Detecting Windows Based Exploit Chains by Means of Event Correlation and Process Monitoring

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What is an Exploit Chain?

- An exploit chain is a group of exploits that executes synchronously, in order to achieve the system exploitation.
- Unlike high-risk vulnerabilities that allow system exploitation using only one execution step, an exploit chain takes advantage of multiple medium and low risk vulnerabilities

Single Vulnerability Being Exploited To Achieve Exploitation

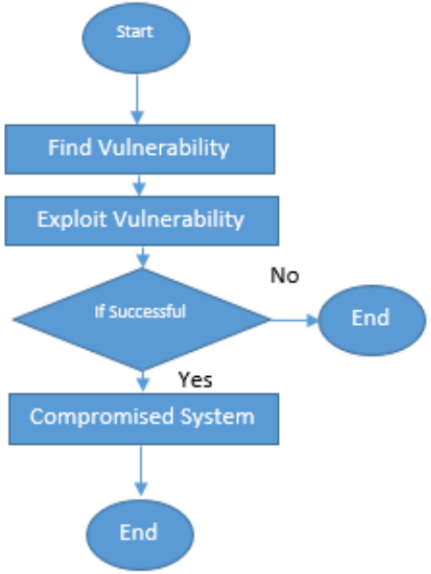


Fig (1) Example of traditional exploit with a single vulnerability

Multiple Vulnerabilities Exploited To Achieve Exploitations

Fig (2) Example of exploit chain with multiple vulnerability

Example of Exploit Chain

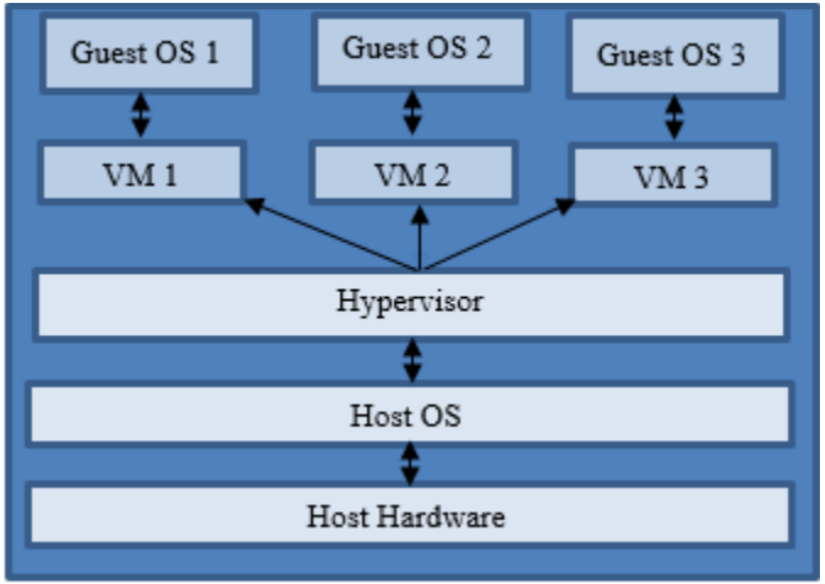


Fig (3) Isolated guest and host in virtualized environment

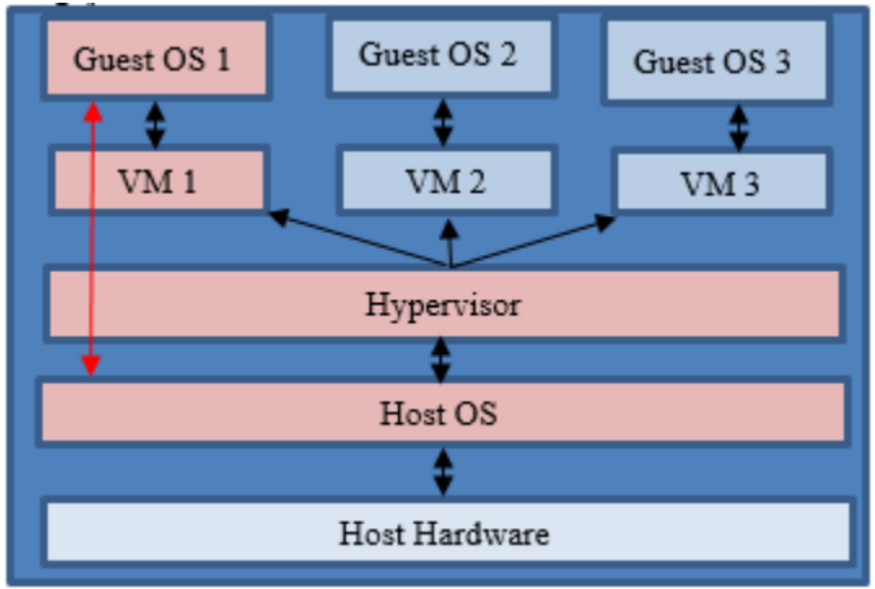


Fig (4) Broken isolation between guest and host

Guest To Host Exploit

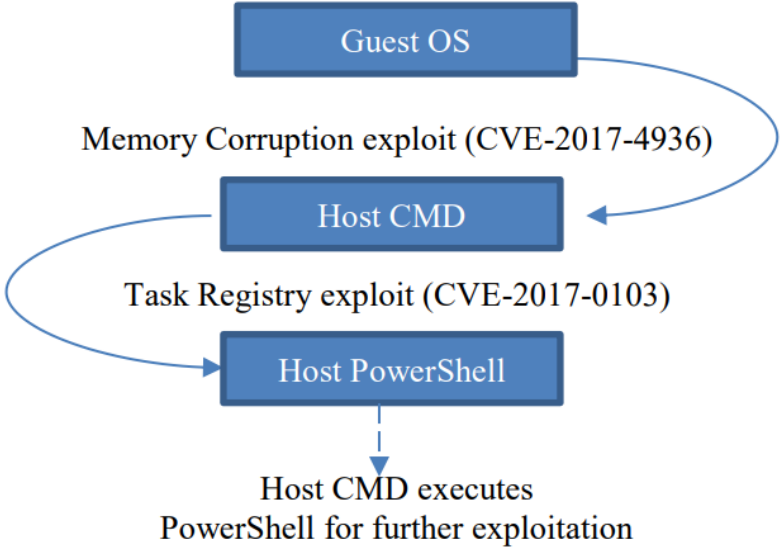


Fig (5) Guest to host escape exploit chain

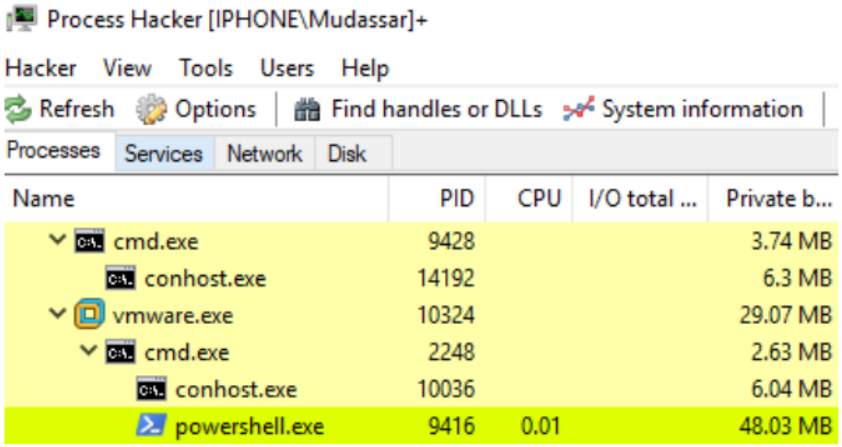


Fig (6) Guest to host exploit execution

Event Logging

- Event logging mechanism allows the identification of the type of computer events happening in Windows based systems when an exploit is executed.
- Structure of New Windows Process Creation Event
  - **SubjectUserSid** : Security id of account from where the process is executed
  - **SubjectUserName** : Account name from where the process is executed
  - **SubjectDomainName** : Domain Name
  - **SubjectLogonId** : Logon id of account from where the process is executed
  - **NewProcessId** : Unique hexadecimal new process identifier
  - **NewProcessName** : New process name executed by parent process
  - **ProcessId** : Unique hexadecimal process identifier
  - **CommandLine** : Command which is executed
  - **TargetUserSid** : Security id of account on which process executed
  - **TargetUserName** : User name
  - **TargetDomainName** : Computer name
  - **TargetLogonId** : Login id of account on which process executed
  - **ParentProcessName** : Name of process which executes new process
  - **MandatoryLabel** : Secure object control integrity label assigned to new process

Process Monitoring

- Process being executed after exploitation
  - CMD
  - PowerShell
  - Regsvr
  - Rundll32

..etc

Algorithm [noun]:

Word used by programmers when they do not want to explain what they did.

