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Why is removing malware so difficult?

A look at malware persistence—registry, service, DLL hijacking and bootkit

www.encase.com/ceic

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KEYW
Keywcorp.com

Hexis CYBER SOLUTIONS a KEYW company
Hexiscyber.com

Parrot Labs™
KEYW Corporation
Training.keywcorp.com

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Purpose

This presentation seeks to:

- Discuss the concepts of malware persistence
- Put them into practice
- Educate beginner to intermediate network defense practitioners

Assumptions

- All necessary privileges are gained
- Stealth is not in play

Page 3

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Lab environment

Virtual Machine

- Win 7 SP 1 32bit
- Code for running the techniques
- Tools
  - Sysinternals
  - Depends
  - Autopsy
  - Windows CLI foo

Page 4

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Presentation does not contain original research

Page 5

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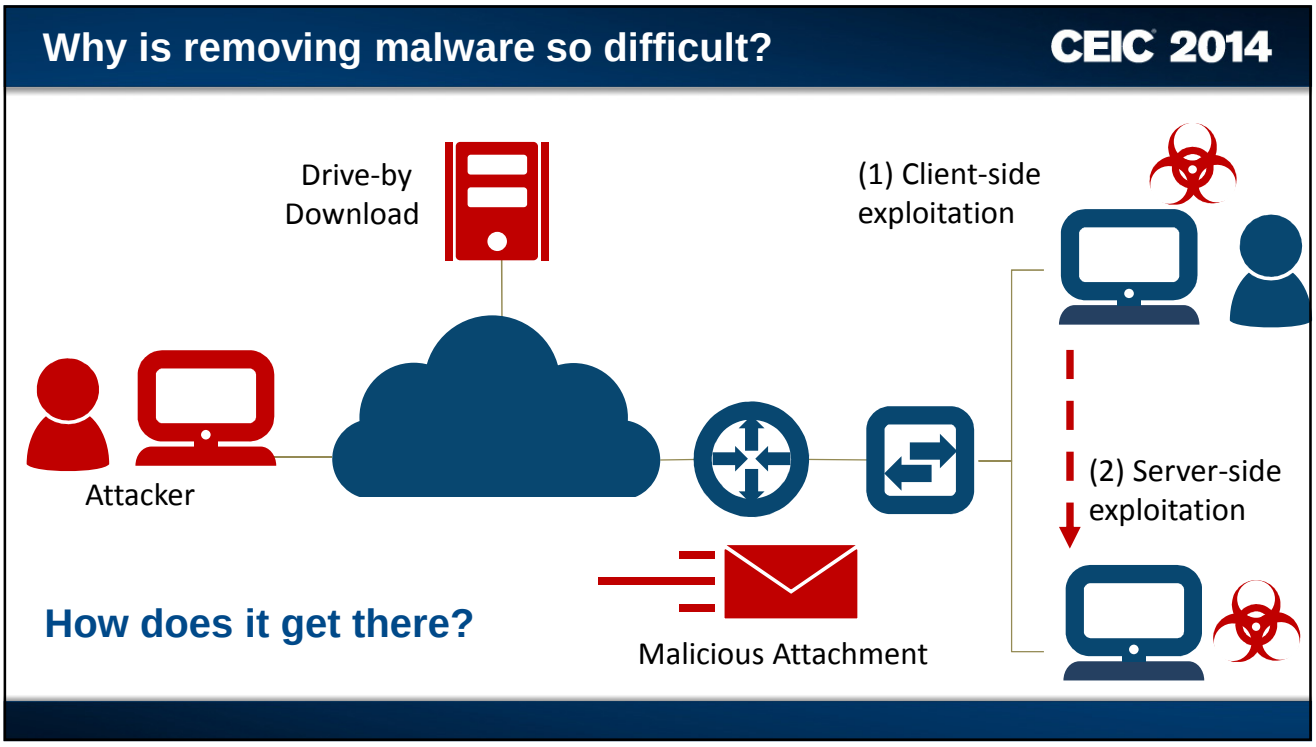
What is persistence

