Mars, a red-hot information stealer

blog.sekoia.io/mars-a-red-hot-information-stealer/

April 7, 2022

Mars Stealer is an information stealer sold on underground forums by *MarsTeam* since June 22, 2021, with the malware-as-a-service model. The malware capabilities are those of a classic stealer with a focus on cryptocurrency theft. As a quick summary, Mars Stealer is able to:

- collect data from several browsers (passwords, cookies, credit cards, *etc*.);
- steal credentials from crypto plugins, crypto wallets and 2FA plugins;
- grab files;
- fingerprint the infected host.

It shares code with other information stealers including Arkei, Oski and Vidar.

Given its interesting functionalities, its ease of use and reasonable price, the Mars Stealer malware has become popular on several underground forums. Moreover, the presumed developers regularly release new versions of the malware to fix some bugs and especially to improve the Mars Stealer capabilities in terms of data collection and defense evasion.

Mars Stealer has been recently brought to light by 3xp0rt's in-depth analysis[1] and the release of a cracked version. In the blog post, 3xp0rt wrote an analysis of a Mars Stealer sample of an early version by exposing the different obfuscation methods and the data targeted by the malware on the infected hosts. A few days later, some members of the infosec community shared their findings on the builder and the administration panel of the information stealer. In recent days, some campaigns distributing Mars Stealer have been publicly described[2][3].

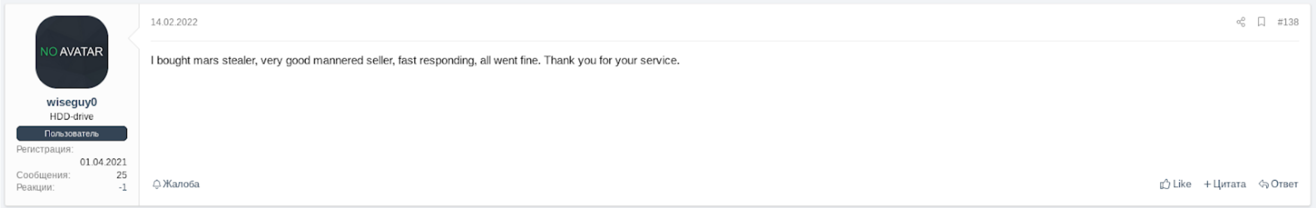
SEKOIA.IO analysts have been monitoring the threat on underground forums to be up-to-date on the latest developments. We have also recently carried out an in-depth analysis of samples of different versions of Mars Stealer, and noticed many changes in the obfuscation techniques.

Why investigate the Mars Stealer malware?

Information stealers are a threat to be considered, as many threat actors are using them to harvest credentials and other personal information. The stolen data can then be sold on underground forums and then possibly leveraged in “Big Game Hunting” operations, as the Lapsus$ threat group does[4].

Among these information stealers, Mars Stealer has become an emerging threat in recent months.

First of all, the malware is widely advertised on numerous underground forums and the publications reach a large audience. Furthermore, users of Mars Stealer usually give good feedback and do not hesitate to recommend it when forum members are looking for an information stealer. The Mars Stealer malware therefore appeared in our Dark Web monitoring during the second half of 2021.

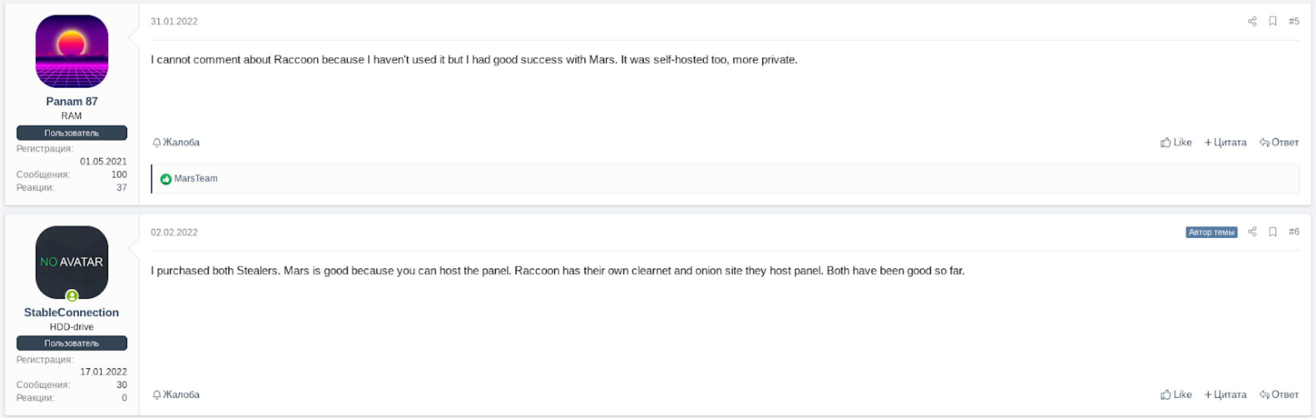


wiseguy0
HDD-drive
Пользователь
Регистрация: 01.04.2021
Сообщения: 25
Реакции: -1

14.02.2022 #138

I bought mars stealer, very good mannered seller, fast responding, all went fine. Thank you for your service.

Figure 1. Positive feedback on the Mars Stealer software and service on the XSS forum



Panam 87
RAM
Пользователь
Регистрация: 01.05.2021
Сообщения: 100
Реакции: 37

31.01.2022 #5

I cannot comment about Raccoon because I haven't used it but I had good success with Mars. It was self-hosted too, more private.

MarsTeam

StableConnection
HDD-drive
Пользователь
Регистрация: 17.01.2022
Сообщения: 30
Реакции: 0

02.02.2022 Автор темы #6

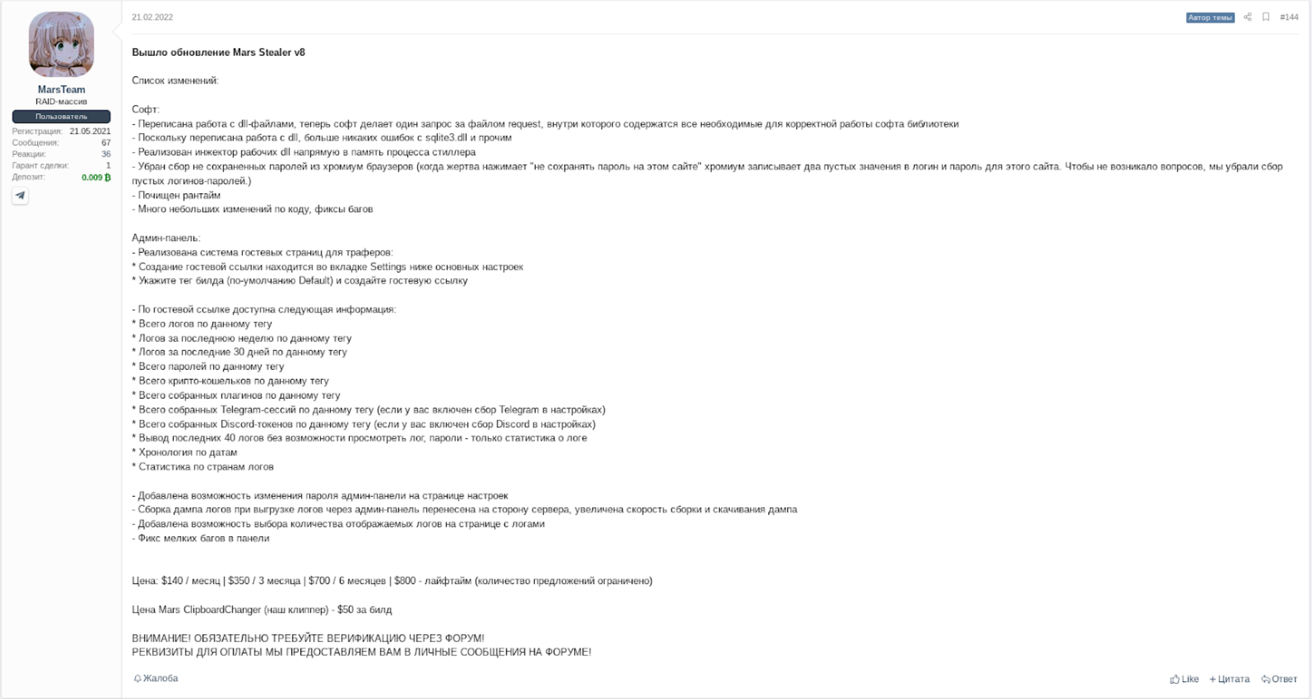
I purchased both Stealers. Mars is good because you can host the panel. Raccoon has their own clearnet and onion site they host panel. Both have been good so far.

Figure 2. Users’ comments advising Mars Stealer on the XSS publication named “Raccoon or Mars Stealer”

Dynamic of ransomware activity in Q1 2022

Download

It is worth noting that Mars Stealer is under continuous development and the project is professionally maintained, which makes it attractive and trustworthy to potential clients. Indeed, the presumed developers (*MarsTeam*) regularly collect user feedback on posts on the underground forums, on the Telegram support channel or on Jabber. *MarsTeam* then takes this feedback into account to make improvements, new features or bug fixes. New versions are regularly released and accompanied by a changelog to list the notable changes made to the Mars Stealer agent and also the panel.



MarsTeam
RAID-массив
Пользователь
Регистрация: 21.05.2021
Сообщения: 67
Реакции: 36
Гарант сделки: 1
Депозит: 0.009 ₿

21.02.2022

Вышло обновление Mars Stealer v8

Список изменений:

Софт:
- Переписана работа с dll-файлами, теперь софт делает один запрос за файлом request, внутри которого содержатся все необходимые для корректной работы софта библиотеки
- Поскольку переписана работа с dll, больше никаких ошибок с sqlite3.dll и прочим
- Реализован инжектор рабочих dll напрямую в память процесса стиллера
- Убран сбор не сохраненных паролей из хромиум браузеров (когда жертва нажимает "не сохранять пароль на этом сайте" хромиум записывает два пустых значения в логин и пароль для этого сайта. Чтобы не возникало вопросов, мы убрали сбор пустых логинов-паролей.)
- Почищен рантайм
- Много небольших изменений по коду, фиксы багов

Админ-панель:
- Реализована система гостевых страниц для траферов:
* Создание гостевой ссылки находится во вкладке Settings ниже основных настроек
* Укажите тег билда (по-умолчанию Default) и создайте гостевую ссылку

- По гостевой ссылке доступна следующая информация:
* Всего логов по данному тегу
* Логов за последнюю неделю по данному тегу
* Логов за последние 30 дней по данному тегу
* Всего паролей по данному тегу
* Всего крипто-кошельков по данному тегу
* Всего собранных плагинов по данному тегу
* Всего собранных Telegram-сессий по данному тегу (если у вас включен сбор Telegram в настройках)
* Всего собранных Discord-токенов по данному тегу (если у вас включен сбор Discord в настройках)
* Вывод последних 40 логов без возможности просмотреть лог, пароли - только статистика о логе
* Хронология по датам
* Статистика по странам логов

- Добавлена возможность изменения пароля админ-панели на странице настроек
- Сборка дампа логов при выгрузке логов через админ-панель перенесена на сторону сервера, увеличена скорость сборки и скачивания дампа
- Добавлена возможность выбора количества отображаемых логов на странице с логами
- Фикс мелких багов в панели

Цена: $140 / месяц | $350 / 3 месяца | $700 / 6 месяцев | $800 - лайфтайм (количество предложений ограничено)

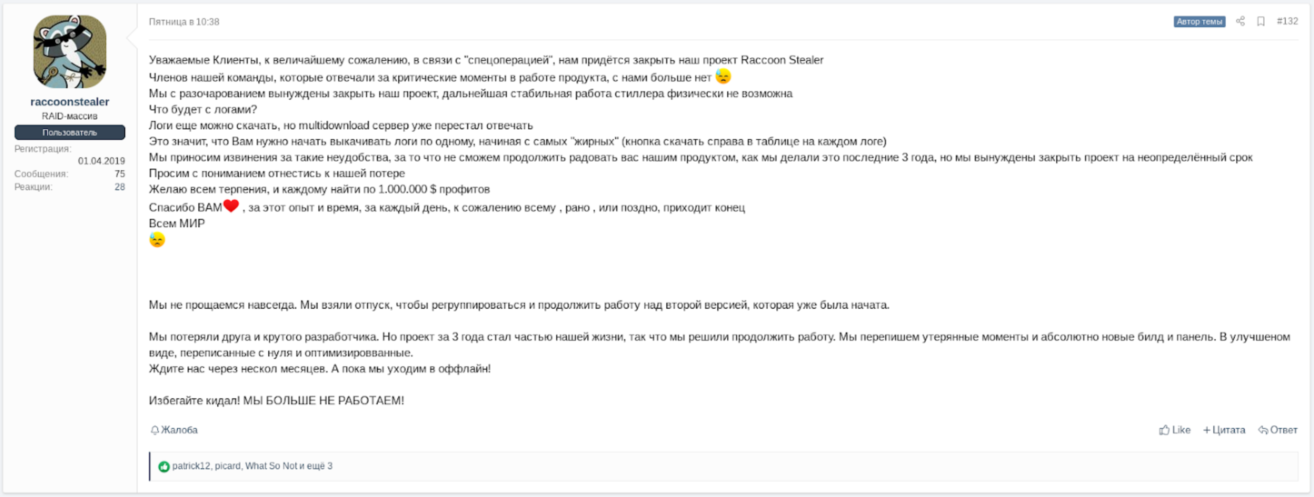
Цена Mars ClipboardChanger (наш клиппер) - $50 за билд

ВНИМАНИЕ! ОБЯЗАТЕЛЬНО ТРЕБУЙТЕ ВЕРИФИКАЦИЮ ЧЕРЕЗ ФОРУМ!
РЕКВИЗИТЫ ДЛЯ ОПЛАТЫ МЫ ПРЕДОСТАВЛЯЕМ ВАМ В ЛИЧНЫЕ СООБЩЕНИЯ НА ФОРУМЕ!

Figure 3. Changelog of the Mars Stealer version 8 published on the XSS forum

Furthermore, the malware appeared in OSINT reports in early 2022, especially with the great 3xp0rt’s in-depth analysis. Since then, its occurrence has increased in the infosec community because of the publication of its builder and above all, some campaigns distributing Mars Stealer have been brought to light in the Cyber Threat Intelligence sphere.

Last, the abrupt shutdown of Raccoon Stealer operations, which is one of the most widespread stealers, leaves a significant part of the market for the information stealers. Indeed, on March 25, 2022, the profile *raccoonstealer* announced on the Russian-speaking underground forum XSS that the group operating Raccoon Stealer closed the project for an undetermined period of time. This unexpected shutdown is due to the loss of a developer of the project Raccoon Stealer during the “special operation”, in reference to the Russian war in Ukraine.



raccoonstealer
RAID-массив
Пользователь
Регистрация: 01.04.2019
Сообщения: 75
Реакции: 28

Пятница в 10:38

Уважаемые Клиенты, к величайшему сожалению, в связи с "спецоперацией", нам придётся закрыть наш проект Raccoon Stealer
Членов нашей команды, которые отвечали за критические моменты в работе продукта, с нами больше нет 😓
Мы с разочарованием вынуждены закрыть наш проект, дальнейшая стабильная работа стиллера физически не возможна
Что будет с логами?
Логи еще можно скачать, но multidownload сервер уже перестал отвечать
Это значит, что Вам нужно начать выкачивать логи по одному, начиная с самых "жирных" (кнопка скачать справа в таблице на каждом логе)
Мы приносим извинения за такие неудобства, за то что не сможем продолжить радовать вас нашим продуктом, как мы делали это последние 3 года, но мы вынуждены закрыть проект на неопределённый срок
Просим с пониманием отнестись к нашей потере
Желаю всем терпения, и каждому найти по 1.000.000 $ профитов
Спасибо ВАМ❤️ , за этот опыт и время, за каждый день, к сожалению всему , рано , или поздно, приходит конец
Всем МИР
😓

Мы не прощаемся навсегда. Мы взяли отпуск, чтобы регруппироваться и продолжить работу над второй версией, которая уже была начата.

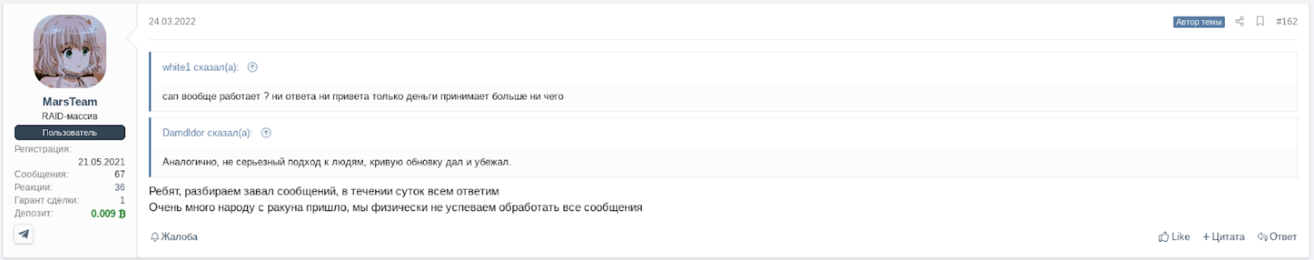
Мы потеряли друга и крутого разработчика. Но проект за 3 года стал частью нашей жизни, так что мы решили продолжить работу. Мы перепишем утерянные моменты и абсолютно новые билд и панель. В улучшеном виде, переписанные с нуля и оптимизированные.
Ждите нас через нескол месяцев. А пока мы уходим в оффлайн!

Избегайте кидал! МЫ БОЛЬШЕ НЕ РАБОТАЕМ!

patrick12, picard, What So Not и ещё 3

Figure 4. Raccoonstealer's statement on the shutdown of the Raccoon Stealer project on the XSS forum

A publication of *MarsTeam* on the XSS forum fully confirmed this hypothesis. On March 24, 2022, *MarsTeam* responded to two potential clients:
"*Guys, deal with the message backlog, will reply to all within 24 hours. A lot of people came from Raccoon. We do not have time to process all messages physically.*"" (translated from Russian)



MarsTeam
RAID-массив
Пользователь
Регистрация: 21.05.2021
Сообщения: 67
Реакции: 36
Гарант сделки: 1
Депозит: 0.009 Ƀ

24.03.2022

white1 сказал(а):
сап вообще работает ? ни ответа ни привета только деньги принимает больше ни чего

Damdldor сказал(а):
Аналогично, не серьезный подход к людям, кривую обновку дал и убежал.

