new ransomware variants
- Track full network breaches
- Detect deployment of ransomware on internal targets.

Legitimate files were used alongside the threats to measure any false positive detections or other sub-optimum interactions.

Carbon Black Cloud performed exceptionally well, providing complete detection and protection against all direct ransomware attacks. It also provided thorough insight into the full network breaches that concluded with ransomware deployments. There were no false positive results. An excellent result in an extremely challenging test.

Executive Summary

| Carbon Black Cloud | | |
|---------------------|----------------|------------|
| | Accuracy Score | Rating (%) |
| Detection Accuracy | 360/360 | 100% |
| Protection Accuracy | 1,768/1,768 | 100% |
| Legitimate Accuracy | 556/556 | 100% |
| Total Accuracy | 2,684/2,684 | 100% |

- The Detection rating shows how effective the product was at detecting the ransomware attacks.

Advanced Security Test Award

The following product wins the SE Labs award:



Broadcom
Carbon Black Cloud

1. How We Tested

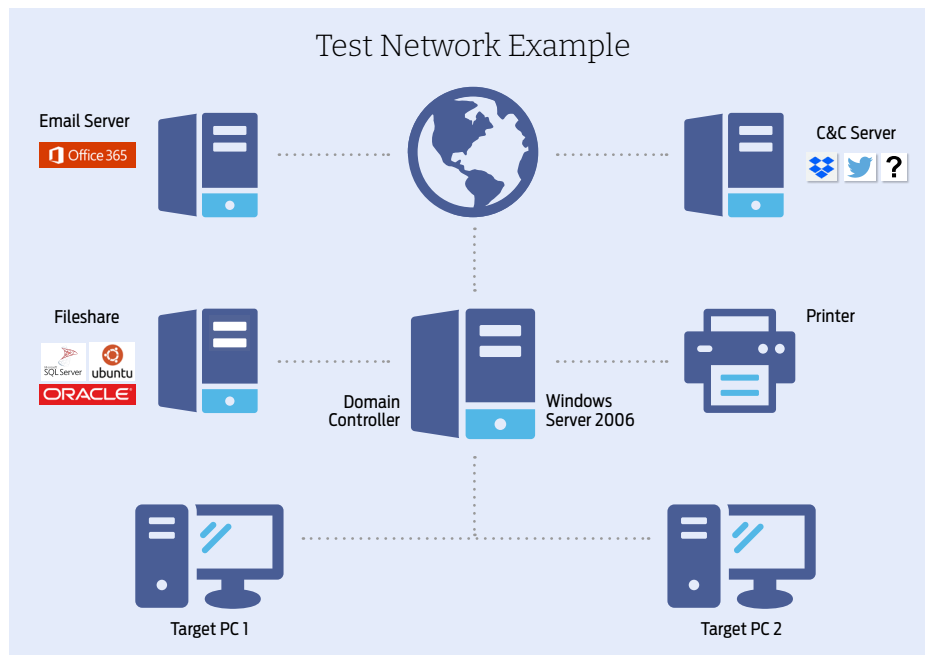
Testers can't assume that products will work a certain way, so running a realistic advanced security test means setting up real networks and hacking them in the same way that real adversaries behave.

In the diagram on the right you will see an example network that contains workstations, some basic infrastructure such as file servers and a domain controller, as well as cloud-based email and a malicious command and control (C&C) server, which may be a conventional computer or a service such as Dropbox, Twitter, Slack or something more imaginative.

As you will see in the **Threat Responses** section on page 7, attackers often jump from one compromised system to another in so-called 'lateral movement'. To allow products to detect this type of behaviour the network needs to be built realistically, with systems available, vulnerable and worth compromising.

It is possible to compromise devices such as enterprise printers and other so-called 'IoT' (internet of things) machines, which is why we've included a representative printer in the diagram.

The techniques that we choose for each test case are largely dictated by the real-world behaviour of online criminals. We observe their tactics and replicate what they do in this test. To see more



details about how the specific attackers behaved, and how we copied them, see **Attack Details** on page 8 and, for a really detailed drill down on the details, **Appendix A: Threat Intelligence** on pages 15-16 and **Appendix F: Attack Details** on pages 21.