- Provides malware the ability to run after reboot
- Provide resiliency, i.e. re-write (download) malware to image after partial removal
- Designed to maintain a foothold on hosts of importance

Page 6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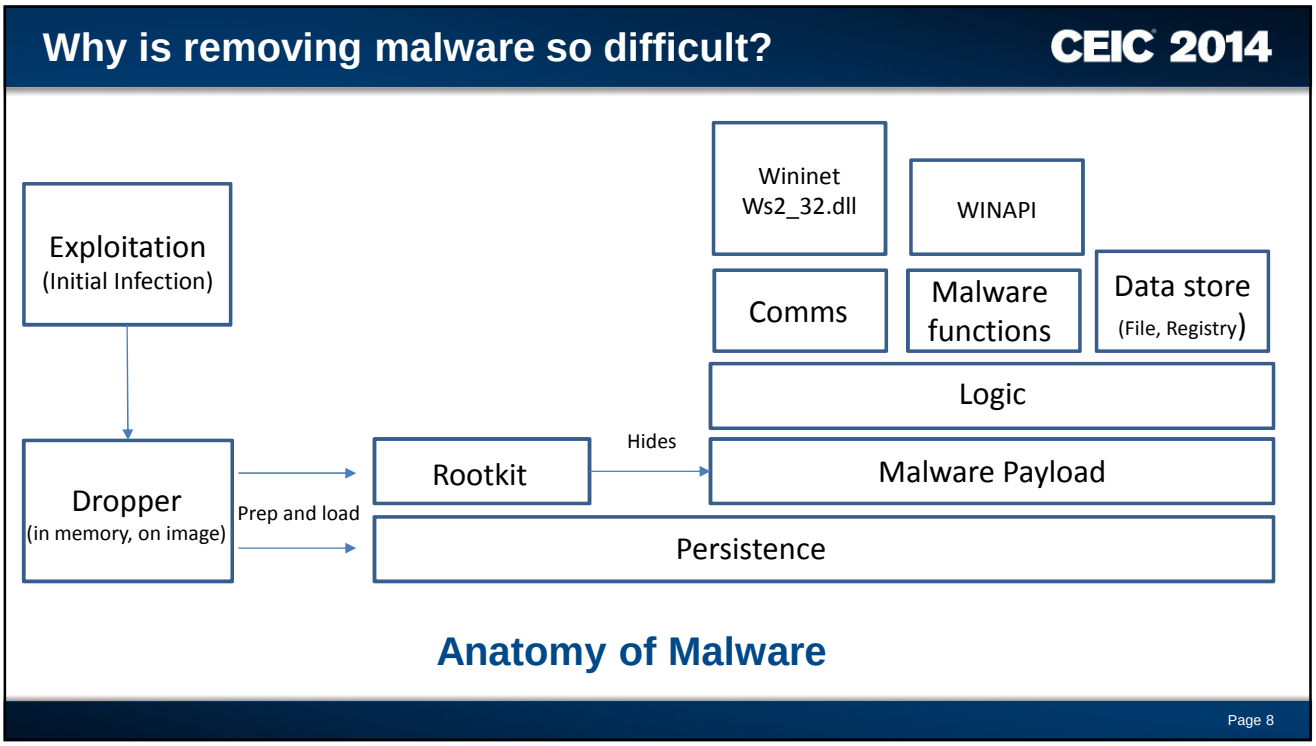
Drive-by Download
(1) Client-side exploitation
Attacker
(2) Server-side exploitation
How does it get there?
Malicious Attachment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Exploitation (Initial Infection)
Dropper (in memory, on image)
Prep and load
Rootkit
Hides
Wininet Ws2_32.dll
WINAPI
Comms
Malware functions
Data store (File, Registry)
Logic
Malware Payload
Persistence
Anatomy of Malware
Page 8