Ребят, разбираем завал сообщений, в течении суток всем ответим
Очень много народу с ракуна пришло, мы физически не успеваем обработать все сообщения

Figure 5. MarsTeam mentioning a wave of clients coming from Raccoon on the XSS forum

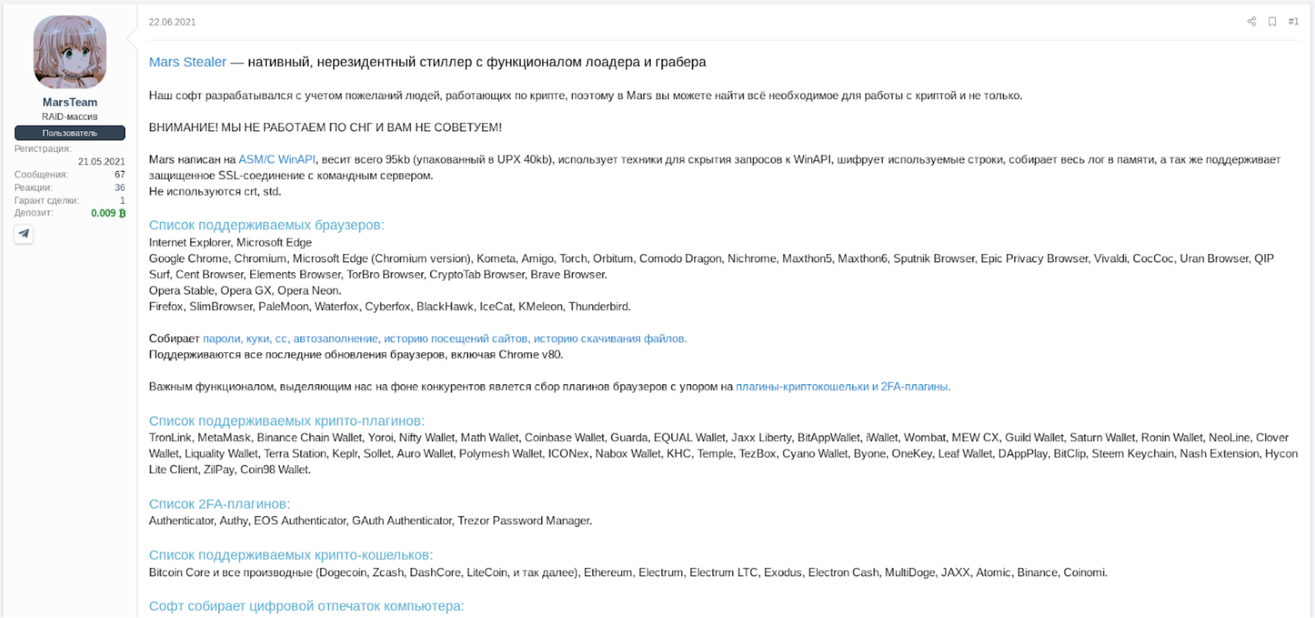
For all of the above reasons it seems relevant to us to monitor the Mars Stealer threat, to stay-up-to-date on the development of the malware and to track Indicators of Compromise (IoCs) to detect Mars Stealer. These two points are the subject of the next parts.

A journey with the malware developers

In this part, we analyze the publications and the activities of the presumed Mars Stealer developers (*MarsTeam*) on underground forums. According to our Dark Web monitoring, *MarsTeam* is active on numerous underground forums including XSS.is, lolz.guru and bhf.io. However, we focus on the XSS forum as *MarsTeam* publishes first, and more frequently on this one.

On May 21, 2021, the Mars Stealer team joined the XSS underground forum under the name *MarsTeam* with a deposit of 0.009 Bitcoin ($336 at May 2021 exchange rate). One month later, *MarsTeam* opened a new discussion whose title translated from Russian is "Mars

Stealer – a native, non-resident stealer with loader and stealer functionality”.



Mars Stealer — нативный, нерезидентный стиллер с функционалом лоадера и грабера

Наш софт разрабатывался с учетом пожеланий людей, работающих по крипте, поэтому в Mars вы можете найти всё необходимое для работы с криптой и не только.

ВНИМАНИЕ! МЫ НЕ РАБОТАЕМ ПО СНГ И ВАМ НЕ СОВЕТУЕМ!

Mars написан на ASM/C WinAPI, весит всего 95kb (упакованный в UPX 40kb), использует техники для скрытия запросов к WinAPI, шифрует используемые строки, собирает весь лог в памяти, а так же поддерживает защищенное SSL-соединение с командным сервером.
Не используются crt, std.

Список поддерживаемых браузеров:
Internet Explorer, Microsoft Edge
Google Chrome, Chromium, Microsoft Edge (Chromium version), Kometa, Amigo, Torch, Orbitum, Comodo Dragon, Nichrome, Maxthon5, Maxthon6, Sputnik Browser, Epic Privacy Browser, Vivaldi, CocCoc, Uran Browser, QIP Surf, Cent Browser, Elements Browser, TorBro Browser, CryptoTab Browser, Brave Browser.
Opera Stable, Opera GX, Opera Neon.
Firefox, SlimBrowser, PaleMoon, Waterfox, Cyberfox, BlackHawk, IceCat, KMeleon, Thunderbird.

Собирает пароли, куки, сс, автозаполнение, историю посещений сайтов, историю скачивания файлов.
Поддерживаются все последние обновления браузеров, включая Chrome v80.

Важным функционалом, выделяющим нас на фоне конкурентов является сбор плагинов браузеров с упором на плагины-криптокошельки и 2FA-плагины.

Список поддерживаемых крипто-плагинов:
TronLink, MetaMask, Binance Chain Wallet, Yoroi, Nifty Wallet, Math Wallet, Coinbase Wallet, Guarda, EQUAL Wallet, Jaxx Liberty, BitAppWallet, iWallet, Wombat, MEW CX, Guild Wallet, Saturn Wallet, Ronin Wallet, NeoLine, Clover Wallet, Liquality Wallet, Terra Station, Keplr, Sollet, Auro Wallet, Polymesh Wallet, ICONex, Nabox Wallet, KHC, Temple, TezBox, Cyano Wallet, Byone, OneKey, Leaf Wallet, DAppPlay, BitClip, Steem Keychain, Nash Extension, Hycon Lite Client, ZilPay, Coin98 Wallet.

Список 2FA-плагинов:
Authenticator, Authy, EOS Authenticator, GAuth Authenticator, Trezor Password Manager.

Список поддерживаемых крипто-кошельков:
Bitcoin Core и все производные (Dogecoin, Zcash, DashCore, LiteCoin, и так далее), Ethereum, Electrum, Electrum LTC, Exodus, Electron Cash, MultiDoge, JAXX, Atomic, Binance, Coinomi.

Софт собирает цифровой отпечаток компьютера:

Figure 6. First publication of MarsTeam advertising Mars Stealer

The publication introduces Mars Stealer as “*a new software developed for people working with crypto*” – to be interpreted: for people who want to steal cryptocurrencies. The malware is sold with the malware-as-a-service model for $140 per month.

Mars Stealer capabilities

As mentioned in the introduction, the Mars Stealer capabilities advertised by *MarsTeam* are those of a classic information stealer with a specific focus on cryptocurrency theft. Our technical analysis of Mars Stealer confirmed that the applications targeted by the malware samples are those described in the *MarsTeam* publications.

The stealer collects personal information from numerous browsers: passwords, cookies, credit cards, autofill data, history of websites visited and files downloaded. The list of supported browsers is quite wide, from the most popular (Google Chrome, Internet Explorer, Microsoft Edge, Firefox, *etc*.) to the less common. Mars Stealer collects this data in the default path of the different browser user data, or browser profiles.

The theft of cryptocurrencies is one of its distinguishing features, *MarsTeam* specifies that: “*Important feature that makes us stand out from competitors is the collection of browser plugins with an emphasis on cryptocurrency and 2FA plugins*” (translated from Russian). Indeed, the list of targeted crypto plugins is very long with more than 40 references, including the most used (Coinbase, MetaMask, Binance). The same goes for the list of crypto wallets and 2FA plugins targeted by the information stealer.

The malware also fingerprints the infected host to collect information about hardware, installed software and other personal information. Mars Stealer collects these data using WinAPI calls such as *GetSystemInfo*, *GetCurrentProcess* or by requesting the Windows Registry keys such as *HARDWARE\DESCRIPTION\System\CentralProcessor\0*, *SOFTWARE\Microsoft\Windows\CurrentVersion\Uninstall*.

Last but not least, Mars Stealer acts as a file grabber which is easily customizable by the operator. *MarsTeam* describes it as "*a powerful feature*" as the start path, file extension, file size and the recursive search can be set up. It also captures a screenshot of the victim's desktop, loads files on the infected machine and executes them with arguments.

High-quality service for malware operators

In addition to the stealing agent, Mars Stealer is sold with the administration panel and customer support. It is worth noting that the malware operator must host the Command & Control (C2) server and associated panel on its own server to access the stolen data. *MarsTeam* insists on the fact that all the traffic is available only for the customer and does not pass through a server of the Mars Stealer developers. This functionality is often requested by information stealer users who want to control and own all the data.

In the first *MarsTeam*'s publication, the Mars Stealer administration panel is described as "*a powerful data search functionality*" and the user experience seems to be a priority in the development of Mars Stealer. *MarsTeam* describes multiple capabilities of the panel on which the operator can easily manage, sort, filter, and remove the logs.

Moreover, the purchase of Mars Stealer includes a high-quality service including the support of all issues, the access to the customer chat and the new releases of the malware.

All the malware capabilities accompanied by a user-friendly interface and quality support make Mars Stealer very attractive and popular to attackers on underground markets.

Underground forum presence

The responsiveness of the Mars Stealer team on the underground forums sends a positive message to potential customers. *MarsTeam* is not only responsive to user requests, but also very active on several underground forums. Since the first communication on Mars Stealer in June 2021, *MarsTeam has regularly* published changelogs to announce new malware releases, as shown by the following figure. Special offers or teasing new features are also the subject of many of *MarsTeam*'s posts.

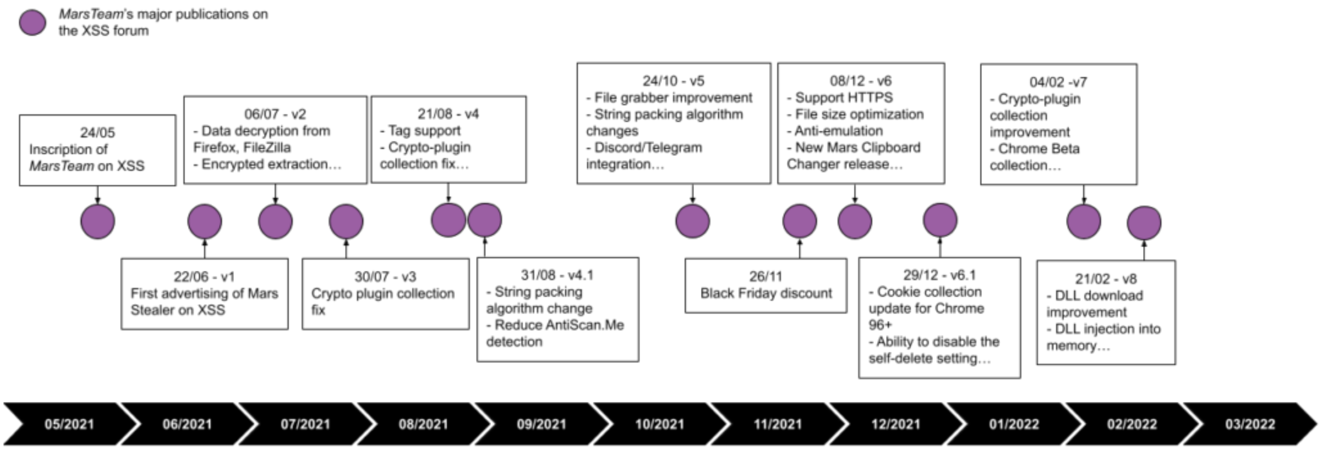

MarsTeam's major publications on the XSS forum
24/05
Inscription of MarsTeam on XSS
06/07 - v2
- Data decryption from Firefox, FileZilla
- Encrypted extraction…
21/08 - v4
- Tag support
- Crypto-plugin collection fix…
24/10 - v5
- File grabber improvement
- String packing algorithm changes
- Discord/Telegram integration…
08/12 - v6
- Support HTTPS
- File size optimization
- Anti-emulation
- New Mars Clipboard Changer release…
04/02 -v7
- Crypto-plugin collection improvement
- Chrome Beta collection…
22/06 - v1
First advertising of Mars Stealer on XSS
30/07 - v3
Crypto plugin collection fix
31/08 - v4.1
- String packing algorithm change
- Reduce AntiScan.Me detection
26/11
Black Friday discount
29/12 - v6.1
- Cookie collection update for Chrome 96+
- Ability to disable the self-delete setting…
21/02 - v8
- DLL download improvement
- DLL injection into memory…
05/2021
06/2021
07/2021
08/2021
09/2021
10/2021
11/2021
12/2021
01/2022
02/2022
03/2022

Figure 7. Timeline of MarsTeam's major publications on the XSS forum

Let us consider the releases of new Mars Stealer versions on the XSS forum. Most of these changelogs include new features, improvements, or bug fixes both on the agent and the administration panel. We noticed that the early versions did not have a version number. The official versioning started with version 4 released on August 21, 2021, so we approximately associated the first versions to *MarsTeam*'s early changelogs. Most of them are divided into two sections: on the software and the administration panel.

Software improvements are focused on the coverage of targeted applications by adding new browsers or new crypto plugins, as well as the upgrade of defense evasion techniques. For example, version 7 introduced the support of the Google Beta browser and numerous crypto plugins, which increased the number of collectable crypto plugins to 101. Version 6 brings new evasion methods for VM and antiviruses.

Improvements achieved on the web administration panel aim to facilitate the user experience by giving new possibilities of sorting, filtering and searching for stolen data. The Mars Stealer developer also optimized the performance related to the SQL database.

The analysis of the *MarsTeam*'s publications on different underground forums shows that the presumed Mars Stealer professionally works on software development, but also on communication and support. This conscientiousness seems to seduce the attackers who want to buy and use an information stealer well maintained and in continuous enhancement.

How to collect Mars Stealer IoCs?

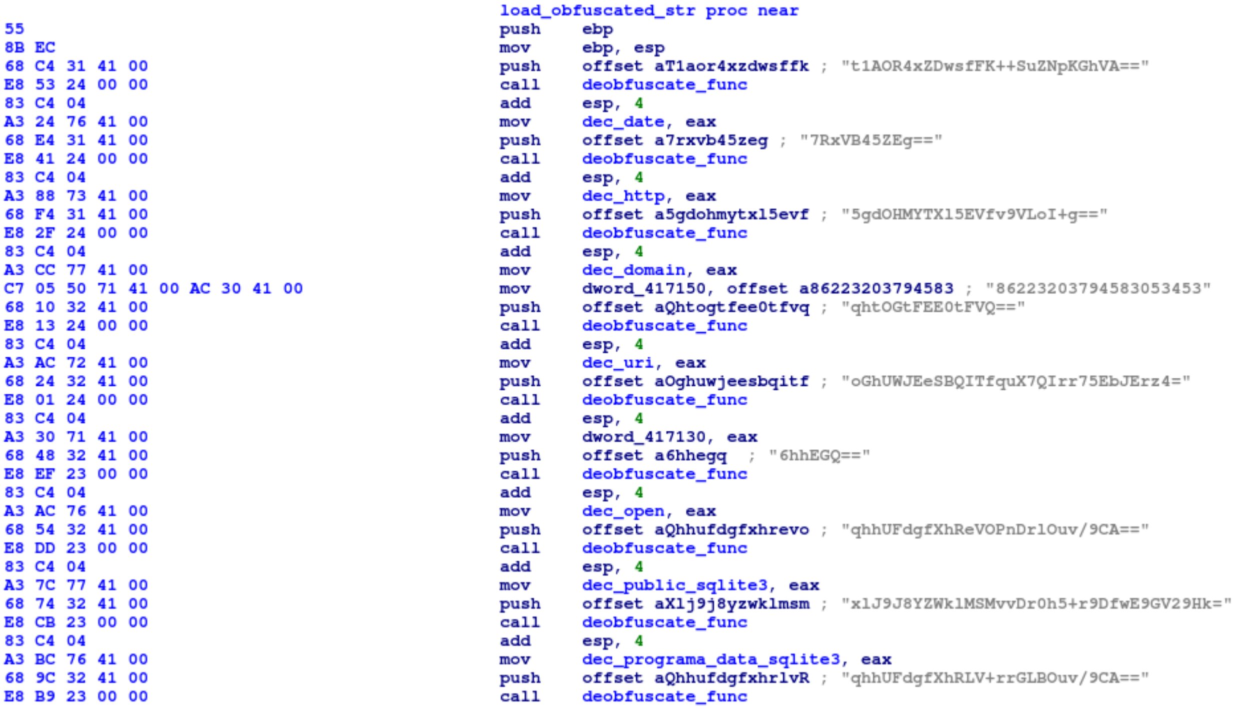
In the previous part, we showed how Mars Stealer has become an emerging threat and why we must be interested in it. In this part we see how to collect Mars Stealer IoCs based on YARA signatures, C2 server tracker and the automated extraction of the malware configuration. The last method requires a technical analysis of Mars Stealer and its versions which implement different obfuscation techniques. This in-depth analysis is the subject of the part named Mars Stealer objective C2.

Collecting Mars Stealer samples

Early versions

Before analyzing the different versions of the Mars Stealer malware, a first step consists of collecting the malware samples. We have therefore written a YARA rule based on the sample shared in the 3xp0rt analysis to identify other Mars Stealer samples.

