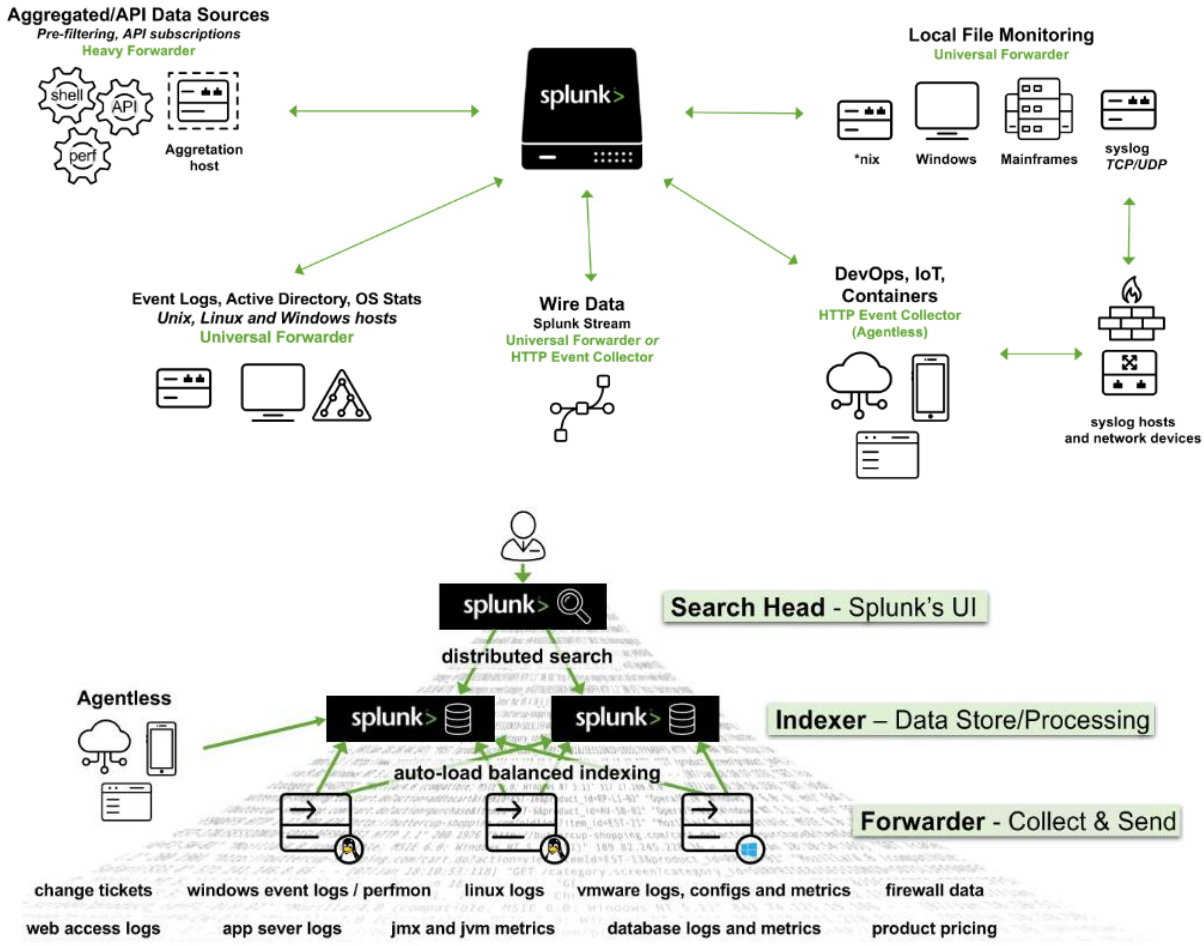
Introduction To Splunk & SPL

What Is Splunk?

Splunk is a highly scalable, versatile, and robust data analytics software solution known for its ability to ingest, index, analyze, and visualize massive amounts of machine data. Splunk has the capability to drive a wide range of initiatives, encompassing cybersecurity, compliance, data pipelines, IT monitoring, observability, as well as overall IT and business management.



Splunk's (Splunk Enterprise) architecture consists of several layers that work together to collect, index, search, analyze, and visualize data. The architecture can be divided into the following main components:

- Forwarders: Forwarders are responsible for data collection. They gather machine data from various sources and forward it to the indexers. The types of forwarders used in Splunk are:
    - Universal Forwarder (UF): This is a lightweight agent that collects data and forwards it to the Splunk indexers without any preprocessing. Universal Forwarders are individual software packages that can be easily installed on remote sources without significantly affecting network or host performance.
    - Heavy Forwarder (HF): This agent serves the purpose of collecting data from remote sources, especially for intensive data aggregation assignments involving sources like firewalls or data routing/filtering points. According to **Splexicon**,

heavy forwarders stand out from other types of forwarders as they parse data before forwarding, allowing them to route data based on specific criteria such as event source or type. They can also index data locally while simultaneously forwarding it to another indexer. Typically, Heavy Forwarders are deployed as dedicated "data collection nodes" for API/scripted data access, and they exclusively support Splunk Enterprise.

    - Please note that there are HTTP Event Collectors (HECs) available for directly collecting data from applications in a scalable manner. HECs operate by using token-based JSON or raw API methods. In this process, data is sent directly to the Indexer level for further processing.

- Indexers: The indexers receive data from the forwarders, organize it, and store it in indexes. While indexing data, the indexers generate sets of directories categorized by age, wherein each directory hold compressed raw data and corresponding indexes that point to the raw data. They also process search queries from users and return results.
- Search Heads: Search heads coordinate search jobs, dispatching them to the indexers and merging the results. They also provide an interface for users to interact with Splunk. On Search Heads, Knowledge Objects can be crafted to extract supplementary fields and manipulate data without modifying the original index data. It is important to mention that Search Heads also offer various tools to enrich the search experience, including reports, dashboards, and visualizations.
- Deployment Server: It manages the configuration for forwarders, distributing apps and updates.
- Cluster Master: The cluster master coordinates the activities of indexers in a clustered environment, ensuring data replication and search affinity.
- License Master: It manages the licensing details of the Splunk platform.

Splunk's key components include:

- Splunk Web Interface: This is the graphical interface through which users can interact with Splunk, carrying out tasks like searching, creating alerts, dashboards, and reports.
- Search Processing Language (SPL): The query language for Splunk, allowing users to search, filter, and manipulate the indexed data.
- Apps and Add-ons: Apps provide specific functionalities within Splunk, while add-ons extend capabilities or integrate with other systems. Splunk Apps enable the coexistence of multiple workspaces on a single Splunk instance, catering to different use cases and user roles. These ready-made apps can be found on **Splunkbase**, providing additional functionalities and pre-configured solutions. Splunk Technology Add-ons serve as an abstraction layer for data collection methods. They often include relevant field extractions, allowing for schema-on-the-fly functionality. Additionally, Technology Add-ons encompass pertinent configuration files (props/transforms) and supporting scripts or binaries. A Splunk App, on the other hand, can be seen as a comprehensive solution that typically utilizes one or more Technology Add-ons to enhance its capabilities.

- Knowledge Objects: These include fields, tags, event types, lookups, macros, data models, and alerts that enhance the data in Splunk, making it easier to search and analyze.

Splunk As A SIEM Solution

When it comes to cybersecurity, Splunk can play a crucial role as a log management solution, but its true value lies in its analytics-driven Security Information and Event Management (SIEM) capabilities. Splunk as a SIEM solution can aid in real-time and historical data analysis, cybersecurity monitoring, incident response, and threat hunting. Moreover, it empowers organizations to enhance their detection capabilities by leveraging User Behavior Analytics.

As discussed, Splunk Processing Language (SPL) is a language containing over a hundred commands, functions, arguments, and clauses. It's the backbone of data analysis in Splunk, used for searching, filtering, transforming, and visualizing data.

Let's assume that main is an index containing Windows Security and Sysmon logs, among others.

1. **Basic Searching**

The most fundamental aspect of SPL is searching. By default, a search returns all events, but it can be narrowed down with keywords, boolean operators, comparison operators, and wildcard characters. For instance, a search for error would return all events containing that word.

Boolean operators AND, OR, and NOT are used for more specific queries.

The search command is typically implicit at the start of each SPL query and is not usually written out. However, here's an example using explicit search syntax:

search index="main" "UNKNOWN"

By specifying the index as main, the query narrows down the search to only the events stored in the main index. The term UNKNOWN is then used as a keyword to filter and retrieve events that include this specific term.

Note: Wildcards (*) can replace any number of characters in searches and field values. Example (implicit search syntax):

index="main" "*UNKNOWN*"

This SPL query will search within the main index for events that contain the term UNKNOWN anywhere in the event data.

2. **Fields and Comparison Operators**

Splunk automatically identifies certain data as fields (like source, sourcetype, host, EventCode, etc.), and users can manually define additional fields. These fields can be used with comparison operators (=, !=, <, >, <=, >=) for more precise searches. Example:

index="main" EventCode!=1

This SPL (Splunk Processing Language) query is used to search within the main index for events that do not have an EventCode value of 1.

3. **The fields command**

The fields command specifies which fields should be included or excluded in the search results. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | fields - User

After retrieving all process creation events from the main index, the fields command excludes the User field from the search results. Thus, the results will contain all fields normally found in the **Sysmon Event ID 1** logs, except for the user that initiated the process. Please note that utilizing sourcetype restricts the scope exclusively to Sysmon event logs.

4. **The table command**

The table command presents search results in a tabular format. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | table _time, host, Image

This query returns process creation events, then arranges selected fields (_time, host, and Image) in a tabular format. _time is the timestamp of the event, host is the name of the host where the event occurred, and Image is the name of the executable file that represents the process.

5. **The rename command**

The rename command renames a field in the search results. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | rename Image as Process

This command renames the Image field to Process in the search results. Image field in Sysmon logs represents the name of the executable file for the process. By renaming it, all the subsequent references to Process would now refer to what was originally the Image field.

6. **The dedup command**

The 'dedup' command removes duplicate events. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | dedup Image

The dedup command removes duplicate entries based on the Image field from the process creation events. This means if the same process (Image) is created multiple times, it will appear only once in the results, effectively removing repetition.

7. **The sort command**

The sort command sorts the search results. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | sort - _time

This command sorts all process creation events in the main index in descending order of their timestamps (_time), i.e., the most recent events are shown first.

8. **The stats command**

The stats command performs statistical operations. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=3 | stats count by _time, Image

This query will return a table where each row represents a unique combination of a timestamp (_time) and a process (Image). The count column indicates the number of network connection events that occurred for that specific process at that specific time.

However, it's challenging to visualize this data over time for each process because the data for each process is interspersed throughout the table. We'd need to manually filter by process (Image) to see the counts over time for each one.

9. **The chart command**

The chart command creates a data visualization based on statistical operations. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=3 | chart count by _time, Image

This query will return a table where each row represents a unique timestamp (_time) and each column represents a unique process (Image). The cell values indicate the number of network connection events that occurred for each process at each specific time.

With the chart command, you can easily visualize the data over time for each process because each process has its own column. You can quickly see at a glance the count of network connection events over time for each process.

10. **The eval command**

The eval command creates or redefines fields. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | eval Process_Path=lower(Image)

This command creates a new field Process_Path which contains the lowercase version of the Image field. It doesn't change the actual Image field, but creates a new field that can be used in subsequent operations or for display purposes.

11. **The rex command**

The rex command extracts new fields from existing ones using regular expressions. Example:

index="main" EventCode=4662 | rex max_match=0 "[^%](?<guid>{.*})" | table guid

- index="main" EventCode=4662 filters the events to those in the main index with the EventCode equal to 4662. This narrows down the search to specific events with the specified EventCode.
- rex max_match=0 "[^%](?<guid>{.*})" uses the rex command to extract values matching the pattern from the events' fields. The regex pattern {.*} looks for substrings that begin with { and end with }. The [^%] part ensures that the match does not begin with a % character. The captured value within the curly braces is assigned to the named capture group guid.
- table guid displays the extracted GUIDs in the output. This command is used to format the results and display only the guid field.
- The max_match=0 option ensures that all occurrences of the pattern are extracted from each event. By default, the rex command only extracts the first occurrence.

This is useful because GUIDs are not automatically extracted from 4662 event logs.

12. **The lookup command**

The lookup command enriches the data with external sources. Example:

Suppose the following CSV file called malware_lookup.csv.

filename, is_malware

notepad.exe, false

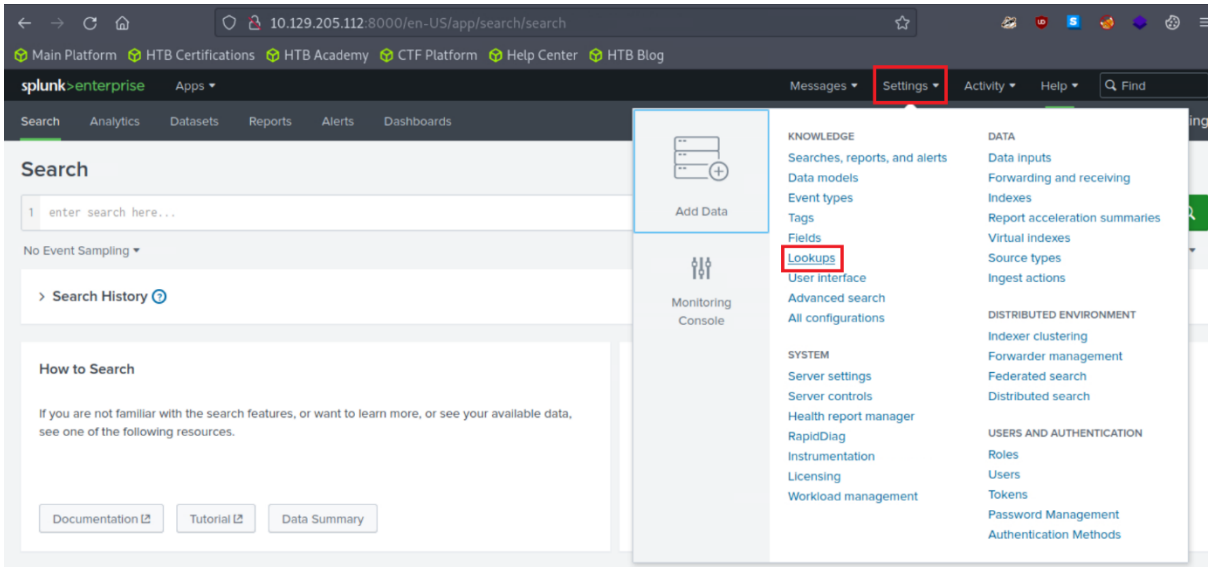
cmd.exe, false

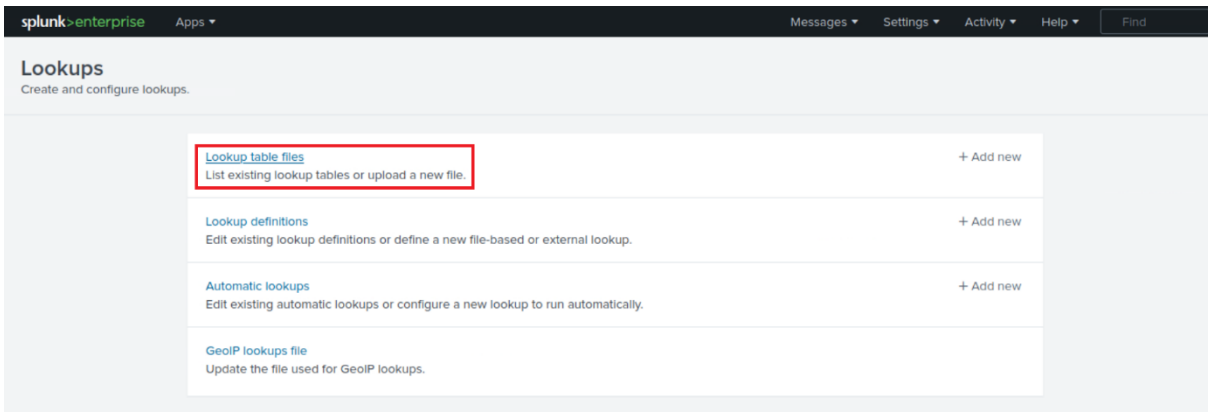
powershell.exe, false

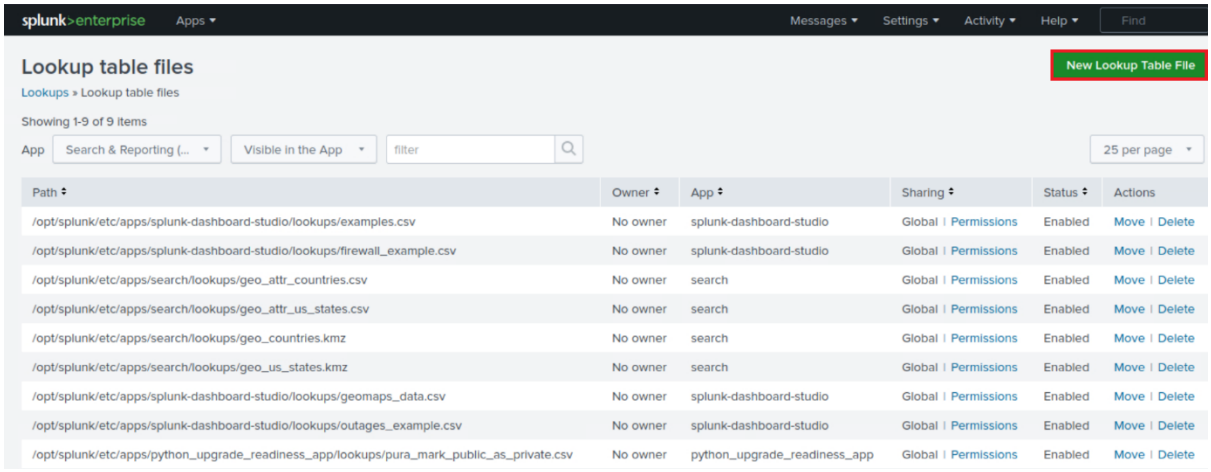
sharphound.exe, true

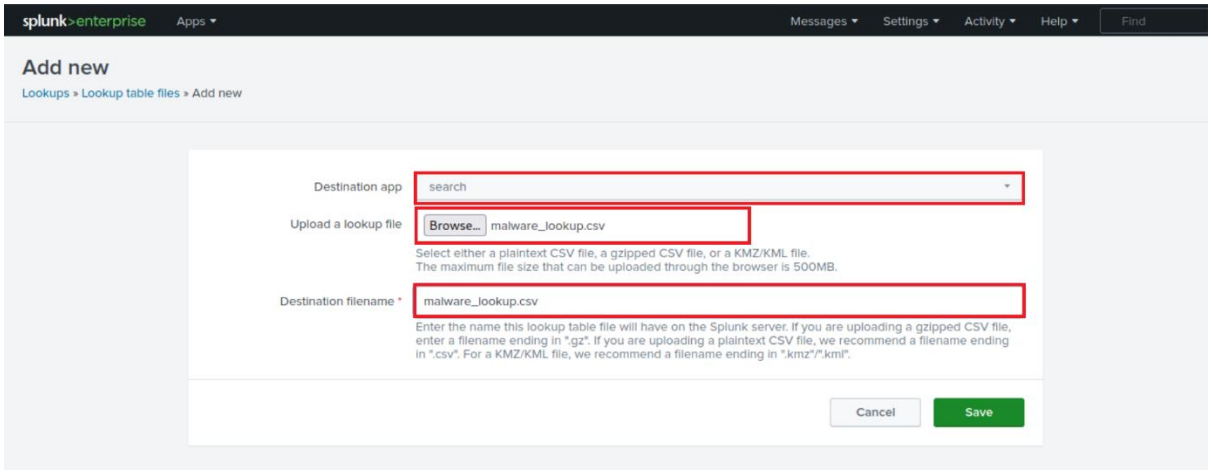
randomfile.exe, true

This CSV file should be added as a new Lookup table as follows.









index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | rex field=Image "(?P<filename>[^\\\]+)$" | eval filename=lower(filename) | lookup malware_lookup.csv filename OUTPUTNEW is_malware | table filename, is_malware

- index="main" sourcetype="WinEventLog:Sysmon" EventCode=1: This is the search criteria. It's looking for Sysmon logs (as identified by the sourcetype) with an EventCode of 1 (which represents process creation events) in the "main" index.
- | rex field=Image "(?P<filename>[^\\\]+)$": This command is using the regular expression (regex) to extract a part of the Image field. The Image field in Sysmon EventCode=1 logs typically contains the full file path of the process. This regex is saying: Capture everything after the last backslash (which should be the filename itself) and save it as filename.
- | eval filename=lower(filename): This command is taking the filename that was just extracted and converting it to lowercase. The lower() function is used to ensure the search is case-insensitive.
- | lookup malware_lookup.csv filename OUTPUTNEW is_malware: This command is performing a lookup operation using the filename as a key. The lookup table (malware_lookup.csv) is expected to contain a list of filenames of known malicious executables. If a match is found in the lookup table, the new field is_malware is added to the event, which indicates whether or not the

process is considered malicious based on the lookup table. <-- filename in this part of the query is the first column title in the CSV.

