Decrypting the Mystery of MedusaLocker

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Shayan Ahmed Khan April 20, 2024

```
if ( !CLSIDFromString(L"{3E5FC7F9-9A51-4367-9063-A120244FBEC7}", &CLSID_CMSTPLUA) )
{
  IID_ICMLuaUtil.Data1 = 0;
  *&IID_ICMLuaUtil.Data2 = 0;
  *IID_ICMLuaUtil.Data4 = 0;
  *&IID_ICMLuaUtil.Data4[4] = 0;
  if ( !IIDFromString(L"{6EDD6D74-C007-4E75-B76A-E5740995E24C}", &IID_ICMLuaUtil) )
  {
    memset(szElevationMoniker, 0, sizeof(szElevationMoniker));
    wcscpy_s(szElevationMoniker, 260u, L"Elevation:Administrator!new:");
    wcscat_s(szElevationMoniker, 260u, L"{3E5FC7F9-9A51-4367-9063-A120244FBEC7}");
    memset_null_var(&pBindOptions, 36u);
    pBindOptions.cbStruct = 36;
    pBindOptions.dwClassContext = CLSCTX_LOCAL_SERVER;
    CMLuaUtil = 0;
    while ( CoGetObject(szElevationMoniker, &pBindOptions, &IID_ICMLuaUtil, &CMLuaUtil) )
      ;
    if ( CMLuaUtil )
    {
      v1 = get_module_handle_cmdline(v3);
      cmdline = ptr_to_value(v1);
      (CMLuaUtil->vtable->ShellExec)(CMLuaUtil, cmdline, NULL, NULL, SEE_MASK_DEFAULT, SW_SHOW);
      std::wstring::~wstring(v3);
      (CMLuaUtil->vtable->Release)(CMLuaUtil);
    }
```

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In this analysis, I will not cover the stage1 and stage2 of MedusaLocker which includes initial access using a maldoc and execution using a batch script that further calls a powershell to initiate the attack. I will analyze the Ransomware executable only which is the stage3 of MedusaLocker.

The MedusaLocker ransomware executable covers most of the MITRE ATT&CK tactics. The MITRE mapping provided by a sandbox of public report is given below:

This variant of MedusaLocker ransomware has a large number of steps in its execution. It follows a number of techniques from initial access to impact that we are going to explore one by one below:

Mutex

Let's start with one of the most common techniques used by ransomware which is creating a unique mutex to avoid running multiple instances of same malware. This is especially helpful in case of the ransomware that have worm like capabilities and can propagate and infect other systems. It is also helpful in case of a persistent malware that automatically starts execution if a time or an event has been triggered.

Check Mutex

Above code is disassembled from a stripped MedusaLocker ransomware executable. First function is a simple *log* subroutine that says "[Locker] Is running". Second function is the string format function called to format the unique mutex and then it is passed to the 3rd function which Creates the mutex.

Privilege Escalation

Before any critical operation, MedusaLocker tries to escalate privileges on the local system. It does so by abusing COM objects to bypass UAC (User Account Control) which is a built-in security measure. There is a known UAC bypass of CMSTPLUA COM interface.

Privilege Escalation by abusing COM objects

This code above is escalating privileges using CMSTPLUA COM object interface. These CLSIDs are referring to wshell exec object that is used to execute the command provided in the screenshot above. Since this is a stripped binary therefore the functions don't make much sense. However, if i rename the functions and parameters then it would be much easier to understand as in screenshot provided below:

Reformed Privilege Escalation Code

I have just extracted a TTP from real world malware. The next step is to emulate this procedure by recreating these malicious behaviors. Here for example, the behavior is mapped as a TTP like:

1.
2.
3.

Defacement

One unique characteristic by MedusaLocker ransomware is that it adds a marker registry key that shows that a particular system has been infected by MedusaLocker. The purpose of this procedure is not known but it looks like a defacement strategy or just leaving a mark in the system. Harmful or not, it's an important behavior followed by a very dangerous ransomware.

MedusaLocker marker

The path for registry key is **“HKEY_CURRENT_USER\SOFTWARE\MDSLK\Self”**. The abbreviation of MDSLK might be MedusaLocker. This tactic is mapped on MITRE as:

1.
2.
3.

Persistence

MedusaLocker uses a different way of achieving persistence. It uses official Microsoft Documented Code for achieving persistence by scheduling a task with repetition of 15 minutes indefinitely. Typically, malware uses either at.exe or schtasks.exe which are official Microsoft apps for scheduling tasks, but in this case the malware scheduled task programmatically in c++ using official code from MSDN page of Microsoft.

Persistence using task scheduling

The malware creates a copy of itself with the name of **“svhost.exe”** in **%APPDATA%** of the system and registers itself in task scheduler to be executed after every 15 minutes indefinitely. Here comes the use of mutex, when its executed again, it first checks if another instance is already running in the system. If it does, then malware exits and let the previous instance continue. The MITRE mapping for this behavior would be:

1.
2.
3.

Defense Evasion

There are multiple defense evasion techniques used by the malware, one of which is to disable UAC (User Account Control) altogether. Since malware achieved elevated privileges using CMSTPLUA bypass. Now it can make critical changes to the system, one of which is to disable the UAC. It does so by changing registry values as shown in the code below:

Disable UAC

It sets the value of **“EnableLUA”** to 0, which means the administrator prompt will not be shown and everything would be executed with elevated privileges. The author of this malware tried another extra step to disable UAC by setting the value of **“ConsentPromptBehaviorAdmin”** to 0 as well. By any chance, if the first didn’t work then the second technique would make sure that UAC is disabled but it would only work after system restart. Their MITRE behavioral mapping is as follow:

1.