A reliable method to detect samples of a malware family consists in searching for operation code (opcode) patterns used in the deobfuscation routine. In the early versions, the malware implemented a deobfuscation function which first decodes base64-encoded strings and then decrypts RC4-encrypted strings. This algorithm is applied on numerous obfuscated strings as shown in the following figure, which corresponds to the function loading obfuscated strings.



```
                                          load_obfuscated_str proc near
55                                        push    ebp
8B EC                                     mov     ebp, esp
68 C4 31 41 00                            push    offset aT1aor4xzdwsffk ; "t1AOR4xZDwsfFK++SuZNpKGhVA=="
E8 53 24 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 24 76 41 00                            mov     dec_date, eax
68 E4 31 41 00                            push    offset a7rxvb45zeg ; "7RxVB45ZEg=="
E8 41 24 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 88 73 41 00                            mov     dec_http, eax
68 F4 31 41 00                            push    offset a5gdohmytx15evf ; "5gdOHMYTX15EVfv9VLoI+g=="
E8 2F 24 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 CC 77 41 00                            mov     dec_domain, eax
C7 05 50 71 41 00 AC 30 41 00             mov     dword_417150, offset a86223203794583 ; "86223203794583053453"
68 10 32 41 00                            push    offset aQhtogtfee0tfvq ; "qhtOGtFEE0tFVQ=="
E8 13 24 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 AC 72 41 00                            mov     dec_uri, eax
68 24 32 41 00                            push    offset aOghuwjeesbqitf ; "oGhUWJEeSBQITfquX7QIrr75EbJErz4="
E8 01 24 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 30 71 41 00                            mov     dword_417130, eax
68 48 32 41 00                            push    offset a6hhegq  ; "6hhEGQ=="
E8 EF 23 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 AC 76 41 00                            mov     dec_open, eax
68 54 32 41 00                            push    offset aQhhufdgfxhrevo ; "qhhUFdgfXhReVOPnDr1Ouv/9CA=="
E8 DD 23 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 7C 77 41 00                            mov     dec_public_sqlite3, eax
68 74 32 41 00                            push    offset aXlj9j8yzwklmsm ; "xlJ9J8YZWklMSMvvDr0h5+r9DfwE9GV29Hk="
E8 CB 23 00 00                            call    deobfuscate_func
83 C4 04                                  add     esp, 4
A3 BC 76 41 00                            mov     dec_programa_data_sqlite3, eax
68 9C 32 41 00                            push    offset aQhhufdgfxhrlvR ; "qhhUFdgfXhRLV+rrGLBOuv/9CA=="
E8 B9 23 00 00                            call    deobfuscate_func
```

Figure 8. Function loading obfuscated strings in a Mars Stealer early version sample

Four instructions are repeated for each obfuscated data: *push*, *call, add* and *mov*. A YARA rule identifying this version of Mars Stealer can be written based on the repetition of these opcodes. Adding to the detection pattern some specific strings can fine-tune the rule in order to identify only Mars Stealer binaries. Here is a possible YARA rule to find Mars Stealer samples:

```
rule infostealer_win_mars_stealer_early_version {
    meta:
        description = "Identifies samples of Mars Stealer early version based on
opcodes of the function loading obfuscated strings."
        source = "SEKOIA.IO"
        reference = "https://blog.sekoia.io/mars-a-red-hot-information-stealer/"
        classification = "TLP:WHITE"
        hash = "7da3029263bfbb0699119a715ce22a3941cf8100428fd43c9e1e46bf436ca687"

    strings:
        $dec = {a3 ?? ?? ?? ?? 68 ?? ?? ?? ?? e8 ?? ?? 00 00 83 c4 ??}

        $api00 = "LoadLibrary" ascii
        $api01 = "GetProcAddress" ascii
        $api02 = "ExitProcess" ascii
        $api03 = "advapi32.dll" ascii
        $api04 = "crypt32.dll" ascii
        $api05 = "GetTickCount" ascii
        $api06 = "Sleep" ascii
        $api07 = "GetUserDefaultLangID" ascii
        $api08 = "CreateMutex" ascii
        $api09 = "GetLastError" ascii
        $api10 = "HeapAlloc" ascii
        $api11 = "GetProcessHeap" ascii
        $api12 = "GetComputerName" ascii
        $api13 = "VirtualProtect" ascii
        $api14 = "GetUserName" ascii
        $api15 = "CryptStringToBinary" ascii

        $str0 = "JohnDoe" ascii

    condition:
        uint16(0)==0x5A4D and
        #dec > 400 and 12 of ($api*) and $str0
}
```

Figure 9. YARA rule identifying Mars Stealer early version samples

We shared the rule on sample sharing platforms and collected several results from this YARA rule. As expected from our Dark Web monitoring, we observed different Mars Stealer versions based on their deobfuscation routine among our collected samples. We also noticed several samples for which a new PE section name appeared: *LLCPPC*. More details on the different versions can be found in the following technical analysis.

LLCPPC versions

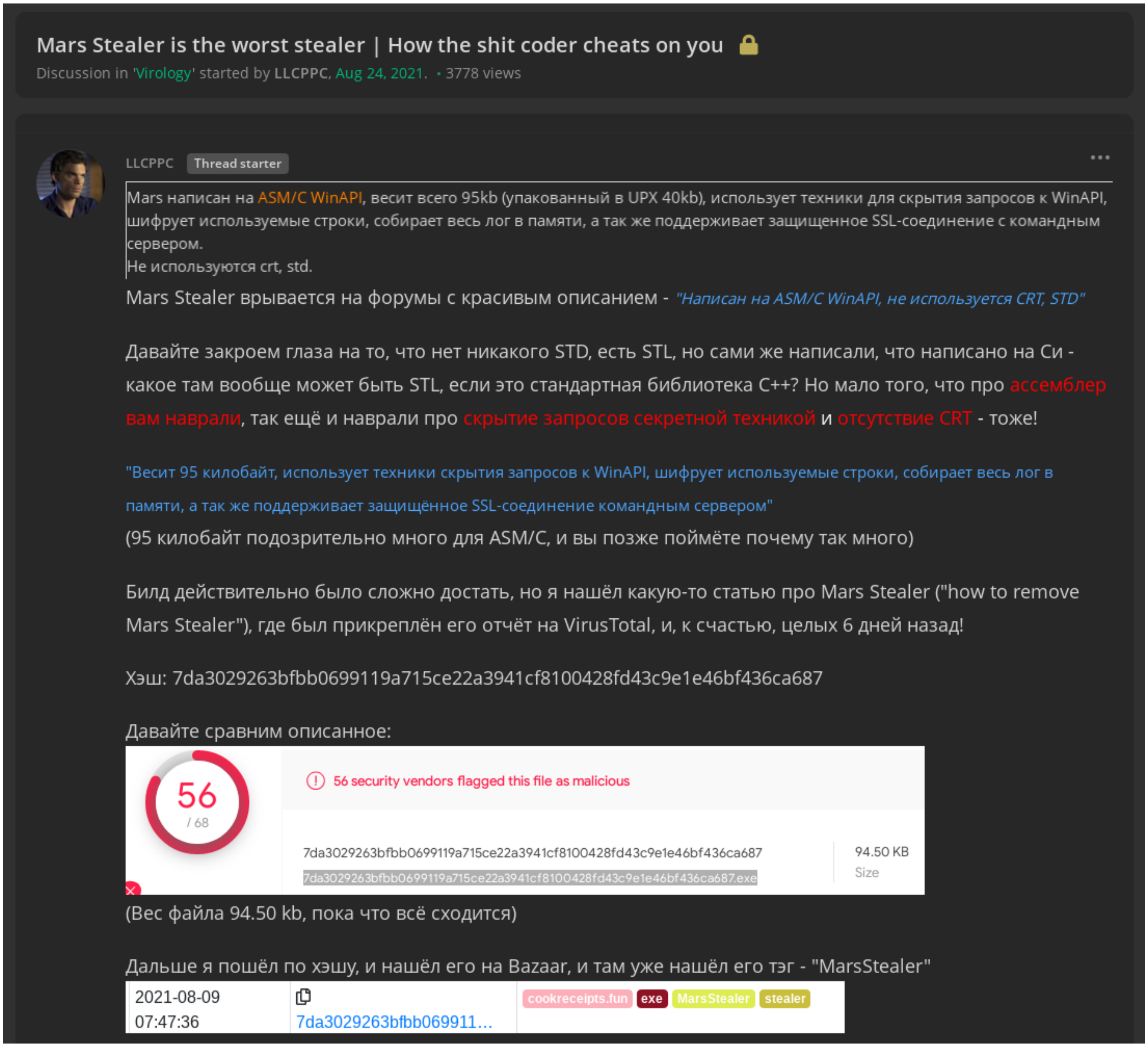
The PE section name *LLCPPC* is a highly discriminating factor of the Mars Stealer malware. We can therefore easily identify Mars Stealer samples using this characteristic in a YARA rule using the PE module:

```
import "pe"

rule infostealer_win_mars_stealer_llcppc {
    meta:
        description = "Identifies samples of Mars Stealer based on the PE section
name LLCPPC."
        source = "SEKOIA.IO"
        reference = "https://blog.sekoia.io/mars-a-red-hot-information-stealer/"
        classification = "TLP:WHITE"
        hash = "fd92fe8a4534bc6e14e177fee38a13f771a091fa6c7171fcee2791c58fbecf40"

    condition:
        uint16(0)==0x5A4D and
        for any i in ( 0..pe.number_of_sections-1 ): (
                pe.sections[i].name == "LLCPPC" and pe.sections[i].raw_data_size <
5000 )
}
```

Figure 10. YARA rule identifying Mars Stealer samples based on the PE section name

For information, *LLCPPC* is a profile on the underground forum lolz.guru that reverses engineer some popular malware (Redline, Mars Stealer, DCRat, X-FILES and SHurkSteal) in order to debunk the misleading information used to advertise the product.

The developer of Mars Stealer probably named the PE section of the malware to rag *LLCPPC* after the analysis of the malware which revealed untruths in the malware’s advertisement. On August 24, 2021, *LLCPPC* published a technical analysis of a Mars Stealer sample with the title “*Mars Stealer is the worst stealer | How the shit coder cheats on you*”.



Mars Stealer is the worst stealer | How the shit coder cheats on you

Discussion in 'Virology' started by LLCPPC, Aug 24, 2021. • 3778 views

LLCPPC Thread starter

> Mars написан на ASM/C WinAPI, весит всего 95kb (упакованный в UPX 40kb), использует техники для скрытия запросов к WinAPI, шифрует используемые строки, собирает весь лог в памяти, а так же поддерживает защищенное SSL-соединение с командным сервером.
> Не используются crt, std.

Mars Stealer врывается на форумы с красивым описанием - *"Написан на ASM/C WinAPI, не используется CRT, STD"*

Давайте закроем глаза на то, что нет никакого STD, есть STL, но сами же написали, что написано на Си - какое там вообще может быть STL, если это стандартная библиотека C++? Но мало того, что про ассемблер вам наврали, так ещё и наврали про скрытие запросов секретной техникой и отсутствие CRT - тоже!

"Весит 95 килобайт, использует техники скрытия запросов к WinAPI, шифрует используемые строки, собирает весь лог в памяти, а так же поддерживает защищённое SSL-соединение командным сервером"

(95 килобайт подозрительно много для ASM/C, и вы позже поймёте почему так много)

Билд действительно было сложно достать, но я нашёл какую-то статью про Mars Stealer ("how to remove Mars Stealer"), где был прикреплён его отчёт на VirusTotal, и, к счастью, целых 6 дней назад!

Хэш: 7da3029263bfbb0699119a715ce22a3941cf8100428fd43c9e1e46bf436ca687

Давайте сравним описанное:

56 / 68

56 security vendors flagged this file as malicious

7da3029263bfbb0699119a715ce22a3941cf8100428fd43c9e1e46bf436ca687
7da3029263bfbb0699119a715ce22a3941cf8100428fd43c9e1e46bf436ca687.exe

94.50 KB
Size

(Вес файла 94.50 kb, пока что всё сходится)

Дальше я пошёл по хэшу, и нашёл его на Bazaar, и там уже нашёл его тэг - "MarsStealer"

2021-08-09 07:47:36	7da3029263bfbb069911…	cookreceipts.fun exe MarsStealer stealer

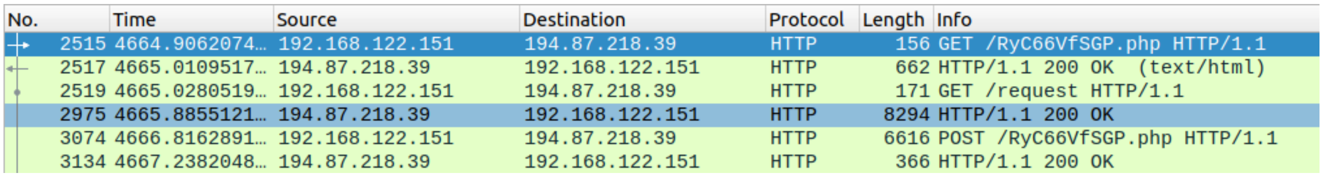
Figure 11. LLCPPC's publication debunking a Mars Stealer sample on the lolz.guru forum

In this analysis, *LLCPPC* concludes that only encryption and the secure import address table are the pros of Mars Stealer while the list of cons is much longer. Among them, *LLCPPC* raised the non-optimized code, the lack of debugging and virtualization evasion, the absence of multithreading, etc. As shown by the previous figure, *LLCPPC* also mentioned that the Mars Stealer sample is well detected by VirusTotal and Any.Run analysis, unlike *MarsTeam* stated.

Latest version (version 8)

The LLCPPC section disappeared in the latest version of Mars Stealer, which corresponds to version 8 according to the *MarsTeam* releases on XSS. Indeed, samples of the latest Mars Stealer version only send one request to retrieve the DLLs (*freebl3.dll*, *mozglue.dll*, *msvcp140.dll*, *nss3.dll*, *softokn3.dll*, *sqlite3.dll* and *vcruntime140.dll*). These files are linked to legitimate third-party DLLs allowing Mars Stealer to collect data from the infected host. As written by *MarsTeam* in the version 8 release notes "*now the software makes one request after the request file, which contains all necessary libraries for correct work of the software*" (translated from Russian), it therefore corresponds to version 8 samples.

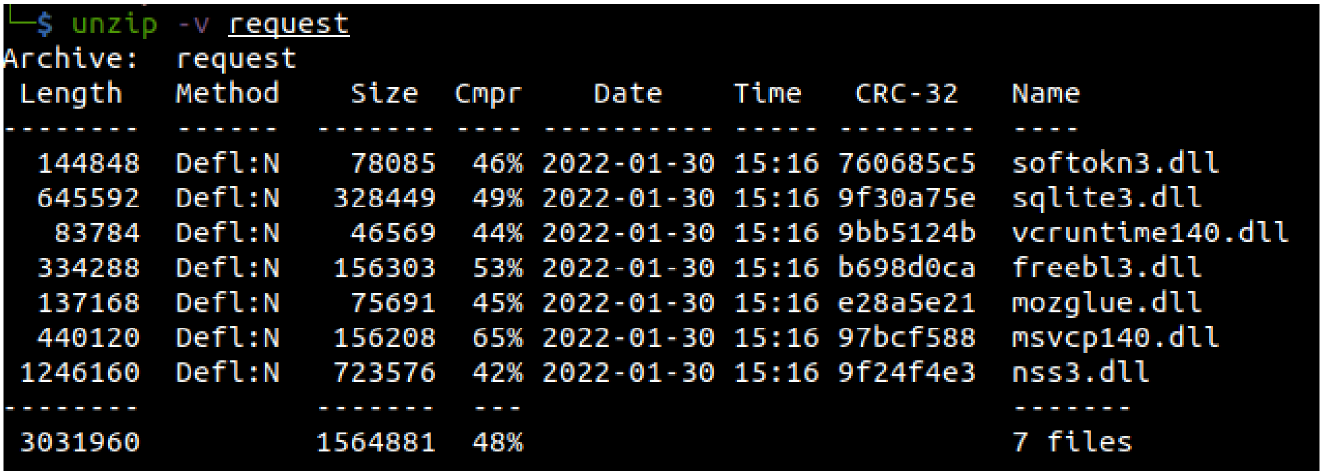
Communication with the C2 server is performed over HTTP, and since version 6, the stealer can use HTTPS.



No.	Time	Source	Destination	Protocol	Length	Info
2515	4664.9062074…	192.168.122.151	194.87.218.39	HTTP	156	GET /RyC66VfSGP.php HTTP/1.1
2517	4665.0109517…	194.87.218.39	192.168.122.151	HTTP	662	HTTP/1.1 200 OK (text/html)
2519	4665.0280519…	192.168.122.151	194.87.218.39	HTTP	171	GET /request HTTP/1.1
2975	4665.8855121…	194.87.218.39	192.168.122.151	HTTP	8294	HTTP/1.1 200 OK
3074	4666.8162891…	192.168.122.151	194.87.218.39	HTTP	6616	POST /RyC66VfSGP.php HTTP/1.1
3134	4667.2382048…	194.87.218.39	192.168.122.151	HTTP	366	HTTP/1.1 200 OK

Figure 12: HTTP communication with the C2 server

1. Implant sends a GET request to the C2 URL to grab its configuration.
2. Implant fetches all DLLs on the "*/request*" endpoint, the libraries are zipped (*c.f.* figure 13).
3. Stolen data are posted to the C2 on the same URL used in step (1).



```
└─$ unzip -v request
Archive:  request
 Length   Method    Size  Cmpr    Date    Time   CRC-32   Name
--------  ------  ------- ---- ---------- ----- --------  ----
  144848  Defl:N    78085  46% 2022-01-30 15:16 760685c5  softokn3.dll
  645592  Defl:N   328449  49% 2022-01-30 15:16 9f30a75e  sqlite3.dll
   83784  Defl:N    46569  44% 2022-01-30 15:16 9bb5124b  vcruntime140.dll
  334288  Defl:N   156303  53% 2022-01-30 15:16 b698d0ca  freebl3.dll
  137168  Defl:N    75691  45% 2022-01-30 15:16 e28a5e21  mozglue.dll
  440120  Defl:N   156208  65% 2022-01-30 15:16 97bcf588  msvcp140.dll
 1246160  Defl:N   723576  42% 2022-01-30 15:16 9f24f4e3  nss3.dll
--------          -------  ---                            -------
 3031960          1564881  48%                            7 files
```

Figure 13: HTTP response on /request that contains all DLLs zipped

To identify and collect these samples, we can again write a YARA rule based on the string deobfuscation routine since the discriminating section name is no longer used. From our technical analysis, we identify the deobfuscation routine based on XOR keys, which is further detailed in the "Mars Stealer objective C2" section. The algorithm consists in xoring each obfuscated string and its corresponding key.

Our resulting YARA rule is:

```
rule infostealer_win_mars_stealer_xor_routine {
    meta:
        description = "Identifies samples of Mars Stealer based on the XOR
deobfuscation routine."
        source = "SEKOIA.IO"
        reference = "https://blog.sekoia.io/mars-a-red-hot-information-stealer/"
        classification = "TLP:WHITE"
        hash = "4bcff4386ce8fadce358ef0dbe90f8d5aa7b4c7aec93fca2e605ca2cbc52218b"

    strings:
        $xor = {8b 4d ?? 03 4d ?? 0f be 19 8b 55 ?? 52 e8 ?? ?? ?? ?? 83 c4 ?? 8b c8
8b 45 ?? 33 d2 f7 f1 8b 45 ?? 0f be 0c 10 33 d9 8b 55 ?? 03 55 ?? 88 1a eb be}
    condition:
        uint16(0)==0x5A4D and $xor
}
```

Figure 14. YARA rule identifying the XOR routine implemented by Mars Stealer

To conclude this section, we would like to mention another rather classical but very efficient method to collect and classify the malware samples based on the PE creation time. Indeed, many unpacked Mars Stealer samples share identical PE creation dates, making them easy to identify on sample sharing platforms: “*2021-08-12T17:45:33*” and “*2022-01-05T14:09:08*”.