● This example of a test network shows one possible topology and ways in which enterprises and criminals deploy resources

Threat Responses

Full Attack Chain: Testing Every Layer of Detection and Protection

Attackers start from a certain point and don't stop until they have either achieved their goal or have reached the end of their resources (which could be a deadline or the limit of their abilities). This means that, in a test, the tester needs to begin the attack from a realistic first position, such as sending a phishing email or setting up an infected website, and moving through many of the likely steps leading to actually stealing data or causing some other form of damage to the network.

If the test starts too far into the attack chain, such as executing malware on an endpoint, then many products will be denied opportunities to use the full extent of their protection and detection abilities. If the test concludes before any 'useful' damage or theft has been achieved, then similarly the product may be denied a chance to demonstrate its abilities in behavioural detection and so on.

Attack Stages

The illustration (below) shows typical stages of an attack. In a test, each of these should be attempted to determine the security solution's effectiveness. This test's results record detection and protection for each of these stages.

We measure how a product responds to the first stages of the attack with a detection and/or protection rating. Sometimes products allow threats to run yet still detect them. Other times they might allow the threat to run briefly before neutralising it. Ideally, they detect and block the threat before it has a chance to run. Products may delete threats or automatically contain them in a 'quarantine' or other safe holding mechanism for later analysis.

Should the initial attack phase succeed, we then measure post-exploitation stages, which are represented by steps two through to seven below. We broadly categorise these stages as: Access

(step 2); Action (step 3); Escalation (step 4); and Post-Escalation (steps 5-6).

In figure 1. you can see a typical attack running from start to end, through various 'hacking' activities. This can be classified as a fully successful breach.

In figure 2. a product or service has interfered with the attack, allowing it to succeed only as far as stage 3, after which it was detected and neutralised. The attacker was unable to progress through stages 4 onwards.

It is possible for an attack to run in a different order with, for example, the attacker attempting to connect to other systems without needing to escalate privileges. However, it is common for password theft (see step 5) to occur before using stolen credentials to move further through the network.

Figure 1. A typical attack starts with an initial contact and progresses through various stages, including reconnaissance, stealing data and causing damage.



Figure 2. This attack was initially successful but only able to progress as far as the reconnaissance phase.



Attack Details

When testing services against targeted attacks it is important to ensure that the attacks used are relevant. Anyone can run an attack randomly against someone else. It is the security vendor's challenge to identify common attack types and to protect against them. As testers, we need to generate threats that in some way relate to the real world.

All of the attacks used in this test are valid ways to compromise an organisation. Without any security in place, all would succeed in attacking the target. Outcomes would include systems infected with ransomware, remote access to networks and data theft.

But we didn't just sit down and brainstorm how we would attack different companies. Instead we used current threat intelligence to look at what the bad guys have been doing over the last few years and copied them quite closely. This way we can test the services' abilities to handle similar threats to those faced by global governments, financial institutions and national infrastructure.

The graphic on this page shows a summary of the attack groups that inspired the targeted attacks used in this test. If a service was able to detect these then there's a good chance they are on track to detect similar attacks in the real world. If they fail, then you might take their bold marketing claims about defeating hackers with a pinch of salt.

| Attacker/ APT Group | Method | Target | Details |
|------------------------|-------------------------------------|-------------------------|--|
| AvosLocker | Phishing attachment | Financial | This malware is hired out as Ransomware as a Service (RaaS) and so is used against a wide variety of targets. |
| BlackMatter | Compromised Credentials | Critical Infrastructure | This threat uses LDAP and SMB file-sharing protocols to spread via Active Directory to all hosts on a network. |
| Cerber | Trojan Software/Email Attachments | Generic RaaS | This malware is hired out as Ransomware as a Service (RaaS) and so is used against a wide variety of targets. |
| Darkside | Phishing Attachment & Phishing Link | Medical, Education | This ransomware threat is developed and distributed as a Ransomware as a Service (RaaS) for attackers to deploy independently. |
| DeathRansom | Macro Enabled Documents | Generic RaaS | Shared through Malware as a Service (MaaS) operations, this ransomware avoids encrypting Windows system files to ensure the target system continues to operate. It targets both local and network resources. |
| GandCrab | Phishing Email/Phishing Attachment | Generic RaaS | This malware is hired out as Ransomware as a Service (RaaS) and so is used against a wide variety of targets. |
| LockBit | RDP/Brute Force | Banks/Financial | An RaaS threat used across a variety of industries and continues to be prolific in 2024. |
| Maolao | Email Attachments | Generic RaaS | This malware is hired out as Ransomware as a Service (RaaS) and so is used against a wide variety of targets. |
| Netwalker | Phishing Email/Phishing Attachment | Generic RaaS | Written in PowerShell, this ransomware's payloads are executed by VBS scripts embedded in Microsoft Office documents. |
| Phobos | RDP/Brute Force | Infrastructure | Phobos operates as Ransomware as a Service (RaaS) and goes beyond simple data encryption, leading to disruption of critical systems. |
| Pysa | Phishing Email/Phishing Attachment | Higher Education | Targeting US and UK educational systems, more than 12 have reported themselves as having been compromised by this threat. |
| Ragnar Locker | RDP/Brute force | Generic RaaS | Highly customised, this ransomware threat is operated by a group known to leak stolen data. |
| Ryuk | Email Attachments | Generic RaaS | Focused on businesses, this group is known to leak stolen data even if the ransom is paid. |
| TeslaCrypt | Fileless attack | Generic RaaS | A so-called 'file-less' threat that gains access to targets and then deploys ransomware. |
| WastedLocker | Zip Files | Banks | This group uses decoy files and PowerShell to spread through networks, deploying the Cobalt Strike penetration testing tool. |