- | table filename, is_malware: This command is formatting the output to show only the fields filename and is_malware. If is_malware is not present in a row, it means that no match was found in the lookup table for that filename.

In summary, this query is extracting the filenames of newly created processes, converting them to lowercase, comparing them against a list of known malicious filenames, and presenting the findings in a table.

An equivalent that also removes duplicates is the following.

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | eval filename=mvdedup(split(Image, "\\")) | eval filename=mvindex(filename, -1) | eval filename=lower(filename) | lookup malware_lookup.csv filename OUTPUTNEW is_malware | table filename, is_malware | dedup filename, is_malware

- index="main" sourcetype="WinEventLog:Sysmon" EventCode=1: This command is the search criteria. It is pulling from the main index where the sourcetype is WinEventLog:Sysmon and the EventCode is 1. The Sysmon EventCode of 1 indicates a process creation event.
- | eval filename=mvdedup(split(Image, "\\")): This command is splitting the Image field, which contains the file path, into multiple elements at each backslash and making it a multivalue field. The mvdedup function is used to eliminate any duplicates in this multivalue field.
- | eval filename=mvindex(filename, -1): Here, the mvindex function is being used to select the last element of the multivalue field generated in the previous step. In the context of a file path, this would typically be the actual file name.
- | eval filename=lower(filename): This command is taking the filename field and converting it into lowercase using the lower function. This is done to ensure the search is not case-sensitive and to standardize the data.
- | lookup malware_lookup.csv filename OUTPUTNEW is_malware: This command is performing a lookup operation. The lookup command is taking the filename field, and checking if it matches any entries in the malware_lookup.csv lookup table. If there is a match, it appends a new field, is_malware, to the event, indicating whether the process is flagged as malicious.
- | table filename, is_malware: The table command is used to format the output, in this case showing only the filename and is_malware fields in a tabular format.
- | dedup filename, is_malware: This command eliminates any duplicate events based on the filename and is_malware fields. In other words, if there are multiple identical entries for the filename and is_malware fields in the search results, the dedup command will retain only the first occurrence and remove all subsequent duplicates.

In summary, this SPL query searches the Sysmon logs for process creation events, extracts the file name from the Image field, converts it to lowercase, matches it against a list of known malware from the malware_lookup.csv file, and then displays the results in a table, removing any duplicates based on the filename and is_malware fields.

13. **The inputlookup command**

The inputlookup command retrieves data from a lookup file without joining it to the search results. Example:

| inputlookup malware_lookup.csv

This command retrieves all records from the malware_lookup.csv file. The result is not joined with any search results but can be used to verify the content of the lookup file or for subsequent operations like filtering or joining with other datasets.

14. **Time Range**

Every event in Splunk has a timestamp. Using the time range picker or
the earliest and latest commands, you can limit searches to specific time periods. Example:

index="main" earliest=-7d EventCode!=1

By combining the index="main" condition with earliest=-7d and EventCode!=1, the query will retrieve events from the main index that occurred in the last seven days and do not have an EventCode value of 1.

15. **The transaction command**

The transaction command is used in Splunk to group events that share common characteristics into transactions, often used to track sessions or user activities that span across multiple events. Example:

index="main" sourcetype="WinEventLog:Sysmon" (EventCode=1 OR EventCode=3) | transaction Image startswith=eval(EventCode=1) endswith=eval(EventCode=3) maxspan=1m | table Image | dedup Image

- index="main" sourcetype="WinEventLog:Sysmon" (EventCode=1 OR EventCode=3): This is the search criteria. It's pulling from the main index where the sourcetype is WinEventLog:Sysmon and the EventCode is either 1 or 3. In Sysmon logs, EventCode 1 refers to a process creation event, and EventCode 3 refers to a network connection event.
- | transaction Image startswith=eval(EventCode=1) endswith=eval(EventCode=3) maxspan=1m: The transaction command is used here to group events based on the Image field, which represents the executable or script involved in the event. This grouping is subject to the conditions: the transaction starts with an event where EventCode is 1 and ends with an event where EventCode is 3.
  The maxspan=1m clause limits the transaction to events occurring within a 1-minute window. The transaction command can link together related events to provide a better understanding of the sequences of activities happening within a system.

- | table Image: This command formats the output into a table, displaying only the Image field.
- | dedup Image: Finally, the dedup command removes duplicate entries from the result set. Here, it's eliminating any duplicate Image values. The command keeps only the first occurrence and removes subsequent duplicates based on the Image field.

In summary, this query aims to identify sequences of activities (process creation followed by a network connection) associated with the same executable or script within a 1-minute window. It presents the results in a table format, ensuring that the listed executables/scripts are unique. The query can be valuable in threat hunting, particularly when looking for indicators of compromise such as rapid sequences of process creation and network connection events initiated by the same executable.

16. **Subsearches**

A subsearch in Splunk is a search that is nested inside another search. It's used to compute a set of results that are then used in the outer search. Example:

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 NOT [search index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | top limit=100 Image | fields Image] | table _time, Image, CommandLine, User, ComputerName

In this query:

- index="main" sourcetype="WinEventLog:Sysmon" EventCode=1: The main search that fetches EventCode=1 (Process Creation) events.
- NOT []: The square brackets contain the subsearch. By placing NOT before it, the main search will exclude any results that are returned by the subsearch.
- search index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | top limit=100 Image | fields Image: The subsearch that fetches EventCode=1 (Process Creation) events, then uses the top command to return the 100 most common Image (process) names.
- table _time, Image, CommandLine, User, Computer: This presents the final results as a table, displaying the timestamp of the event (_time), the process name (Image), the command line used to execute the process (CommandLine), the user that executed the process (User), and the computer on which the event occurred (ComputerName).

This query can help to highlight unusual or rare processes, which may be worth investigating for potential malicious activity. Be sure to adjust the limit in the subsearch as necessary to fit your environment.

As a note, this type of search can generate a lot of noise in environments where new and unique processes are frequently created, so careful tuning and context are important.

This is just the tip of the iceberg when it comes to SPL. Its vast command set and flexible syntax provide comprehensive data analysis capabilities. As with any language, proficiency comes with practice and experience. Find below some excellent resources to start with:

- https://docs.splunk.com/Documentation/SCS/current/SearchReference/Introduction
- https://docs.splunk.com/Documentation/SplunkCloud/latest/SearchReference/
- https://docs.splunk.com/Documentation/SplunkCloud/latest/Search/

How To Identify The Available Data

Data and field identification approach 1: Leverage Splunk's Search & Reporting Application (SPL)

In any robust Security Information and Event Management (SIEM) system like Splunk, understanding the available data sources, the data they provide, and the fields within them is critical to leveraging the system effectively. In Splunk, we primarily use the Search & Reporting application to do this. Let's delve into how we can identify data source types, data, and fields within Splunk.

Splunk can ingest a wide variety of data sources. We classify these data sources into source types that dictate how Splunk formats the incoming data. To identify the available source types, we can run the following SPL command, after selecting the suitable time range in the time picker of the Search & Reporting application.

| eventcount summarize=false index=* | table index

This query uses eventcount to count events in all indexes, then summarize=false is used to display counts for each index separately, and finally, the table command is used to present the data in tabular form.

| metadata type=sourcetypes

This search uses the metadata command, which provides us with various statistics about specified indexed fields. Here, we're focusing on sourcetypes. The result is a list of all sourcetypes in our Splunk environment, along with additional metadata such as the first time a source type was seen (firstTime), the last time it was seen (lastTime), and the number of hosts (totalCount).

For a simpler view, we can use the following search.

| metadata type=sourcetypes index=* | table sourcetype

Here, the metadata command retrieves metadata about the data in our indexes.
The type=sourcetypes argument tells Splunk to return metadata about sourcetypes.
The table command is used to present the data in tabular form.

| metadata type=sources index=* | table source

This command returns a list of all data sources in the Splunk environment.

Once we know our source types, we can investigate the kind of data they contain. Let's say we are interested in a sourcetype named WinEventLog:Security, we can use the table command to present the raw data as follows.

sourcetype="WinEventLog:Security" | table _raw

The table command generates a table with the specified fields as columns.
Here, _raw represents the raw event data. This command will return the raw data for the specified source type.

Splunk automatically extracts a set of default fields for every event it indexes, but it can also extract additional fields depending on the source type of the data. To see all fields available in a specific source type, we can use the fields command.

sourcetype="WinEventLog:Security" | table *

This command generates a table with all fields available in the WinEventLog:Security sourcetype. However, be cautious, as the use of table * can result in a very wide table if our events have a large number of fields. This may not be visually practical or effective for data analysis.

A better approach is to identify the fields you are interested in using the fields command as mentioned before, and then specifying those field names in the table command. Example:

sourcetype="WinEventLog:Security" | fields Account_Name, EventCode | table Account_Name, EventCode

If we want to see a list of field names only, without the data, we can use the fieldsummary command instead.

sourcetype="WinEventLog:Security" | fieldsummary

This search will return a table that includes every field found in the events returned by the search (across the sourcetype we've specified). The table includes several columns of information about each field:

- field: The name of the field.
- count: The number of events that contain the field.
- distinct_count: The number of distinct values in the field.
- is_exact: Whether the count is exact or estimated.
- max: The maximum value of the field.
- mean: The mean value of the field.
- min: The minimum value of the field.
- numeric_count: The number of numeric values in the field.
- stdev: The standard deviation of the field.
- values: Sample values of the field.

We may also see:

- modes: The most common values of the field.
- numBuckets: The number of buckets used to estimate the distinct count.

Please note that the values provided by the fieldsummary command are calculated based on the events returned by our search. So if we want to see all fields within a specific sourcetype, we need to make sure our time range is large enough to capture all possible fields.

index=* sourcetype=* | bucket _time span=1d | stats count by _time, index, sourcetype | sort -_time

Sometimes, we might want to know how events are distributed over time. This query retrieves all data (index=* sourcetype=*), then bucket command is used to group the events based on the _time field into 1-day buckets. The stats command then counts the number of events for each day (_time), index, and sourcetype. Lastly, the sort command sorts the result in descending order of _time.

index=* sourcetype=* | rare limit=10 index, sourcetype

The rare command can help us identify uncommon event types, which might be indicative of abnormal behavior. This query retrieves all data and finds the 10 rarest combinations of indexes and sourcetypes.

index="main" | rare limit=20 useother=f ParentImage

This command displays the 20 least common values of the ParentImage field.

index=* sourcetype=* | fieldsummary | where count < 100 | table field, count, distinct_count

A more complex query can provide a detailed summary of fields. This search shows a summary of all fields (fieldsummary), filters out fields that appear in less than 100 events (where count < 100), and then displays a table (table) showing the field name, total count, and distinct count.

index=* | sistats count by index, sourcetype, source, host

We can also use the sistats command to explore event diversity. This command counts the number of events per index, sourcetype, source, and host, which can provide us a clear picture of the diversity and distribution of our data.

index=* sourcetype=* | rare limit=10 field1, field2, field3

The rare command can also be used to find uncommon combinations of field values. Replace field1, field2, field3 with the fields of interest. This command will display the 10 rarest combinations of these fields.

By combining the above SPL commands and techniques, we can explore and understand the types of data source, the data they contain, and the fields within them. This understanding is the foundation upon which we build effective searches, reports, alerts, and dashboards in Splunk.

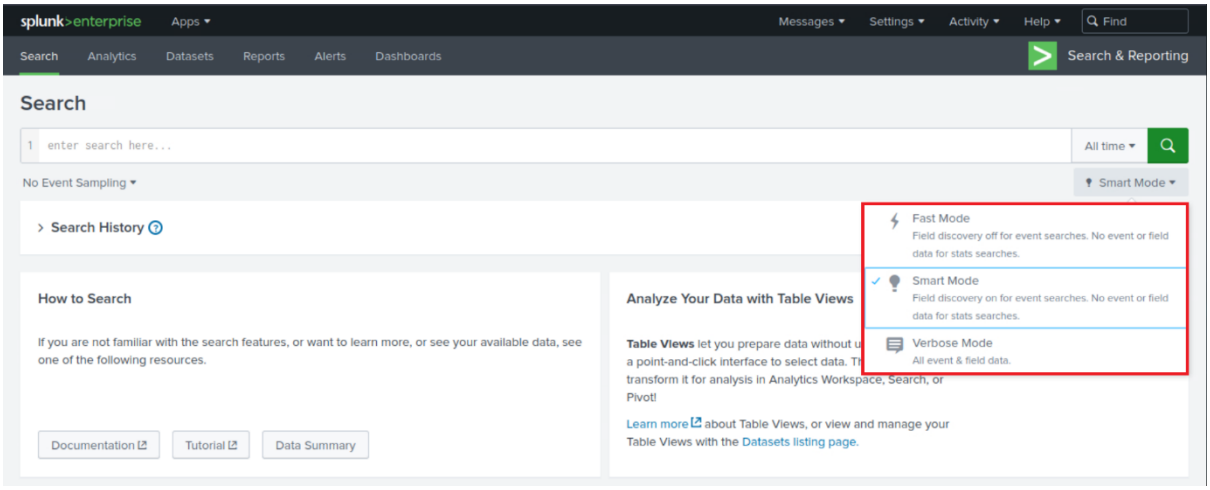
Lastly, remember to follow your organization's data governance policies when exploring data and source types to ensure you're compliant with all necessary privacy and security guidelines.

Data and field identification approach 2: Leverage Splunk's User Interface

When using the Search & Reporting application's user interface, identifying the available data source types, the data they contain, and the fields within them becomes a task that involves interacting with various sections of the UI. Let's examine how we can effectively use the Splunk Web interface to identify these elements.

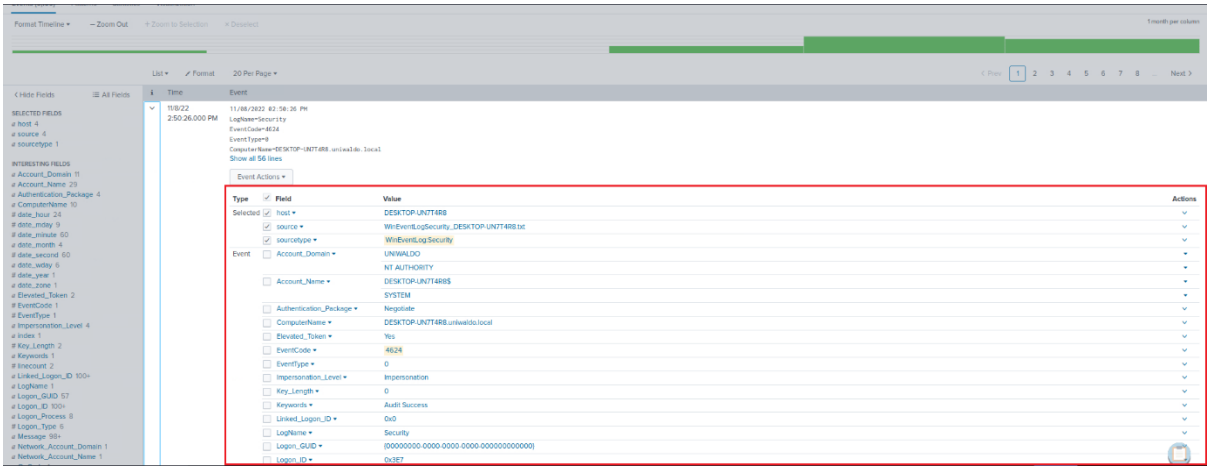
- Data Sources: The first thing we want to identify is our data sources. We can do this by navigating to the Settings menu, which is usually located on the top right corner of our Splunk instance. In the dropdown, we'll find Data inputs. By clicking on Data inputs, we'll see a list of various data input methods, including files & directories, HTTP event collector, forwarders, scripts, and many more. These represent the various sources through which data can be brought into Splunk. Clicking into each of these will give us an overview of the data sources being utilized.