The Command & Control infrastructures of cyber attackers observed in 2021 by SEKOIA.IO

Download

Tracking Mars Stealer C2 servers

Tracking servers used to host malware C2 servers or more widely adversary infrastructures is a proactive hunting approach we have intensively developed at SEKOIA.IO[5]. Concerning the Mars Stealer malware, C2 servers are hosted by the attackers and not by the malware developer. This makes it more difficult or even impossible to identify a heuristic based on the HTTP response to find the malware C2 servers, as each attacker should configure its own HTTP server hosting the Mars Stealer administration panel.

However, a good and simple method to track the widely sold malware consists in finding servers hosting one of the characteristic web pages of the administration panel. By searching the hash of these specific web pages (JavaScript, PHP or HTML pages) on URL scanning platforms, we can identify the servers used by the malware to download payloads and exfiltrate the stolen information.

Concerning the Mars Stealer administration panel, we can track several pages which are specific to the malware panel. For example:

- *d8f09307b60c5bef5ceacfd8501bd3d91f1de9e5e746bb2d7def94d86789da50* and *304288329069ad8eaafce0f10a369101607c9248fbc9aaaa733c9e2dab5c467f* are specific to the Mars Stealer PHP login pages (*login.php*). The first hash corresponds to the login page of the version 8 of Mars Stealer, while the second corresponds to the login page of the version 7 and below. We were able to confirm these results from the leaked source code of the administration panel.
- *9faf0345bf0785854343b9303734c2f4d3adba818cb408dcc6e2384ccc8a7aa2* and *20e6bb3cf9d13f10bca7b7b5d1f4cb82146c274747e8c2ae7fe3307881f00829* are specific to CSS pages used by the Mars Stealer login page (*bootstrap.min.css*).

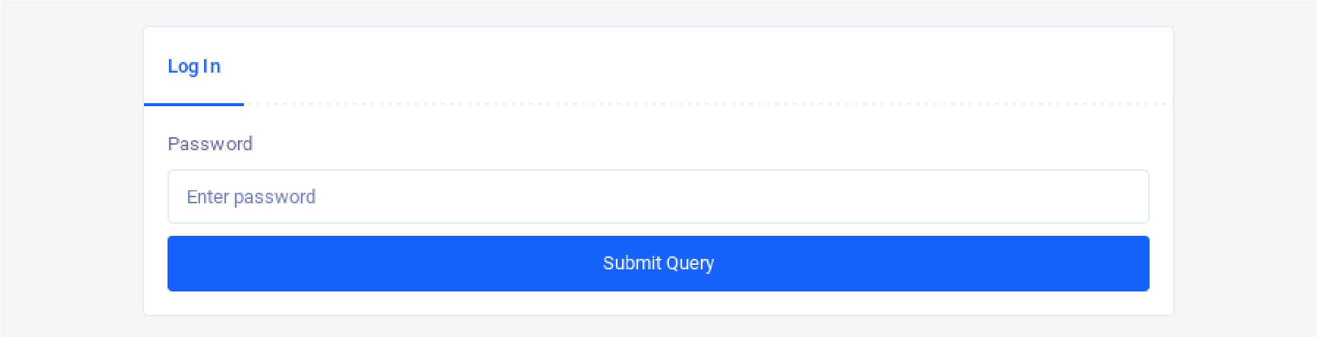
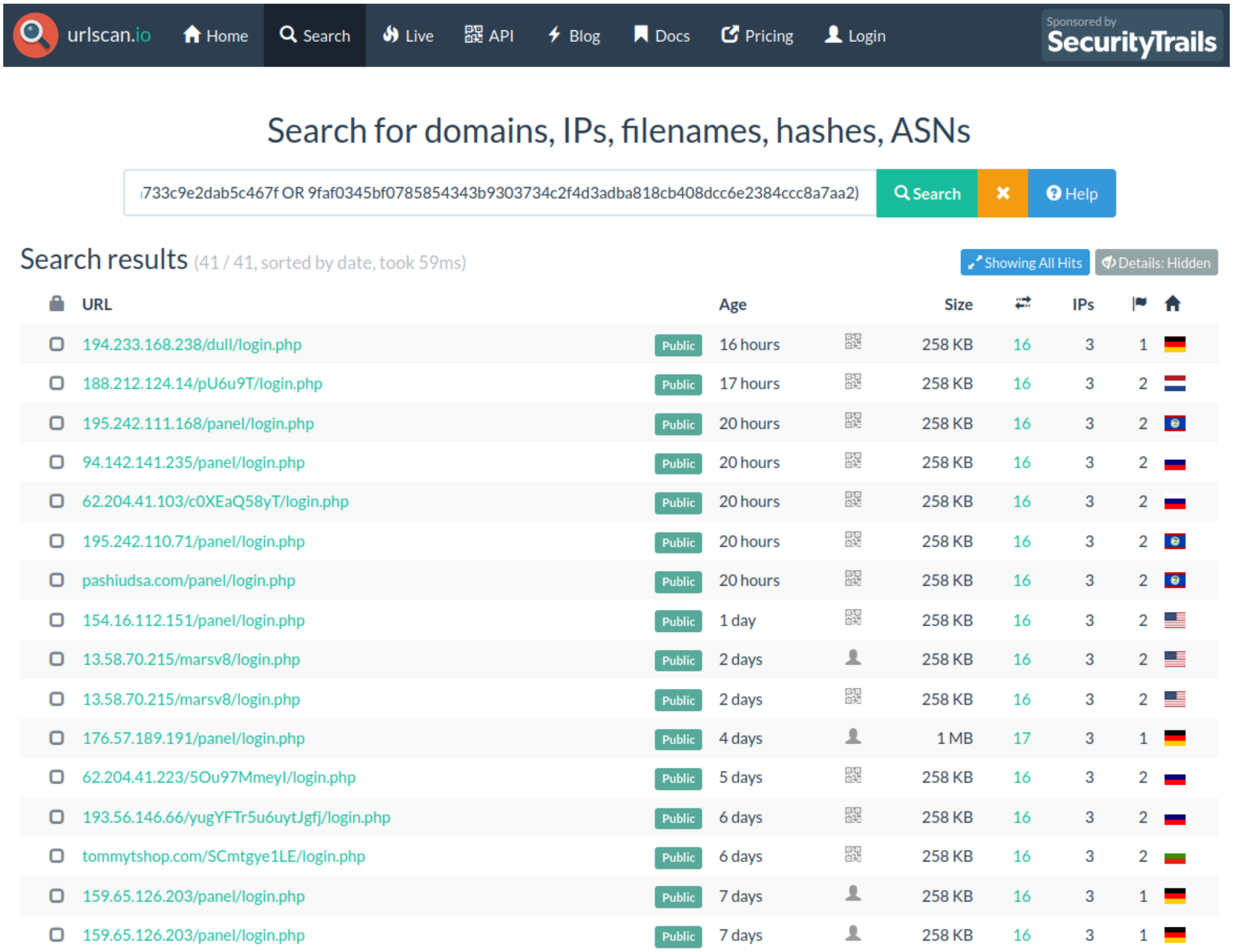


Figure 15. Login page of the Mars Stealer administration panel

From this information, we can write a heuristic on urlscan.io[6] (or other similar services) like:

```
hash:(20e6bb3cf9d13f10bca7b7b5d1f4cb82146c274747e8c2ae7fe3307881f00829 OR
304288329069ad8eaafce0f10a369101607c9248fbc9aaaa733c9e2dab5c467f OR
9faf0345bf0785854343b9303734c2f4d3adba818cb408dcc6e2384ccc8a7aa2 OR
d8f09307b60c5bef5ceacfd8501bd3d91f1de9e5e746bb2d7def94d86789da50)
```

On April 7, 2022, this query resulted in 43 URLs which hosted a Mars Stealer administration panel.



Search for domains, IPs, filenames, hashes, ASNs

ı733c9e2dab5c467f OR 9faf0345bf0785854343b9303734c2f4d3adba818cb408dcc6e2384ccc8a7aa2)

Search results (41 / 41, sorted by date, took 59ms)

🔒	URL		Age		Size	⇄	IPs	⚑	⌂
□	194.233.168.238/dull/login.php	Public	16 hours	▦	258 KB	16	3	1	🇩🇪
□	188.212.124.14/pU6u9T/login.php	Public	17 hours	▦	258 KB	16	3	2	🇳🇱
□	195.242.111.168/panel/login.php	Public	20 hours	▦	258 KB	16	3	2	🇧🇿
□	94.142.141.235/panel/login.php	Public	20 hours	▦	258 KB	16	3	2	🇷🇺
□	62.204.41.103/c0XEaQ58yT/login.php	Public	20 hours	▦	258 KB	16	3	2	🇷🇺
□	195.242.110.71/panel/login.php	Public	20 hours	▦	258 KB	16	3	2	🇧🇿
□	pashiudsa.com/panel/login.php	Public	20 hours	▦	258 KB	16	3	2	🇧🇿
□	154.16.112.151/panel/login.php	Public	1 day	▦	258 KB	16	3	2	🇺🇸
□	13.58.70.215/marsv8/login.php	Public	2 days	👤	258 KB	16	3	2	🇺🇸
□	13.58.70.215/marsv8/login.php	Public	2 days	▦	258 KB	16	3	2	🇺🇸
□	176.57.189.191/panel/login.php	Public	4 days	👤	1 MB	17	3	1	🇩🇪
□	62.204.41.223/5Ou97MmeyI/login.php	Public	5 days	▦	258 KB	16	3	2	🇷🇺
□	193.56.146.66/yugYFTr5u6uytJgfj/login.php	Public	6 days	▦	258 KB	16	3	2	🇷🇺
□	tommytshop.com/SCmtgye1LE/login.php	Public	6 days	▦	258 KB	16	3	2	🇧🇬
□	159.65.126.203/panel/login.php	Public	7 days	👤	258 KB	16	3	1	🇩🇪
□	159.65.126.203/panel/login.php	Public	7 days	👤	258 KB	16	3	1	🇩🇪

Figure 16. Urlscan.io results on the heuristic identifying Mars Stealer login pages

This method is based on URL submissions and, unfortunately, is not as proactive as heuristics based on the HTTP response. But it has the merit of collecting network IoCs (domain names or IP addresses) over time. Moreover, the webpages of the malware administration panel rarely changes, unlike the source code of the agent. It is therefore a good way to track a malware family over time and then pivot to new samples that might not be detected by our YARA rules.

Another way of tracking Mars Stealer C2 servers is to pivot on the file *request* (*3de1fb0d1108907fd61d6d6b9a4c6b856af509e0af35578f158cfce5d634fe07*) which is the archive containing the legitimate DLLs. All Mars Stealer samples of version 8 request this resource. For example, on VirusTotal, some C2 servers can be identified hosting the zip file and samples requesting it.

In conclusion, we are tracking the Mars Stealer threat by different means which allows us to collect network and system IoCs. Another technique we used to collect Mars Stealer C2 URLs consists of extracting them from the samples. The next part is focused on our in-depth analysis of several Mars Stealer versions, which allowed us to implement a configuration extractor.

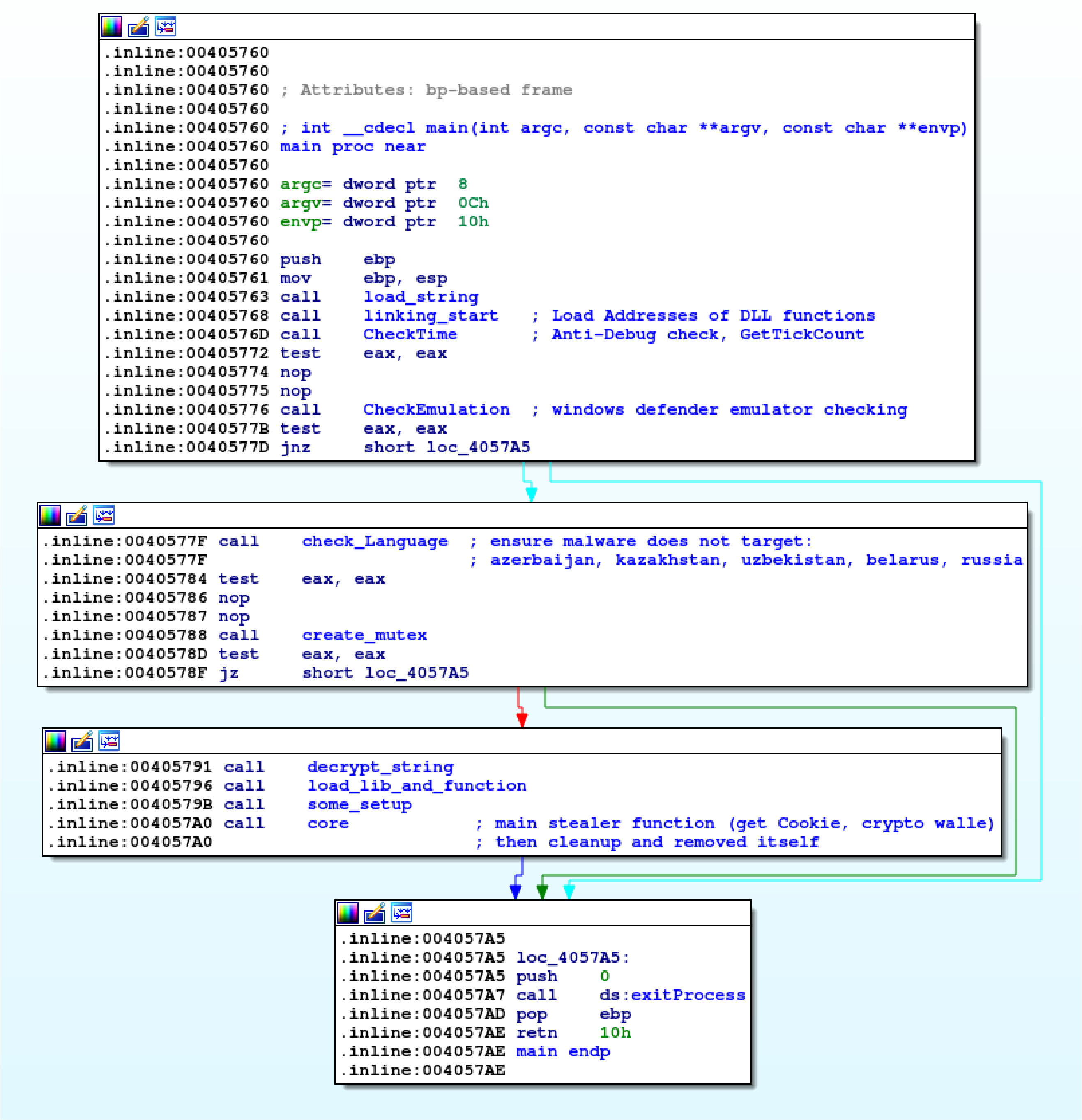
Mars Stealer objective C2

An in-depth analysis of this malware has been done by 3xp0rt, the article describes how the strings are loaded, the checks performed against the infected hosts (languages, anti-emulation, *e.g.*: *John Doe* & *HALT9*), the cookies and crypto wallets extraction, the C2 exfiltration and configuration grabbing. In our context, the analysis here is focused on the Command and Control configuration moreover, on how to automatically extract it. To answer this need, an analysis of the different versions of the malware and on how the C2 URL is deobfuscated and loaded in PE is required. From this analysis, we tried to identify the Mars Stealer releases based on the *MarsTeam* publications on XSS forum.

Mars Stealer main functionalities

The figure below briefly introduces what Mars Stealer core function looks like (for more details checks 3xp0rt in-depth analysis[1]), its main function could be split in 8 units described below:

1. Load static string: this function prepares the malware to load further libraries and functions and setup the decryption key;
2. Link basic function to setup malware functionalities for step 3 to 4 includes;
3. Anti-debugging / Anti-emulation:
    1. Check time
    2. Check Windows Defender sandbox
4. Decrypt all strings: this includes other libraries' function name, strings used by the stealer (e.g. SQL requests for cookies extraction);
5. Load all required functions and libraries (*sqlite3.dll*, *freebl3.dll*, *mozglue.dll*, etc…);
6. Steal cookies, crypto wallet, password, *etc…*;
7. Exfiltration stolen data over HTTP to its C2;
8. Removed itself via a *ShellExecuteExA* (`C:\Windows\System32\cmd.exe /c timeout /t 5 & del /f /q "%s" & exit`).



```
.inline:00405760
.inline:00405760
.inline:00405760 ; Attributes: bp-based frame
.inline:00405760
.inline:00405760 ; int __cdecl main(int argc, const char **argv, const char **envp)
.inline:00405760 main proc near
.inline:00405760
.inline:00405760 argc= dword ptr  8
.inline:00405760 argv= dword ptr  0Ch
.inline:00405760 envp= dword ptr  10h
.inline:00405760
.inline:00405760 push    ebp
.inline:00405761 mov     ebp, esp
.inline:00405763 call    load_string
.inline:00405768 call    linking_start    ; Load Addresses of DLL functions
.inline:0040576D call    CheckTime        ; Anti-Debug check, GetTickCount
.inline:00405772 test    eax, eax
.inline:00405774 nop
.inline:00405775 nop
.inline:00405776 call    CheckEmulation   ; windows defender emulator checking
.inline:0040577B test    eax, eax
.inline:0040577D jnz     short loc_4057A5
```

```
.inline:0040577F call    check_Language  ; ensure malware does not target:
.inline:0040577F                         ; azerbaijan, kazakhstan, uzbekistan, belarus, russia
.inline:00405784 test    eax, eax
.inline:00405786 nop
.inline:00405787 nop
.inline:00405788 call    create_mutex
.inline:0040578D test    eax, eax
.inline:0040578F jz      short loc_4057A5
```

```
.inline:00405791 call    decrypt_string
.inline:00405796 call    load_lib_and_function
.inline:0040579B call    some_setup
.inline:004057A0 call    core            ; main stealer function (get Cookie, crypto walle)
.inline:004057A0                         ; then cleanup and removed itself
```

```
.inline:004057A5
.inline:004057A5 loc_4057A5:
.inline:004057A5 push    0
.inline:004057A7 call    ds:exitProcess
.inline:004057AD pop     ebp
.inline:004057AE retn    10h
.inline:004057AE main endp
.inline:004057AE
```