2. 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 chart.

The chart below takes into account not only the 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 stops the threat 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 that 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.

Scoring a product's response to a potential breach requires a granular method, which we outline in **4. Response Details (Ransomware Deep Attacks)** on page 12.

Total Accuracy Ratings



- Total Accuracy Ratings combine protection and false positives.

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3. Protection Ratings (Ransomware Direct Attacks)

The following results relate to the direct ransomware attacks, in which ransomware payloads are sent directly to targets in realistic ways, such as via phishing emails.

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 detects 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.

■ 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.

■ Neutralised (+1)

Products that kill all running malicious processes 'neutralise' the threat and win one point.

■ Persistent Neutralisation (-2)

This result occurs when a product continually blocks a persistent threat from achieving its aim, while not removing it from the system.

■ Compromised (-5)

If the threat compromises 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:

Protection Rating =
 (1x number of Detected) +
 (2x number of Blocked) +
 (1x number of Neutralised) +
 (1x number of Complete remediation) +
 (-5x 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.

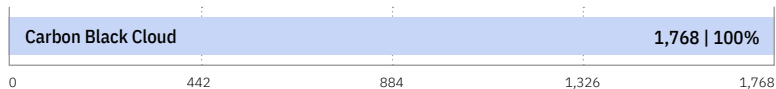
These ratings are based on our opinion of how important these different outcomes are. You may have a different view on how seriously you treat a 'Compromise' or 'Neutralisation without complete remediation'. If you want to create your own rating system, you can use the raw data from **Protection Details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

Protection Score (Ransomware Direct Attacks)

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 Score



- Protection Scores are a simple count of how many times a product protected the system.

Protection Details (Ransomware Direct Attacks)

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 sometimes detect more threats than they protect against. This can happen when they recognise an element of the threat but aren't equipped to stop it. Products can also provide protection even if they don't detect certain threats. Some threats abort on detecting specific Endpoint protection software.

Protection Details

| Product | Detected | Blocked | Neutralised | Compromised | Protected |
|--------------------|----------|---------|-------------|-------------|-----------|
| Carbon Black Cloud | 556 | 556 | 0 | 0 | 556 |



- This data shows in detail how each product handled the threats used.

4. Response Details (Ransomware Deep Attacks)

In this test security products are exposed to attacks, which comprise multiple stages. The perfect product will detect all relevant elements of an attack. The term 'relevant' is important, because sometimes detecting one part of an attack means it's not necessary to detect another.

For example, in the table below certain stages of the attack chain have been grouped together. As mentioned in **2. Total Accuracy Ratings**, these groups are as follows:

Delivery/Execution (+10)

If the product detects either the delivery or execution of the initial attack stage then a detection for this stage is recorded.

Action (+10)

When the attack performs one or more actions, while remotely controlling the target, the product should detect at least one of those actions.

Privilege Escalation/Action (+10)

As the attack progresses there will likely be an attempt to escalate system privileges and to perform more powerful and insidious actions. If the product can detect either the escalation process itself, or any resulting actions, then a detection is recorded.

Lateral Movement/Action (+10)

The attacker may attempt to use the target as a launching system to other vulnerable systems.

If this attempt is discovered, or any subsequent action, a detection is reported.