- Data (Events): Now, let's move on to identifying the data itself, in other words, the events. For this, we'll want to navigate to the Search & Reporting app. By exploring the events in the Fast mode, we can quickly scan through our data. The Verbose mode, on the other hand, lets us dive deep into each event's details, including its raw event data and all the fields that Splunk has extracted from it.



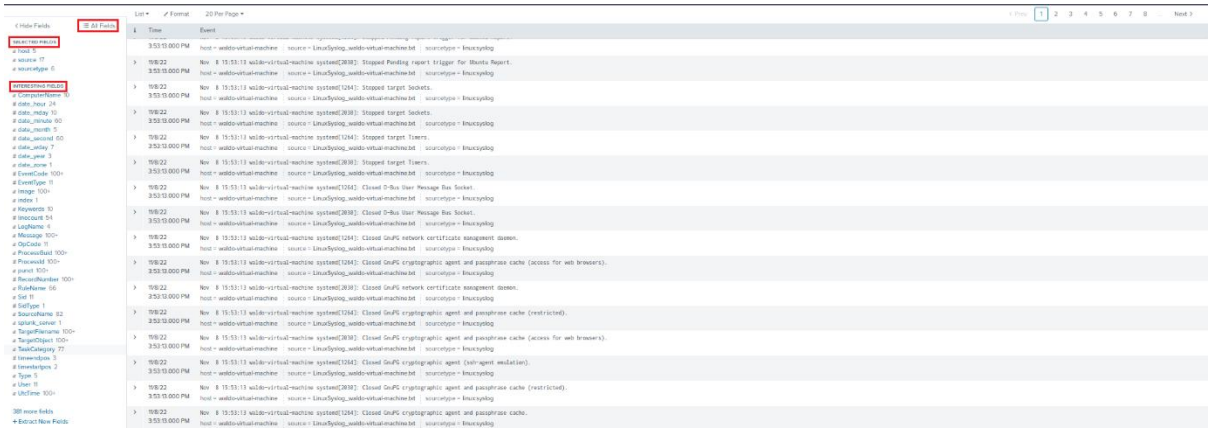
In the search bar, we could simply put * and hit search, which will bring up all the data that we have indexed. However, this is usually a massive amount of data, and it might not be the most efficient way to go about it. A better approach might be to leverage the time picker and select a smaller time range (let's be careful while doing so though to not miss any important/useful historic logs).

- Fields: Lastly, to identify the fields in our data, let's look at an event in detail. We can click on any event in our search results to expand it.

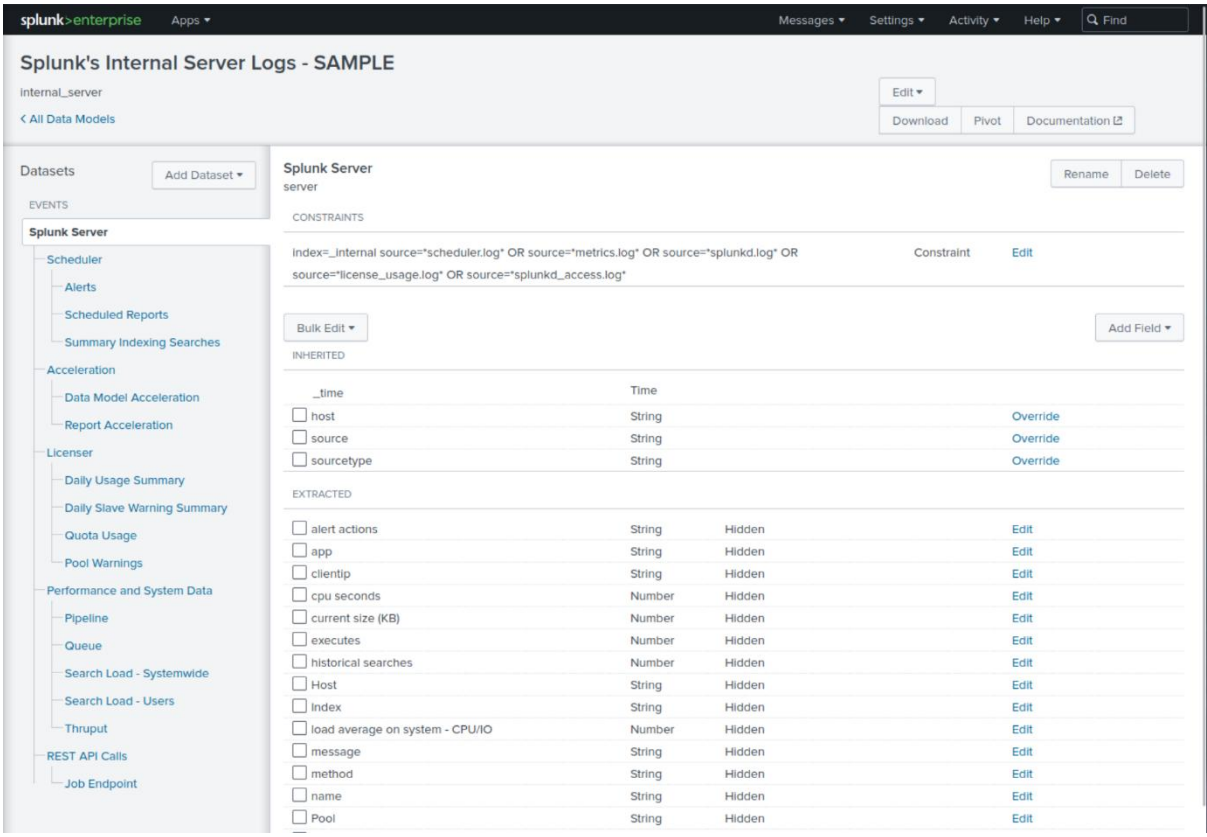


We can also see on the left hand side of the "Search & Reporting" application two categories of fields: Selected Fields and Interesting Fields. Selected Fields are fields that are always shown in the events (like host, source, and sourcetype),

while Interesting Fields are those that appear in at least 20% of the events. By clicking All fields, we can see all the fields present in our events.

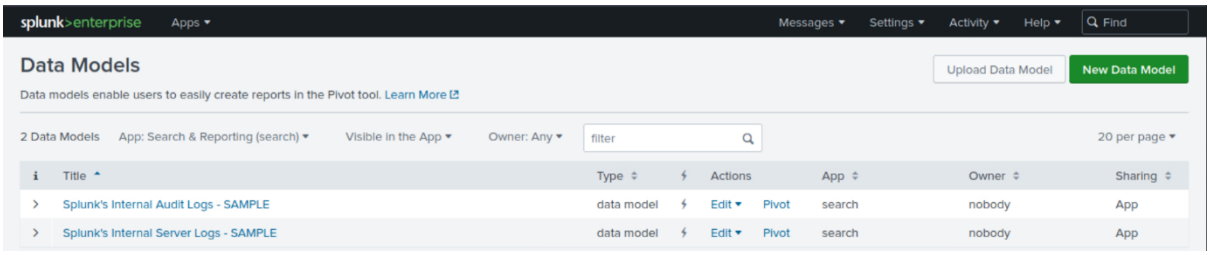


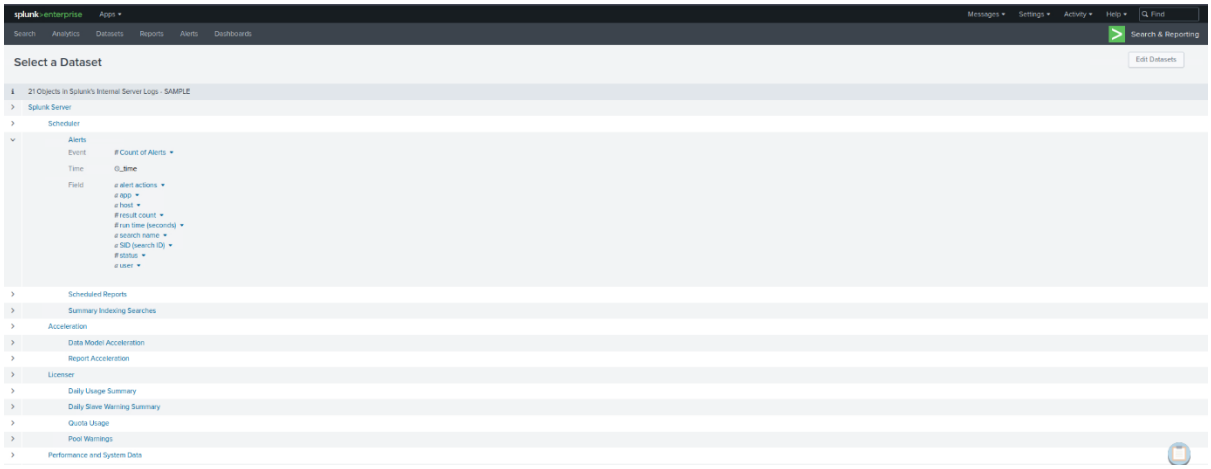
- Data Models: Data Models provide an organized, hierarchical view of our data, simplifying complex datasets into understandable structures. They're designed to make it easier to create meaningful reports, visualizations, and dashboards without needing a deep understanding of the underlying data sources or the need to write complex SPL queries. Here is how we can use the Data Models feature to identify and understand our data:
    - Accessing Data Models: To access Data Models, we click on the Settings tab on the top right corner of the Splunk Web interface. Then we select Data Models under the Knowledge section. This will lead us to the Data Models management page. <-- If it appears empty, please execute a search and navigate to the Data Models page again.
    - Understanding Existing Data Models: On the Data Models management page, we can see a list of available Data Models. These might include models created by ourselves, our team, or models provided by Splunk Apps. Each Data Model is associated with a specific app context and is built to describe the structured data related to the app's purpose.
    - Exploring Data Models: By clicking on the name of a Data Model, we are taken to the Data Model Editor. This is where the true power of Data Models lies. Here, we can view the hierarchical structure of the data model, which is divided into objects. Each object represents a specific part of our data and contains fields that are relevant to that object.



For example, if we have a Data Model that describes web traffic, we might see objects like Web Transactions, Web Errors, etc. Within these objects, we'll find fields like status, url, user, etc.

- Pivots: Pivots are an extremely powerful feature in Splunk that allows us to create complex reports and visualizations without writing SPL queries. They provide an interactive, drag-and-drop interface for defining and refining our data reporting criteria. As such, they're also a fantastic tool for identifying and exploring the available data and fields within our Splunk environment. To start with Pivots to identify available data and fields, we can use the Pivot button that appears when we're browsing a particular data model in the Data Models page.





Using Splunk Applications

Splunk Applications

Splunk applications, or apps, are packages that we add to our Splunk Enterprise or Splunk Cloud deployments to extend capabilities and manage specific types of operational data. Each application is tailored to handle data from specific technologies or use cases, effectively acting as a pre-built knowledge package for that data. Apps can provide capabilities ranging from custom data inputs, custom visualizations, dashboards, alerts, reports, and more.

Splunk Apps enable the coexistence of multiple workspaces on a single Splunk instance, catering to different use cases and user roles. These ready-made apps can be found on Splunkbase.

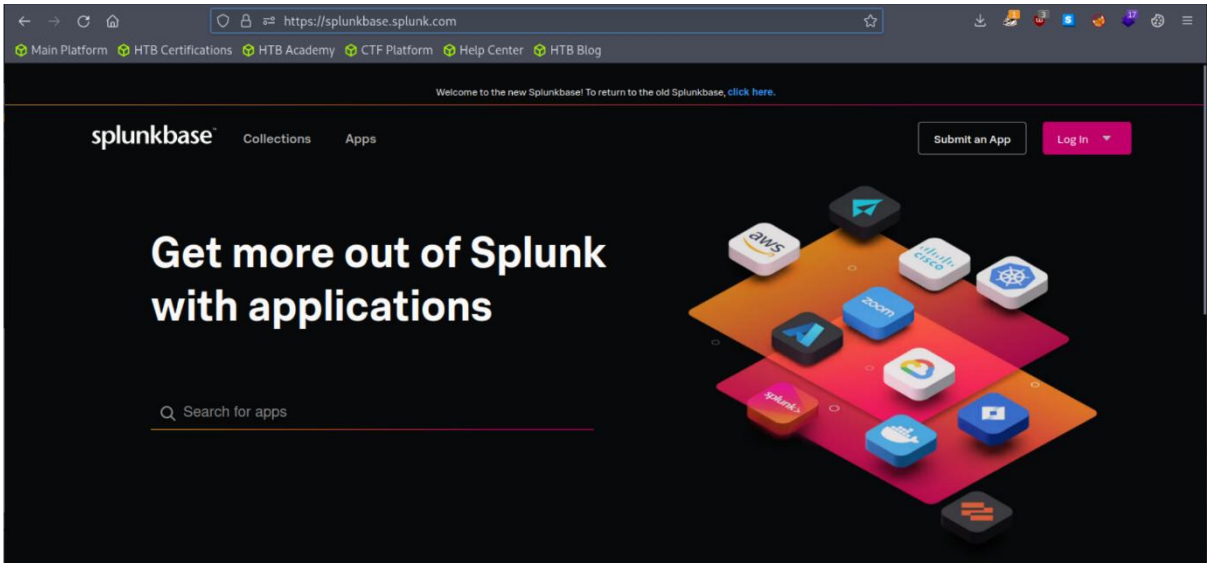
As an integral part of our cybersecurity operations, the Splunk apps designed for Security Information and Event Management (SIEM) purposes provide a range of capabilities to enhance our ability to detect, investigate, and respond to threats. They are designed to ingest, analyze, and visualize security-related data, enabling us to detect complex threats and perform in-depth investigations.

When using these apps in our Splunk environment, we need to consider factors such as data volume, hardware requirements, and licensing. Many apps can be resource-intensive, so we must ensure our Splunk deployment is sized correctly to handle the additional workload. Further, it's also important to ensure we have the correct licenses for any premium apps, and that we are aware of the potential for increased license usage due to the added data inputs.

In this segment, we'll be leveraging the Sysmon App for Splunk developed by Mike Haag.

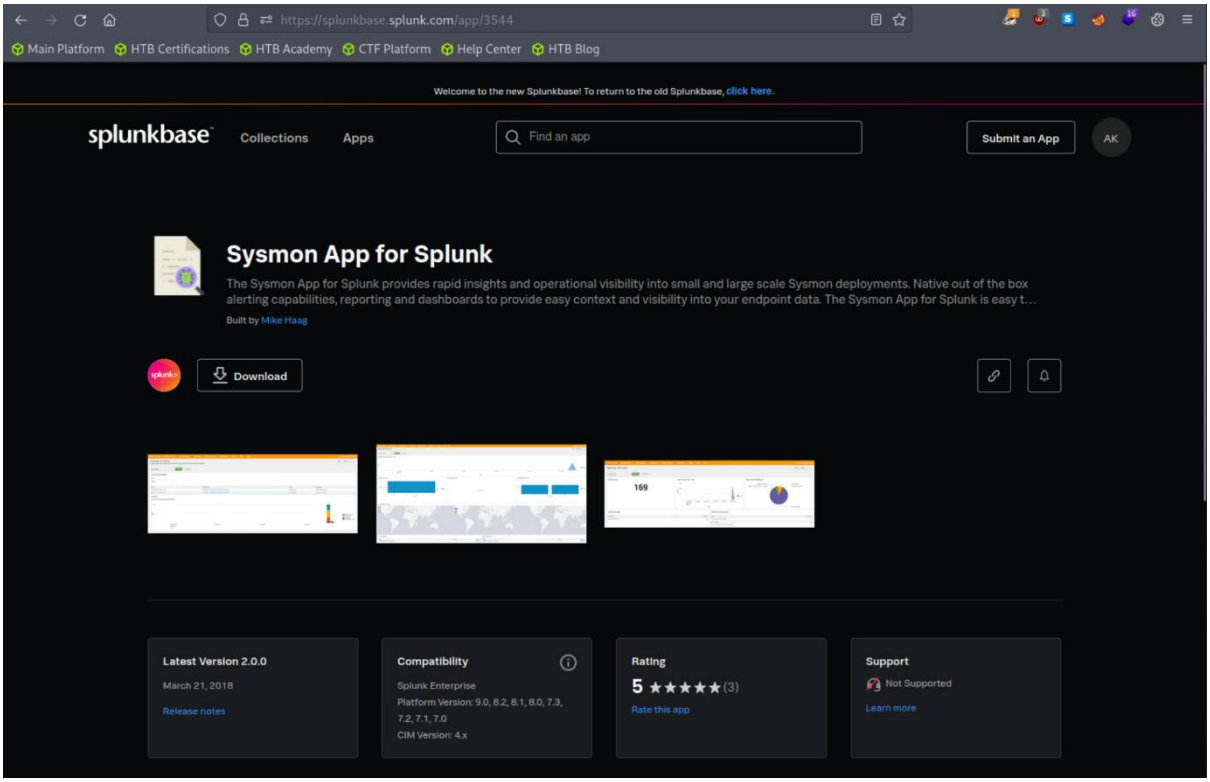
To download, add, and use this application, follow the steps delineated below:

1. Sign up for a free account at [splunkbase]

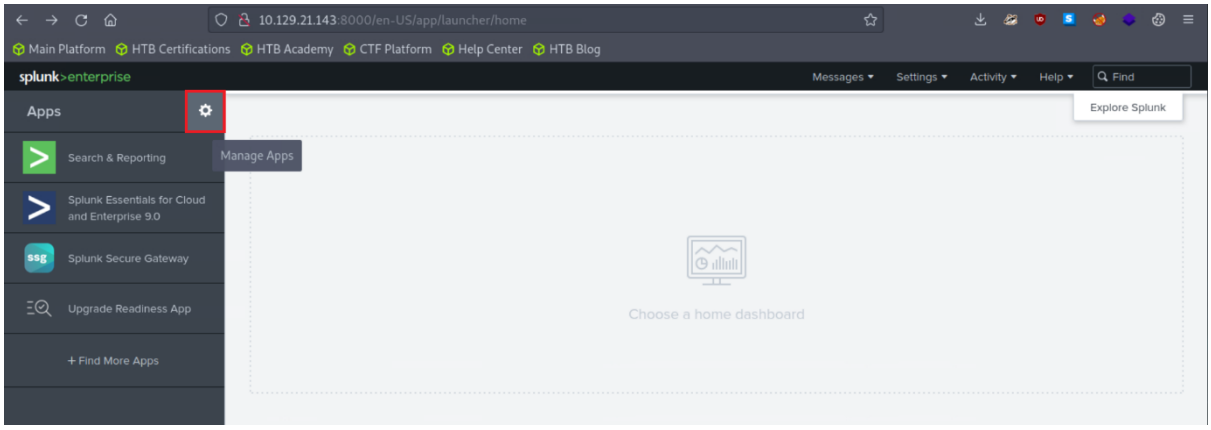


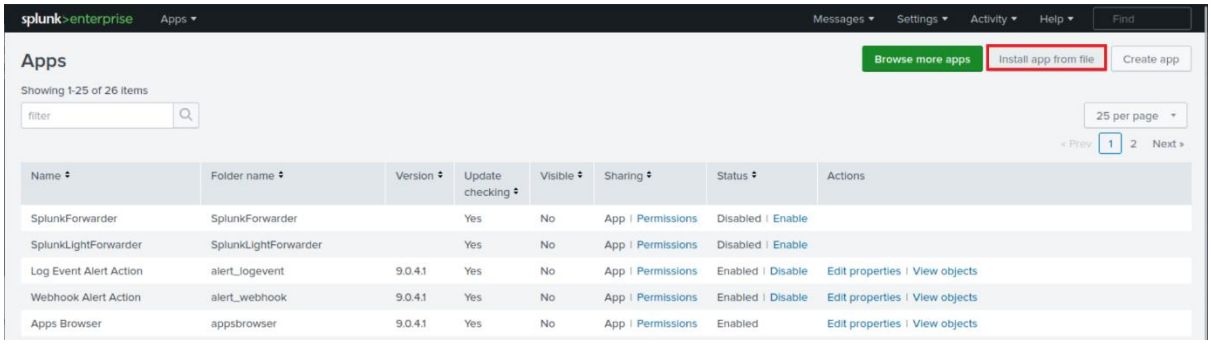
2. Once registered, log into your account

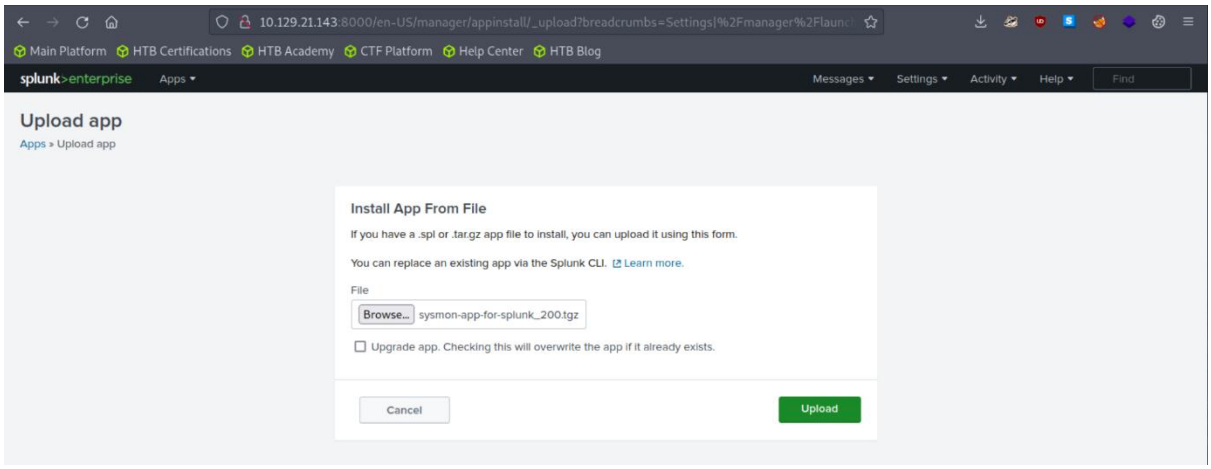
3. Head over to the [Sysmon App for Splunk] page to download the application.



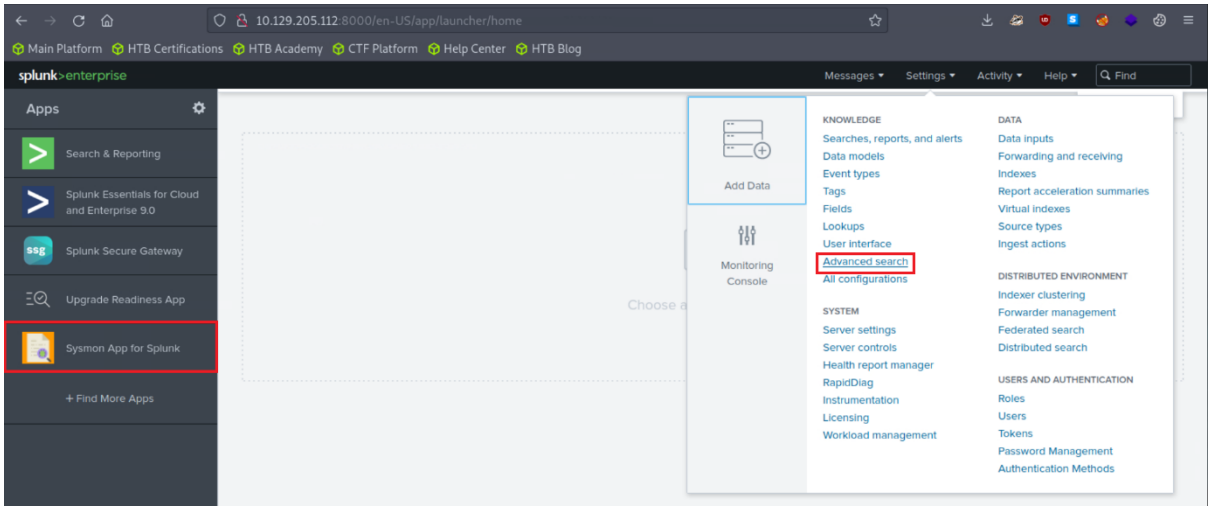
4. Add the application as follows to your search head.

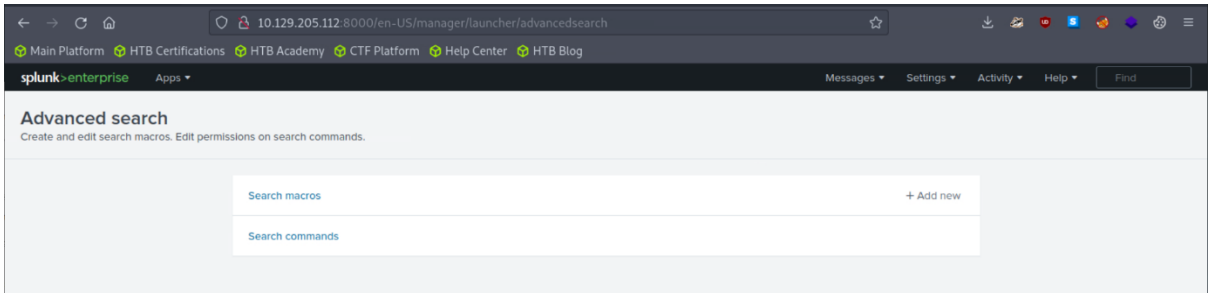


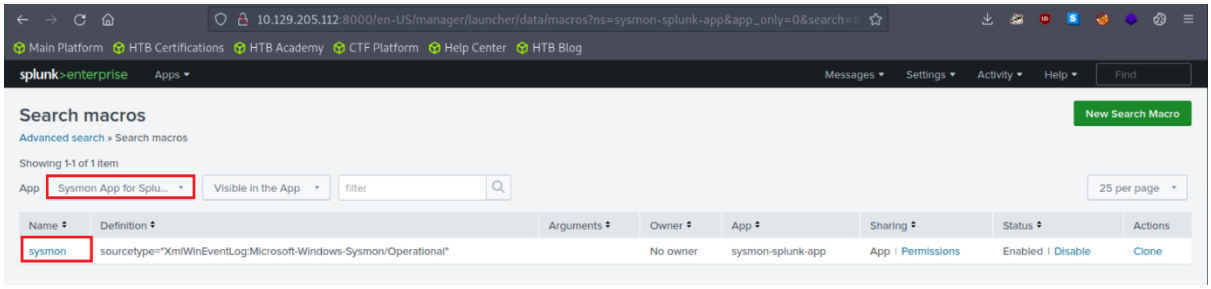


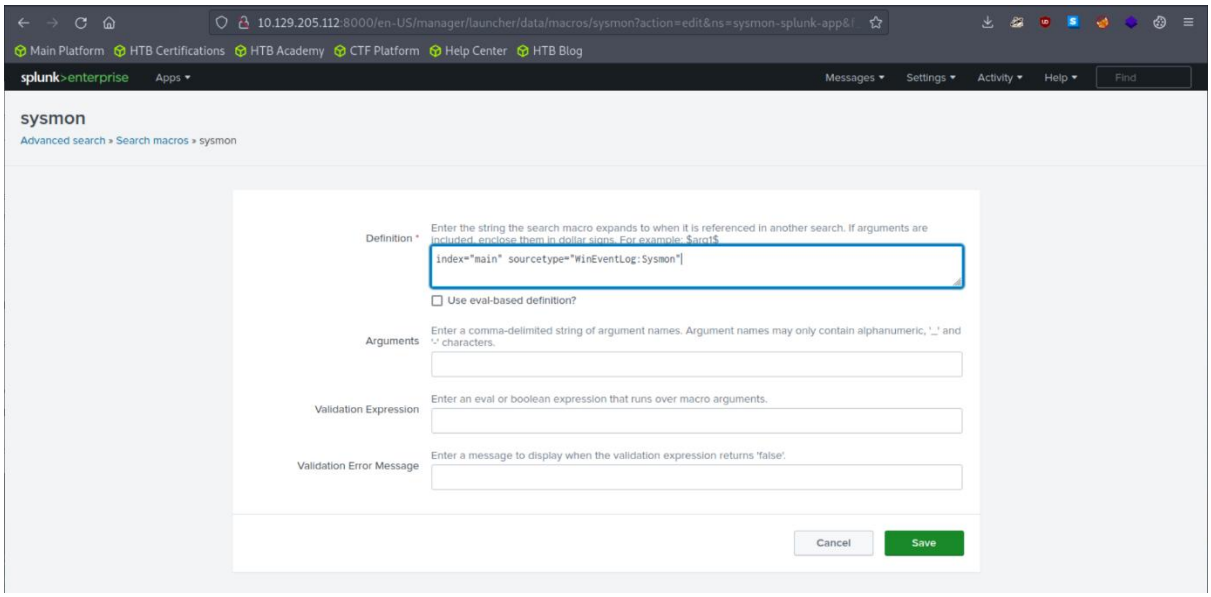


5. Adjust the application's **macro** so that events are loaded as follows.

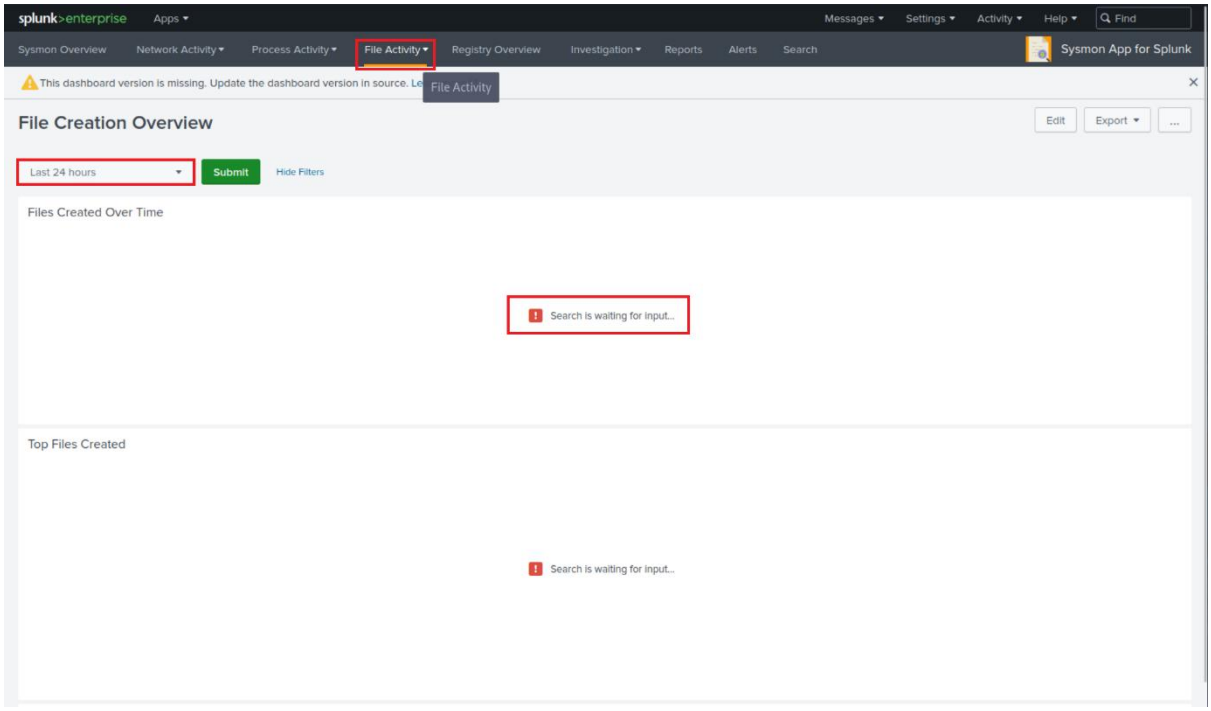




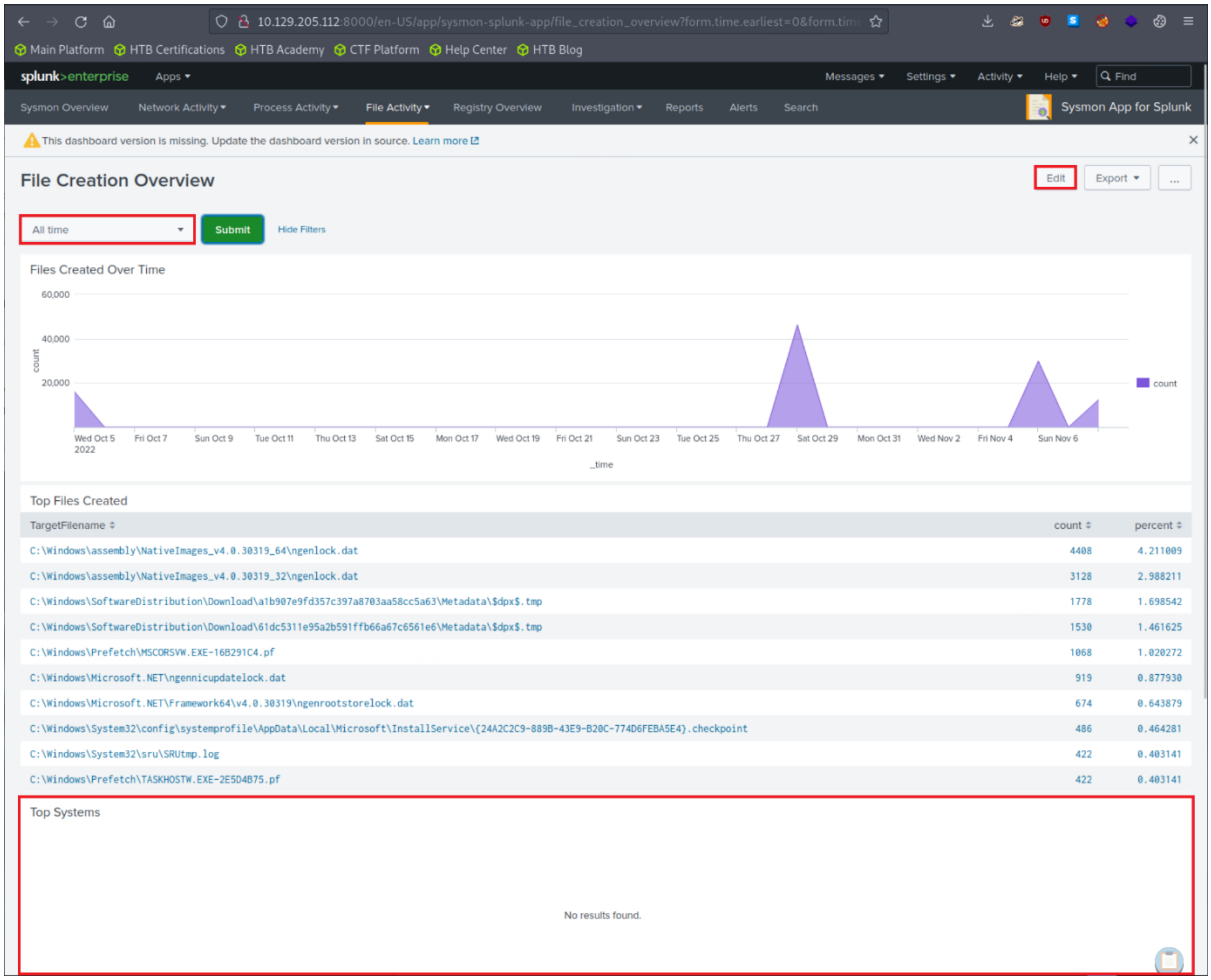




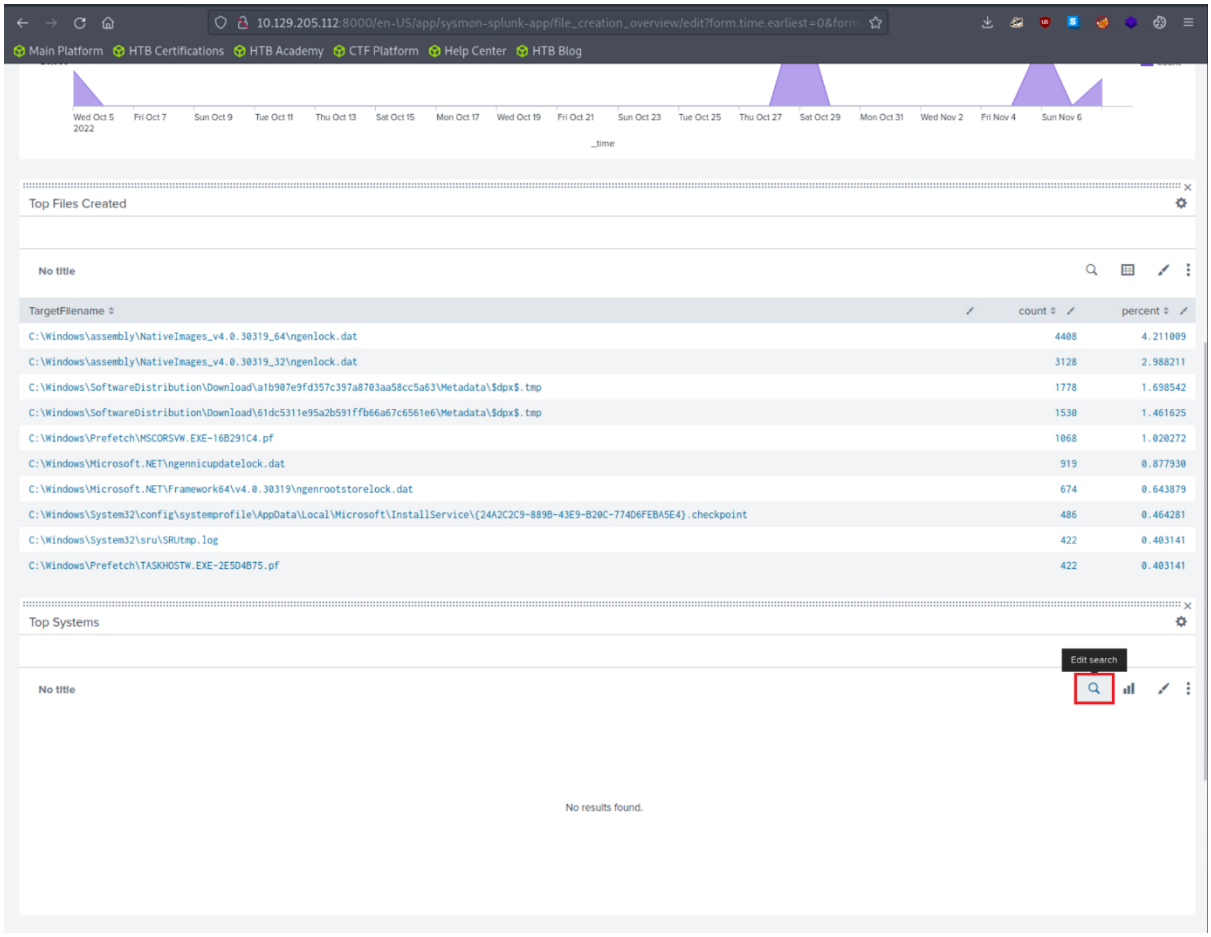
Let's access the Sysmon App for Splunk by locating it in the "Apps" column on the Splunk home page and head over to the File Activity tab.



