BLUEHAT
SHANGHAI 2019

360

Needle in A Haystack: Catch Multiple Zero-days Using Sandbox

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About Us

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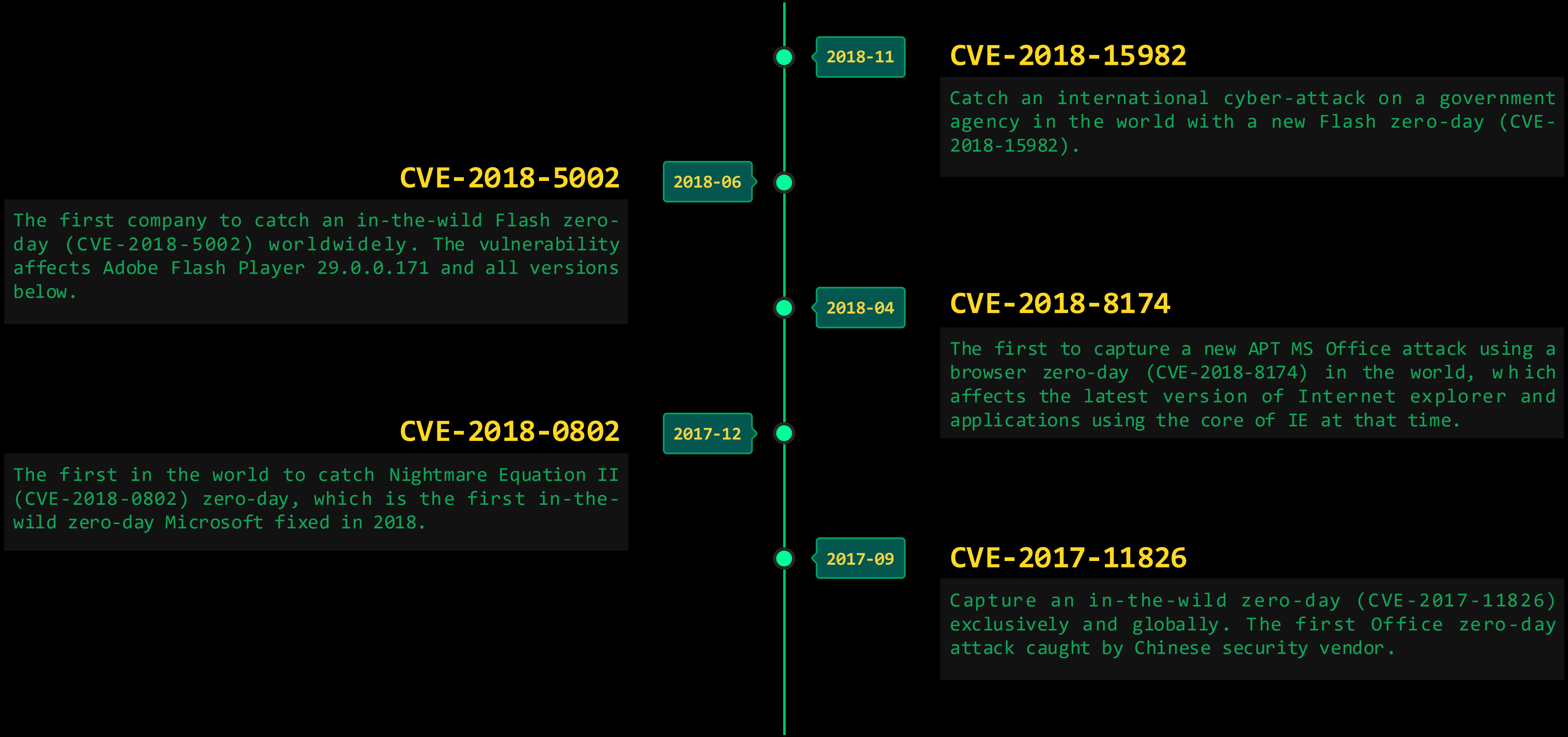
Outline

- **Advanced Threat Automation and Sandbox**
- **Find in-the-wild zero-days using Sandbox**

Cyber Attacks are Everywhere



2018-11

CVE-2018-15982

Catch an international cyber-attack on a government agency in the world with a new Flash zero-day (CVE-2018-15982).

2018-06

CVE-2018-5002

The first company to catch an in-the-wild Flash zero-day (CVE-2018-5002) worldwidely. The vulnerability affects Adobe Flash Player 29.0.0.171 and all versions below.

2018-04

CVE-2018-8174

The first to capture a new APT MS Office attack using a browser zero-day (CVE-2018-8174) in the world, which affects the latest version of Internet explorer and applications using the core of IE at that time.

2017-12

CVE-2018-0802

The first in the world to catch Nightmare Equation II (CVE-2018-0802) zero-day, which is the first in-the-wild zero-day Microsoft fixed in 2018.

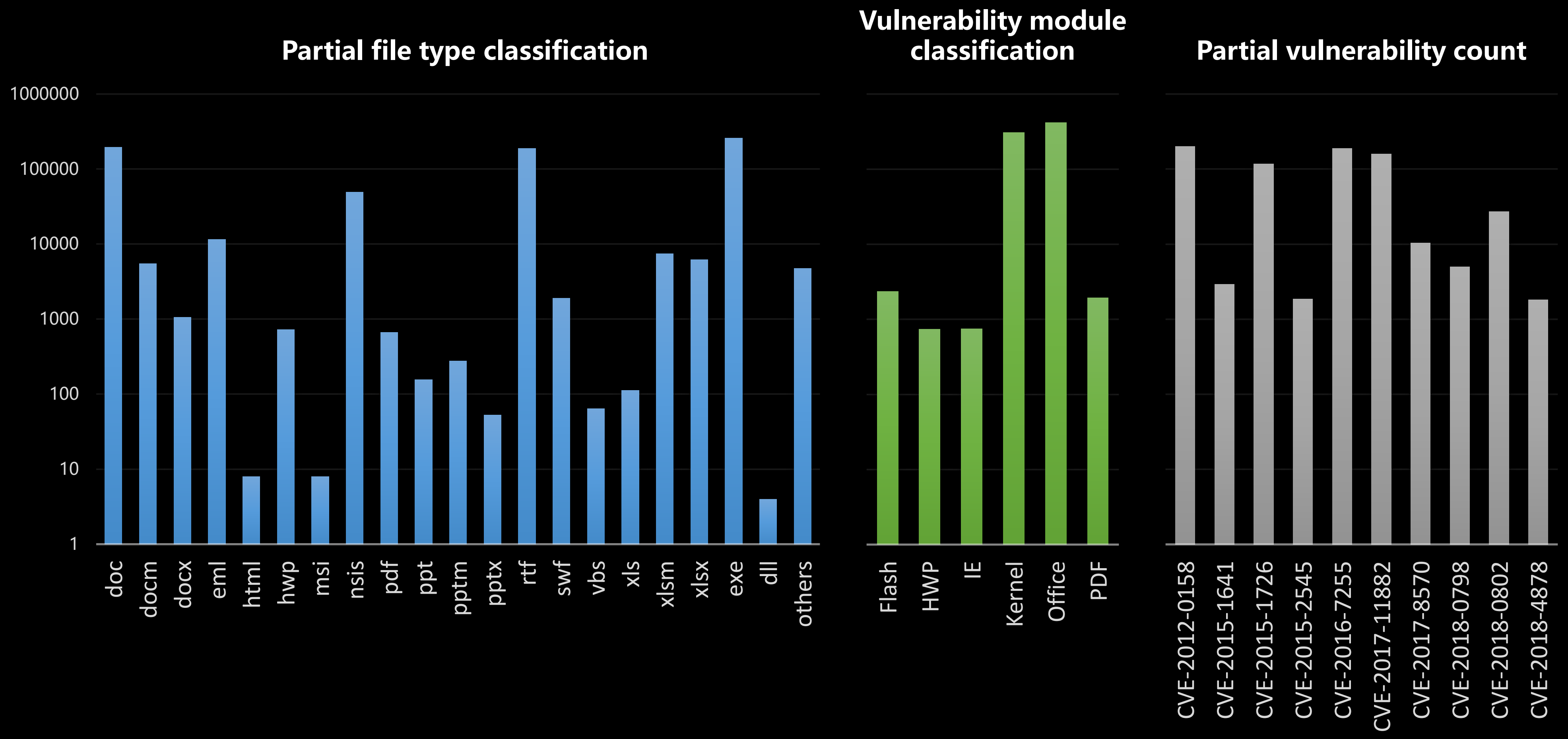
2017-09

CVE-2017-11826

Capture an in-the-wild zero-day (CVE-2017-11826) exclusively and globally. The first Office zero-day attack caught by Chinese security vendor.

The five in-the-wild exploiting zero-day attacks we captured up to now

Cyber Attacks are Everywhere



Partial file type classification

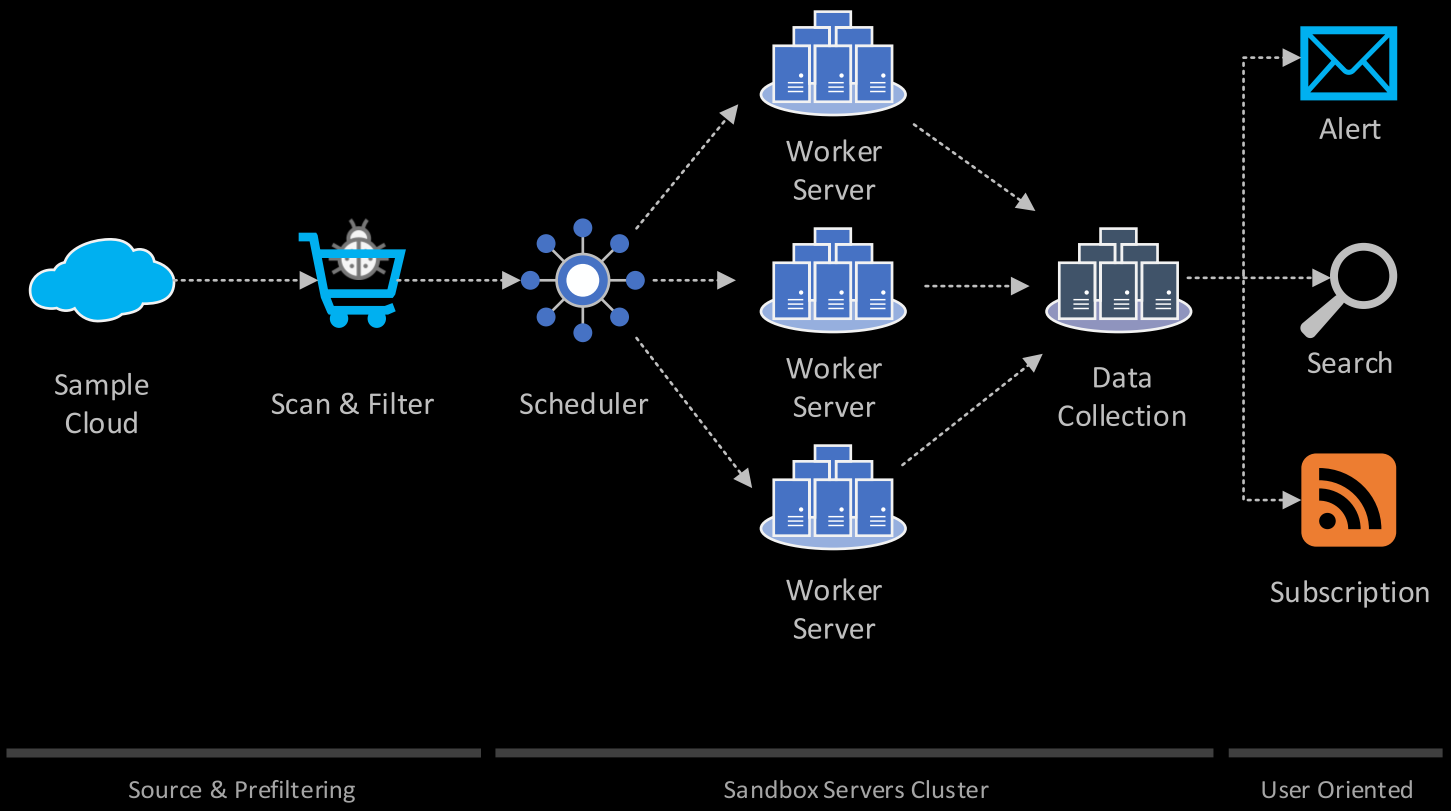
Vulnerability module classification

Partial vulnerability count

Statistics for some of the N-day exploits we detected from March 2018 to March 2019

Advanced Threat Automation

- **Large-scale Sample Cloud**
- **Static Anti-virus Engine**
  - `AVE QEX QVM`
- **Sample Pre-filtering Strategy**
- **Sandbox Servers Cluster**
  - Virtual Machine Isolation Environments
  - Sandbox Detection Engine
  - Rule Scoring System
- **Result Alarm and Response**



Advanced Threat Automation

- **Large-scale Sample Cloud**
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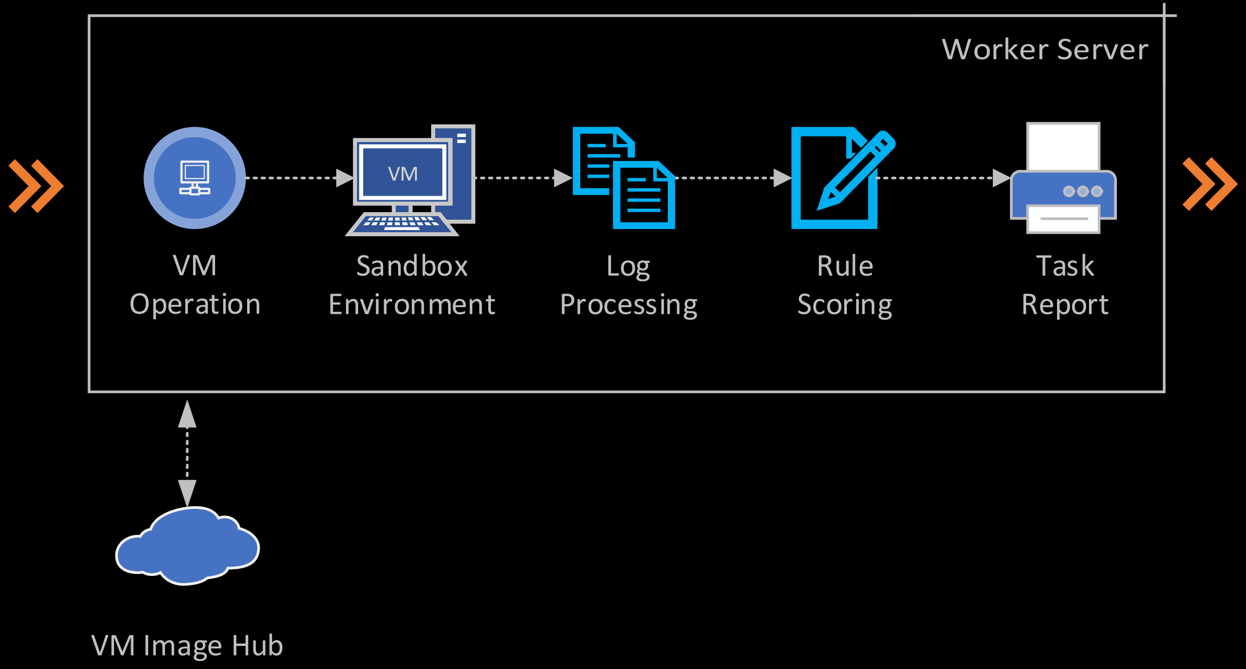


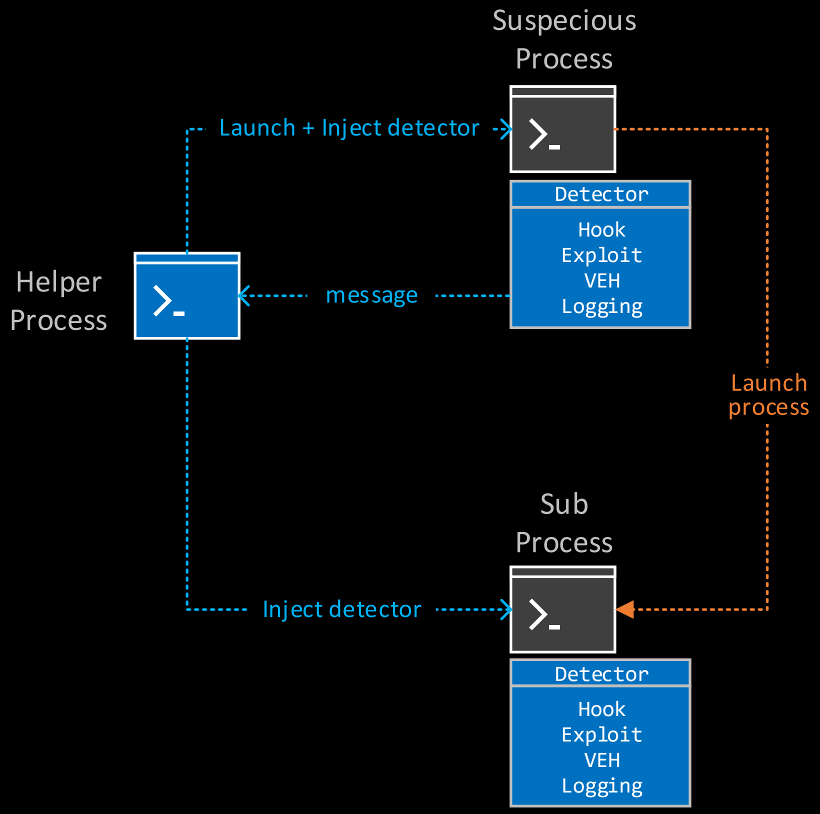
Sandbox Detection Engine

How to do it?

Sandbox Detection Engine

- **Initial Scenario: Dynamic Library**

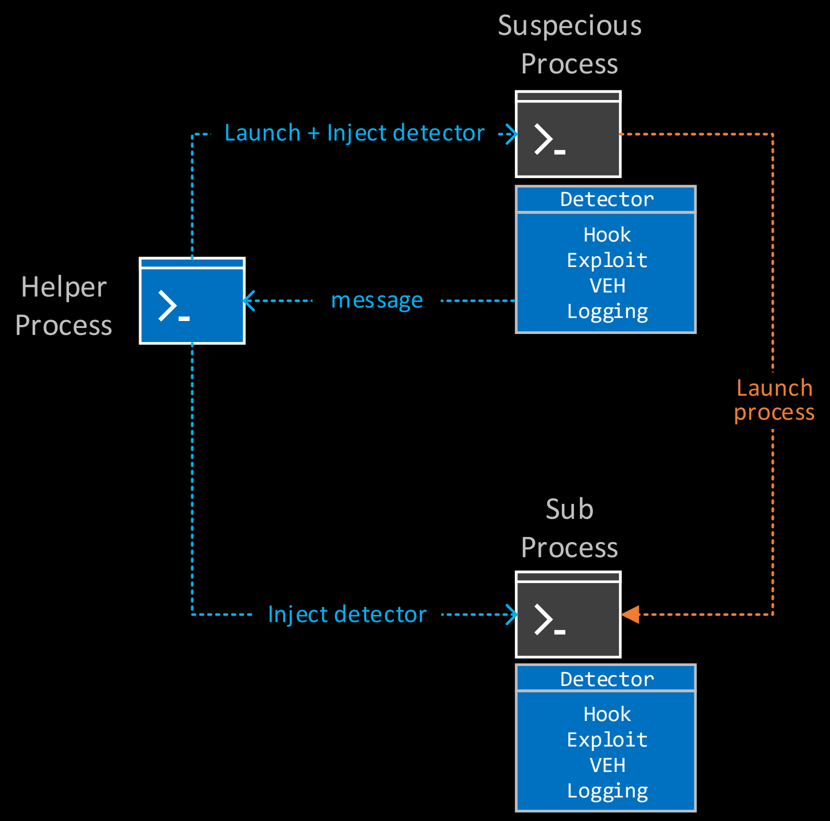
- **Inject into target processes to work**
- **Hook export functions of system libs**



Sandbox Detection Engine

- **Initial Scenario: Dynamic Library**

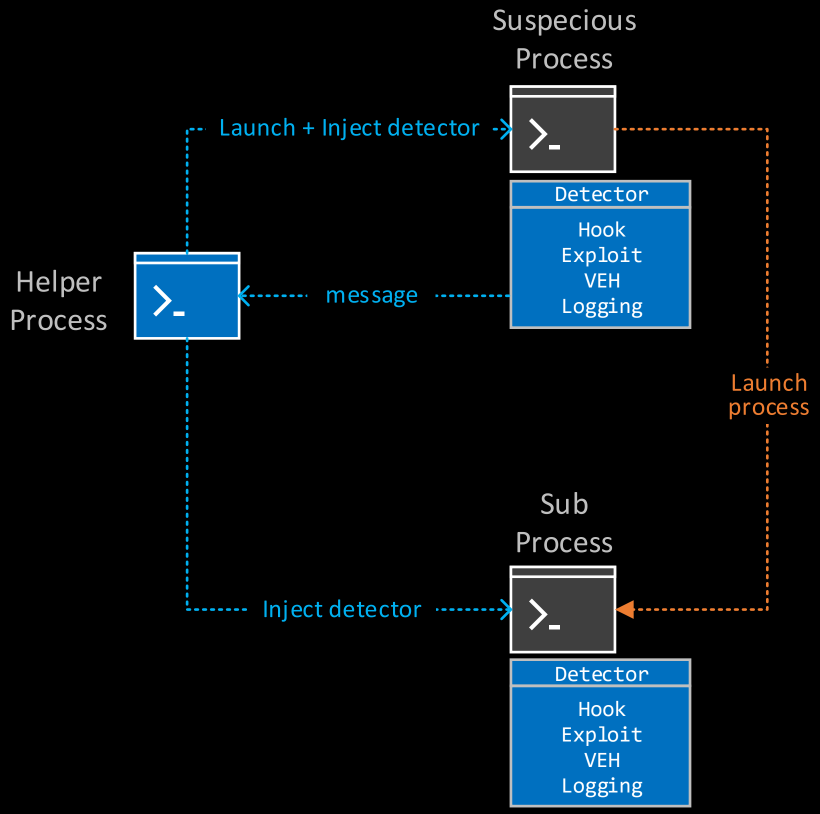
- **Inject into target processes to work**
- **Hook export functions of system libs**
- **Lightweight** 😀



