IT-Security (ITS) B1

DIKU, E2020

Today’s agenda

Part 1: Some common and notable bugs

Part 2: Fuzzing – automatiing bug discovery

Lecture plan

36	31 Aug	10-12	TL	Introduction, security concepts and the threat of hacking
	04 Sep	10-12	TL	Buffer overflow
37	07 Sep	10-12	CJ	Software security, Operating system security
	11 Sep	10-12	CJ	User authentication and access control
38	14 Sep	10-12	TL	Malicious software
	18 Sep	10-12	CJ	Firewalls and denial-of-service attacks
39	21 Sep	10-12	CJ	Cloud and IoT
	25 Sep	10-12	TL	Cryptography
40	28 Sep	10-12	TL	Internet security protocols
	02 Oct	10-12	TL	Intrusion detection
41	05 Oct	10-12	TL	Forensics
	09 Oct	10-12	CJ	IT security management
42				Fall Vacation - No lectures
43	19 Oct	10-12	CJ	Privacy 1
	23 Oct	10-12	CJ	Privacy 2
44	26 Oct	10-11	Guest	Final guest lecture
		11-12	All	Recap and Q/A
45	xx Nov			Exam

Definitions

Software contains bugs

A vulnerability is a bug that can exploited by an attacker

Not all bugs can be exploited

Not all vulnerabilities matter the same

(Vulnerabilities are exploited to run malware, in a nutshell)

Types of vulnerabilities

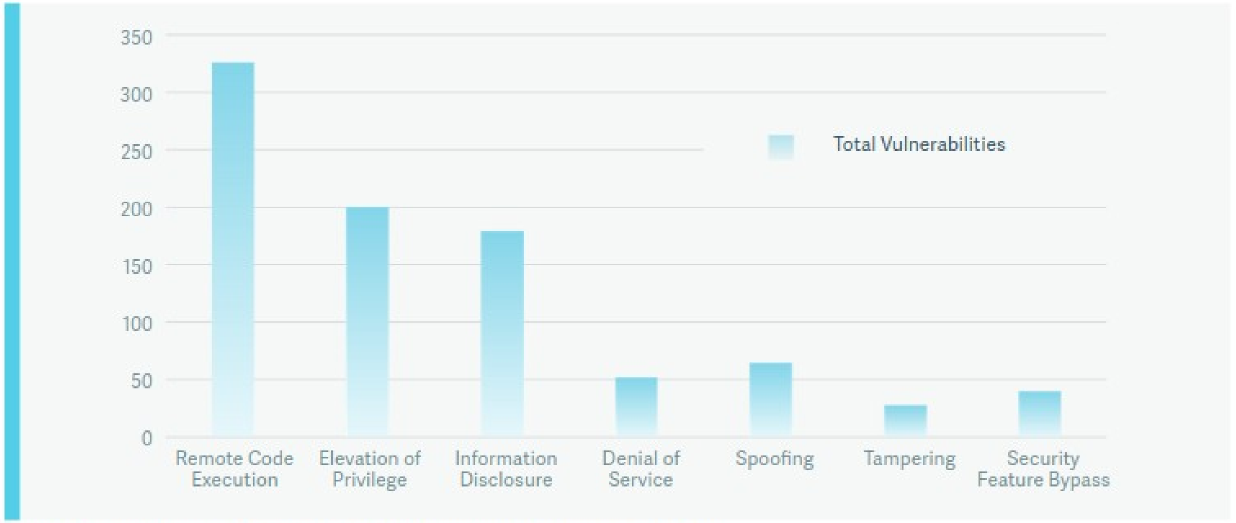
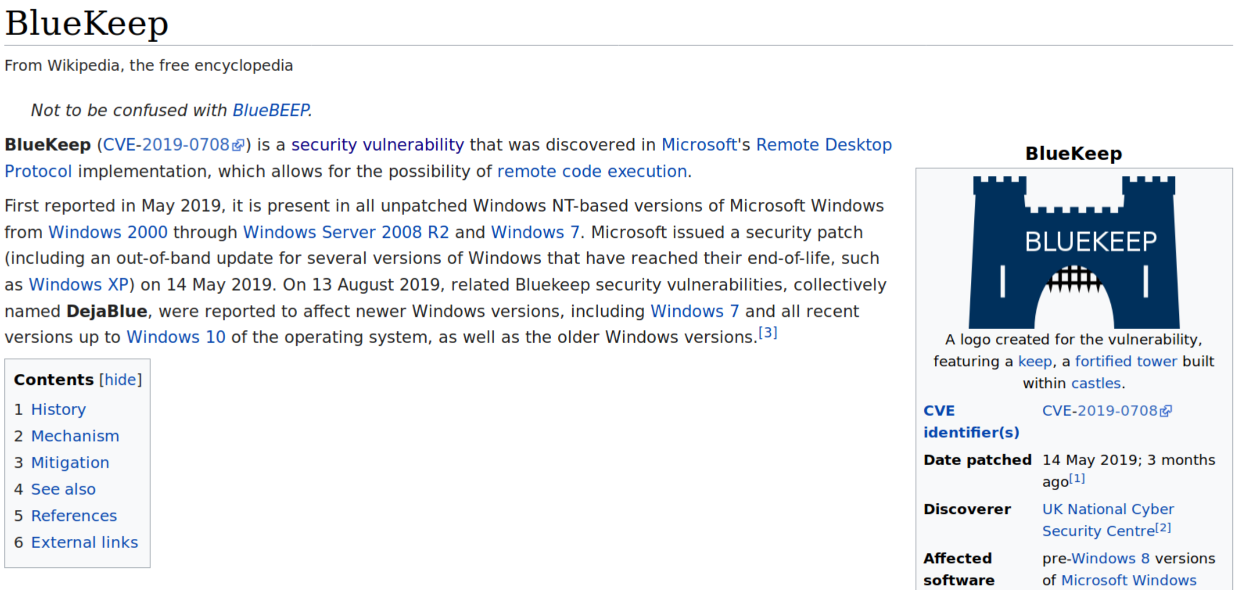


Figure 1: Breakdown of Microsoft Vulnerability Categories (2019)

A vulnerability



BlueKeep

From Wikipedia, the free encyclopedia

Not to be confused with BlueBEEP.

