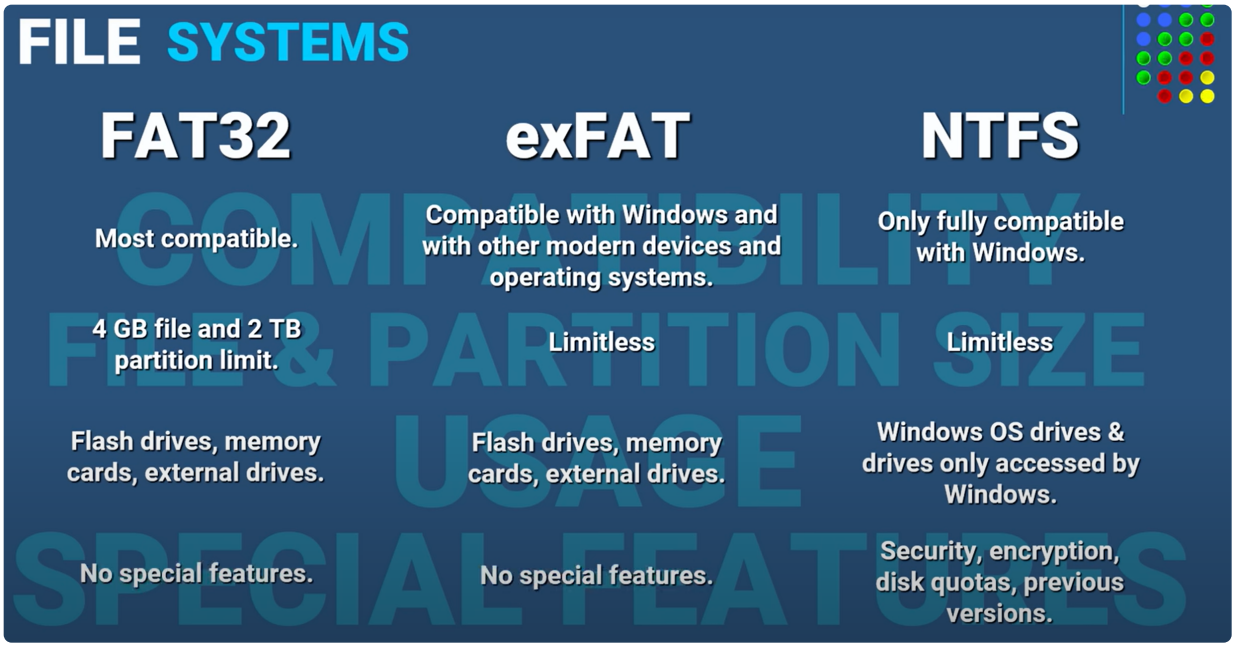
Labs - Introduction to Digital Forensics

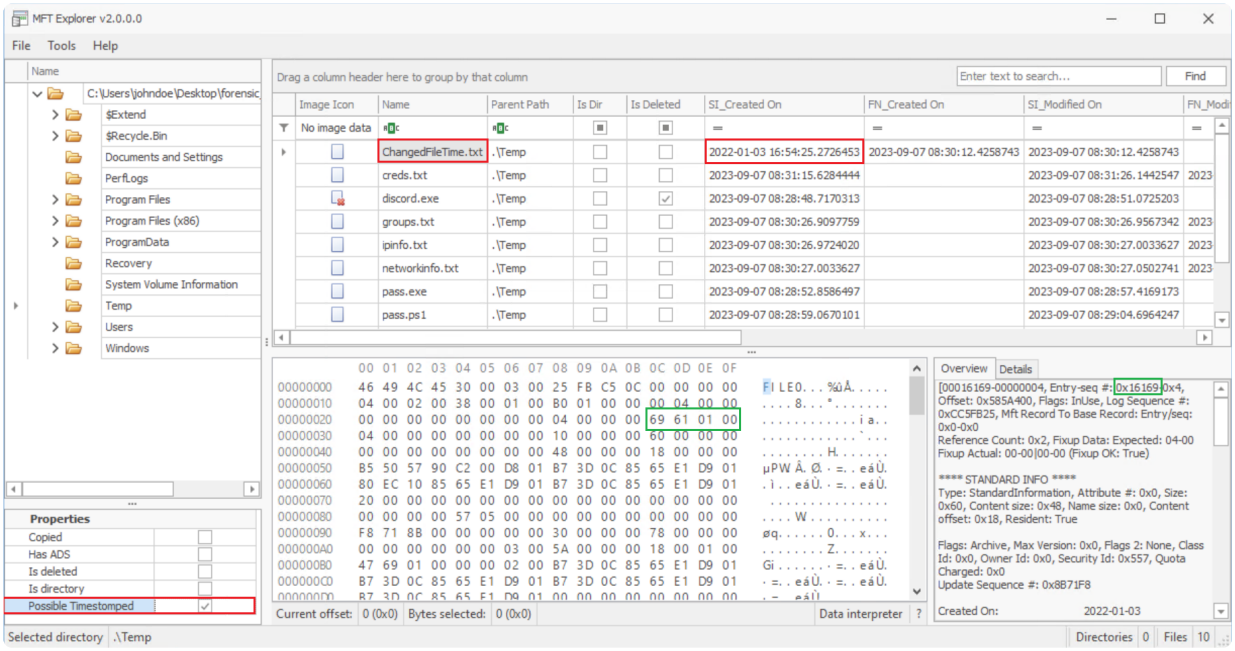
Preliminary knowledge

- Forensics image: An direct copy of a physical storage device (including computers).
- File System: Organised storage of data on computer for efficiency, compatibility...
- FAT: Known as File allocation table, it's the earliest file system and the most compatible File System but support file only up to 4gb and supports max partition of 2TB
- exFat: Known as extended File allocation table, it's an improvement over FAT and supports max partition size of much much over 2TB (limitless) as well as file size but not as compatbile as FAT.
- NTFS: Known as New Technology File system, it's benefit over FAT is unlimit File and disk partition size and become particular after release of Windows XP. It also supports my features than FAT32 and exFAT (such as security and previous versions (shadow copy) on the file tab as an illustration) but has the least compatibility of the three.

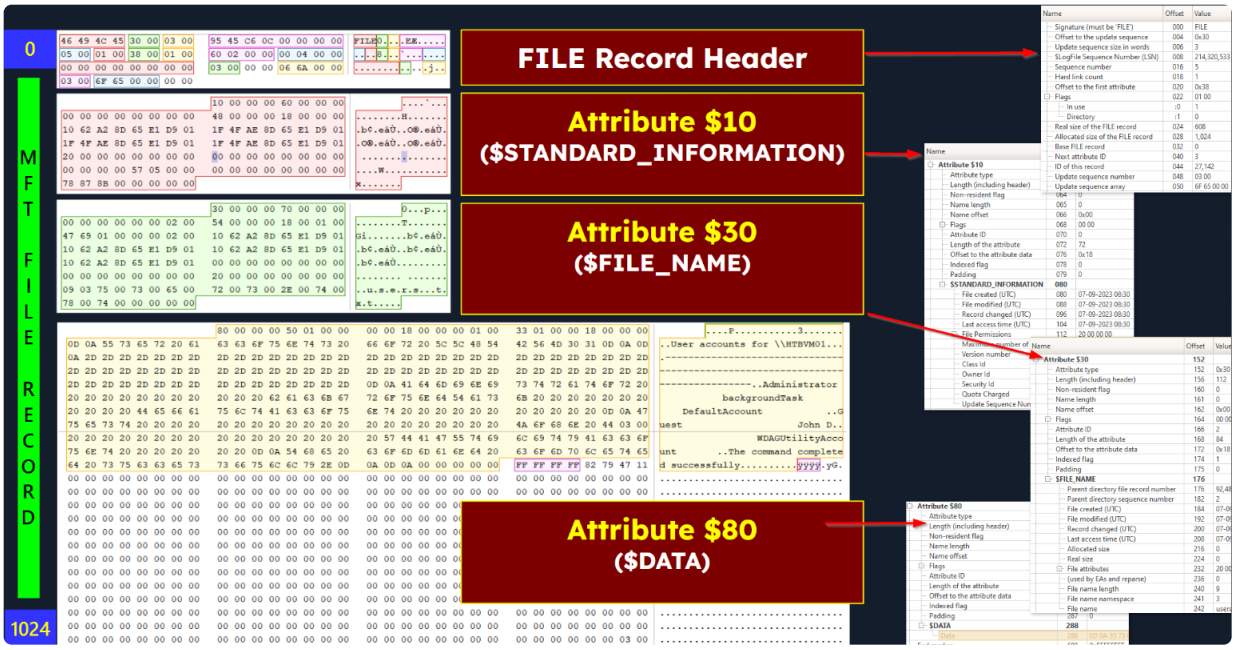


https://www.youtube.com/watch?v=bYjQakUxeVY

- MFT: Known as master file table, it's a file that contains the file metadata for the NTFS file system.
  - Cool thing is that when files are deleted (e.g. from an NTFS system volume), the MFT entries are marked as free and may be reused (so recovery isn't always possible)
  https://www.youtube.com/watch?v=h8Mb55ox5OE
- MFT entry sequence number (seems to be an sequence number that conveniently maps to the MFT file), also known as the ID of this record:

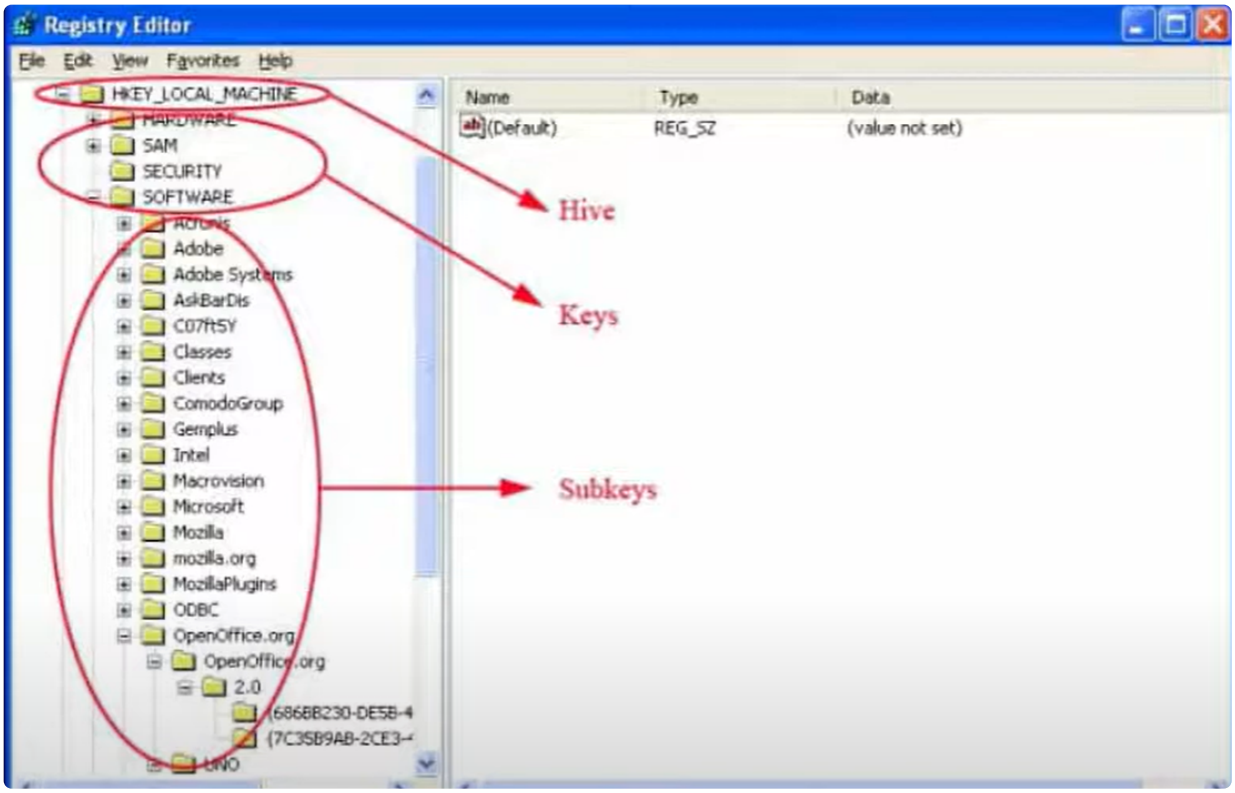


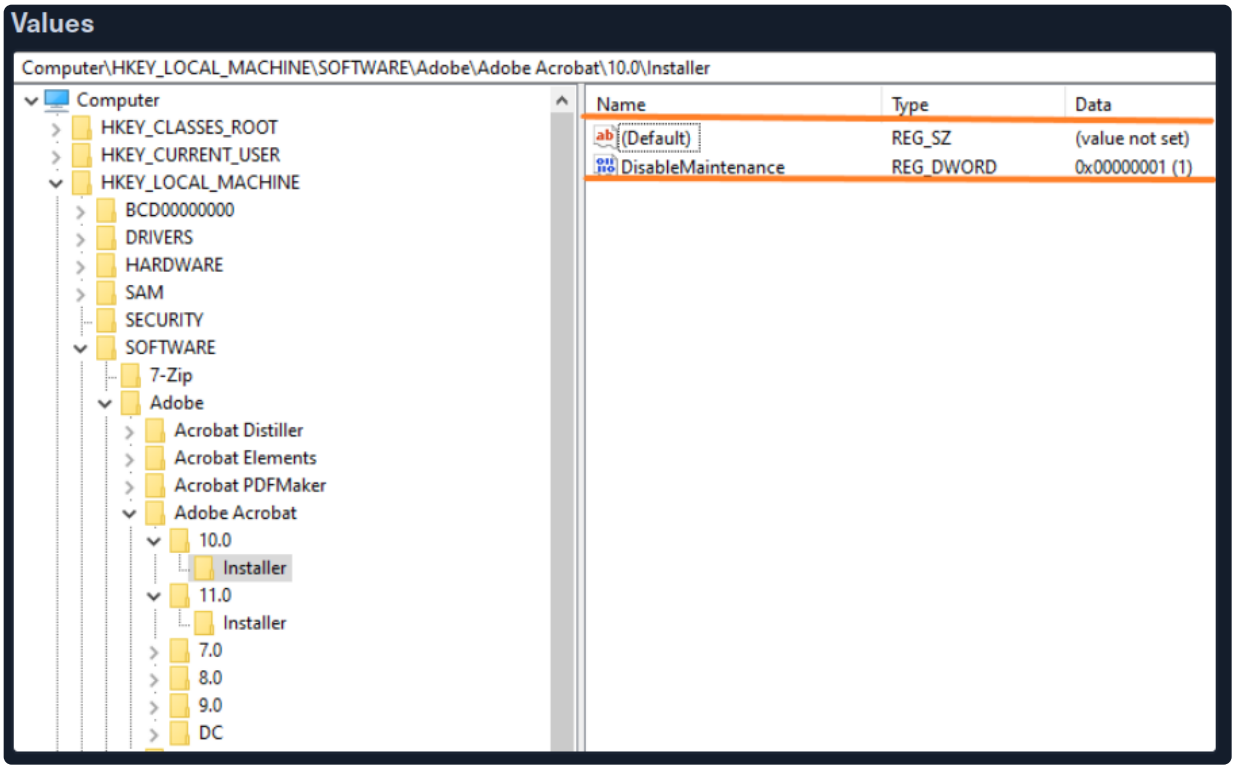

```
Usage:
  MFTECmd [options]

Options:
  -f <f>            File to process ($MFT | $J | $Boot | $SDS | $I30). Required
  -m <m>            $MFT file to use when -f points to a $J file (Use this to resolve parent path in $J CSV output)
  --json <json>     Directory to save JSON formatted results to. This or --csv required unless --de or --body is
                    specified
  --jsonf <jsonf>   File name to save JSON formatted results to. When present, overrides default name
  --csv <csv>       Directory to save CSV formatted results to. This or --json required unless --de or --body is
                    specified
  --csvf <csvf>     File name to save CSV formatted results to. When present, overrides default name
  --body <body>     Directory to save bodyfile formatted results to. --bdl is also required when using this option
  --bodyf <bodyf>   File name to save body formatted results to. When present, overrides default name
  --bdl <bdl>       Drive letter (C, D, etc.) to use with bodyfile. Only the drive letter itself should be provided
  --blf             When true, use LF vs CRLF for newlines [default: False]
  --dd <dd>         Directory to save exported $MFT FILE record. --do is also required when using this option
  --do <do>         Offset of the $MFT FILE record to dump as decimal or hex. Ex: 5120 or 0x1400 Use --de or --debug to
                    see offsets
  --de <de>         Dump full details for $MFT entry/sequence #. Format is 'Entry' or 'Entry-Seq' as decimal or hex.
                    Example: 5, 624-5 or 0x270-0x5.
  --dr              When true, dump $MFT resident files to dir specified by --csv, in 'Resident' subdirectory. Files
                    will be named '<EntryNumber>-<SequenceNumber>_<FileName>.bin'
  --fls             When true, displays contents of directory from $MFT specified by --de. Ignored when --de points to a

                    file [default: False]
  --ds <ds>         Dump full details for Security Id from $SDS as decimal or hex. Example: 624 or 0x270
  --dt <dt>         The custom date/time format to use when displaying time stamps. See https://goo.gl/CNVq0k for
                    options [default: yyyy-MM-dd HH:mm:ss.fffffff]
  --sn              Include DOS file name types in $MFT output [default: False]
  --fl              Generate condensed file listing of parsed $MFT contents. Requires --csv [default: False]
  --at              When true, include all timestamps from 0x30 attribute vs only when they differ from 0x10 in the $MFT

                    [default: False]
  --rs              When true, recover slack space from FILE records when processing $MFT files. This option has no
                    effect for $I30 files [default: False]
  --vss             Process all Volume Shadow Copies that exist on drive specified by -f [default: False]
  --dedupe          Deduplicate -f & VSCs based on SHA-1. First file found wins [default: False]
  --debug           Show debug information during processing [default: False]
  --trace           Show trace information during processing [default: False]
  --version         Show version information
  -?, -h, --help    Show help and usage information
```

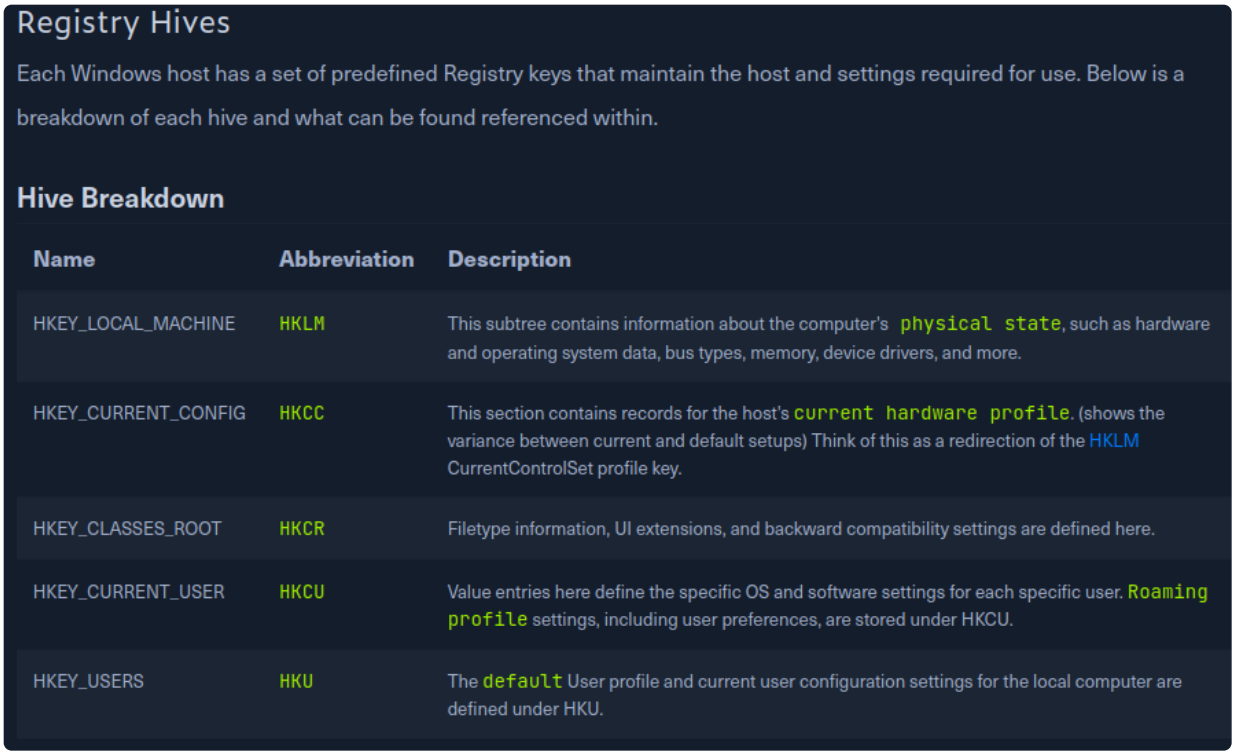


- File slack: Unused portion of storage given its memory allocation. The pudding and bowel illustration is an great explanation of this.
- Hard disk clusters: The smallest possible unit of storage on a hardware disk.
  https://www.canto.com/blog/file-slack/
  https://www.techrepublic.com/article/anatomy-of-hard-disk-clusters/
- File signature: An Specific byte sequence unique to a file
  https://nordvpn.com/cybersecurity/glossary/file-signature/
- USN Journal: Known as the update sequence number journal maintains change logs (creation, deletion and modification details) to file made to NTFS or ReFs volumes.
- Volumes: A volume is also known as a logical drive, where it is an accessible storage area with a single file system.
- A partition is a logcial separation of a hard disk.
  https://forensafe.com/blogs/usnjournal.html
  https://learn.microsoft.com/en-us/windows-hardware/drivers/ifs/storage-device-stacks--storage-volumes--and-file-system-stacks
  https://en.wikipedia.org/wiki/Volume_(computing)
- .LNK Files: It is known as a Windows short cut, which points to and is used to open another file, folder or application.
  https://fileinfo.com/extension/lnk
- Prefetch file: Files created by Windows OS to speed up loading time of applications through caching the necessary data for frequently used program.
- Cache: A smaller amount of faster but expensive memory for accessing data.
  https://www.geeksforgeeks.org/prefetch-files-in-windows/
  https://www.techtarget.com/searchstorage/definition/cache
- Windows registry: A hierarchical database that stores low-level settings for Microsoft Windows OS and for applications that uses the registry.

- Registry Hives: A logical group of keys, subkeys and values in the registry that has a set of supporting file loaded into memory when the OS is started or a user logs in.







Registry Hives

Each Windows host has a set of predefined Registry keys that maintain the host and settings required for use. Below is a breakdown of each hive and what can be found referenced within.

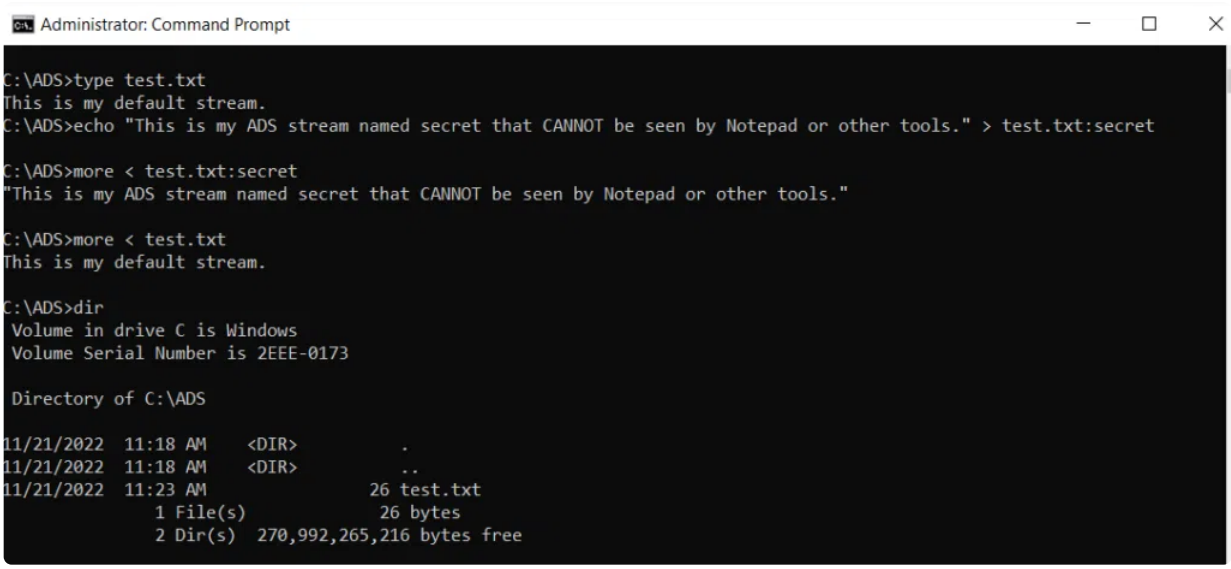
Hive Breakdown

Name	Abbreviation	Description
HKEY_LOCAL_MACHINE	HKLM	This subtree contains information about the computer's `physical state`, such as hardware and operating system data, bus types, memory, device drivers, and more.
HKEY_CURRENT_CONFIG	HKCC	This section contains records for the host's `current hardware profile`. (shows the variance between current and default setups) Think of this as a redirection of the HKLM CurrentControlSet profile key.
HKEY_CLASSES_ROOT	HKCR	Filetype information, UI extensions, and backward compatibility settings are defined here.
HKEY_USERS	HKU	The `default` User profile and current user configuration settings for the local computer are defined under HKU.

https://learn.microsoft.com/en-us/windows/win32/sysinfo/registry-hives
https://en.wikipedia.org/wiki/Windows_Registry

- Shellbags: Shellbags are set of registry keys which contain details about a user's viewed folder, such as its size, position and icon.
  https://medium.com/ce-digital-forensics/shellbag-analysis-18c9b2e87ac7
  https://www.youtube.com/watch?v=YvVemshnpKQ
- Thumbnail cache: It stores thumbnail images for for Window's Explorer's thumbnail view, so these images don't need to be calculated everytime it is viewed.
- File Explorer/Window's explorer: A file manager application that provides an GUI access for accessing file systems.
  https://en.wikipedia.org/wiki/Windows_thumbnail_cache
  https://en.wikipedia.org/wiki/File_Explorer
- Alternative Data Streams (ADS): An file stream that does not belong to the main data which can allow malicious data about a file hidden from the user. It is usually created manually.
  - Generally it is mostly used for zone.identifier for identifying web downloads in digital forensics.

E.g. Alternative data stream of secret.



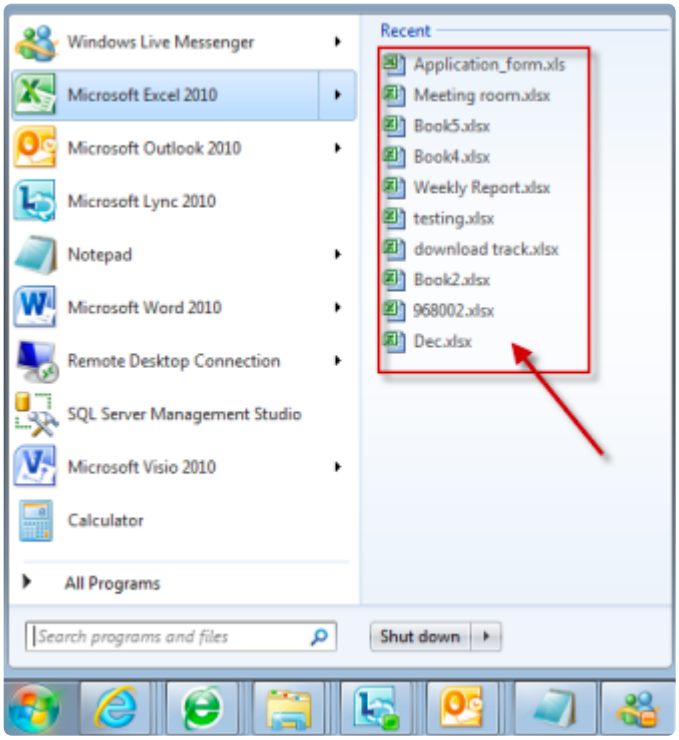
- File stream: An sequence of bytes about an data. By default there is only one main stream ($DATA or "").
  https://www.malwarebytes.com/blog/news/2015/07/introduction-to-alternate-data-streams
  https://blog.netwrix.com/2022/12/16/alternate_data_stream/
- Security identifier (SID): A unique value of variable length to identify a trustee (user account, group account, logon session) to which an access control entry (ACE).
- Security descriptor: A security descriptor contains security information (e.g. SIDS, DACL, SACL...) associated with a securable object
- Securable Object: An object that can have a security descriptor, where all named Windows object are securable.
  - Some e.g. of named object (?):

Object type	Security descriptor functions
Files or directories on an NTFS file system	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Named pipes Anonymous pipes	GetSecurityInfo, SetSecurityInfo
Processes Threads	GetSecurityInfo, SetSecurityInfo
File-mapping objects	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Access tokens	SetKernelObjectSecurity, GetKernelObjectSecurity
Window-management objects (window stations and desktops)	GetSecurityInfo, SetSecurityInfo
Registry keys	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Windows services	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Local or remote printers	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Network shares	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Interprocess synchronization objects (events, mutexes, semaphores, and waitable timers)	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Job objects	GetNamedSecurityInfo, SetNamedSecurityInfo, GetSecurityInfo, SetSecurityInfo
Directory service objects	These objects are handled by Active Directory Objects. For more information, see Active Directory Service Interfaces.