Exploit Chain Detector Algorithm

Exploit Chain Detector (ECD) Algorithm

Input: a list of ordered Windows event logs A; a list of process names to be monitored B

/* an event logs has the following attributes: NewProcessId, ProcessId, ProcessName, TargetDomainName*/

/* B contains a list of process names that are executed after a vulnerability is exploited retrieved from report[1] [15] */

Output: a list of string stacks D, a Boolean represents if exploit chains are detected c

/* D will contain all exploit chains detected by the algorithm, and c is true if one chain is found*/

Initialization: create an empty event log a ; initialize c with the value false ; create integer m with initial value 0

```
for (i=0; i<Size(A); i++) do
    if (A_i.ProcessId ∈ B) then
        a=A_i
        for (j=i; i<Size(A); j++) do
            if (a. ProcessId == A_j.NewProcessId && a.TargetDomainName == A_j.TargetDomainName) then
                D_m.Push(a.ProcessName)
                a=A_j
                if(A_(j+m).NewProcessId==Null) then
                    c=true
                    m=m+1
                end if
            end if
        end for
    end if
end for
```

Working

- **EventData**
  - **SubjectUserSid** S-1-5-21-703565726-1159332285-768548448-1001
  - **SubjectUserName** Mudassar
  - **SubjectDomainName** IPHONE
  - **SubjectLogonId** 0x8abbe
  - **NewProcessId** 0xf18
  - **NewProcessName** C:\Windows\SysWOW64\WindowsPowerShell\v1.0\powershell.exe
  - **TokenElevationType** %%1938
  - **ProcessId** 0xa10
  - **CommandLine** powershell
  - **TargetUserSid** S-1-0-0
  - **TargetUserName** -
- **System**
- **EventData**
  - **SubjectUserSid** S-1-5-21-703565726-1159332285-768548448-1001
  - **SubjectUserName** Mudassar
  - **SubjectDomainName** IPHONE
  - **SubjectLogonId** 0x8abbe
  - **NewProcessId** 0xa10
  - **NewProcessName** C:\Windows\SysWOW64\cmd.exe
  - **TokenElevationType** %%1938
  - **ProcessId** 0x270
  - **CommandLine** "C:\Windows\System32\cmd.exe"
  - **TargetUserSid** S-1-0-0
  - **TargetUserName** -
- **System**
- **EventData**
  - **SubjectUserSid** S-1-5-21-703565726-1159332285-768548448-1001
  - **SubjectUserName** Mudassar
  - **SubjectDomainName** IPHONE
  - **SubjectLogonId** 0x8abbe
  - **NewProcessId** 0x270
  - **NewProcessName** C:\Program Files (x86)\VMware\VMware Workstation\vmware.exe
  - **TokenElevationType** %%1938
  - **ProcessId** 0x189c
  - **CommandLine** "C:\Program Files (x86)\VMware\VMware Workstation\vmware.exe"
  - **TargetUserSid** S-1-0-0
  - **TargetUserName** -