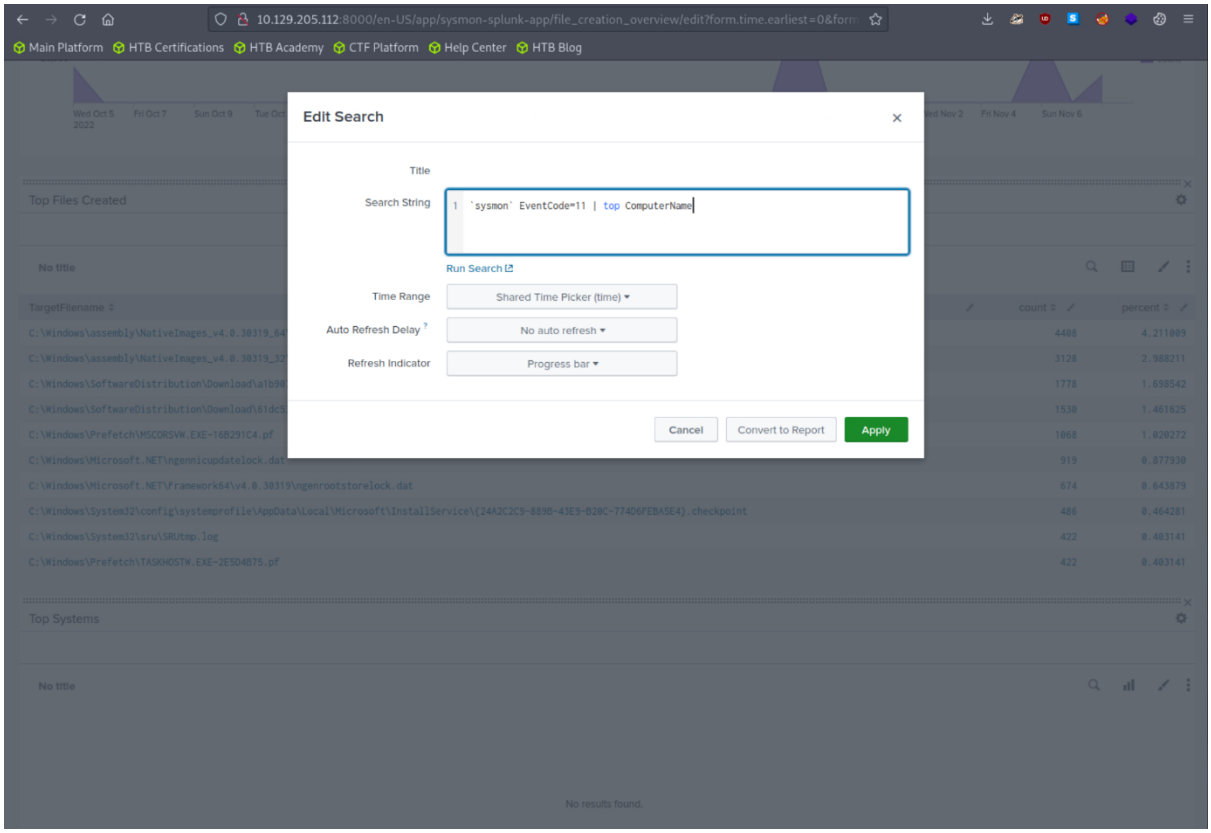
Let's now specify "All time" on the time picker and click "Submit". Results are generated successfully; however, no results are appearing in the "Top Systems" section.



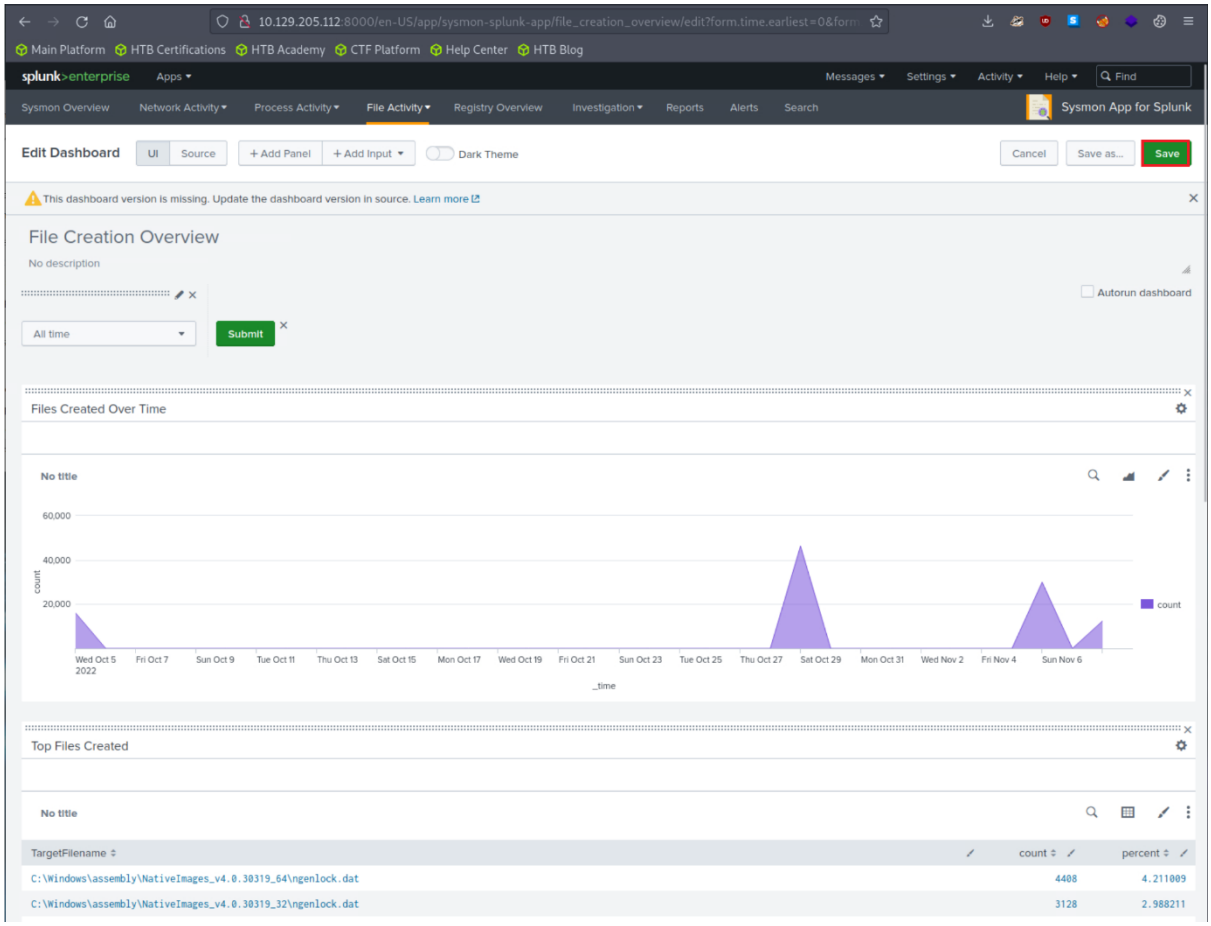
We can fix that by clicking on "Edit" (upper right hand corner of the screen) and editing the search.



The Sysmon Events with ID 11 do not contain a field named Computer, but they do include a field called ComputerName. Let's fix that and click "Apply"



Results should now be generated successfully in the "Top Systems" section.



Feel free to explore and experiment with this Splunk application. An excellent exercise is to modify the searches when no results are generated due to non-existent fields being specified, continuing until the desired results are obtained.

Detecting Attacker Behavior With Splunk Based On TTPs

In the ever-evolving world of cybersecurity, proficient threat detection is crucial. This necessitates a thorough understanding of the myriad tactics, techniques, and procedures (TTPs) utilized by potential adversaries, along with a deep insight into our own network systems and their typical behaviors. Effective threat detection often revolves around identifying patterns that either match known malicious behaviors or diverge significantly from expected norms.

In crafting detection-related SPL (Search Processing Language) searches in Splunk, we utilize two main approaches:

- The first approach is grounded in known adversary TTPs, leveraging our extensive knowledge of specific threats and attack vectors. This strategy is akin to playing a game of spot the known. If an entity behaves in a way that we recognize as characteristic of a particular threat, it draws our attention.
- The second approach, while still informed by an understanding of attacker TTPs, leans heavily on statistical analysis and anomaly detection to identify abnormal behavior

within the sea of normal activity. This strategy is more of a game of spot the unusual. Here, we're not just relying on pre-existing knowledge of specific threats. Instead, we make extensive use of mathematical and statistical techniques to highlight anomalies, working on the premise that malicious activity will often manifest as an aberration from the norm.

Together, these approaches give us a comprehensive toolkit for identifying and responding to a wide spectrum of cybersecurity threats. Each methodology offers unique advantages and, when used in tandem, they create a robust detection mechanism, one that is capable of identifying known threats while also surfacing potential unknown risks.

Additionally, in both approaches, the key is to understand our data and environment, then carefully tune our queries and thresholds to balance the need for accurate detection with the desire to avoid false positives. Through continuous review and revision of our SPL queries, we can maintain a high level of security posture and readiness.

Now, let's delve deeper into these two approaches.

Please be aware that the upcoming sections do not pertain to detection engineering. The emphasis in these sections is on comprehending the two distinct approaches for constructing searches, rather than the actual process of analyzing an attack, identifying relevant log sources, and formulating searches. Furthermore, the provided searches are not finely tuned. As previously mentioned, fine-tuning necessitates a deep comprehension of the environment and its normal activity.

Crafting SPL Searches Based On Known TTPs

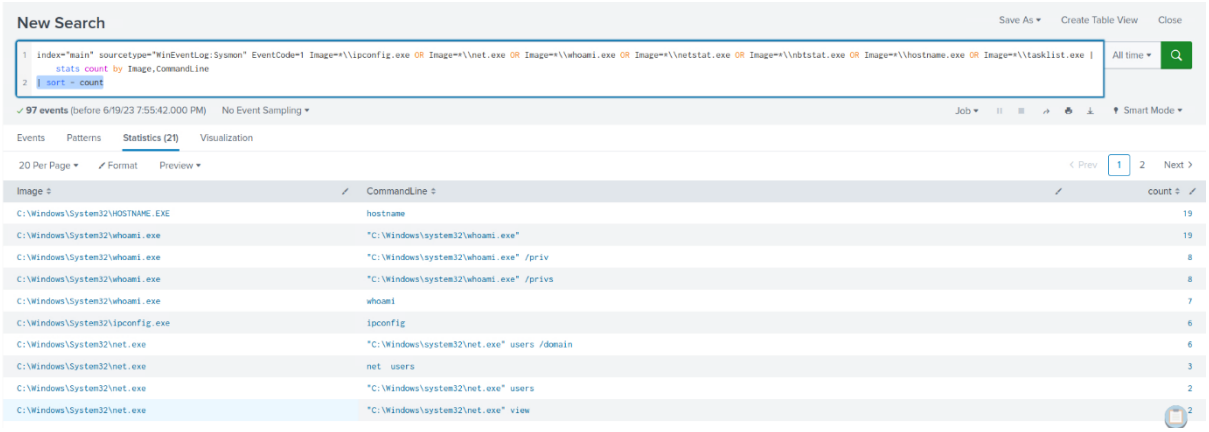
As mentioned above, the first approach revolves around a comprehensive understanding of known attacker behavior and TTPs. With this strategy, our focus is on recognizing patterns that we've seen before, which are indicative of specific threats or attack vectors.

Below are some detection examples that follow this approach.

1. **Example: Detection Of Reconnaissance Activities Leveraging Native Windows Binaries**

Attackers often leverage native Windows binaries (such as net.exe) to gain insights into the target environment, identify potential privilege escalation opportunities, and perform lateral movement. Sysmon Event ID 1 can assist in identifying such behavior.

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 Image=*\\ipconfig.exe OR Image=*\\net.exe OR Image=*\\whoami.exe OR Image=*\\netstat.exe OR Image=*\\nbtstat.exe OR Image=*\\hostname.exe OR Image=*\\tasklist.exe | stats count by Image,CommandLine | sort - count

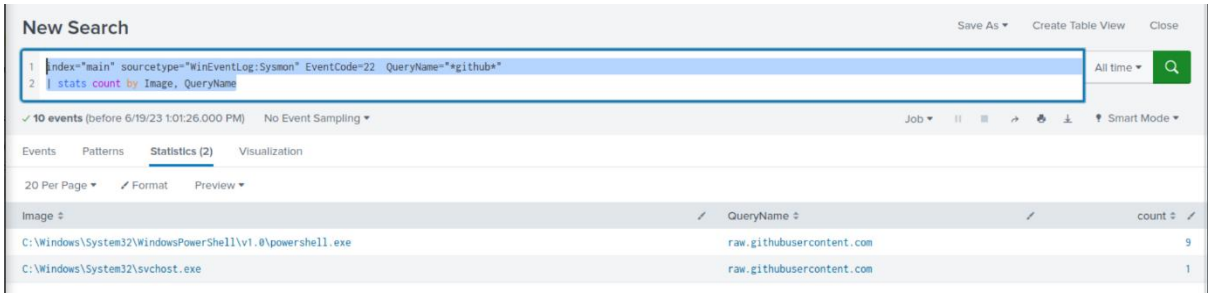


Within the search results, clear indications emerge, highlighting the utilization of native Windows binaries for reconnaissance purposes.

2. **Example: Detection Of Requesting Malicious Payloads/Tools Hosted On Reputable/Whitelisted Domains (Such As githubusercontent.com)**

Attackers frequently exploit the use of githubusercontent.com as a hosting platform for their payloads. This is due to the common whitelisting and permissibility of the domain by company proxies. Sysmon Event ID 22 can assist in identifying such behavior.

index="main" sourcetype="WinEventLog:Sysmon" EventCode=22 QueryName="*github*" | stats count by Image, QueryName



Within the search results, clear indications emerge, highlighting the utilization of githubusercontent.com for payload/tool-hosting purposes.

3. **Example: Detection Of PsExec Usage**

PsExec, a part of the Windows Sysinternals suite, was initially conceived as a utility to aid system administrators in managing remote Windows systems. It offers the convenience of connecting to and interacting with remote systems via a command-line interface, and it's available to members of a computer's Local Administrator group.

The very features that make PsExec a powerful tool for system administrators also make it an attractive option for malicious actors. Several MITRE ATT&CK techniques, including T1569.002 (System Services: Service Execution), T1021.002 (Remote Services: SMB/Windows Admin Shares), and T1570 (Lateral Tool Transfer), have seen PsExec in play.

Despite its simple facade, PsExec packs a potent punch. It works by copying a service executable to the hidden Admin$ share. Subsequently, it taps into the Windows Service Control Manager API to jump-start the service. The service uses named pipes to link back to the PsExec tool. A major highlight is that PsExec can be deployed on both local and remote machines, and

it can enable a user to act under the NT AUTHORITY\SYSTEM account. By studying **https://www.synacktiv.com/publications/traces-of-windows-remote-command-execution** and **https://hurricanelabs.com/splunk-tutorials/splunking-with-sysmon-part-3-detecting-psexec-in-your-environment/** we deduce that Sysmon Event ID 13, Sysmon Event ID 11, and Sysmon Event ID 17 or Sysmon Event ID 18 can assist in identifying usage of PsExec.