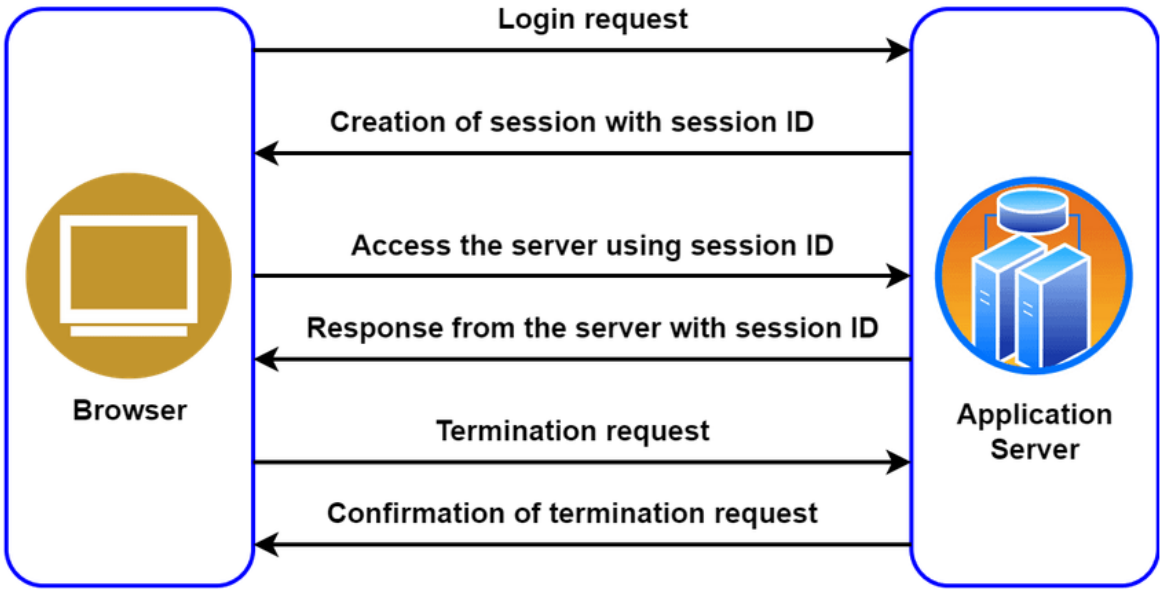
https://learn.microsoft.com/en-us/windows/win32/secauthz/security-descriptors
https://learn.microsoft.com/en-us/windows/win32/secauthz/trustees
https://learn.microsoft.com/en-us/windows/win32/secauthz/securable-objects

- Shimcache/AppCompatCache: It stores details about program execution details, including full file path, file size, process execution flag and is stored in the registry.
  - It is designed for installed programs/executables (does not necessarily need to be executed) and uses this info for troubleshooting with Compatibility mode.
- Amcache: It stores information abut program executions, including full execution path, deleted time, file hashes... and is stored in a registry or BCF file.
  - It is designed for applications that has been executed.
  https://medium.com/@mehrnoush/shimcache-amcache-forensic-analysis-99a8a9733772
  https://www.reddit.com/r/digitalforensics/comments/uvosan/the_difference_between_shimcache_amchachehve/

- UserAssist: A feature in windows that tracks the usage of executable files and application launched by the user.
  https://www.magnetforensics.com/blog/artifact-profile-userassist/
- RunMRU list: Known as the Run Most Recently used list is an window registry that stores most recently run/executed program.
  https://docs.velociraptor.app/artifact_references/pages/windows.timeline.registry.runmru/
- Jump List: Jump list is a feature that allows user to view most recently accessed or used files for specific applications.
  E.g. Jump list for Microsoft Excel 2010



- Registry run keys: Adding references to program of a run key causes the program referenced to run at startup and is often used by malicious actors.
  https://attack.mitre.org/techniques/T1547/001/
- Session: An mechanism that uses an unique ID to identify the user after it logs in (for web)


Login request
Creation of session with session ID
Access the server using session ID
Response from the server with session ID
Termination request
Confirmation of termination request
Browser
Application Server

In a world without cookies/ sessions....

I'm calling to confirm whether you changed my address like I asked you last Monday?

Ummm....excuse me sir, I have no idea who you are?

In a world with cookies/session...

Changed my address? Here's my ID card.

Of course,let me bring up your records to find out who you are.

I see that you are Brian May.Yes, we can confirm a change of address.Thank you for providing us with your ID

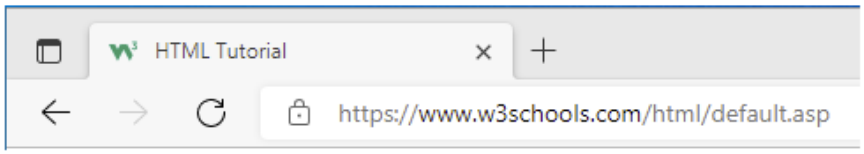
your ID

(By Ben Koshy, BKSpurgeon) - and yes, Queen is my fav band in the whole world!!

https://stackoverflow.com/questions/3804209/what-are-sessions-how-do-they-work
https://www.baeldung.com/cs/web-sessions

- Favicon: A favicon is a small image on the left next to the page title on the left.

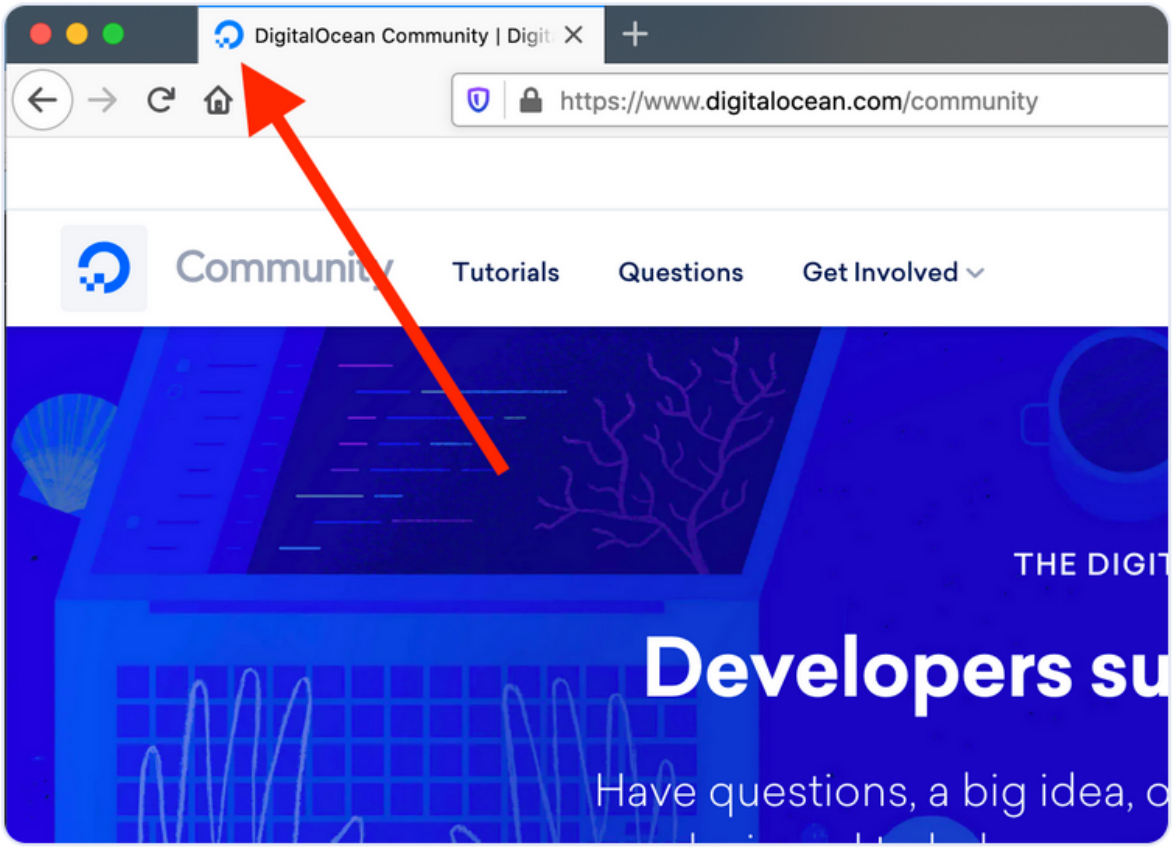
A favicon image is displayed to the left of the page title in the browser tab, like this:



To add a favicon to your website, either save your favicon image to the root directory of your we
images, and save your favicon image in this folder. A common name for a favicon image is "favi

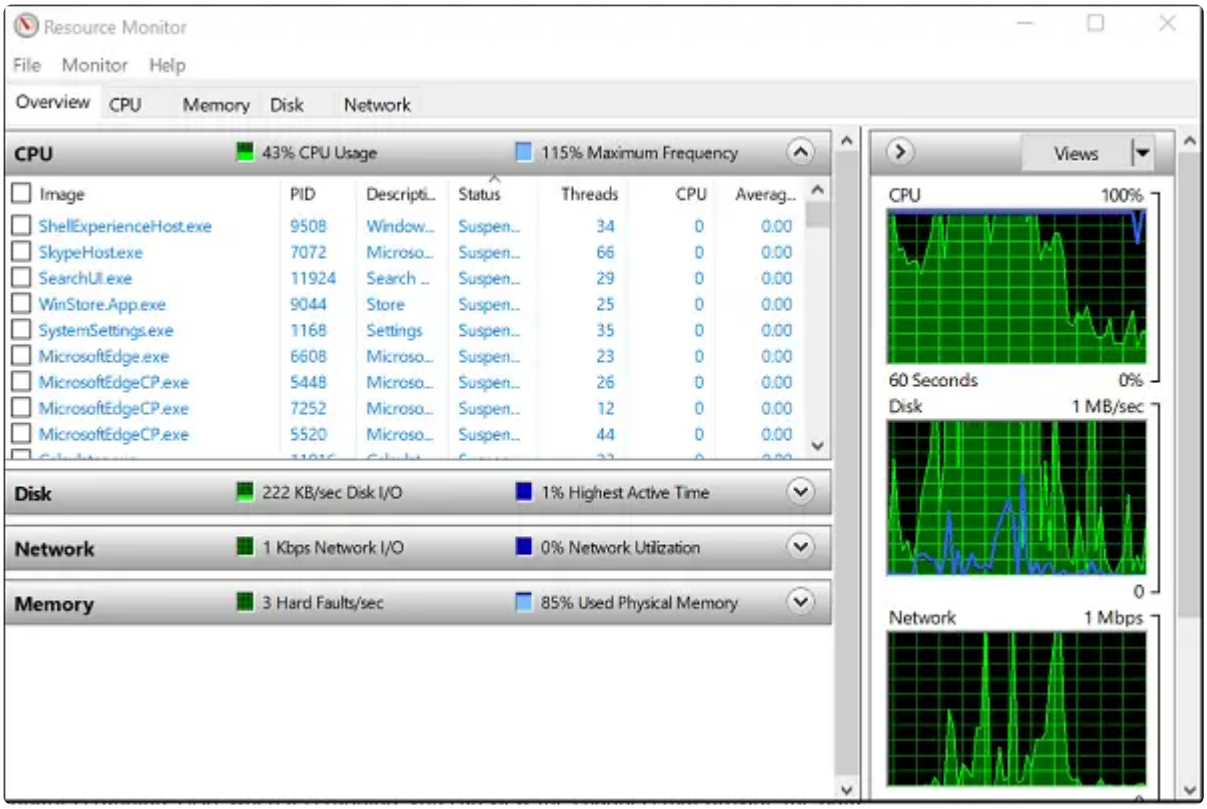
Next, add a `<link>` element to your "index.html" file, after the `<title>` element, like this:

A favicon is a small image that is located in the browser tab to the left of a webpage's title. The image below illustrates the location of a favicon.



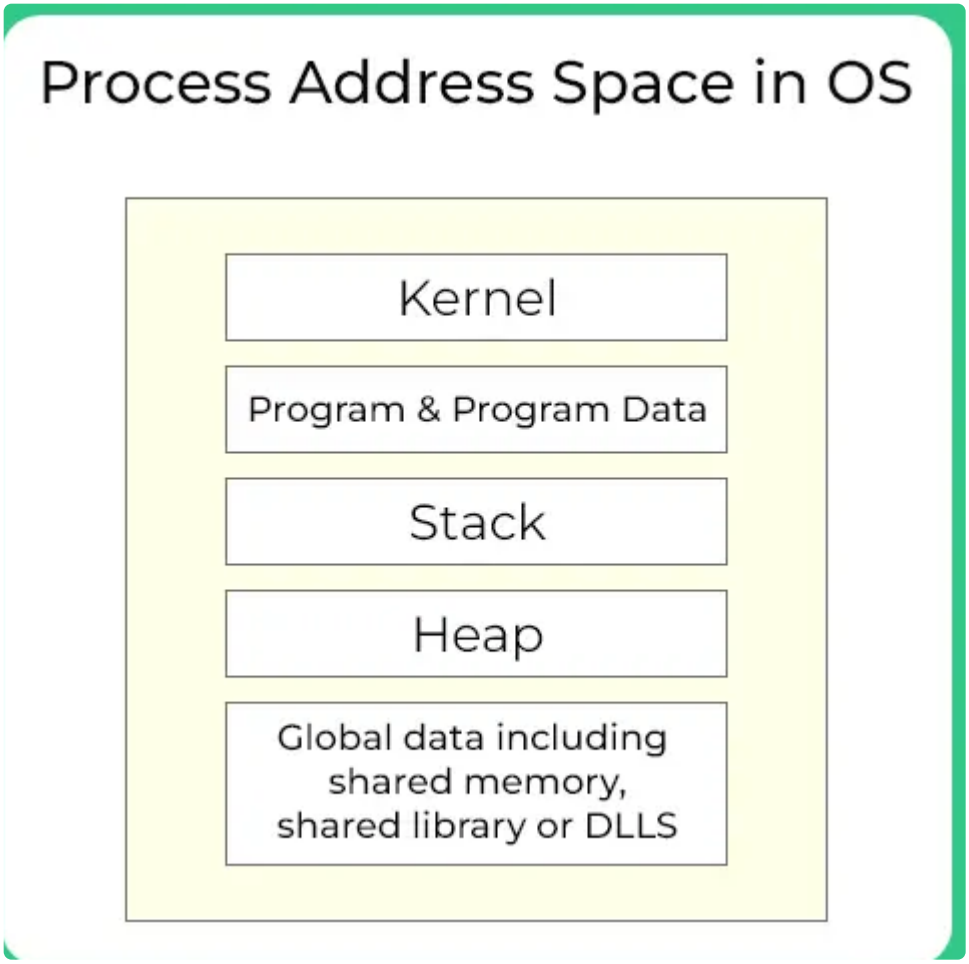
https://www.digitalocean.com/community/tutorials/how-to-add-a-favicon-to-your-website-with-html
https://www.w3schools.com/html/html_favicon.asp

- Tab recovery data: A feature that modern browsers implement and supports recovery of browser crash.
  https://helpdeskgeek.com/how-to/how-to-recover-closed-tabs-in-any-web-browser/
- SRUM: Known as System resource usage monitor, it tracks resource utilisation and application usage pattern.
  E.g. It looks like the following:



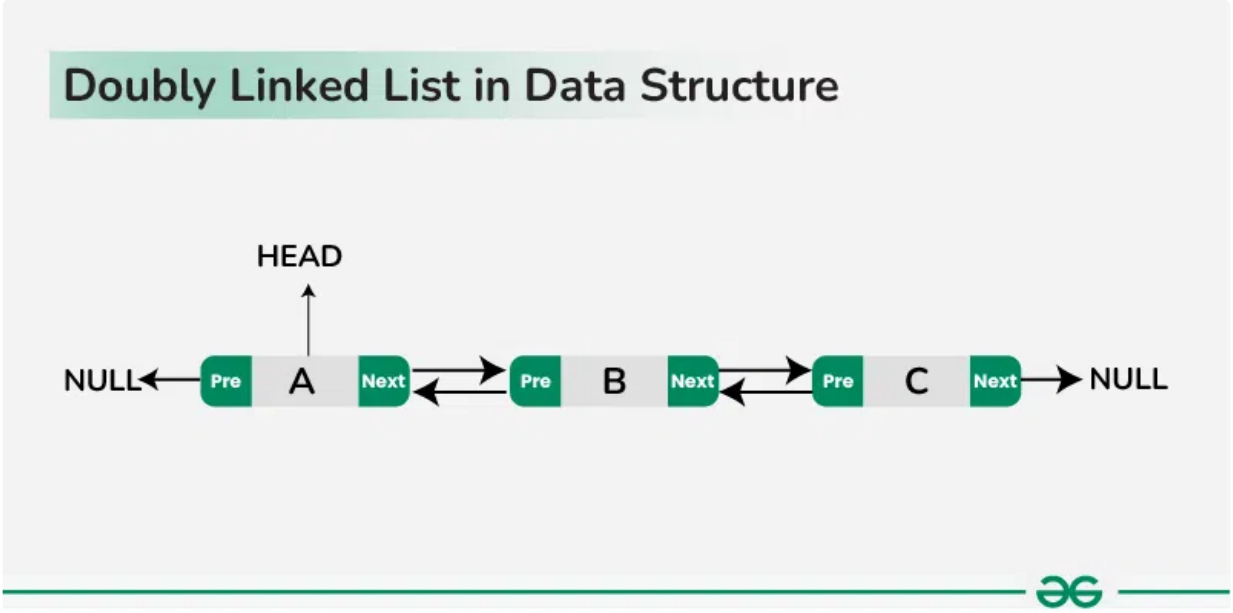
https://www.thewindowsclub.com/use-resource-monitor-windows-10

- SRUDB: It is the SRUM database and is also the same kinda of database used in AD, it is being written hourly and at system shutdown.
  https://www.magnetforensics.com/blog/srum-forensic-analysis-of-windows-system-resource-utilization-monitor/
- KAPE: A useful solution for extracting useful artifacts for forensic analysis.
- Artifacts: Pieces of evidence that maybe useful for our analysis.
- Handle: A handle in Windows is an abstract reference value to the resources, often memory or an open file, or a pipe.
  https://stackoverflow.com/questions/902967/what-is-a-windows-handle
- Beaconing: Beaconing is a term where malware periodically sends brief message from an infected host to an attacker's machine and is waiting for further instructions.
  https://healthybyte.net/cybersecurity/what-is-malware-beaconing
- Process hollowing: An technique where adversaries inject malicious code into suspended and hollowed process. It is a method of executing arbitrary code in the address space of a separate live process
- Process address space: The amount and space of memory allocated to a process. E.g. For an OS



https://prepinsta.com/operating-systems/process-address-space/
https://attack.mitre.org/techniques/T1055/012/

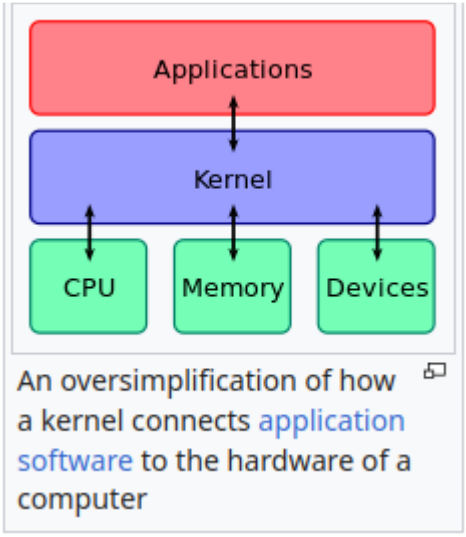
- Rootkit: An rootkit malware is an collection of software designed to give malicious actors control of a computer network or applications. They may also set up further exploits and deliver additional malware.
  https://www.crowdstrike.com/cybersecurity-101/malware/rootkits/
- Volatality: Open source tool for conducting memory forensic. Useful documentations are as follows:
  https://github.com/volatilityfoundation/volatility/wiki/Command-Reference
  https://github.com/volatilityfoundation/volatility/wiki/Command-Reference-Mal
  https://blog.onfvp.com/post/volatility-cheatsheet/
- Doubly linked list: A doubly linked list is a datastrcuture where it consist a set of nodes, each of which contains a value and two pointers.



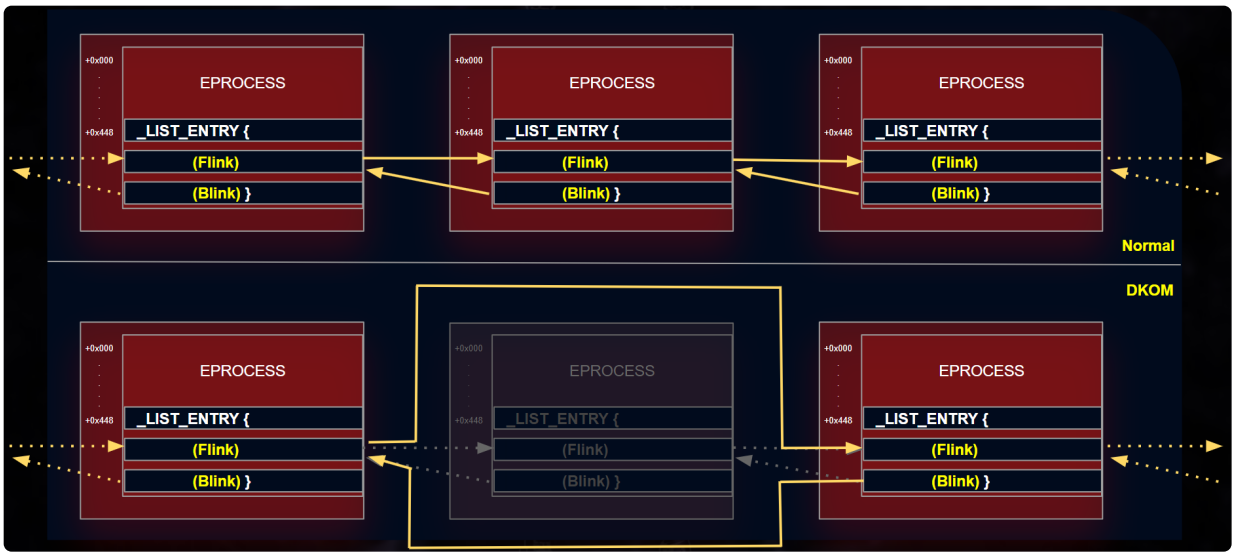
https://www.geeksforgeeks.org/doubly-linked-list/

- WoW64: Known as Windows 32-bit on Windows 64-bit, is a subsystem of Windows OS that can run 32-bit applications on 64-bit Windows.
  - It is included in all 64-bit versions of Windows.
- 32bit vs 64bit: it is where data units (such as integers, memory addresses) are in 32 or 64 bit untis respectively for the processing unit of the computer.
  https://en.wikipedia.org/wiki/WoW64
  https://www.lifewire.com/32-bit-64-bit-2624554
- Win7SP1x64: An specific windows version known as Windows 7 Service pack 1 (SP1)
- Memory pool: It is a logical division of main memory that is reserved for processing a job or group of jobs.
- Pool tag: A 4 byte character that is associated with a dynamically allocated chunk of pool memory. It is specified by a driver when it allocated the memory.
  - Pool tag scanning can help find process that previously terminated or have been hidden or unlinked by a rootkit.
  - But this pool tag can also be overwritten, but not often seem.
  https://www.geeksforgeeks.org/what-is-a-memory-pool/
  https://techcommunity.microsoft.com/t5/ask-the-performance-team/an-introduction-to-pool-tags/ba-p/372983
- svchost: A system process that can host one or more windows service on an Windows OS.
  https://en.wikipedia.org/wiki/Svchost.exe
- LoadCount: Load count is a 16-bit value which tells you whether an DLL is statically linked (if it is treated as an -1 0xffffff, otherwise it is dynamically linked).
  https://stackoverflow.com/questions/22855932/is-0x0000ffff-the-default-load-count-of-a-dll-in-windows

- Static vs dynamic linking: Dynamic link programs at run time, while static copies code the program would use from other files (e.g. object file) at compile time.
  https://earthly.dev/blog/static-and-dynamic-linking/
- Kernel: The core of an OS and controls over everything in the system



  https://en.wikipedia.org/wiki/Kernel_(operating_system)
- EProcess: A structure that is the Kernel's representation of a process object.
  https://www.geoffchappell.com/studies/windows/km/ntoskrnl/inc/ntos/ps/eprocess/index.htm
- Task scheduler: A job scheduler that launches computer programs or scripts at pre-defined times or specific time interval.
  https://en.wikipedia.org/wiki/Windows_Task_Scheduler
- Direct Kernel Object manipulation: A common rootkit technique to hide malciious program from task manager and event scheduler.
- E.g. (EProcess structure unlinking)



  https://en.wikipedia.org/wiki/Direct_kernel_object_manipulation
- Strings: Command that extracts strings out of files that aren't primarily text-based (guessing it most likely convert bytes values into ascii strings)

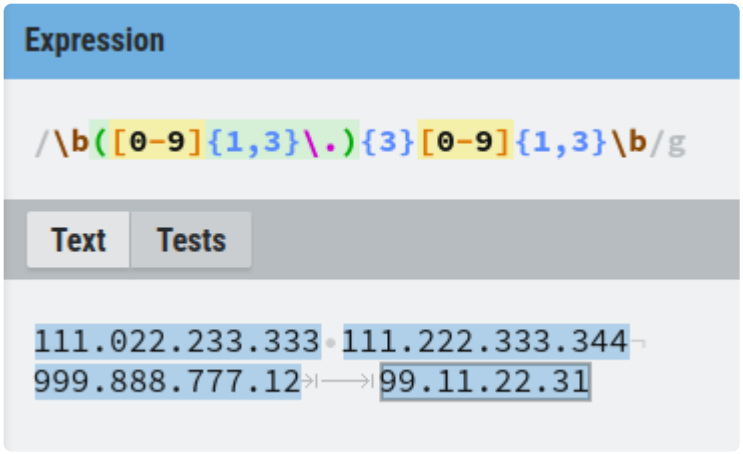
https://linuxopsys.com/strings-command-in-linux

- Word Boundaries: In regex, this is seen as boundaries between words, denoted as `\b` and there are three ways to use so for an character/words:
  1. Before
  2. After
  3. Before and after

  1.Before (notice how after s there is an word boundary, such as space/tab)

2. After (notice how there is an s boundary before the letter i)

3. Before and after (notice how between the ip address there are boundaries (tab, new line and space))

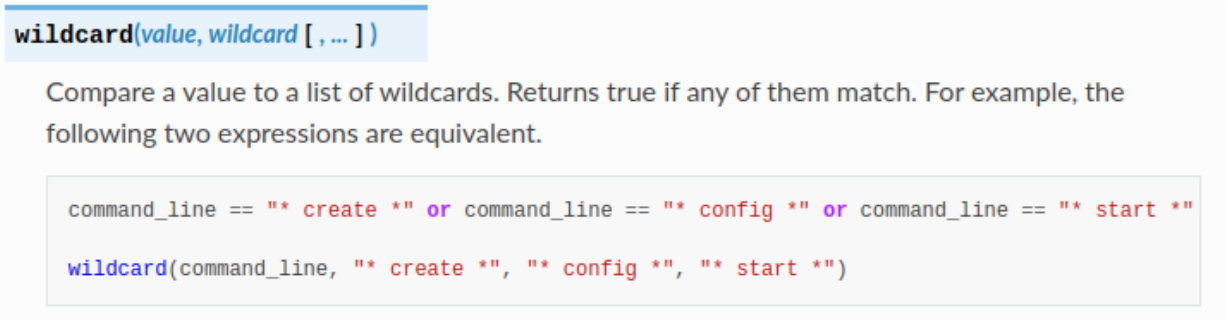


https://www.regular-expressions.info/wordboundaries.html
https://regexr.com/

- Timestomp: It is where adversaries modify file time attributes to hide new or changes to existing files.
  - In particular, they modify the timestamps of a file (the modify, access, create, and change times), often to mimic files that are in the same folder.
  - Looking at the MFT attribute would reveal the file genuine modification date, as attack need to have kernel level access to tamper that
  - If looking at the different in date between $FILE_NAME and $STANDARD_INFO have different values for date then that's a usually sign of timestompping.
- Zone.Identifier: It is a file that describes the security zone associated with another file.
  - It usually describes how "safe" the origin of the file is.
  - It is also an alternative data stream for the file.
  - It is also in an entry of the MFT
  https://fileinfo.com/extension/zone.identifier
- Logical drive: Defined as the portion of a storage drive, typically defined a letter in front of it, such as C:\.
  https://www.computerhope.com/jargon/l/logidriv.htm
- Parsing: In forensics, this means taking readable data and organising it into neat, usable format.
  https://cellebrite.com/en/glossary/parsing-mobile-device-forensics/
- Get-Item vs Get-Content: Get-Item gets you the item while Get-Content gets you the content of the item. It's like getting a bag, Get-Item gets you the bag while Get-Content gets you what's inside the bag (?)
  https://learn.microsoft.com/en-us/powershell/module/microsoft.powershell.management/get-content?view=powershell-7.4
  https://learn.microsoft.com/en-us/powershell/module/microsoft.powershell.management/get-item?view=powershell-7.4
- Non-terminating vs terminating errors: Non-terminating errors are errors that generate a warning to the user but doesn't shutdown the script while terminating errors are those that do
  https://www.oreilly.com/library/view/mastering-windows-powershell/9781787126305/bb1584d6-221a-4b22-8b65-8a2b1cb0e847.xhtml
- Refer url: The url refers/directs you to the host address (e.g. in an Zone.Identifier file stream) usually through an link.
  https://developer.mozilla.org/en-US/docs/Web/HTTP/Headers/Referer
- Mark of the Web (Motw): It is a security mechanism (warns user if they want to execute the file and if it's a word doc it runs in restricted mode... etc) that Windows use if files are downloaded from unsafe sources like the Internet. It is implemented through

ADS on zone.identifier of a file.
https://www.outflank.nl/blog/2020/03/30/mark-of-the-web-from-a-red-teams-perspective/

- MTFECmd: An command line MFT parser (also some similar files like USN Journal denoted as $J), particularly designed for NTFS file system.
  https://binaryforay.blogspot.com/2018/06/introducing-mftecmd.html
  https://github.com/EricZimmerman/MFTECmd
- .crdownload: A partially downloaded file created by google chrome, ms edge and chromium browsers that stores the content of the file when downloading it.
- Chromium browser: An open source software project first created by google that are used as an "base" or customised by many other browsers including Opera and Microsoft edge.
  https://www.microsoft.com/en-us/edge/learning-center/what-is-chromium-how-does-it-enhance-your-browser?form=MA13I2
  https://fileinfo.com/extension/crdownload
- Disable AntiSpyware registry key: By making the value to 1, we set the value of the key to true and turns on Microsoft Defender Antivirus.
  https://learn.microsoft.com/en-us/windows-hardware/customize/desktop/unattend/security-malware-windows-defender-disableantispyware
- scrape-events.ps1: Useful powerful shell function for parsing Sysmon events from the EQL repository.
  https://www.elastic.co/blog/getting-started-eql
- EQL query structure on Wildcard: The syntax equivalence as shown below.