2.
3.

Service Stop

Another highly critical impact this malware has is that it stops and deletes a set of pre-defined services and processes to avoid any interruption for its encryption process. These sets of services can be found in simple static analysis of strings from the binary.

List of services to stop

Image above shows all the services and processes that it tries to enumerate and kills them off. It uses Windows Service Control Manager APIs to interact with services to stop and even delete the services. For processes, it uses famous process enumerator APIs “CreateToolhelp32Snapshot, Process32First and Process32Next”. MITRE mapping for this behavior is given below:

1.
2.

Inhibit System Recovery

Like most of the ransomware, MedusaLocker also tries to delete ways of recovering data from the victim system. However, unlike most ransomware, it does so by deleting multiple recovery options instead of just deleting shadow copies. It uses both **vssadmin** and **wbadmin** to delete shadow copies from the system. It also deletes other recovery options using **bcdedit.exe** to prevent the system from being rebooted into the recovery mode. As an additional step, it also empties the recycle bin just to make sure.

Deleting recovery options

Every single command listed above is executed by **CreateProcessW** API, which takes the first whitespace as an indicator for process name and rest as an argument to that process. Highlighted sub-routine named **sub_41E9A0** creates these processes as follows:

Create process for deleting recovery files

The MITRE mapping for this malware behavior can be mapped on the Impact as follows:

1.
2.

Encryption

Like most of the ransomware, MedusaLocker also uses symmetric encryption for fast processing. It uses AES-256 for encrypting all files on the system. However, it uses a combination of both RSA and AES in the malware process. The encryption key is encrypted with the pre-defined public key embedded into the malware which could only be decrypted with the attacker's private key. The malware authors wrote code in such a way that every file is encrypted with random generated AES key which is in turn encrypted using RSA public key and saved on the system along with multiple ransom notes.

Encryption Routine

In the above screenshot, it can be seen that the a base64 encoded public key has been embedded into the malware. I have extracted the strings from the malware using floss utility. The base64 encoded key is then converted to binary format using **"CryptStringToBinaryA"** API for use in cryptographic functions. Finally, the symmetric key is generated using **"CryptGenKey"** API which is encrypted with public key and saved in the html ransom note. After that the encryptor is started which establishes important folders and extensions to skip during encryption as shown in the extracted strings just below the public key.

The MITRE mapping for this malware behavior can be mapped on the Impact as follows:

1.
2.

To recreate this test-case, I can write a c++ code that starts an asynchronous thread for encryptor function that constantly searches and encrypts the files. Meanwhile, also saving the ransom html note that includes encrypted symmetric key in it.

Discovery and Lateral Movement

The malware possesses a networking module that enables it to establish connections to remote systems within the local network and scan for SMB shares. The initial step involves sending an ICMP "Ping" to each system in a sequential order and verifying if a response is received. After that, the malware will proceed to examine the system for any open SMB shares, excluding shares with a "$" in their name, which indicates hidden shares. The malware will then accumulate the remaining shares in a list, which will be encrypted at a later stage.

Ping systems

The MITRE mapping for this malware behavior can be mapped on the Impact as follows:

1.
2.
3.

I have covered most of the major attack paths or malicious behaviors from MedusaLocker ransomware. In the next part of this report, I will discuss how to emulate these behaviors for thorough security testing and reporting.

Behavior Emulation

We call every phase of attack cycle as a malicious behavior and every behavior is mapped on one MITRE tactic, technique, or sub-technique. Since, I have extracted all the major behaviors from MedusaLocker Ransomware therefore, the next step is to recreate these behaviors in safe exploitation manner for complete APT emulation. I use a combination of techniques to recreate these behaviors, like tracing API calls used by malware or coding the exact way the malware has achieved a certain behavior or contacting the same malicious urls as used by the malware. I have also incorporated chatGPT in this behavior recreation phase, I analyze the malware, understand its practices and APIs used by malware and recreate those behaviors using chatGPT.

For example, I am going to recreate the behavior of **Impact** tactic with **Inhibit System Recovery** as the technique. The behavior used by malware is to execute a number of commands from an array using **CreateProcessW** to delete shadow copies and other recovery options from the system. I queried chatGPT with the commands to be executed and the API by which they must be executed and as a result it recreated the whole behavior itself.

Behavior recreation with ChatGPT

As can be seen in the screenshot above, chatGPT recreated fairly similar code to what we saw in the binary during our reverse engineering of the malware sample. I can recreate most of the behaviors with little tweaking using this methodology.

Once all the behaviors have been recreated, we then launch all behaviors in a sequential manner and then evaluate where a security control is weak against a particular APT campaign or attack path. This methodology of dividing and testing against individual behaviors provides us in-depth analysis of security controls and their weaknesses. One problem with running exploit as a whole is that we do not know on what basis the security control or system policies have been able to detect and quarantine the malware. Hence, the mitigation could not be accurate.

Check out my Github Repo of Malware Analysis Series!!!

Sample hash: 26af2222204fca27c0fdabf9eefbfdb638a8a9322b297119f85cce3c708090f0