BlueKeep (CVE-2019-0708) is a security vulnerability that was discovered in Microsoft's Remote Desktop Protocol implementation, which allows for the possibility of remote code execution.

First reported in May 2019, it is present in all unpatched Windows NT-based versions of Microsoft Windows from Windows 2000 through Windows Server 2008 R2 and Windows 7. Microsoft issued a security patch (including an out-of-band update for several versions of Windows that have reached their end-of-life, such as Windows XP) on 14 May 2019. On 13 August 2019, related Bluekeep security vulnerabilities, collectively named **DejaBlue**, were reported to affect newer Windows versions, including Windows 7 and all recent versions up to Windows 10 of the operating system, as well as the older Windows versions.[3]

Contents [hide]

BlueKeep

A logo created for the vulnerability, featuring a keep, a fortified tower built within castles.

CVE identifier(s)	CVE-2019-0708
Date patched	14 May 2019; 3 months ago[1]
Discoverer	UK National Cyber Security Centre[2]
Affected software	pre-Windows 8 versions of Microsoft Windows

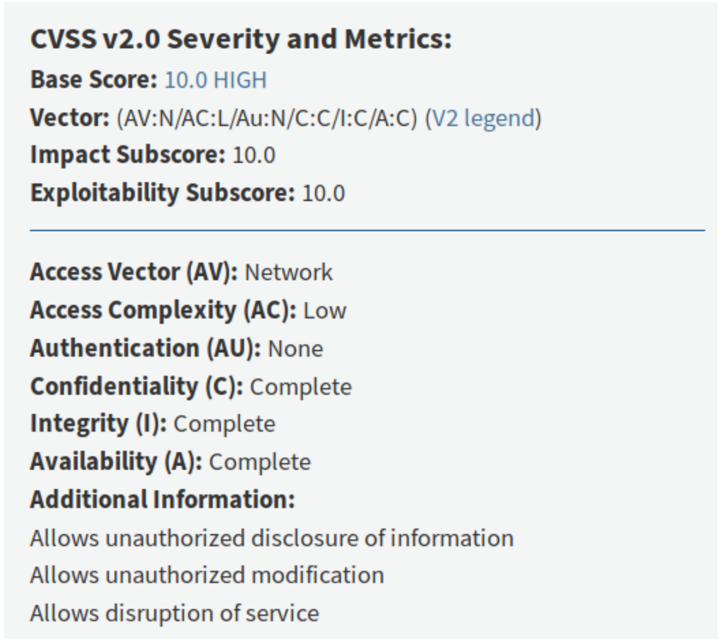
Common Vulnerabilities Scoring System

Attack vector: Local vs. Remote

Attack complexity: High, Medium, Low

Authentication: Required vs. Not

Impact: C/I/A



CVSS v2.0 Severity and Metrics:

Base Score: 10.0 HIGH

Vector: (AV:N/AC:L/Au:N/C:C/I:C/A:C) (V2 legend)

Impact Subscore: 10.0

Exploitability Subscore: 10.0

Access Vector (AV): Network

Access Complexity (AC): Low

Authentication (AU): None

Confidentiality (C): Complete

Integrity (I): Complete

Availability (A): Complete

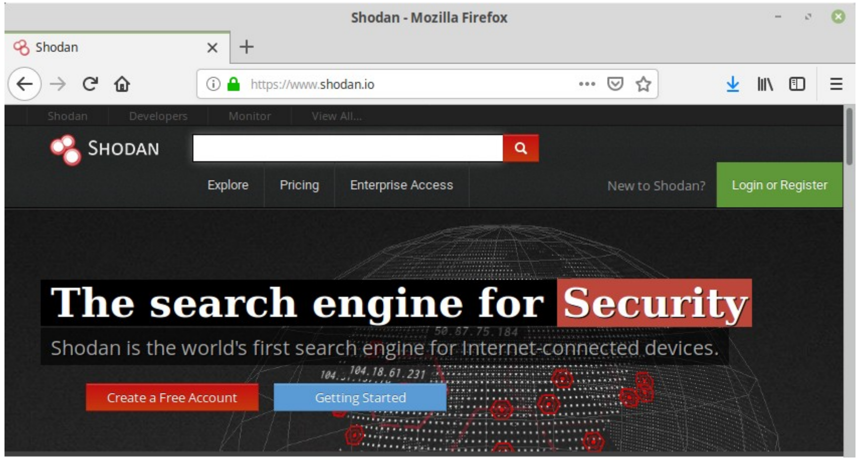
Additional Information:

Allows unauthorized disclosure of information

Allows unauthorized modification

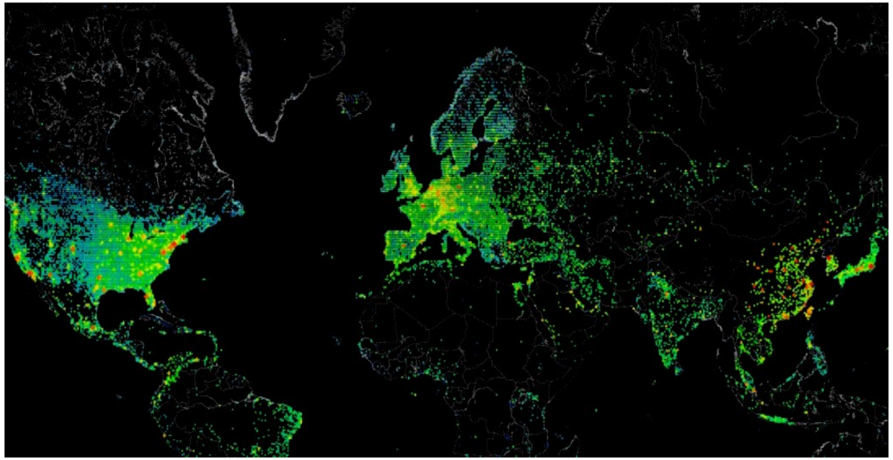
Allows disruption of service

Shodan and BlueKeep

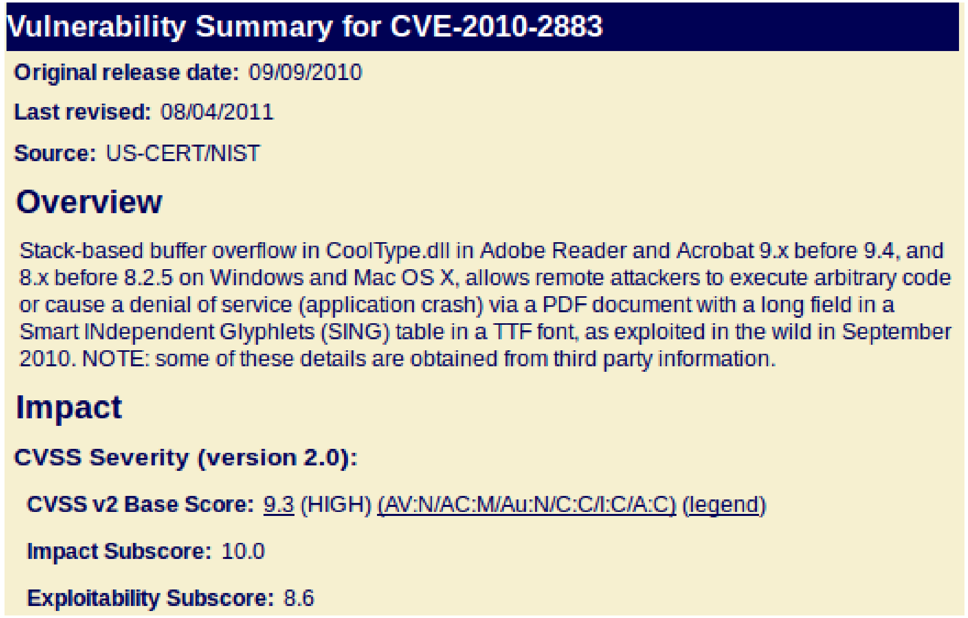


The search engine for Security

Shodan is the world's first search engine for Internet-connected devices.



Another vulnerability



Vulnerability Summary for CVE-2010-2883

Original release date: 09/09/2010

Last revised: 08/04/2011

Source: US-CERT/NIST

Overview

Stack-based buffer overflow in CoolType.dll in Adobe Reader and Acrobat 9.x before 9.4, and 8.x before 8.2.5 on Windows and Mac OS X, allows remote attackers to execute arbitrary code or cause a denial of service (application crash) via a PDF document with a long field in a Smart INdependent Glyphlets (SING) table in a TTF font, as exploited in the wild in September 2010. NOTE: some of these details are obtained from third party information.

Impact

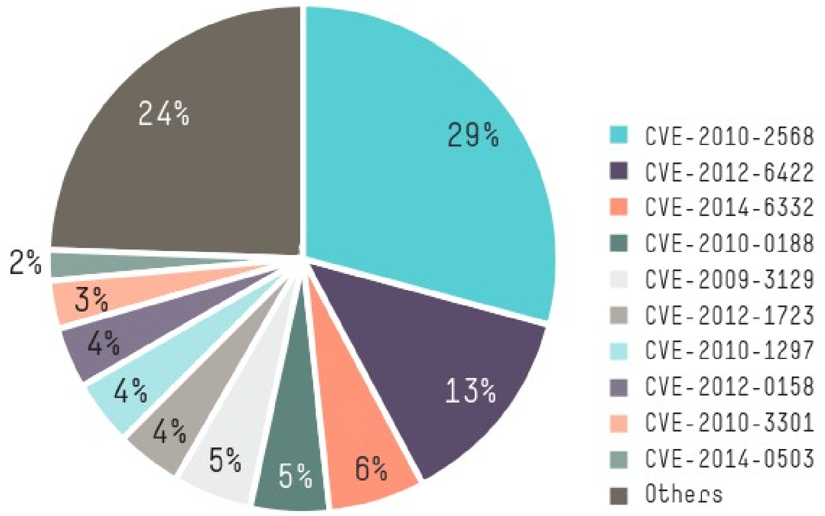
CVSS Severity (version 2.0):

CVSS v2 Base Score: 9.3 (HIGH) (AV:N/AC:M/Au:N/C:C/I:C/A:C) (legend)