Sandbox Detection Engine

- Initial Scenario: Dynamic Library

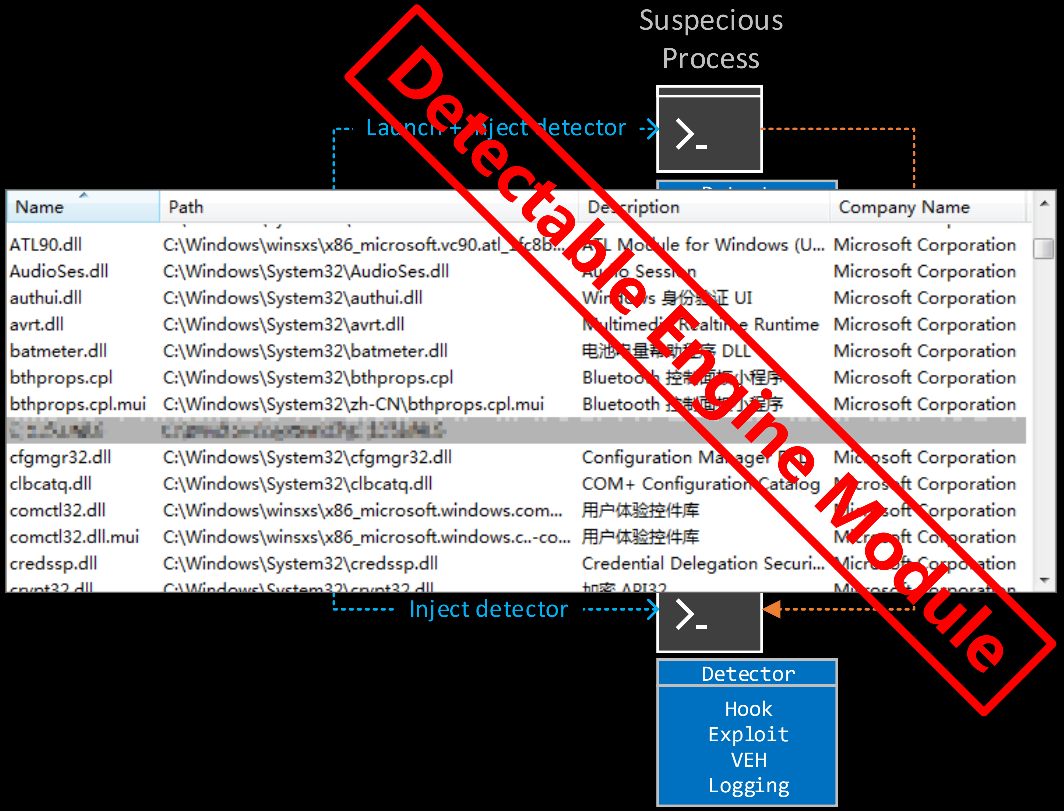
- Inject into target processes to work
- Hook export functions of system libs
- Lightweight 😀
- Is that enough?



Sandbox Detection Engine

- **Initial Scenario: Dynamic Library**

- **Inject into target processes to work**
- **Hook export functions of system libs**
- **Lightweight 😀**
- **Is that enough?**
- **Can be detected easily ☹**

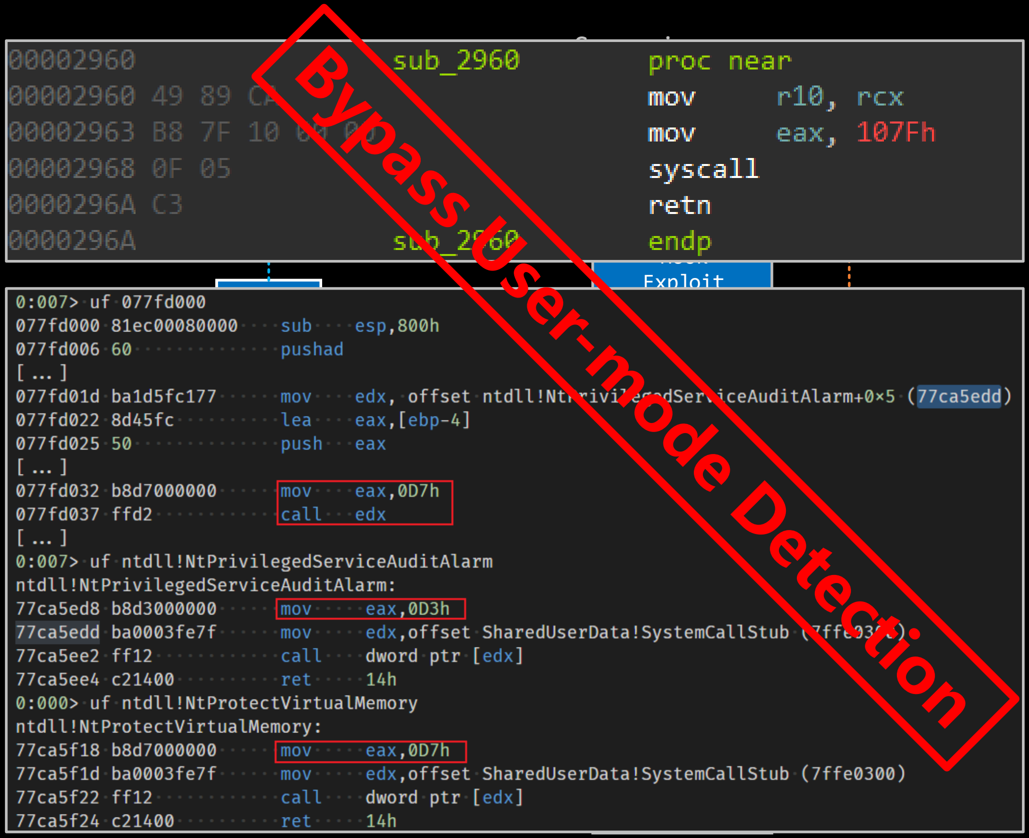


Name	Path	Description	Company Name
ATL90.dll	C:\Windows\winsxs\x86_microsoft.vc90.atl_1fc8b...	ATL Module for Windows (U...	Microsoft Corporation
AudioSes.dll	C:\Windows\System32\AudioSes.dll	Audio Session	Microsoft Corporation
authui.dll	C:\Windows\System32\authui.dll	Windows 身份验证 UI	Microsoft Corporation
avrt.dll	C:\Windows\System32\avrt.dll	Multimedia Realtime Runtime	Microsoft Corporation
batmeter.dll	C:\Windows\System32\batmeter.dll	电池电量帮助程序 DLL	Microsoft Corporation
bthprops.cpl	C:\Windows\System32\bthprops.cpl	Bluetooth 控制面板小程序	Microsoft Corporation
bthprops.cpl.mui	C:\Windows\System32\zh-CN\bthprops.cpl.mui	Bluetooth 控制面板小程序	Microsoft Corporation
[redacted]	[redacted]		
cfgmgr32.dll	C:\Windows\System32\cfgmgr32.dll	Configuration Manager DLL	Microsoft Corporation
clbcatq.dll	C:\Windows\System32\clbcatq.dll	COM+ Configuration Catalog	Microsoft Corporation
comctl32.dll	C:\Windows\winsxs\x86_microsoft.windows.com...	用户体验控件库	Microsoft Corporation
comctl32.dll.mui	C:\Windows\winsxs\x86_microsoft.windows.c..-co...	用户体验控件库	Microsoft Corporation
credssp.dll	C:\Windows\System32\credssp.dll	Credential Delegation Securi...	Microsoft Corporation
crypt32.dll	C:\Windows\System32\crypt32.dll	加密 API32	Microsoft Corporation

Sandbox Detection Engine

- Initial Scenario: Dynamic Library

- Inject into target processes to work
- Hook export functions of system libs
- Lightweight 😃
- Is that enough?
- Can be detected easily ☹
- Can be bypassed easily ☹



```
00002960                   sub_2960        proc near
00002960 49 89 CA                          mov     r10, rcx
00002963 B8 7F 10 00 00                    mov     eax, 107Fh
00002968 0F 05                             syscall
0000296A C3                                retn
0000296A                   sub_2960        endp
```

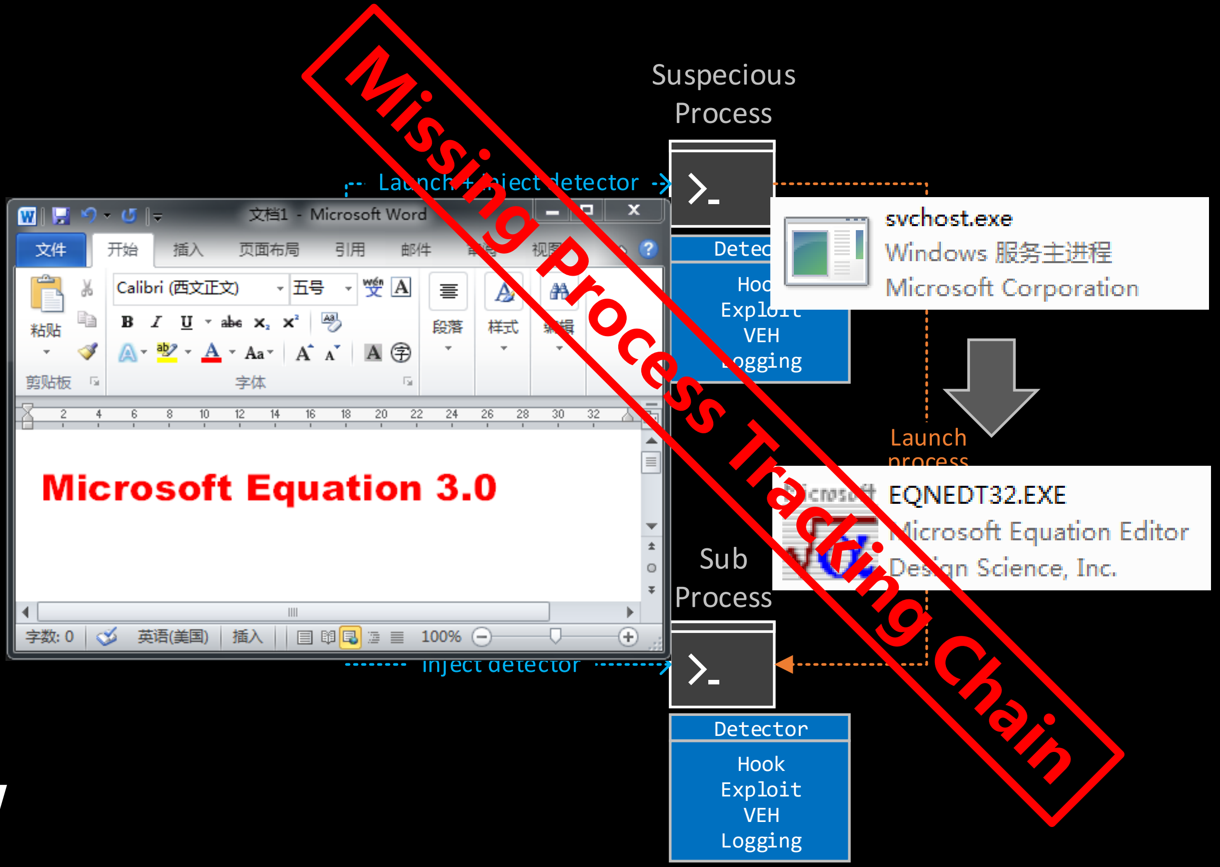
```
0:007> uf 077fd000
077fd000 81ec00080000    sub    esp,800h
077fd006 60              pushad
[ ... ]
077fd01d ba1d5fc177      mov    edx, offset ntdll!NtPrivilegedServiceAuditAlarm+0x5 (77ca5edd)
077fd022 8d45fc          lea    eax,[ebp-4]
077fd025 50              push   eax
[ ... ]
077fd032 b8d7000000      mov    eax,0D7h
077fd037 ffd2            call   edx
[ ... ]
0:007> uf ntdll!NtPrivilegedServiceAuditAlarm
ntdll!NtPrivilegedServiceAuditAlarm:
77ca5ed8 b8d3000000      mov     eax,0D3h
77ca5edd ba0003fe7f      mov     edx,offset SharedUserData!SystemCallStub (7ffe0300)
77ca5ee2 ff12            call    dword ptr [edx]
77ca5ee4 c21400          ret     14h
0:000> uf ntdll!NtProtectVirtualMemory
ntdll!NtProtectVirtualMemory:
77ca5f18 b8d7000000      mov     eax,0D7h
77ca5f1d ba0003fe7f      mov     edx,offset SharedUserData!SystemCallStub (7ffe0300)
77ca5f22 ff12            call    dword ptr [edx]
77ca5f24 c21400          ret     14h
```

Bypass User-mode Detection

Sandbox Detection Engine

- Initial Scenario: Dynamic Library

- Inject into target processes to work
- Hook export functions of system libs
- Lightweight 😀
- Is that enough?
- Can be detected easily ☹
- Can be bypassed easily ☹
- Easy to lose the tracking chain to new processes launched remotely ☹



Missing Process Tracking Chain

Suspecious Process

Launch + inject detector

Detector
Hook
Exploit
VEH
Logging

svchost.exe
Windows 服务主进程
Microsoft Corporation

Launch process

EQNEDT32.EXE
Microsoft Equation Editor
Design Science, Inc.

Sub Process

inject detector

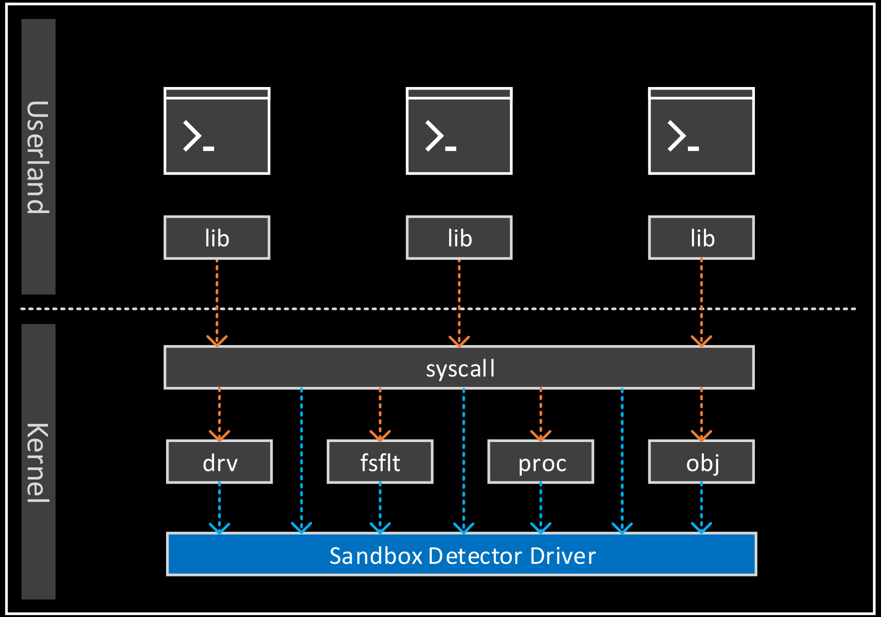
Detector
Hook
Exploit
VEH
Logging

Microsoft Equation 3.0

Sandbox Detection Engine

- The 2nd Option: Driver

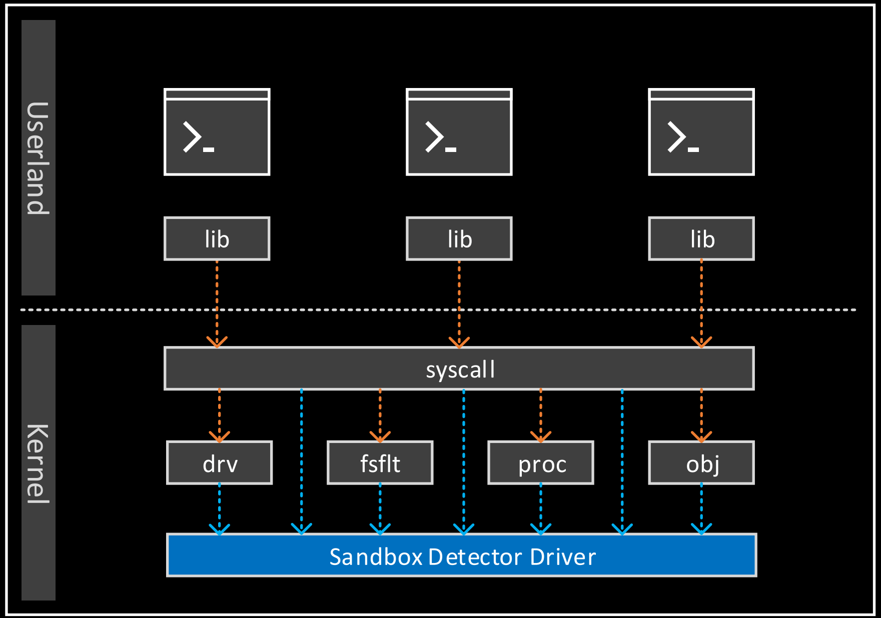
- Monitor system call from target in kernel
- System callbacks, notifications, filters



Sandbox Detection Engine

- The 2nd Option: Driver

- Monitor system call from target in kernel
- System callbacks, notifications, filters
- More complete monitoring coverage 😁
- More comprehensive stain tracking 😁



Sandbox Detection Engine

- The 2nd Option: Driver

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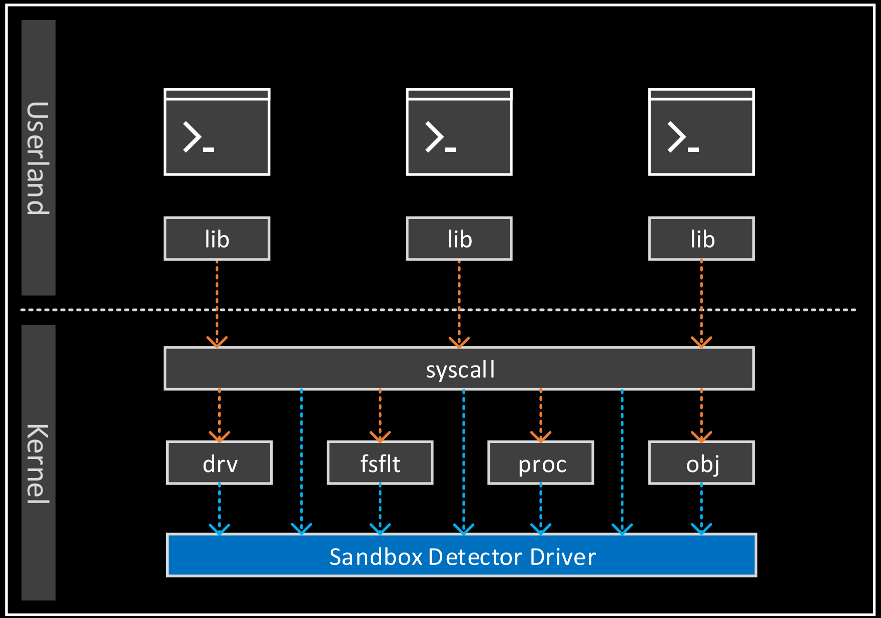
- Is that all right?