Figure 17. Mars Stealer core function

SIGMA, design and MITRE ATT&CK… new features of the XDR and CTI platform

Read the article

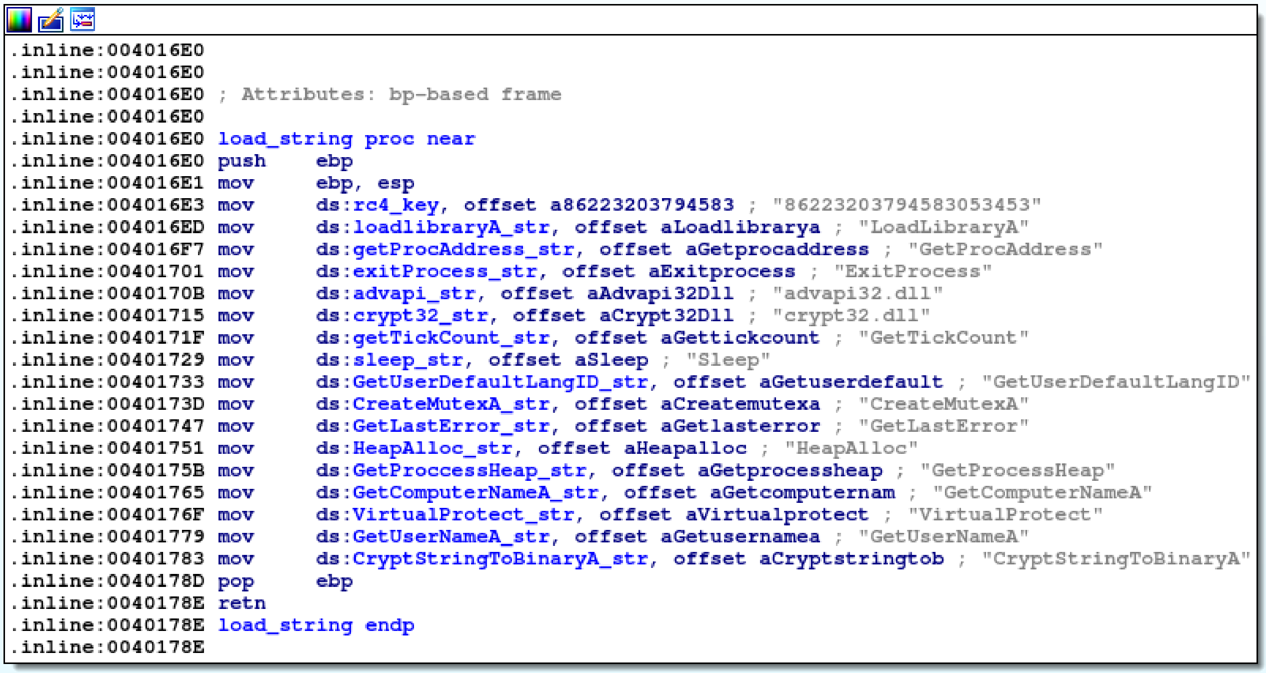
This article focuses on differences observed through the different Mars Stealer samples we have collected. As mentioned previously in the analysis of publications on underground forums, *MarsTeam* tries to improve its product with each release (bug fix, some obfuscation & new functionalities). Release advertisements on the XSS forum might not match what has been identified as a version in this article. The version identification process is based on how the malware stores and deobfuscates its C2, which could lead to version overlap of the announced versions by *MarsTeam* and our work.

The next section describes the first and older technique used by Mars Stealer to load its C2, which involved retrieving the RC4 key and spotting the position of the Command and Control in the PE.

String loading

One of the first functions of the malware aims to load a small set of strings, which are used a bit later with the two known functions of *Kernel32.dll*: *LoadLibrary* and *GetProcAddress*. These two functions are used for further functions and library loading. In this same function (*load_string*), the first string loaded is twenty bytes long, which appears to be the key used to decrypt (RC4) strings of the malware.

Those obfuscated strings are stored in the *.data* section in this given format: encrypted string with RC4 (Rivest Cipher 4)[7] algorithm stored in base64. Figure below shows how the RC4 key is loaded.



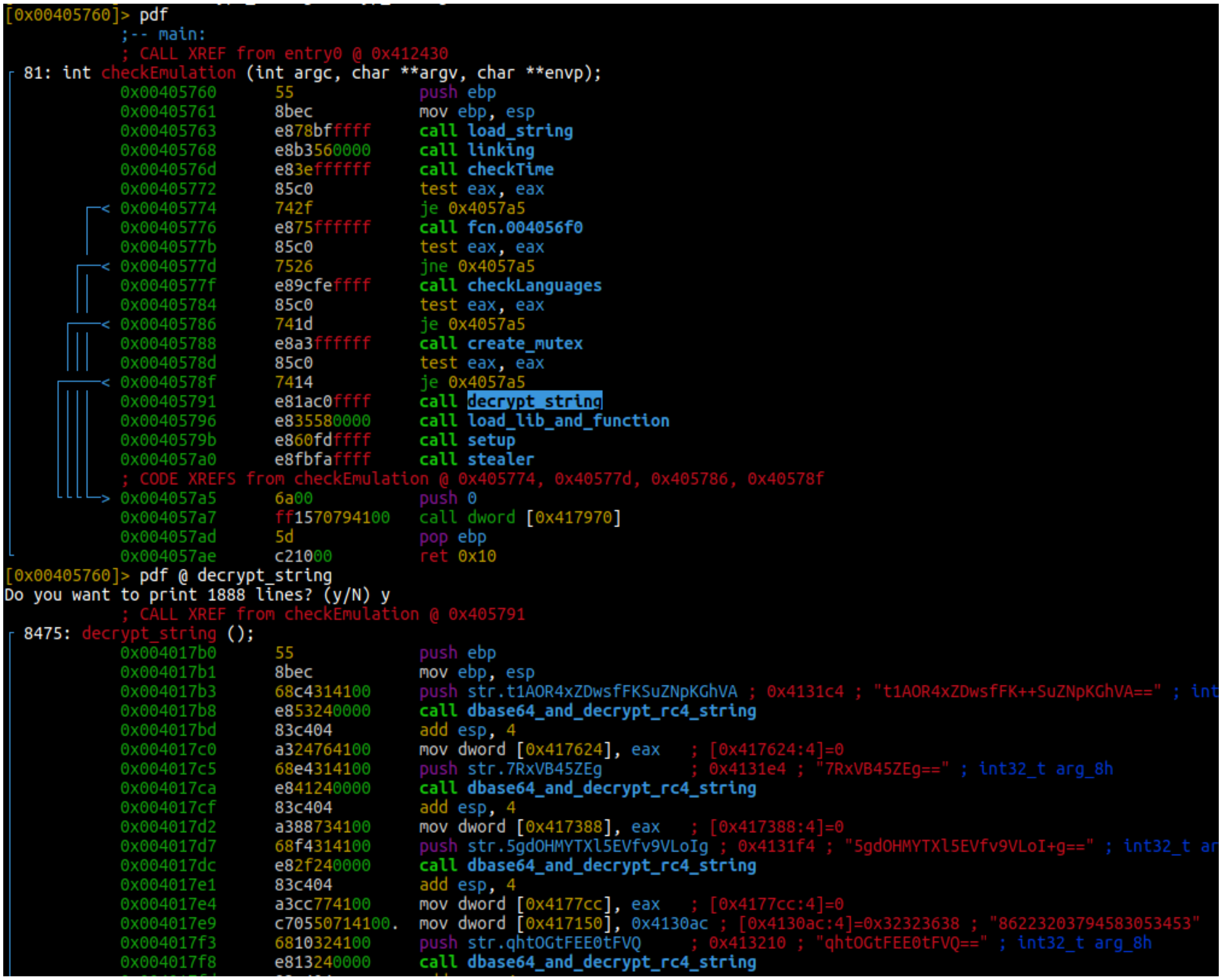
```
.inline:004016E0
.inline:004016E0
.inline:004016E0 ; Attributes: bp-based frame
.inline:004016E0
.inline:004016E0 load_string proc near
.inline:004016E0 push    ebp
.inline:004016E1 mov     ebp, esp
.inline:004016E3 mov     ds:rc4_key, offset a86223203794583 ; "86223203794583053453"
.inline:004016ED mov     ds:loadlibraryA_str, offset aLoadlibrarya ; "LoadLibraryA"
.inline:004016F7 mov     ds:getProcAddress_str, offset aGetprocaddress ; "GetProcAddress"
.inline:00401701 mov     ds:exitProcess_str, offset aExitprocess ; "ExitProcess"
.inline:0040170B mov     ds:advapi_str, offset aAdvapi32Dll ; "advapi32.dll"
.inline:00401715 mov     ds:crypt32_str, offset aCrypt32Dll ; "crypt32.dll"
.inline:0040171F mov     ds:getTickCount_str, offset aGettickcount ; "GetTickCount"
.inline:00401729 mov     ds:sleep_str, offset aSleep ; "Sleep"
.inline:00401733 mov     ds:GetUserDefaultLangID_str, offset aGetuserdefault ; "GetUserDefaultLangID"
.inline:0040173D mov     ds:CreateMutexA_str, offset aCreatemutexa ; "CreateMutexA"
.inline:00401747 mov     ds:GetLastError_str, offset aGetlasterror ; "GetLastError"
.inline:00401751 mov     ds:HeapAlloc_str, offset aHeapalloc ; "HeapAlloc"
.inline:0040175B mov     ds:GetProccessHeap_str, offset aGetprocessheap ; "GetProcessHeap"
.inline:00401765 mov     ds:GetComputerNameA_str, offset aGetcomputernam ; "GetComputerNameA"
.inline:0040176F mov     ds:VirtualProtect_str, offset aVirtualprotect ; "VirtualProtect"
.inline:00401779 mov     ds:GetUserNameA_str, offset aGetusernamea ; "GetUserNameA"
.inline:00401783 mov     ds:CryptStringToBinaryA_str, offset aCryptstringtob ; "CryptStringToBinaryA"
.inline:0040178D pop     ebp
.inline:0040178E retn
.inline:0040178E load_string endp
.inline:0040178E
```

Figure 18. RC4 key loading

For example, for the following string: “*K3vgIP3rMlysQNU=*“:

1. The base64-decoded string is *2b7be020fdeb325cac40d5*.
2. The RC4-decrypted string with the key *85297062256884302049* is “*MachineGuid*”.

RC4 key retrieving is the first step to get the C2 in clear text. Then, finding the offset of the string that contains the C2 is the objective. This strings are the third and the fourth string loaded and decrypted in the function *decrypt_string*.



```
[0x00405760]> pdf
            ;-- main:
            ; CALL XREF from entry0 @ 0x412430
┌ 81: int checkEmulation (int argc, char **argv, char **envp);
│           0x00405760      55             push ebp
│           0x00405761      8bec           mov ebp, esp
│           0x00405763      e878bfffff     call load_string
│           0x00405768      e8b3560000     call linking
│           0x0040576d      e83effffff     call checkTime
│           0x00405772      85c0           test eax, eax
│       ┌─< 0x00405774      742f           je 0x4057a5
│       │   0x00405776      e875ffffff     call fcn.004056f0
│       │   0x0040577b      85c0           test eax, eax
│      ┌──< 0x0040577d      7526           jne 0x4057a5
│      ││   0x0040577f      e89cfeffff     call checkLanguages
│      ││   0x00405784      85c0           test eax, eax
│     ┌───< 0x00405786      741d           je 0x4057a5
│     │││   0x00405788      e8a3ffffff     call create_mutex
│     │││   0x0040578d      85c0           test eax, eax
│    ┌────< 0x0040578f      7414           je 0x4057a5
│    ││││   0x00405791      e81ac0ffff     call decrypt_string
│    ││││   0x00405796      e835580000     call load_lib_and_function
│    ││││   0x0040579b      e860fdffff     call setup
│    ││││   0x004057a0      e8fbfaffff     call stealer
│    ││││   ; CODE XREFS from checkEmulation @ 0x405774, 0x40577d, 0x405786, 0x40578f
│    └└└└─> 0x004057a5      6a00           push 0
│           0x004057a7      ff1570794100   call dword [0x417970]
│           0x004057ad      5d             pop ebp
└           0x004057ae      c21000         ret 0x10
[0x00405760]> pdf @ decrypt_string
Do you want to print 1888 lines? (y/N) y
            ; CALL XREF from checkEmulation @ 0x405791
┌ 8475: decrypt_string ();
│           0x004017b0      55             push ebp
│           0x004017b1      8bec           mov ebp, esp
│           0x004017b3      68c4314100     push str.t1AOR4xZDwsfFKSuZNpKGhVA ; 0x4131c4 ; "t1AOR4xZDwsfFK++SuZNpKGhVA==" ; int
│           0x004017b8      e853240000     call dbase64_and_decrypt_rc4_string
│           0x004017bd      83c404         add esp, 4
│           0x004017c0      a324764100     mov dword [0x417624], eax   ; [0x417624:4]=0
│           0x004017c5      68e4314100     push str.7RxVB45ZEg         ; 0x4131e4 ; "7RxVB45ZEg==" ; int32_t arg_8h
│           0x004017ca      e841240000     call dbase64_and_decrypt_rc4_string
│           0x004017cf      83c404         add esp, 4
│           0x004017d2      a388734100     mov dword [0x417388], eax   ; [0x417388:4]=0
│           0x004017d7      68f4314100     push str.5gdOHMYTXl5EVfv9VLoIg ; 0x4131f4 ; "5gdOHMYTXl5EVfv9VLoI+g==" ; int32_t ar
│           0x004017dc      e82f240000     call dbase64_and_decrypt_rc4_string
│           0x004017e1      83c404         add esp, 4
│           0x004017e4      a3cc774100     mov dword [0x4177cc], eax   ; [0x4177cc:4]=0
│           0x004017e9      c70550714100.  mov dword [0x417150], 0x4130ac ; [0x4130ac:4]=0x32323638 ; "86223203794583053453"
│           0x004017f3      6810324100     push str.qhtOGtFEE0tFVQ     ; 0x413210 ; "qhtOGtFEE0tFVQ==" ; int32_t arg_8h
│           0x004017f8      e813240000     call dbase64_and_decrypt_rc4_string
```

Figure 19. Offset of C2 encoded in base64 and encrypted with RC4 (addresses: 0x4131f4 and 0x413210)

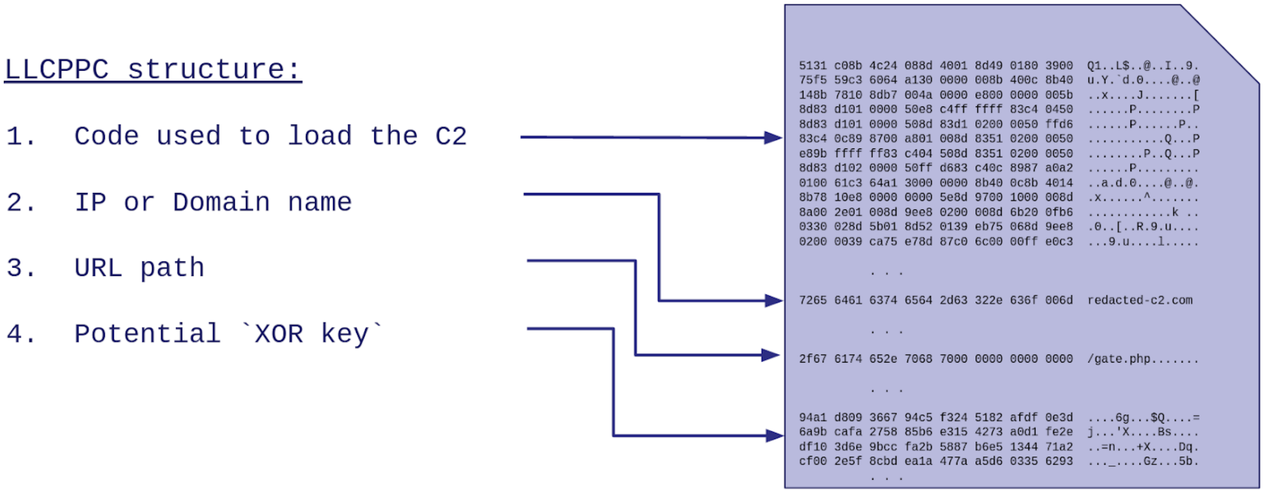
In one of the most recent releases, a new section was created by the Mars Stealer authors. The C2 location is now at an offset defined in the LLCPPC code, *c.f.* figure 20. This version and its upgrade are analyzed in depth in the next three sections.

A new section entered the ring

As introduced in the section “Collecting Mars Stealer samples”, a new section with the singular name LLCPPC has been introduced in the Mars Stealer PE structure.

The structure of this section has evolved during the different releases. First of all, this section was composed of one segment that contains code used by the malware, and then authors add data, sometimes in clear text or obfuscated.