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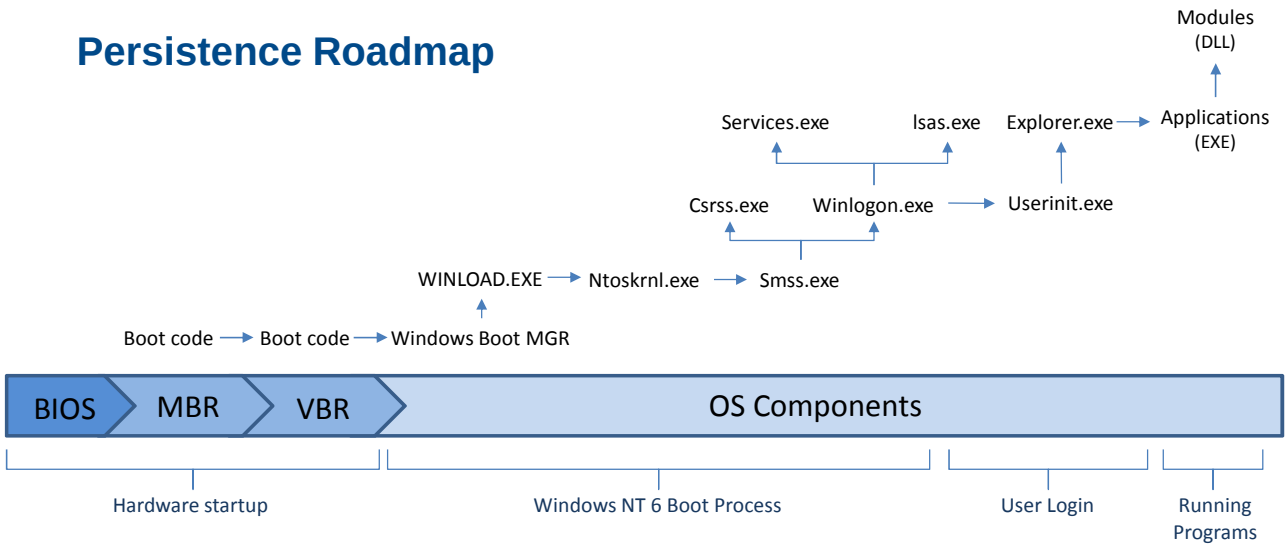
Persistence Roadmap



Page 9

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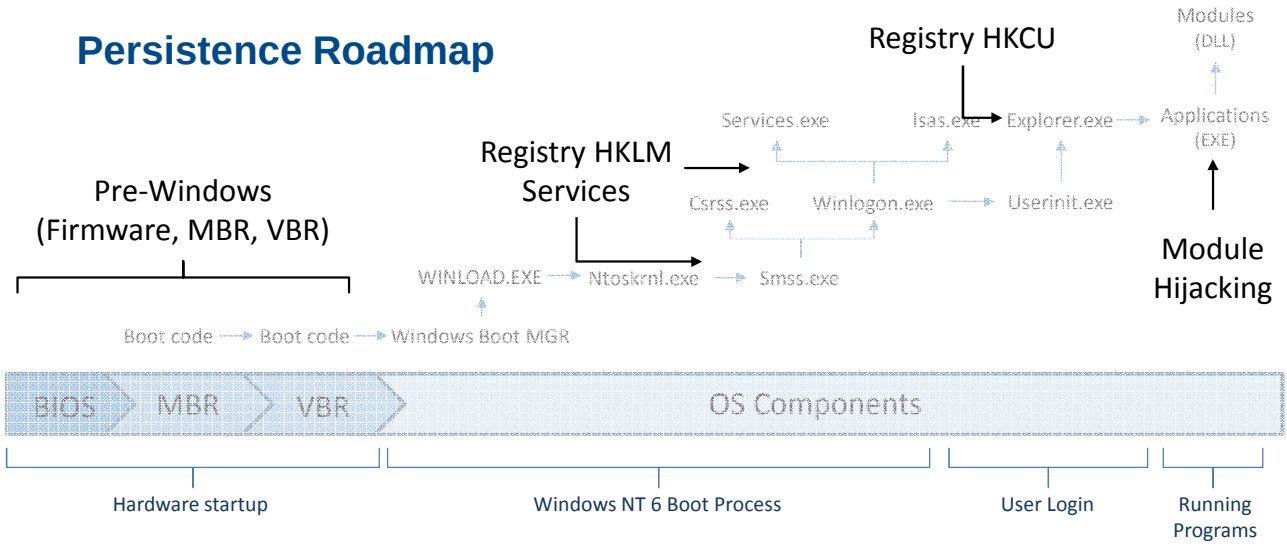
Persistence Roadmap