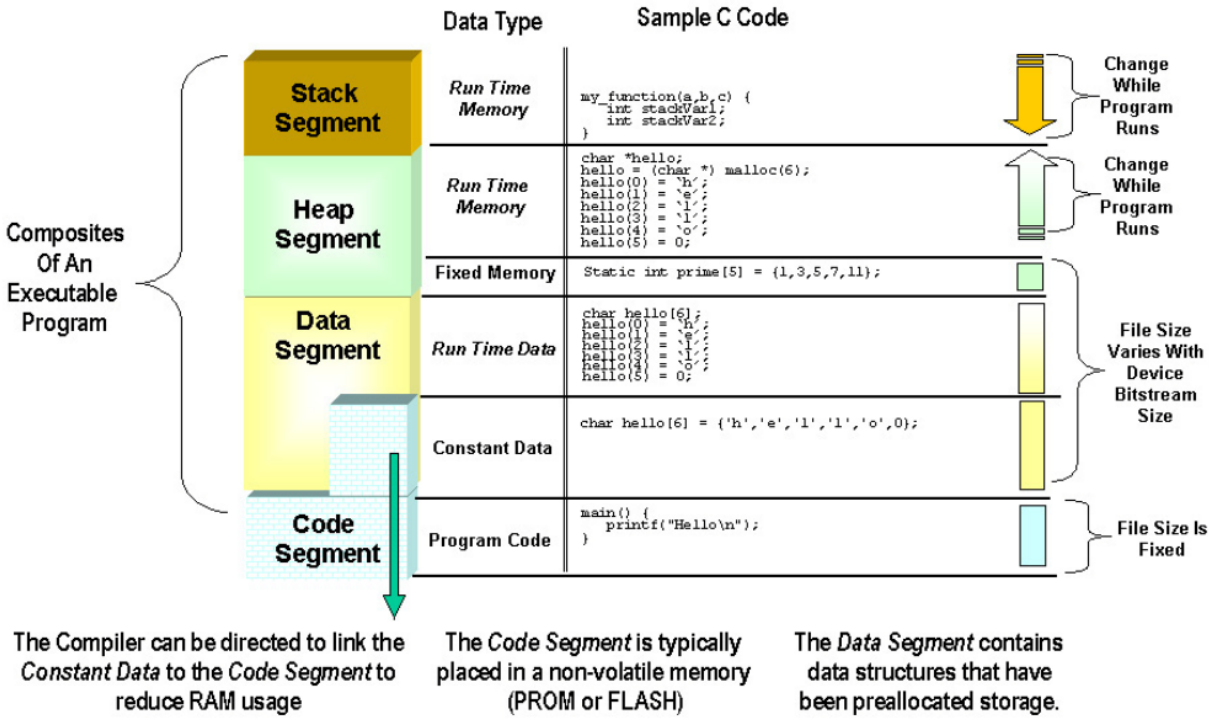


  -> One thing to note it doesn't go in great depth of the syntax and is different with the eql manual page (no syntax like process where process_name but just uses the function wildcard)
  -> Good reference guide overall
  https://eql.readthedocs.io/en/latest/query-guide/functions.html
- NTUSER.Dat: It is a hidden file that contains setting and preferences for each user.
- UsrClass.Dat: It is a user data file present on all computers
  https://answers.microsoft.com/en-us/windows/forum/all/delete-a-dat-file/5744c250-

105d-460a-bc52-d6c17948764d
https://www.howtogeek.com/401365/what-is-the-ntuser-file/

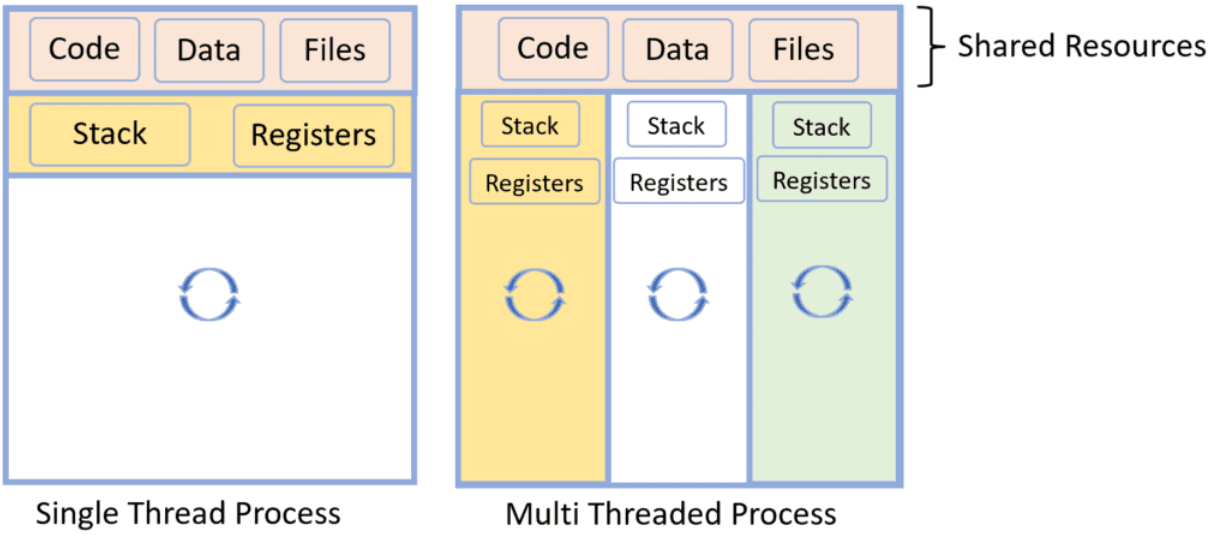
- Registry Transaction log files: These are files that act as journals that stores data written to the registry before written to the hive files, as they may be locked for writing or corruption.
  https://cloud.google.com/blog/topics/threat-intelligence/digging-up-the-past-windows-registry-forensics-revisited/
- Dirty hives: It is when the hives are probably not the most updated (since windows registry gets updated/flushed once every hour), so we need to replay the transaction log to make it "clean".
  https://medium.com/@mohit.r.phy/exploring-the-hive-deep-inside-the-windows-registry-pt-2-a46d7a3a7f7
  https://medium.com/@shunxianou/tryhackme-windows-forensics-1-detailed-write-up-5f4e3eaf8bd2
- Registry plugins: Based on observing its behaviour and description, they seem to be retrieving registry values or doing something related to registry.
- NIC: Known as the network interface card, it is an piece of hardware that allows computer to communicate with other devices on a network.
  - It also represents computer on the network and routers and switches uses the MAC address of the NIC card to identify the computer.
  https://www.codecademy.com/resources/blog/network-interface-card/
- Static/Dynamic Ip address: An Ip address that does not change/change
  https://www.techtarget.com/whatis/definition/static-IP-address#:~:text=A%20static%20IP%20address%20does,their%20ISP%20to%20change%20it.
- DHCP lease time: The amount of time you "leased" or can you use IP address given by the DHCP server.
  https://lazyadmin.nl/home-network/dhcp-lease-time/
- Bookmark in Registry Explorer: A shortcut for us to access keys/subkeys of the hive.
- sc.exe: Known as Windows service configuration tool and can be used to control a service.
  https://learn.microsoft.com/en-us/windows/win32/services/controlling-a-service-using-sc
  https://www.file.net/process/sc.exe.html
- Background Activity Moderator: Known as BAM, it is a windows service that controls activity of background applications.
  - For foresnics, it can be used to provide evidence of program execution.
  https://forensafe.com/blogs/bam.html

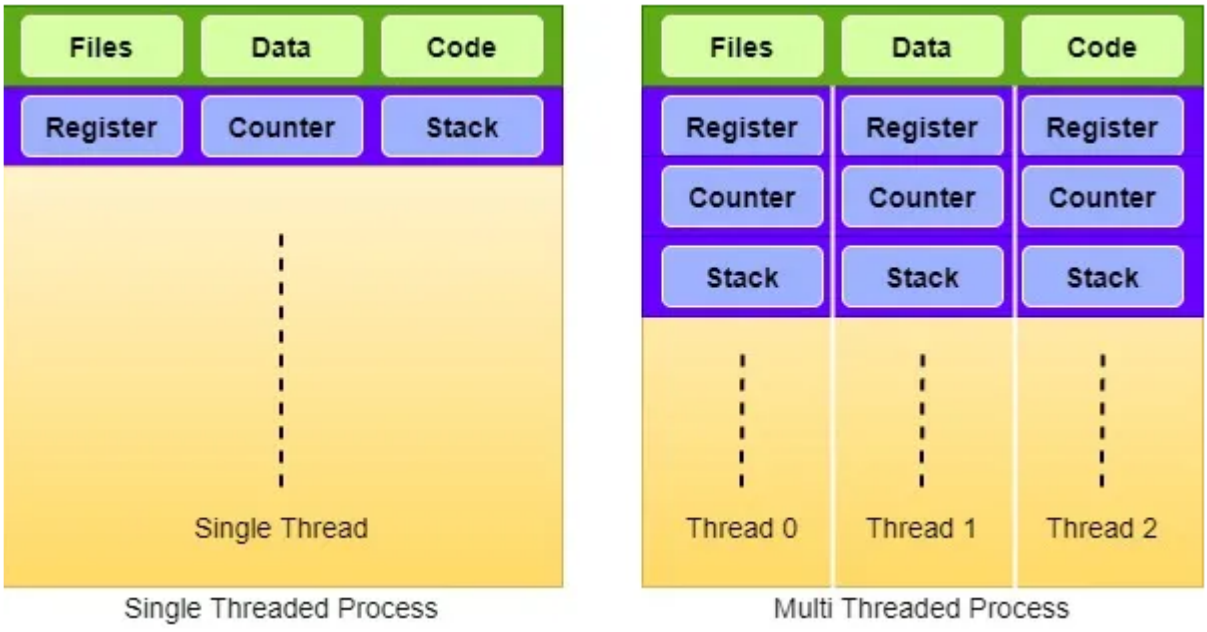
- Windows service: A windows service is a program that operates in the background (without user intervention).
  https://en.wikipedia.org/wiki/Windows_service
- RegOpenKeyExa: Windows API that opens an specific registry and receives the handle of the desired registry through the phkResult pointer that is inputted in the API call.
- RegSetValueExa: Sets the value of an registry key, which is usually combined with the registry key handle obtained via RegOpenKeyExa.
  https://learn.microsoft.com/en-us/windows/win32/api/winreg/nf-winreg-regopenkeyexa
  https://learn.microsoft.com/en-us/windows/win32/api/winreg/nf-winreg-regsetvalueexa
- REG_SZ registry value: An null-terminated string that is either a unicode or ANSI string.
  https://learn.microsoft.com/en-us/windows/win32/sysinfo/registry-value-types
- ANSI, unicode encoding: They are a specific type of encoding, while ANSI a modified form of ISO-8859-1 encoding, a superset of ANSI encoding (the one we commonly see), while Unicode is a encoding standard aimed at Universality.
  https://www.howtogeek.com/45765/htg-explains-what-are-character-encodings-and-how-do-they-differ/
- Process Injection: A technique where adversaries execute arbitrary code in the address space of a separate live process.
  https://attack.mitre.org/techniques/T1055/
- Memory segment of a executable program: Stack, heap, data and code segment. E.g. Visualisation

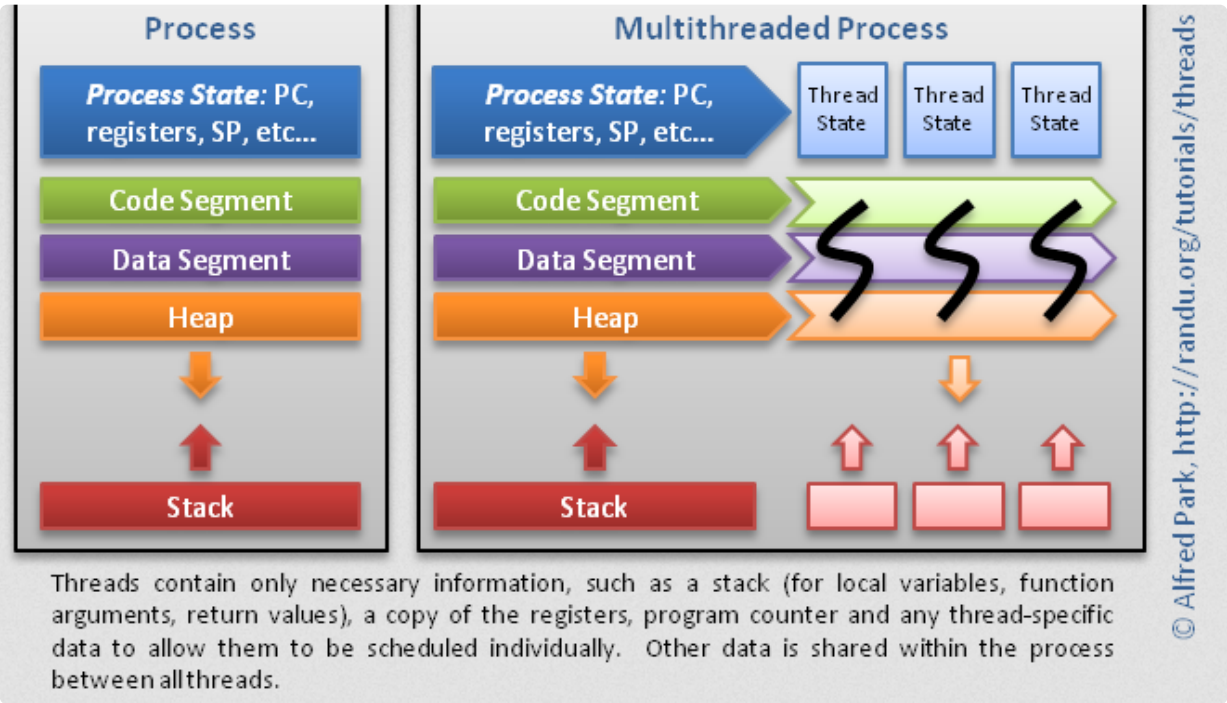


https://www.centennialsoftwaresolutions.com/post/good-visualization-of-stack-heap-etc

- Thread: An execution context for a process (book analogy: threads of the same program are like bookmarks of the same book, while CPU is like the person reading it).
  - The main difference between thread and processes are that distinct process exist in different memory spaces while distinct threads of a same process share all segment of a executable program except the stack.
  - Moreover, though threads have independent stack, we can still have pointers toward it and access the other thread's local memory.
  - E.g. Example of threads



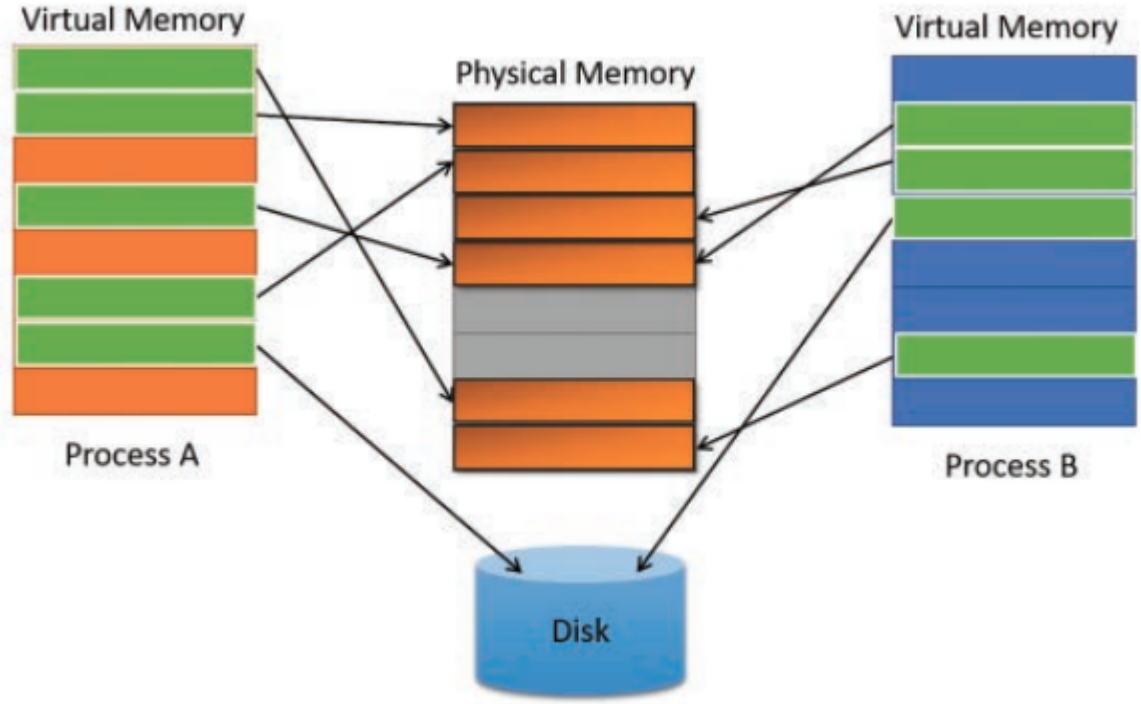




https://stackoverflow.com/questions/5201852/what-is-a-thread-really
https://stackoverflow.com/questions/1762418/what-resources-are-shared-between-threads
https://www.baeldung.com/cs/threads-sharing-resources
https://medium.com/@jithmisha/a-brief-intro-to-shared-memory-programming-with-posix-threads-a663b590e38c

- CreateProcessA: A windows api function that creates a new process and its primary thread.
  https://learn.microsoft.com/en-us/windows/win32/api/processthreadsapi/nf-processthreadsapi-createprocessa
- Create_Suspended process creation flag: It makes the primary thread of the new process in a suspended state and does not run until ResumeThread function is called.
  https://learn.microsoft.com/en-us/windows/win32/procthread/process-creation-flags
- Memory paging: It is an windows memory management mechanism that divides memory into chunks of 4kb called "pages".
  - Memory in windows OS are also not directly mapped to physical memory, instead they use a virtual memory that is mapped to physical memory.
  - The end goal seems to be saving as much physical memory as possible and allows processes to have different virtual memory but share the physical memory.

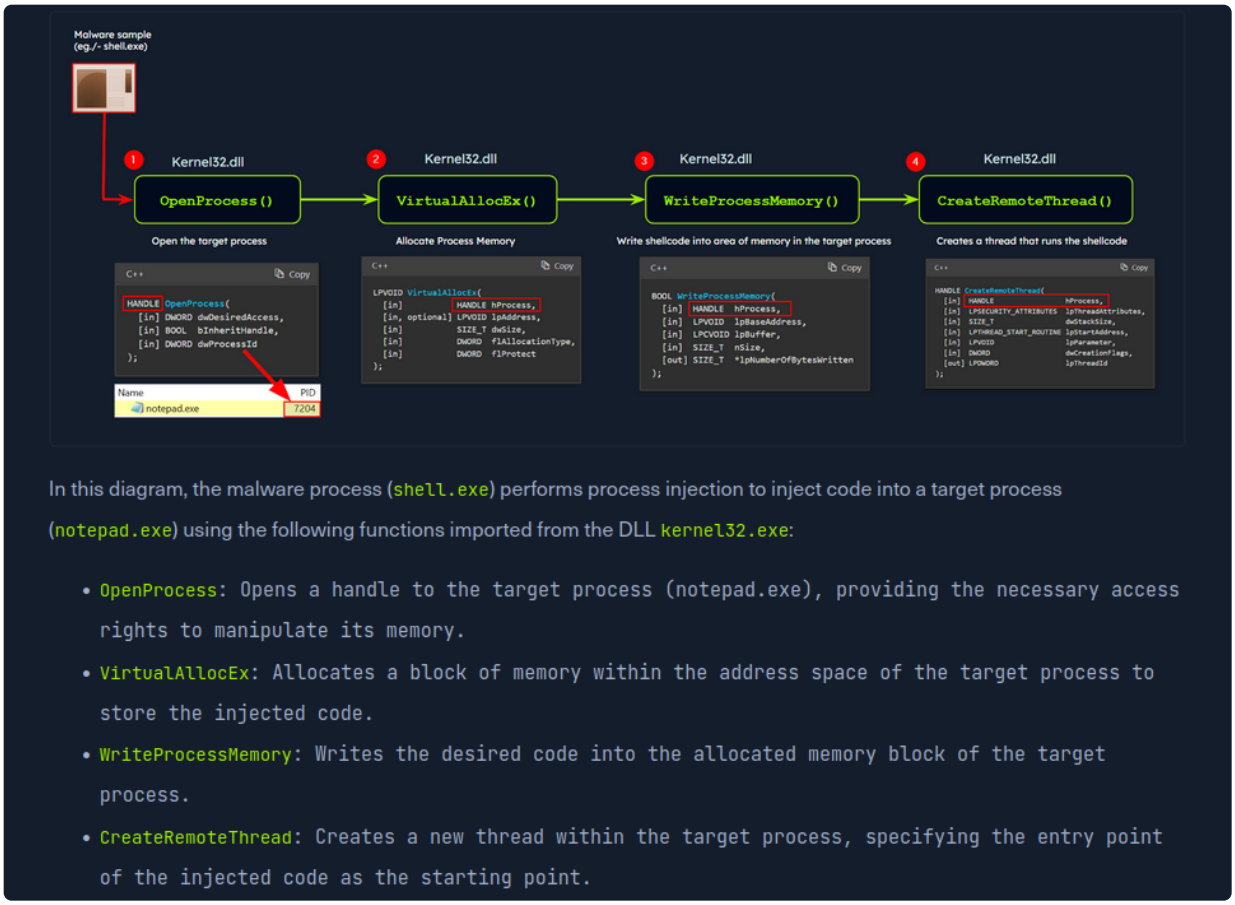
E.g Illustration from System internals



- Memory page state: The state of the virtual memory within a process can be in one of three states:
  - Free: The memory can be reserved, committed, or simultaneously reserved and committed.
  - Reserved: It is where the page has been reserved for future use and this reserved addresses can't be used by other memory allocation function such as malloc.
  - Committed: This is where memory charges has been made from the overall size of RAM and paging files on the disk (i.e. mapping between virtual and physical memory has been achieved).
    - Three access to committed pages is also determined by the memory protection constant set on the page (e.g. includes page_no_access, page_execute_read_write, page_readonly which their name shows what type of access is allowed on the page).
- OpenProcess: Windows API that opens the processes and returns an handle to the open process
- VirtualAlloc: Windows API that allocates memory (reserve, commit or change) given a handle to a process and returns a handle of the base address of the allocated region of pages.
- WriteProcessMemory: Write data to an specified area of memory in a specified process (given the process handle, base address of memory to write, data to write and size of data to write) which returns a non-zero value if it succeeds.
- CreateRemoteThread: Creates a thread that runs in the virtual address of another process (given the process handle, base address of thread execution) and returns a

handle to the thread if succeed.
https://learn.microsoft.com/en-us/windows/win32/api/processthreadsapi/nf-processthreadsapi-openprocess
https://learn.microsoft.com/en-us/windows/win32/api/memoryapi/nf-memoryapi-virtualallocex
https://learn.microsoft.com/en-us/windows/win32/api/memoryapi/nf-memoryapi-writeprocessmemory

- E.g. From malware analysis for a succinct summary.



