



BLOG

Rundll32: The Infamous Proxy for Executing Malicious Code



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WRITTEN BY Cybereason Blue Team

Today, we are going to dwell on a Microsoft tool, the infamous *rundll32.exe*, which allows you to load and execute code. It is often used by adversaries during their offensive operations to execute malicious code through a process which we will explain in detail.

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```
C:\>signtool verify /v C:\Windows\System32\rundll32.exe  
c:\windows\system32\rundll32.exe:  
  Verified: Signed  
  Signing date: 7:25 PM 3/2/2022  
  Publisher: Microsoft Windows  
  Company: Microsoft Corporation  
  Description: Windows host process (Rundll32)  
  Product: Microsoft Windows Operating System  
  Prod version: 10.0.17763.1697  
  File version: 10.0.17763.1697 (WinBuild.160101.0800)  
  MachineType: 64-bit  
C:\Users\Administrator>
```

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Figure 1 - Rundll32.exe signature overview

```
Administrator: Windows PowerShell  
Windows PowerShell  
Copyright (C) Microsoft Corporation. All rights reserved.  
PS C:\Users\Administrator> Get-AuthenticodeSignature 'C:\Windows\System32\rundll32.exe' | Format-List  
  
SignerCertificate : [Subject]  
  CN=Microsoft Windows, O=Microsoft Corporation, L=Redmond, S=Washington, C=US  
  
  [Issuer]  
  CN=Microsoft Windows Production PCA 2011, O=Microsoft Corporation, L=Redmond, S=Washington,  
  C=US  
  
  [Serial Number]  
  330000033C89C66A7B45BB1F8D00000000033C  
  
  [Not Before]  
  9/2/2021 11:23:41 AM  
  
  [Not After]  
  9/1/2022 11:23:41 AM  
  
  [Thumbprint]  
  FE51E838A087B8561BBB2DD98A20143384A03B3F  
  
TimeStamperCertificate : [Subject]  
  CN=Microsoft Time-Stamp Service, OU=Thales TSS ESN:F87A-E374-D789, OU=Microsoft Operations  
  Puerto Rico, O=Microsoft Corporation, L=Redmond, S=Washington, C=US  
  
  [Issuer]  
  CN=Microsoft Time-Stamp PCA 2010, O=Microsoft Corporation, L=Redmond, S=Washington, C=US  
  
  [Serial Number]  
  3300001638864C6C985966576000000000163  
  
  [Not Before]  
  1/14/2021 11:02:23 AM  
  
  [Not After]  
  4/11/2022 12:02:23 PM  
  
  [Thumbprint]  
  ED2CG01FDD49DD2A934D2AB32DCACC19940161EF  
  
Status : Valid  
StatusMessage : Signature verified.  
Path : C:\Windows\System32\rundll32.exe  
SignatureType : Catalog  
IsOSBinary : True
```

Figure 2 - Rundll32.exe signature details

On the one hand, rundll32.exe is an executable signed by Microsoft which is natively present on all Windows systems; on the other hand, it is also very flexible and efficient for loading code into memory, acting as a proxy for this purpose. Moreover, because rundll32.exe benefits from a certain degree of trust, it could be a possible AppLocker and Software Restriction Policies (SRP) bypass.

Last but not least, rundll32.exe is also able to help to dump the memory of processes, such as the LSASS (*Local Security Authority Subsystem Service*) process to retrieve credentials, which we will demonstrate.

For these reasons, it is a very interesting and frequently

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Tactic	Defense Evasion
Technique ID	T1218 .011
Technique Name	System Binary Proxy Execution
Sub-technique Name	System Binary Proxy Execution: Rundll32
Defense Bypassed	Anti-virus, Application control, Digital Certificate Validation

WHO IS CURRENTLY ABUSING RUNDLL32.EXE?

Although rundll32.exe has frequent and undeniable legitimate use, it is also taken advantage of by many attackers, ranging from state-affiliated groups (APTs) to cybercriminal groups to proxy execution of malicious code.

Some of these threat actors are among the most sophisticated attackers around and still rely on rundll32.exe during their operation. Just to cite a few, we can have:

- **HAFNIUM**: A likely state-sponsored cyber espionage group operating out of China that targets entities in the US across a number of industry sectors, including infectious disease researchers, law firms, higher education institutions, defense contractors, policy think tanks, and NGOs.
- **APT29** (aka Cozy Bear): A threat group that has been attributed to Russia's Foreign Intelligence Service (SVR) that often targets government networks in Europe and NATO member countries, research institutes, and think tanks. APT29 reportedly compromised the Democratic National Committee starting in the summer of 2015 and is reportedly responsible for the SolarWinds breach and the resulting supply-chain attack in 2020, where victims of this campaign included government, consulting, technology, telecom, and other organizations in North America, Europe, Asia, and the Middle East.

importance, dangerousness and diversity of these groups that rely on rundll32.exe, so it is important to understand its mechanism to detect it.

HOW DOES RUNDLL32.EXE WORK?

Microsoft does not provide detailed information about rundll32.exe, but they mention the syntax below:

Figure 3 - Microsoft documentation for rundll32.exe

The syntax is not perfectly correct, you have to specify an entry point into the dynamic-link library (DLL) as below (otherwise nothing will happen):