Page 10

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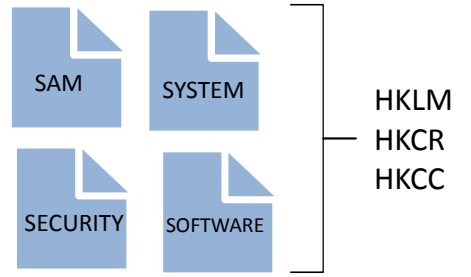
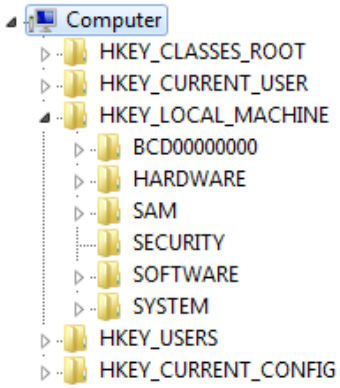


<SYSTEM_ROOT>\System32\config

C:\Users\<user_name>



- Autorun keys
- Easy to hide data (most users have no idea!)
- Gain execution on system start or user login
- Fairly standard but effective!

Page 11

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Persistence with the Registry

- Load malware on Startup
  - HKLM (services)
- Load malware on User login
  - HKLM
  - HKCU

Page 12

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On start up (Services)

Can be accomplished via Service Control Manager

HKLM\SYSTEM\CurrentControlset\services\<service_name>

HKLM\SYSTEM\CurrentControlset\services\<service_name>\Parameters\ServiceDll

Start and Type DWORD values matter

http://support.microsoft.com/kb/103000

Page 13

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On user login

- HKCU\Software\Microsoft\Windows\CurrentVersion\Run
- HKCU\Software\Microsoft\Windows\CurrentVersion\RunOnce
- HKLM\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Windows\Appinit_Dlls
- HKCU\software\Microsoft\windows NT\CurrentVersion\winlogon\Shell
- HKCU\software\Microsoft\windows NT\CurrentVersion\winlogon\Userinit

Page 14

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Persistence with the Registry in action

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DLL Search Order Hijacking

- DLL (dynamic-link library)
- DLL = shared object which contains resources
  - (code, data, etc.)
- Programs (.exe) use DLLs for modularity
- DLL's are loaded into memory space and functions are imported (import table)
- DLL's export functions (export table)

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DLL Search Order

1. Directory from which the application is loaded
2. The system directory (C:\Windows\system32)
3. The 16-bit system directory (C:\Windows\system)
4. The Windows directory (C:\Windows)
5. The current directory (User context)
6. Directories that are listed in the PATH environment variable