The Detection Rating is calculated by adding points for each group in a threat chain that is detected. When at least one detection occurs in a single group, a 'group detection' is recorded and 10 points are awarded. Each test round contains one threat chain, which itself contains four groups (as shown below), meaning that complete visibility of each attack adds 40 points to the total value.

A product that detects the delivery of a threat, but nothing subsequently to that, wins only 10 points, while a product that detects delivery and action, but not privilege escalation or lateral behaviours, is rated at 20 for that test round.

Understanding Detection Groups

| First Group | | | Second Group | | Third Group | | Fourth Group | |
|--------------|-----------|----------|--------------|--------|-------------|-----------|------------------|----------------|
| Incident No: | Detection | Delivery | Execution | Action | Escalation | PE Action | Lateral Movement | Lateral Action |
| 1 | ✓ | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ |
| 2 | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 3 | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4 | ✓ | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ |

| Attacker/ Apt Group | Number of Incidents | Attacks Detected | Delivery/Execution | Action | Privilege Escalation/Action | Lateral Movement Action |
|-------------------------|---------------------|------------------|--------------------|--------|-----------------------------|-------------------------|
| Dragonfly & Dragonfly 2 | 4 | 4 | 4 | 2 | 4 | 4 |

Elements of the attack chain are put into groups. For example, the Delivery and Execution stages of an attack are in the same group. Similarly, we group the Post Escalation stage with the Post Escalation Action (PE Action) stage. When we count detections we look to see at least one detection (tick) in each group. One or two detections in a group is a success.

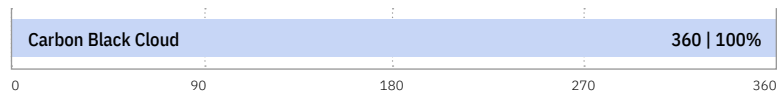
In this example we have four test cases, which we call 'incidents'. In Incident No. 1 there was a detection recorded for the delivery of the threat and when it was executed. These two results count as one detection. In Incident No. 2 the threat delivery was not detected, but its execution was. This also counts as one detection.

When no detection is registered in any part of a group the result will be a 'miss'. In Incident No. 1 there was no detection when the attacker performed the 'Action' stage of the attack. This is a miss for the product. In fact, this product only detected two of the four Action stages, which is why the Response Details table shows '2' in the Action column.

Detection Accuracy Rating

To understand how we calculate these ratings, see **Appendix B: Response Details** on page 17.

Detection Score



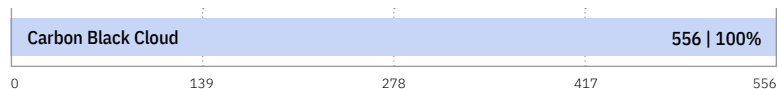
- Detection Ratings are weighted to show that how products detect threats can be subtler than just 'win' or 'lose'.

Legitimate Software Rating

These ratings indicate how accurately the product classifies legitimate applications and URLs, while also taking into account the interactions that the 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.

Legitimate Software Rating



- Legitimate Accuracy Ratings can indicate how well a vendor has tuned its detection engine.

5. Conclusion

This report looks at how effectively a security product can protect against a wide range of ransomware attacks. It also investigates the product's capabilities in tracking the behaviour of attackers that use ransomware as a final payload.

Ransomware Deep Attacks

Attackers used to rely on random and widespread ransomware deployment to extort payment from as many hapless victims as they could. Today's ransomware attacks are much more targeted and persistent—aimed at large organisations that can pay in the millions of dollars.

This test mimics how attackers breach large organisations by running full, advanced attacks against the target systems and by installing malware at the end of each attack. We wanted to assess how well **Carbon Black Cloud** could track the hacking attacks through the network, as well as registering the ransomware attacks at the end.

The methods of attacking the target systems were a combination of tactics used by a number of different ransomware groups. You can see a summary of these in **Appendix A: Threat Intelligence**, on pages 15 and 16, and a full rundown of each in **Appendix F: Ransomware Deep Attack Details**.

We also used a concept called 'group detection'. For example, we expect a product to detect either the delivery or execution of a malicious file. We prefer it if a

product detects both events in this group, but our scoring allows the product to achieve top marks if it only detects one or the other.

We jumped from target systems to others on the internal network (moving laterally) and ran ransomware on these deeper targets. We did this except for test cases 1 and 2 for both the first and second group tests when we installed the ransomware directly on the main target systems. This is why the Lateral Movement and Lateral Action results for these cases are not applicable (N/A).