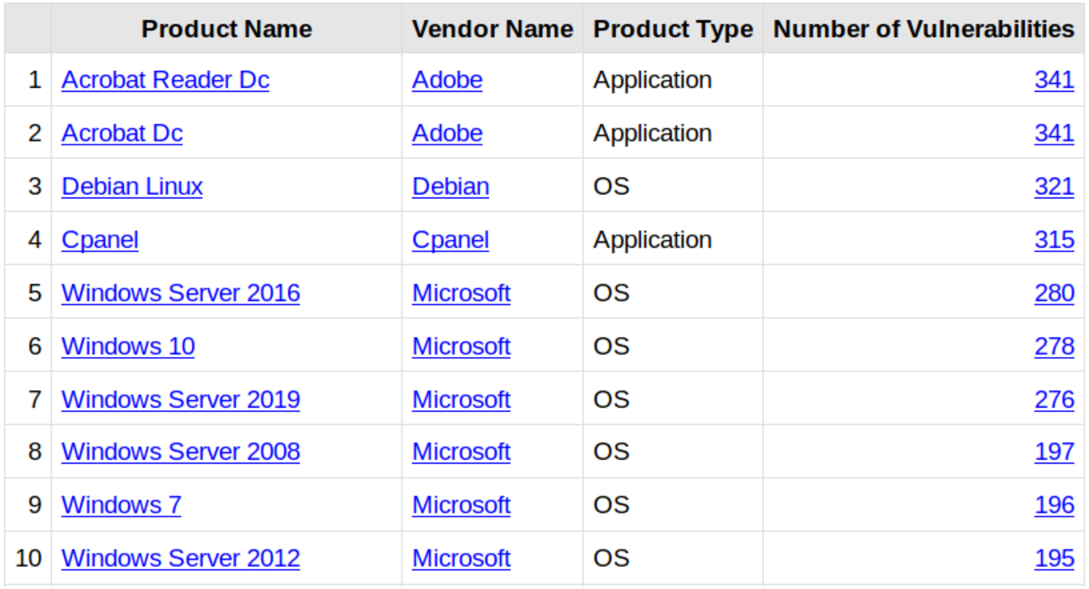
Impact Subscore: 10.0

Exploitability Subscore: 8.6

Too old? Old exploits never die (2015)



2019



	Product Name	Vendor Name	Product Type	Number of Vulnerabilities
1	Acrobat Reader Dc	Adobe	Application	341
2	Acrobat Dc	Adobe	Application	341
3	Debian Linux	Debian	OS	321
4	Cpanel	Cpanel	Application	315
5	Windows Server 2016	Microsoft	OS	280
6	Windows 10	Microsoft	OS	278
7	Windows Server 2019	Microsoft	OS	276
8	Windows Server 2008	Microsoft	OS	197
9	Windows 7	Microsoft	OS	196
10	Windows Server 2012	Microsoft	OS	195

Types of vulnerabilities, include:

Format string

Overflow

Over-read

Load order

Use-after-free

Dangling pointers

Code injection

Command injection

Race conditions

Typos, and more

Where’s the bug?

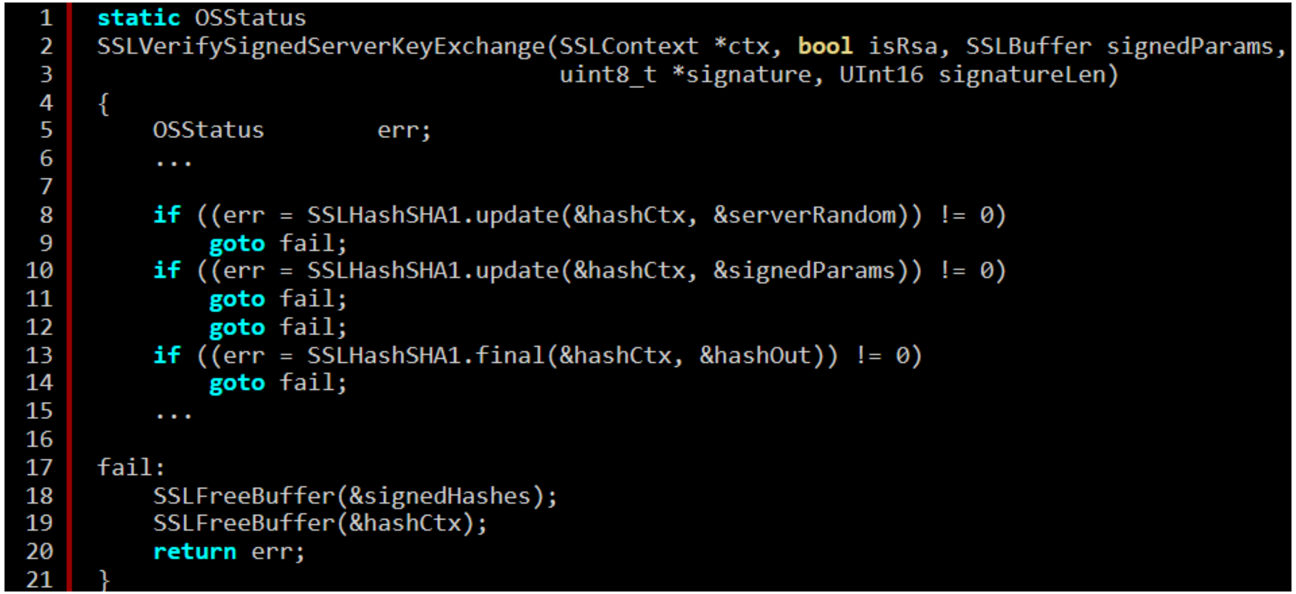
```c
#include <stdio.h>

int main () {
    int i;
    printf("Enter a value: ");
    scanf("%d", &i);

    if (i < 0)
        goto fail;
    if (i > 100)
        goto fail;
        goto fail;
    if (i%2 == 0)
        goto fail;

    return;

fail:
    printf("Fail\n");
    return;
}
```

```
$ ./a.out
Enter a value: 2
Fail

$ ./a.out
Enter a value: 3
Fail
```

```
#include <stdio.h>

int main () {
    int i;
    printf("Enter a value: ");
    scanf("%d", &i);

    if (i < 0)
        goto fail;
    if (i > 100)
        goto fail;
        //goto fail;
    if (i%2 == 0)
        goto fail;

    return;

fail:
    printf("Fail\n");
    return;
}
```

```
$ ./a.out
Enter a value: 2
Fail

$ ./a.out
Enter a value: 3
Fail
```