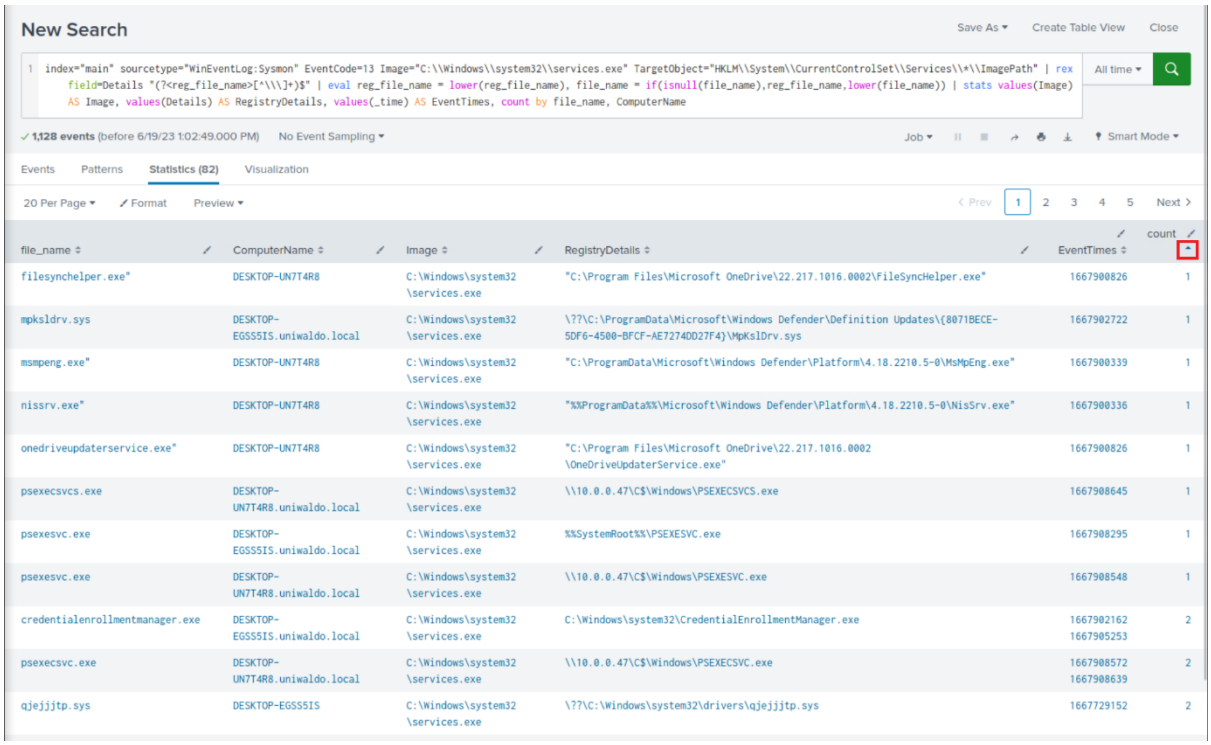
Case 1: Leveraging Sysmon Event ID 13

```
index="main" sourcetype="WinEventLog:Sysmon" EventCode=13
Image="C:\\Windows\\system32\\services.exe"
TargetObject="HKLM\\System\\CurrentControlSet\\Services\\*\\ImagePath" | rex field=Details
"(?<reg_file_name>[^\\]+)$" | eval reg_file_name = lower(reg_file_name), file_name =
if(isnull(file_name),reg_file_name,lower(file_name)) | stats values(Image) AS Image,
values(Details) AS RegistryDetails, values(_time) AS EventTimes, count by file_name,
ComputerName
```

Let's break down each part of this query:

- index="main" sourcetype="WinEventLog:Sysmon" EventCode=13 Image="C:\\Windows\\system32\\services.exe" TargetObject="HKLM\\System\\CurrentControlSet\\Services*\\ImagePath": This part of the query is selecting logs from the main index with the sourcetype of WinEventLog:Sysmon. We're specifically looking for events with EventCode=13. In Sysmon logs, EventCode 13 represents an event where a registry value was set. The Image field is set to C:\\Windows\\system32\\services.exe to filter for events where the services.exe process was involved, which is the Windows process responsible for handling service creation and management. The TargetObject field specifies the registry keys that we're interested in. In this case, we're looking for changes to the ImagePath value under any service key in HKLM\\System\\CurrentControlSet\\Services. The ImagePath registry value of a service specifies the path to the executable file for the service.
- | rex field=Details "(?<reg_file_name>[^\\]+)$": The rex command here is extracting the file name from the Details field using a regular expression. The pattern [^\\]+)$ captures the part of the path after the last backslash, which is typically the file name. This value is stored in a new field reg_file_name.
- | eval file_name = if(isnull(file_name),reg_file_name,(file_name)): This eval command checks if the file_name field is null. If it is, it sets file_name to the value of reg_file_name (the file name we extracted from the Details field). If file_name is not null, it remains the same.
- | stats values(Image), values(Details), values(TargetObject), values(_time), values(EventCode), count by file_name, ComputerName: Finally, the stats command aggregates the data by file_name and ComputerName. For each unique combination of file_name and ComputerName, it collects all the unique values of Image, Details, TargetObject, and _time, and counts the number of events.

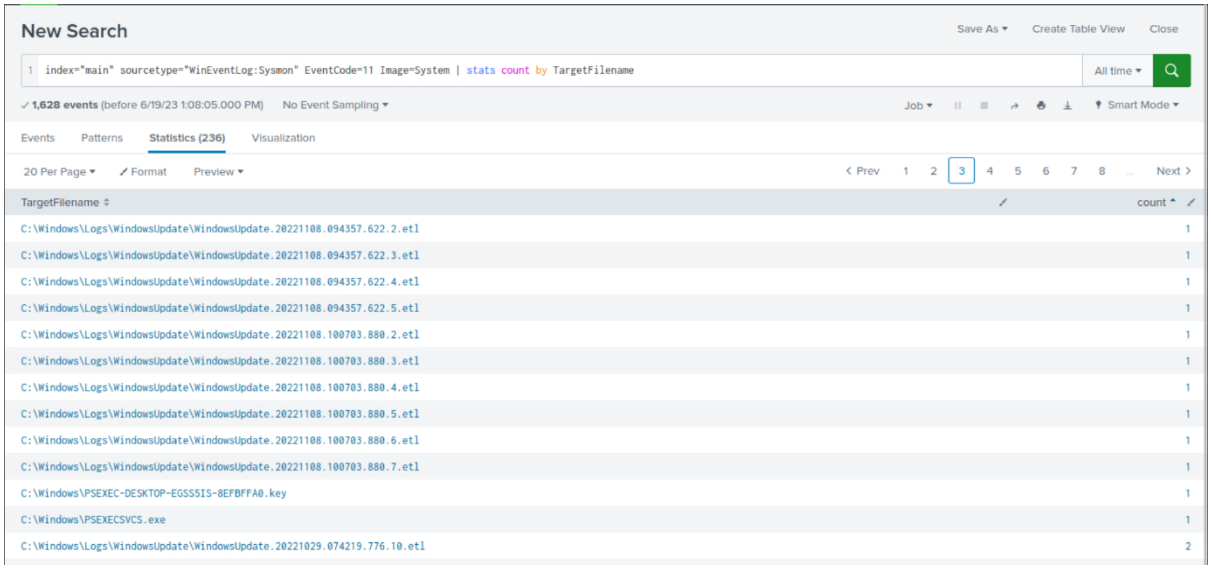
In summary, this query is looking for instances where the services.exe process has modified the ImagePath value of any service. The output will include the details of these modifications, including the name of the modified service, the new ImagePath value, and the time of the modification.



Among the less frequent search results, it is evident that there are indications of execution resembling PsExec.

Case 2: Leveraging Sysmon Event ID 11

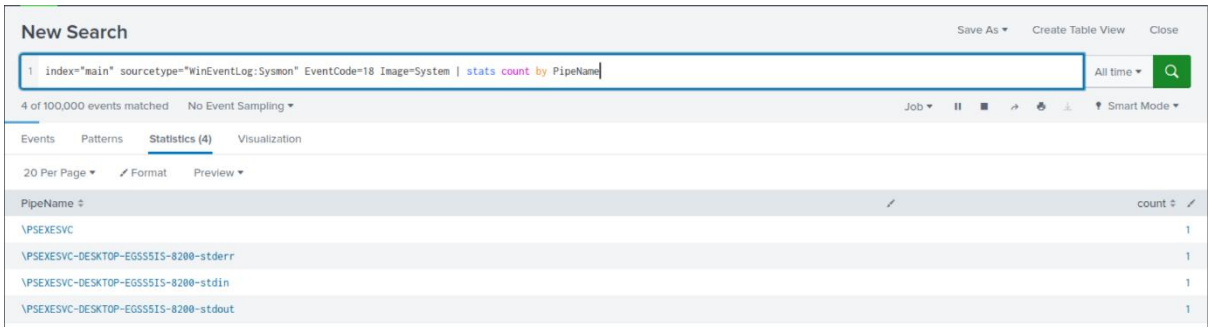
index="main" sourcetype="WinEventLog:Sysmon" EventCode=11 Image=System | stats count by TargetFilename



Again, among the less frequent search results, it is evident that there are indications of execution resembling PsExec.

Case 3: Leveraging Sysmon Event ID 18

index="main" sourcetype="WinEventLog:Sysmon" EventCode=18 Image=System | stats count by PipeName

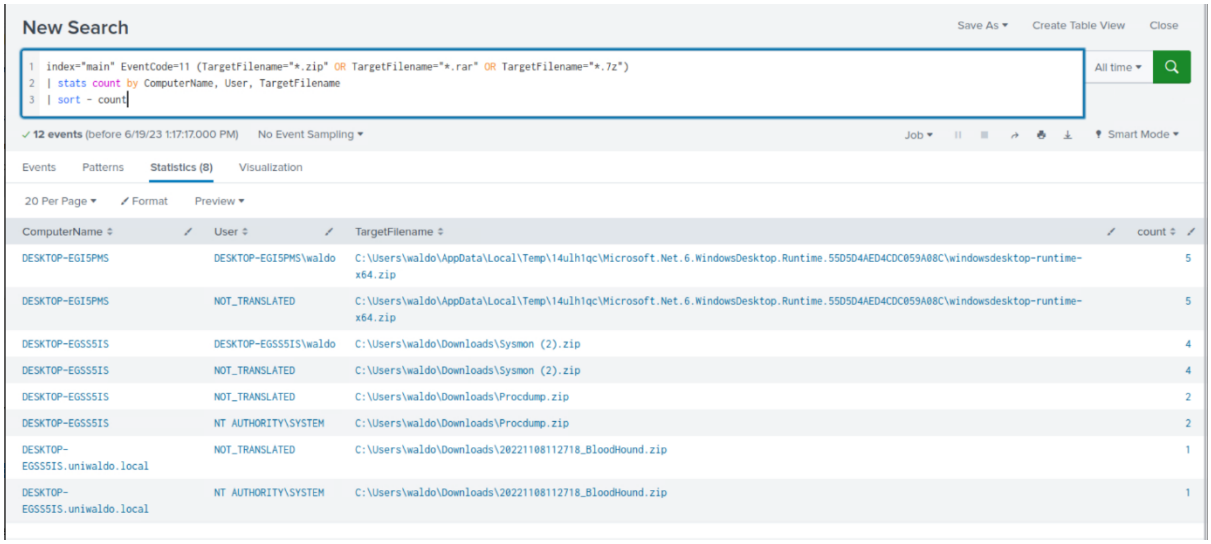


This time, the results are more manageable to review and they continue to suggest an execution pattern resembling PsExec.

4. **Example: Detection Of Utilizing Archive Files For Transferring Tools Or Data Exfiltration**

Attackers may employ zip, rar, or 7z files for transferring tools to a compromised host or exfiltrating data from it. The following search examines the creation of zip, rar, or 7z files, with results sorted in descending order based on count.

index="main" EventCode=11 (TargetFilename="*.zip" OR TargetFilename="*.rar" OR TargetFilename="*.7z") | stats count by ComputerName, User, TargetFilename | sort - count

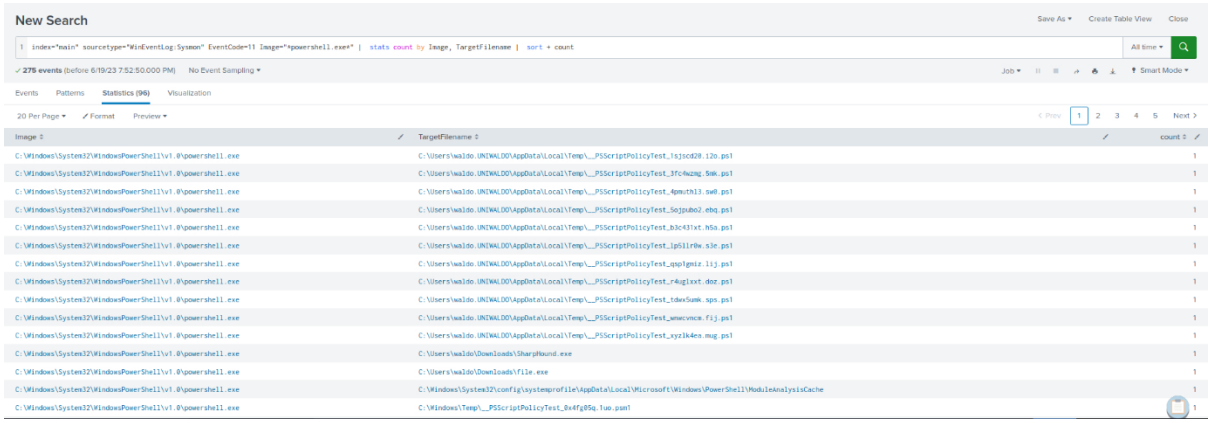


Within the search results, clear indications emerge, highlighting the usage of archive files for tool-transferring and/or data exfiltration purposes.

5. **Example: Detection Of Utilizing PowerShell or MS Edge For Downloading Payloads/Tools**

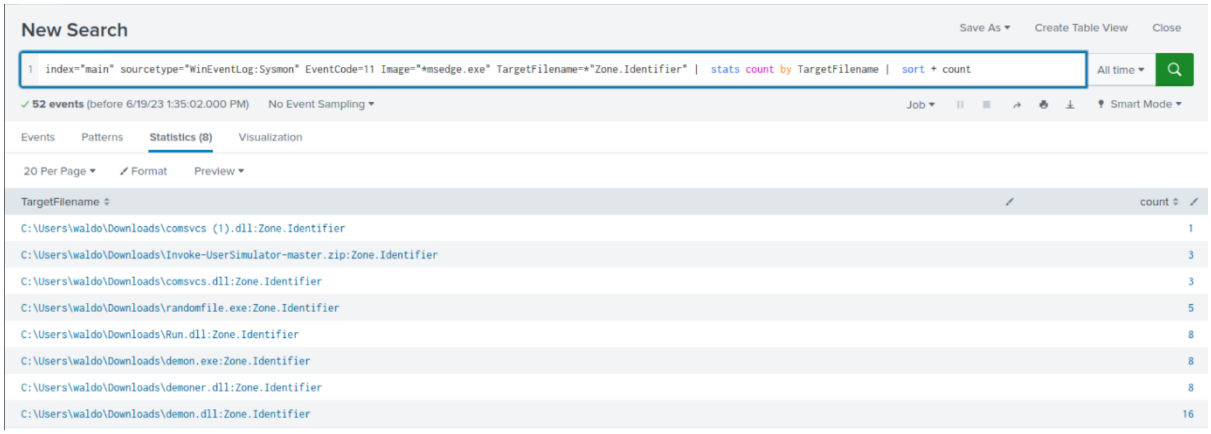
Attackers may exploit PowerShell to download additional payloads and tools, or deceive users into downloading malware via web browsers. The following SPL searches examine files downloaded through PowerShell or MS Edge.

index="main" sourcetype="WinEventLog:Sysmon" EventCode=11 Image="*powershell.exe*" | stats count by Image, TargetFilename | sort + count



index="main" sourcetype="WinEventLog:Sysmon" EventCode=11 Image="*msedge.exe" TargetFilename=*"Zone.Identifier" | stats count by TargetFilename | sort + count

The *Zone.Identifier is indicative of a file downloaded from the internet or another potentially untrustworthy source. Windows uses this zone identifier to track the security zones of a file. The Zone.Identifier is an ADS (Alternate Data Stream) that contains metadata about where the file was downloaded from and its security settings.

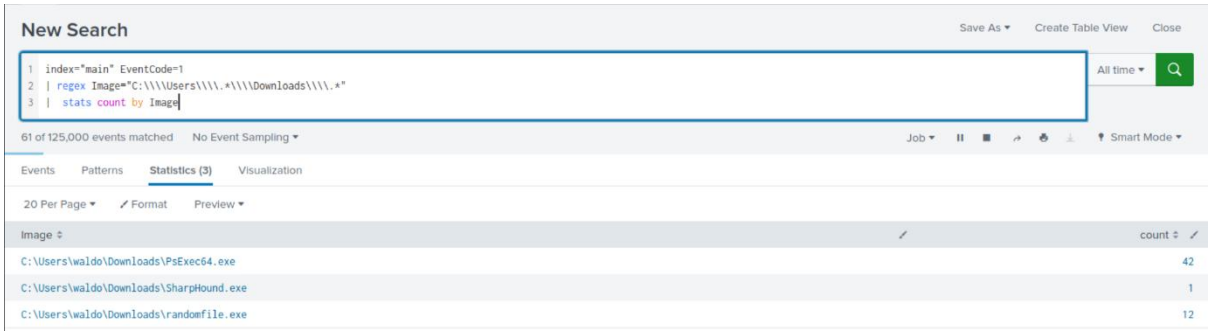


Within both search results, clear indications emerge, highlighting the usage of PowerShell and MS edge for payload/tool-downloading purposes.