Carbon Black Cloud achieved a Detection Accuracy Rating of 100% by detecting all of the attacks. Moreover, the **Response Details** on page 17 show that the product generated alerts for all of the attack stages in each of the attacks. This demonstrates that the product not only detected the ransomware in every case but had a thorough insight into the entire process of hacking the network.

This level of visibility would be a significant advantage for a security professional who is battling a persistent attacker in real time.

Ransomware Direct Attacks

In the second part of the test, we used a large group of ransomware attack files. The files formed a combination of malicious software both known and unknown by security researchers. Our goal was to see how well a product could identify ransomware that has already been analysed by security experts, as well as

new, never-before-seen variations that represent potential future attacks.

We modified files from prevalent ransomware families using techniques designed to make the malware look different (although the malware would perform the same malicious activities). We had 556 ransomware files—about a third of which were originals and the others, variations. We exposed target systems to these ransomware files using very direct methods of attack, such as sending the malware (or links to the malware) via phishing emails.

Carbon Black Cloud detected and blocked every single ransomware file, including all of the new variants. The product also blocked almost all of the ransomware files upon delivery. The execution of the very few that were delivered was promptly blocked before they could cause damage. This is an excellent result.

Finally, we tested how **Carbon Black Cloud** handled legitimate software. It made no mistakes, demonstrating that it was configured in a realistic and usable way.

Carbon Black Cloud performed exceptionally well at protecting against known and new variants of ransomware, as well as tracking network attacks that concluded with ransomware payloads. It is fully deserving of its AAA Advanced Security EDR Protection award.

Group 1

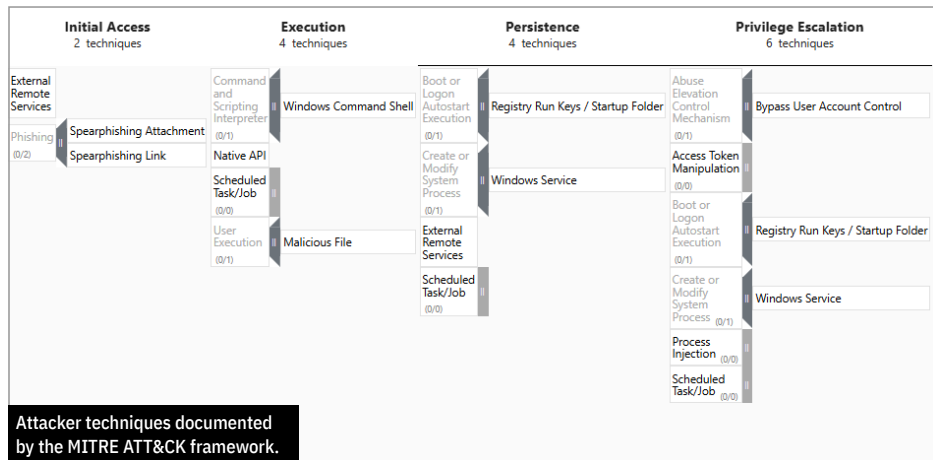
| Initial Access | | Execution | | Persistence | | Privilege Escalation | | Defense Evasion | |
|--------------------------|--------------------------|---|-----------------------|--------------------------|--|---|-----------------------------|---|-----------------------------|
| 2 techniques | | 2 techniques | | 1 techniques | | 3 techniques | | 7 techniques | |
| External Remote Services | | Command and Scripting Interpreter (0/3) | PowerShell | External Remote Services | | Abuse Elevation Control Mechanism (0/1) | | Abuse Elevation Control Mechanism (0/1) | |
| Phishing (0/2) | Spearphishing Attachment | | Visual Basic | | | | Bypass User Account Control | | Bypass User Account Control |
| | Spearphishing Link | User Execution (0/1) | Windows Command Shell | | | | Create Process with Token | Access Token Manipulation (0/2) | Create Process with Token |
| | | | Malicious File | | | Process Injection (0/0) | Token Impersonation/Theft | | Token Impersonation/Theft |
| | | | | | | | | Impair Defenses (0/1) | Disable or Modify Tools |
| | | | | | | | | Indicator Removal (0/1) | File Deletion |
| | | | | | | | | Modify Registry | |
| | | | | | | | | Obfuscated Files or Information (0/0) | |
| | | | | | | | | Process Injection (0/2) | |