Sandbox Detection Engine

- The 2nd Option: Driver

- Monitor system call from target in kernel
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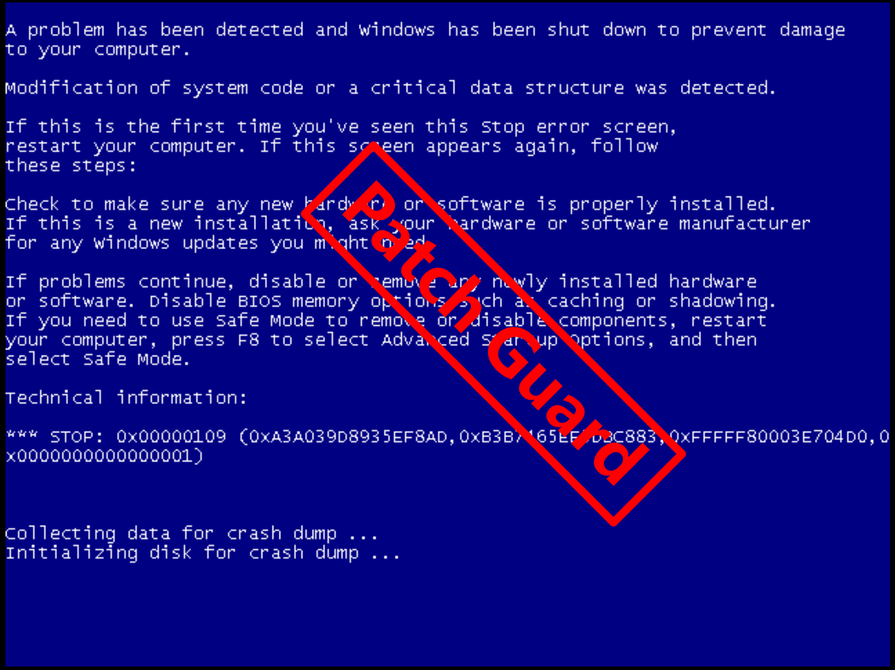
- Is that all right?
- PATCH GUARD for 64-bit OS ☹

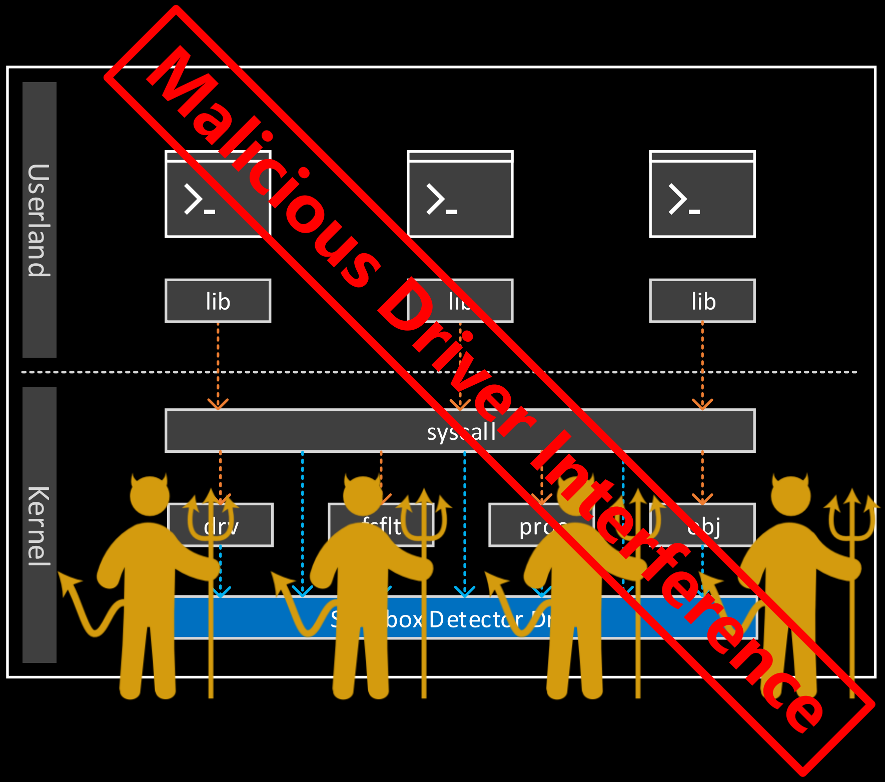


```
A problem has been detected and windows has been shut down to prevent damage
to your computer.

Modification of system code or a critical data structure was detected.

If this is the first time you've seen this Stop error screen,
restart your computer. If this screen appears again, follow
these steps:

Check to make sure any new hardware or software is properly installed.
If this is a new installation, ask your hardware or software manufacturer
for any Windows updates you might need.

If problems continue, disable or remove any newly installed hardware
or software. Disable BIOS memory options such as caching or shadowing.
If you need to use Safe Mode to remove or disable components, restart
your computer, press F8 to select Advanced Startup Options, and then
select Safe Mode.

Technical information:

*** STOP: 0x00000109 (0xA3A039D8935EF8AD,0xB3B7465EED3C883,0xFFFFF80003E704D0,0
x0000000000000001)


Collecting data for crash dump ...
Initializing disk for crash dump ...
```

Sandbox Detection Engine

- The 2nd Option: Driver

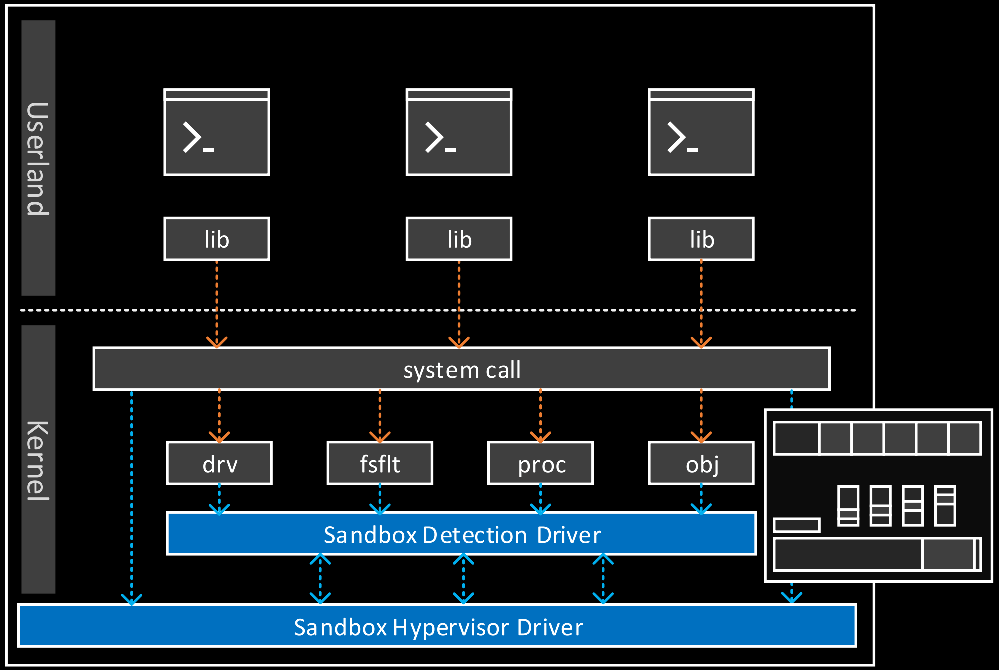
- Monitor system call from target in kernel
- System callbacks, notifications, filters
- More complete monitoring coverage 😃
- More comprehensive stain tracking 😃
- Is that all right?
- PATCH GUARD for 64-bit OS ☹
- Interference from malwares with drivers ☹



Sandbox Detection Engine

- The 3rd Option: Virtualization-based Driver

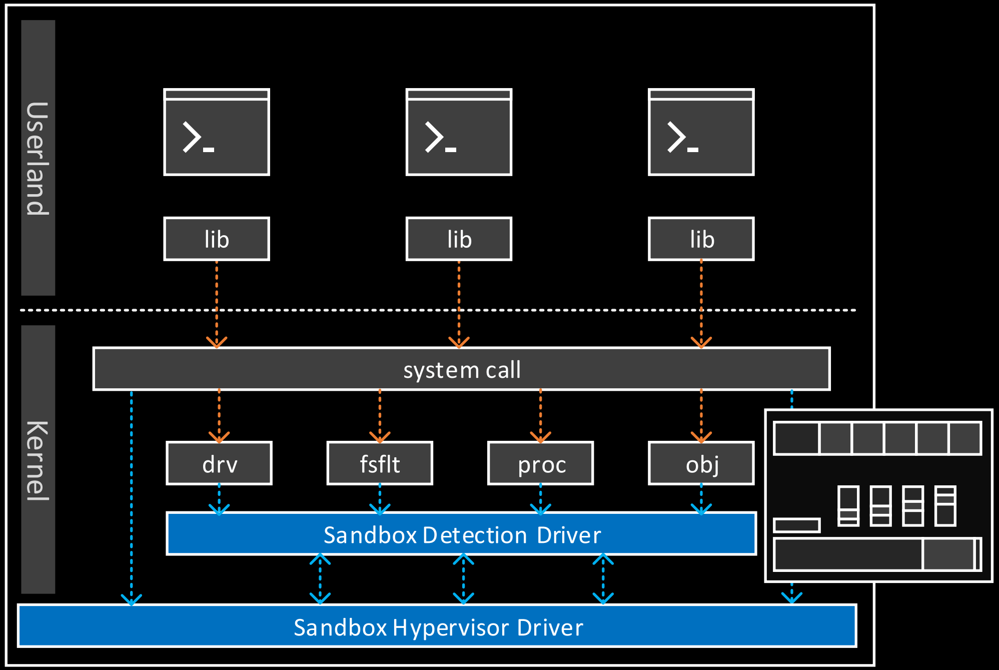
- Virtualization-based system call monitoring
- R/W access to sensitive memory monitoring



Sandbox Detection Engine

- The 3rd Option: Virtualization-based Driver

- Virtualization-based system call monitoring
- R/W access to sensitive memory monitoring
- Avoid BSOD caused by PATCH GUARD 😀
- Protect private driver code and data 😀
- Expand more comprehensive detection 😀



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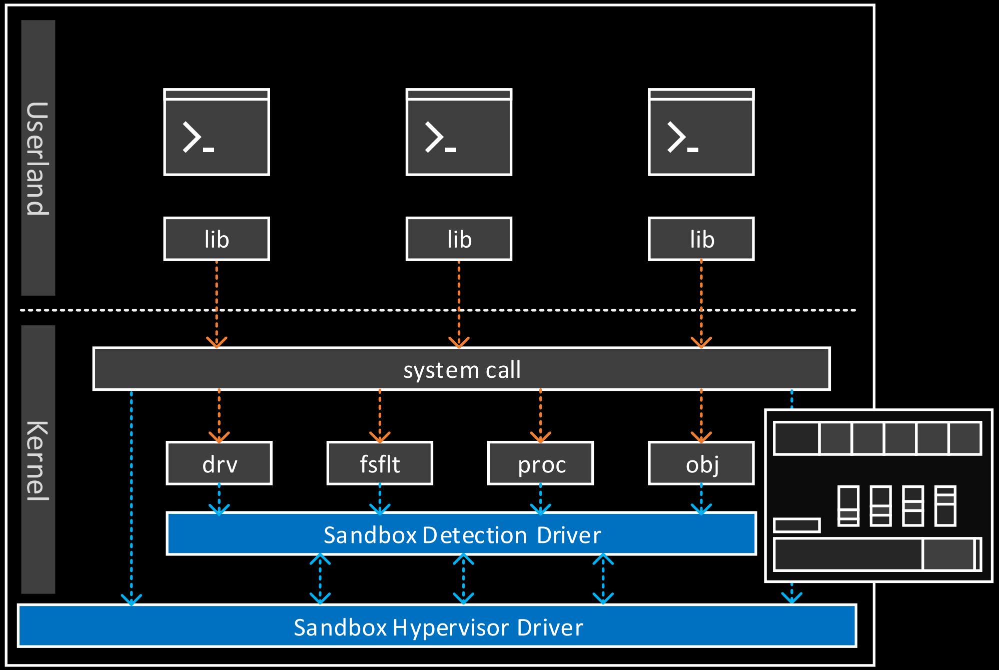
- Is this foolproof?



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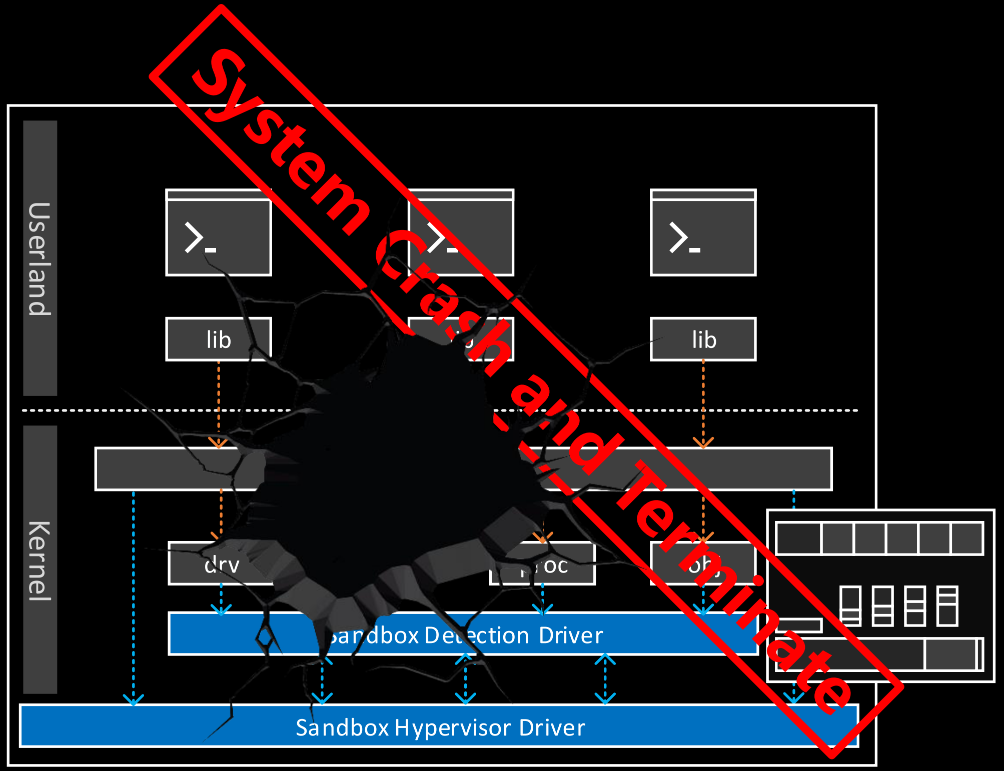
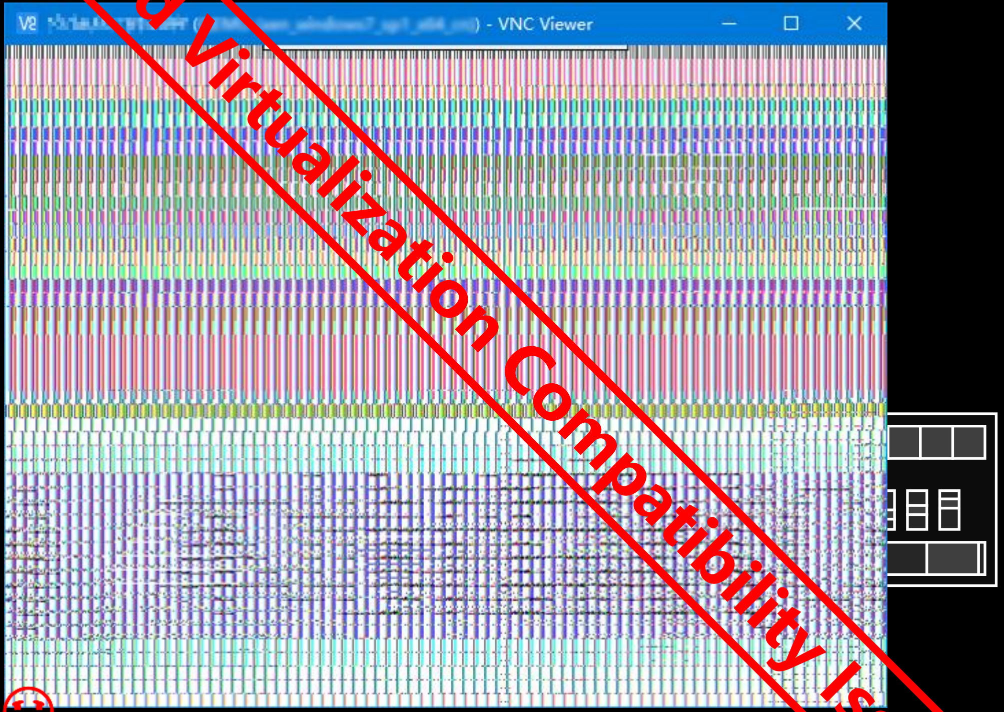
- Unsecured reliability of other kernel modules ☹



Sandbox Detection Engine

- The 3rd Option: Virtualization-based Driver

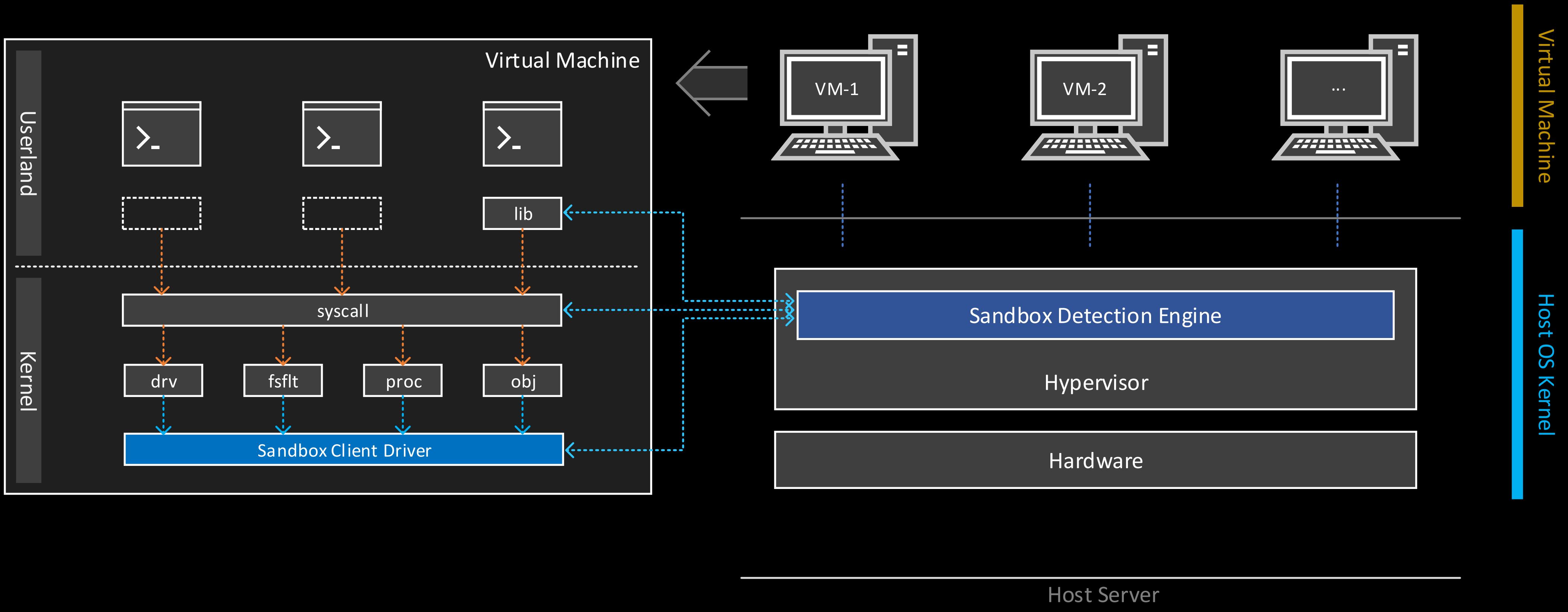
- Virtualization-based system call monitoring
- R/W access to sensitive memory monitoring
- Avoid BSOD caused by PATCH GUARD 😀
- Protect private driver code and data 😀
- Expand more comprehensive detection 😀
- Is this foolproof?
- Unsecured reliability of other kernel modules 😞
- Poor nested virtualization support of Virtual machine software 😞



Nested Virtualization Compatibility Issues

Sandbox Detection Engine

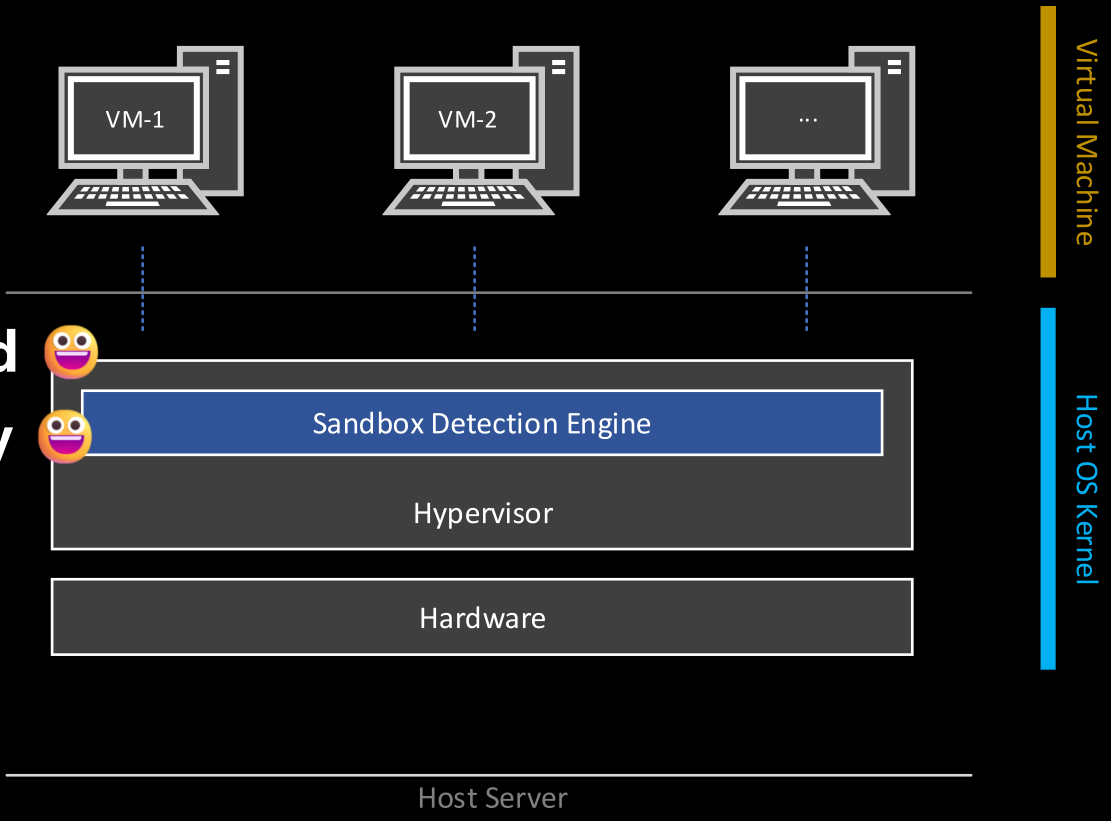
- **The 4th Option: Detection Scheme Based on Global Virtual Machine Monitor**