6. **Example: Detection Of Execution From Atypical Or Suspicious Locations**

The following SPL search is designed to identify any process creation (EventCode=1) occurring in a user's Downloads folder.

index="main" EventCode=1 | regex Image="C:\\\\Users\\\\.*\\\\Downloads\\\\.*" | stats count by Image

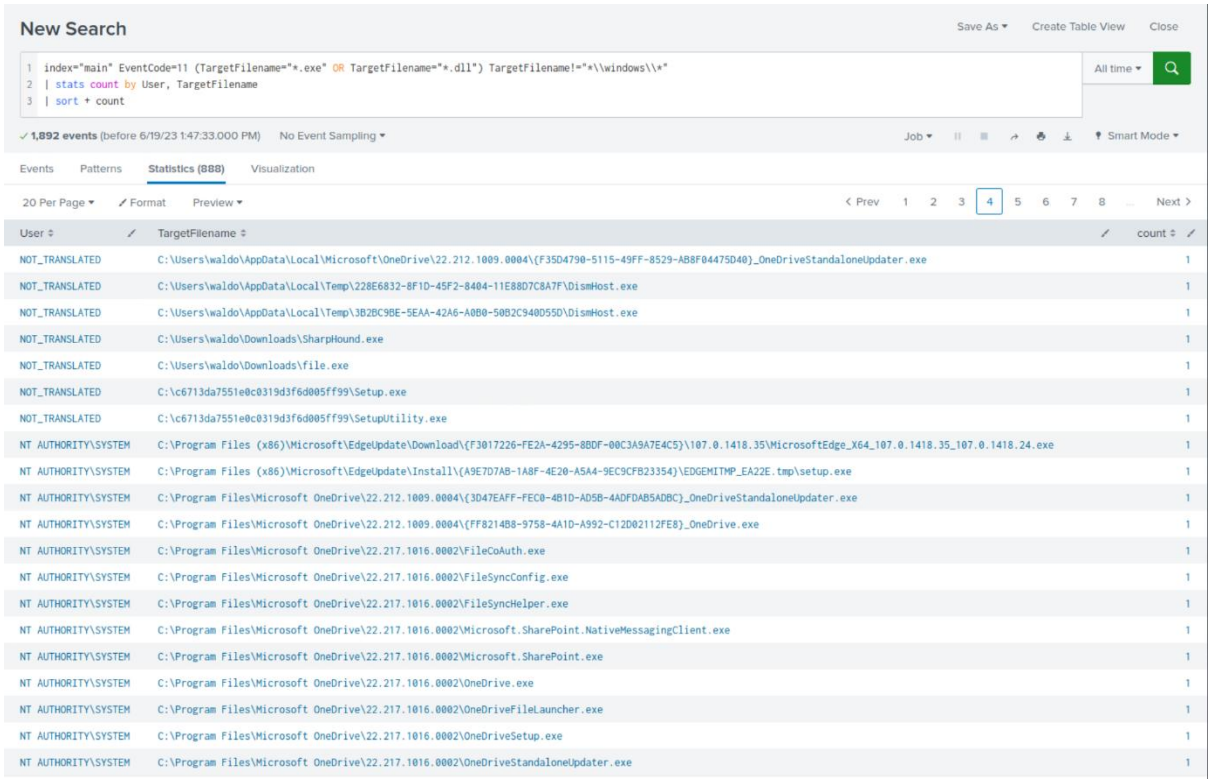


Within the less frequent search results, clear indications emerge, highlighting execution from a user's Downloads folder.

7. **Example: Detection Of Executables or DLLs Being Created Outside The Windows Directory**

The following SPL identifies potential malware activity by checking for the creation of executable and DLL files outside the Windows directory. It then groups and counts these activities by user and target filename.

index="main" EventCode=11 (TargetFilename="*.exe" OR TargetFilename="*.dll") TargetFilename!="*\\windows*" | stats count by User, TargetFilename | sort + count



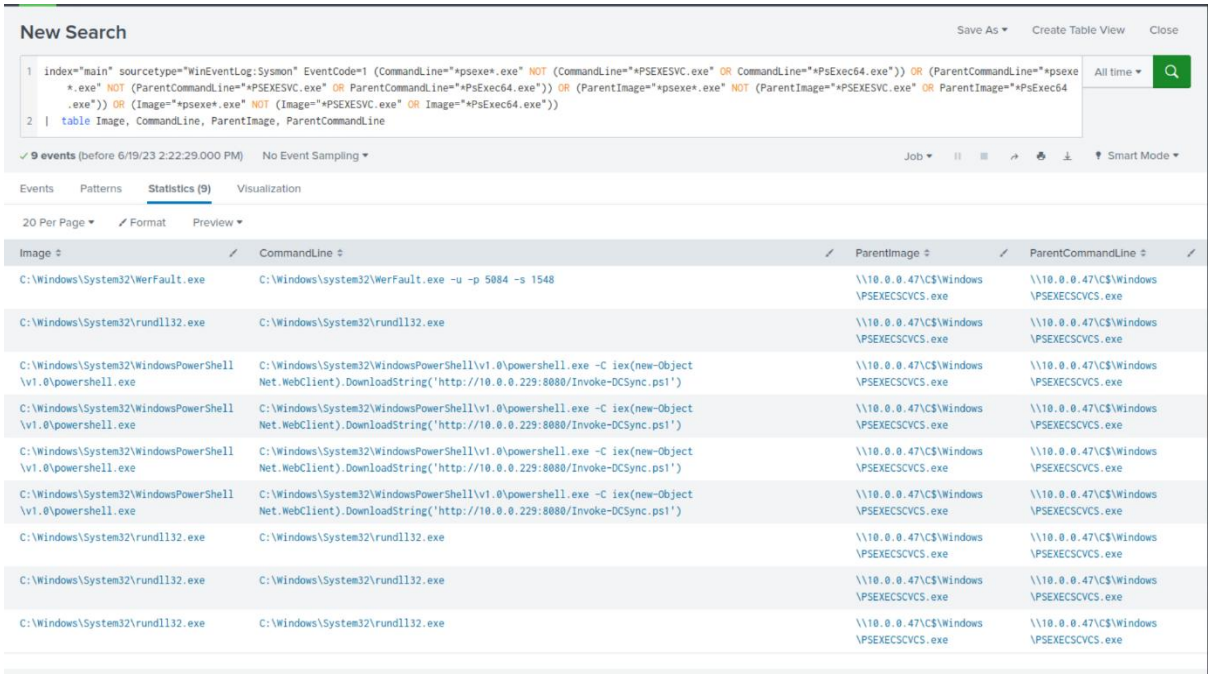
Within the less frequent search results, clear indications emerge, highlighting the creation of executables outside the Windows directory.

8. **Example: Detection Of Misspelling Legitimate Binaries**

Attackers often disguise their malicious binaries by intentionally misspelling legitimate ones to blend in and avoid detection. The purpose of the following SPL search is to detect potential misspellings of the legitimate PSEXESVC.exe binary, commonly used by PsExec. By examining

the Image, ParentImage, CommandLine and ParentCommandLine fields, the search aims to identify instances where variations of psexe are used, potentially indicating the presence of malicious binaries attempting to masquerade as the legitimate PsExec service binary.

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 (CommandLine="*psexe*.exe" NOT (CommandLine="*PSEXESVC.exe" OR CommandLine="*PsExec64.exe")) OR (ParentCommandLine="*psexe*.exe" NOT (ParentCommandLine="*PSEXESVC.exe" OR ParentCommandLine="*PsExec64.exe")) OR (ParentImage="*psexe*.exe" NOT (ParentImage="*PSEXESVC.exe" OR ParentImage="*PsExec64.exe")) OR (Image="*psexe*.exe" NOT (Image="*PSEXESVC.exe" OR Image="*PsExec64.exe")) | table Image, CommandLine, ParentImage, ParentCommandLine

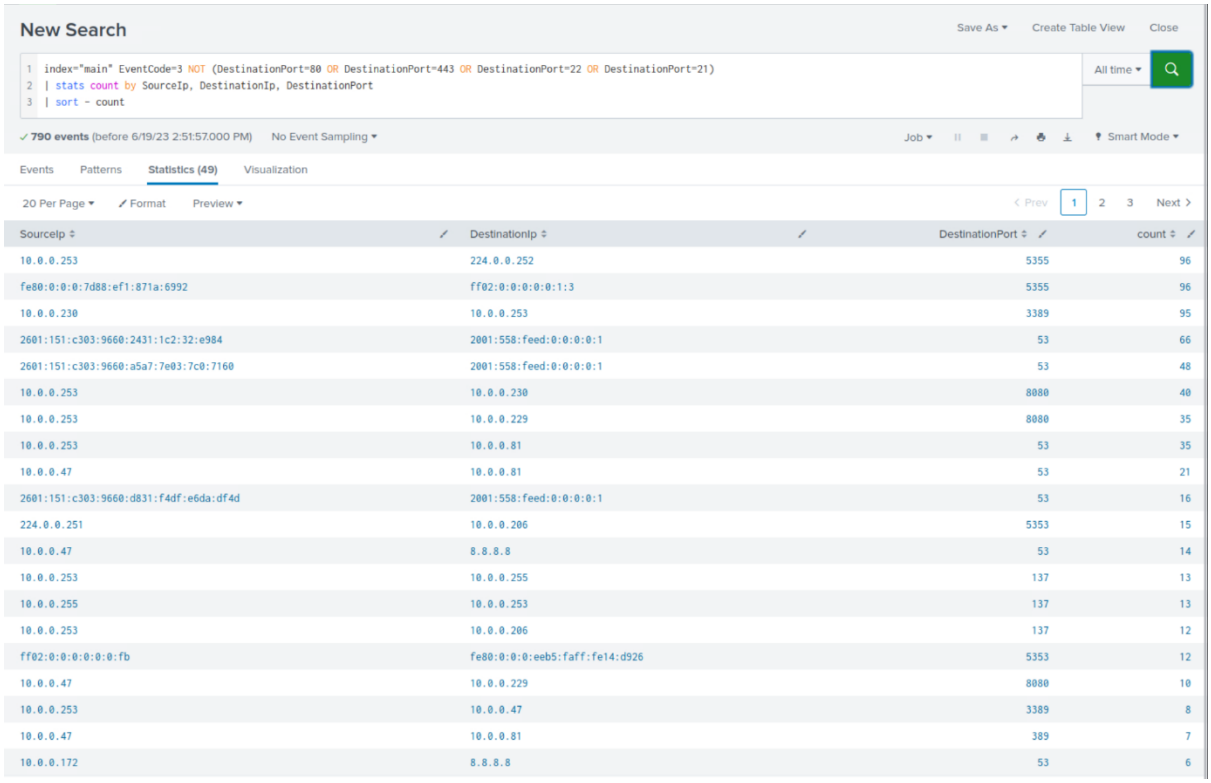


Within the search results, clear indications emerge, highlighting the misspelling of PSEXESVC.exe for evasion purposes.

9. **Example: Detection Of Using Non-standard Ports For Communications/Transfers**

Attackers often utilize non-standard ports during their operations. The following SPL search detects suspicious network connections to non-standard ports by excluding standard web and file transfer ports (80, 443, 22, 21). The stats command aggregates these connections, and they are sorted in descending order by count.

index="main" EventCode=3 NOT (DestinationPort=80 OR DestinationPort=443 OR DestinationPort=22 OR DestinationPort=21) | stats count by SourceIp, DestinationIp, DestinationPort | sort - count



Within the search results, clear indications emerge, highlighting the usage of non-standard ports communication or tool-transferring purposes.

It should be apparent by now that with a comprehensive understanding of attacker tactics, techniques, and procedures (TTPs), we could have detected the compromise of our environment more swiftly. However, it is essential to note that crafting searches solely based on attacker TTPs is insufficient as adversaries continuously evolve and employ obscure or unknown TTPs to avoid detection.

Detecting Attacker Behavior With Splunk Based On Analytics

As previously mentioned, the second approach leans heavily on statistical analysis and anomaly detection to identify abnormal behavior. By profiling normal behavior and identifying deviations from this baseline, we can uncover suspicious activities that may signify an intrusion. These statistical detection models, although driven by data, are invariably shaped by the broader understanding of attacker techniques, tactics, and procedures (TTPs).

A good example of this approach in Splunk is the use of the streamstats command. This command allows us to perform real-time analytics on the data, which can be useful for identifying unusual patterns or trends.

Consider a scenario where we are monitoring the number of network connections initiated by a process within a certain time frame.

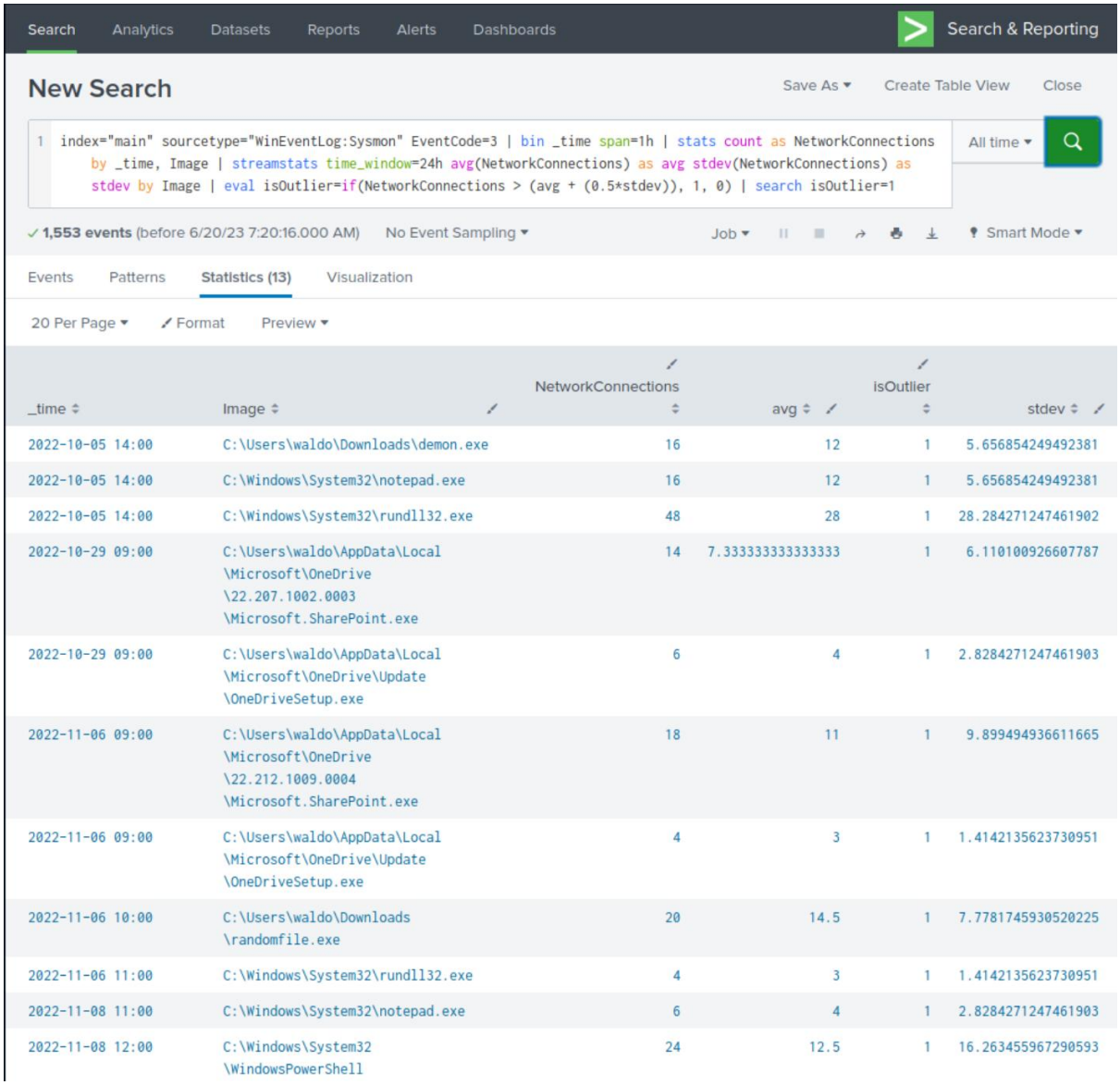
index="main" sourcetype="WinEventLog:Sysmon" EventCode=3 | bin _time span=1h | stats count as NetworkConnections by _time, Image | streamstats time_window=24h

avg(NetworkConnections) as avg stdev(NetworkConnections) as stdev by Image | eval isOutlier=if(NetworkConnections > (avg + (0.5*stdev)), 1, 0) | search isOutlier=1

In this search:

- We start by focusing on network connection events (EventCode=3), and then group these events into hourly intervals (bin can be seen as a bucket alias). For each unique process image (Image), we calculate the number of network connection events per time bucket.
- We then use the streamstats command to calculate a rolling average and standard deviation of the number of network connections over a 24-hour period for each unique process image. This gives us a dynamic baseline to compare each data point to.
- The eval command is then used to create a new field, isOutlier, and assigns it a value of 1 for any event where the number of network connections is more than 0.5 standard deviations away from the average. This labels these events as statistically anomalous and potentially indicative of suspicious activity.
- Lastly, the search command filters our results to only include the outliers, i.e., the events where isOutlier equals 1.

By monitoring for anomalies in network connections initiated by processes, we can detect potentially malicious activities such as command-and-control communication or data exfiltration attempts. However, as with any anomaly detection method, it's important to remember that it may yield false positives and should be calibrated according to the specifics of your environment.



_time	Image	NetworkConnections	avg	isOutlier	stdev
2022-10-05 14:00	C:\Users\waldo\Downloads\demon.exe	16	12	1	5.656854249492381
2022-10-05 14:00	C:\Windows\System32\notepad.exe	16	12	1	5.656854249492381
2022-10-05 14:00	C:\Windows\System32\rundll32.exe	48	28	1	28.284271247461902
2022-10-29 09:00	C:\Users\waldo\AppData\Local\Microsoft\OneDrive\22.207.1002.0003\Microsoft.SharePoint.exe	14	7.333333333333333	1	6.110100926607787
2022-10-29 09:00	C:\Users\waldo\AppData\Local\Microsoft\OneDrive\Update\OneDriveSetup.exe	6	4	1	2.8284271247461903
2022-11-06 09:00	C:\Users\waldo\AppData\Local\Microsoft\OneDrive\22.212.1009.0004\Microsoft.SharePoint.exe	18	11	1	9.899494936611665
2022-11-06 09:00	C:\Users\waldo\AppData\Local\Microsoft\OneDrive\Update\OneDriveSetup.exe	4	3	1	1.4142135623730951
2022-11-06 10:00	C:\Users\waldo\Downloads\randomfile.exe	20	14.5	1	7.7781745930520225
2022-11-06 11:00	C:\Windows\System32\rundll32.exe	4	3	1	1.4142135623730951
2022-11-08 11:00	C:\Windows\System32\notepad.exe	6	4	1	2.8284271247461903
2022-11-08 12:00	C:\Windows\System32\WindowsPowerShell	24	12.5	1	16.263455967290593

Upon closer examination of the results, we observe the presence of numerous suspicious processes that were previously identified, although not all of them are evident.

Crafting SPL Searches Based On Analytics

Below are some more detection examples that follow this approach.