Fig (7) Windows event logs generated from a guest to host exploit

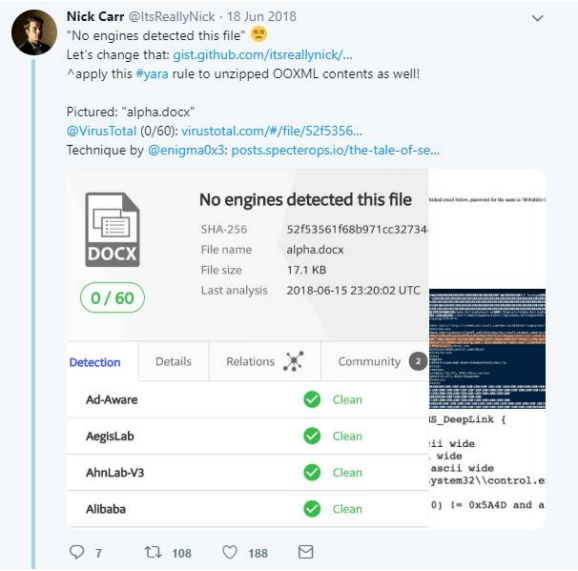
Detected Exploit Chain

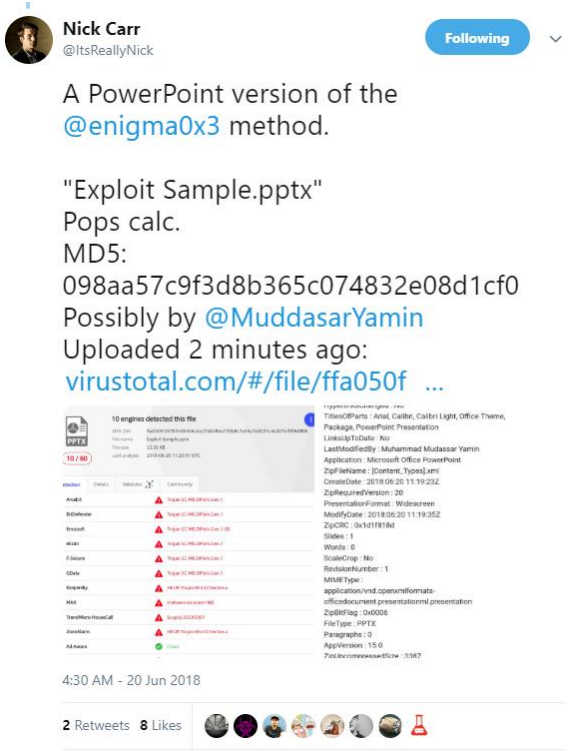
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Python36_64\python.exe

```
Logging Security events
Total events in Security = 17727
Malacious Exploit Process Launch On Host:iphone, Time:2018-05-27 13:14:26
-->Exploit Chain:vmware.exe; cmd.exe; powershell.exe;
---->Exploit Injection Tracer:
```

Fig (8) Guest-to-host exploit detection

Experiments





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Experimental Result Comparison

Solution	Detection Yes/No
Proposed Algorithm	Yes
Ad-Aware	No
AegisLab	No
AhnLab-V3	No
ALYac	No
Antiy-AVL	No
Arcabit	No
Avast	No
Avast Mobile Security	No
AVG	No

Table (1) Result of Comparative Detection Analysis of Developed algorithm and Different Software Security Software

List of Publications

- Yamin, Muhammad Mudassar, Basel Katt, and Vasileios Gkioulos. "Detecting Windows Based Exploit Chains by Means of Event Correlation and Process Monitoring." In Future of Information and Communication Conference, pp. 1079-1094. Springer, Cham, 2019.
- Yamin, M. M., & Katt, B. A Survey of Automated Information Exchange Mechanisms Among CERTs.
- Yamin, M. M., & Katt, B. (2019, January). Mobile device management (MDM) technologies, issues and challenges. In Proceedings of the 3rd International Conference on Cryptography, Security and Privacy (pp. 143-147). ACM.
- Yamin, Muhammad Mudassar, Basel Katt, Kashif Sattar, and Maaz Bin Ahmad. "Implementation of Insider Threat Detection System Using Honeypot Based Sensors and Threat Analytics." In Future of Information and Communication Conference, pp. 801-829. Springer, Cham, 2019.
- Yamin, Muhammad Mudassar, and Basel Katt “Ethical Problems and Legal Issues in Development and Usage Autonomous Adversaries in Cyber Domain”
- Yamin, Muhammd Mudassar, and Basel Katt. "Detecting Malicious Windows Commands Using Natural Language Processing Techniques." In International Conference on Security for Information Technology and Communications, pp. 157-169. Springer, Cham, 2018.
- Yamin, Muhammad Mudassar, and Basel Katt. "Inefficiencies in Cyber-Security Exercises Life-Cycle: A Position Paper.“ AAAI Adversarial Aware Learning Symposium 2018
- Yamin, Muhammad Mudassar, Basel Katt, Espen Torseth, Vasileios Gkioulos, and Stewart James Kowalski. "Make it and Break it: An IoT Smart Home Testbed Case Study." In Proceedings of the 2nd International Symposium on Computer Science and Intelligent Control, p. 26. ACM, 2018.
- Awan, K. M., ur Rehman, Z., Yamin, M. M., & Shah, P. A. (2017, December). Implementation of information security techniques on modern android based Kiosk ATM/remittance machines. In 2017 International Conference on Information and Communication Technologies (ICICT) (pp. 75-80). IEEE.

“Questions are guaranteed in life; answers aren’t”