Sandbox Detection Engine

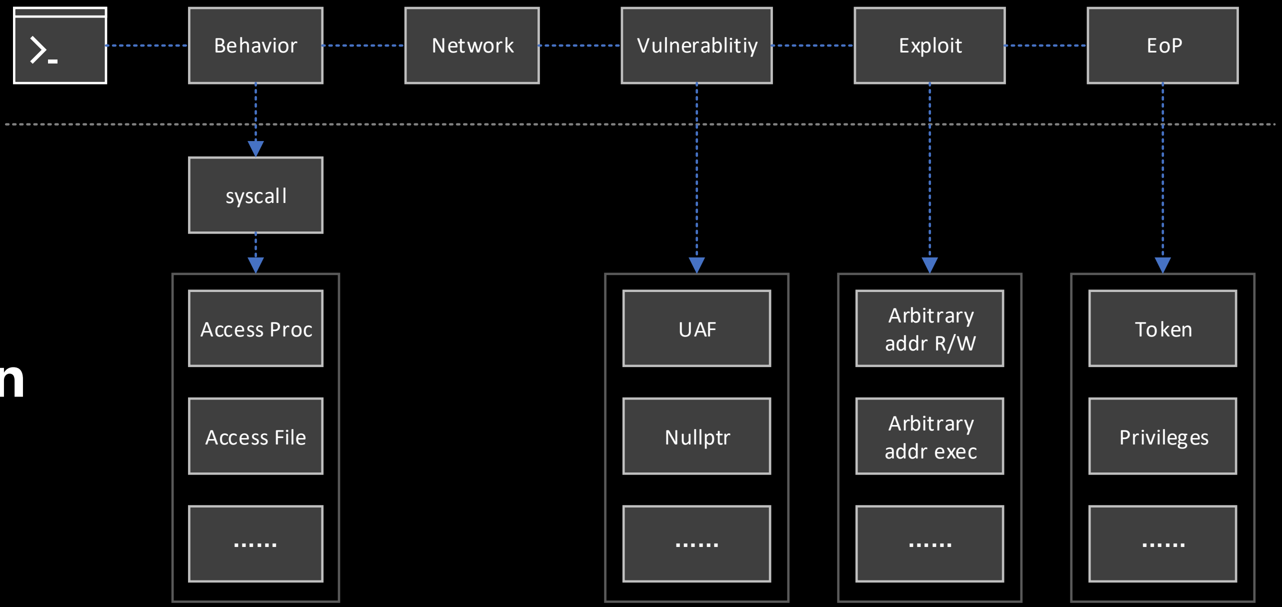
- The 4th Option: Detection Scheme Based on Global Virtual Machine Monitor

- Core detection code in host OS kernel
- Integrated Advantages from previous
- Independent of modules inside VM 😀
- No affect on detection when VM crashed 😀
- Data outputs host record service directly 😀



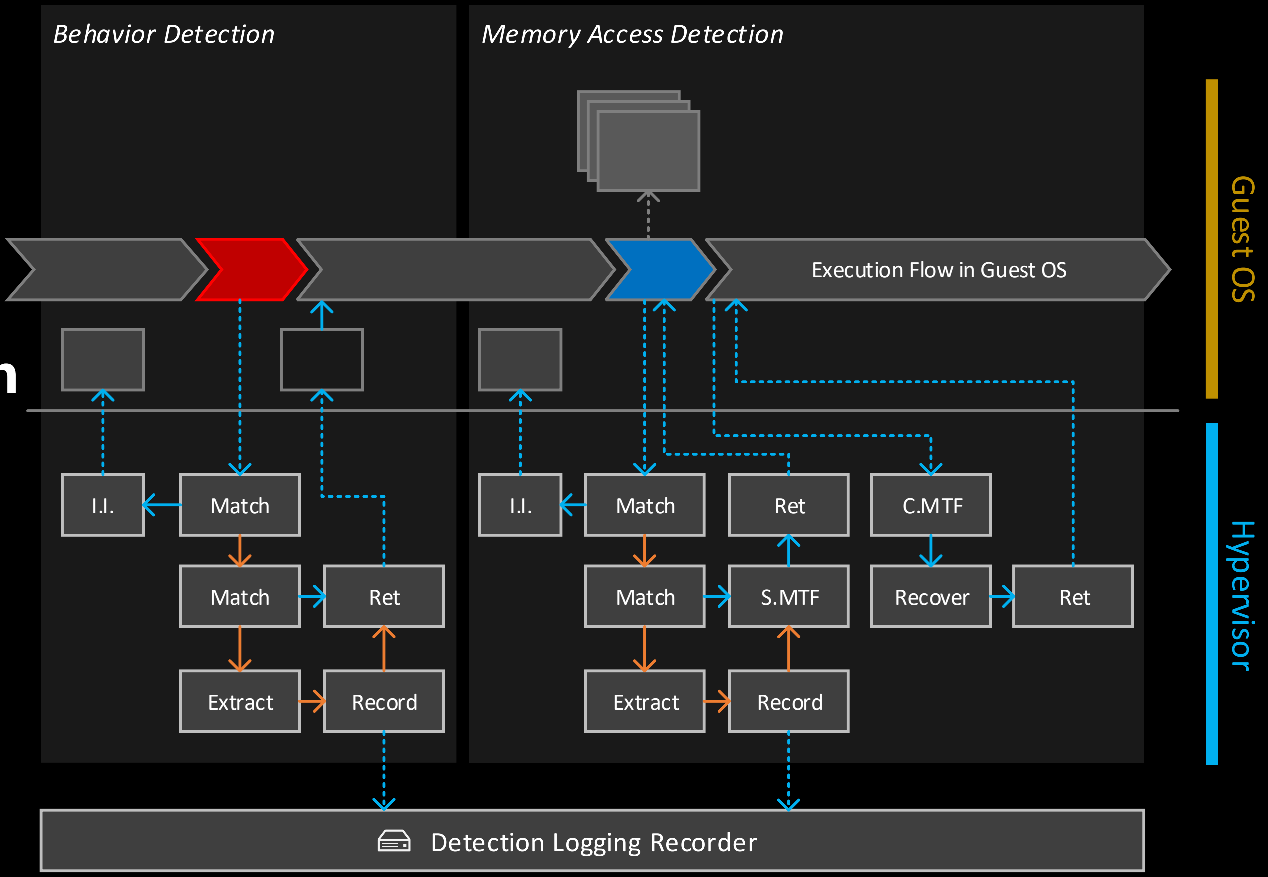
Sandbox Detection Technology

- Behavior Detection
- Memory Access Detection
- Kernel Exploit Detection
- Kernel Exception Detection
- Known Vulnerabilities Detection
- User-mode Exploit Detection



Sandbox Detection Technology

- **Behavior Detection**
- **Memory Access Detection**
- **Kernel Exploit Detection**
- **Kernel Exception Detection**
- **Known Vulnerabilities Detection**
- **User-mode Exploit Detection**

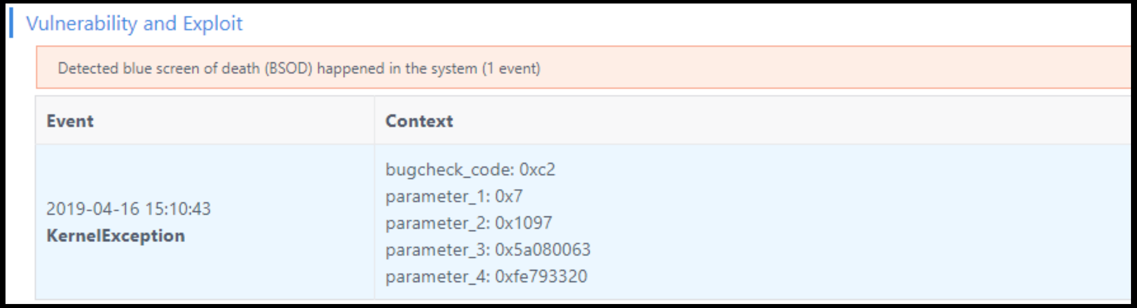


Kernel Exploit Detection

Vulnerability Triggering	Exploiting	Exploit Result
UAF	Pool/heap spray	Token
Nullptr	Corrupting window	Privileges
OOB	…	Integrity
…		ACL
		…

Kernel Exception Detection

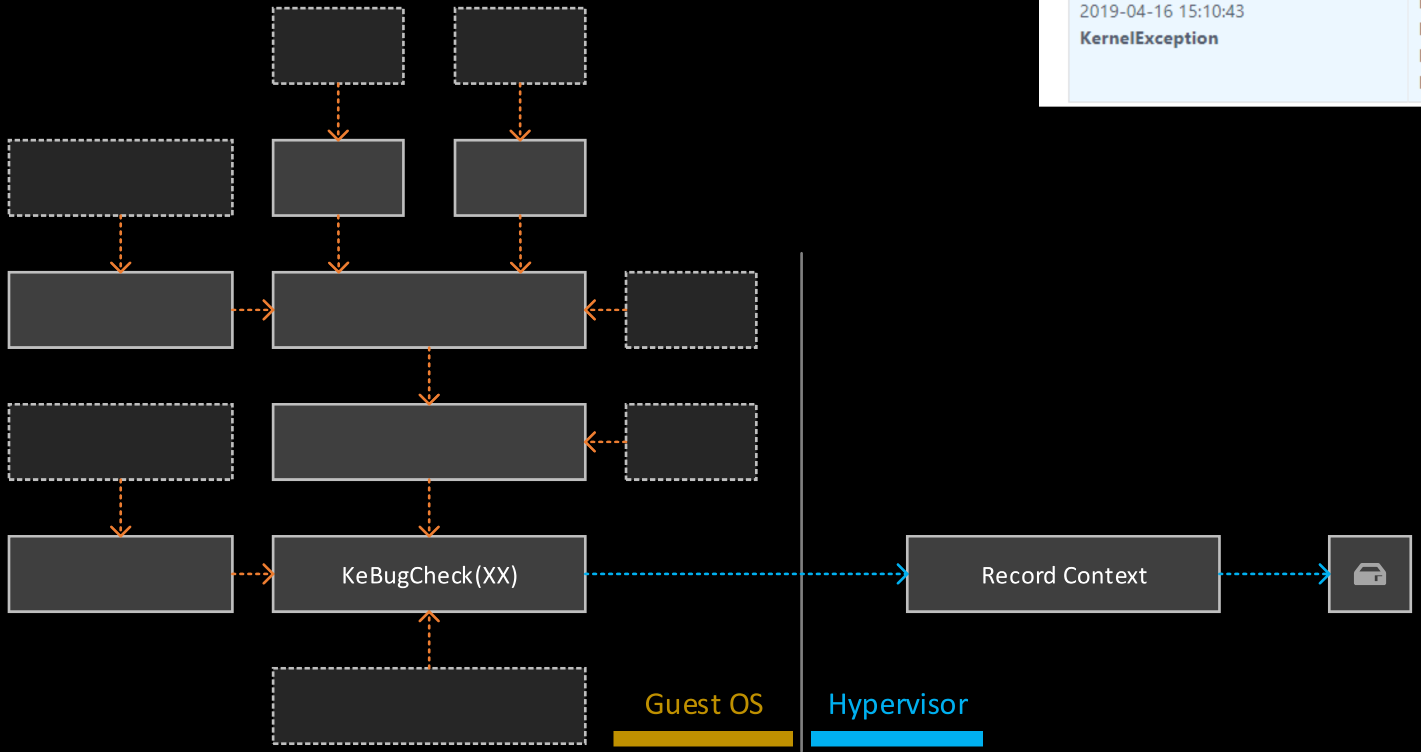
- **Record critical context when the system kernel crashes**



Vulnerability and Exploit

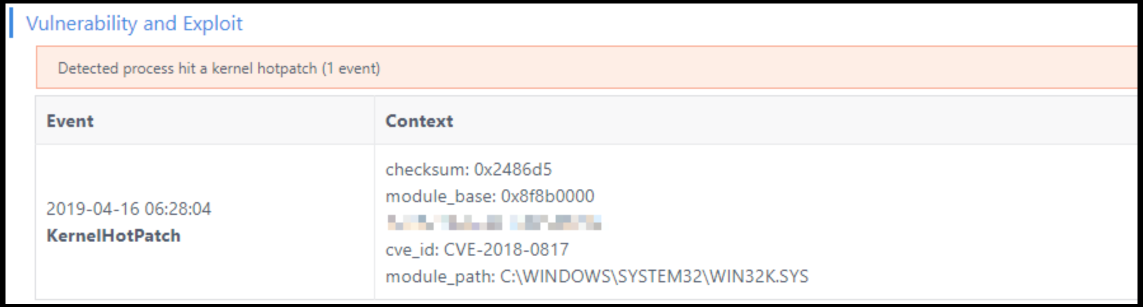
Detected blue screen of death (BSOD) happened in the system (1 event)

Event	Context
2019-04-16 15:10:43 **KernelException**	bugcheck_code: 0xc2 parameter_1: 0x7 parameter_2: 0x1097 parameter_3: 0x5a080063 parameter_4: 0xfe793320



Known Vulnerabilities Detection

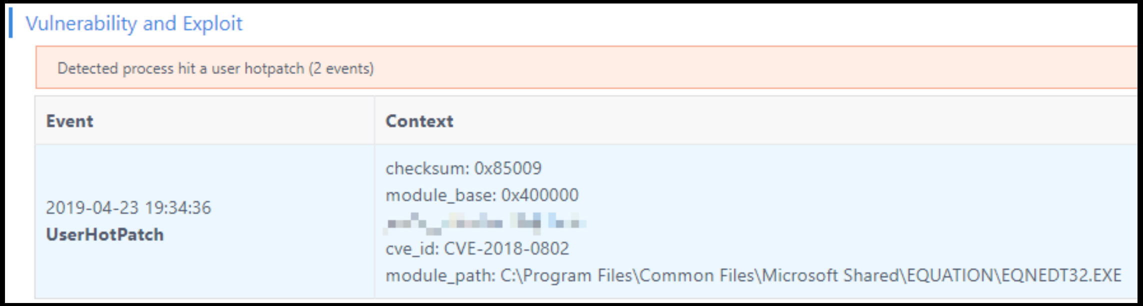
- **Identify tasks that exploit known vulnerabilities accurately**



Vulnerability and Exploit

Detected process hit a kernel hotpatch (1 event)

Event	Context
2019-04-16 06:28:04 **KernelHotPatch**	checksum: 0x2486d5 module_base: 0x8f8b0000 [redacted] cve_id: CVE-2018-0817 module_path: C:\WINDOWS\SYSTEM32\WIN32K.SYS



Vulnerability and Exploit

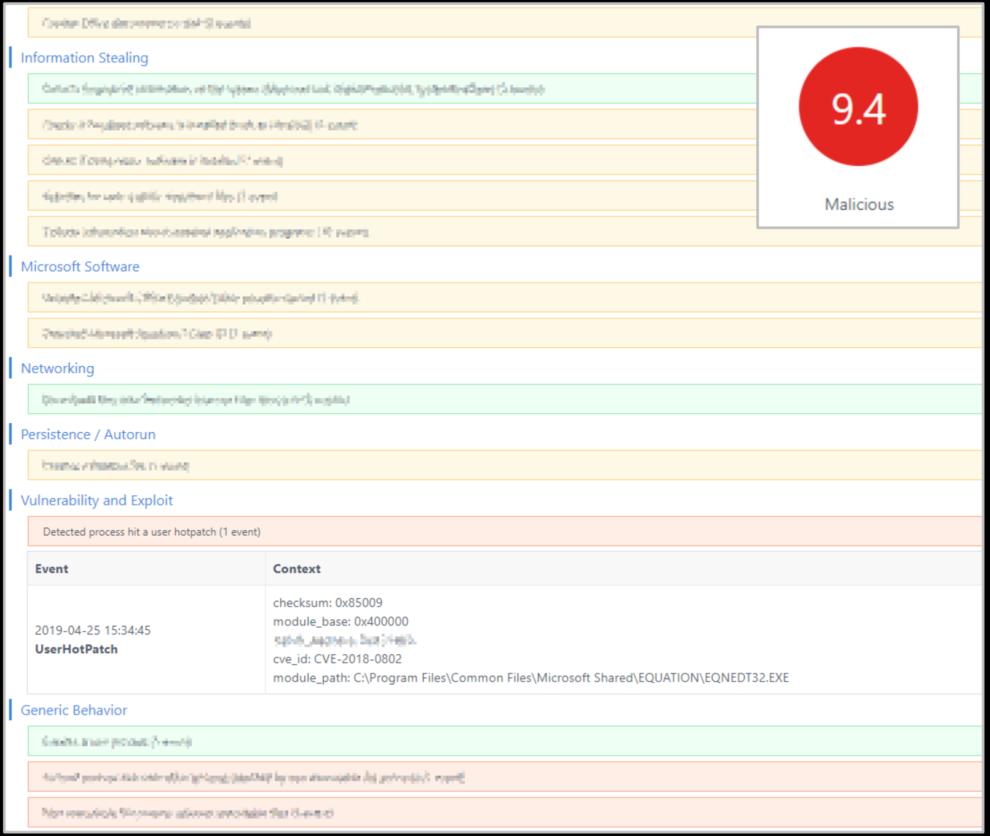
Detected process hit a user hotpatch (2 events)

Event	Context
2019-04-23 19:34:36 **UserHotPatch**	checksum: 0x85009 module_base: 0x400000 [redacted] cve_id: CVE-2018-0802 module_path: C:\Program Files\Common Files\Microsoft Shared\EQUATION\EQNEDT32.EXE

User-mode Exploit Detection

- **Heap Spray Limit Detection**
- **Export Address Table Filtering**
- **Import Address Table Filtering**
- **ROP Detection**
- **Flash Specific Detection**
  - Vector Length Detection
  - ByteArray Length Detection
  - LoadBytes Dump
  - Other Detection Features
- **VBScript Specific Detection**
- **……**

Detection Result Alarm



[illegible]

Information Stealing

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

9.4

Malicious

Microsoft Software

[illegible]

[illegible]

Networking

[illegible]

Persistence / Autorun

[illegible]

Vulnerability and Exploit

Detected process hit a user hotpatch (1 event)

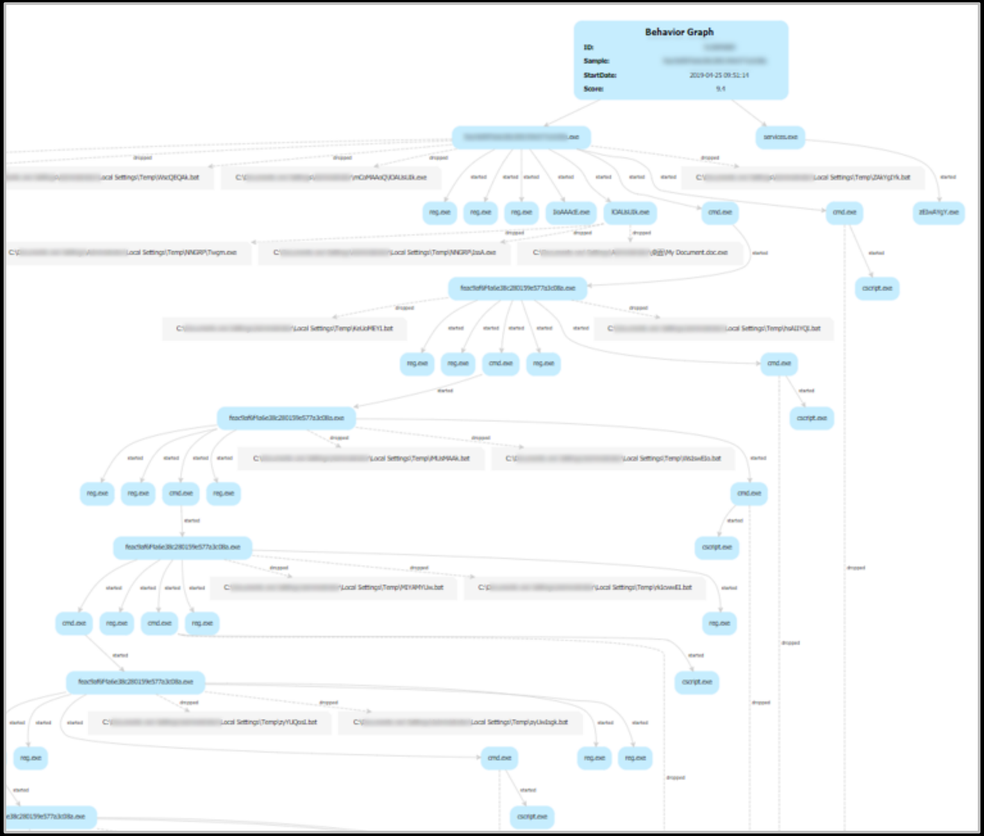
Event	Context
2019-04-25 15:34:45 **UserHotPatch**	checksum: 0x85009 module_base: 0x400000 [illegible] cve_id: CVE-2018-0802 module_path: C:\Program Files\Common Files\Microsoft Shared\EQUATION\EQNEDT32.EXE

Generic Behavior

[illegible]

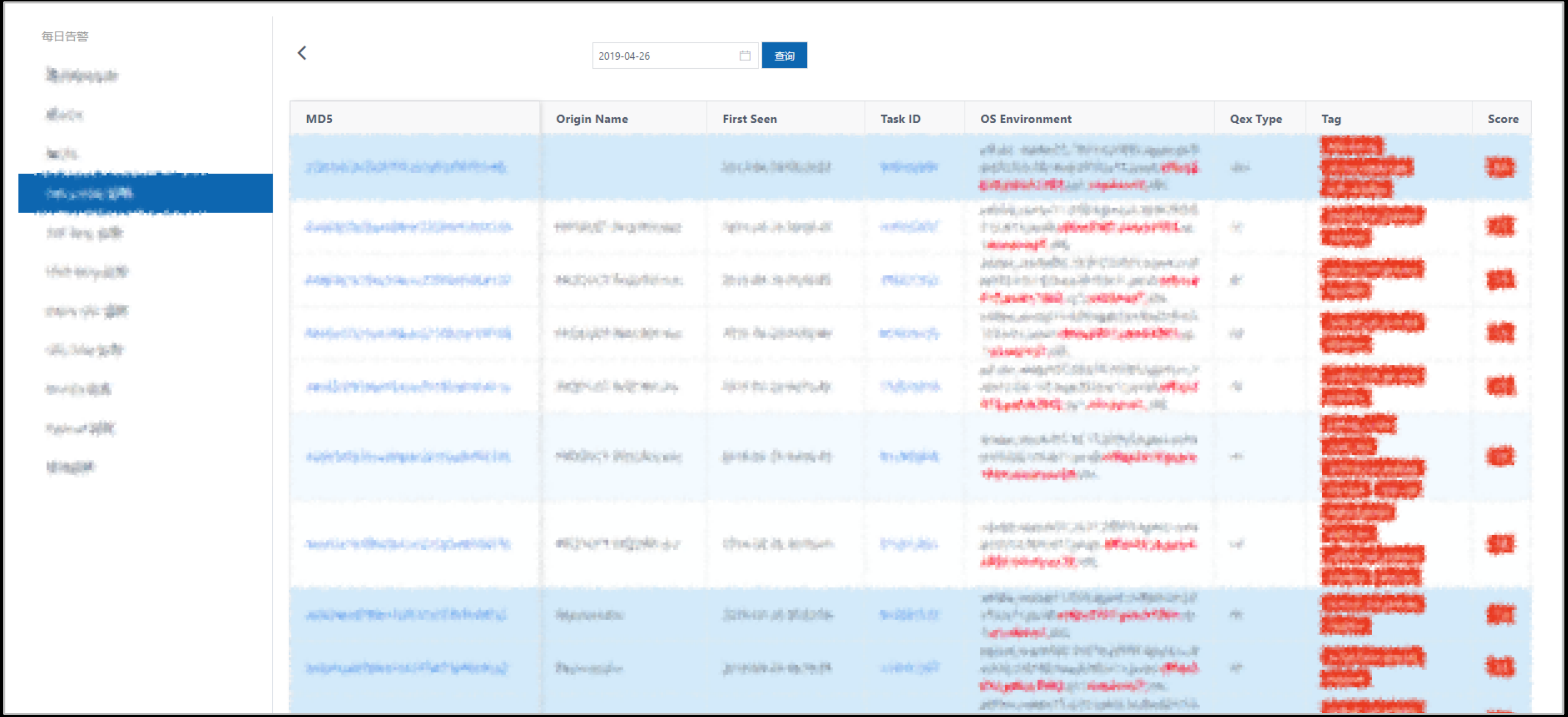
[illegible]

[illegible]



Advanced Threat Automation Platform

Detection Result Alarm



每日告警

[redacted]

2019-04-26 查询

MD5	Origin Name	First Seen	Task ID	OS Environment	Qex Type	Tag	Score
[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Advanced Threat Automation Platform

How to find zero-day using sandbox?