Attacker techniques documented by the MITRE ATT&CK framework.

| Delivery | Execution | Action | Privilege Escalation | Post-Escalation | Lateral Movement | Lateral Action |
|---------------------------|---------------------------------|------------------------------|---|------------------------------|------------------|----------------|
| Spear Phishing Attachment | Powershell | Process Injection | Access Token Manipulation - Create Process with Token | Disable or Modify Tools | N/A | N/A |
| | Obfuscated Files or Information | System Information Discovery | | File Deletion | | |
| | Malicious File | System Service Discovery | | Exfiltration Over C2 Channel | | |
| | Windows Command Shell | | | Data Destruction | | |
| | Asymmetric Cryptography | | | Data Encrypted for Impact | | |
| | | | | Inhibit System Recovery | | |
| | Service Stop | | | | | |

Group 2

After the system was completely compromised, testers deployed ransomware from groups including DeathRansom, GandCrab and LockBit.



Example Ransomware Deep Attack Group 2

| Delivery | Execution | Action | Privilege Escalation | Post-Escalation | Lateral Movement | Lateral Action |
|---------------------|----------------|--|---------------------------|------------------------------|------------------|----------------|
| Spear Phishing Link | Malicious File | Process Discovery | Access Token Manipulation | Credentials In Files | N/A | N/A |
| | | System Information Discovery | | Exfiltration Over C2 Channel | | |
| | | Permission Groups Discovery | | Data Destruction | | |
| | | System Network Configuration Discovery | | Data Encrypted for Impact | | |
| | | File and Directory Discovery | | Inhibit System Recovery | | |
| | | System Owner/User Discovery | | Service Stop | | |

Appendix B: Response Details

Group 1

| Incident No. | Detection | Delivery | Execution | Action | Escalation | PE Action | Lateral Movement | Lateral Action |
|--------------|-----------|----------|-----------|--------|------------|-----------|------------------|----------------|
| 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | N/A | N/A |
| 2 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | N/A | N/A |
| 3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Group 2

| Incident No. | Detection | Delivery | Execution | Action | Escalation | PE Action | Lateral Movement | Lateral Action |
|--------------|-----------|----------|-----------|--------|------------|-----------|------------------|----------------|
| 1 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | N/A | N/A |
| 2 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | N/A | N/A |
| 3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| Attacker/APT Group | Number of Incidents | Attacks Detected | Delivery/Execution | Action | Privilege Escalation/Action | Lateral Movement/Action |
|--------------------|---------------------|------------------|--------------------|-----------|-----------------------------|-------------------------|
| Group 1 | 5 | 5 | 5 | 5 | 5 | 3 |
| Group 2 | 5 | 5 | 5 | 5 | 5 | 3 |
| TOTAL | 10 | 10 | 10 | 10 | 10 | 6 |

- This data shows how the product handled different group stages of each APT. The Detection column shows the basic level of detection.

Detection Accuracy Rating Details

| Attacker/ APT Group | Number of Incidents | Attacks Detected | Group Detections | Detection Rating |
|---------------------|---------------------|------------------|------------------|------------------|
| Group 1 | 5 | 5 | 18 | 180 |
| Group 2 | 5 | 5 | 18 | 180 |
| TOTAL | 10 | 10 | 36 | 360 |

- Different levels of detection, and failure to detect, are used to calculate the Detection Rating.

Group Detections

We record detections in groups, as described above in Understanding Detection Groups. To get an overview of how a product handled the entire set of threats we then combine these detections into 'Group Detections'.

In a test with four incidents and four detection groups (Delivery/Execution; Action; Escalation/PE Action; and Lateral Movement/Lateral Action) the maximum score would be 16. This is because for each of the four threats a product that detects everything would score 4.

Our overall Detection Rating is based on the number of Detection Groups achieved.

Appendix C: Legitimate 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 FPs 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.