- Security_Attributes structure: A structure that contains the security descriptor for an object and specifies whether this structure is inheritable.
https://learn.microsoft.com/en-us/previous-versions/windows/desktop/legacy/aa379560(v=vs.85)
- Signed script: Powershell script are signed when they have a digital signature (encrypted message using author's private key), which we can choose to trust or (through validating the digital certificate of the author with the chain of CA).
https://learn.microsoft.com/en-us/powershell/module/microsoft.powershell.core/about/about_signing?view=powershell-7.4
- Powershell execution policy: A safety feature that controls the condition under which Powershell load configuration files and run script.
- It is important to note that it is not a security feature as execution policy can easily be

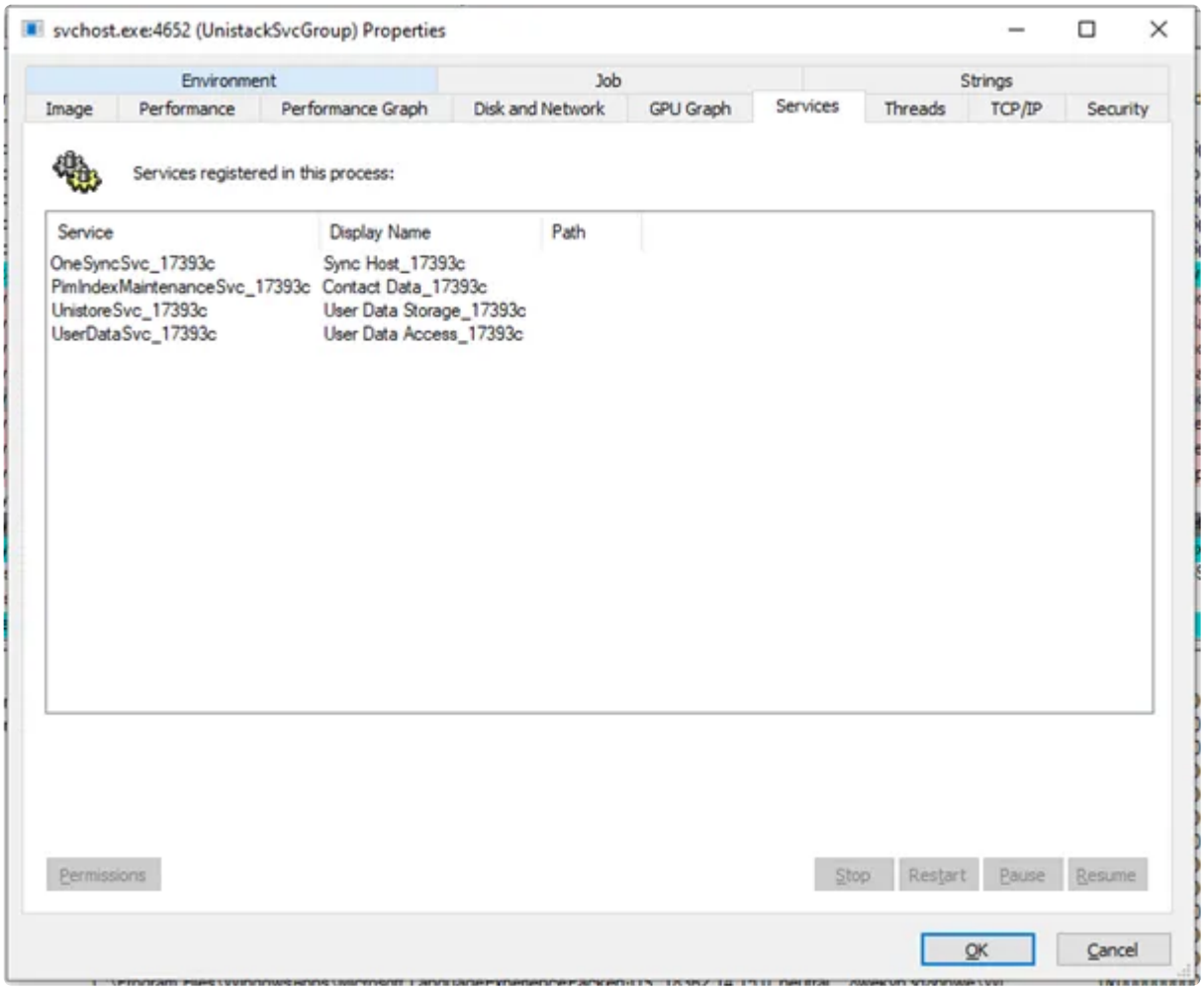
bypassed.
https://learn.microsoft.com/en-us/powershell/module/microsoft.powershell.core/about/about_execution_policies?view=powershell-7.4

- Schtasks: A Windows command that schedules tasks, including the creation of tasks.
https://learn.microsoft.com/en-us/windows-server/administration/windows-commands/schtasks-create
- Rundll32: This program is also known as "Run a dll as an App" program can execute dll's files, which malware can use to execute malicious code.
https://malwaretips.com/blogs/rundll32-exe-what-it-is-should-i-remove-it/
- StartW: In Rundll32, this is function that executes the dll present. It is often associated with Cobalt Strike payload.
https://www.microsoft.com/en-us/security/blog/2022/04/13/dismantling-zloader-how-malicious-ads-led-to-disabled-security-tools-and-ransomware/
https://research.splunk.com/endpoint/9319dda5-73f2-4d43-a85a-67ce961bddb7/
- Autopsy case: Like the name suggests, it is the "case" that we are dealing with. In the cse we can add data sources and do alot more things. To open a case we select the .aut file that already exists.
https://sleuthkit.org/autopsy/docs/user-docs/3.1/cases_page.html
https://www.youtube.com/watch?v=fEqx0MeCCHg
- Chrome Cache file: A file format used by google chrome and chromium to store persistent cache data.
  - Combing insights gained from Chrome Cache file and the location of the file we obtain, we may be able to obtain further insights (e.g. file probably downloaded from internet, as it appears in download folder + cache file).
https://github.com/libyal/dtformats/blob/main/documentation/Chrome%20Cache%20file%20format.asciidoc
- .arn: Known as Native auto run binary file format, it displays everything thats runs automatically when Windows start. It can be viewed using applications like Autoruns.
- Publisher verification: A mechanism implemented by Microsoft to give users about the authenticity developer's platform.
  - Not-verified means the developer's platform of the app can be suspicious.
https://learn.microsoft.com/en-us/entra/identity-platform/publisher-verification-overview
- Svchost.exe: Known as the service host, it serves as an shell for loading services from DLL files.
  - It is also known as malware impersonating it due to the relative ease of doing so (name the malware svchost.exe and give it and description of “Host Process for Windows Services” and it would be hard to distinguish it for the legitmate svchost.exe)
  - Some notable flags include -k and -s flag.
  - When it uses the -k flag, it will look for the look at an registry key name, located at

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Svchost which has references to various service name (which it can load).
- E.g. See the shell command below and it looking it at the registry key name UnistackSvcGroup at the location above.

```
        - When it uses the -s flag, it is usually combined with the -
k flag and will tell svchost.exe to load the specific service name.
                - E.g.  (Load only UnistackSvcGroup with combo of
svchost shell command)
                 ![[Pasted image 20240812135957.png]]
E.g. Svchost shell command and it hosting services:
Shell Command
```

Hosting multiple services:

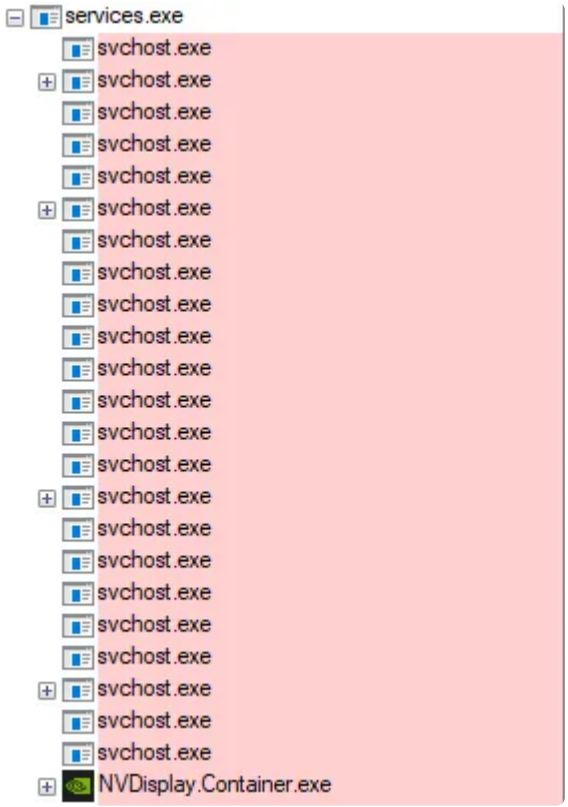


- Svchost.exe also commonly run with System privileges when being abused by malware.

> ## How Malware Abuses SvcHost.exe
>
> Cybercriminals often target svchost.exe for malware impersonation because of its common presence and high privileges. Tactics include:
>
> ### 1. Mimicry
>
> Malware authors name executables svchost.exe and install them in the system folders. This makes them appear legitimate and blend into the crowd of real svchost entries.
>
> ### 2. Service Hijacking
>
> Some malware hijacks existing svchost-hosted services by registering themselves as a service. This grants them the same trusted execution context as critical system services.
>
> ### 4. Privilege Escalation
>
> Svchost runs with SYSTEM privileges, enabling full access to the OS. By impersonating it, malware inherits powerful permissions to bypass restrictions.
>
> ### 5. Stealth
>
> Blending in as one of numerous svchost instances allows malware to operate discreetly, circumventing detection. Malware svchosts are sometimes hidden entirely from task managers.

https://malwaretips.com/blogs/svchost-exe-virus-removal/#normal_behavior_for_svchostexe

- Service.exe: It is known as the process for running and managing services on the system.
  - We'd often seen svchost.exe as an children of Service.exe, as shown below:



https://nasbench.medium.com/demystifying-the-svchost-exe-process-and-its-command-line-options-508e9114e747

- User Account Control: A mechanism that prompts the user for credential or approval when it performs operations or tries to access app at an elevated level, as the app requires the user's administrative token (Windows by default let admin access resources and execute apps under the security context of a standard user).

  ```
  - UAC can be bypassed if some applications run in auto-elevated context, such as fodhelp.exe with autoelevated feature set to true.
  - It often just makes life harder for attacker's and generate noise and is not an security measure.
  ```

  https://learn.microsoft.com/en-us/windows/security/application-security/application-control/user-account-control/how-it-works
  https://pentestlab.blog/2017/06/07/uac-bypass-fodhelper/
- ParseExact: It converts a string representation of time into its DateTime object struct equivalent (which represents an instant in time).
  https://stackoverflow.com/questions/50214955/how-to-parse-datetime-by-parseexact-in-powershell
  https://learn.microsoft.com/en-us/dotnet/api/system.datetime.parseexact?view=net-8.0
  https://learn.microsoft.com/en-us/dotnet/api/system.datetime?view=net-8.0
- Import-CSV: Creates a table-like custom object for items in a CSV file.
  https://learn.microsoft.com/en-us/powershell/module/microsoft.powershell.utility/import-csv?view=powershell-7.4
- Where-Object: Selects object from a collection (collection of objects) based on their property value.
  - $_ is an automatic variable which represents each object that is passed to the where-Object cmdlet.
  https://learn.microsoft.com/en-us/powershell/module/microsoft.powershell.core/where-object?view=powershell-7.4
- -as: In powershell this is like object casting (based on behaviour observed)
  E.g. Powershell (casting object timestamp as `[DateTime]` object)

```
Where-Object { $_.timestamp -as [DateTime] -ge $time1 -and $_.timestamp -as [DateTime] -lt $time2 }
```

- USN Journal Reason: In USN journal, this is the flag that identify reasons for changes that have accumulated in this file/directory record since the directory opened.
  https://learn.microsoft.com/en-us/windows/win32/api/winioctl/ns-winioctl-usn_record_v2
- Select-String: Finds text in strings and files
  https://learn.microsoft.com/en-us/powershell/module/microsoft.powershell.utility/select-string?view=powershell-7.4
- Pagefile.sys: It is a file that uses physical memory to help supplement the system's RAM when it is almost full, which offloads some less critical file to it.
  - Being a physical memory, it will be slower to read from it than RAM, but faster than closing the app than reopening it.
  - It is usually (by default) located in the C:\ drive
  https://www.makeuseof.com/windows-pagefile-sys-guide/
- Plaso: An python-based engine used by several tools for the automatic creation of timelines.
  - It is also what Autopsy use behind the scenes.
  https://github.com/log2timeline/plaso
- Sans triage parameter: An configuration parameter for KAPE which allows useful collection of artifacts for KAPE.
  - E.g. What Sans triage collects (can see useful files like usn journal, mft file... etc)

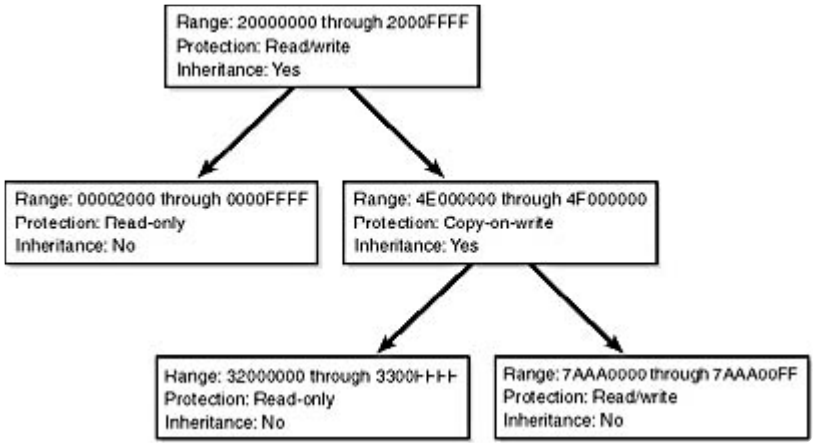
_SANS_Triage	☑	SANS Triage Collection (by Mark Hallman): $Boot, $J, $J, $LogFile, $MFT, $Max, $Max, $SDS, $SDS, $T, $T, AVG AV Logs, AVG AV Logs (XP), AVG AV Report Logs (XP), AVG FileInfo DB, AVG Persistent Logs, AVG Report Logs, AVG lsdbj2 JSON, ActivitiesCache.db, Addons, Addons XP, Amcache, Amcache, Amcache transaction files, Amcache transaction files, Ammyy Program Data, AnyDesk Chat Logs - User Profile, AnyDesk Logs - ProgramData - *.conf, AnyDesk Logs - ProgramData - *.trace, AnyDesk Logs - ProgramData - connection_trace.txt, AnyDesk Logs - System User Account, AnyDesk Logs - User Profile - *.conf, AnyDesk Logs - User Profile - *.trace, AnyDesk Logs - User Profile - connection_trace.txt, AnyDesk Videos, AppCompat PCA Folder, Application Event Log Win7+, Application Event Log Win7+, Application Event Log XP, Application Event Log XP, Avast AV Index, Avast AV Logs, Avast AV Logs (XP), Avast AV User Logs, Avast Icarus Logs, Avast Persistent Data Logs, Avira Activity Logs, Avira Security Logs, Avira VPN Logs, BITS files, Bitdefender Endpoint Security Logs, Bitdefender Internet Security Logs, Bitdefender SQLite DB Files, Bookmarks, Bookmarks, Bookmarks, Box Drive Application Metadata, Box Sync Application Metadata, Chrome Cookies, Chrome Cookies XP, Chrome Current Session, Chrome Current Session XP, Chrome Current Tabs, Chrome Current Tabs XP, Chrome Download Metadata, Chrome Extension Cookies, Chrome Favicons, Chrome Favicons XP, Chrome History, Chrome History XP, Chrome Last Session, Chrome Last Session XP, Chrome Last Tabs, Chrome Last Tabs XP, Chrome Login Data,

- Virtual Address Descriptors (VADs): It is a set of data structures that each process maintains, where it each of them describes the range of virtual address in the process's address space have been reserved or not.
  - These set that each process maintain are stored in a self-balanced binary tree for efficiency purpose.
  - They are created because memory manager uses a demand paging in the OS, so it

needs to know the status of each memory range (you can load memory in physical memory later, but you must have a mechanism of tracking it before it gets loaded).
- Each node also has some useful flags associated with them, these include the following:

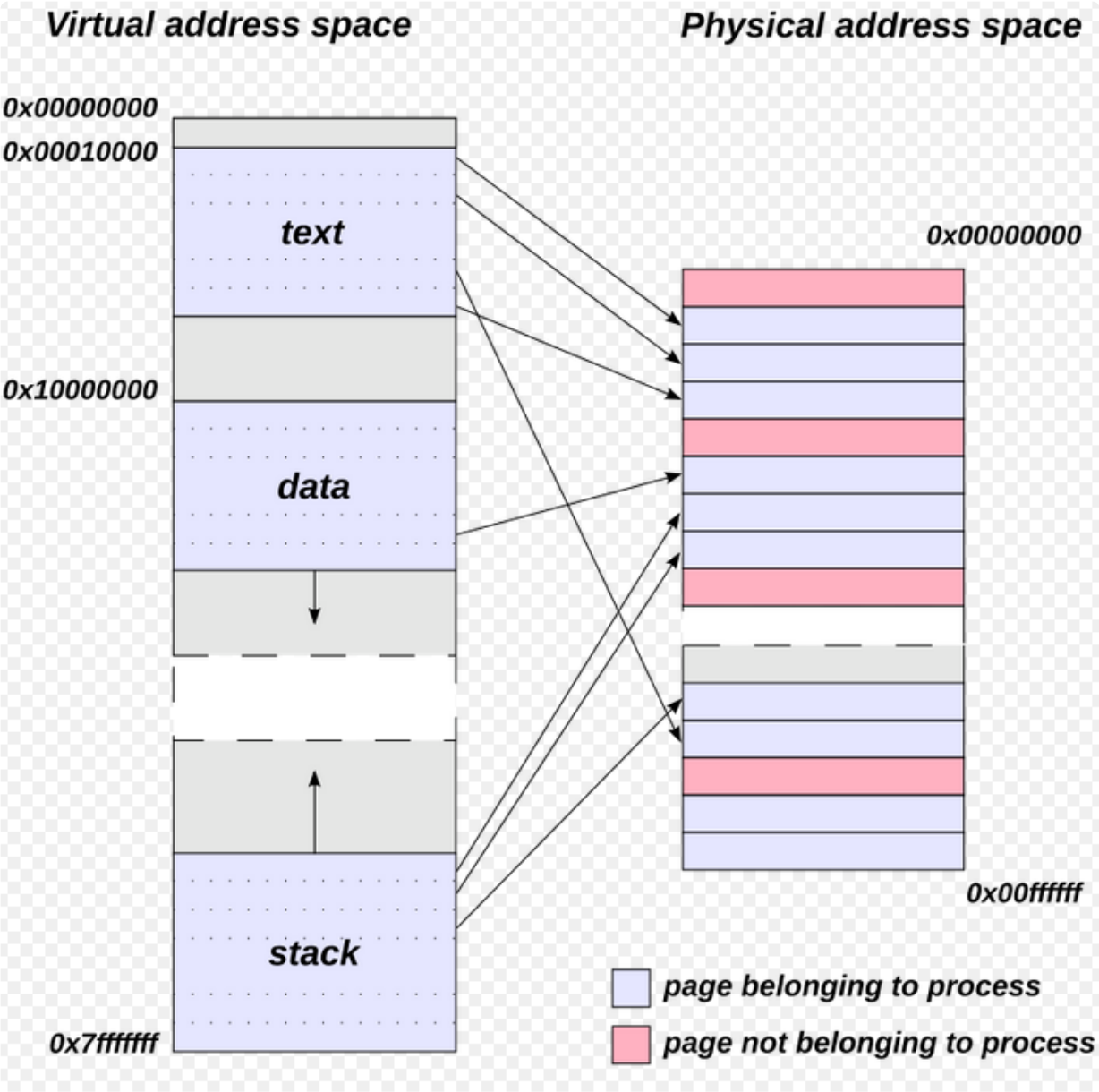
- Protection: This field gives an indication of the type of access allowed to the memory region. Some of the protection constants are:
  - PAGE_EXECUTE: Memory can be executed but cannot be written to
  - PAGE_EXECUTE_READ: Memory can be executed or read but cannot be written to
  - PAGE_EXECUTE_READWRITE: Memory can be executed, read and write.
  - PAGE_NOACCESS: No access to this memory region
  - PAGE_READONLY: Only read access to the memory
  - PAGE_READWRITE: Read, Write access to the memory but no execution.
- Private Memory: This field refers to committed regions that cannot be shared with other processes.

E.g. Example of VADs in a process using self-balanced binary tree



https://flylib.com/books/en/3.169.1.64/1/
https://www.infosecinstitute.com/resources/penetration-testing/finding-enumerating-processes-within-memory-part-2/

- Demanding Paging: A memory management scheme used in OS that loads memory in a "lazy evaluation" fashion (load into memory only when needed through page fault mechanism)
  - This improves the performance of OS and system performance.
- Page Fault: A technique used in virtual memory systems where page enters main memory (actual mapping achieved) only when requested or needed by the CPU.
  - A page fault occurs when the program needed to access a page that is not currently in memory, which the OS then loads the required page from disk into memory and update the tables (mapping table between virtual and physical memory) accordingly.
  - E.g. Page table for virtual address translation



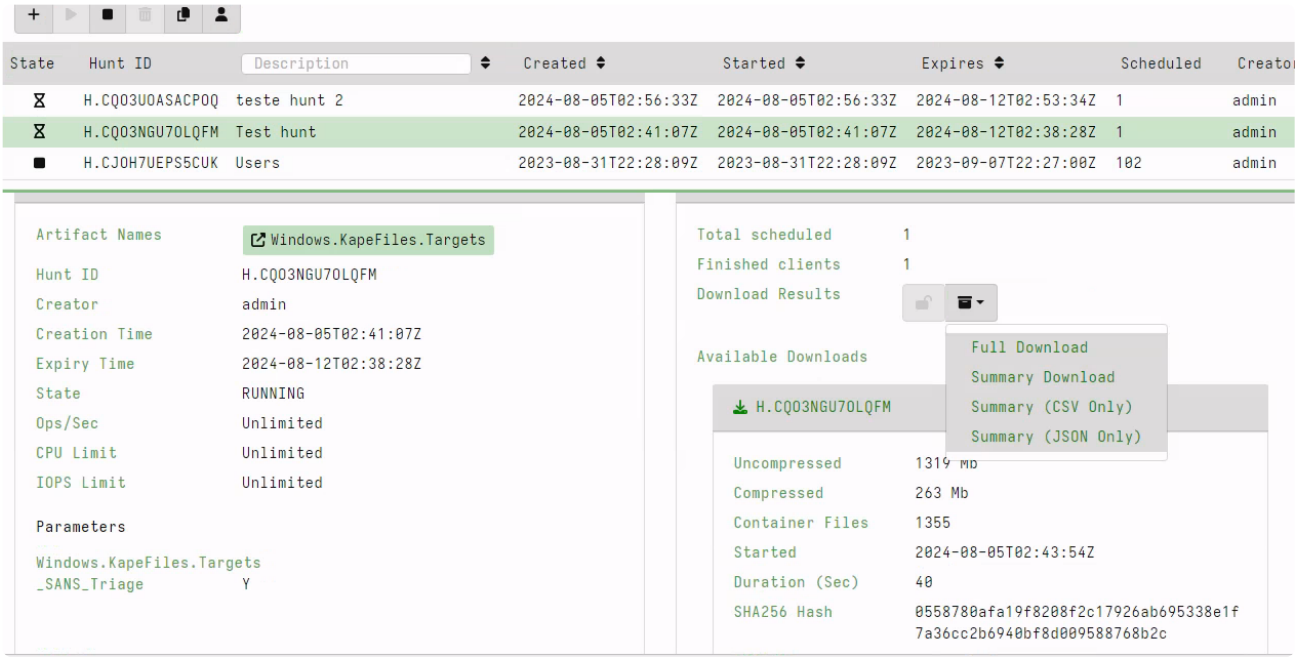
https://www.geeksforgeeks.org/what-is-demand-paging-in-operating-system/
https://en.wikipedia.org/wiki/Page_table

Evidence Acquisition Techniques & Tools

Question

- Visit the URL "https://127.0.0.1:8889/app/index.html#/search/all" and log in using the credentials: admin/password. After logging in, click on the circular symbol adjacent to "Client ID". Subsequently, select the displayed "Client ID" and click on "Collected". Initiate a new collection and gather artifacts labeled as "Windows.KapeFiles.Targets" using the _SANS_Triage configuration. Lastly, examine the collected artifacts and enter the name of the scheduled task that begins with 'A' and concludes with 'g' as your answer.

-> We login and start collect the artifacts using kapefiles.target and download as follows

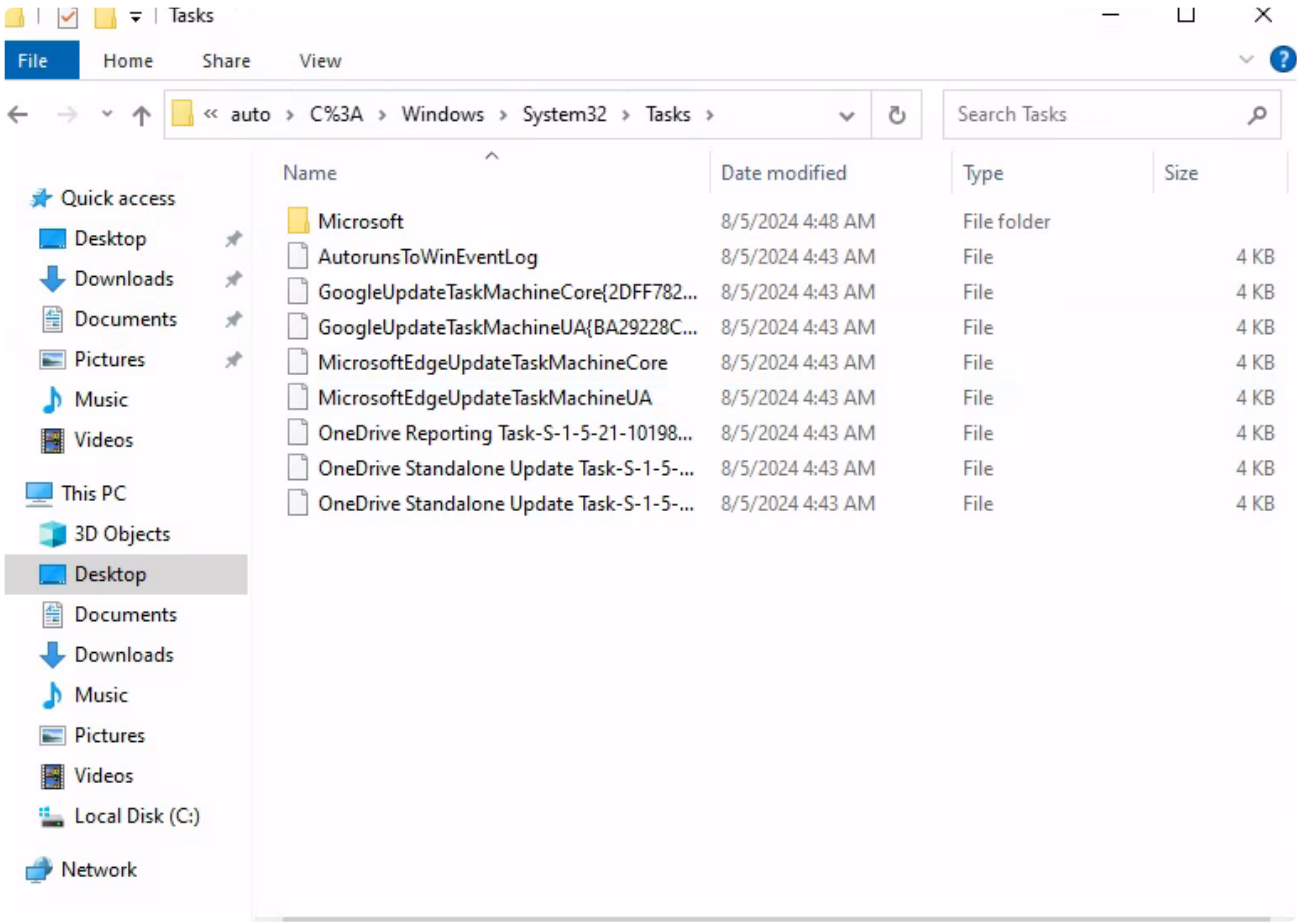


-> We then search up on where the folder for scheduled tasks is located on windows 10 (since our machine is windows 10), where we came across that it is saved on the folder below

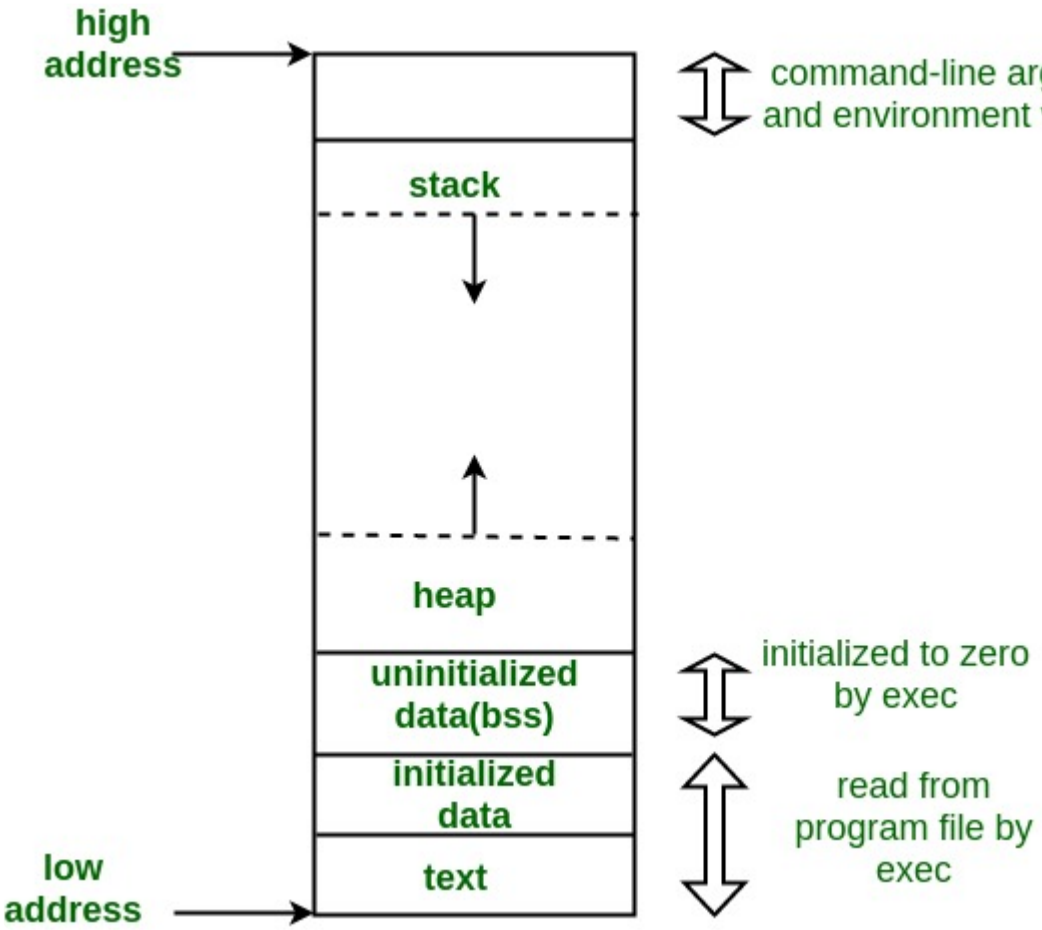
```
C:\Windows\System32\Tasks
```

with reference to this stackoverflow link https://stackoverflow.com/questions/2913816/how-to-find-the-location-of-the-scheduled-tasks-folder