Speaking from CVE-2017-0199...

Sandbox Advantage

- **Multiple Environments**
  - Each version of Windows
  - Each version of Office
  - Each version of Flash
- **Dynamic Execution**
  - Analog interaction
  - Anti-static obfuscation (especially RTF files)
- **Record And Restore The Scene**
- **Accurate**
  - Vulnerability and exploit identification
- **Automation**
  - Automatically show process behaviors
  - Automatically dump files
  - Automatically dump exploit code loaded by LoadBytes

Build Automation Detection System

- **Historical Event Research**
  - History 0day/1day study
- **Data Source**
  - Massive data from 360
  - High quality shared data source
- **Analysis System**
  - Sandbox
- **Notification System**
- **Manual Confirmation**
  - Related Vulnerability Analysts

Related Vulnerabilities in Nearly 6 Years

2013	2014	2015	2016	2017	2018
CVE-2013-0634	CVE-2014-1761	CVE-2015-1642	CVE-2016-4117	CVE-2017-0199	CVE-2018-0798
CVE-2013-3906	CVE-2014-4114	CVE-2015-2424	CVE-2016-7193	CVE-2017-0261	CVE-2018-0802
	CVE-2014-6352	CVE-2015-2545	CVE-2016-7855	CVE-2017-0262	CVE-2018-4878
		CVE-2015-5119		CVE-2017-8570	CVE-2018-5002
		CVE-2015-5122		CVE-2017-8759	CVE-2018-8174
				CVE-2017-11292	CVE-2018-8373
				CVE-2017-11826	CVE-2018-15982
				CVE-2017-11882	

Historical Vulnerability Classification

RTF Control Word Parsing Problem	Open XML Tag Parsing Problem	ActiveX Control Parsing Problem	Office Embedded Flash 0day
CVE-2010-3333 CVE-2014-1761 CVE-2016-7193	CVE-2015-1641 CVE-2017-11826	CVE-2012-0158 CVE-2012-1856 CVE-2015-2424 CVE-2017-11882 CVE-2018-0798 CVE-2018-0802	CVE-2011-0609 CVE-2011-0611 CVE-2013-0634 Code from HackingTeam CVE-2016-4117 CVE-2016-7855 CVE-2018-4878 CVE-2018-5002 CVE-2018-15982
TIFF Image Parsing Problem	**EPS File Parsing Problem**	**Moniker**	**Other Office Logic Vulnerabilities**
CVE-2013-3906	CVE-2015-2545 CVE-2017-0261 CVE-2017-0262	CVE-2017-0199 CVE-2017-8570 CVE-2017-8759 CVE-2018-8174 CVE-2018-8373	CVE-2014-4114 CVE-2014-6352 CVE-2015-0097

History is Always Similar

RTF Control Word Parsing Problem	Open XML Tag Parsing Problem	ActiveX Control Parsing Problem	Office Embedded Flash 0day
CVE-2010-3333 CVE-2014-1761 CVE-2016-7193	CVE-2015-1641 **CVE-2017-11826**	CVE-2012-0158 CVE-2012-1856 CVE-2015-2424 CVE-2017-11882 CVE-2018-0798 **CVE-2018-0802**	CVE-2011-0609 CVE-2011-0611 CVE-2013-0634 Code from HackingTeam CVE-2016-4117 CVE-2016-7855 CVE-2018-4878 **CVE-2018-5002** **CVE-2018-15982**
TIFF Image Parsing Problem	**EPS File Parsing Problem**	**Moniker**	**Other Office Logic Vulnerabilities**
CVE-2013-3906	CVE-2015-2545 CVE-2017-0261 CVE-2017-0262	CVE-2017-0199 CVE-2017-8570 CVE-2017-8759 **CVE-2018-8174** CVE-2018-8373	CVE-2014-4114 CVE-2014-6352 CVE-2015-0097

Constant Reflection

A few missteps: 4 0days + 1 1day

April 2017

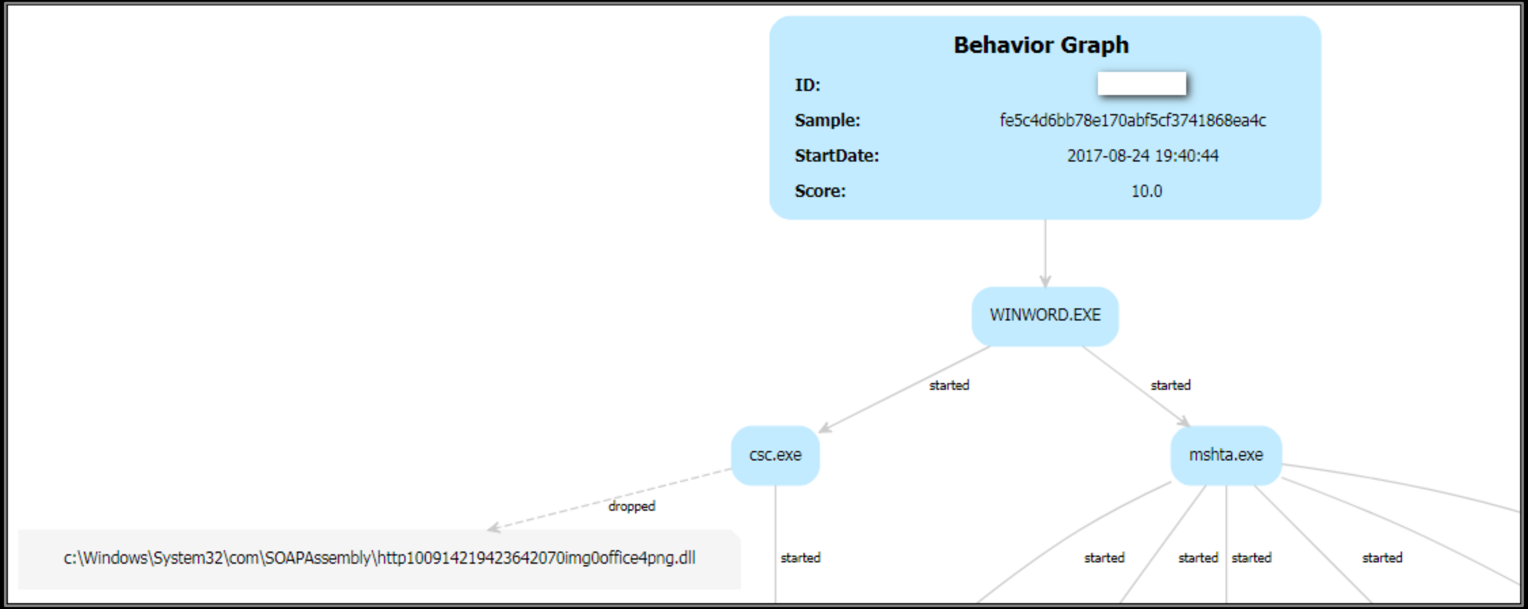
- **CVE-2017-0261 (0day)**
- **CVE-2017-0262 (0day) + CVE-2017-0263 (0day)**

- **Reflection**
  - Sandbox Detection Engine is defective ☹
  - CVE-2017-0261 sample cannot be triggered in Office 2010 ☹
  - CVE-2017-0262 sample cannot be triggered in Office 2007 ☹
  - When the user-mode engine meets a kernel zero-day ☹

August 2017

- **CVE-2017-8759 (0day)**

- **Reflection**
  - The sandbox ran out of the sample, but failed to notify the analyst in time ☹



Behavior Graph

ID: [redacted]

Sample: fe5c4d6bb78e170abf5cf3741868ea4c

StartDate: 2017-08-24 19:40:44

Score: 10.0

October 2017

- **CVE-2017-11292 (1day)**

- **Reflection**
  - Lack of understanding of the DealersChoice framework 😞
  - If the target is a low version of Flash, issue CVE-2015-7645 😞
  - If the target is a high version of Flash, issue CVE-2017-11292 😀

Research Attack Framework

- **DealersChoice**
  - Named by @Unit42_Intel
  - Used by APT28
  - Continuous improvement to avoid detection as much as possible
- **Initial Approach**
  - Check current Flash version
  - Filter geographical location
  - Short survival time
- **New Approach**
  - Anti-sandbox: need to simulate document slide
  - Rewrite open source code, add malicious features, avoid static detection

Continue to Innovate

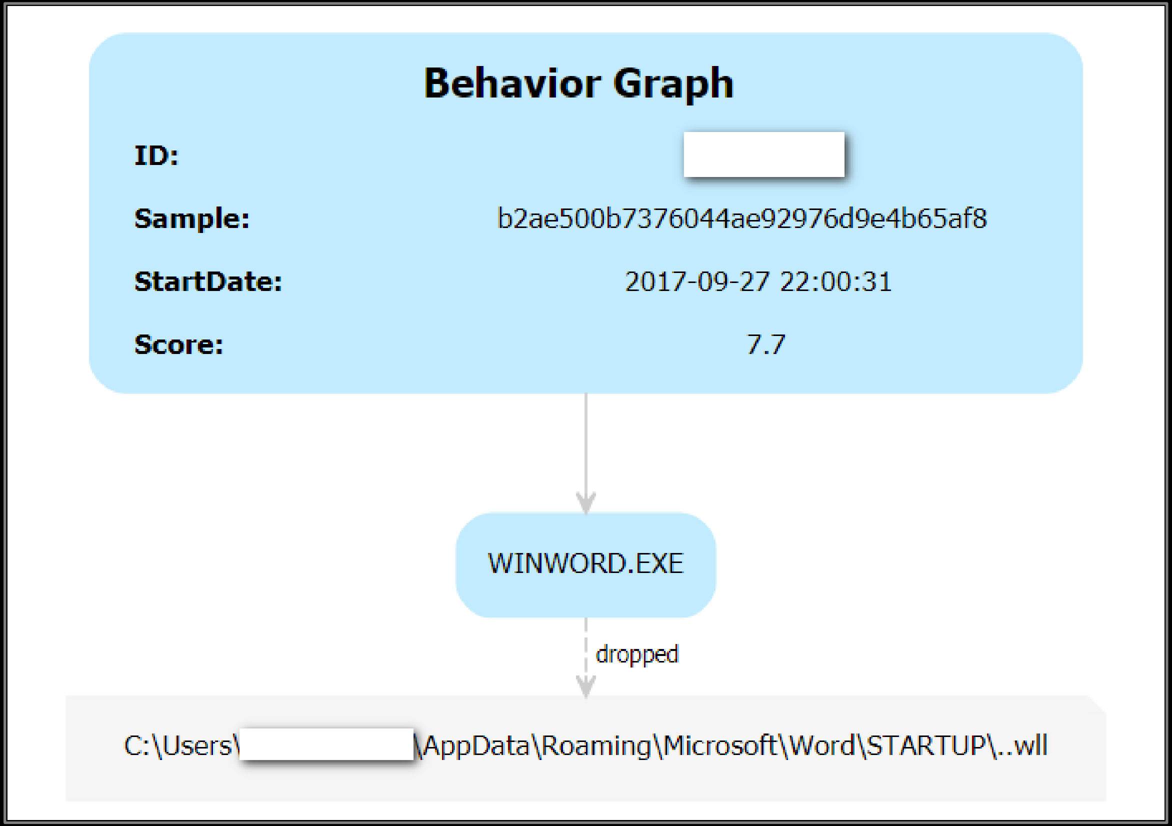
- **Sandbox Detection Engine defects** ☹
  - Develop the next generation of sandbox detection engine 😀
- **Correctly environment is not selected** ☹
  - Make a variety of environments 😀
  - Make delivery strategies with high trigger rate 😀
- **Failure to notify analysts in a timely manner** ☹
  - Build a real-time notification system 😀
- **Not familiar enough with the attack framework** ☹
  - Research DealersChoice framework 😀
  - Enhance Flash specific detection 😀

From 0 to 1

CVE-2017-11826

From 0 to 1

- September 27, 2017



Behavior Graph

ID: [redacted]

Sample: b2ae500b7376044ae92976d9e4b65af8

StartDate: 2017-09-27 22:00:31

Score: 7.7

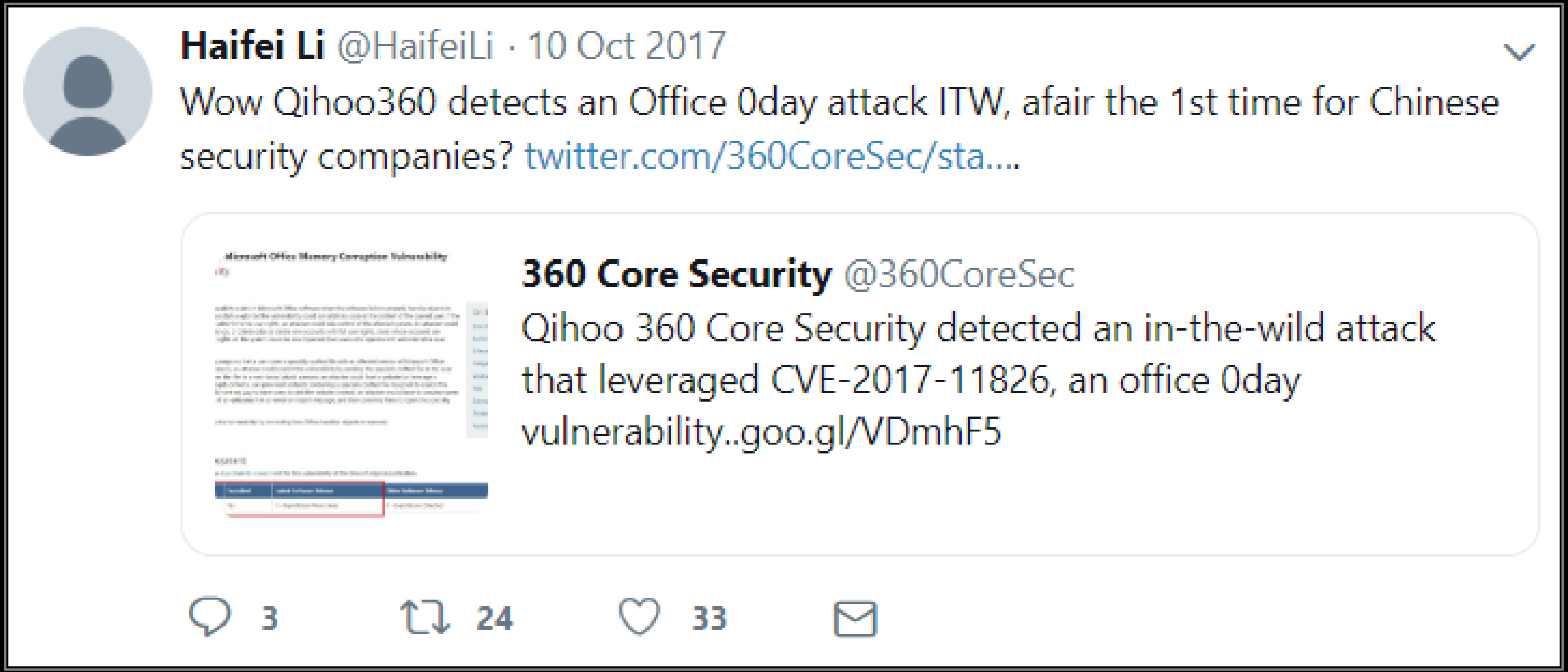
WINWORD.EXE

dropped

C:\Users\[redacted]\AppData\Roaming\Microsoft\Word\STARTUP\..wll

From 0 to 1

- **For the first time Chinese security company caught an in-the-wild Office zero-day**



Haifei Li @HaifeiLi · 10 Oct 2017

Wow Qihoo360 detects an Office 0day attack ITW, afair the 1st time for Chinese security companies? twitter.com/360CoreSec/sta....