Apple iOS Goto Fail



```
static OSStatus
SSLVerifySignedServerKeyExchange(SSLContext *ctx, bool isRsa, SSLBuffer signedParams,
                                 uint8_t *signature, UInt16 signatureLen)
{
    OSStatus        err;
    ...

    if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
        goto fail;
    if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
        goto fail;
        goto fail;
    if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
        goto fail;
    ...

fail:
    SSLFreeBuffer(&signedHashes);
    SSLFreeBuffer(&hashCtx);
    return err;
}
```

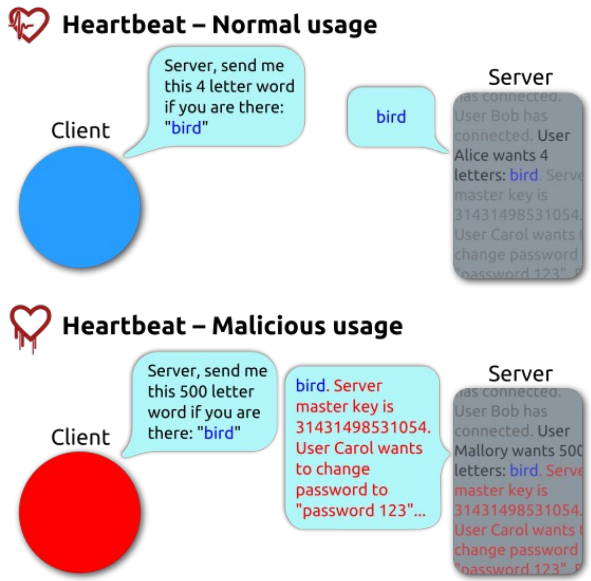
```c
#include <stdio.h>
#include <string.h>

int main () {

   char buf[20] = "http://www.diku.dk";
   char shh[30] = "mumstheword";
   char out[64];
   int chars;

   printf("Buffer contents: %s\n", buf);

   printf("Chars to copy: ");
   scanf("%d", &chars);

   memcpy(out, buf, chars);

   printf("Copied: ");
   fwrite(out, chars, 1, stdout);
   printf("\n");
```

```
$ ./a.out
Buffer contents: http://www.diku.dk
Chars to copy: 12
Copied: http://www.d

$ ./a.out
Buffer contents: http://www.diku.dk
Chars to copy: 50
Copied: http://www.diku.dk�¨0L�H�¨mumstheword
```

```c
#include <stdio.h>
#include <string.h>

int main () {

  char buf[20] = "http://www.diku.dk";
  char shh[30] = "mumstheword";
  char out[64];
  int chars;

  printf("Buffer contents: %s\n", buf);

  printf("Chars to copy: ");
  scanf("%d", &chars);
  if (chars > sizeof(buf)) chars = sizeof(buf);
  memcpy(out, buf, chars);

  printf("Copied: ");
  fwrite(out, chars, 1, stdout);
  printf("\n");
```

```
$ ./a.out
Buffer contents: http://www.diku.dk
Chars to copy: 12
Copied: http://www.d

$ ./a.out
Buffer contents: http://www.diku.dk
Chars to copy: 50
Copied: http://www.diku.dk�¨0L�H�¨mumstheword
```

The HeartBleed Bug


Heartbeat – Normal usage
Client
Server, send me this 4 letter word if you are there: "bird"
bird
Server
User Bob has connected. User Alice wants 4 letters: bird. Serve master key is 31431498531054. User Carol wants t change password "password 123".
Heartbeat – Malicious usage
Client
Server, send me this 500 letter word if you are there: "bird"
bird. Server master key is 31431498531054. User Carol wants to change password to "password 123"...
Server
User Bob has connected. User Mallory wants 500 letters: bird. Serve master key is 31431498531054. User Carol wants t change password "password 123".

```c
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char **argv)
{

   printf("Current time: ");
   fflush(stdout);
   system("date");
   return 0;

}
```

```
$ ./a.out
Current time: Fri Sep  6 09:30:47 CEST 2019

$ export PATH=`pwd`:$PATH
$ echo -e '#!/bin/sh\necho "Hello"' > date
$ chmod 700 date

$ ./a.out
Current time: Hello
```

```c
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char **argv)
{

   printf("Current time: ");
   fflush(stdout);
   system("/bin/date");
   return 0;

}
```

```
$ ./a.out
Current time: Fri Sep  6 09:30:47 CEST 2019

$ export PATH=`pwd`:$PATH
$ echo -e '#!/bin/sh\necho "Hello"' > date
$ chmod 700 date

$ ./a.out
Current time: Hello
```

Real-world example: PlugX

PlugX drops

- A legitimate NVIDIA file (NvSmart.exe)
- A malicious DLL (NvSmartMax.dll)

Normally, NvSmart.exe would load a legitimate NvSmartMax.dll

But if a (malicious) version the DLL file is located in the same directory, this will load instead

```
#!/usr/bin/perl

open(FH, $ARGV[0]);

while(<FH>)
{
   print $_;
}

close(FH);
```

```
$ ./code.pl code.pl
#!/usr/bin/perl

open(FH, $ARGV[0]);

while(<FH>)
{
   print $_;
}

close(FH);

$ ./code.pl 'ls -l code.pl|'
-rwx------ 1 user user 79 Sep  1 10:45 code.pl
```

```
#!/usr/bin/perl

open(FH, "< ".$ARGV[0]); #force read open with '<'

while(<FH>)
{
   print $_;
}

close(FH);
```

```
$ ./code.pl code.pl
#!/usr/bin/perl

open(FH, $ARGV[0]);

while(<FH>)
{
   print $_;
}

close(FH);

$ ./code.pl 'ls -l code.pl|'
-rwx------ 1 user user 79 Sep  1 10:45 code.pl
```