-> Then, we go into thhis folder as follows and see that the name of the scheduled tasks is `AutorunsToWinEventLog`:



- VAD: An artifact available in Velociraptor that allows enumeration of process memory sections via Virtual Address Descriptor (VAD). https://docs.velociraptor.app/artifact_references/pages/windows.system.vad/
- Process Memory section: The sections of the process memory includes code segment, data segment, stack and memory sections.



https://www.geeksforgeeks.org/memory-layout-of-c-program/

- Process Environment Block: Known as PEB, it is an process's user-mode representation.
  - It has highest level knowledge of a process in kernel model and lowest-level in user mode.
  https://www.geoffchappell.com/studies/windows/km/ntoskrnl/inc/api/pebteb/peb/index.htm
- Impersonation token: An impersonation access token describes the security context of the client being impersonated.
  https://learn.microsoft.com/en-us/windows/win32/secauthz/impersonation-tokens
- Hard link: A file-representation of a file through which more than one path references the same file in the same volume.
  - Basically hard copies of file that are linked (changing file in a hard link reflect changes to files in all other hard link) in the same volume.
  https://learn.microsoft.com/en-us/windows/win32/fileio/hard-links-and-junctions#hard-links

Evidence Examination & Analysis

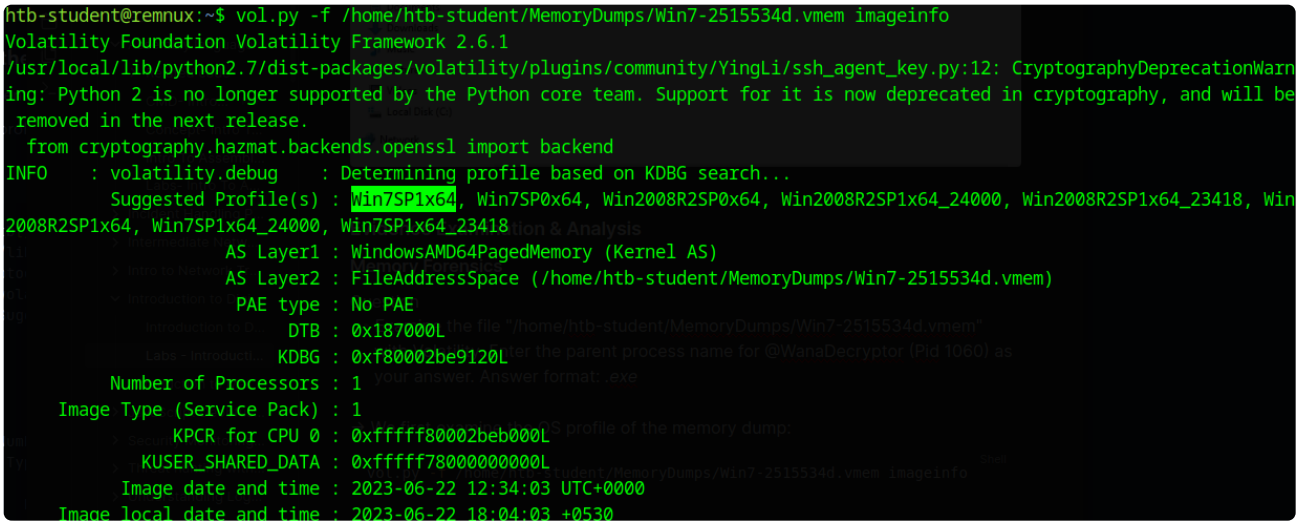
Memory Forensics

Question

- Examine the file "/home/htb-student/MemoryDumps/Win7-2515534d.vmem" with Volatility. Enter the parent process name for @WanaDecryptor (Pid 1060) as your answer. Answer format: _.exe

-> We first examine the OS profile of the memory dump:

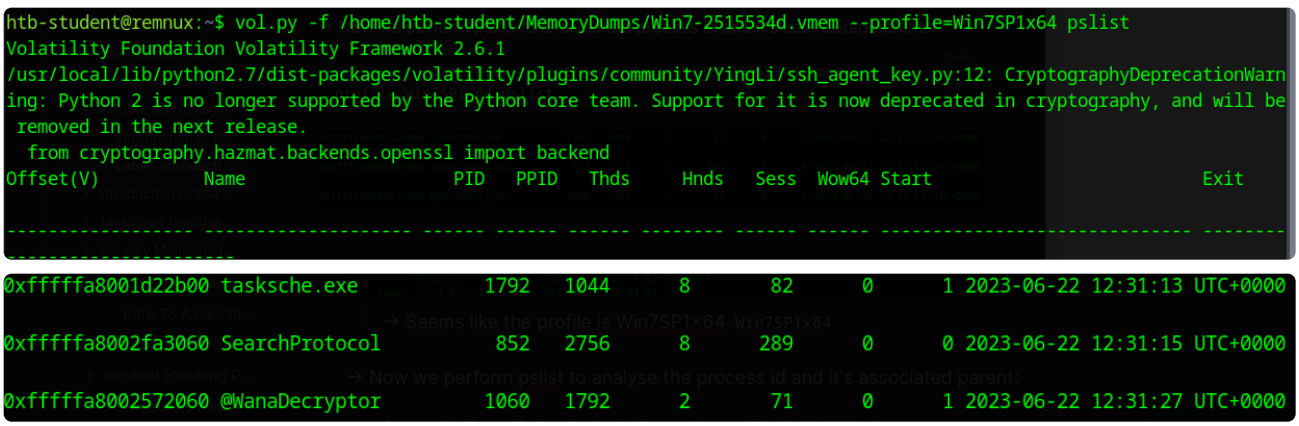
```
vol.py -f /home/htb-student/MemoryDumps/Win7-2515534d.vmem imageinfo
```



-> Seems like the profile is Win7SP1x64 `Win7SP1x64`

-> Now we perform pslist to analyse the process id and it's associated parent:

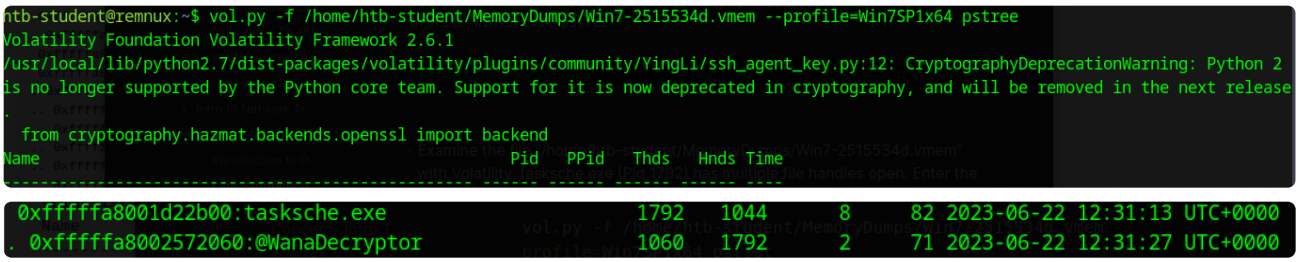
```
vol.py -f /home/htb-student/MemoryDumps/Win7-2515534d.vmem --
profile=Win7SP1x64 pslist
```



-> Hence, the parent process name is tasksche.exe

-> Or, we can use pstree for a more clearer illustration of parent-child relationship (reference to github wiki page)

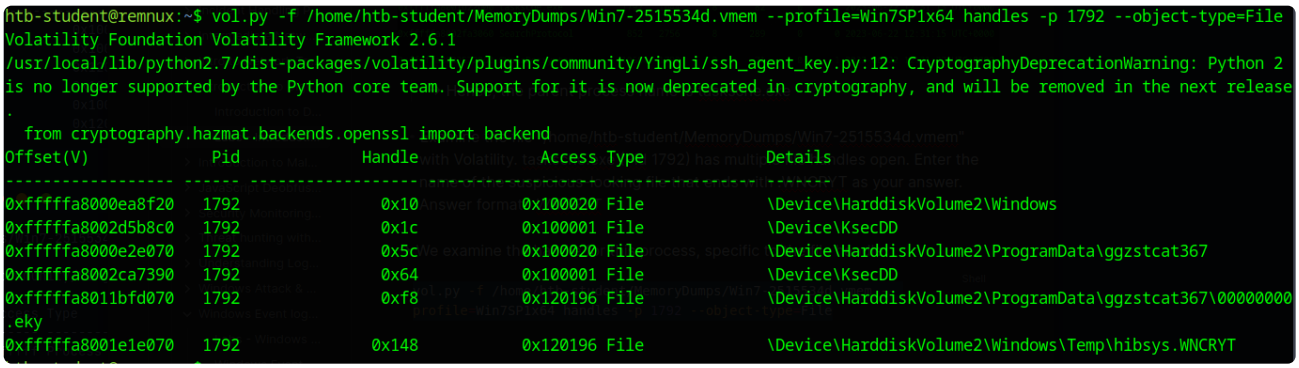
```
vol.py -f /home/htb-student/MemoryDumps/Win7-2515534d.vmem --
profile=Win7SP1x64 pstree
```



- Examine the file "/home/htb-student/MemoryDumps/Win7-2515534d.vmem" with Volatility. tasksche.exe (Pid 1792) has multiple file handles open. Enter the name of the suspicious-looking file that ends with .WNCRYT as your answer. Answer format: _.WNCRYT

-> We examine the handle for this process, specific to the file handle

```
vol.py -f /home/htb-student/MemoryDumps/Win7-2515534d.vmem --
profile=Win7SP1x64 handles -p 1792 --object-type=File
```



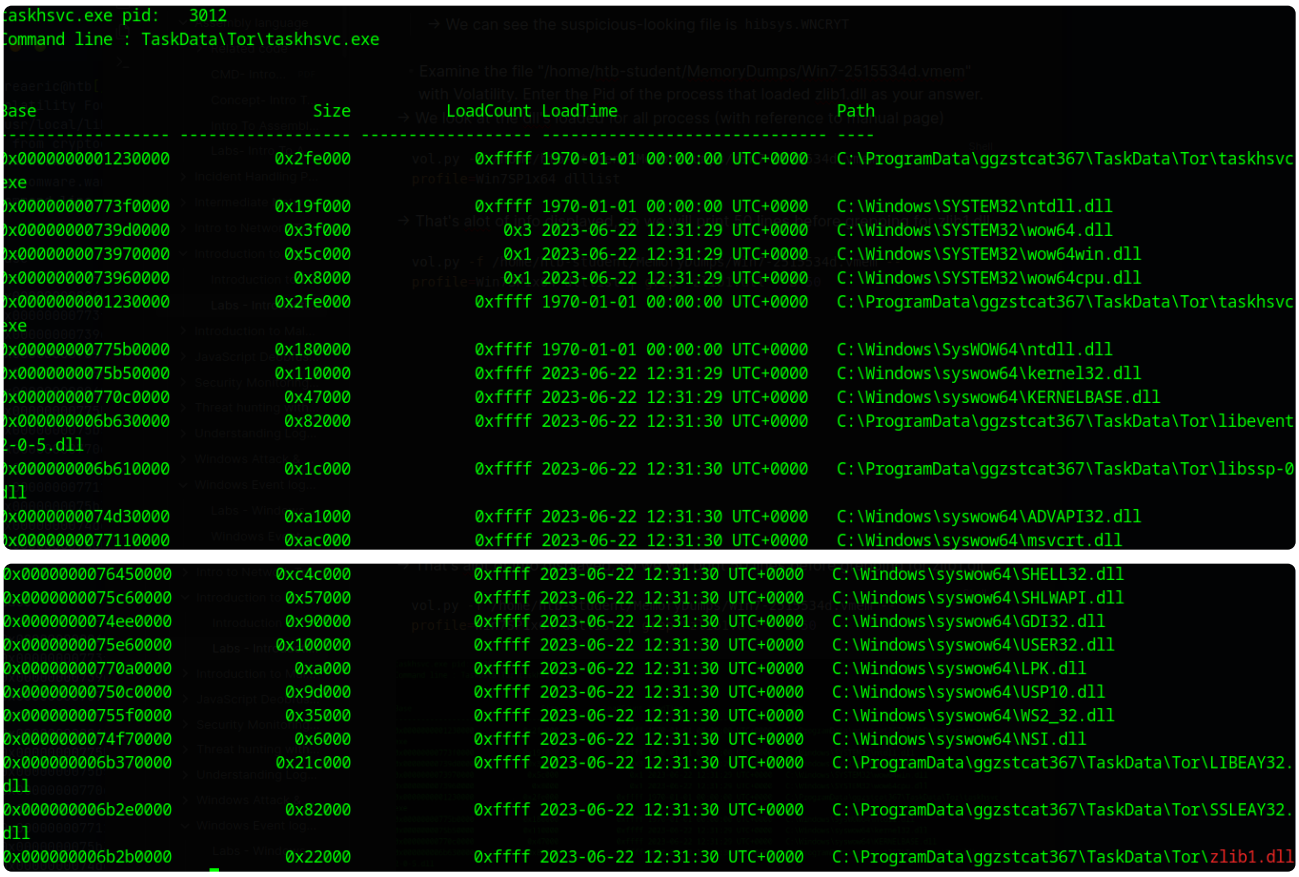
-> We can see the suspicious-looking file is `hibsys.WNCRYT`

- Examine the file "/home/htb-student/MemoryDumps/Win7-2515534d.vmem" with Volatility. Enter the Pid of the process that loaded zlib1.dll as your answer.
  -> We look at the dll's loaded for all process (with reference to github wiki page)

```
vol.py -f /home/htb-student/MemoryDumps/Win7-2515534d.vmem --
profile=Win7SP1x64 dlllist
```

-> That's alot of info displayed, so we will print 50 lines before grepping for zlib1.dll

```
vol.py -f /home/htb-student/MemoryDumps/Win7-2515534d.vmem --
profile=Win7SP1x64 dlllist | grep "zlib1.dll" -B 50
```



-> Hence, we see it is taskhsvc.exe with pid of 3012 loading the dll.

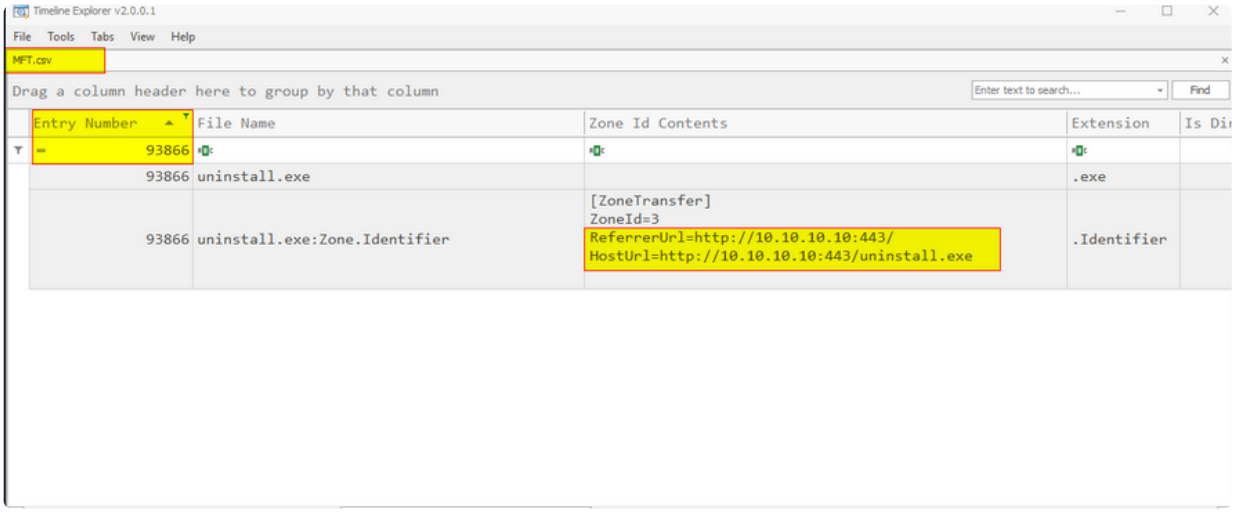
Rapid Triage Examination & Analysis Tools

Questions

- During our examination of the USN Journal within Timeline Explorer, we observed "uninstall.exe". The attacker subsequently renamed this file. Use Zone.Identifier information to determine its new name and enter it as your answer.
  -> Given that file is renamed, the metadata of the file is not erased, but duplicated over instead.
  -> Hence, we first obtain the zone.identifier information for "uninstall.exe" and use that

to identify the new file name.

-> Given the entry number is given as 93866, and zone identifier is



shown in the section, we can use the time explorer to filter for zone id that has the same zone id contents (we search for uninstall in Zone Id Contents)

-> We see a file that has the same zone Id Contents, which looks suspicious and is last accessed later than the uninstall.exe (bottom one)

->We obtain the entry number of the file and look into it using MTFECmd.exe:

Line	Tag	Entry Number	Sequence Number	Parent Entry Number	Parent Sequence Number	In Use	Parent Path
115697	☐	90469	4	4241	1	☑	.\Windows\Tasks
120500	☐	93866	3	92487	2	☐	.\Temp

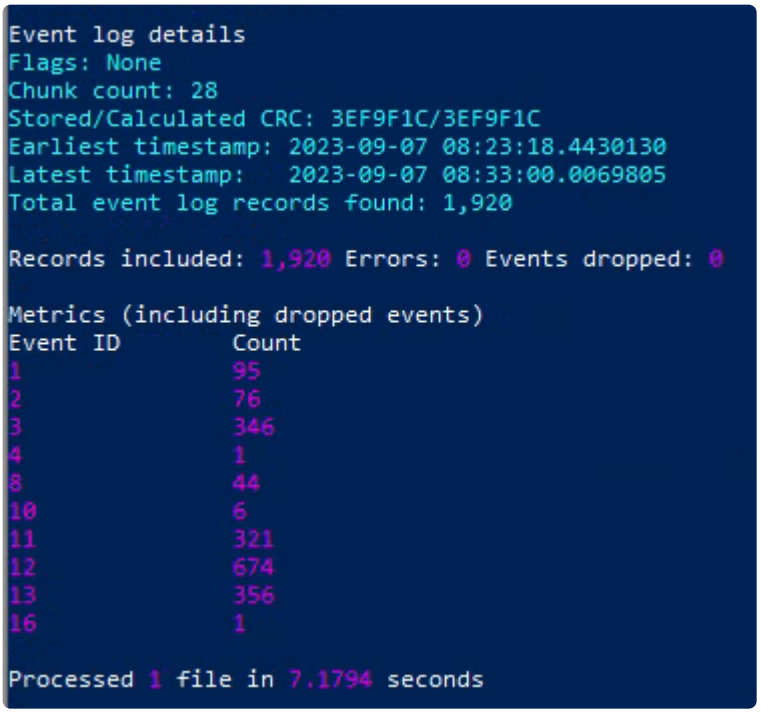
```
.\MFTECmd.exe -f 'C:\Users\johndoe\Desktop\forensic_data\kape_output\D\$MFT' --de 90469
```

```
  File name: MICROS~1.EXE
  Flags: Archive, Name Type: Dos, Reparse Value: 0x0, Physical Size: 0x233000, Logical Size: 0x0
  Parent Entry-seq #: 0x1091-0x1

  Created On:         2023-09-07 08:30:06.9411940
  Modified On:        2023-09-07 08:30:06.9411940
  Record Modified On: 2023-09-07 08:30:06.9411940
  Last Accessed On:   2023-09-07 08:30:06.9411940

**** FILE NAME ****
  Attribute #: 0x2, Size: 0xA0, Content size: 0x86, Name size: 0x0, ContentOffset 0x18. Resident: True

  File name: microsoft.windowskits.feedback.exe
  Flags: Archive, Name Type: Windows, Reparse Value: 0x0, Physical Size: 0x233000, Logical Size: 0x0
  Parent Entry-seq #: 0x1091-0x1

  Created On:         2023-09-07 08:30:06.9411940
  Modified On:        2023-09-07 08:30:06.9411940
  Record Modified On: 2023-09-07 08:30:06.9411940
  Last Accessed On:   2023-09-07 08:30:06.9411940

**** DATA ****
  Attribute #: 0x1, Size: 0x48, Content size: 0x0, Name size: 0x0, ContentOffset 0x0. Resident: False

  Non-Resident Data
  Starting Virtual Cluster #: 0x0, Ending Virtual Cluster #: 0x232, Allocated Size: 0x233000, Actual Size: 0x232F78, Ini
tialized Size: 0x232F78

  DataRuns Entries (Cluster offset -> # of clusters)
  0x18FA7D                        ->      0x233

**** DATA ****
  Attribute #: 0x4, Size: 0xA8, Content size: 0x6D, Name size: 0xF, ContentOffset 0x38. Resident: True
  Name: Zone.Identifier

  Resident Data

  Data: 5B-5A-6F-6E-65-54-72-61-6E-73-66-65-72-5D-0D-0A-5A-6F-6E-65-49-64-3D-33-0D-0A-52-65-66-65-72-72-65-72-55-72-6C-3
D-68-74-74-70-3A-2F-2F-31-30-2E-31-30-2E-31-30-2E-31-30-3A-34-34-33-2F-0D-0A-48-6F-73-74-55-72-6C-3D-68-74-74-70-3A-2F-2
F-31-30-2E-31-30-2E-31-30-2E-31-30-3A-34-34-33-2F-75-6E-69-6E-73-74-61-6C-6C-2E-65-78-65-0D-0A

    ASCII:   [ZoneTransfer]
ZoneId=3
ReferrerUrl=http://10.10.10.10:443/
HostUrl=http://10.10.10.10:443/uninstall.exe

    UNICODE: ????????????????????????????????????????????????????????????
```

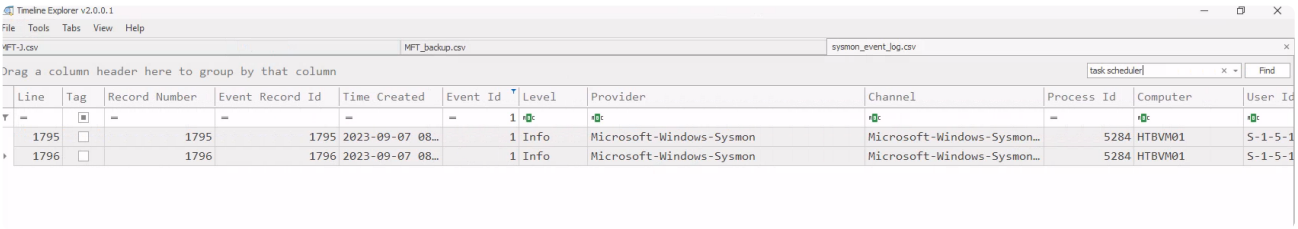
-> Hence, we obtain that the new file name is `microsoft.windowskits.feedback.exe`

- Review the file at "C:\Users\johndoe\Desktop\forensic_data\kape_output\D\Windows\System32\winevt\logs\Microsoft-Windows-Sysmon%4Operational.evtx" using Timeline Explorer. It documents the creation of two scheduled tasks. Enter the name of the scheduled task that begins with "M" and concludes with "r" as your answer.
  -> We first do the conversion from .evtx file to .csv file

```
.\EvtxECmd.exe -f 'C:\Users\johndoe\Desktop\forensic_data\kape_output\D\Windows\System32\winevt\logs\Microsoft-Windows-Sysmon%4Operational.evtx' --csv "C:\Users\johndoe\Desktop\forensic_data\event_logs\csv_timeline" --csvf sysmon_event_log.csv
```

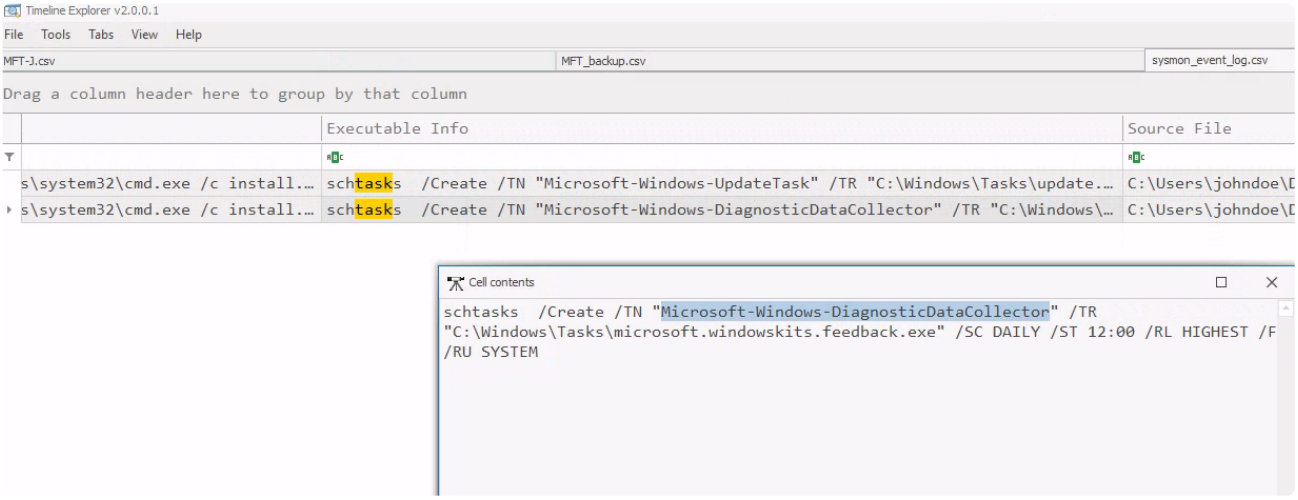


-> We look for the keyword scheduler in timeline explorer:

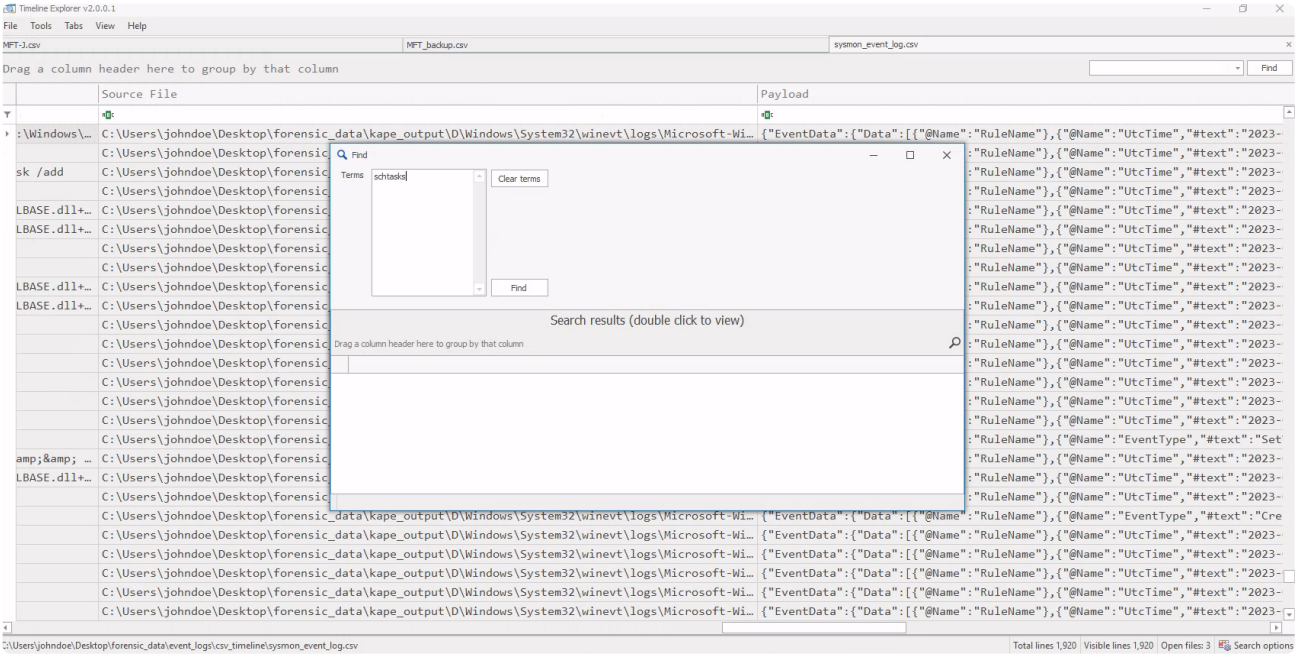


-> We only have 2 events, this is very promising.
-> We see from the executable info that the second scheduled tasks matches what we want and that it is created an task name Microsoft-Windows-DiagnositcDataCollcetor and

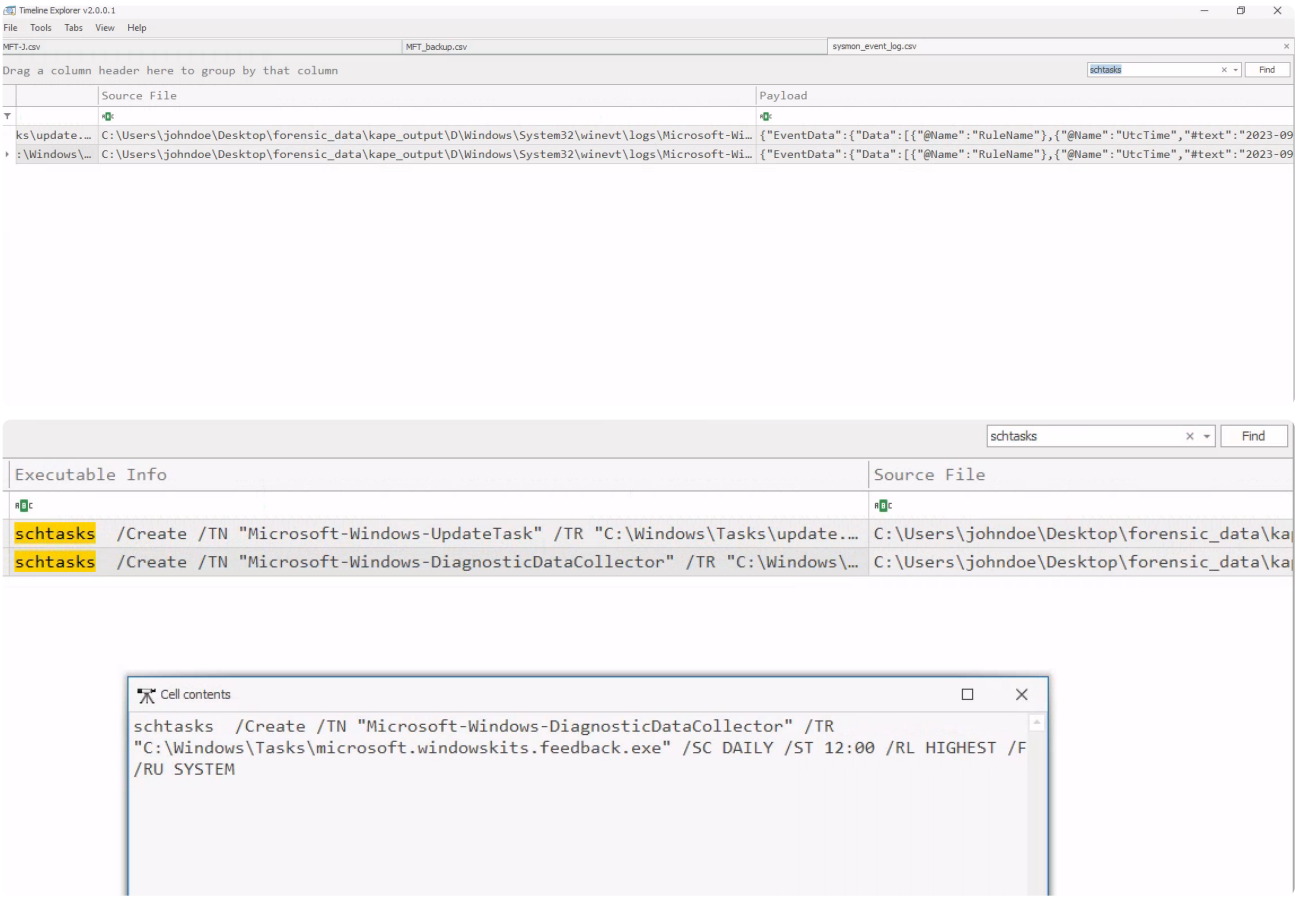
its running the suspicious software we previously identified.