The new section of malware has the given structure:



LLCPPC structure:

1. Code used to load the C2
2. IP or Domain name
3. URL path
4. Potential `XOR key`

```
5131 c08b 4c24 088d 4001 8d49 0180 3900  Q1..L$..@..I..9.
75f5 59c3 6064 a130 0000 008b 400c 8b40  u.Y.`d.0....@..@
148b 7810 8db7 004a 0000 e800 0000 005b  ..x....J.......[
8d83 d101 0000 50e8 c4ff ffff 83c4 0450  ......P........P
8d83 d101 0000 508d 83d1 0200 0050 ffd6  ......P......P..
83c4 0c89 8700 a801 008d 8351 0200 0050  ...........Q...P
e89b ffff ff83 c404 508d 8351 0200 0050  ........P..Q...P
8d83 d102 0000 50ff d683 c40c 8987 a0a2  ......P.........
0100 61c3 64a1 3000 0000 8b40 0c8b 4014  ..a.d.0....@..@.
8b78 10e8 0000 0000 5e8d 9700 1000 008d  .x......^.......
8a00 2e01 008d 9ee8 0200 008d 6b20 0fb6  ............k ..
0330 028d 5b01 8d52 0139 eb75 068d 9ee8  .0..[..R.9.u....
0200 0039 ca75 e78d 87c0 6c00 00ff e0c3  ...9.u....l.....

          . . .

7265 6461 6374 6564 2d63 322e 636f 006d  redacted-c2.com

          . . .

2f67 6174 652e 7068 7000 0000 0000 0000  /gate.php.......

          . . .

94a1 d809 3667 94c5 f324 5182 afdf 0e3d  ....6g...$Q....=
6a9b cafa 2758 85b6 e315 4273 a0d1 fe2e  j...'X....Bs....
df10 3d6e 9bcc fa2b 5887 b6e5 1344 71a2  ..=n...+X....Dq.
cf00 2e5f 8cbd ea1a 477a a5d6 0335 6293  ..._....Gz...5b.
          . . .
```

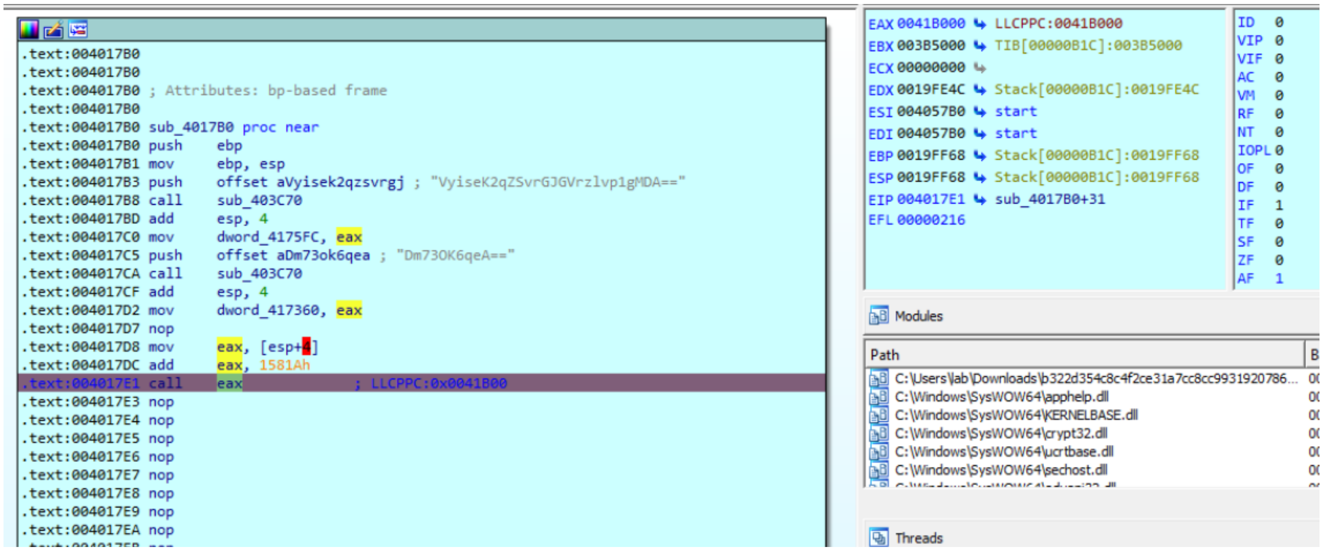
Figure 20. LLCPPC section structure

In the previous LLCPPC section structure, the C2 URL is in clear text, that means it is not obfuscated and the XOR key is not used. However, in most samples, the C2 URL is obfuscated with the XOR key.

Three different versions of this section have been observed during our investigation. The first version of this section is the one using RC4 encryption on the C2 located in the data section, then in next version malware developers append at the bottom of the section the C2 and change the obfuscation method. Data can be obfuscated with XOR operation or can be stored in clear text.

LLCPPC with RC4 encryption

The simplest version of the LLCPPC section only contains code. The code is in charge of loading the obfuscated string from a specific offset and calling the deobfuscation function (*e.g.* base64 decode plus RC4 decryption).



```
.text:004017B0
.text:004017B0
.text:004017B0 ; Attributes: bp-based frame
.text:004017B0
.text:004017B0 sub_4017B0 proc near
.text:004017B0 push    ebp
.text:004017B1 mov     ebp, esp
.text:004017B3 push    offset aVyisek2qzsvrgj ; "VyiseK2qZSvrGJGVrzlvp1gMDA=="
.text:004017B8 call    sub_403C70
.text:004017BD add     esp, 4
.text:004017C0 mov     dword_4175FC, eax
.text:004017C5 push    offset aDm73ok6qea ; "Dm73OK6qeA=="
.text:004017CA call    sub_403C70
.text:004017CF add     esp, 4
.text:004017D2 mov     dword_417360, eax
.text:004017D7 nop
.text:004017D8 mov     eax, [esp+4]
.text:004017DC add     eax, 1581Ah
.text:004017E1 call    eax             ; LLCPPC:0x0041B00
.text:004017E3 nop
.text:004017E4 nop
.text:004017E5 nop
.text:004017E6 nop
.text:004017E7 nop
.text:004017E8 nop
.text:004017E9 nop
.text:004017EA nop
```

```
EAX 0041B000 ↳ LLCPPC:0041B000
EBX 003B5000 ↳ TIB[00000B1C]:003B5000
ECX 00000000 ↳
EDX 0019FE4C ↳ Stack[00000B1C]:0019FE4C
ESI 004057B0 ↳ start
EDI 004057B0 ↳ start
EBP 0019FF68 ↳ Stack[00000B1C]:0019FF68
ESP 0019FF68 ↳ Stack[00000B1C]:0019FF68
EIP 004017E1 ↳ sub_4017B0+31
EFL 00000216
```

```
ID   0
VIP  0
VIF  0
AC   0
VM   0
RF   0
NT   0
IOPL 0
OF   0
DF   0
IF   1
TF   0
SF   0
ZF   0
AF   1
```

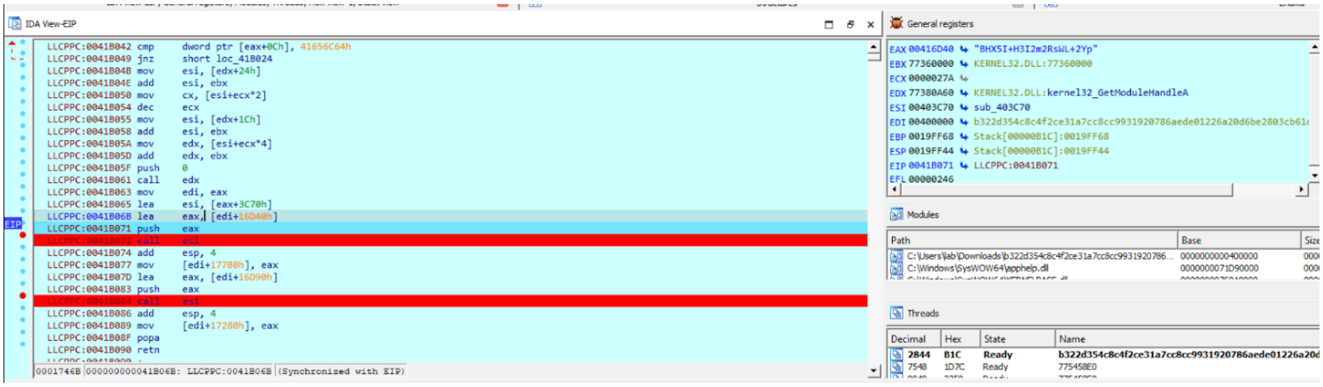
Modules

```
Path
C:\Users\lab\Downloads\b322d354c8c4f2ce31a7cc8cc9931920786...
C:\Windows\SysWOW64\apphelp.dll
C:\Windows\SysWOW64\KERNELBASE.dll
C:\Windows\SysWOW64\crypt32.dll
C:\Windows\SysWOW64\ucrtbase.dll
C:\Windows\SysWOW64\sechost.dll
```

Figure 21. IDA decompilation of the function "decrypt_string" that calls a function in LLCPPC section to load the C2

Malware developers had replaced the C2 decryption (*see figure 21)* by a call to the function located at the beginning of the LLCPPC section, oddly followed by multiple NOP operations.

The calling function of the LLCPPC section is the following one:



```
LLCPPC:0041B042 cmp     dword ptr [eax+0Ch], 41656C64h
LLCPPC:0041B049 jnz     short loc_41B024
LLCPPC:0041B04B mov     esi, [edx+24h]
LLCPPC:0041B04E add     esi, ebx
LLCPPC:0041B050 mov     cx, [esi+ecx*2]
LLCPPC:0041B054 dec     ecx
LLCPPC:0041B055 mov     esi, [edx+1Ch]
LLCPPC:0041B058 add     esi, ebx
LLCPPC:0041B05A mov     edx, [esi+ecx*4]
LLCPPC:0041B05D add     edx, ebx
LLCPPC:0041B05F push    0
LLCPPC:0041B061 call    edx
LLCPPC:0041B063 mov     edi, eax
LLCPPC:0041B065 lea     esi, [eax+3C70h]
LLCPPC:0041B06B lea     eax, [edi+16D40h]
LLCPPC:0041B071 push    eax
LLCPPC:0041B072 call    esi
LLCPPC:0041B074 add     esp, 4
LLCPPC:0041B077 mov     [edi+177B0h], eax
LLCPPC:0041B07D lea     eax, [edi+16D90h]
LLCPPC:0041B083 push    eax
LLCPPC:0041B084 call    esi
LLCPPC:0041B086 add     esp, 4
LLCPPC:0041B089 mov     [edi+17280h], eax
LLCPPC:0041B08F popa
LLCPPC:0041B090 retn
0001746B 000000000041B06B: LLCPPC:0041B06B (Synchronized with EIP)
```

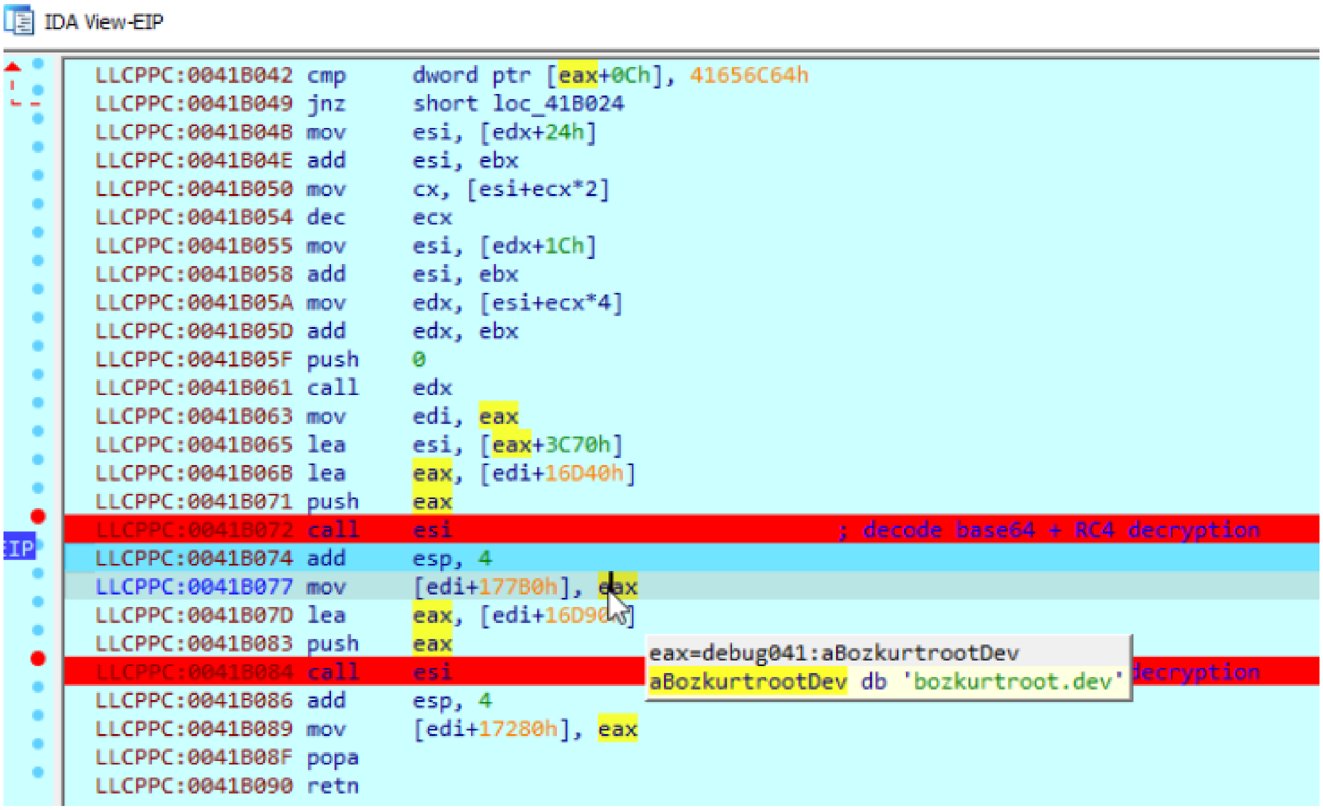
```
EAX 00416D40 ↳ "BHX5I+H3I2m2RsWL+2Yp"
EBX 77360000 ↳ KERNEL32.DLL:77360000
ECX 0000027A ↳
EDX 77380A60 ↳ KERNEL32.DLL:kernel32_GetModuleHandleA
ESI 00403C70 ↳ sub_403C70
EDI 00400000 ↳ b322d354c8c4f2ce31a7cc8cc9931920786aede01226a20d6be2803cb61
EBP 0019FF68 ↳ Stack[00000B1C]:0019FF68
ESP 0019FF44 ↳ Stack[00000B1C]:0019FF44
EIP 0041B071 ↳ LLCPPC:0041B071
EFL 00000246
```

Path	Base	Size
C:\Users\lab\Downloads\b322d354c8c4f2ce31a7cc8cc9931920786...	0000000000400000	000
C:\Windows\SysWOW64\apphelp.dll	0000000071D90000	000

Decimal	Hex	State	Name
2844	B1C	Ready	b322d354c8c4f2ce31a7cc8cc9931920786aede01226a20d
7548	1D7C	Ready	775458E0

Figure 22. IDA decompilation of the C2 loading before its decryption (RC4)

1. The call *edx* is a call to the *kernel32.dll* function *GetModuleHandleA* used to return the handle to the file that is loaded, where the request module here is 0, this is a trick to return the base address of the PE.
2. From this address an offset is computed (different in each Mars Stealer sample): *lea eax*, *[edi + 0x16d40]*, *edi* which holds the base address of the PE.
3. Then, a call *esi* is performed, register *esi* contains the address of the function that decodes base64 and decrypts RC4. This function is located in the .text section and is used to decrypt other strings of the malware. This is the same function that is called multiple times by *decrypt_string*.
4. Finally, the decoded and decrypted string is then stored at a specific location with *mov dword [edi + 0x177b0]*, *eax*; the *edi* register still contains the base address of the PE.



IDA View-EIP

```
LLCPPC:0041B042 cmp     dword ptr [eax+0Ch], 41656C64h
LLCPPC:0041B049 jnz     short loc_41B024
LLCPPC:0041B04B mov     esi, [edx+24h]
LLCPPC:0041B04E add     esi, ebx
LLCPPC:0041B050 mov     cx, [esi+ecx*2]
LLCPPC:0041B054 dec     ecx
LLCPPC:0041B055 mov     esi, [edx+1Ch]
LLCPPC:0041B058 add     esi, ebx
LLCPPC:0041B05A mov     edx, [esi+ecx*4]
LLCPPC:0041B05D add     edx, ebx
LLCPPC:0041B05F push    0
LLCPPC:0041B061 call    edx
LLCPPC:0041B063 mov     edi, eax
LLCPPC:0041B065 lea     esi, [eax+3C70h]
LLCPPC:0041B06B lea     eax, [edi+16D40h]
LLCPPC:0041B071 push    eax
LLCPPC:0041B072 call    esi                             ; decode base64 + RC4 decryption
LLCPPC:0041B074 add     esp, 4
LLCPPC:0041B077 mov     [edi+177B0h], eax
LLCPPC:0041B07D lea     eax, [edi+16D90h]
LLCPPC:0041B083 push    eax
LLCPPC:0041B084 call    esi                                                   decryption
LLCPPC:0041B086 add     esp, 4
LLCPPC:0041B089 mov     [edi+17280h], eax
LLCPPC:0041B08F popa
LLCPPC:0041B090 retn
```

```
eax=debug041:aBozkurtrootDev
aBozkurtrootDev db 'bozkurtroot.dev'
```

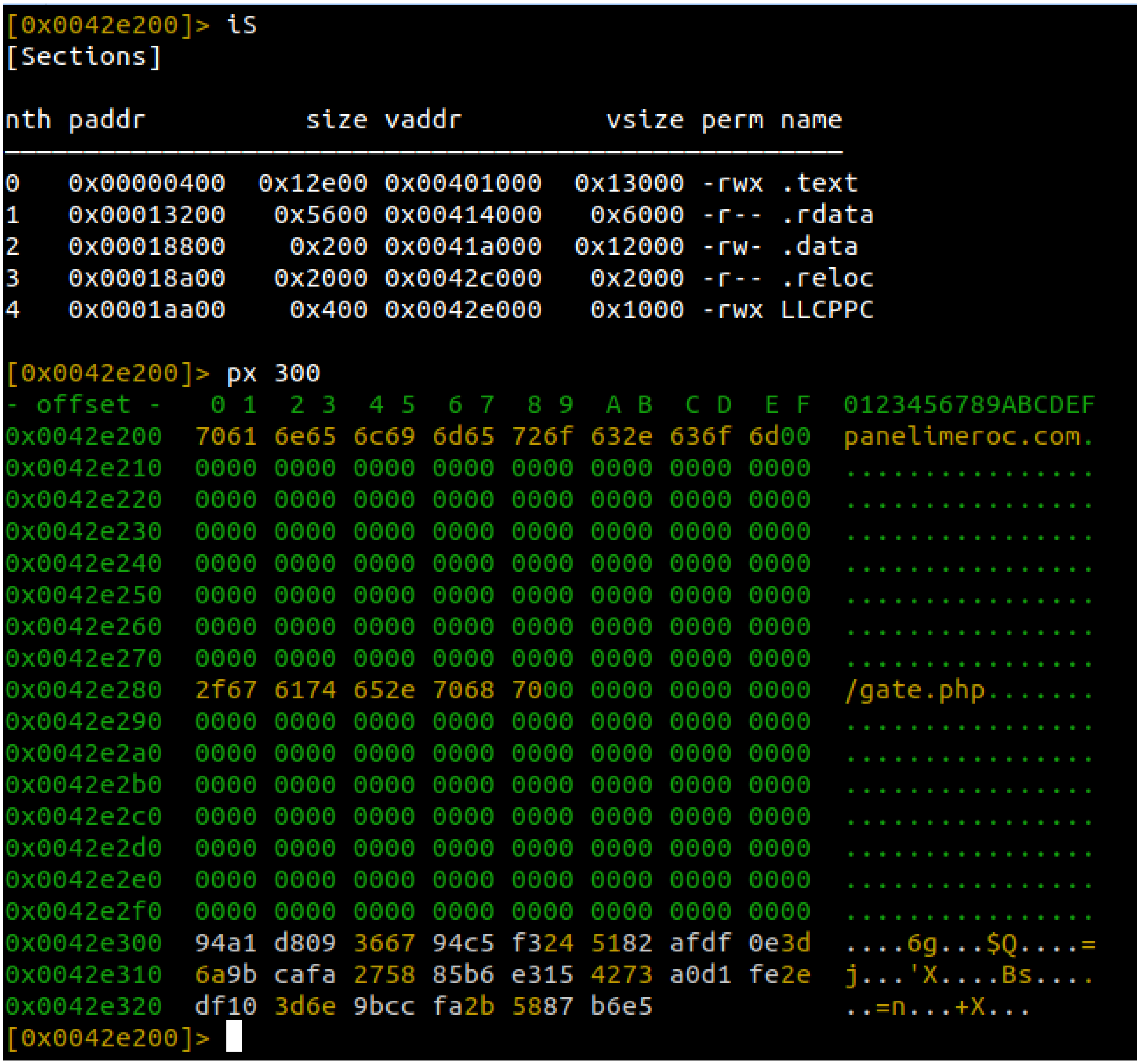
Figure 23. IDA decompilation of the C2 bozkurtoot[.]dev loading after its decryption (RC4)

The deobfuscation process is called twice, once for the C2 IP address or domain name and for the URL path as highlighted in the figure above.