Explanation

According to the Perl documentation

> If filename ends with a "|", filename is interpreted as a command which pipes output

```c
#include <string.h>
#include <stdio.h>
#include <stdlib.h>

int main (int argc, char **argv)
{

  char buffer[64];
  strncpy(buffer, argv[1], sizeof(buffer));

  printf("You entered: ");
  printf(buffer);
  printf("\n");
}
```

```
$ ./a.out A
You entered: A

$ ./a.out %s
You entered: You entered:

$ ./a.out %x
You entered: 510a2000

$ ./a.out %x%x
You entered: 437a00041569e0
```

```
#include <string.h>
#include <stdio.h>
#include <stdlib.h>

int main (int argc, char **argv)
{

   char buffer[64];
   strncpy(buffer, argv[1], sizeof(buffer));

   printf("You entered: ");
   printf("%s", buffer);
   printf("\n");
}
```

```
$ ./a.out A
You entered: A

$ ./a.out %s
You entered: You entered:

$ ./a.out %x
You entered: 510a2000

$ ./a.out %x%x
You entered: 437a00041569e0
```

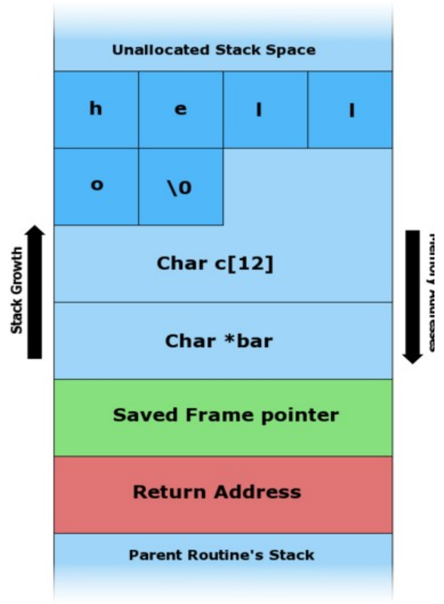
```
#include <string.h>

void foo (char *bar)
{
   char  c[12];
   strcpy(c, bar);
}

int main (int argc, char **argv)
{
   foo(argv[1]);
}
```

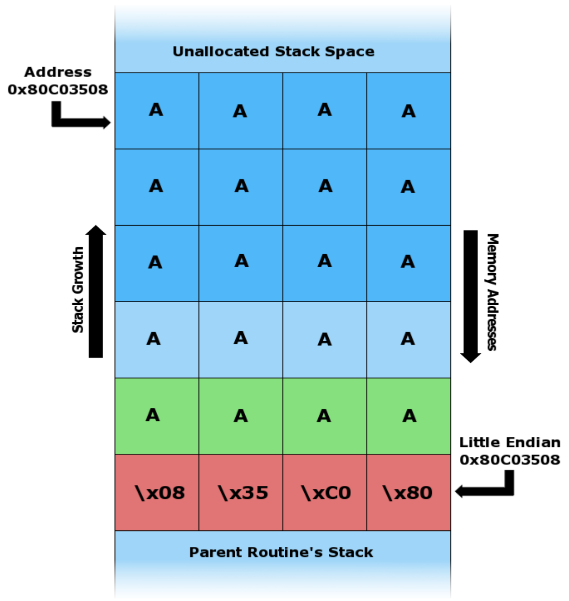
```
$ ./6.out A

$ ./6.out AAAAAAAAAAAAAAA

$ ./6.out AAAAAAAAAAAAAAAAAAAAAAAAA
Segmentation fault
```

```c
#include <string.h>

void foo (char *bar)
{
   char  c[12];
   strncpy(c, bar, sizeof(c));
}

int main (int argc, char **argv)
{
   foo(argv[1]);
}
```

```
$ ./6.out A

$ ./6.out AAAAAAAAAAAAAAA

$ ./6.out AAAAAAAAAAAAAAAAAAAAAAAAA
Segmentation fault
```

```
#include <string.h>

void foo (char *bar)
{
   char  c[12];
   strcpy(c, bar);
}

int main (int argc, char **argv)
{
   foo(argv[1]);
}
```



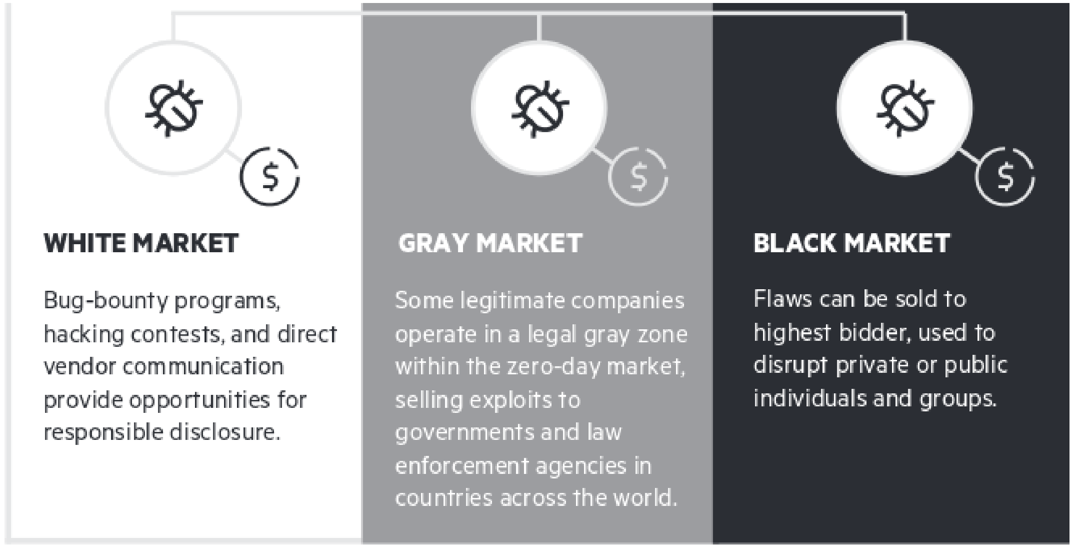


Some countermeasures

- Stack canaries
    - Check stack not altered when function returns
- Data execution prevention (DEP)
    - Prevent the execution of data on the stack or heap
- Address space layout randomization (ASLR)
    - Rearrange memory positions to make successful exploitation more difficult

Okay, so you’ve found a bug

Options



WHITE MARKET

Bug-bounty programs, hacking contests, and direct vendor communication provide opportunities for responsible disclosure.