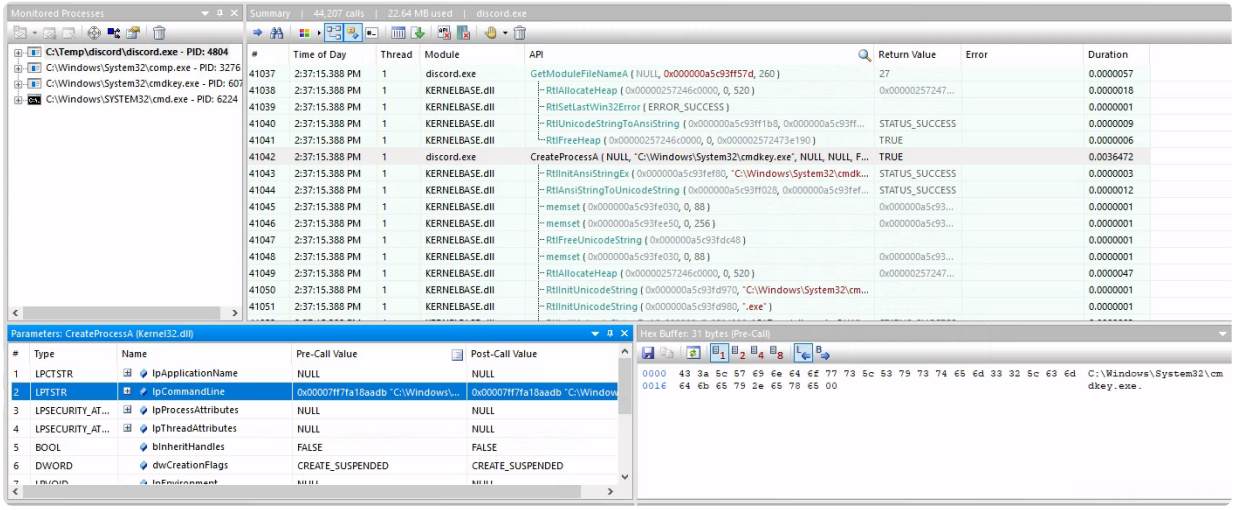
-> Alternatively, we can search for schtasks, as from the microsoft documentation it mentioned that that is how scheduled task are created, through schtasks /create:



-> And we would get similar results

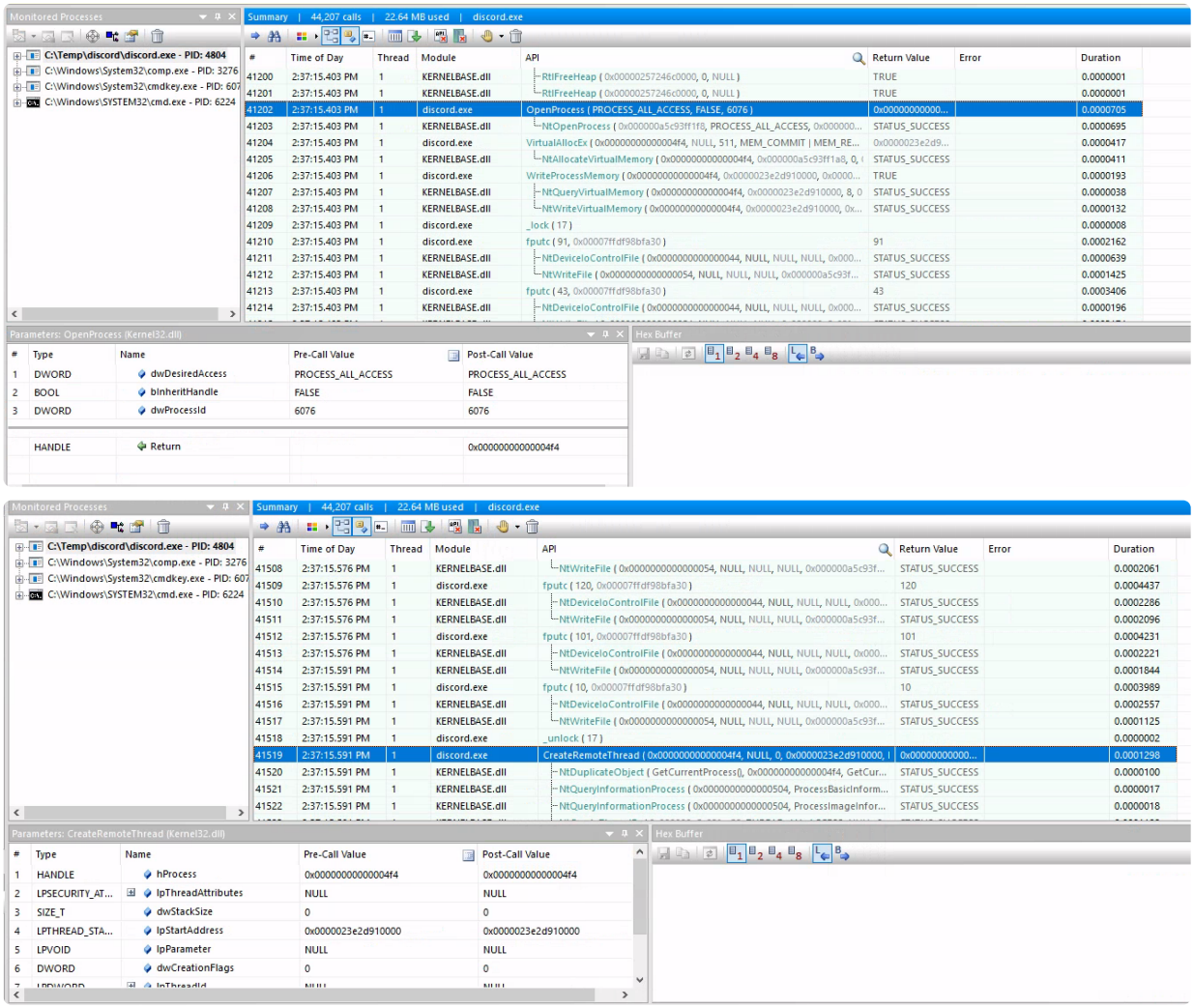


- Examine the contents of the file located at "C:\Users\johndoe\Desktop\forensic_data\APMX64\discord.apmx64" using API Monitor. "discord.exe" performed process injection against another process as well. Identify its name and enter it as your answer.
  -> We know from the section that first process injection is performed on comp.exe achieved by discord.exe.
  -> Looking down, we another Create Process with an similar Create_Suspended dwCreationFlags.



-> Searching for another OpenProcess, we see it opening process cmdkey.exe (with PID of 6076), virutal alloc, writing memory functions and create remote thread (on the

manual memory allocated to cmdkey.exe) happening immediately afterwards, which is indicative of process injection.

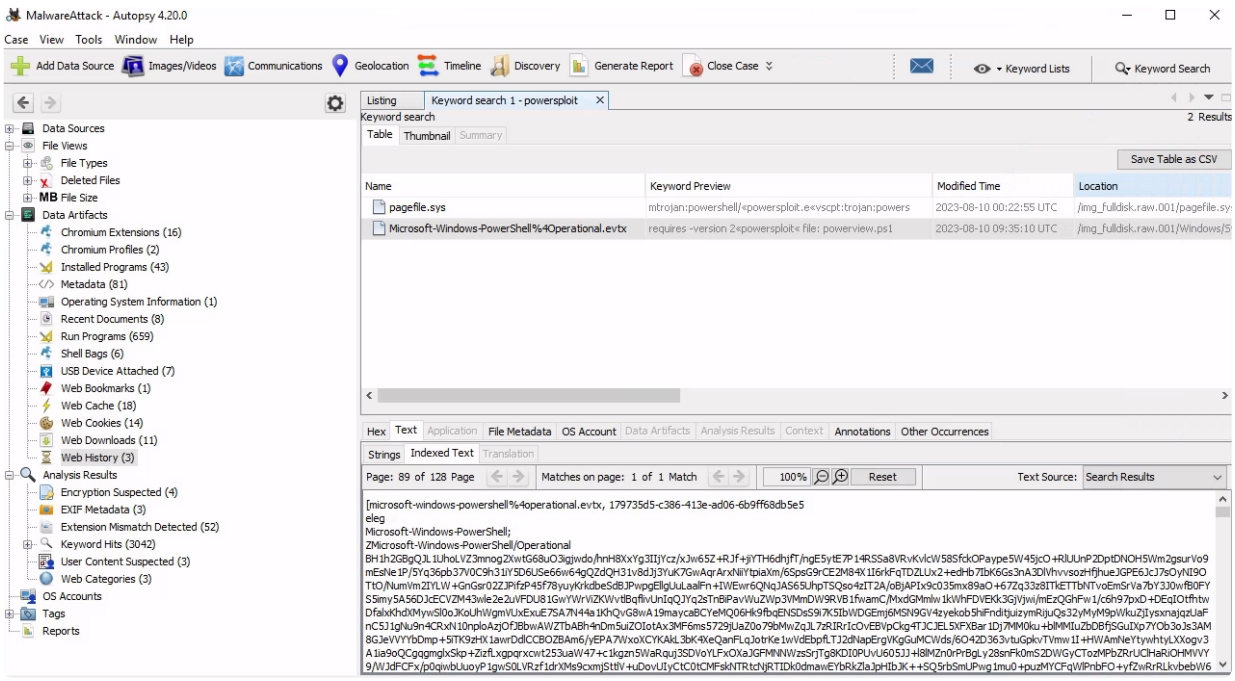


-> Hence, we can say that process injection is happening on the process cmdkey.exe.

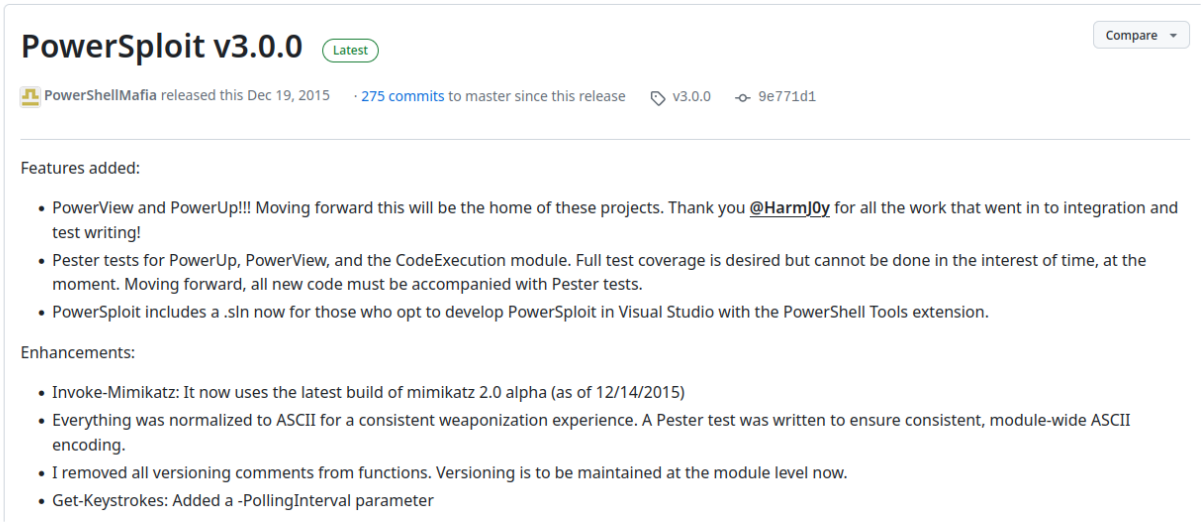
Practical digital forensic scenario

Question

- Extract and scrutinize the memory content of the suspicious PowerShell process which corresponds to PID 6744. Determine which tool from the PowerSploit repository (accessible at https://github.com/PowerShellMafia/PowerSploit) has been utilized within the process, and enter its name as your answer.
  -> We performed a keyword search on powersploit in Autopsy and we see it seems to be PowerView on the Keyword Preview.



-> We verify this by going to the link given in github and see that PowerView and PowerUp appears, so it seems to be powerview.



-> Alternative way: Dumping memory and using strings (example in Memory forensics using linux) function to analyse it

-> We can also dump the memory of pid 6744 and perform an string analysis of it.

```
python vol.py -q -f ..\memdump\PhysicalMemory.raw windows.memmap --pid
6744 --dump
```

```
0xf6fffffc3000  0x200000        0x1000  0x18d5c000      pid.6744.dmp
0xf6fffffc4000  0x200000        0x1000  0x18d5d000      pid.6744.dmp
0xf6fffffc5000  0x200000        0x1000  0x18d5e000      pid.6744.dmp
0xf6fffffc6000  0x200000        0x1000  0x18d5f000      pid.6744.dmp
0xf6fffffc7000  0x200000        0x1000  0x18d60000      pid.6744.dmp
0xf6fffffc8000  0x200000        0x1000  0x18d61000      pid.6744.dmp
0xf6fffffc9000  0x200000        0x1000  0x18d62000      pid.6744.dmp
0xf6fffffca000  0x200000        0x1000  0x18d63000      pid.6744.dmp
0xf6fffffcb000  0x200000        0x1000  0x18d64000      pid.6744.dmp
0xf6fffffcc000  0x200000        0x1000  0x18d65000      pid.6744.dmp
0xf6fffffcd000  0x200000        0x1000  0x18d66000      pid.6744.dmp
0xf6fffffce000  0x200000        0x1000  0x18d67000      pid.6744.dmp
0xf6fffffcf000  0x200000        0x1000  0x18d68000      pid.6744.dmp
0xf6fffffd0000  0x200000        0x1000  0x18d69000      pid.6744.dmp
0xf6fffffd1000  0x200000        0x1000  0x18d6a000      pid.6744.dmp
0xf6fffffd2000  0x200000        0x1000  0x18d6b000      pid.6744.dmp
0xf6fffffd3000  0x200000        0x1000  0x18d6c000      pid.6744.dmp
0xf6fffffd4000  0x200000        0x1000  0x18d6d000      pid.6744.dmp
0xf6fffffd5000  0x200000        0x1000  0x18d6e000      pid.6744.dmp
0xf6fffffd6000  0x200000        0x1000  0x18d6f000      pid.6744.dmp
0xf6fffffd7000  0x200000        0x1000  0x18d70000      pid.6744.dmp
0xf6fffffd8000  0x200000        0x1000  0x18d71000      pid.6744.dmp
0xf6fffffd9000  0x200000        0x1000  0x18d72000      pid.6744.dmp
0xf6fffffda000  0x200000        0x1000  0x18d73000      pid.6744.dmp
0xf6fffffdb000  0x200000        0x1000  0x18d74000      pid.6744.dmp
0xf6fffffdc000  0x200000        0x1000  0x18d75000      pid.6744.dmp
0xf6fffffdd000  0x200000        0x1000  0x18d76000      pid.6744.dmp
0xf6fffffde000  0x200000        0x1000  0x18d77000      pid.6744.dmp
0xf6fffffdf000  0x200000        0x1000  0x18d78000      pid.6744.dmp
0xf6fffffe0000  0x200000        0x1000  0x18d79000      pid.6744.dmp
```

-> To use strings function in Windows, we need to obtain system internals as follows to our attack machine on the website: https://learn.microsoft.com/en-us/sysinternals/downloads/

```
wget https://download.sysinternals.com/files/SysinternalsSuite.zip
```

-> We then open a web server and transfer it over as follows

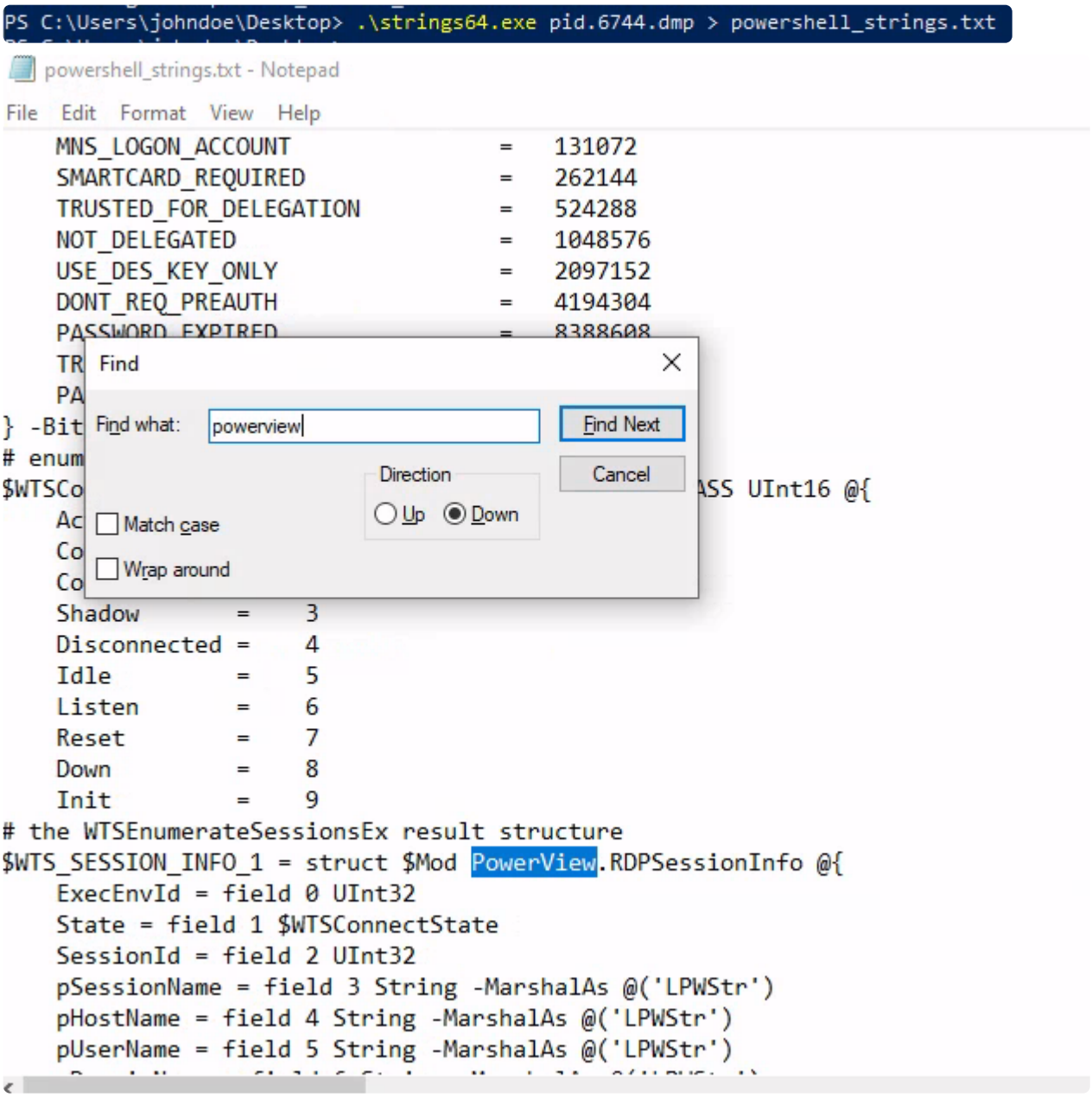
```
python -m http.server

wget http://10.10.16.5:8000/strings64.exe -OutFile strings64.exe
```

```
└──╼ [★]$ python -m http.server
Serving HTTP on 0.0.0.0 port 8000 (http://0.0.0.0:8000/) ...
10.129.228.173 - - [13/Aug/2024 16:52:47] "GET /strings64.exe HTTP/1.1" 200 -
```

```
PS C:\Users\johndoe\Desktop> wget http://10.10.16.5:8000/strings64.exe -OutFile strings64.exe
```

-> We then apply string functions to it and search for powerview

```
.\strings64.exe pid.6744.dmp > powershell_strings.txt
```

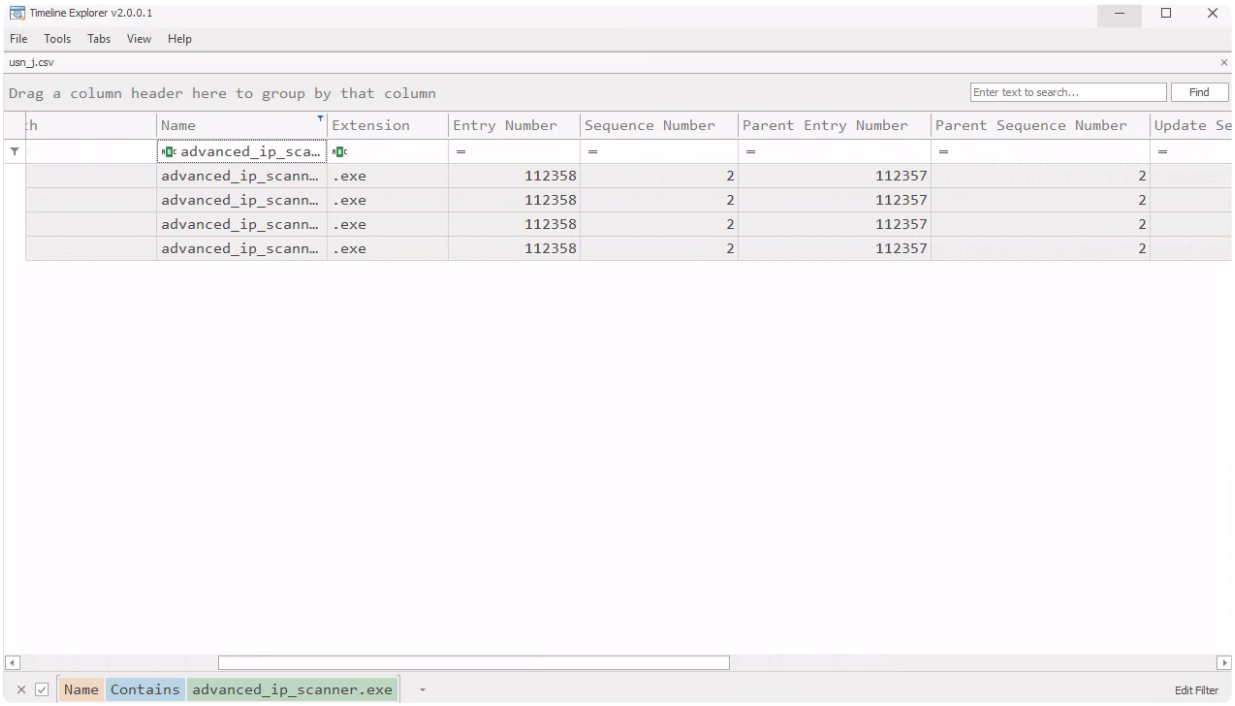


-> Hence, we confirmed using 2 different techniques that it is indeed Powerview being utilised in the powershell process.