360 Core Security @360CoreSec

Qihoo 360 Core Security detected an in-the-wild attack that leveraged CVE-2017-11826, an office 0day vulnerability..goo.gl/VDmhF5

CVE-2017-11826

- **OLEObject & Font object type obfuscation + ActiveX heap spray**

```
; Normal execution under Office 2007

; mov     eax, [eax+44h]
0:000> dc 38450f4 l4c/4
038450f4  0000ffff 0000ffff 00000004 00000004  ................
03845104  00000001 00000000 00000000 00000000  ................
03845114  00000000 ffffffff ffffffff 00000000  ................
03845124  00000000 ffffffff 00000000 00000000  ................
03845134  00000000 01d9ffa0 67a02e58           ........X..g

; mov     eax, [eax+44h]
0:000> dc 01d9ffa0 l4c/4
01d9ffa0  00000001 00000001 01f47928 00000009  ........(y......
01d9ffb0  00000000 00000000 00000000 00000000  ................
01d9ffc0  00000000 000004b0 00000000 00000000  ................
01d9ffd0  0005003c 00000000 00000000 00000000  <...............
01d9ffe0  00000002 01f7e0a0 00000000           ............

; mov     ecx, [eax]
0:000> dd 01f7e0a0 l1
01f7e0a0  65d9420c

; call    dword ptr [ecx+4]
0:000> dds 65d9420c l2
65d9420c  65b527ad mso!Ordinal1072+0x2dd
65d94210  658bbe71 mso!Ordinal836+0xaf    // AddRef
```

```
; Vuln triggered under Office 2007

; mov     eax, [eax+44h]
0:000> dc 5998140 l4c/4
05998140  000001de 000000dd 00000015 00000010  ................
05998150  00000000 00000000 00000000 00000000  ................
05998160  00000000 ffffffff ffffffff 00000000  ................
05998170  00000000 ffffffff 00000000 00000000  ................
05998180  00000000 04131700 67110a89           ...........g

; mov     eax, [eax+44h]
0:000> dc 04131700 l4c/4
04131700  0000045f 00000000 00000000 00000000  _...............
04131710  00000000 00000000 00000000 00000000  ................
04131720  00000000 00000000 0069004c 0063006e  ........L.i.n.c.
04131730  00720065 00680043 00720061 00680043  e.r.C.h.a.r.C.h.
04131740  00720061 088888ec 006f0066           a.r.....f.o.

; mov     ecx, [eax]
0:000> dd 088888ec l1
088888ec  088883ec

; call    dword ptr [ecx+4]
0:000> dds 088883ec l2
088883ec  72980e2b MSVBVM60!IID_IVbaHost+0x127eb
088883f0  72980e2b MSVBVM60!IID_IVbaHost+0x127eb // Stack Pivot
```

From 1 to N

CVE-2018-0802

CVE-2018-8174

CVE-2018-5002

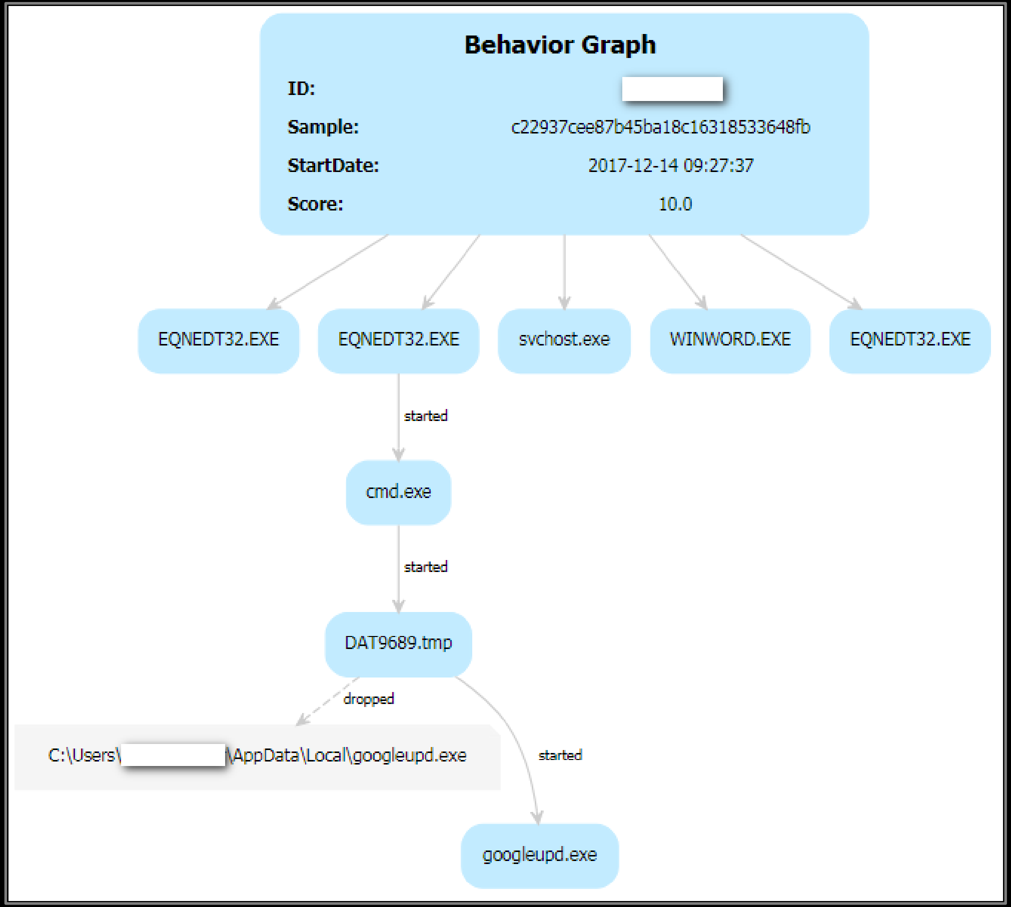
CVE-2018-15982

CVE-2018-0802

- **Stack Overflow in Equation Editor**

- **December 14, 2017**
- **Embedding two vulnerabilities**
  - CVE-2017-11882
  - CVE-2018-0802
  - Can be triggered and exploited successfully 😀

- **December 19, 2017**
- **Embedding only one vulnerability**
  - CVE-2018-0802
  - Cannot trigger properly ☹
  - Can be successfully used after reconstructing OLE 😀



Behavior Graph

ID: [redacted]

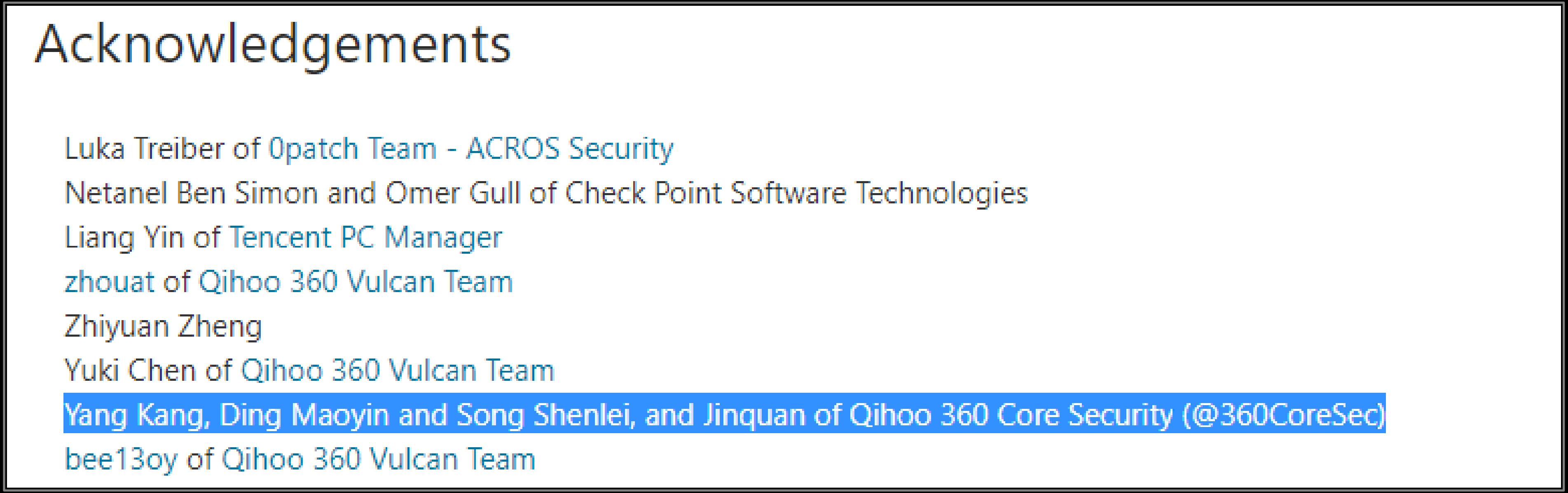
Sample: c22937cee87b45ba18c16318533648fb

StartDate: 2017-12-14 09:27:37

Score: 10.0

CVE-2018-0802

- Both samples were reported to Microsoft
- On January 10, 2018, Microsoft acknowledged us



Acknowledgements

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Zhiyuan Zheng

Yuki Chen of Qihoo 360 Vulcan Team

Yang Kang, Ding Maoyin and Song Shenlei, and Jinquan of Qihoo 360 Core Security (@360CoreSec)

bee13oy of Qihoo 360 Vulcan Team

CVE-2018-0802

- **Sample of December 19, 2017**
  - MD5: 299D0C5F43E59FC9415D70816AEE56C6
  - Embedded 0day 😀
  - RTF obfuscation 😀
  - OLE data construct error ☹

Wrong equation flow :

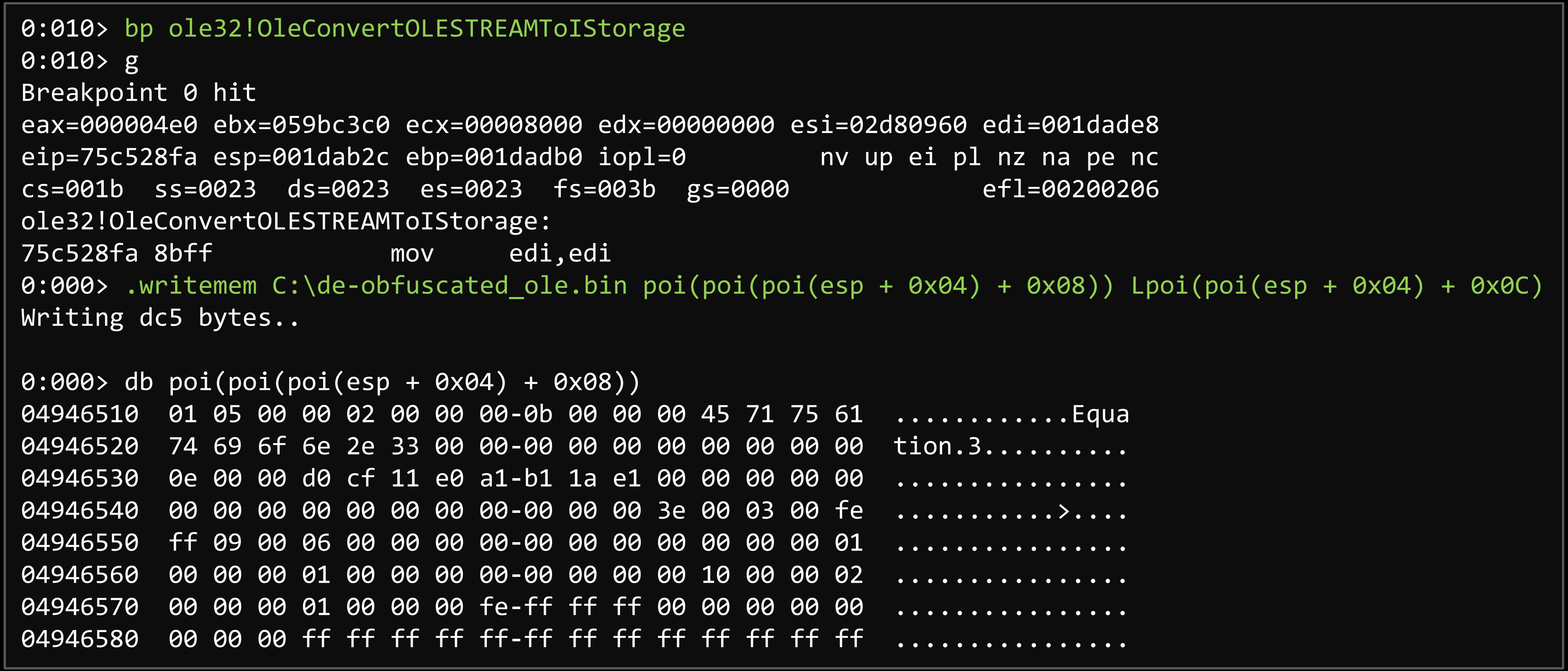
```
DirEntry SID=4:
'\xe7\x90\x80\xe6\xa4\x80\xe7\x98\x80\xe6\x94\x80\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\xe2\
x80\x80\xc8\x80\xef\xbc\x80\xef\xbf\xbf\xef\xbf\xbf\xef\xbf\xbf\xef\xbf\xbf\xef\xbf\xbf\xc3\xbf\x00'
 - type: 0
 - sect: 0
 - SID left: 0, right: 0, child: 0
 - size: 0 (sizeLow=0, sizeHigh=0) # logged by olefile.py
```

Normal equation flow :

```
DirEntry SID=4: 'Equation Native'
 - type: 2
 - sect: 4
 - SID left: 4294967295, right: 4294967295, child: 4294967295
 - size: 197 (sizeLow=197, sizeHigh=0) # logged by olefile.py
```

CVE-2018-0802

- **Where is the error?**
  - Extract the confusing OLE object

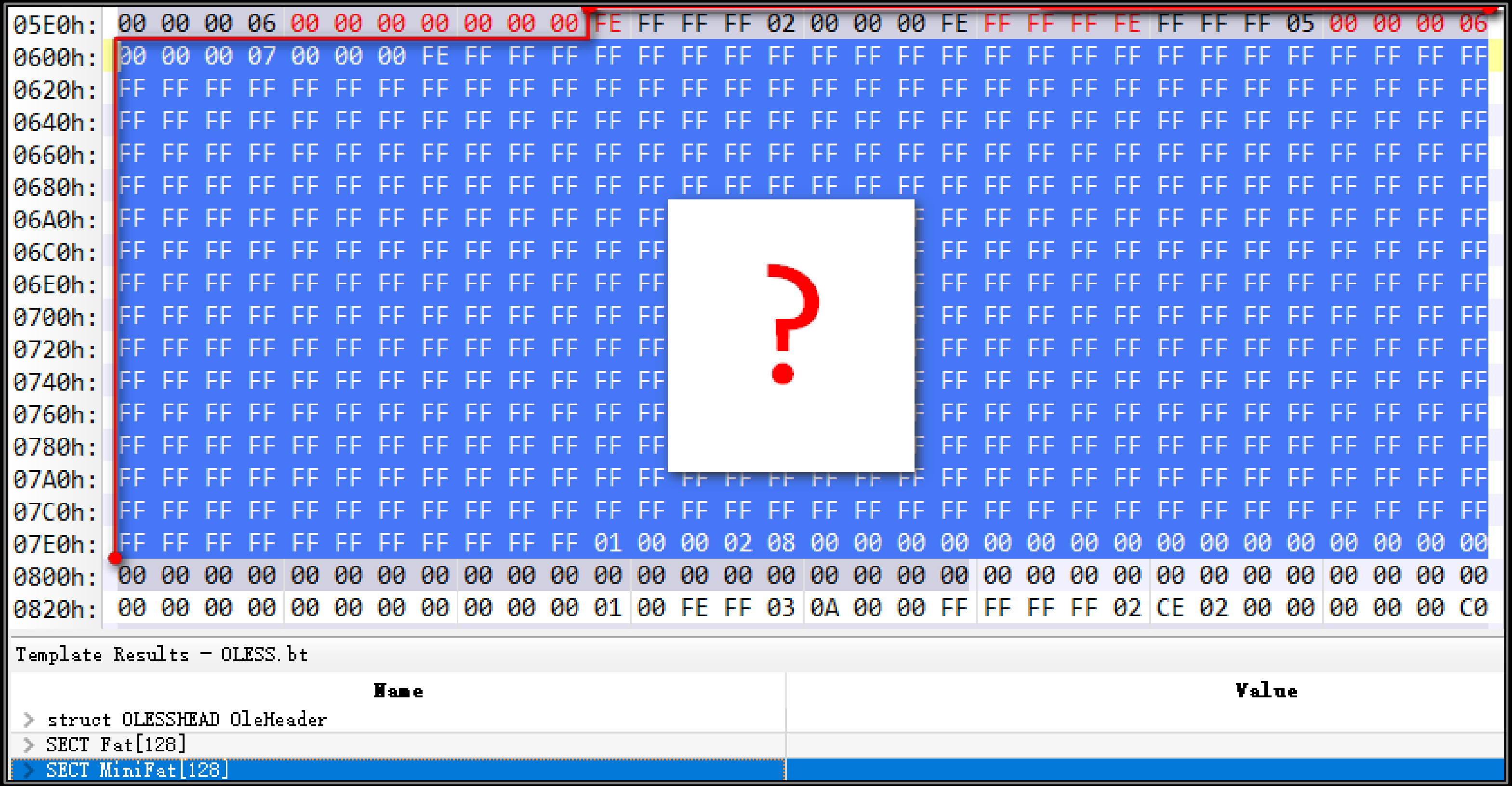


```
0:010> bp ole32!OleConvertOLESTREAMToIStorage
0:010> g
Breakpoint 0 hit
eax=000004e0 ebx=059bc3c0 ecx=00008000 edx=00000000 esi=02d80960 edi=001dade8
eip=75c528fa esp=001dab2c ebp=001dadb0 iopl=0         nv up ei pl nz na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00200206
ole32!OleConvertOLESTREAMToIStorage:
75c528fa 8bff            mov     edi,edi
0:000> .writemem C:\de-obfuscated_ole.bin poi(poi(poi(esp + 0x04) + 0x08)) Lpoi(poi(esp + 0x04) + 0x0C)
Writing dc5 bytes..

0:000> db poi(poi(poi(esp + 0x04) + 0x08))
04946510  01 05 00 00 02 00 00 00-0b 00 00 00 45 71 75 61  ............Equa
04946520  74 69 6f 6e 2e 33 00 00-00 00 00 00 00 00 00 00  tion.3..........
04946530  0e 00 00 d0 cf 11 e0 a1-b1 1a e1 00 00 00 00 00  ................
04946540  00 00 00 00 00 00 00 00-00 00 00 3e 00 03 00 fe  ...........>....
04946550  ff 09 00 06 00 00 00 00-00 00 00 00 00 00 00 01  ................
04946560  00 00 00 01 00 00 00 00-00 00 00 00 10 00 00 02  ................
04946570  00 00 00 01 00 00 00 fe-ff ff ff 00 00 00 00 00  ................
04946580  00 00 00 ff ff ff ff ff-ff ff ff ff ff ff ff ff  ................
```

CVE-2018-0802

- **Where is the error?**
  - MiniFat Sector misaligned 0x15 bytes



```
05E0h: 00 00 00 06 00 00 00 00 00 00 00 FE FF FF FF 02 00 00 00 FE FF FF FF FE FF FF FF 05 00 00 00 06
0600h: 00 00 00 07 00 00 00 FE FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0620h: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0640h: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0660h: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0680h: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
06A0h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
06C0h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
06E0h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
0700h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
0720h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
0740h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
0760h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
0780h: FF FF FF FF FF FF FF FF FF FF FF FF FF                 F FF FF FF FF FF FF FF FF FF FF FF FF FF
07A0h: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
07C0h: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
07E0h: FF FF FF FF FF FF FF FF FF FF FF 01 00 00 02 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0800h: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0820h: 00 00 00 00 00 00 00 00 00 00 00 01 00 FE FF 03 0A 00 00 FF FF FF FF 02 CE 02 00 00 00 00 00 C0
```

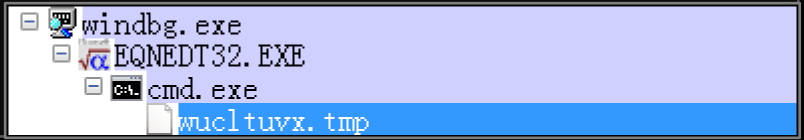
Template Results - OLESS.bt

Name	Value
> struct OLESSHEAD OleHeader	
> SECT Fat[128]	
> SECT MiniFat[128]	

CVE-2018-0802

- **How to "fix"?**
  - Make minor modifications to the original RTF document 😜

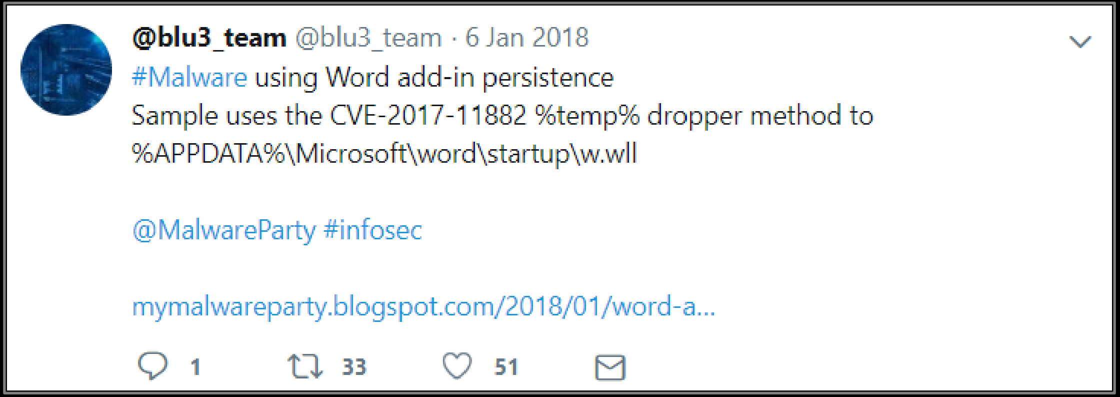
```
{\object\objemb\objupdate{\*\objclass Equation.3}\objw380\objh260{\*\objdata 01050000{{\object}}
02000000
0b000000
4571756174696f6e2e3300
00000000
00000000
000e0000 ; Data Size
d0cf11e0a1b11ae1000000000000000000000000000000003e000300feff090006000000000000
...
000000000000000000000000000000000000000000feffffff02000000 ; Fill 0 forty-two times before MiniFat Sector
...
{\oldff}0a00ffffffff0100000000001c000000fb021000070000000000bc02000000000102022253797374656d000048008a0100000a0006000
0004800{\ole}8a01ffffffff7cef1800040000002d0101000400000f0010000030000000000000000000000000000000000000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000 ; Make up
the length to satisfy Data Size
...
0105000000000000 ; extra Presentation data
```



```
⊟ windbg.exe
  ⊟ EQNEDT32.EXE
    ⊟ cmd.exe
        wucltuvx.tmp
```

CVE-2018-0802

- After the New Year's Day in 2018, more CVE-2018-0802 samples appeared
- Other researchers noticed the samples but didn't know they used a zero-day ☹

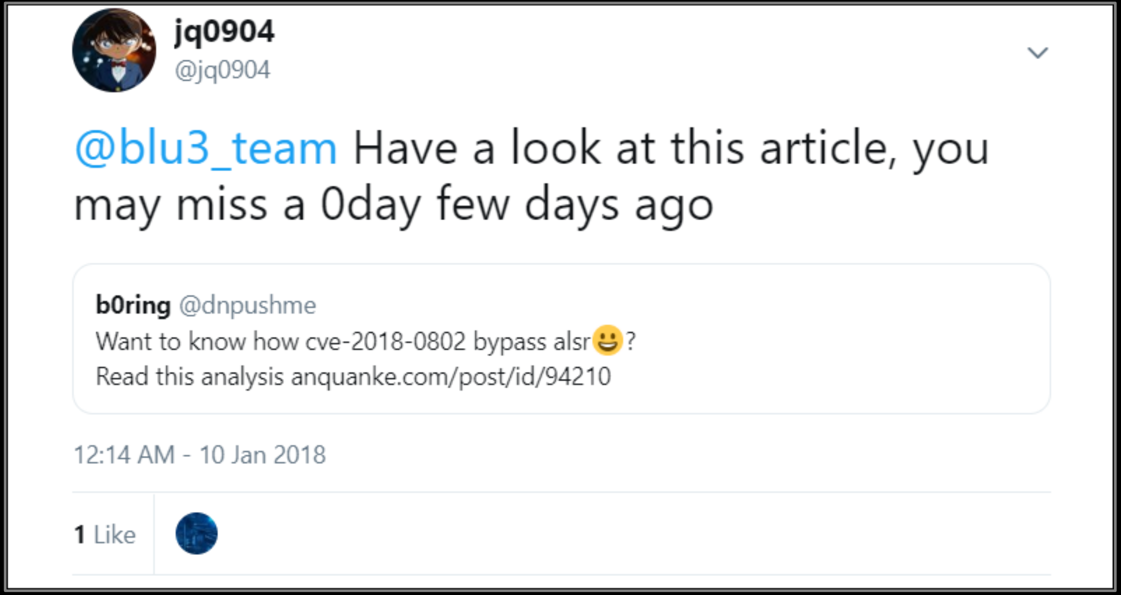


@blu3_team @blu3_team · 6 Jan 2018

#Malware using Word add-in persistence
Sample uses the CVE-2017-11882 %temp% dropper method to
%APPDATA%\Microsoft\word\startup\w.wll