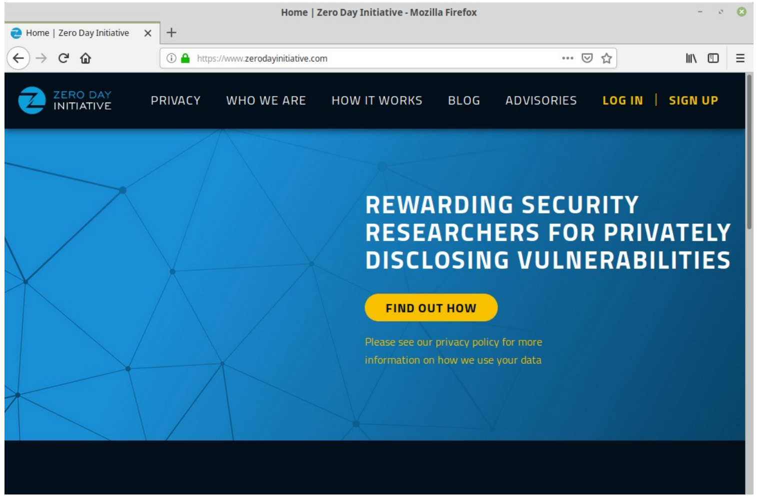
GRAY MARKET

Some legitimate companies operate in a legal gray zone within the zero-day market, selling exploits to governments and law enforcement agencies in countries across the world.

BLACK MARKET

Flaws can be sold to highest bidder, used to disrupt private or public individuals and groups.

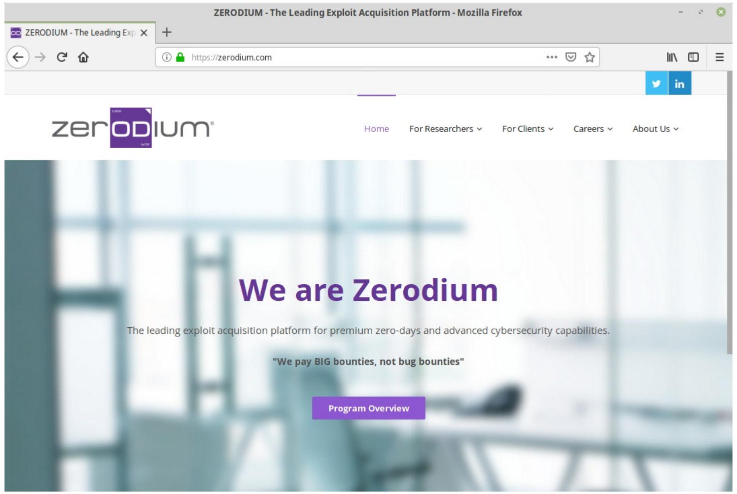
Options


Home | Zero Day Initiative - Mozilla Firefox

https://www.zerodayinitiative.com

REWARDING SECURITY RESEARCHERS FOR PRIVATELY DISCLOSING VULNERABILITIES

Please see our privacy policy for more information on how we use your data


ZERODIUM - The Leading Exploit Acquisition Platform - Mozilla Firefox

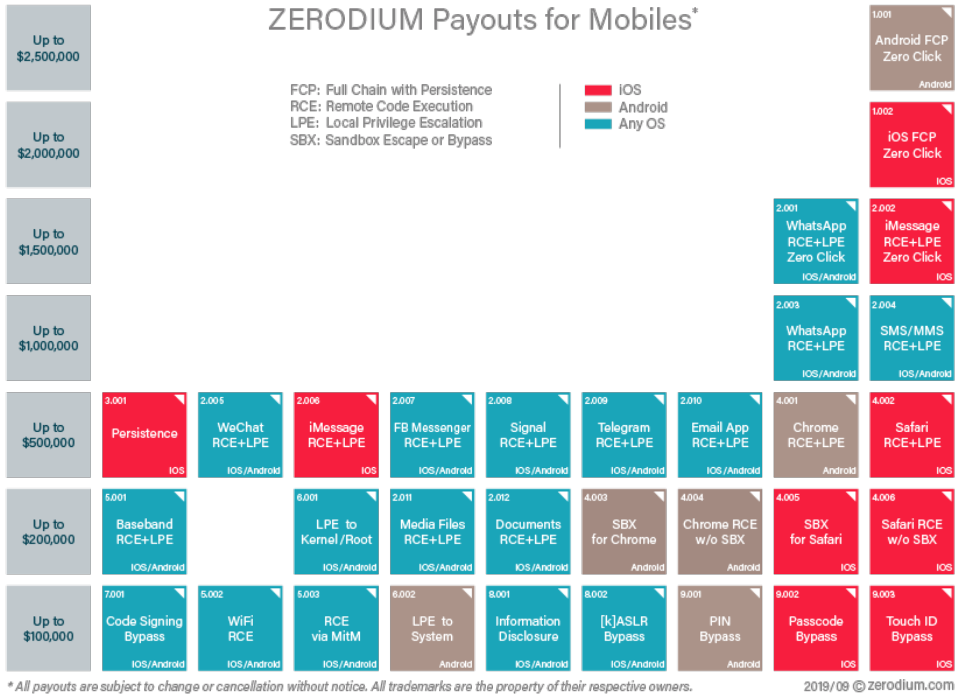
https://zerodium.com

We are Zerodium

The leading exploit acquisition platform for premium zero-days and advanced cybersecurity capabilities.