```
rundll32.exe <DLL PATH>, <DLL Entry Point>
```

Note that <DLL PATH> could be both local and remote when the DLL is hosted on an accessible share, using UNC (Universal naming convention) paths in the second scenario.

Even if the entry point does not exist, the system will call the DllMain function with the DLL_PROCESS_ATTACH value first and the relevant code will be executed followed by an error message because of the missing entry point.

Indeed, rundll32.exe process uses the LoadLibraryExW function which calls DllMain (DLL's entry point) and load the DLL into the virtual address space of the rundll32.exe process as we notice below:

Figure 4 - Rundll32.exe relies on LoadLibraryExW function

Analyzing the stack, we notice a LoadLibraryExW call with:

- ESI register containing the DLL Path
(C:\\Code\\RUNDLL32_TEST.dll)

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```
MODULE LoadLibraryExW; // From C:\Windows\SYSTEM32\LIBC.LIB  
example:  
[in] LPCWSTR lpLibFileName, //  
L"C:\\Code\\RUNDLL32_TEST.dll"  
     HANDLE hFile,          // 0  
[in] DWORD   dwFlags       // 8  
);
```

The following parameters are used:

- **lpLibFileName:** This string specifies the file name of the module to load
- **hFile:** This parameter is set to NULL (it is reserved for future use)
- **dwFlags:** The search strategy is set to 8 which correspond to LOAD_WITH_ALTERED_SEARCH_PATH

Know that LoadLibraryExW is theoretically able to load a DLL module without calling the DllMain function of the DLL but here, rundll32.exe is using dwFlags set to 8 which isn't inducing this behavior. The code is equivalent to:

```
hLibModule = LoadLibraryExW(<DLL PATH>, (HANDLE) 0x0, 8);  
if (hLibModule == (HMODULE) 0x0) {  
    res = GetLastError();  
    if (res == 0xc1) {  
        // ...  
    }  
    else {  
        Arguments = (LPCWSTR *) 0x0;  
        dwFlags = 0x1200;  
        // ...  
    }  
// ...
```

Note: As per Microsoft API documentation, when rundll32.exe calls the DllMain function with any specific entry point, (i.e. a value other than DLL_PROCESS_ATTACH), the return value is ignored. If the return value is FALSE when DllMain is called during process initialization, the process