@MalwareParty #infosec

mymalwareparty.blogspot.com/2018/01/word-a...



jq0904
@jq0904

@blu3_team Have a look at this article, you may miss a 0day few days ago

> **b0ring** @dnpushme
> Want to know how cve-2018-0802 bypass alsr😃?
> Read this analysis anquanke.com/post/id/94210

12:14 AM - 10 Jan 2018

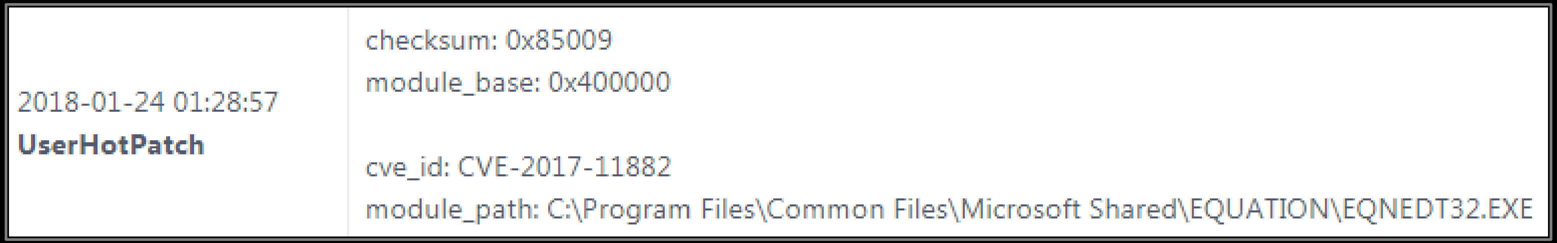
How to Distinguish Two Vulnerabilities

```
IPersistStorage::Load(406881)
    offset:406a93     call ReadMTEFData(42f8ff)
        offset:42f921     call 43755c
            offset:4375d5    call 43a720
                offset:43a72a    call 43a87a
                    offset:43a89b    call 43b418
                        ; Font tag parse Logic
                        offset:43b44b    call ReadFontName(4164fa)
                        offset:43b461    call 4214c6
                            offset:4214dd    call LogfontStruct_Overflow(421774)
                                offset:4217c3    call 421e39
                                    offset:421e5e    rep movsd <- CVE-2018-0802
                                offset:4218cb    call 451d50
                                offset:4218df    call 4115a7
                                    offset:4115d3    call final_overflow(4115d3)
                                        offset:411658    rep movsd <- CVE-2017-11882
                                        offset:411874    retn

Eqnedt32.exe 2000.11.9.0
```

How to Distinguish Multiple Vulnerabilities

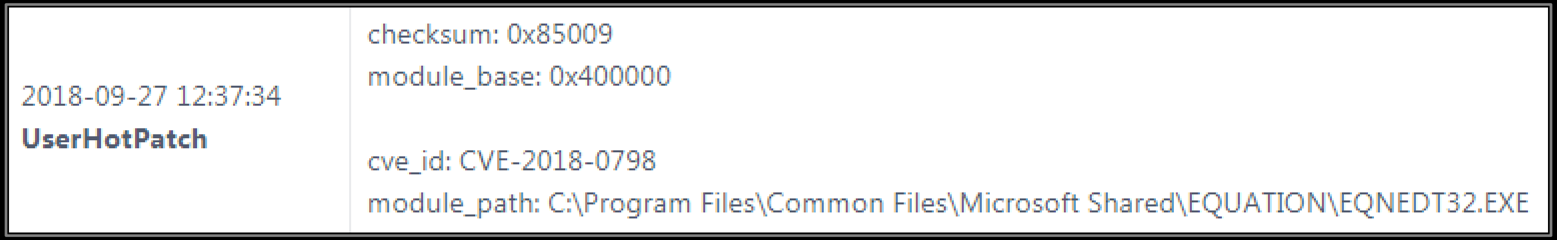
- **Accurately distinguish between the three equation editor vulnerabilities**



2018-01-24 01:28:57
UserHotPatch

checksum: 0x85009
module_base: 0x400000

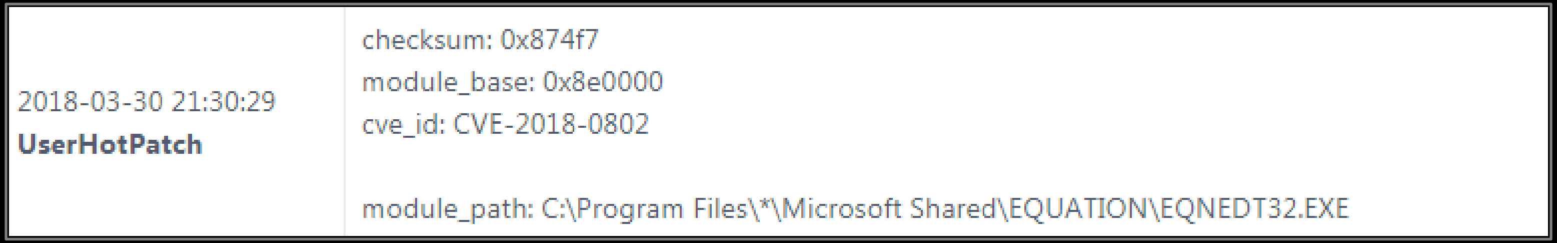
cve_id: CVE-2017-11882
module_path: C:\Program Files\Common Files\Microsoft Shared\EQUATION\EQNEDT32.EXE



2018-09-27 12:37:34
UserHotPatch

checksum: 0x85009
module_base: 0x400000

cve_id: CVE-2018-0798
module_path: C:\Program Files\Common Files\Microsoft Shared\EQUATION\EQNEDT32.EXE



2018-03-30 21:30:29
UserHotPatch

checksum: 0x874f7
module_base: 0x8e0000
cve_id: CVE-2018-0802

module_path: C:\Program Files*\Microsoft Shared\EQUATION\EQNEDT32.EXE

CVE-2018-8174

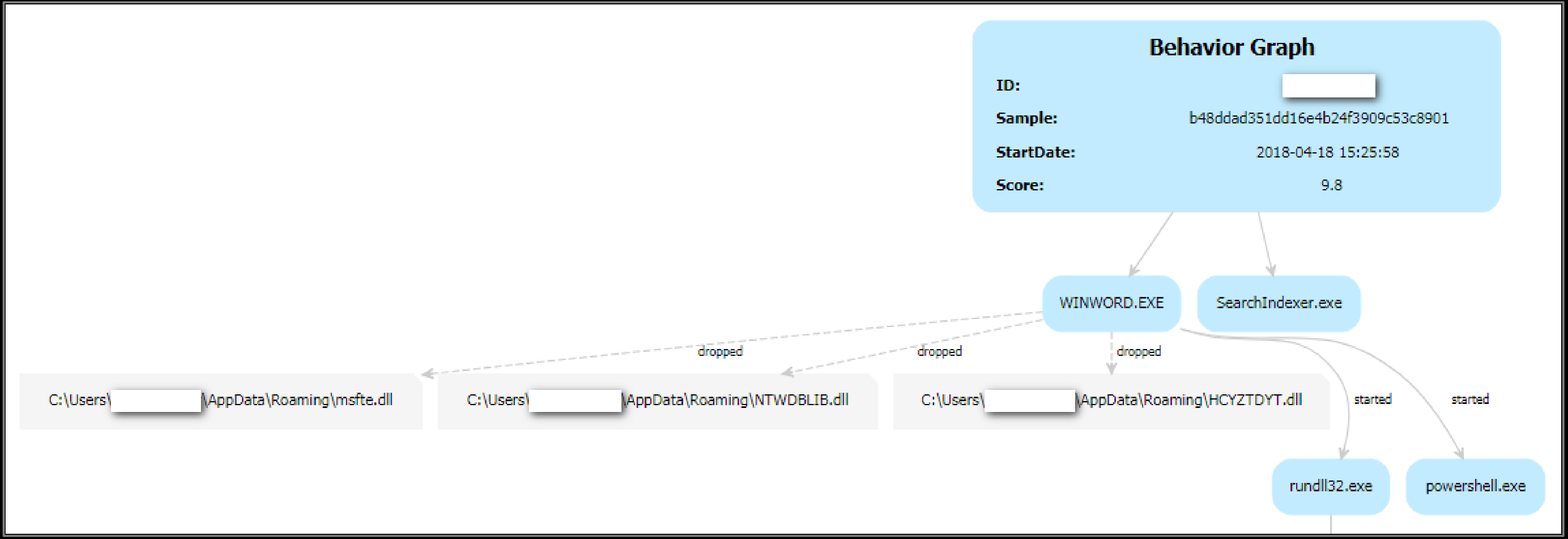
- **Two earlier Office samples**
- **Moniker remote loading CVE-2014-6332**

- **January 17, 2018**
  - Document MD5: A9D3F7A1ACD624DE705CF27EC699B6B6
  - Moniker: hxxp://s.dropcanvas[.]com/1000000/940000/939574/akw.html
  - akw.html MD5: C40A128AE7AEFFA3C1720A516A99BBDF

- **February 23, 2018**
  - Document MD5: 2E658D4A286F3A4176A60B2450E9E729
  - Moniker: hxxp://s.dropcanvas[.]com/1000000/942000/941030/IE.html
  - IE.html MD5: C36D544588BAF97838588E732B3D47E9

CVE-2018-8174

- April 18, 2018
- RTF document loading and executing VBScript zero-day



Behavior Graph

ID: [redacted]

Sample: b48ddad351dd16e4b24f3909c53c8901

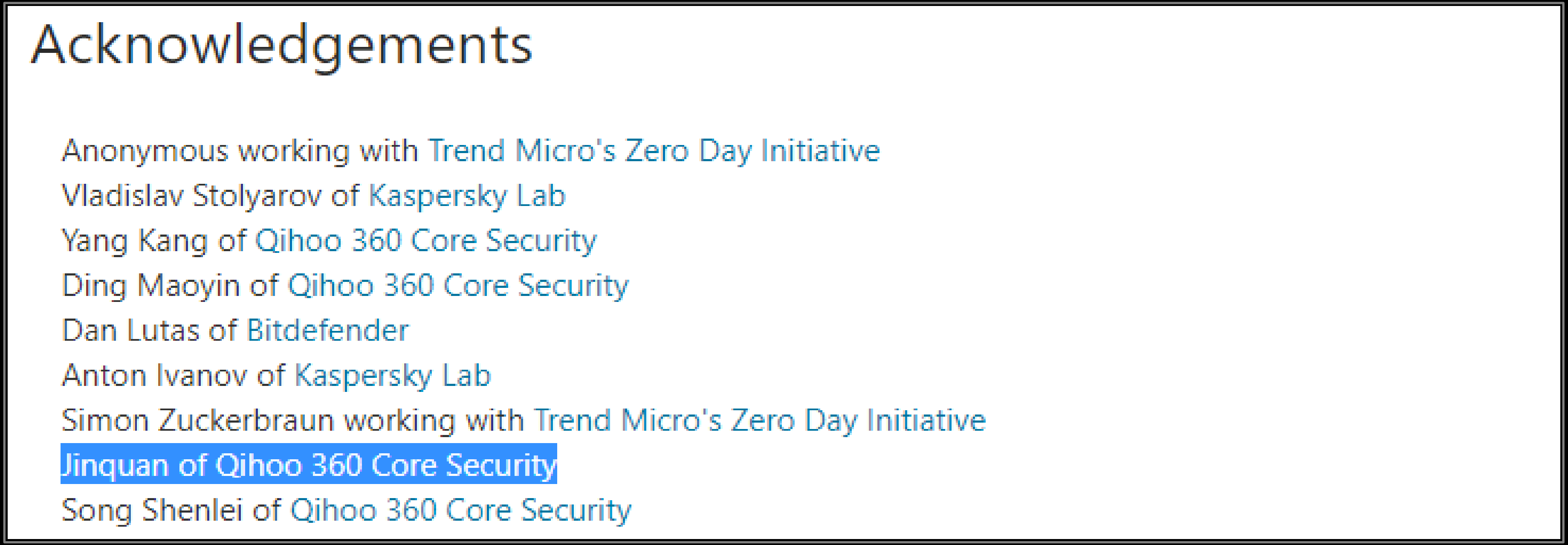
StartDate: 2018-04-18 15:25:58

Score: 9.8

WINWORD.EXE
SearchIndexer.exe
dropped
dropped
dropped
C:\Users\[redacted]\AppData\Roaming\msfte.dll
C:\Users\[redacted]\AppData\Roaming\NTWDBLIB.dll
C:\Users\[redacted]\AppData\Roaming\HCYZTDYT.dll
started
started
rundll32.exe
powershell.exe

CVE-2018-8174

- On May 8, 2018, Microsoft acknowledged us



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Anton Ivanov of Kaspersky Lab
Simon Zuckerbraun working with Trend Micro's Zero Day Initiative
Jinquan of Qihoo 360 Core Security
Song Shenlei of Qihoo 360 Core Security

CVE-2018-8174

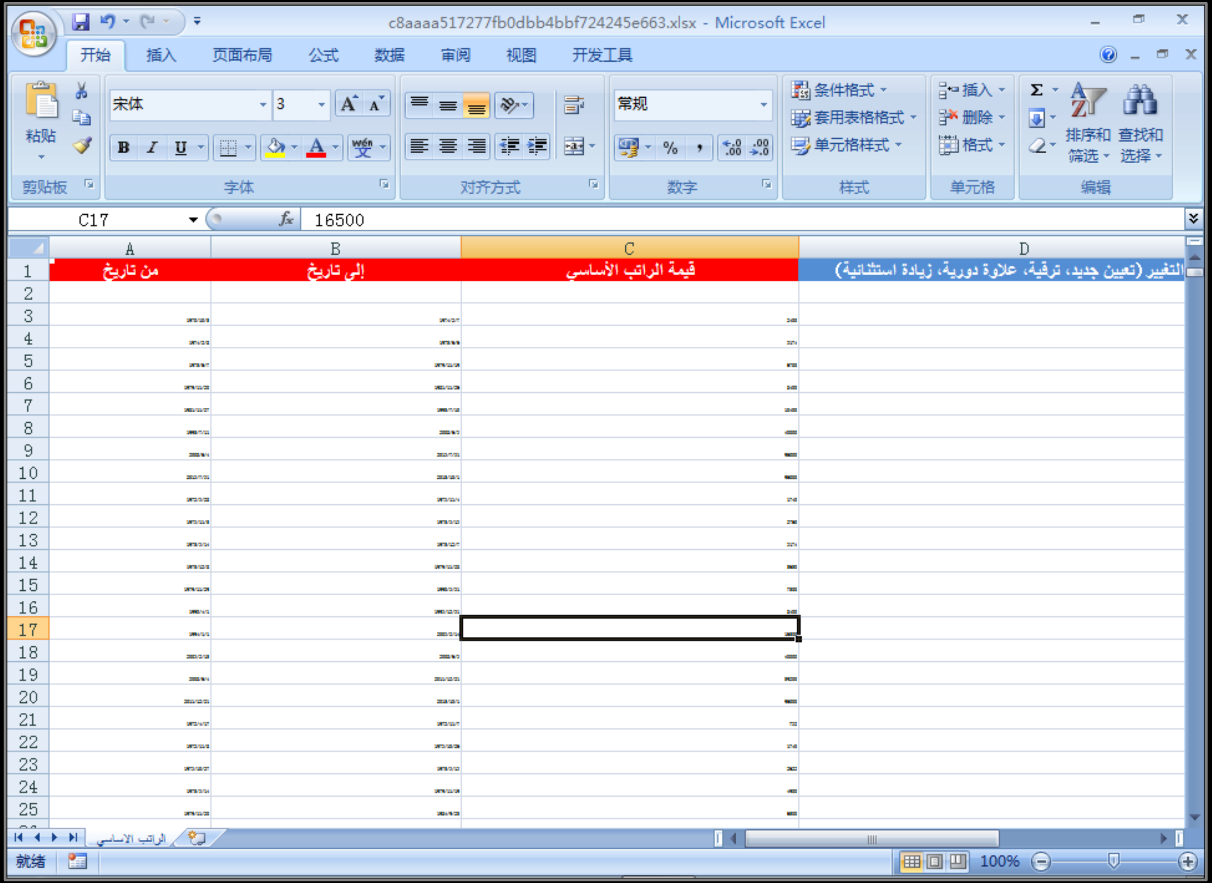
- **UAF -> overlength array -> arbitrary address read and write**

```
Class class_setprop_a
    Dim mem

    Function P
    End Function

    Function SetProp(Value)
        mem = Value 'callback
        SetProp = 0
    End Function
End Class
```

```
// before mem = Value
0:005> dd 022cb91c l4
022cb91c  00000008 00000000 04730834 00000000
0:005> dd 04730834 l6
04730834  08800001 00000001 00000000 00000000
04730844  7fffffff 00000000

// after mem = Value
0:007> dd 022cb91c l4
022cb91c  0000200c 00000000 04730834 00000000
0:007> dd 04730834 l6
04730834  08800001 00000001 00000000 00000000
04730844  7fffffff 00000000
```

CVE-2018-5002

- **June 1, 2018**
- **A complex Flash control framework**
- **AVM2 Interpreter Vulnerability**



c8aaaa517277fb0dbb4bbf724245e663.xlsx - Microsoft Excel

C17 *fx* 16500

	A	B	C	D
1	من تاريخ	إلى تاريخ	قيمة الراتب الأساسي	التغيير (تعيين جديد، ترقية، علاوة دورية، زيادة استثنائية)
2				
3	[illegible]	[illegible]	[illegible]	
4	[illegible]	[illegible]	[illegible]	
5	[illegible]	[illegible]	[illegible]	
6	[illegible]	[illegible]	[illegible]	
7	[illegible]	[illegible]	[illegible]	
8	[illegible]	[illegible]	[illegible]	
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13	[illegible]	[illegible]	[illegible]	
14	[illegible]	[illegible]	[illegible]	
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17	[illegible]	[illegible]	[illegible]	
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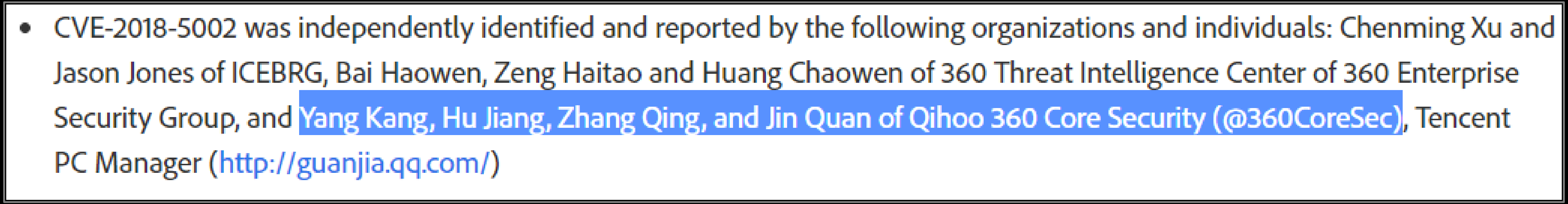
19	[illegible]	[illegible]	[illegible]	
20	[illegible]	[illegible]	[illegible]	
21	[illegible]	[illegible]	[illegible]	
22	[illegible]	[illegible]	[illegible]	
23	[illegible]	[illegible]	[illegible]	
24	[illegible]	[illegible]	[illegible]	
25	[illegible]	[illegible]	[illegible]	

CVE-2018-5002

- On June 7, 2018, Adobe acknowledged us



- CVE-2018-5002 was independently identified and reported by the following organizations and individuals: Chenming Xu and Jason Jones of ICEBRG, Bai Haowen, Zeng Haitao and Huang Chaowen of 360 Threat Intelligence Center of 360 Enterprise Security Group, and Yang Kang, Hu Jiang, Zhang Qing, and Jin Quan of Qihoo 360 Core Security (@360CoreSec), Tencent PC Manager (http://guanjia.qq.com/)

CVE-2018-5002

- **Bypass ROP detection** 😃
- **Override return address to bypass CFG** 😃
- **Unable to bypass EAF detection** ☹

```
var cls25:class_25 = new class_25(cls8, RtlUnwind_Addr);
var NtProtectVirtualMemory_Addr:uint = cls25.GetFuncAddrByEAT("NtProtectVirtualMemory");
if(0 == NtProtectVirtualMemory_Addr)
{
    return new Array();
}

var NtPrivilegedServiceAuditAlarm_Addr:uint = cls25.GetFuncAddrByEAT("NtPrivilegedServiceAuditAlarm");
if(0 == NtPrivilegedServiceAuditAlarm_Addr)
{
    return new Array();
}
```