"We pay BIG bounties, not bug bounties"

Zerodium



ZERODIUM Payouts for Mobiles*

FCP: Full Chain with Persistence
RCE: Remote Code Execution
LPE: Local Privilege Escalation
SBX: Sandbox Escape or Bypass

🟥 iOS
🟫 Android
🟦 Any OS

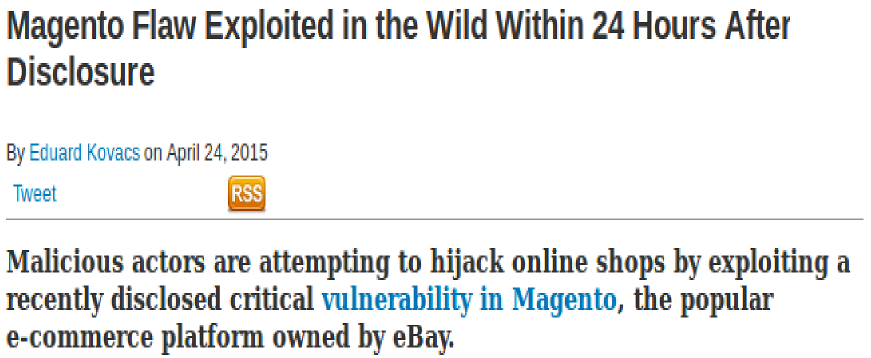
Up to $2,500,000									1.001 Android FCP Zero Click Android
Up to $2,000,000									1.002 iOS FCP Zero Click iOS
Up to $1,500,000								2.001 WhatsApp RCE+LPE Zero Click iOS/Android	2.002 iMessage RCE+LPE Zero Click iOS
Up to $1,000,000								2.003 WhatsApp RCE+LPE iOS/Android	2.004 SMS/MMS RCE+LPE iOS/Android
Up to $500,000	3.001 Persistence iOS	2.005 WeChat RCE+LPE iOS/Android	2.006 iMessage RCE+LPE iOS	2.007 FB Messenger RCE+LPE iOS/Android	2.008 Signal RCE+LPE iOS/Android	2.009 Telegram RCE+LPE iOS/Android	2.010 Email App RCE+LPE iOS/Android	4.001 Chrome RCE+LPE Android	4.002 Safari RCE+LPE iOS
Up to $200,000	5.001 Baseband RCE+LPE iOS/Android		6.001 LPE to Kernel/Root iOS/Android	2.011 Media Files RCE+LPE iOS/Android	2.012 Documents RCE+LPE iOS/Android	4.003 SBX for Chrome Android	4.004 Chrome RCE w/o SBX Android	4.005 SBX for Safari iOS	4.006 Safari RCE w/o SBX iOS
Up to $100,000	7.001 Code Signing Bypass iOS/Android	5.002 WiFi RCE iOS/Android	5.003 RCE via MitM iOS/Android	6.002 LPE to System Android	8.001 Information Disclosure iOS/Android	8.002 [k]ASLR Bypass iOS/Android	9.001 PIN Bypass Android	9.002 Passcode Bypass iOS	9.003 Touch ID Bypass iOS

*All payouts are subject to change or cancellation without notice. All trademarks are the property of their respective owners.

2019/09 © zerodium.com

“A patch is out”

Patching challenges

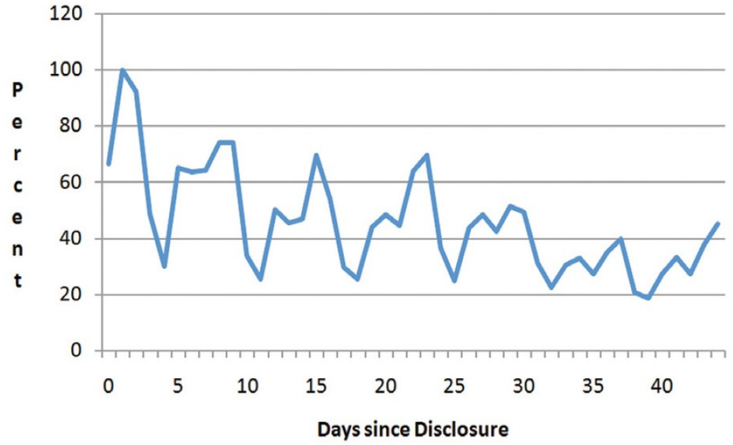


Magento Flaw Exploited in the Wild Within 24 Hours After Disclosure

By Eduard Kovacs on April 24, 2015

Tweet RSS

Malicious actors are attempting to hijack online shops by exploiting a recently disclosed critical vulnerability in Magento, the popular e-commerce platform owned by eBay.



Lecture plan

36	31 Aug	10-12	TL	Introduction, security concepts and the threat of hacking
	04 Sep	10-12	TL	Buffer overflow
37	07 Sep	10-12	CJ	Software security, Operating system security
	11 Sep	10-12	CJ	User authentication and access control
38	14 Sep	10-12	TL	Malicious software
	18 Sep	10-12	CJ	Firewalls and denial-of-service attacks
39	21 Sep	10-12	CJ	Cloud and IoT
	25 Sep	10-12	TL	Cryptography
40	28 Sep	10-12	TL	Internet security protocols
	02 Oct	10-12	TL	Intrusion detection
41	05 Oct	10-12	TL	Forensics
	09 Oct	10-12	CJ	IT security management
42				Fall Vacation - No lectures
43	19 Oct	10-12	CJ	Privacy 1
	23 Oct	10-12	CJ	Privacy 2
44	26 Oct	10-11	Guest	Final guest lecture
		11-12	All	Recap and Q/A
45	xx Nov			Exam