LLCPPC with embedded data

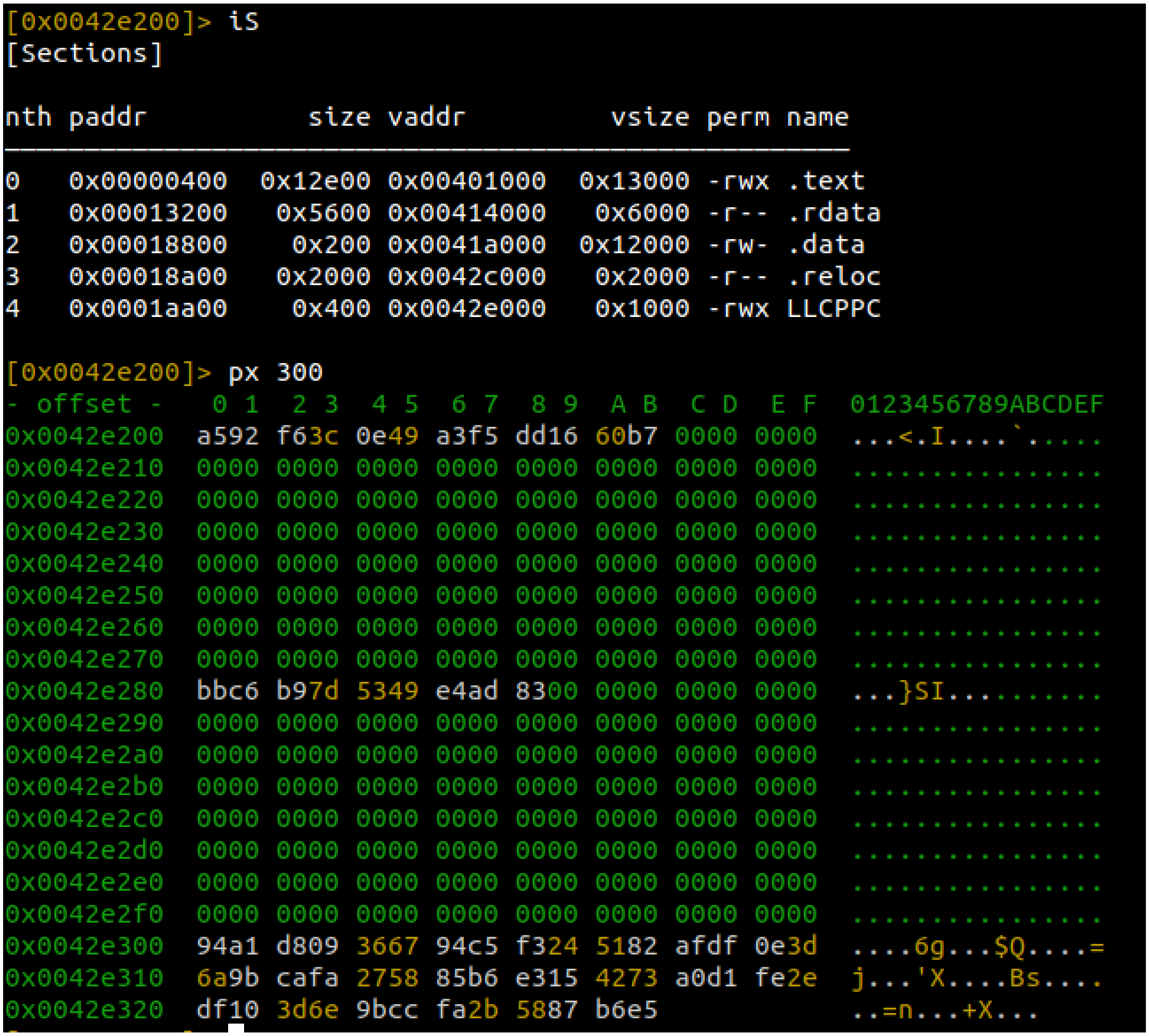
As mentioned previously, some versions of this section embed data, those data appear to be the C2 (IP address or domain name) plus its URL path.

From now two variants exist, one with the C2 in clear text (*c.f.* figure 24) and a variant where the C2 is xored (*c.f.* figure 25):



```
[0x0042e200]> iS
[Sections]

nth paddr          size vaddr         vsize perm name
―――――――――――――――――――――――――――――――――――――――――――――――――――――
0   0x00000400  0x12e00 0x00401000  0x13000 -rwx .text
1   0x00013200   0x5600 0x00414000   0x6000 -r-- .rdata
2   0x00018800    0x200 0x0041a000  0x12000 -rw- .data
3   0x00018a00   0x2000 0x0042c000   0x2000 -r-- .reloc
4   0x0001aa00    0x400 0x0042e000   0x1000 -rwx LLCPPC

[0x0042e200]> px 300
- offset -   0 1  2 3  4 5  6 7  8 9  A B  C D  E F  0123456789ABCDEF
0x0042e200  7061 6e65 6c69 6d65 726f 632e 636f 6d00  panelimeroc.com.
0x0042e210  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e220  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e230  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e240  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e250  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e260  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e270  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e280  2f67 6174 652e 7068 7000 0000 0000 0000  /gate.php.......
0x0042e290  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2a0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2b0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2c0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2d0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2e0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2f0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e300  94a1 d809 3667 94c5 f324 5182 afdf 0e3d  ....6g...$Q....=
0x0042e310  6a9b cafa 2758 85b6 e315 4273 a0d1 fe2e  j...'X....Bs....
0x0042e320  df10 3d6e 9bcc fa2b 5887 b6e5            ..=n...+X...
[0x0042e200]>
```

Figure 24. Radare2 dump of LLCPPC section with C2 in clear text



```
[0x0042e200]> iS
[Sections]

nth paddr          size vaddr         vsize perm name
―――――――――――――――――――――――――――――――――――――――――――――――――――――
0   0x00000400  0x12e00 0x00401000  0x13000 -rwx .text
1   0x00013200   0x5600 0x00414000   0x6000 -r-- .rdata
2   0x00018800    0x200 0x0041a000  0x12000 -rw- .data
3   0x00018a00   0x2000 0x0042c000   0x2000 -r-- .reloc
4   0x0001aa00    0x400 0x0042e000   0x1000 -rwx LLCPPC

[0x0042e200]> px 300
- offset -   0 1  2 3  4 5  6 7  8 9  A B  C D  E F  0123456789ABCDEF
0x0042e200  a592 f63c 0e49 a3f5 dd16 60b7 0000 0000  ...<.I....`.....
0x0042e210  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e220  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e230  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e240  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e250  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e260  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e270  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e280  bbc6 b97d 5349 e4ad 8300 0000 0000 0000  ...}SI..........
0x0042e290  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2a0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2b0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2c0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2d0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2e0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e2f0  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x0042e300  94a1 d809 3667 94c5 f324 5182 afdf 0e3d  ....6g...$Q....=
0x0042e310  6a9b cafa 2758 85b6 e315 4273 a0d1 fe2e  j...'X....Bs....
0x0042e320  df10 3d6e 9bcc fa2b 5887 b6e5            ..=n...+X...
```

Figure 25. Radare2 dump of LLCPPC section with C2 obfuscated

A dynamic analysis helps to identify how the C2 was obfuscated and where its obfuscation key was stored.

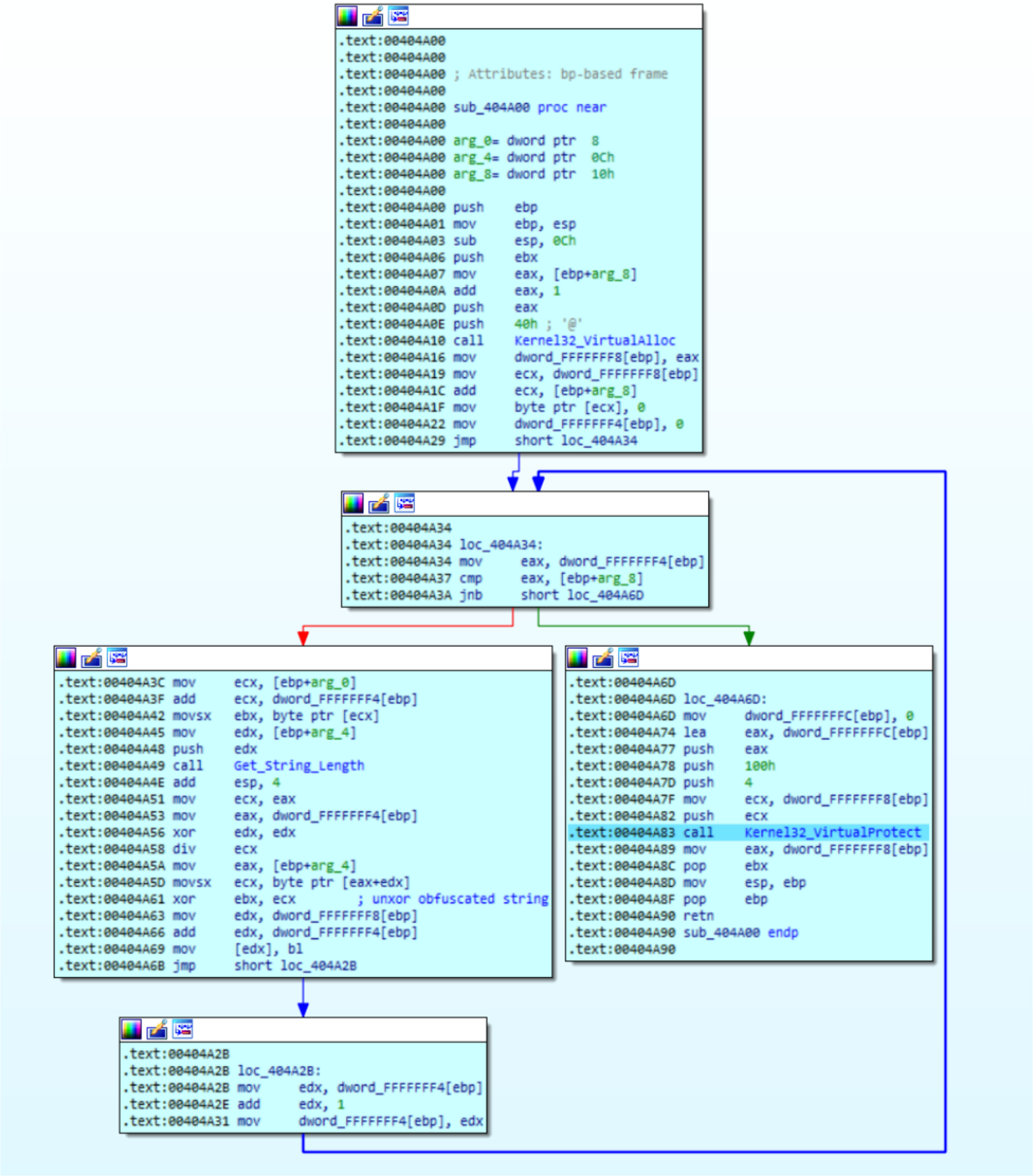
The deobfuscation function (*c.f.* figure 27) determines the string length, then loads the C2 and xor key from a known offset located in the LLCPPC section to finally call the function that unxors data. Besides, this function is located in the *.text* section and is also used for other strings deobfuscation.

In fact, the obfuscated C2 could be read in clear text with the short following Python snippet of code:

```
def unxor(string: iterable, key: iterable) -> str:
    """Method to unxor obfuscated data from llcppc section"""

    unxored = ""

    for c1, c2 in zip(key, string):
            unxored += chr(c1 ^ c2)

    return unxored
```

Figure 26. Function deobfuscating data from LLCPPC section

The function responsible for the string unxor data is the following one:



```
.text:00404A00
.text:00404A00
.text:00404A00 ; Attributes: bp-based frame
.text:00404A00
.text:00404A00 sub_404A00 proc near
.text:00404A00
.text:00404A00 arg_0= dword ptr  8
.text:00404A00 arg_4= dword ptr  0Ch
.text:00404A00 arg_8= dword ptr  10h
.text:00404A00
.text:00404A00 push    ebp
.text:00404A01 mov     ebp, esp
.text:00404A03 sub     esp, 0Ch
.text:00404A06 push    ebx
.text:00404A07 mov     eax, [ebp+arg_8]
.text:00404A0A add     eax, 1
.text:00404A0D push    eax
.text:00404A0E push    40h ; '@'
.text:00404A10 call    Kernel32_VirtualAlloc
.text:00404A16 mov     dword_FFFFFFF8[ebp], eax
.text:00404A19 mov     ecx, dword_FFFFFFF8[ebp]
.text:00404A1C add     ecx, [ebp+arg_8]
.text:00404A1F mov     byte ptr [ecx], 0
.text:00404A22 mov     dword_FFFFFFF4[ebp], 0
.text:00404A29 jmp     short loc_404A34
```

```
.text:00404A34
.text:00404A34 loc_404A34:
.text:00404A34 mov     eax, dword_FFFFFFF4[ebp]
.text:00404A37 cmp     eax, [ebp+arg_8]
.text:00404A3A jnb     short loc_404A6D
```

```
.text:00404A3C mov     ecx, [ebp+arg_0]
.text:00404A3F add     ecx, dword_FFFFFFF4[ebp]
.text:00404A42 movsx   ebx, byte ptr [ecx]
.text:00404A45 mov     edx, [ebp+arg_4]
.text:00404A48 push    edx
.text:00404A49 call    Get_String_Length
.text:00404A4E add     esp, 4
.text:00404A51 mov     ecx, eax
.text:00404A53 mov     eax, dword_FFFFFFF4[ebp]
.text:00404A56 xor     edx, edx
.text:00404A58 div     ecx
.text:00404A5A mov     eax, [ebp+arg_4]
.text:00404A5D movsx   ecx, byte ptr [eax+edx]
.text:00404A61 xor     ebx, ecx        ; unxor obfuscated string
.text:00404A63 mov     edx, dword_FFFFFFF8[ebp]
.text:00404A66 add     edx, dword_FFFFFFF4[ebp]
.text:00404A69 mov     [edx], bl
.text:00404A6B jmp     short loc_404A2B
```

```
.text:00404A6D
.text:00404A6D loc_404A6D:
.text:00404A6D mov     dword_FFFFFFFC[ebp], 0
.text:00404A74 lea     eax, dword_FFFFFFFC[ebp]
.text:00404A77 push    eax
.text:00404A78 push    100h
.text:00404A7D push    4
.text:00404A7F mov     ecx, dword_FFFFFFF8[ebp]
.text:00404A82 push    ecx
.text:00404A83 call    Kernel32_VirtualProtect
.text:00404A89 mov     eax, dword_FFFFFFF8[ebp]
.text:00404A8C pop     ebx
.text:00404A8D mov     esp, ebp
.text:00404A8F pop     ebp
.text:00404A90 retn
.text:00404A90 sub_404A00 endp
.text:00404A90
```

```
.text:00404A2B
.text:00404A2B loc_404A2B:
.text:00404A2B mov     edx, dword_FFFFFFF4[ebp]
.text:00404A2E add     edx, 1
.text:00404A31 mov     dword_FFFFFFF4[ebp], edx
```

Figure 27. IDA decompilation of function responsible to unxor string

As observed while computing analysis on multiple samples using XOR obfuscation and data stored in the LLCPPC section (*c.f.* figure 20). The obfuscated C2 target, C2 URL path and XOR key are located at the same position for each sample of this version; this indicates a static assignment of the location by the authors.

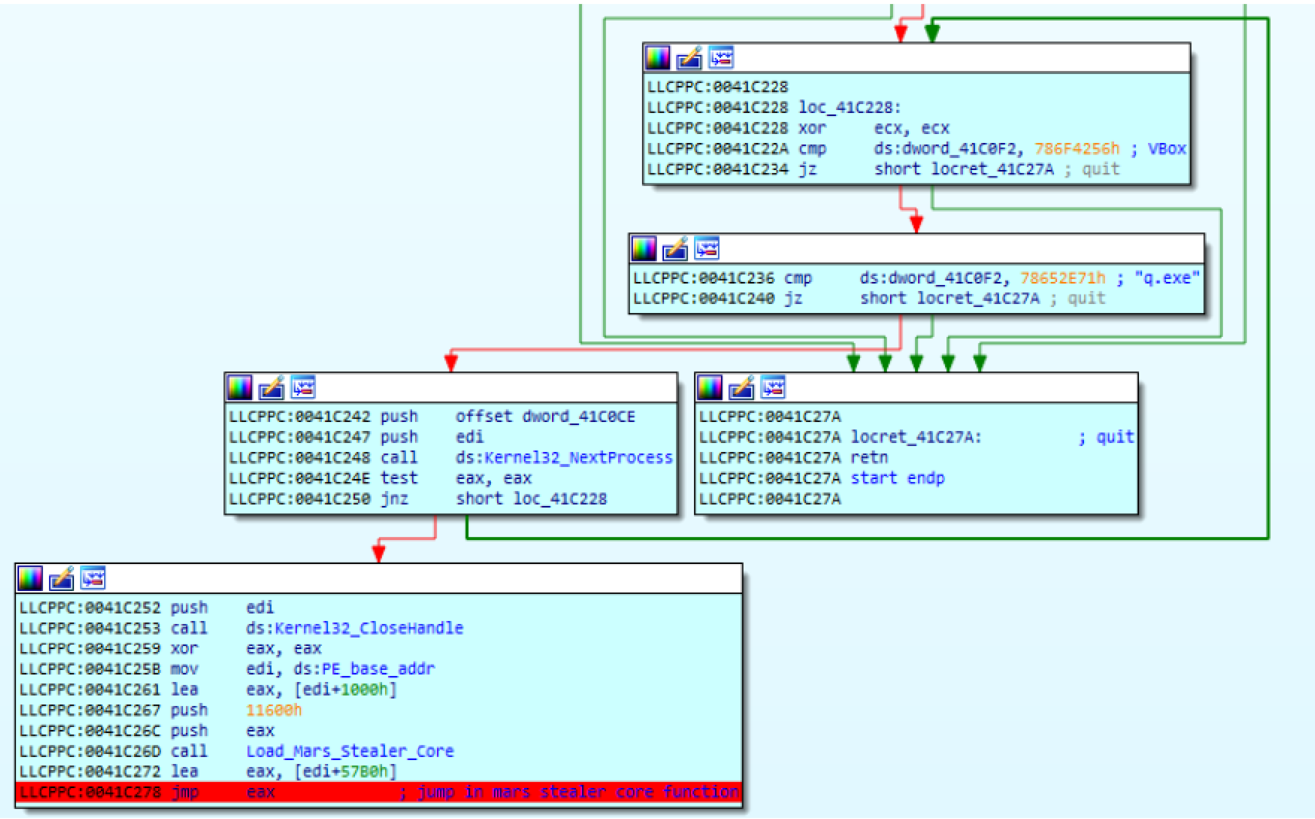
- C2 target offset is: `LLCPPC base address + 0x200`.