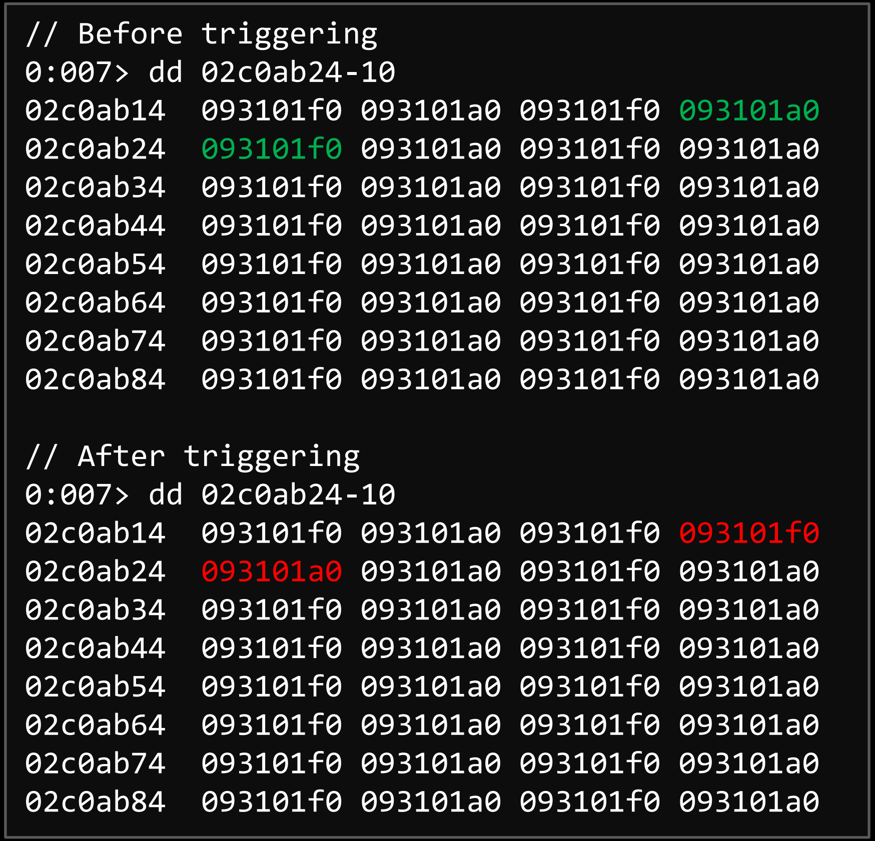
How to Debug CVE-2018-5002

- Reverse -> ASC2.0 Compile -> Modify bytecode with FFDEC -> Debuggable swf file
- Open source WinDBG plugin
  - https://github.com/michaelpdu/flashext_pykd
- Add 3 lines of code to make the plugin more perfect 😃

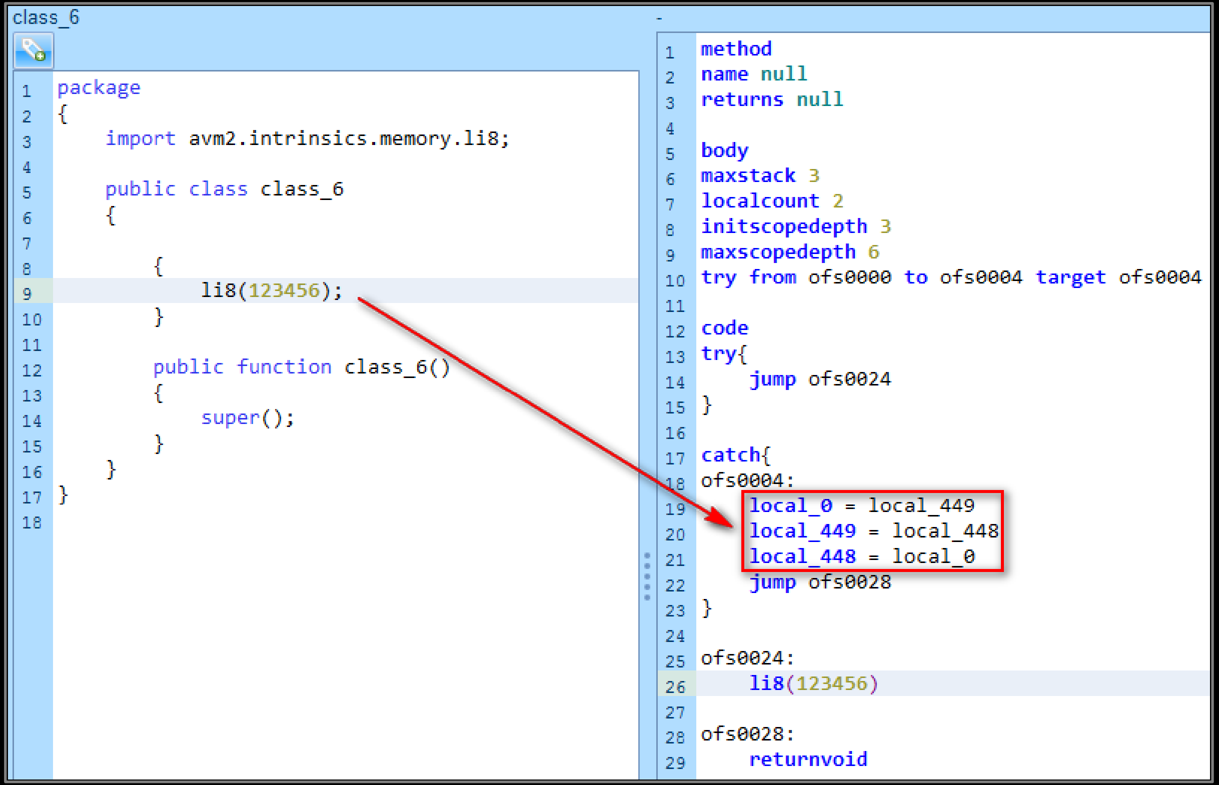
```
def callback_after_call_getmethodname(self):
    # dprintln("Enter into callback_after_call_getmethodname")
    reg_eax = reg("eax")
    # dprintln("EAX = " + hex(reg_eax))
    addr_name = ptrPtr(reg_eax + 0x08)
    len_name = ptrPtr(reg_eax + 0x10)

    if 0 == addr_name and 0 != len_name:
        if ptrPtr(reg_eax + 0x0C) != 0:
            addr_name = ptrPtr(ptrPtr(reg_eax + 0x0C) + 0x08)
```

CVE-2018-5002 in the Debugger

- **Trigger Vulnerability -> Swap Pointer on stack -> Type Confusion**



```
// Before triggering
0:007> dd 02c0ab24-10
02c0ab14  093101f0 093101a0 093101f0 093101a0
02c0ab24  093101f0 093101a0 093101f0 093101a0
02c0ab34  093101f0 093101a0 093101f0 093101a0
02c0ab44  093101f0 093101a0 093101f0 093101a0
02c0ab54  093101f0 093101a0 093101f0 093101a0
02c0ab64  093101f0 093101a0 093101f0 093101a0
02c0ab74  093101f0 093101a0 093101f0 093101a0
02c0ab84  093101f0 093101a0 093101f0 093101a0

// After triggering
0:007> dd 02c0ab24-10
02c0ab14  093101f0 093101a0 093101f0 093101f0
02c0ab24  093101a0 093101a0 093101f0 093101a0
02c0ab34  093101f0 093101a0 093101f0 093101a0
02c0ab44  093101f0 093101a0 093101f0 093101a0
02c0ab54  093101f0 093101a0 093101f0 093101a0
02c0ab64  093101f0 093101a0 093101f0 093101a0
02c0ab74  093101f0 093101a0 093101f0 093101a0
02c0ab84  093101f0 093101a0 093101f0 093101a0
```

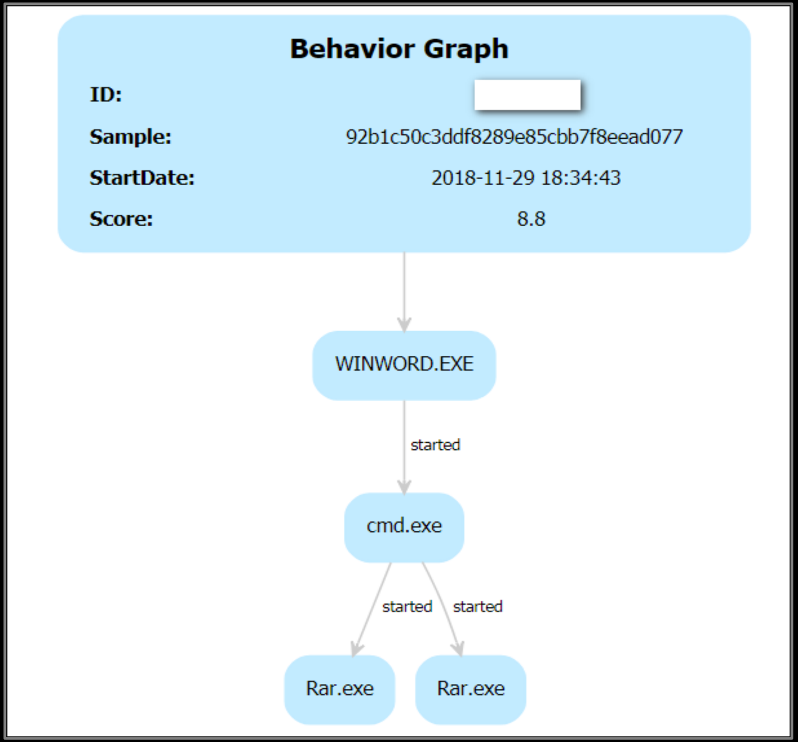


```
package
{
    import avm2.intrinsics.memory.li8;

    public class class_6
    {

        {
            li8(123456);
        }

        public function class_6()
        {
            super();
        }
    }
}
```

```
method
name null
returns null

body
maxstack 3
localcount 2
initscopedepth 3
maxscopedepth 6
try from ofs0000 to ofs0004 target ofs0004

code
try{
    jump ofs0024
}

catch{
ofs0004:
    local_0 = local_449
    local_449 = local_448
    local_448 = local_0
    jump ofs0028
}

ofs0024:
    li8(123456)

ofs0028:
    returnvoid
```

CVE-2018-15982

- November 29, 2018
- 2 hours, 2 samples
- UAF Vulnerability in TVSDK



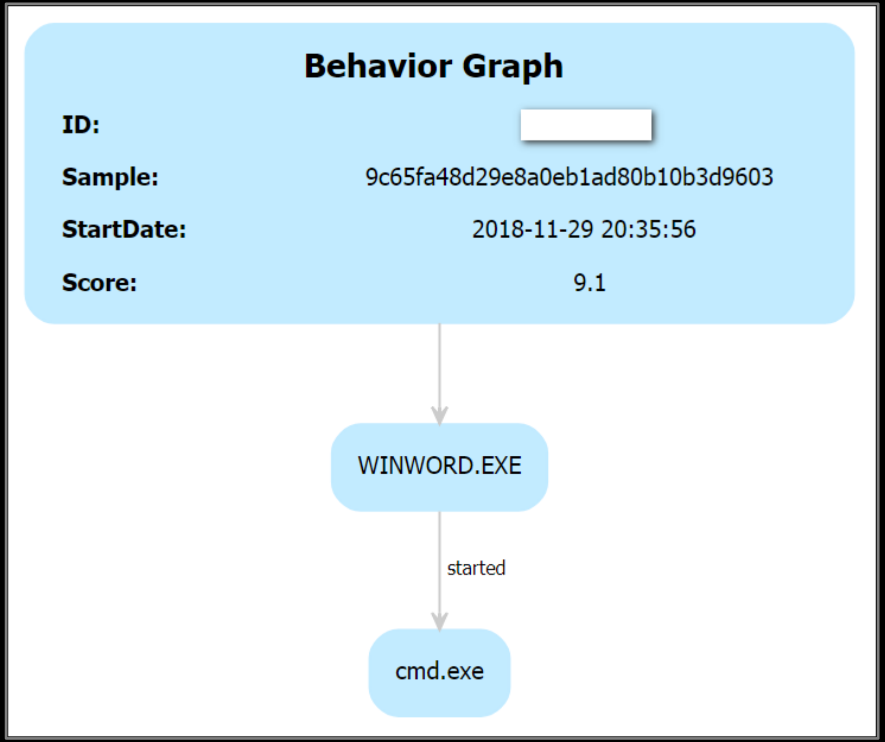
Behavior Graph

ID: [redacted]

Sample: 92b1c50c3ddf8289e85cbb7f8eead077

StartDate: 2018-11-29 18:34:43

Score: 8.8



Behavior Graph

ID: [redacted]

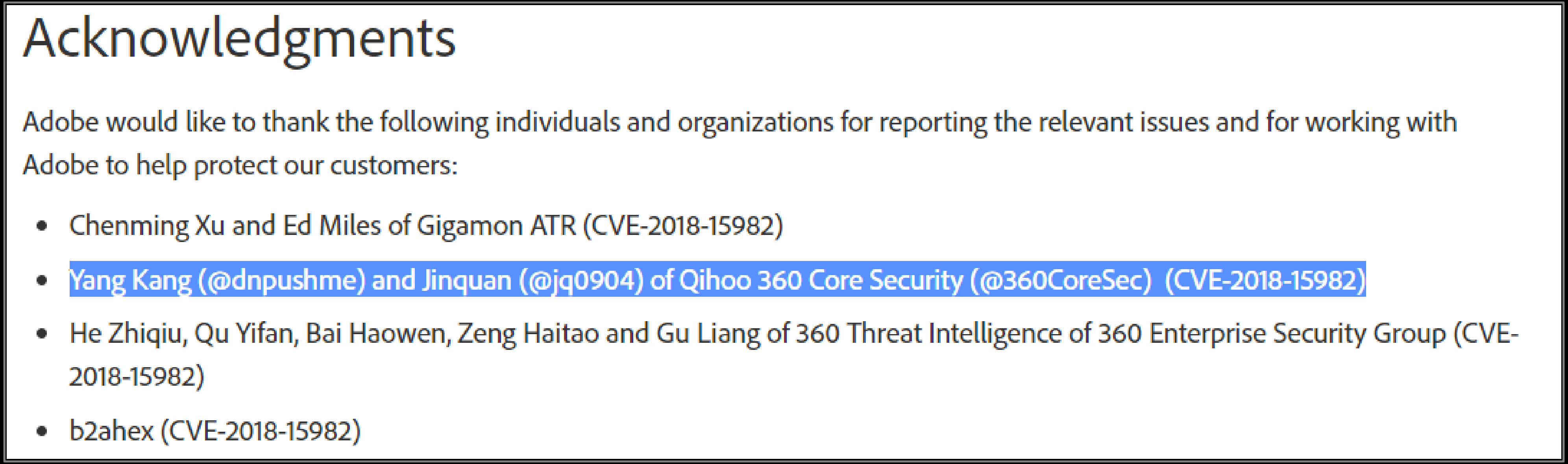
Sample: 9c65fa48d29e8a0eb1ad80b10b3d9603

StartDate: 2018-11-29 20:35:56

Score: 9.1

CVE-2018-15982

- **On December 5, 2018, Adobe acknowledged us again**



Acknowledgments

Adobe would like to thank the following individuals and organizations for reporting the relevant issues and for working with Adobe to help protect our customers:

- Chenming Xu and Ed Miles of Gigamon ATR (CVE-2018-15982)
- Yang Kang (@dnpushme) and Jinquan (@jq0904) of Qihoo 360 Core Security (@360CoreSec) (CVE-2018-15982)
- He Zhiqiu, Qu Yifan, Bai Haowen, Zeng Haitao and Gu Liang of 360 Threat Intelligence of 360 Enterprise Security Group (CVE-2018-15982)
- b2ahex (CVE-2018-15982)

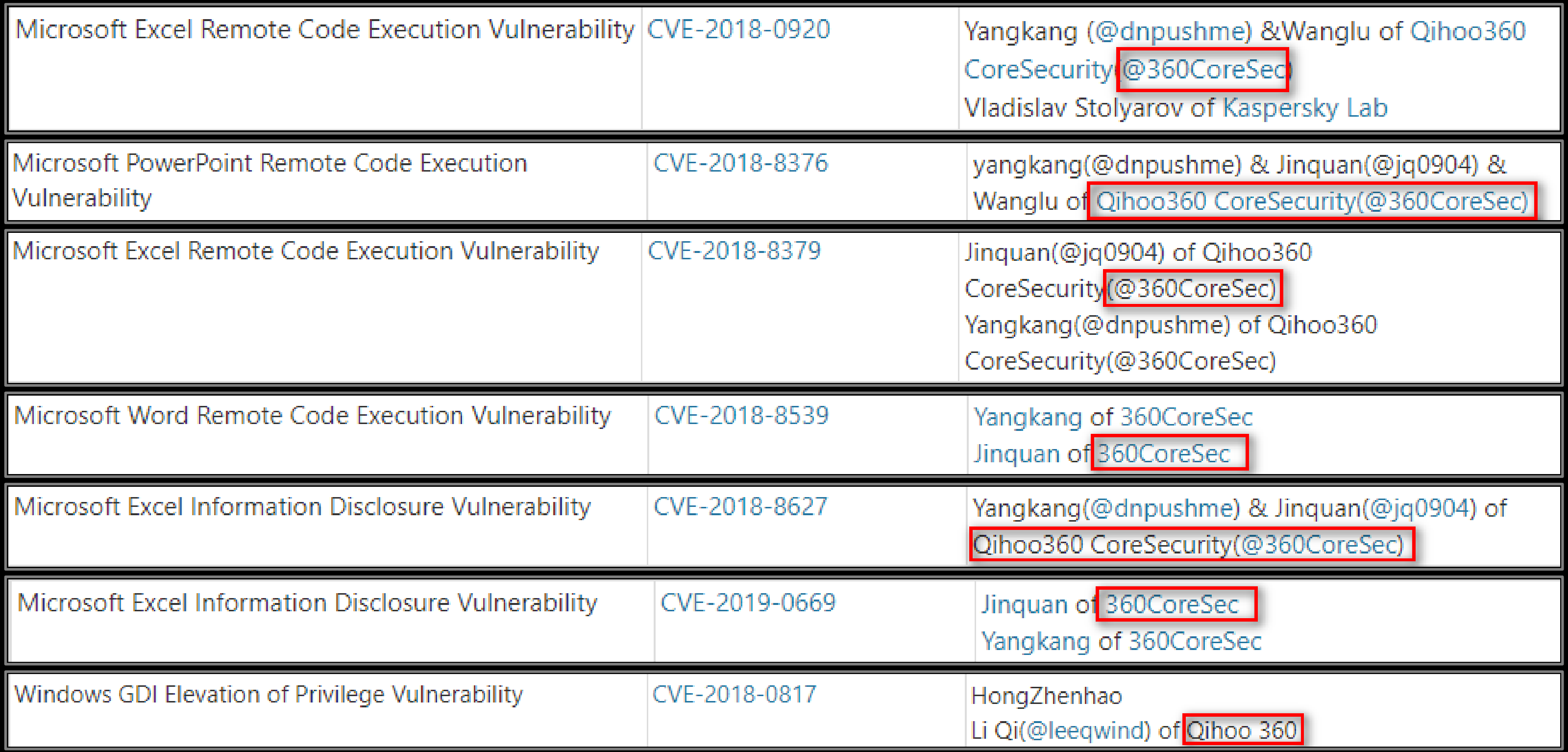
CVE-2018-15982

- **Use HackingTeam's trick to bypass ROP detection 😃**
- **Unable to evade EAF detection ☹**

```
// Virt(ualPro)tect = 74726956 74636574
var vp_addr:uint = this.getFuncAddrByEAT32(0x74726956, 0x74636574, 10, kernel32_addr);

...

this.writeDWORD32(sc_addr + 8 + 0x80 + 0x1c, vp_addr);
this.writeDWORD32(ptbl, sc_addr + 8 + 0x80);
this.writeDWORD32(p + 0x1c, sc_addr);
this.writeDWORD32(p + 0x20, vec_uint.length * 4);
var args:Array = new Array(0x41);
Payload.call.apply(null, args); // Call VirtualProtect to bypass DEP
```

Other Harvest

- 1 Word CVE 😀
- 1 PowerPoint CVE 😀
- 4 Excel CVE 😀
- 1 Win32k CVE 😀



Microsoft Excel Remote Code Execution Vulnerability	CVE-2018-0920	Yangkang (@dnpushme) &Wanglu of Qihoo360 CoreSecurity(@360CoreSec) Vladislav Stolyarov of Kaspersky Lab
Microsoft PowerPoint Remote Code Execution Vulnerability	CVE-2018-8376	yangkang(@dnpushme) & Jinquan(@jq0904) & Wanglu of Qihoo360 CoreSecurity(@360CoreSec)

Microsoft Excel Remote Code Execution Vulnerability	CVE-2018-8379	Jinquan(@jq0904) of Qihoo360 CoreSecurity(@360CoreSec)
		Yangkang(@dnpushme) of Qihoo360 CoreSecurity(@360CoreSec)

Microsoft Word Remote Code Execution Vulnerability	CVE-2018-8539	Yangkang of 360CoreSec Jinquan of 360CoreSec
Microsoft Excel Information Disclosure Vulnerability	CVE-2018-8627	Yangkang(@dnpushme) & Jinquan(@jq0904) of Qihoo360 CoreSecurity(@360CoreSec)
Microsoft Excel Information Disclosure Vulnerability	CVE-2019-0669	Jinquan of 360CoreSec Yangkang of 360CoreSec
Windows GDI Elevation of Privilege Vulnerability	CVE-2018-0817	HongZhenhao Li Qi(@leeqwind) of Qihoo 360

Summary

- Easy from 1 to N, hard from 0 to 1
- Know your opponent, reflect upon yourself, beat your opponent
- Always on the road

Acknowledgement

- **Thanks to all the partners of 360 Advanced Threat Team**

- **Thanks to** @programmeboy, @guhe120, @binjo, @Unit42_Intel

- **Special thanks to** @HaifeiLi **and his sharing about Office security**

BLUEHAT
SHANGHAI 2019

Needle in A Haystack: Catch Multiple Zero-days Using Sandbox

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