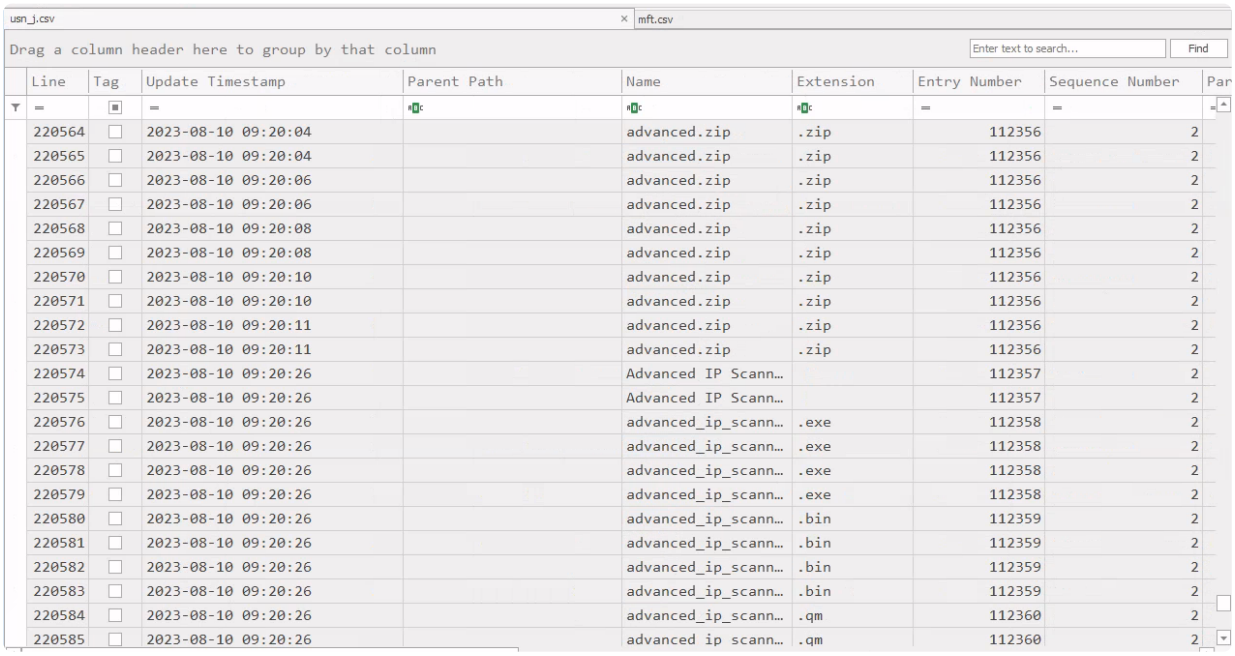
- Investigate the USN Journal located at "C:\Users\johndoe\Desktop\kapefiles\ntfs\%5C%5C.%5CC%3A$Extend$UsnJrnl%3A$J" to determine how "advanced*ip_scanner.exe" was introduced to the compromised system. Enter the name of the associated process as your answer. Answer format:* .exe
- We first parse the the usn journal into CSV format as shown below and open it in time explorer.

```
.\MFTECmd.exe -f 'C:\Users\johndoe\Desktop\kapefiles\ntfs\%5C%5C.%5CC%3A\$Extend\$UsnJrnl%3A$J' --csv C:\Users\johndoe\Desktop --csvf usn_j.csv
```

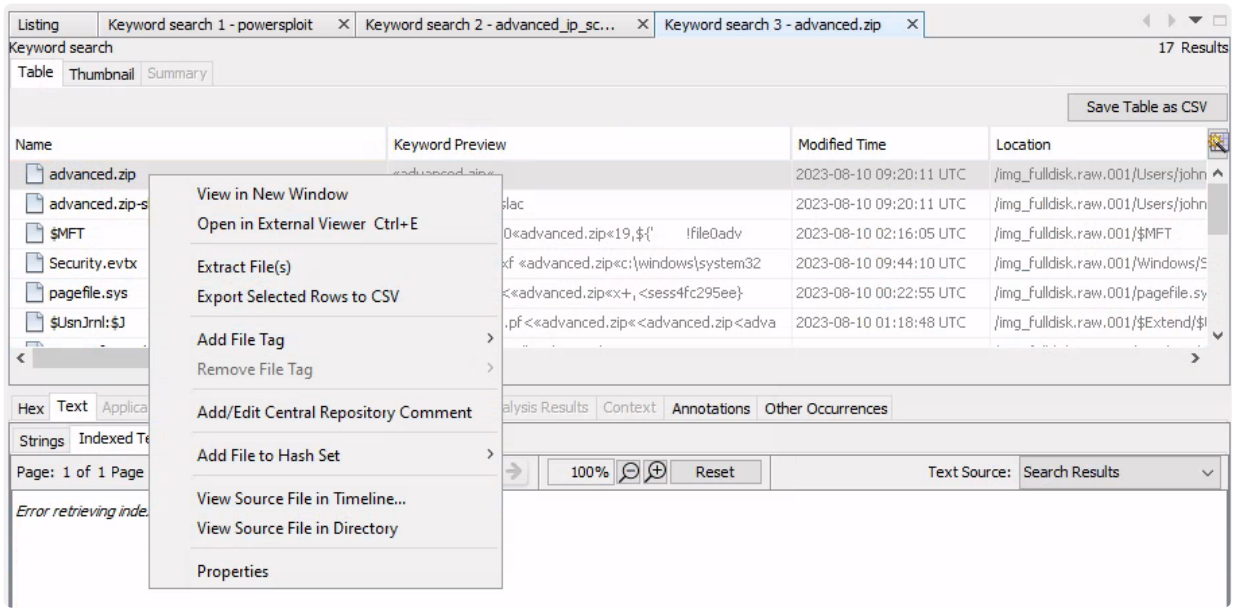
- We filter for the name advanced_ip scanner



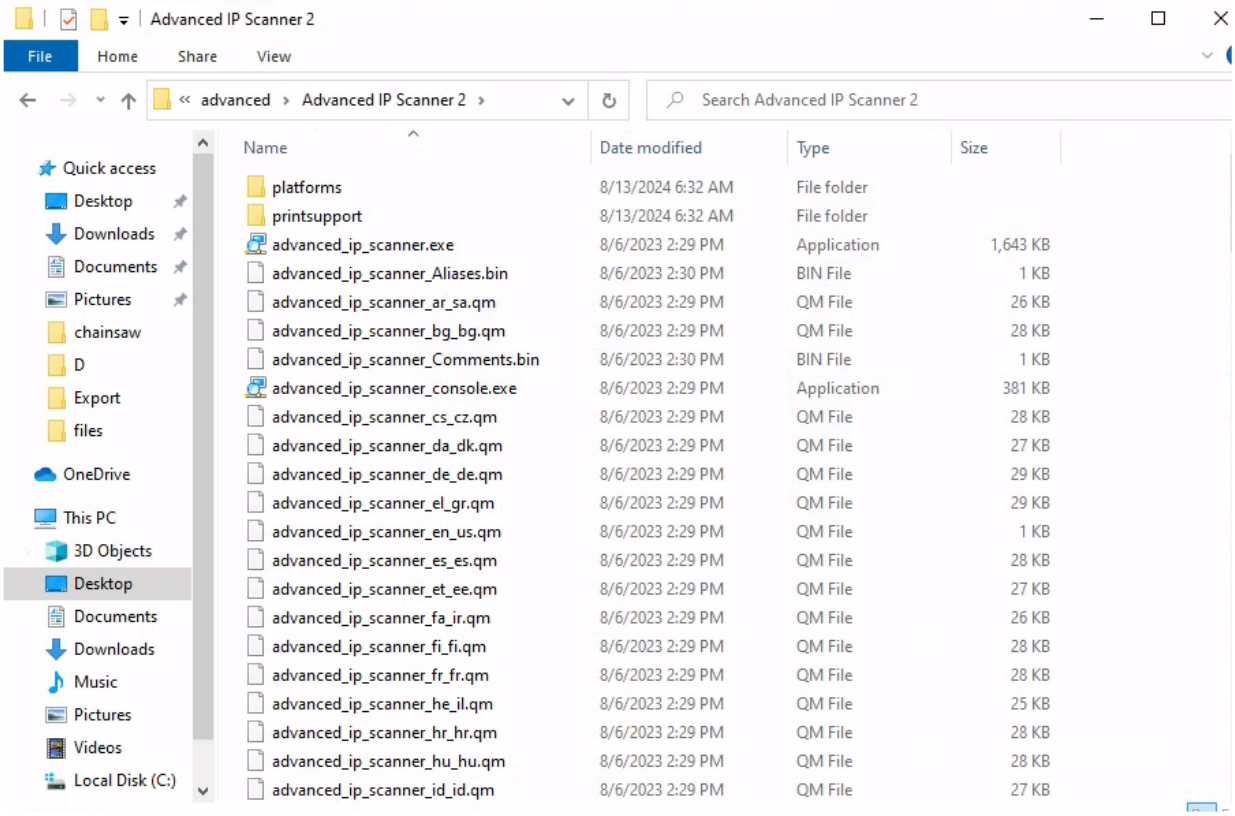
- We also see that it right before advanced_ip_scanner.exe there is an zip file called advanced.zip.



-> Hence, we search for this keyword in autopsy and decide to extract the file to see whether it contains advance_ip_scanner.exe



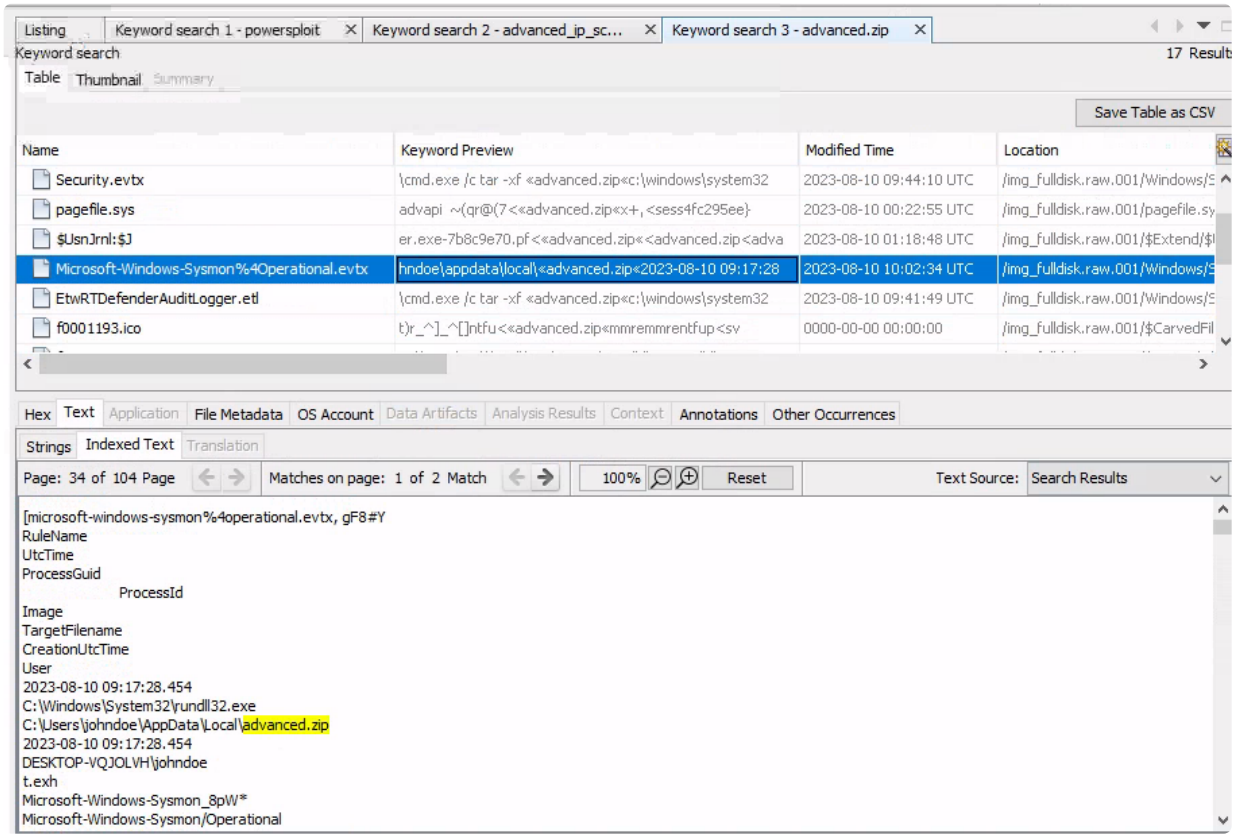
-> Unzipping the file we confirmed our suspicion and saw advanced_ip_scanner.exe in it.



-> As such, we only have to look at the windows event log for file creation of this advanced.zip file and find the corresponding process associated with it.

-> We go back to Autopsy and examine the sysmon log file and saw that it indeed

recorded the event for file creation and the associated process (image) is rundll32.exe.



Skills Assessment

Scenario:

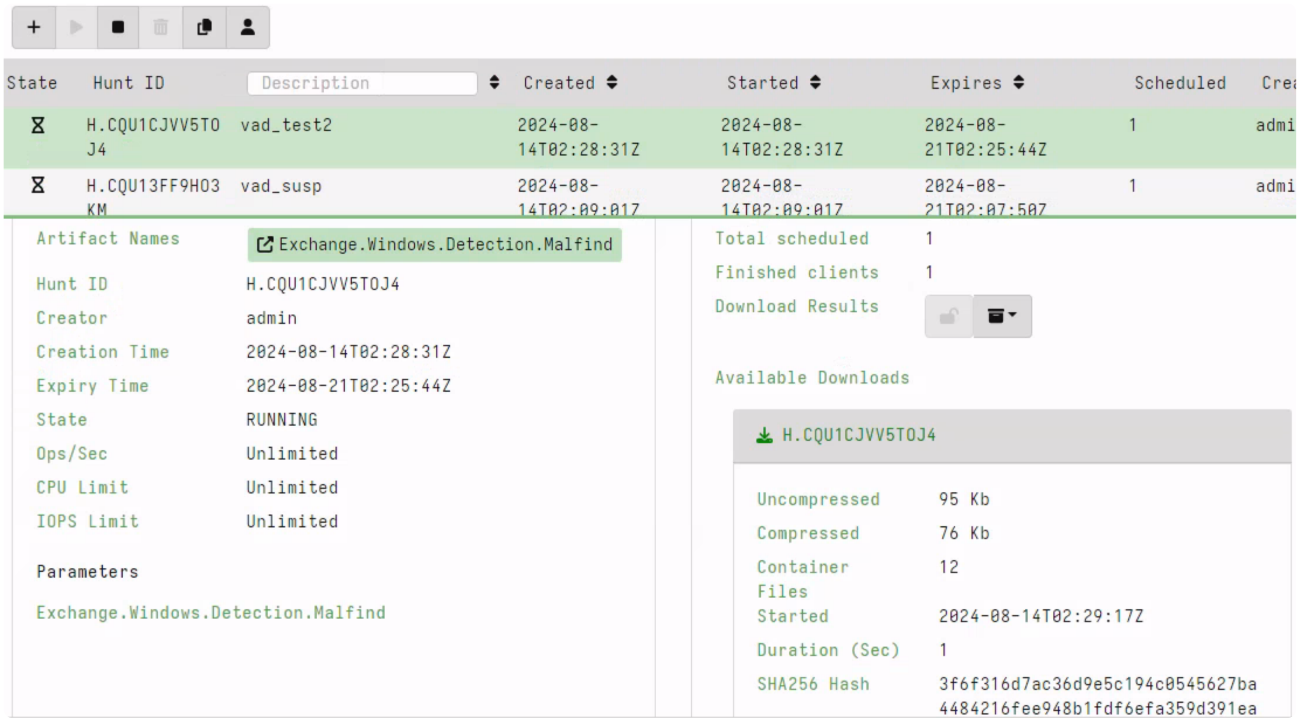
- Upon identifying signs of data exfiltration from an unusual process on a system, the SOC manager tasked you with conducting a forensic investigation through `Velociraptor`.
- Once you've established a connection to the target of this section via RDP, visit the URL `https://127.0.0.1:8889/app/index.html#/search/all` and log in using the credentials: `admin/password`. After logging in, click on the circular symbol adjacent to `Client ID`. Subsequently, select the displayed `Client ID` and click on `Collected`.
- Answer the questions below through Velociraptor collections that gather artifacts similar to the ones presented in this module.
- **Note**: You can initiate Velociraptor collections in the same manner as Velociraptor hunts.

Questions

- Using VAD analysis, pinpoint the suspicious process and enter its name as your

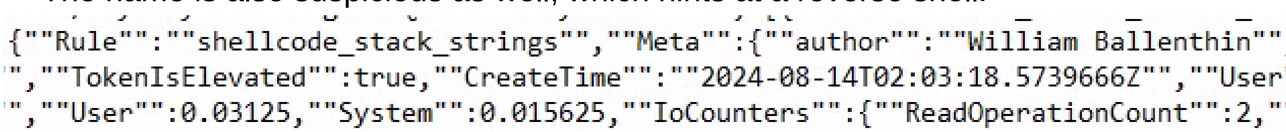
answer. Answer format: _.exe

-> We first try different collection methods that uses VAD on Velociraptor and the artifact that proved to work is Exchange.Windows.Detection.Malfind, where it looks for memory regions that has read, write and execute and uses yara rules to look for suspicious process as shown below:



-> We download the result and open the csv file, we immediately found the suspicious process reverse.exe, which seems to be identified with the rule shellcode_stack_strings and indicates shell code execution.

-> The name is also suspicious as well, which hints at a reverse shell.



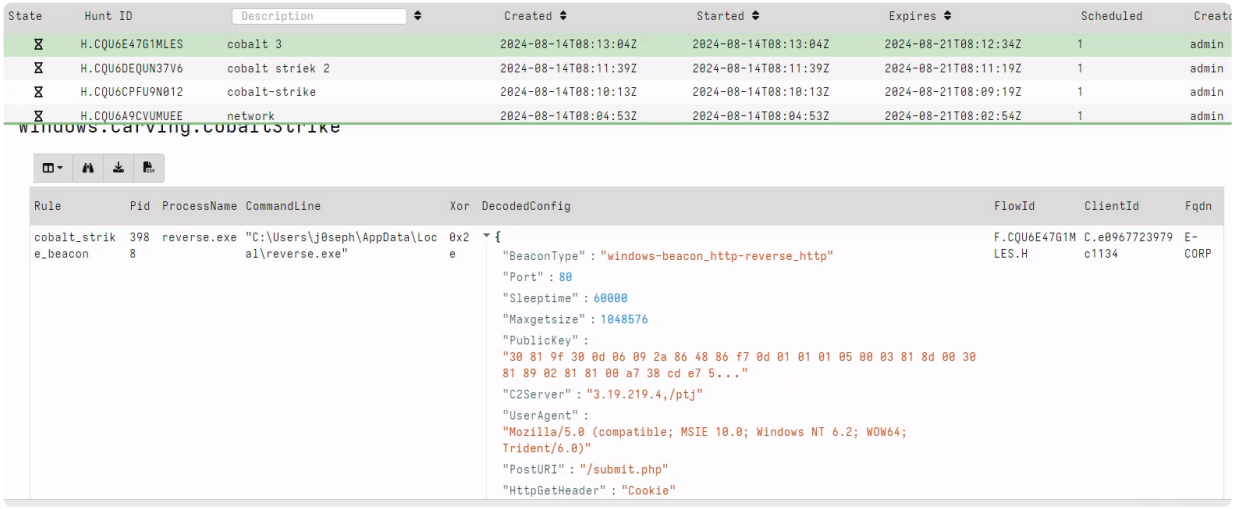
-> We can also look at it in velocirpator notebook section and see that it is likely an cobalt strike payload.

State	Hunt ID	Description	Created	Started	Expires	Scheduled	Creat
⧖	H.CQU6A9CVUMUEE	network	2024-08-14T08:04:53Z	2024-08-14T08:04:53Z	2024-08-21T08:02:54Z	1	admin
■	H.CJOH7UEPS5CUK	Users	2023-08-31T22:28:09Z	2023-08-31T22:28:09Z	2023-09-07T22:27:00Z	102	admin

CreateTime	Pid	Name	AddressRange	Protection	SectionSize	HexHeader	DataMagic	SectionData	YaraHit	ProcessChain	FlowId	ClientId	Fqdn
2024-08-14T08:00:47Z	3988	reverse.exe	750000-79e000	xrw	319488	4d 5a	PE32+ executable (DLL) (GUI) x86-64, for MS Windows	MZARUH..H.	[0 : { "Rule" : "win_cobalt_strike_auto" "Meta" : { ...} "Tags" : NULL "String" : { ...} } 1 : {...}	[0 : { ...} 1 : { ...}]	F.CQU6A9CVUMUEE.H	C.e0967723979c1134	E-CORP

-> This hints that the next thing we should look at is cobalt strike related artifact analysis if we were to do analysis on C2 server that it connects back or just further analysis of the payload.
-> It also has pid of 3988.

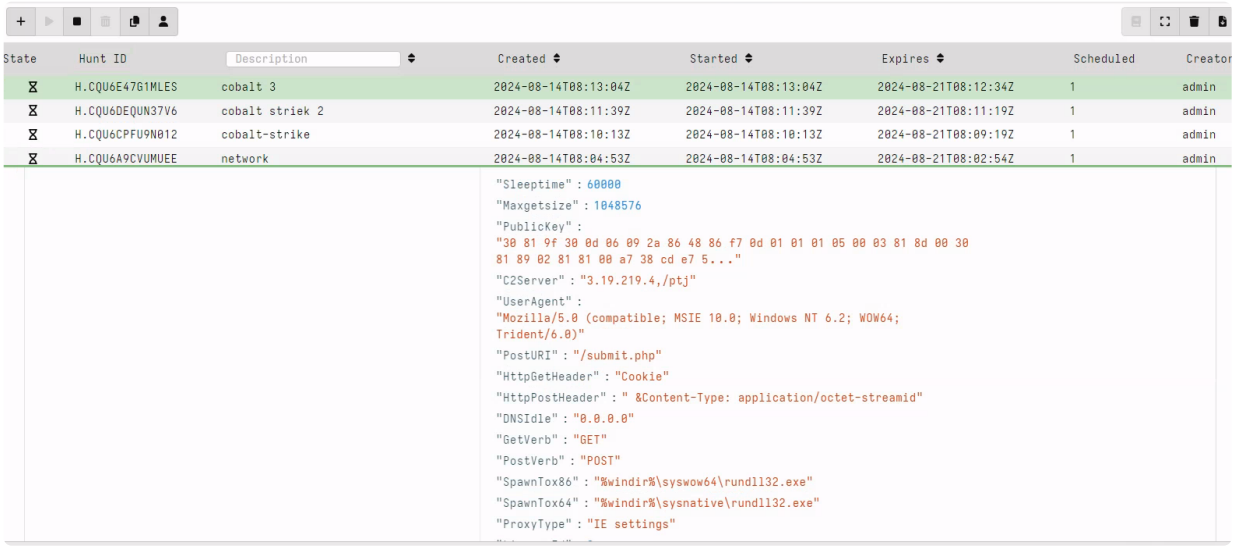
- Determine the IP address of the C2 (Command and Control) server and enter it as your answer.
  -> From the previous question, we use the windows.carving.cobalt strike, filtering with regex of process name of reverse, since we know it is an cobalt strike payload from the previous question and we can extract the configuration.
  ->We get the following below:



State	Hunt ID	Description	Created	Started	Expires	Scheduled	Creat
⧖	H.CQU6E47G1MLES	cobalt 3	2024-08-14T08:13:04Z	2024-08-14T08:13:04Z	2024-08-21T08:12:34Z	1	admin
⧖	H.CQU6DEQUN37V6	cobalt striek 2	2024-08-14T08:11:39Z	2024-08-14T08:11:39Z	2024-08-21T08:11:19Z	1	admin
⧖	H.CQU6CPFU9N012	cobalt-strike	2024-08-14T08:10:13Z	2024-08-14T08:10:13Z	2024-08-21T08:09:19Z	1	admin
⧖	H.CQU6A9CVUMUEE	network	2024-08-14T08:04:53Z	2024-08-14T08:04:53Z	2024-08-21T08:02:54Z	1	admin

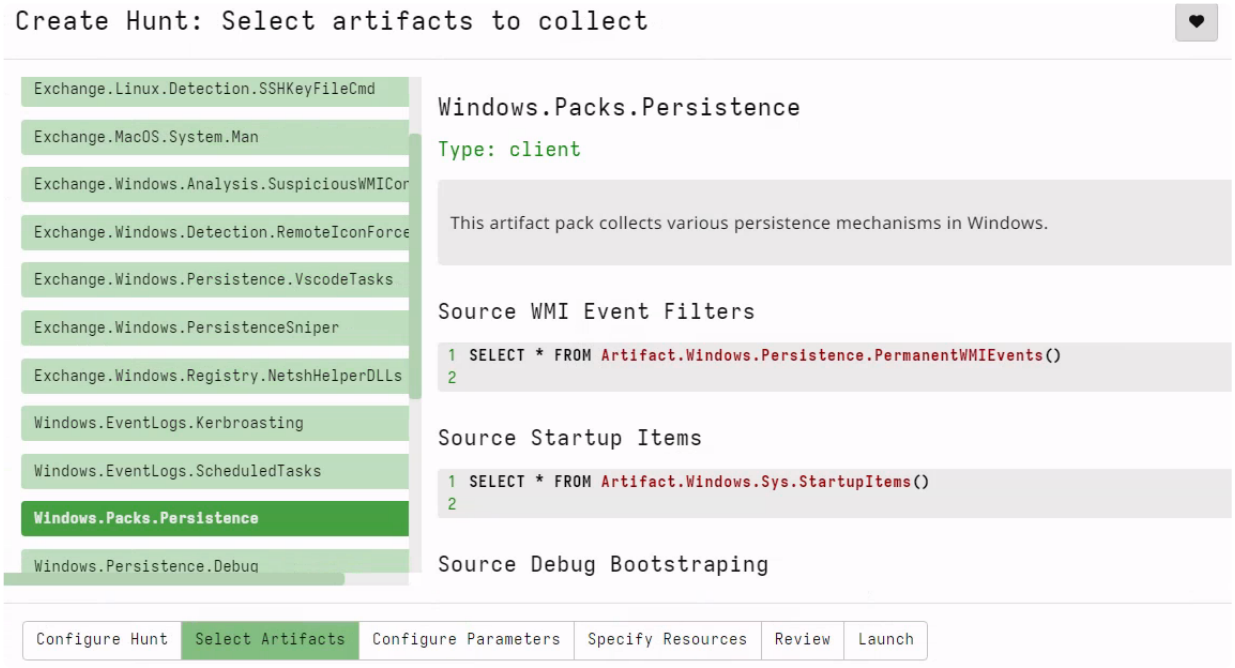
windows.carving.cobaltstrike

Rule	Pid	ProcessName	CommandLine	Xor	DecodedConfig	FlowId	ClientId	Fqdn
cobalt_strike_beacon	3988	reverse.exe	"C:\Users\j0seph\AppData\Local\reverse.exe"	0x2e	{ "BeaconType" : "windows-beacon_http-reverse_http" "Port" : 80 "Sleeptime" : 60000 "Maxgetsize" : 1048576 "PublicKey" : "30 81 9f 30 0d 06 09 2a 86 48 86 f7 0d 01 01 01 05 00 03 81 8d 00 30 81 89 02 81 81 00 a7 38 cd e7 5..." "C2Server" : "3.19.219.4,/ptj" "UserAgent" : "Mozilla/5.0 (compatible; MSIE 10.0; Windows NT 6.2; WOW64; Trident/6.0)" "PostURI" : "/submit.php" "HttpGetHeader" : "Cookie"	F.CQU6E47G1MLES.H	C.e0967723979c1134	E-CORP

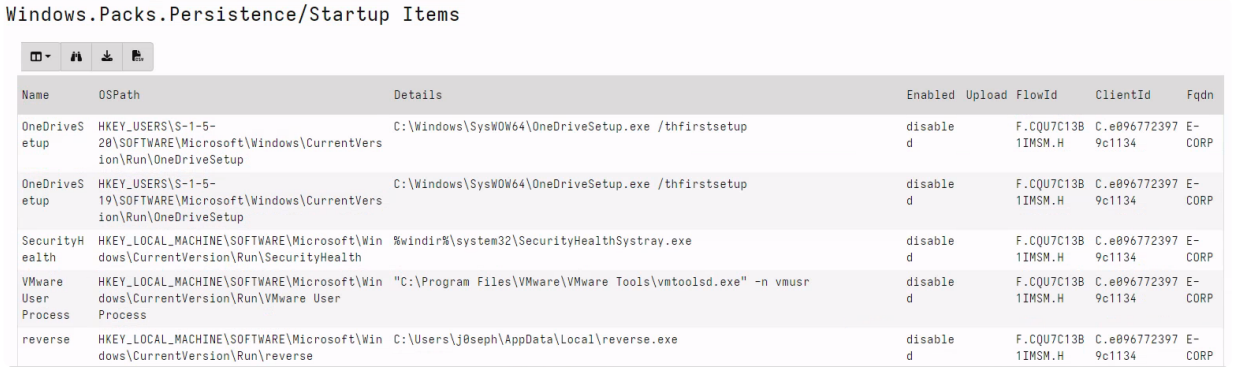


-> And we see that the C2 server has an ip address of 3.19.219.4

- Determine the registry key used for persistence and enter it as your answer.
  -> We look at the artifact that contains collects various persistence mechanism in windows (including event filers, startup items..).



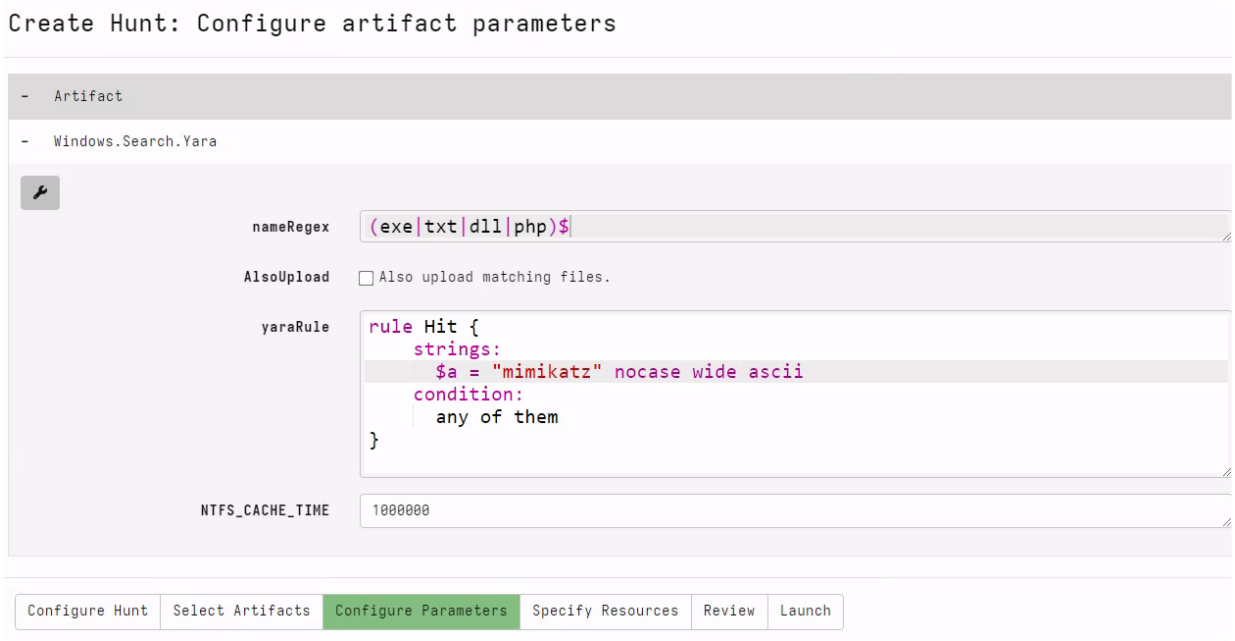
-> We saw the suspicious reverse process that we previously identified!