Prevalence Ratings

There is a significant difference between an

| | None (allowed) | Click to Allow (default allow) | Click to Allow/ Block (no recommendation) | Click to Block (default block) | None (blocked) | |
|----------------|----------------|--------------------------------|---|--------------------------------|----------------|---|
| Safe | 2 | 1.5 | 1 | | | A |
| Unknown | 2 | 1 | 0.5 | 0 | -0.5 | B |
| Not Classified | 2 | 0.5 | 0 | -0.5 | -1 | C |
| Suspicious | 0.5 | 0 | -0.5 | -1 | -1.5 | D |
| Unwanted | 0 | -0.5 | 1 | -1.5 | -2 | E |
| Malicious | | | | 2 | -2 | F |
| | 1 | 2 | 3 | 4 | 5 | |

Legitimate Software Prevalence Rating Modifiers

| | |
|------------------|---|
| Very High Impact | 5 |
| High Impact | 4 |
| Medium Impact | 3 |
| Low Impact | 2 |
| Very Low Impact | 1 |

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 table above.

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.

Legitimate Interaction Ratings

| Product | None (allowed) | Click to allow/block (no recommendation) | None (allowed) |
|--------------------|----------------|--|----------------|
| Carbon Black Cloud | 75 | 0 | 0 |

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

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

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 = $2 \times 3 = 6$

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 **Legitimate Software Rating** on page 13.

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 | 24 |
| High Impact | 24 |
| Medium Impact | 13 |
| Low Impact | 9 |
| Very Low Impact | 5 |

Appendix D: Terms Used

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 E: FAQs

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

A Partner organisations benefit from our consultancy services after a test has been run. Partners may gain access to low-level data that can be useful in product improvement initiatives and have permission to use award logos, where appropriate, for marketing purposes. We do not share data on one partner with other partners. We do not partner with organisations that do not engage in our testing.

Q We are a customer considering buying or changing our endpoint protection and/ or endpoint detection and response (EDR) product. Can you help?

A Yes, we frequently run private testing for organisations that are considering changing their security products. Please contact us at info@selabs.uk for more information.

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

- The test was conducted between 5th March and 1st April 2025.
- All products were configured according to each vendor's recommendations, when such recommendations were provided.
- Targeted attacks were selected and verified by SE Labs.
- Malicious emails, URLs, attachments and legitimate messages were independently located and verified by SE Labs.
- Malicious and legitimate data was provided to partner organisations once the test was complete.

Appendix F: Ransomware Deep Attack Details

Group 1

| Incident No. | Delivery | Execution | Action | Privilege Escalation | Post-Escalation | Lateral Movement | Lateral Action |
|--------------|---------------------------|---------------------------------|---|---|------------------------------|--------------------------|------------------------------|
| 1 | Spear Phishing Attachment | Powershell | Process Injection | Access Token Manipulation - Create Process with Token | Disable or Modify Tools | N/A | N/A |
| | | Obfuscated Files or Information | System Information Discovery | | File Deletion | | |
| | | Malicious File | System Service Discovery | | Exfiltration Over C2 Channel | | |
| | | Windows Command Shell | | | Data Destruction | | |
| | | Asymmetric Cryptography | | | Data Encrypted for Impact | | |
| | | | | | Inhibit System Recovery | | |
| | | Service Stop | | | | | |
| 2 | Spear Phishing Link | Malicious File | File and Directory Discovery | Access Token Manipulation - Token Impersonation/Theft Process Injection | Credentials In Files | N/A | N/A |
| | | | System Information Discovery | | Data Destruction | | |
| | | | Process Discovery | | Data Encrypted for Impact | | |
| | | | System Owner/User Discovery | | Inhibit System Recovery | | |
| | | | Internet Connection Discovery | | Service Stop | | |
| | | | Query Registry | | Exfiltration over C2 Channel | | |
| | | | Domain Account | | | | |
| | | | Domain Groups | | | | |
| | | | Network Share Discovery | | | | |
| 3 | Spear Phishing Link | Powershell | Query Registry | Access Token Manipulation - Create Process with Token | Modify Registry | External Remote Services | Exfiltration over C2 Channel |
| | | Malicious File | System Information Discovery | | Service Stop | | Data Destruction |
| | | Windows Command Shell | System Location Discovery - System Language Discovery | | | | Data Encrypted for Impact |
| | | Asymmetric Cryptography | File Deletion | | | | Inhibit System Recovery |
| | | Service Stop | | | | | |
| 4 | Spear Phishing Attachment | Windows Command Shell | System Information Discovery | Access Token Manipulation - Token Impersonation/Theft Process Injection | Disable or Modify Tools | Lateral Tool Transfer | Exfiltration over C2 Channel |
| | | Malicious File | Permission Groups Discovery - Domain Groups | | Inhibit System Recovery | Remote Desktop Protocol | Data Destruction |
| | | | Process Injection | | | | Data Encrypted for Impact |
| | | Visual Basic | File Deletion | | | | Inhibit System Recovery |
| | | | | | | | Service Stop |