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value and we will create a specific exported entry point to execute cmd.exe. Let's also provide debug information using MessageBox:

```
#include "pch.h"
#include <windows.h>

// Reference:
// https://docs.microsoft.com/en-
us/windows/win32/dlls/dllmain
// https://docs.microsoft.com/en-
us/windows/win32/dlls/dynamic-link-library-
entry-point-function

BOOL APIENTRY DllMain(
    HMODULE hModule, // handle to DLL module
    (same as HINSTANCE)
    DWORD fdwReason, // reason for calling
    function
    LPVOID lpReserved // reserved
) {

    STARTUPINFOA si = {
        sizeof(STARTUPINFOA)
    };
    PROCESS_INFORMATION pi;
    LPCSTR appCalc =
    "C:\\Windows\\System32\\calc.exe";

    // Perform actions based on the reason
    for calling
    switch (fdwReason) {

        case DLL_PROCESS_ATTACH:

            // A process loads the DLL
            (initialize once for each new process)
            // Return FALSE to fail DLL load

            // Start a "calc.exe" child process
            if (!CreateProcessA(appCalc, NULL,
                NULL, NULL, FALSE, 0, NULL, NULL, &si, &pi))
    
```

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```
attached"), TEXT("Hi!"), MB_OK |  
MB_ICONINFORMATION);  
    return TRUE;  
  
    case DLL_THREAD_ATTACH:  
        // Do thread-specific initialization  
        break;  
  
    case DLL_THREAD_DETACH:  
        // Thread exits normally  
        // Do thread-specific cleanup  
        break;  
  
    case DLL_PROCESS_DETACH:  
        // A process unloads the DLL  
        // Perform any necessary cleanup  
        break;  
  
    }  
    return TRUE; // Successful  
DLL_PROCESS_ATTACH  
}  
  
// Export function  
extern "C"  
__declspec(dllexport) void  
SpecificEntryPoint() {  
  
    MessageBox(NULL, TEXT("Hello from a DLL  
exported function"), TEXT("Hi!"), MB_OK |  
MB_ICONINFORMATION);  
  
    STARTUPINFOA si = {  
        sizeof(STARTUPINFOA)  
    };  
    PROCESS_INFORMATION pi;  
    LPCSTR appCmd =  
"C:\\Windows\\System32\\cmd.exe";  
  
    // Start a "cmd.exe" child process  
    if (!CreateProcessA(appCmd, NULL, NULL,  
NULL, FALSE, 0, NULL, NULL, &si, &pi)) {  
        MessageBox(NULL,
```

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It is important to note that even when targeting a specific entry point (DLL-exported function), the code within the DllMain function from DLL_PROCESS_ATTACH will still be executed.

Note: This behavior was previously discussed, it is related to the dwFlags set to LOAD_WITH_ALTERED_SEARCH_PATH when calling LoadLibraryExW from rundll32.exe (this flag is not under control).

With our DLL, we will have two applications executed (calc.exe and cmd.exe) and two message boxes in this scenario when using the SpecificEntryPoint.

Finally, please note that it is not a good practice to call CreateProcess within DllMain, as it could lead to improper synchronization and cause an application to deadlock as creating a process can load another DLL.

LET'S PLAY WITH OUR DLL!

Let's first execute calc.exe (DllMain function with the DLL_PROCESS_ATTACH value and a fictive but mandatory entry point):

```
rundll32.exe RUNDLL32_TEST.dll,ThisEntryDoesNotExist
```

This command, targeting a fictive entry point (non-existing DLL-exported function), will result in the execution of calc.exe because of the previously mentioned point.

Note: Without an entry point, even non-existing one, the DLL will not be loaded (despite what Microsoft's documentation describes).

Now, let's play with our DLL-exported function named SpecificEntryPoint to execute cmd.exe using the following command:

```
rundll32.exe RUNDLL32_TEST.dll,SpecificEntryPoint
```

Figure 5 - Thread's stack overview (reaching a provided DLL's entry-point)

As result, we could notice a spawned cmd.exe with non-existing parent because the rundll32.exe process (PID 1844) is terminated and cmd.exe process (PID 10904) was created as a new and independent process:

Figure 6 - Process overview (rundll32 spawned a child with "unmapped" parent)

However, thanks to the [Cybereason Defense Platform](#), we could examine the history, all loaded modules and all other relevant information and also visualize the processes tree to notice that rundll32.exe is the parent of cmd.exe:

Figure 7 - Cybereason's investigation dashboard to hunt for rundll32.exe executions

Figure 8 - Visualization of the rundll32.exe Process Tree using Cybereason

This example isn't malicious by itself therefore we wouldn't raise a MalOp™ for this execution, nevertheless, all relevant context and information are stored and accessible.

WHAT ELSE COULD RUNDLL32.EXE DO?

We have seen that rundll32.exe is a powerful asset for adversaries to proxy execution of arbitrary and malicious code. This binary has another ace in the hole, it could leverage comsvcs.dll (a Microsoft-signed DLL) which exports a function called MiniDumpW that rely on MiniDumpWriteDump to dump lsass.exe (Local Security Authority Subsystem Service) process memory to retrieve credentials.

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```
rundll32.exe -c windows\comsvcs.dll MiniDump <LSASS PID> <DUMP PATH> full
```

Where <LSASS PID> is the process ID of LSASS and <DUMP PATH> the output to be written. Note that this requires Local Administrator or SYSTEM privileges.

Example:

```
rundll32.exe -c windows\comsvcs.dll MiniDump <LSASS PID> <DUMP PATH> full
```

Figure 9 - Rundll32.exe using comsvcs.dll to dump LSASS process memory

We demonstrated that rundll32.exe, which is a signed Microsoft binary, helps to proxy execution of arbitrary and malicious code and dump credentials.

Anything else, please? Of course! This binary is also able to:

- Execute JavaScript
- Execute VBScript
- Execute content from Alternate Data Stream (ADS)
- Manipulate COM Objects
- Etc.

You can [refer to the LOLBas projects](#) for further information and examples.

HOW DOES CYBEREASON DETECT RUNDLL32.EXE?

Thanks to our advanced AI-powered technology, we offer the perfect alternative to manually triaging and investigating a flood of alerts full of false positives: the Cybereason [MalOp](#)—an interactive graphical display of the full malicious operation from root cause. Instantly see all elements of an attack correlated across every impacted asset with the option for automated or one-click remediation, reducing investigation periods by as much as 93% so Defenders can eliminate threats in a matter of minutes rather than days.

Indeed, on the one hand, we already noticed that

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In the above scenario, such a technique isn't dangerous, but below we demonstrate how Rundll32.exe can be abused.

Note: For the following tests, we configured the EDR with features and options in "detection" mode only to demonstrate detection capabilities without immediately blocking the attacks ("prevention" mode).

MALICIOUS EXAMPLE #1 - LSASS DUMP

However, Cybereason will – of course – detect malicious behaviors of rundll32.exe and trigger active MalOps when it is relevant. For example, we demonstrated a technique when adversaries abuse rundll32.exe and comsvcs.dll to dump LSASS memory.

The Defender can leverage the MalOp™ to quickly ascertain all relevant information about the attack:

Figure 11 - MalOp for Rundll32.exe dumping LSASS process memory as seen in the Cybereason Defense Platform

The Defender is then able to explore the process tree to hunt for suspicious activities:

Figure 12 - Rundll32.exe Process Tree as seen in the Cybereason Defense Platform (Malicious)

MALICIOUS EXAMPLE #2 - METERPRETER PAYLOAD

To continue our examples, we could now create a malicious DLL using msfvenom to initiate a reverse shell to an adversary-controlled system. We will select a staged Reverse TCP Meterpreter payload and name it sample.dll:

Figure 13 - Msfvenom - Meterpreter payload creation (DLL)

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Defender:

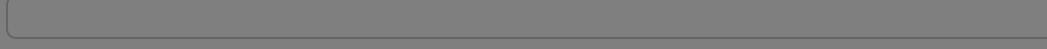


Figure 14 - MalOp on “rundll32.exe” when loading a Meterpreter payload (DLL)

Note: The DLL is injecting a Meterpreter payload in Memory using Reflective DLL Injection technique, hence the reference to the “Module Injection” within the MalOp.