http://msdn.microsoft.com/en-us/library/windows/desktop/ms682586(v=vs.85).aspx

Page 17

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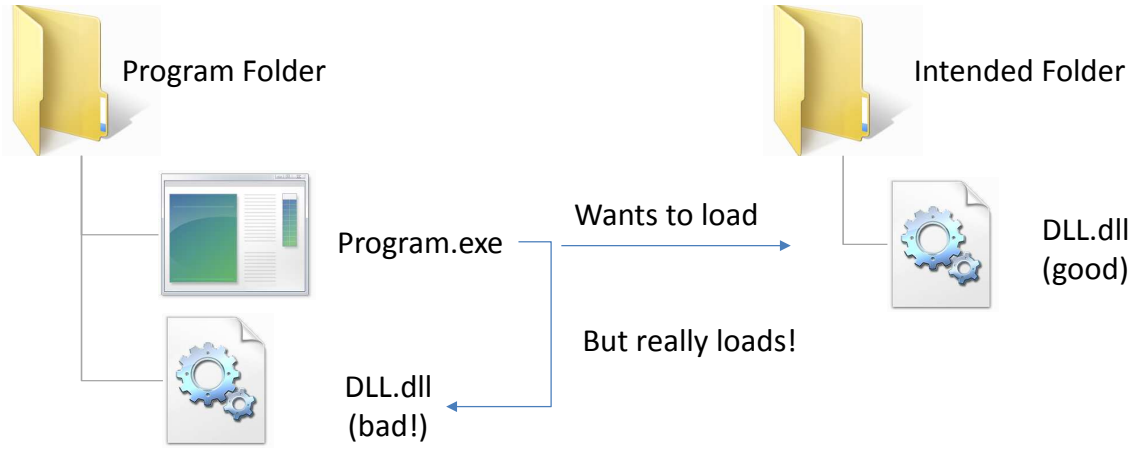
The Hijack



Page 18

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Are all DLLs hijackable?

- The system has certain DLLs cached
- HKLM\system\currentcontrolset\control\session manager\knowndlls

Clbcatq.dll	LPK.dll	Setupapi.dll	Difxapi.dll
Ole32.dll	MSCTF.dll	SHELL32.dll	
Advapi32.dll	MSVCRT.dll	SHLWAPI.dll	
COMDLG32.dll	NORMALIZ.dll	URLMON.dll	
Gdi32.dll	NSI.dll	User32.dll	
IERTUTIL.dll	OLEAUT32.dll	USP10.dll	
IMAGEHLP.dll	PSAPI.DLL	WININET.dll	
IMM32.dll	Rpcrt4.dll	WLDAP32.dll	
Kernel32.dll	Sechost.dll	WS2_32.dll	

Page 19

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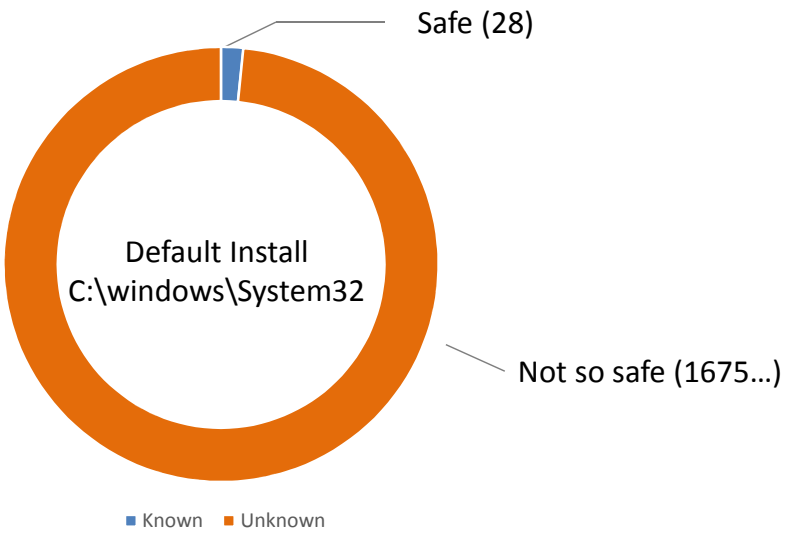

Page 20

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Going Deeper

- Look for programs that load DLL's and import their functions
- Try to find a common DLL that any system has (max target space)
  - Typically part of the 1675 in system32
- Make sure the DLL is not protected
- Can't overwrite WFP DLLs (so location matters!)