| Incident No. | Delivery | Execution | Action | Privilege Escalation | Post-Escalation | Lateral Movement | Lateral Action |
|--------------|---------------------------|-----------------------|------------------------------|--|-----------------------|--------------------------|------------------------------|
| 5 | Spear Phishing Attachment | Windows Command Shell | System Information Discovery | Bypass User Account Control; Valid Accounts | Ingress Tool Transfer | External Remove Services | Exfiltration over C2 Channel |
| | | Malicious File | Query Registry | | Modify Registry | | Data Destruction |
| | | | | | | | Data Encrypted for Impact |
| | | | | | | | Inhibit System Recovery |
| | | | | | | | Service Stop |

Group 2

| Incident No. | Delivery | Execution | Action | Privilege Escalation | Post-Escalation | Lateral Movement | Lateral Action |
|---------------------------------|------------------------------|------------------------|--|-----------------------------|-------------------------------|---------------------------|----------------|
| 1 | Spear Phishing Link | Malicious File | Process Discovery | Access Token Manipulation | Credentials In Files | N/A | N/A |
| | | | System Information Discovery | | Exfiltration Over C2 Channel | | |
| | | | Permission Groups Discovery | | Data Destruction | | |
| | | | System Network Configuration Discovery | | Data Encrypted for Impact | | |
| | | | File and Directory Discovery | | Inhibit System Recovery | | |
| | | | System Owner/User Discovery | | Service Stop | | |
| 2 | Spear Phishing Link | Malicious File | Process Discovery | Bypass User Account Control | Data From Local System | N/A | N/A |
| | | Windows Command Shell | System Information Discovery | Valid Accounts | Exfiltration Over C2 Channel | | |
| | | Masquerading | Account Discovery - Local Account | | Credentials from Web Browsers | | |
| | | Software Packing | System Network Configuration Discovery | | Data Destruction | | |
| | | Native API | | | Data Encrypted for Impact | | |
| | | Symmetric Cryptography | | | Inhibit System Recovery | | |
| | | | | | Service Stop | | |
| | | 3 | Spear Phishing Link | Malicious File | Process Discovery | | |
| Windows Command Shell | System Information Discovery | | | Valid Accounts | Exfiltration Over C2 Channel | Automated Collection | |
| Software Packing | Network Share Discovery | | | | Modify Registry | Data Destruction | |
| Obfuscated Files or Information | System Service Discovery | | | | | Data Encrypted for Impact | |
| | | | | | | Inhibit System Recovery | |
| | | | | | | Service Stop | |
| | | | | | | | |

| Incident No. | Delivery | Execution | Action | Privilege Escalation | Post-Escalation | Lateral Movement | Lateral Action |
|--------------|---------------------------|---------------------------------|-------------------------------|-----------------------------|------------------------------------|--------------------------|--|
| 4 | Spear Phishing Attachment | Malicious File | Process Discovery | Bypass User Account Control | Credentials in Files | External Remote Services | Exfiltration Over Alternative Protocol |
| | | Windows Command Shell | System Information Discovery | Valid Accounts | System Owner/User Discovery | | Data Destruction |
| | | Software Packing | Credentials from Web Browsers | | Modify Registry | | Data Encrypted for Impact |
| | | Masquerading | | | Windows Service | | Inhibit System Recovery |
| 5 | Spear Phishing Link | | | | | Lateral Tool Transfer | Service Stop |
| | | Malicious File | Process Discovery | Bypass User Account Control | Scheduled Task | | Exfiltration Over C2 Channel |
| | | Windows Command Shell | System Information Discovery | Valid Accounts | Registry Run Keys / Startup Folder | | Automated Collection |
| | | Obfuscated Files or Information | Credentials from Web Browsers | | | | Data Destruction |
| | | | System Owner/User Discovery | | | | Data Encrypted for Impact |
| | | | | | | | |
| | | | | | | | Service Stop |

Appendix G: Product Version

The table below shows the service's name as it was being marketed at the time of the test.

| Vendor | Product | Build Version (start) | Build Version (end) |
|----------|--------------------|-----------------------|---------------------|
| Broadcom | Carbon Black Cloud | Version: 4.0.3.2029 | Version: 4.0.3.2029 |

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