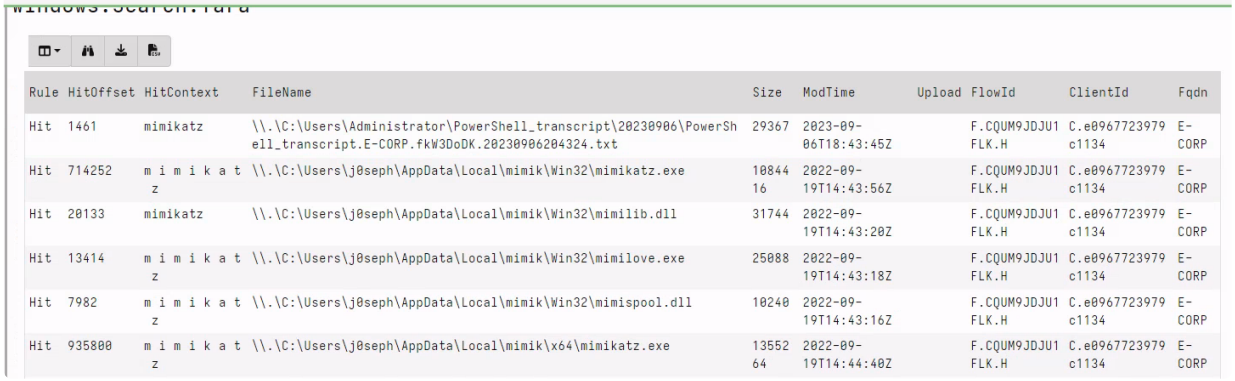
-> We see the suspicious reverse shell under the key

`HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Run` which we previously identified!

- Determine the folder that contains all Mimikatz-related files and enter the full path as your answer.
  -> We search for the yara.search artifact (for file look up) with mimikatz as initial guess/hunt.
  -> The motivation behind is because mimkatz is an malware that can be detected through Yara signature-based detection, so yara is an solid choice here.



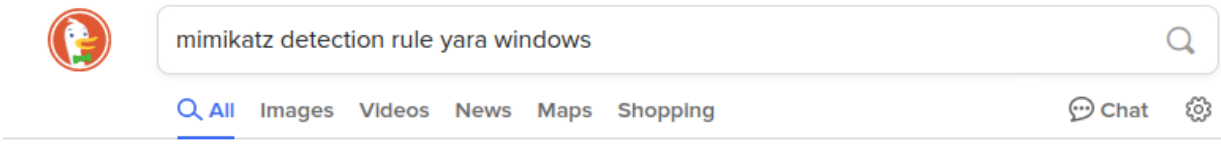
-> And we get the result of the directory



Rule	HitOffset	HitContext	FileName	Size	ModTime	Upload	FlowId	ClientId	Fqdn
Hit	1461	mimikatz	\\.\C:\Users\Administrator\PowerShell_transcript\20230906\PowerShell_transcript.E-CORP.fkW3DoDK.20230906204324.txt	29367	2023-09-06T18:43:45Z		F.CQUM9JDJU1FLK.H	C.e0967723979c1134	E-CORP
Hit	714252	m i m i k a t z	\\.\C:\Users\j0seph\AppData\Local\mimik\Win32\mimikatz.exe	1084416	2022-09-19T14:43:56Z		F.CQUM9JDJU1FLK.H	C.e0967723979c1134	E-CORP
Hit	20133	mimikatz	\\.\C:\Users\j0seph\AppData\Local\mimik\Win32\mimilib.dll	31744	2022-09-19T14:43:20Z		F.CQUM9JDJU1FLK.H	C.e0967723979c1134	E-CORP
Hit	13414	m i m i k a t z	\\.\C:\Users\j0seph\AppData\Local\mimik\Win32\mimilove.exe	25088	2022-09-19T14:43:18Z		F.CQUM9JDJU1FLK.H	C.e0967723979c1134	E-CORP
Hit	7982	m i m i k a t z	\\.\C:\Users\j0seph\AppData\Local\mimik\Win32\mimispool.dll	10240	2022-09-19T14:43:16Z		F.CQUM9JDJU1FLK.H	C.e0967723979c1134	E-CORP
Hit	935800	m i m i k a t z	\\.\C:\Users\j0seph\AppData\Local\mimik\x64\mimikatz.exe	1355264	2022-09-19T14:44:40Z		F.CQUM9JDJU1FLK.H	C.e0967723979c1134	E-CORP

```
C:\Users\j0seph\AppData\Local\mimik\
```

-> However the above is not the most reliable method (can be easily evaded through tweaking file names), we could also search for detecting mimikatz using a more reliable rule (based on the property of the mimikatz) which we searched below:



https://adsecurity.org › ?p=1567

Detecting Mimikatz Use - Active Directory Security

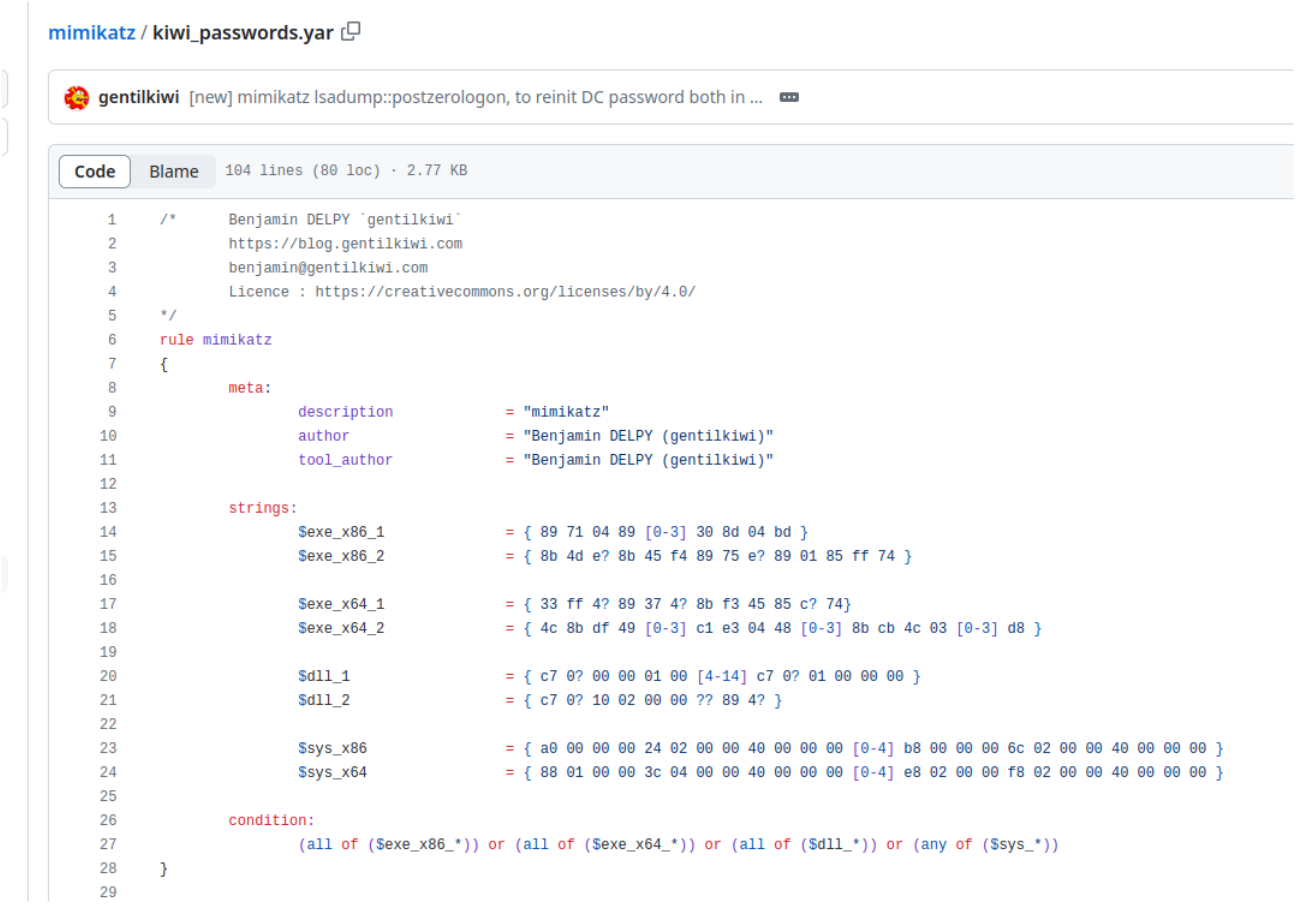
YARA is multi-platform, running on **Windows**, Linux and Mac OS X, and can be used through its command-line interface or from your own Python scripts with the **yara**-python extension. Based on the published data, this data enables **detection** of the **Mimikatz** exe, dll, and artifacts such as kirbi ticket...

...

YARA is multi-platform, running on Windows, Linux and Mac OS X, and can be used through its command-line interface or from your own Python scripts with the yara-python extension.

Based on the published data, this data enables detection of the Mimikatz exe, dll, and artifacts such as kirbi ticket files, as well as WCE.
Here's the data:

```
/*   Benjamin DELPY `gentilkiwi`
http://blog.gentilkiwi.com
benjamin@gentilkiwi.com
Licence : http://creativecommons.org/licenses/by/3.0/fr/
*/
rule mimikatz
{
meta:
description     = "mimikatz"
author          = "Benjamin DELPY (gentilkiwi)"
tool_author     = "Benjamin DELPY (gentilkiwi)"
strings:
$exe_x86_1      = { 89 71 04 89 [0-3] 30 8d 04 bd }
$exe_x86_2      = { 89 79 04 89 [0-3] 38 8d 04 b5 }

$exe_x64_1      = { 4c 03 d8 49 [0-3] 8b 03 48 89 }
$exe_x64_2      = { 4c 8b df 49 [0-3] c1 e3 04 48 [0-3] 8b cb 4c 03 [0-3] d8 }
```



mimikatz / kiwi_passwords.yar

gentilkiwi [new] mimikatz lsadump::postzerologon, to reinit DC password both in ...

Code Blame 104 lines (80 loc) · 2.77 KB

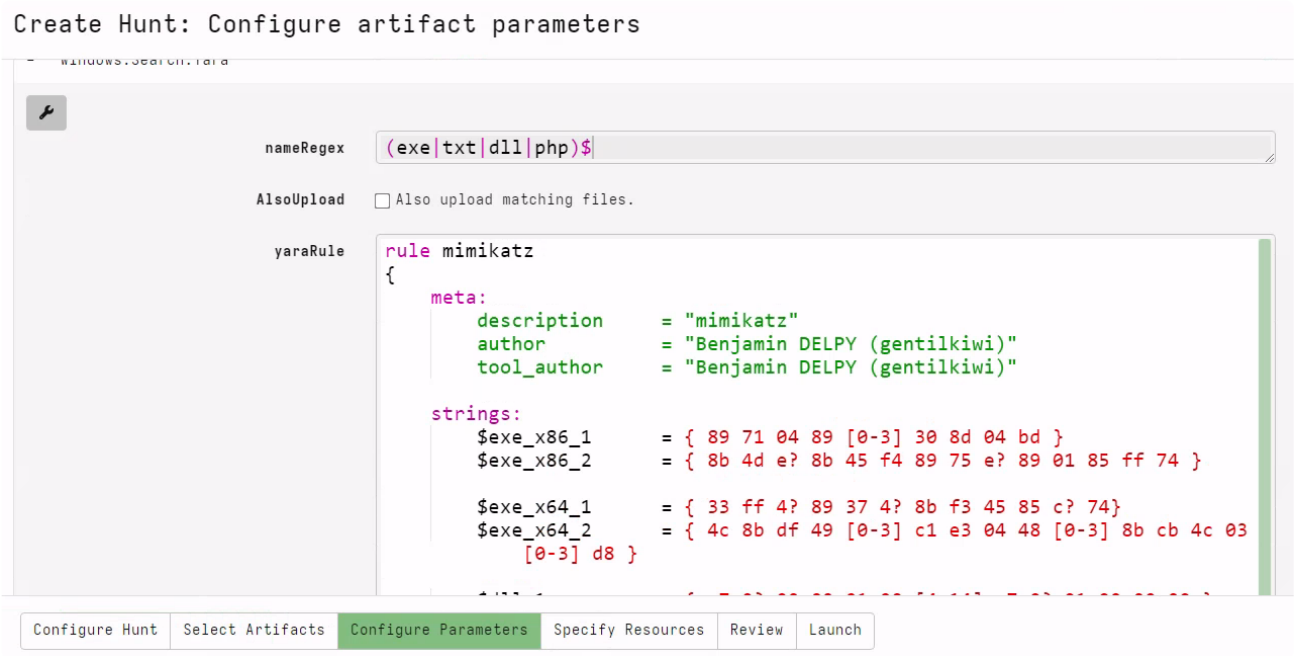
```
/*      Benjamin DELPY `gentilkiwi`
        https://blog.gentilkiwi.com
        benjamin@gentilkiwi.com
        Licence : https://creativecommons.org/licenses/by/4.0/
*/
rule mimikatz
{
        meta:
                description             = "mimikatz"
                author                  = "Benjamin DELPY (gentilkiwi)"
                tool_author             = "Benjamin DELPY (gentilkiwi)"

        strings:
                $exe_x86_1              = { 89 71 04 89 [0-3] 30 8d 04 bd }
                $exe_x86_2              = { 8b 4d e? 8b 45 f4 89 75 e? 89 01 85 ff 74 }

                $exe_x64_1              = { 33 ff 4? 89 37 4? 8b f3 45 85 c? 74}
                $exe_x64_2              = { 4c 8b df 49 [0-3] c1 e3 04 48 [0-3] 8b cb 4c 03 [0-3] d8 }

                $dll_1                  = { c7 0? 00 00 01 00 [4-14] c7 0? 01 00 00 00 }
                $dll_2                  = { c7 0? 10 02 00 00 ?? 89 4? }

                $sys_x86                = { a0 00 00 00 24 02 00 00 40 00 00 00 [0-4] b8 00 00 00 6c 02 00 00 40 00 00 00 }
                $sys_x64                = { 88 01 00 00 3c 04 00 00 40 00 00 00 [0-4] e8 02 00 00 f8 02 00 00 40 00 00 00 }

        condition:
                (all of ($exe_x86_*)) or (all of ($exe_x64_*)) or (all of ($dll_*)) or (any of ($sys_*))
}
```

https://github.com/gentilkiwi/mimikatz/blob/master/kiwi_passwords.yar

-> Where we use the following rule for searching mimikatz

```
rule mimikatz
{
        meta:
                description             = "mimikatz"
                author                  = "Benjamin DELPY (gentilkiwi)"
                tool_author             = "Benjamin DELPY (gentilkiwi)"

        strings:
                $exe_x86_1              = { 89 71 04 89 [0-3] 30 8d 04
bd }
                $exe_x86_2              = { 8b 4d e? 8b 45 f4 89 75 e?
89 01 85 ff 74 }

                $exe_x64_1              = { 33 ff 4? 89 37 4? 8b f3 45
85 c? 74}
                $exe_x64_2              = { 4c 8b df 49 [0-3] c1 e3 04
48 [0-3] 8b cb 4c 03 [0-3] d8 }

                $dll_1                  = { c7 0? 00 00 01 00 [4-14] c7
```

```
0? 01 00 00 00 }
                $dll_2                  = { c7 0? 10 02 00 00 ?? 89 4? }

                $sys_x86                = { a0 00 00 00 24 02 00 00 40
00 00 00 [0-4] b8 00 00 00 6c 02 00 00 40 00 00 00 }
                $sys_x64                = { 88 01 00 00 3c 04 00 00 40
00 00 00 [0-4] e8 02 00 00 f8 02 00 00 40 00 00 00 }

        condition:
                (all of ($exe_x86_*)) or (all of ($exe_x64_*)) or (all
of ($dll_*)) or (any of ($sys_*))
}
```



-> Hunting with the more accurate yara rule, we see an more accurate detection result.

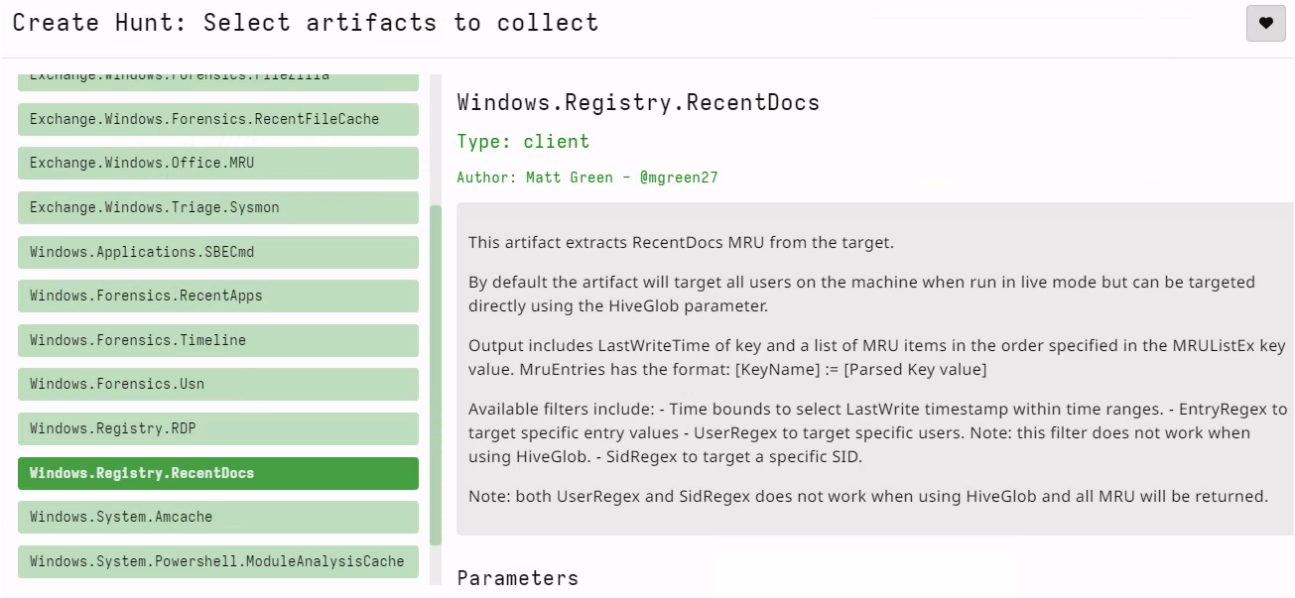
Windows.Search.Yara

Rule	HitOffset	HitContext	FileName	Size	ModTime	Upload	FlowId	ClientId	Fqdn
mimikatz	1021796	`◆q ◆0◆ ◆`	\\.\C:\Users\j0seph\AppData\Local\mimik\Win32\mimikatz.exe	1084416	2022-09-19T14:43:56Z		F.CQUMF0BUDAJQU.H	C.e0967723979c1134	E-CORP
mimikatz	1890	`◆ ◆D$ ◆ ◆ ◆D$ ◆`	\\.\C:\Users\j0seph\AppData\Local\mimik\Win32\mimilib.dll	31744	2022-09-19T14:43:20Z		F.CQUMF0BUDAJQU.H	C.e0967723979c1134	E-CORP
mimikatz	1278752	`3◆A◆7L◆◆E◆◆t`	\\.\C:\Users\j0seph\AppData\Local\mimik\x64\mimikatz.exe	1355264	2022-09-19T14:44:40Z		F.CQUMF0BUDAJQU.H	C.e0967723979c1134	E-CORP
mimikatz	2395	`◆ I◆ A◆`	\\.\C:\Users\j0seph\AppData\Local\mimik\x64\mimilib.dll	37376	2022-09-19T14:44:02Z		F.CQUMF0BUDAJQU.H	C.e0967723979c1134	E-CORP

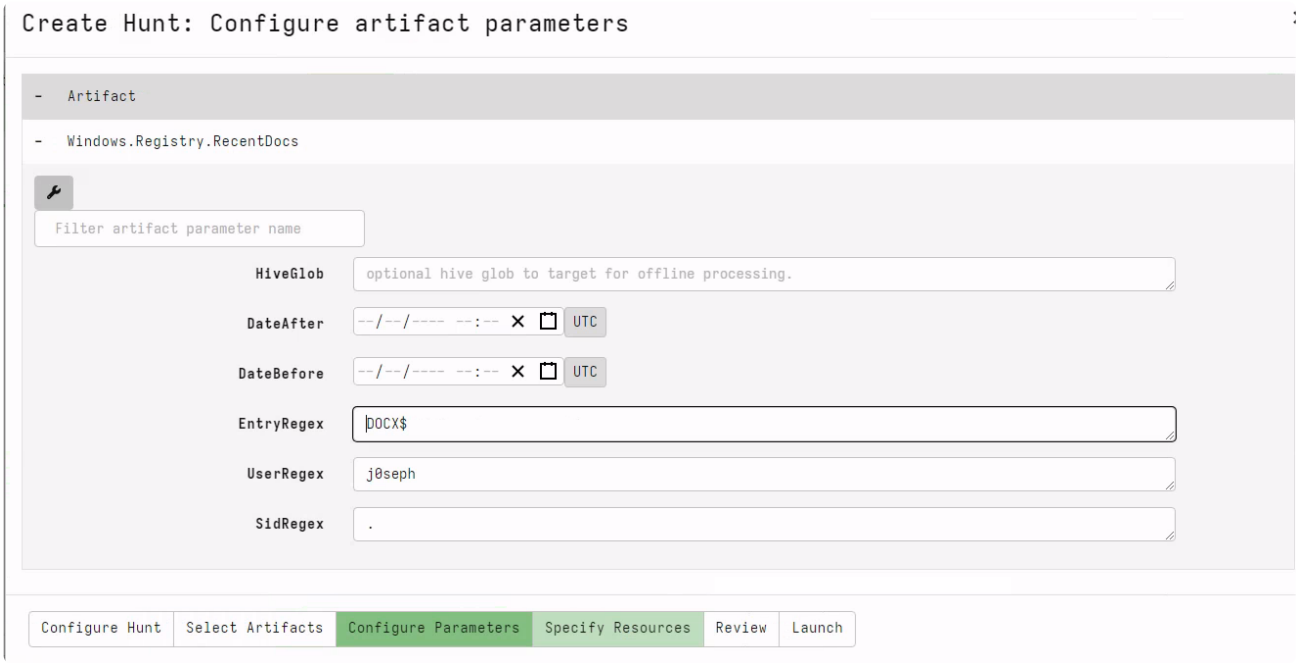
- Determine the Microsoft Word document that j0seph recently accessed and enter its name as your answer. Answer format: __.DOCX

-> We search for recently used document in Velociraptor and we come across the interesting artifact Windows.Registry.RecentDocs, which extracts RecentDocs MRU (most

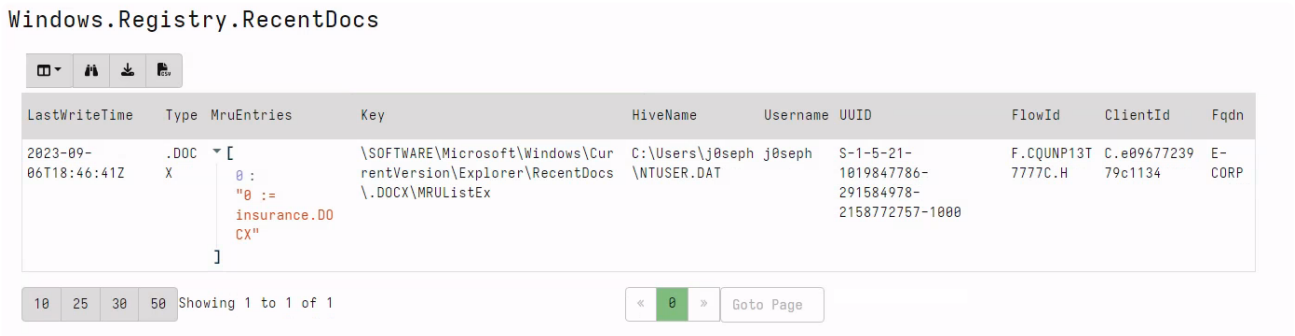
recently used) from the target.



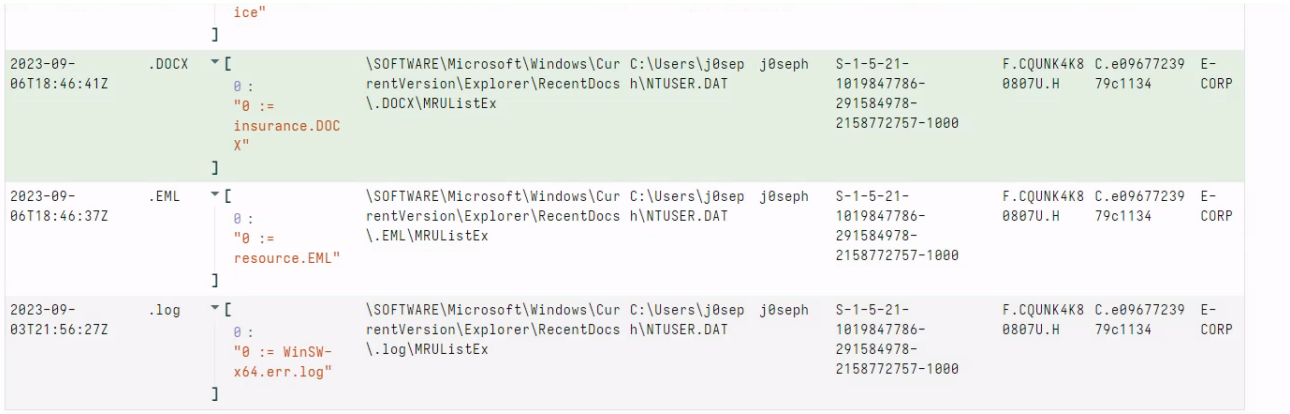
-> We filter for the j0seph user and .DOCX regex as follows in parameter configuration:



-> Inspecting the result of the artifact collected, we see that insurance.DOCX is the .DOCX file last accessed.



-> Alternatively, we can also ignore the DOCX$ in the EntryRegex (while keeping the j0seph for UserRegex) and still obtain the result, but we just have to scroll the results obtained to see insurance.DOCX:



		ice"]							
2023-09-06T18:46:41Z	.DOCX	[0 : "0 := insurance.DOCX"]	\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\RecentDocs\.DOCX\MRUListEx	C:\Users\j0seph\NTUSER.DAT	j0seph	S-1-5-21-1019847786-291584978-2158772757-1000	F.CQUNK4K80807U.H	C.e09677239 79c1134	E-CORP
2023-09-06T18:46:37Z	.EML	[0 : "0 := resource.EML"]	\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\RecentDocs\.EML\MRUListEx	C:\Users\j0seph\NTUSER.DAT	j0seph	S-1-5-21-1019847786-291584978-2158772757-1000	F.CQUNK4K80807U.H	C.e09677239 79c1134	E-CORP
2023-09-03T21:56:27Z	.log	[0 : "0 := WinSW-x64.err.log"]	\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\RecentDocs\.log\MRUListEx	C:\Users\j0seph\NTUSER.DAT	j0seph	S-1-5-21-1019847786-291584978-2158772757-1000	F.CQUNK4K80807U.H	C.e09677239 79c1134	E-CORP

Summary for skills assessment

- Another way to conduct forensic investigation is to use Velocirpator (or tools like it) using the different artifact collection methods.
  - E.g. We don't always need the memory dump and/or kape artifact in front of us and analyse it with the EricZimmerann tools and more ..., sometimes its not possible or less convenient, though it is another way and can give us more detailed insight.