The Defender is well alerted and then able to explore the process tree to continue the hunt:

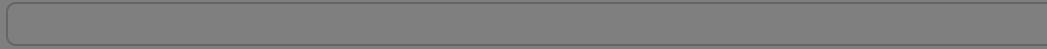


Figure 15 - Process tree of rundll32.exe when loading a Meterpreter Payload (DLL) as seen in the Cybereason Defense Platform

The Defender can proceed with additional adversary hunting from the process tree where we notice floating modules which are indicators of Reflective DLL Injection (Delivering Meterpreter):



Figure 16 - Meterpreter - Detection of floating modules

We notice a machine with IP 10.160.155.26 (victim) connecting to another machine with IP 10.160.201.220 on port TCP/8080. This corresponds to the reverse Meterpreter (TCP) payload we created (sample.dll) and executed using rundll32.exe:



Figure 17 - Meterpreter - Connection to the attacker

MALICIOUS EXAMPLE #3 - VBSCRIPT EXECUTION

Let's take a look at another technique to execute VBScript and spawn a PowerShell prompt:



```
rundll32.exe vbscript://"\\mshtml.RunHTMLApplication
```

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execution means.

Thanks to our *Behavioral Execution Protection* feature, it is correctly marked as suspicious (unlike the cmd.exe and calc.exe executions we have previously seen, if you do remember):

Figure 18 - MalOp on rundll32.exe "Malicious process" (Behavioral execution protection) as seen in the Cybereason Defense Platform

HUNTING QUERIES

The queries provided in this section can be used to hunt for possible malicious rundll32.exe processes. First of all, the following query provide all instances of rundll32.exe (including non-malicious ones), to have an overview of activities:

```
/#/s/search?queryString=0<-
Process"elementDisplayName:) rundll32.exe"&viewDetails
=false
```

Result:

Figure 19 - [Hunt] List of all Rundll32.exe processes as seen in the Cybereason Defense Platform

Then, it is possible to refine and limit the search to suspicious occurrences, you can filter on Has Suspicion is True and/or Has Malops is True with the query below or using the user interface:

```
/#/s/search?queryString=0<-
Process"elementDisplayName:) rundll32.exe
,hasSuspictions:true,hasMalops:true"&sorting=
elementDisplayName&sortingDirection=1&viewDetails=false
```



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connections with the query below (or using the user interface to graphically build the query):

```
/#/s/search?queryString=2<-
Process"elementDisplayName:") rundll32.exe,hasOutgoingCo
nnection:true"->connections-
>remoteAddress&sorting=elementDisplayName&sortingDirec
tion=1&viewDetails=false
```

Result:

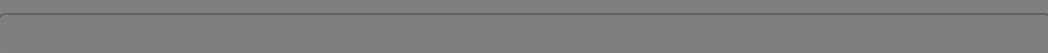


Figure 21 - [Hunt] Query creation - Rundll32 with outgoing connections as seen in the Cybereason Defense Platform

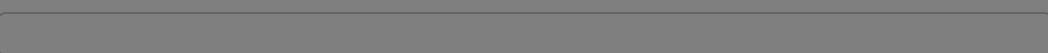


Figure 22 - [Hunt] Results - Rundll32 with outgoing connections as seen in the Cybereason Defense Platform

We notice the remote IP 10.160.201.222 which is the adversary-controlled machine that received the Meterpreter reverse shell from the victim machine.

In the real world, this IP address could be used as a pivot (or "IoC" for indicator of Compromise) to pursue the Incident Response (IR) process and hunt for other malicious activities related to this specific address.

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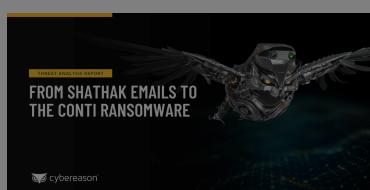
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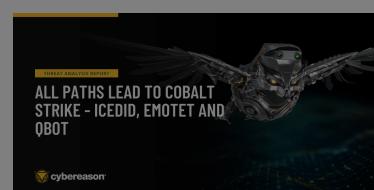
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