Page 21

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Finding Hijack-able DLLs

- Identifying DLL dependencies, depends.exe
  - http://www.dependencywalker.com/
- Automated identification, finddllhijack.exe
  - http://blog.mandiant.com/wp-content/ammo/finddllhijack1.zip
- Our role your own with Python pefile module
  - https://code.google.com/p/pefile/

Page 22

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The Tables

- Export Address Table
  - Functions the DLL will export
  - Method is referenced by ordinal or ASCII name (usually method name)
- Import Address Table
  - The functions that the process imports from a given DLL

	PI	Ordinal ^	Hint	Function	Entry Point
SOLITAIRE.EXE					
KERNEL32.DLL		N/A	82 (0x0052)	CloseHandle	0x77E305B7
USER32.DLL		N/A	129 (0x0081)	CreateDirectoryW	0x77E2EC9A

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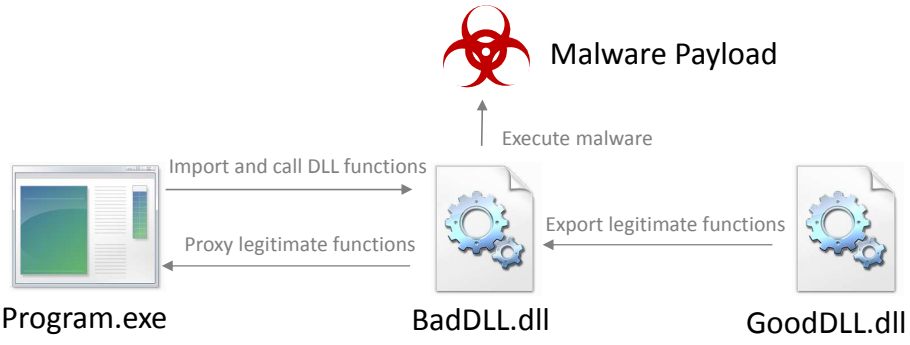
DLL Proxy

- To take advantage of Window's behavior, we need a DLL proxy (the persistence vector)
- Purpose is to gain execution while still exporting legitimate functions for the parent program



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DLL Hijacking in Action

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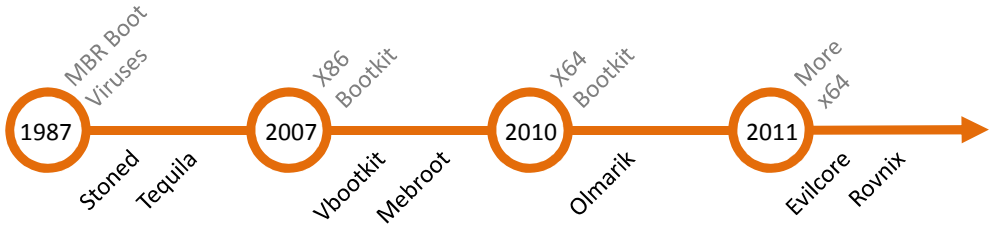
Bootkit

- Malware hooks prior to the OS loading
- Enables malware to load in a privilege mode upon reboot
- Concept of Bootkits have been around for a while (technique has changed)



http://go.eset.com/us/resources/white-papers/Rodionov-Matrosov.pdf

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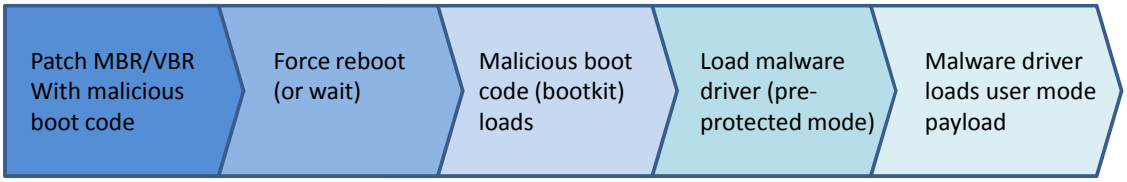
How it works



Page 27

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Bootkit in Action

Page 28

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Other Persistence Mechanisms of Interest

- Firmware
  - Write into the Firmware from the OS
- Browser Helper Objects
  - Browser loads DLL to provide pluggable functionality
  - Can be used to execute malware payload

Page 29

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Remediation Strategy

- Do you really trust what the system tells you?
- Assume compromise
- When in doubt, wipe the host…sometimes that may not save you!

Page 30

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Q & A