- C2 target clear text is in the .data section: `0x41A800`.
- C2 URL path offset is: `LLCPPC base address + 0x280`.
- C2 URL path clear text is in .data section: `0x41A2A0`.
- XOR key for C2 target and C2 URL path is: `LLCPPC base address + 0x300`.

The mechanism described in the above section to get the C2 might be assigned to version 4 and above. A new variant then came with virtual machines and environment analysis detection.

LLCPPC Anti VM mechanism

The Mars Stealer team has updated its C2 loading; some anti-VM checks have been introduced in a new version. As shown by the figure below, the malware loops over the running process looking for particular process names. This version checks if a process contains *VBOX* or if a process is named *q.exe* which is a the Sysinternal tool: Rootkit detection utility[8]. In case none of the suspicious processes is identified, the malware allocated a virtual memory space for the Mars Stealer core function (*c.f.* figure 17) and then execute it (*c.f.* figure 28, “jmp eax”).



```
LLCPPC:0041C228
LLCPPC:0041C228 loc_41C228:
LLCPPC:0041C228 xor     ecx, ecx
LLCPPC:0041C22A cmp     ds:dword_41C0F2, 786F4256h ; VBox
LLCPPC:0041C234 jz      short locret_41C27A ; quit
```

```
LLCPPC:0041C236 cmp     ds:dword_41C0F2, 78652E71h ; "q.exe"
LLCPPC:0041C240 jz      short locret_41C27A ; quit
```

```
LLCPPC:0041C242 push    offset dword_41C0CE
LLCPPC:0041C247 push    edi
LLCPPC:0041C248 call    ds:Kernel32_NextProcess
LLCPPC:0041C24E test    eax, eax
LLCPPC:0041C250 jnz     short loc_41C228
```

```
LLCPPC:0041C27A
LLCPPC:0041C27A locret_41C27A:          ; quit
LLCPPC:0041C27A retn
LLCPPC:0041C27A start endp
LLCPPC:0041C27A
```

```
LLCPPC:0041C252 push    edi
LLCPPC:0041C253 call    ds:Kernel32_CloseHandle
LLCPPC:0041C259 xor     eax, eax
LLCPPC:0041C25B mov     edi, ds:PE_base_addr
LLCPPC:0041C261 lea     eax, [edi+1000h]
LLCPPC:0041C267 push    11600h
LLCPPC:0041C26C push    eax
LLCPPC:0041C26D call    Load_Mars_Stealer_Core
LLCPPC:0041C272 lea     eax, [edi+57B0h]
LLCPPC:0041C278 jmp     eax                 ; jump in mars stealer core function
```

Figure 28. Anti-VM mechanism

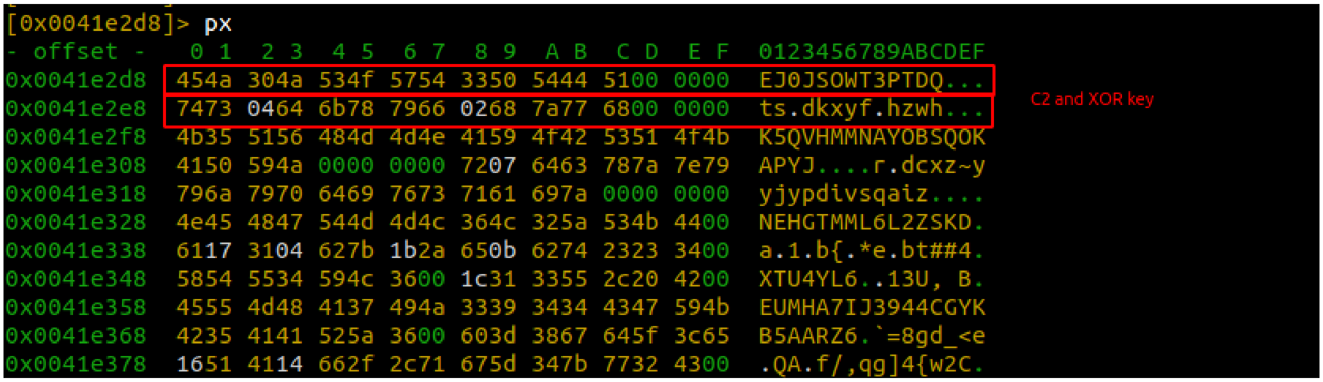
The C2 loading method for this version does not differ that much from other LLCPPC versions. Indeed, after the virtual memory allocation of Mars Stealer core function followed by the jump into this new allocated memory area, the code of Mars Stealer remains the same as the one described in the “Mars Stealer capabilities” section. However, from a scripting point of view it will be required to look a step further to find out the “OEP” (Original Entry Point).

LLCPPC left the game: Mars Stealer V8

As explained previously in the section “Collecting Mars Stealer samples”, the last version has evolved, both the C2 server and the implant benefit from some upgrades. From the implant point of view, two major functionalities were introduced:

1. Downloaded DLLs are now grouped in a single ZIP file named and fetched from the “/request” URL.
2. A new anti-analysis check is introduced.

The C2 is obfuscated using the same techniques as described in the section “LLCPPC with embedded data”, but for this version, obfuscated data are located in the *.rdata* section. Moreover, each part of the C2, the IP address or the domain name and the URL path, has their own XOR key. The structure of the code does not change regarding the previous version with XOR obfuscation; the xored string is followed in the PE structure by its XOR key.



```
[0x0041e2d8]> px
- offset -   0 1  2 3  4 5  6 7  8 9  A B  C D  E F  0123456789ABCDEF
0x0041e2d8  454a 304a 534f 5754 3350 5444 5100 0000  EJ0JSOWT3PTDQ...
0x0041e2e8  7473 0464 6b78 7966 0268 7a77 6800 0000  ts.dkxyf.hzwh...
0x0041e2f8  4b35 5156 484d 4d4e 4159 4f42 5351 4f4b  K5QVHMMNAYOBSQOK
0x0041e308  4150 594a 0000 0000 7207 6463 787a 7e79  APYJ....r.dcxz~y
0x0041e318  796a 7970 6469 7673 7161 697a 0000 0000  yjypdivsqaiz....
0x0041e328  4e45 4847 544d 4d4c 364c 325a 534b 4400  NEHGTMML6L2ZSKD.
0x0041e338  6117 3104 627b 1b2a 650b 6274 2323 3400  a.1.b{.*e.bt##4.
0x0041e348  5854 5534 594c 3600 1c31 3355 2c20 4200  XTU4YL6..13U, B.
0x0041e358  4555 4d48 4137 494a 3339 3434 4347 594b  EUMHA7IJ3944CGYK
0x0041e368  4235 4141 525a 3600 603d 3867 645f 3c65  B5AARZ6.`=8gd_<e
0x0041e378  1651 4114 662f 2c71 675d 347b 7732 4300  .QA.f/,qg]4{w2C.
```

Figure 29. Obfuscated C2 IP address followed by its XOR key

This simple version 8 of Mars Stealer does not represent the trend we observed during our tracking session, various samples identified as version 8 are packed with Themida[9].

Extra analysis notes

As mentioned in the past section, the samples retrieved from VirusTotal were identified with only two different RC4 keys: *8529706225688430204* and *86223203794583053453* with massive usage of the first one. We cannot affirm that one key is linked to a specific release, nor a selling batch, nor a threat actor (this hypothesis does not make sense here, in a malware-as-a-service context).

The XOR key located at the end of the LLCPPC section is repeatedly present even if no obfuscation is applied on the C2 (*c.f.* figure 24).

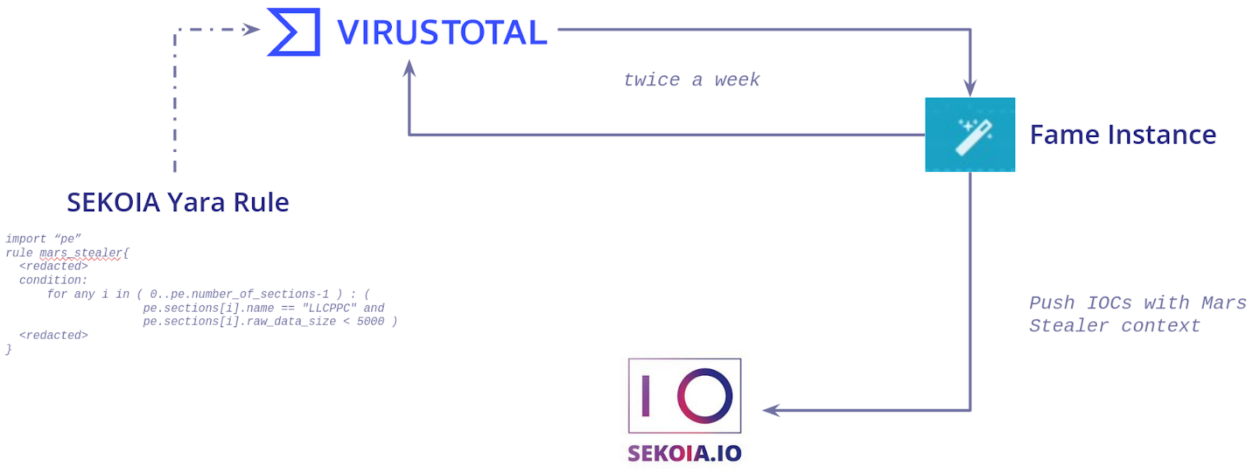
Some older (below version 7) Mars Stealer samples came “packed” with a VMProtect layer, related hashes are:

- *a6cd1f6158ce5a16bd500218333e81fcb6ecd960da3cfa0c1b701a5cf9f98dec*
- *8ded24590c991f33438fe38f3ae10e91672369b1f029bf339a94d74c8645932a*
- *af503eb7e314b4a8acb2ef849fc7cea7f273fa9544b40904314b651859b66a17*

SEKOIA.IO interaction

Malware C2 loading and deobfuscation have been analyzed in their different versions and the behavior of the multiple versions are now identified. A FAME module[10] to automatically extract Command and Control has been developed. This module uses the Python library r2pipe[11] to interact with the PE file.

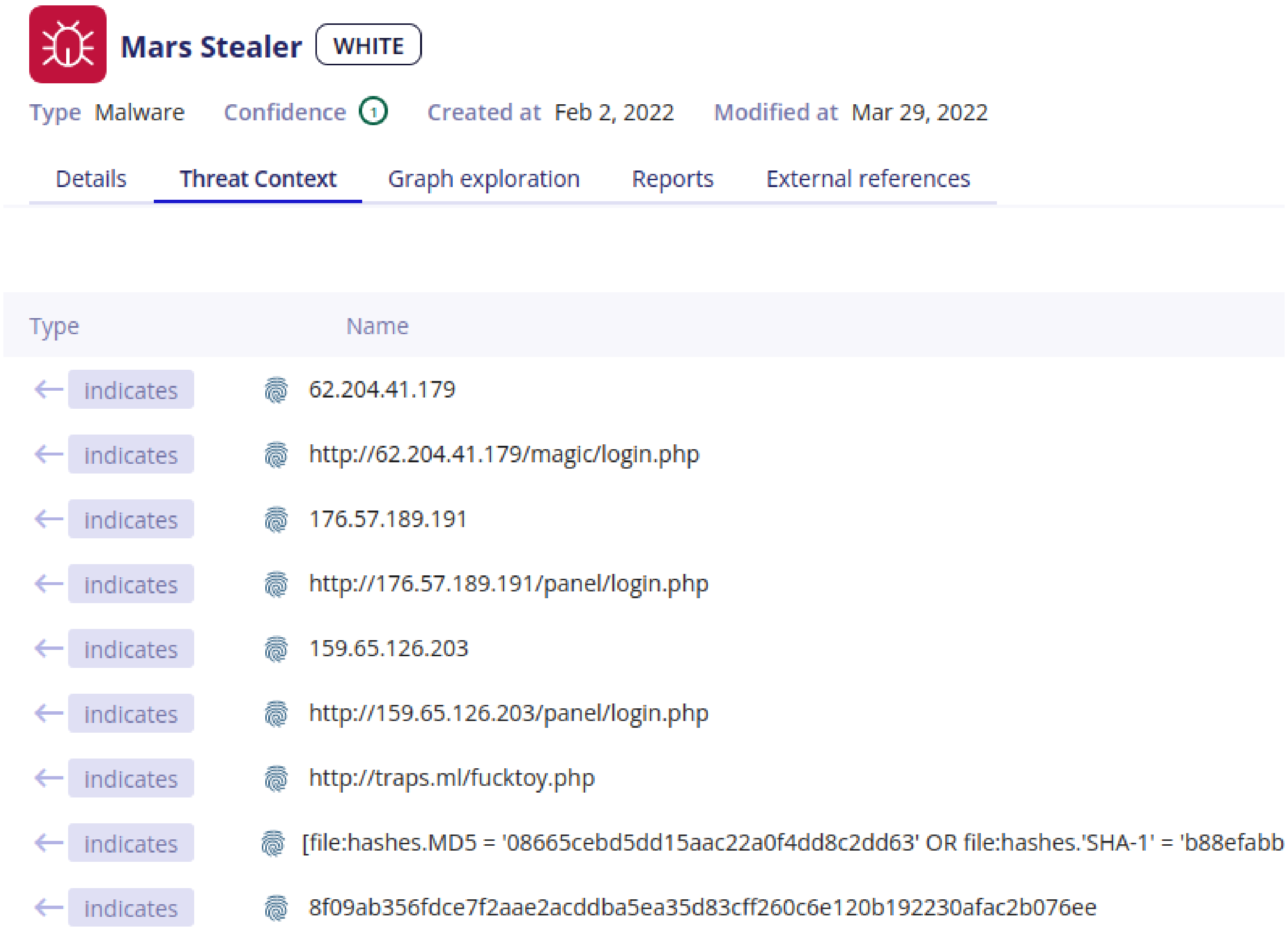
Twice a week, one of our workers of the SEKOIA Malware Watcher project pulls samples from VirusTotal that match our YARA rule mentioned in the “Collecting Mars Stealer samples” section and submits these samples to our FAME instance. C2 are extracted via FAME and finally pushed contextualized to SEKOIA.IO with the relationship indicating the Mars Stealer malware.



```
import “pe”
rule mars_stealer{
  <redacted>
  condition:
      for any i in ( 0..pe.number_of_sections-1 ) : (
                   pe.sections[i].name == "LLCPPC" and
                   pe.sections[i].raw_data_size < 5000 )
  <redacted>
}
```

Figure 29. From VirusTotal to SEKOIA.IO with FAME

The FAME module will be release as Open Source on the SEKOIA.IO public Github repository named fame_module[12]. The extractor is available as standalone script[13].



Type Malware Confidence 1 Created at Feb 2, 2022 Modified at Mar 29, 2022

Type	Name
← indicates	62.204.41.179
← indicates	http://62.204.41.179/magic/login.php
← indicates	176.57.189.191
← indicates	http://176.57.189.191/panel/login.php
← indicates	159.65.126.203
← indicates	http://159.65.126.203/panel/login.php
← indicates	http://traps.ml/fucktoy.php
← indicates	[file:hashes.MD5 = '08665cebd5dd15aac22a0f4dd8c2dd63' OR file:hashes.'SHA-1' = 'b88efabb
← indicates	8f09ab356fdce7f2aae2acddba5ea35d83cff260c6e120b192230afac2b076ee

Figure 30. Pushed IoCs in SEKOIA.IO from SEKOIA Malware Watcher

Extracted IoCs can be found in the SEKOIA.IO Intelligence Center under the Mars Stealer malware object on the Threat Context tab and these IoCs are tagged with the source SEKOIA Malware Watcher.

Resources

- IoCs: https://github.com/SEKOIA-IO/Community/blob/main/IOCs/marsstealer/mars_stealer_iocs_20220407.csv
- YARA rules:
  - infostealer_win_mars_stealer_early_version: https://github.com/SEKOIA-IO/Community/blob/main/IOCs/marsstealer/infostealer_marsstealer_early_version.yar
  - infostealer_win_mars_stealer_llcppc: https://github.com/SEKOIA-IO/Community/blob/main/IOCs/marsstealer/infostealer_marsstealer_llcppc.yar
  - infostealer_win_mars_stealer_xor_routine: https://github.com/SEKOIA-IO/Community/blob/main/IOCs/marsstealer/infostealer_marsstealer_xor_routine.yar

- Standalone extraction script: https://github.com/SEKOIA-IO/Community/blob/main/scripts/mars_stealer_c2_extractor.py

External references

[1] 3xp0rt analysis of Mars Stealer, February 1, 2022

[2] Exclusive Threat Research: Mars (Stealer) Attacks!, MorphisecLab, March 29, 2022

[3] Масове розповсюдження шкідливої програми MarsStealer серед громадян України та вітчизняних організацій, CERT UA, March 30, 2022

[4] Lapsus$: when kiddies play in the big league, SEKOIA TDR, March 23, 2022

[5] The Command & Control infrastructures of cyber attackers observed in 2021 by SEKOIA.IO, SEKOIA TDR, January, 2022

[6] URL Scan Mars Stealer Administration Panel Heuristic

[7] RC4: Rivest Cipher 4, Wikipedia

[8] Sysinternal tool: Rootkit detection utility, Microsoft

[9] Themida Overview, Oreans Technologies

[10] FAME Automates Malware Evaluation, CERT Société Générale & CERT SEKOIA

[11] Python library r2pipe, Radare2

[12] FAME module: Mars Stealer configuration extractor, SEKOIA TDR

[13] Standalone script: Mars Stealer configuration extractor, SEKOIA TDR

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