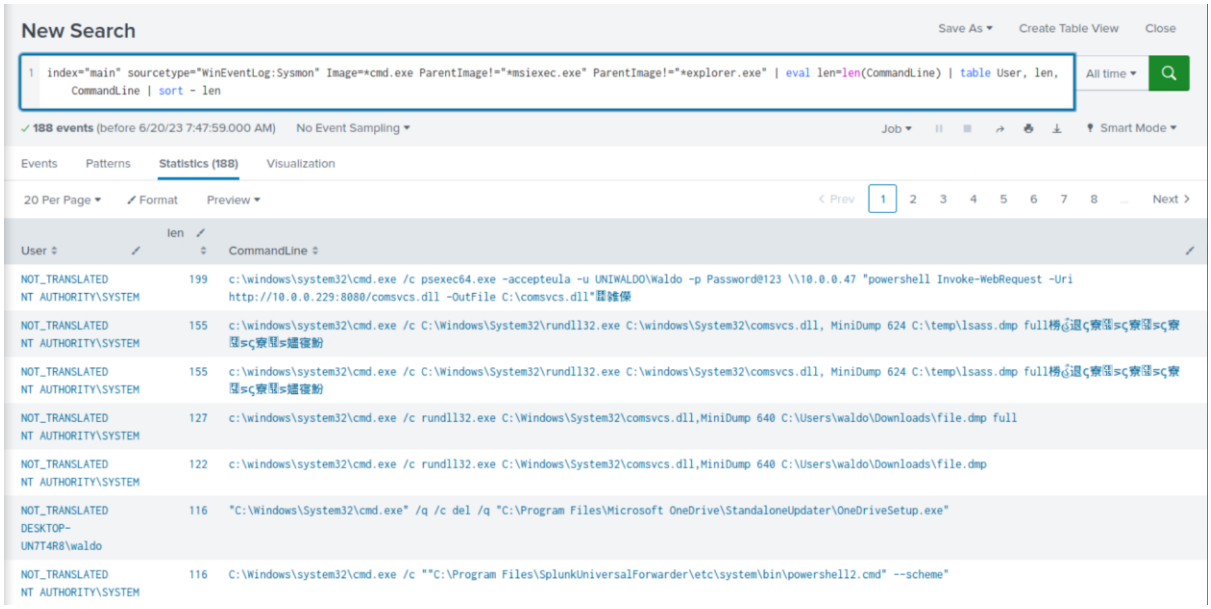
1. **Example: Detection Of Abnormally Long Commands**

Attackers frequently employ excessively long commands as part of their operations to accomplish their objectives.

index="main" sourcetype="WinEventLog:Sysmon" Image=*cmd.exe | eval len=len(CommandLine) | table User, len, CommandLine | sort - len

After reviewing the results, we notice some benign activity that can be filtered out to reduce noise. Let's apply the following modifications to the search.

index="main" sourcetype="WinEventLog:Sysmon" Image=*cmd.exe ParentImage!="*msiexec.exe" ParentImage!="*explorer.exe" | eval len=len(CommandLine) | table User, len, CommandLine | sort - len

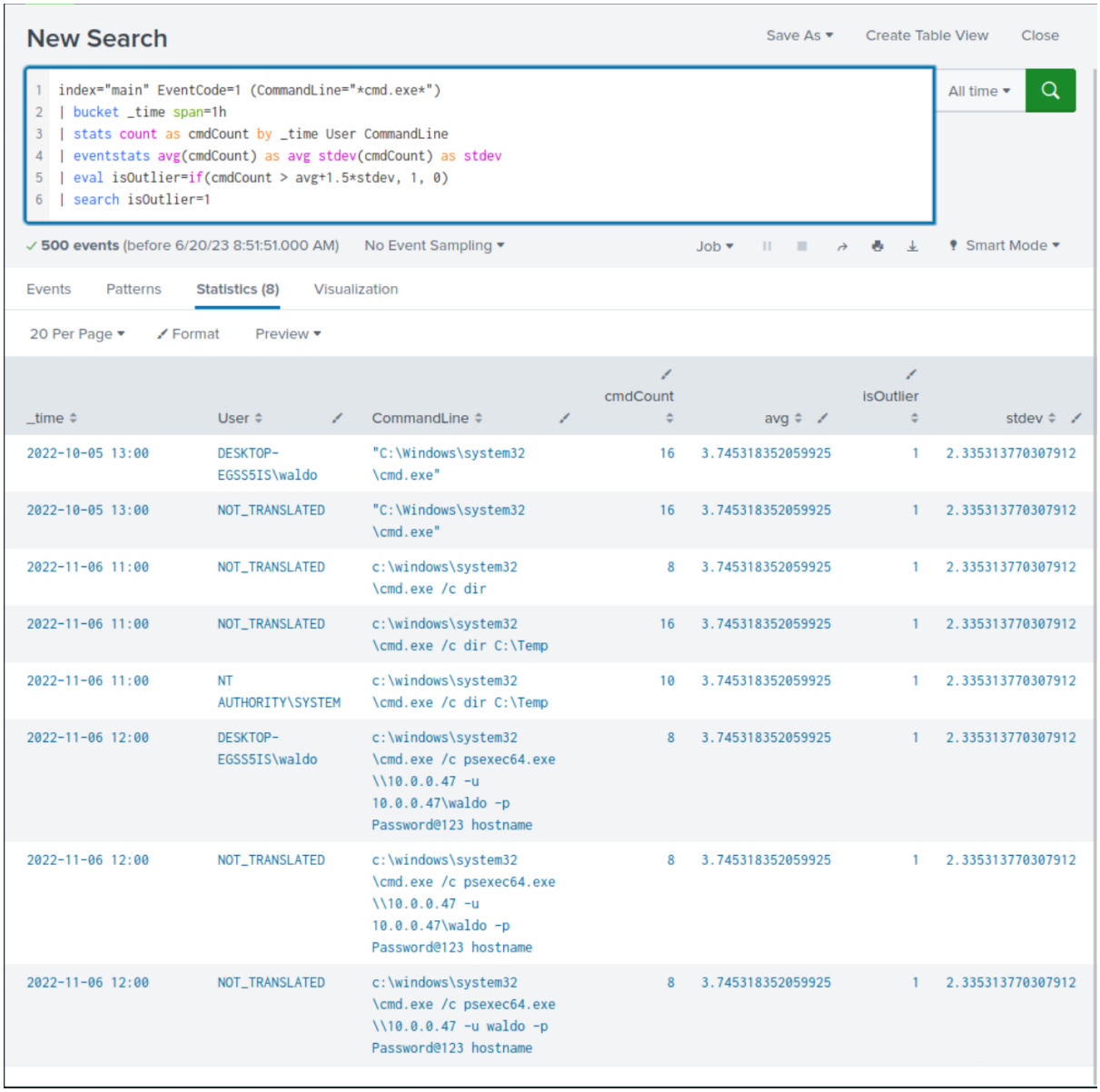


Once again, we observe the recurrence of malicious activity that we previously identified during our investigation.

2. **Example: Detection Of Abnormal cmd.exe Activity**

The following search identifies unusual cmd.exe activity within a certain time range. It uses the bucket command to group events by hour, calculates the count, average, and standard deviation of cmd.exe executions, and flags outliers.

index="main" EventCode=1 (CommandLine="*cmd.exe*") | bucket _time span=1h | stats count as cmdCount by _time User CommandLine | eventstats avg(cmdCount) as avg stdev(cmdCount) as stdev | eval isOutlier=if(cmdCount > avg+1.5*stdev, 1, 0) | search isOutlier=1



_time	User	CommandLine	cmdCount	avg	isOutlier	stdev
2022-10-05 13:00	DESKTOP-EGSS5IS\waldo	"C:\Windows\system32\cmd.exe"	16	3.745318352059925	1	2.335313770307912
2022-10-05 13:00	NOT_TRANSLATED	"C:\Windows\system32\cmd.exe"	16	3.745318352059925	1	2.335313770307912
2022-11-06 11:00	NOT_TRANSLATED	c:\windows\system32\cmd.exe /c dir	8	3.745318352059925	1	2.335313770307912
2022-11-06 11:00	NOT_TRANSLATED	c:\windows\system32\cmd.exe /c dir C:\Temp	16	3.745318352059925	1	2.335313770307912
2022-11-06 11:00	NT AUTHORITY\SYSTEM	c:\windows\system32\cmd.exe /c dir C:\Temp	10	3.745318352059925	1	2.335313770307912
2022-11-06 12:00	DESKTOP-EGSS5IS\waldo	c:\windows\system32\cmd.exe /c psexec64.exe \\10.0.0.47 -u 10.0.0.47\waldo -p Password@123 hostname	8	3.745318352059925	1	2.335313770307912
2022-11-06 12:00	NOT_TRANSLATED	c:\windows\system32\cmd.exe /c psexec64.exe \\10.0.0.47 -u 10.0.0.47\waldo -p Password@123 hostname	8	3.745318352059925	1	2.335313770307912
2022-11-06 12:00	NOT_TRANSLATED	c:\windows\system32\cmd.exe /c psexec64.exe \\10.0.0.47 -u waldo -p Password@123 hostname	8	3.745318352059925	1	2.335313770307912

Upon closer examination of the results, we observe the presence of suspicious commands that were previously identified, although not all of them are evident.

3. **Example: Detection Of Processes Loading A High Number Of DLLs In A Specific Time**

It is not uncommon for malware to load multiple DLLs in rapid succession. The following SPL can assist in monitoring this behavior.

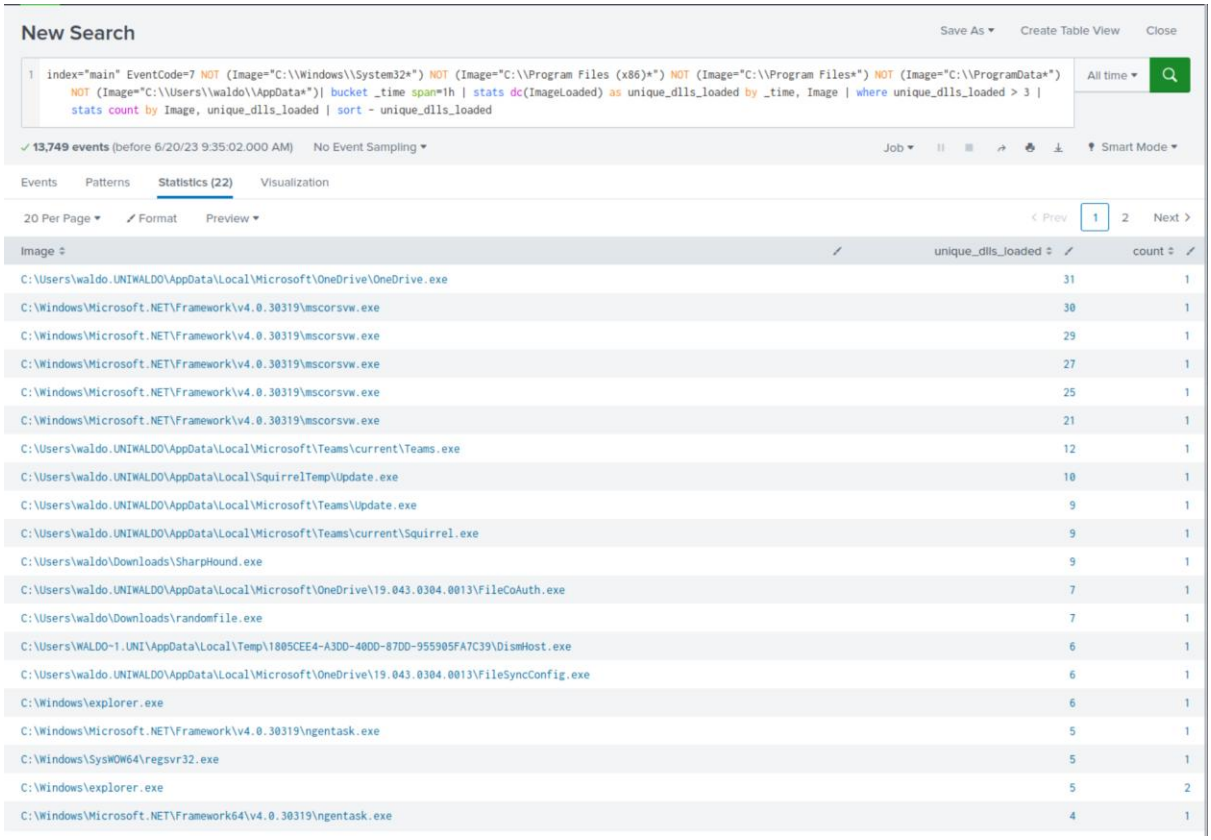
index="main" EventCode=7 | bucket _time span=1h | stats dc(ImageLoaded) as unique_dlls_loaded by _time, Image | where unique_dlls_loaded > 3 | stats count by Image, unique_dlls_loaded

After reviewing the results, we notice some benign activity that can be filtered out to reduce noise. Let's apply the following modifications to the search.

index="main" EventCode=7 NOT (Image="C:\\Windows\\System32*") NOT (Image="C:\\Program Files (x86)*") NOT (Image="C:\\Program Files*") NOT

(Image="C:\\ProgramData*") NOT (Image="C:\\Users\\waldo\\AppData*")| bucket _time span=1h | stats dc(ImageLoaded) as unique_dlls_loaded by _time, Image | where unique_dlls_loaded > 3 | stats count by Image, unique_dlls_loaded | sort - unique_dlls_loaded

- index="main" EventCode=7 NOT (Image="C:\\Windows\\System32*") NOT (Image="C:\\Program Files (x86)*") NOT (Image="C:\\Program Files*") NOT (Image="C:\\ProgramData*") NOT (Image="C:\\Users\\waldo\\AppData*"): This part of the query is responsible for fetching all the events from the main index where EventCode is 7 (Image loaded events in Sysmon logs). The NOT filters are excluding events from known benign paths (like "Windows\System32", "Program Files", "ProgramData", and a specific user's "AppData" directory).
- | bucket _time span=1h: This command is used to group the events into time buckets of one hour duration. This is used to analyze the data in hourly intervals.
- | stats dc(ImageLoaded) as unique_dlls_loaded by _time, Image:
  The stats command is used to perform statistical operations on the events. Here, dc(ImageLoaded) calculates the distinct count of DLLs loaded (ImageLoaded) for each process image (Image) in each one-hour time bucket.
- | where unique_dlls_loaded > 3: This filter excludes the results where the number of unique DLLs loaded by a process within an hour is 3 or less. This is based on the assumption that legitimate software usually loads DLLs at a moderate rate, whereas malware might rapidly load many different DLLs.
- | stats count by Image, unique_dlls_loaded: This command calculates the number of times each process (Image) has loaded more than 3 unique DLLs in an hour.
- | sort - unique_dlls_loaded: Finally, this command sorts the results in descending order based on the number of unique DLLs loaded (unique_dlls_loaded).



Upon closer examination of the results, we observe the presence of suspicious processes that were previously identified, although not all of them are evident.

It's important to note that this behavior can also be exhibited by legitimate software in numerous cases, so context and additional investigation would be necessary to confirm malicious activity.

4. **Example: Detection Of Transactions Where The Same Process Has Been Created More Than Once On The Same Computer**

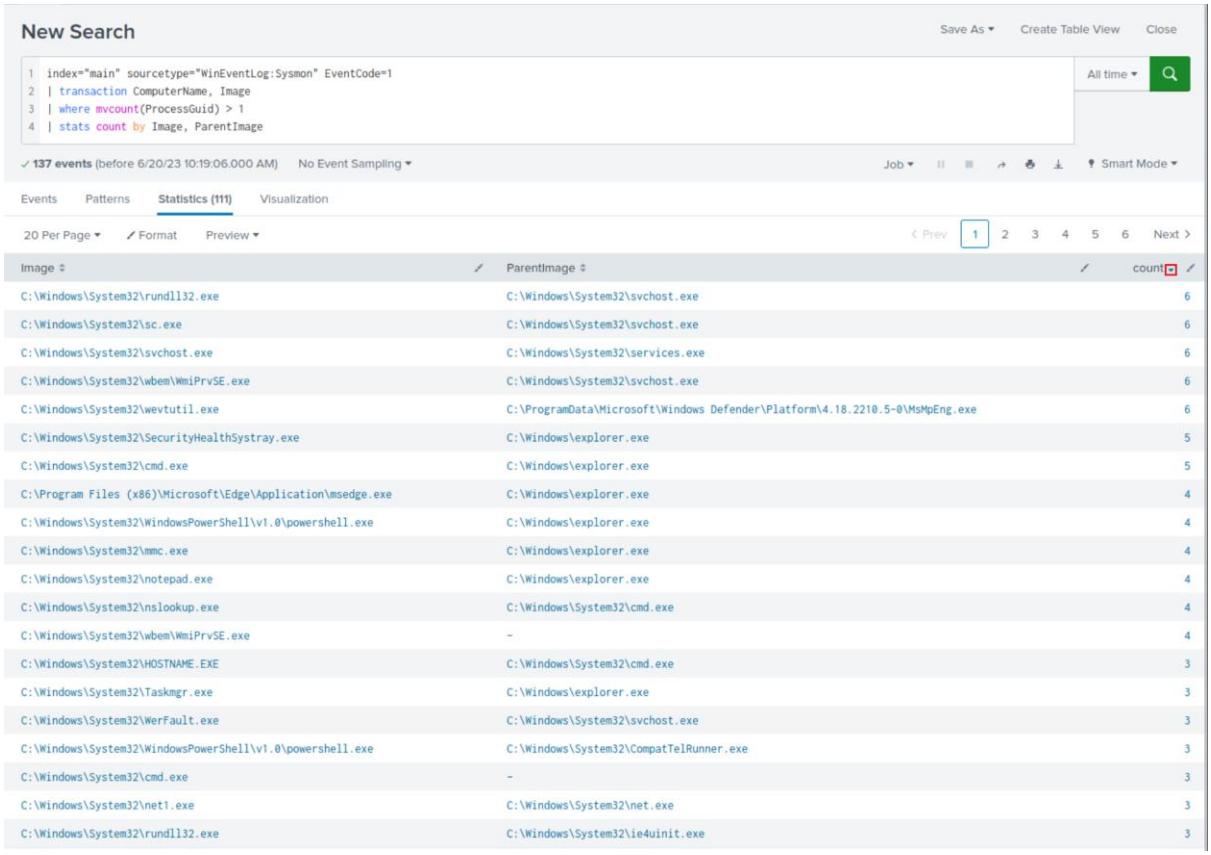
We want to correlate events where the same process (Image) is executed on the same computer (ComputerName) since this might indicate abnormalities depending on the nature of the processes involved. As always, context and additional investigation would be necessary to confirm if it's truly malicious or just a benign occurrence. The following SPL can assist in monitoring this behavior.

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | transaction ComputerName, Image | where mvcount(ProcessGuid) > 1 | stats count by Image, ParentImage

- index="main" sourcetype="WinEventLog:Sysmon" EventCode=1: This part of the query fetches all the Sysmon process creation events (EventCode=1) from the main index. Sysmon event code 1 represents a process creation event, which includes details such as the process that was started, its command line arguments, the user that started it, and the process that it was started from.
- | transaction ComputerName, Image: The transaction command is used to group related events together based on shared field values. In this case, events are being grouped together if they share the

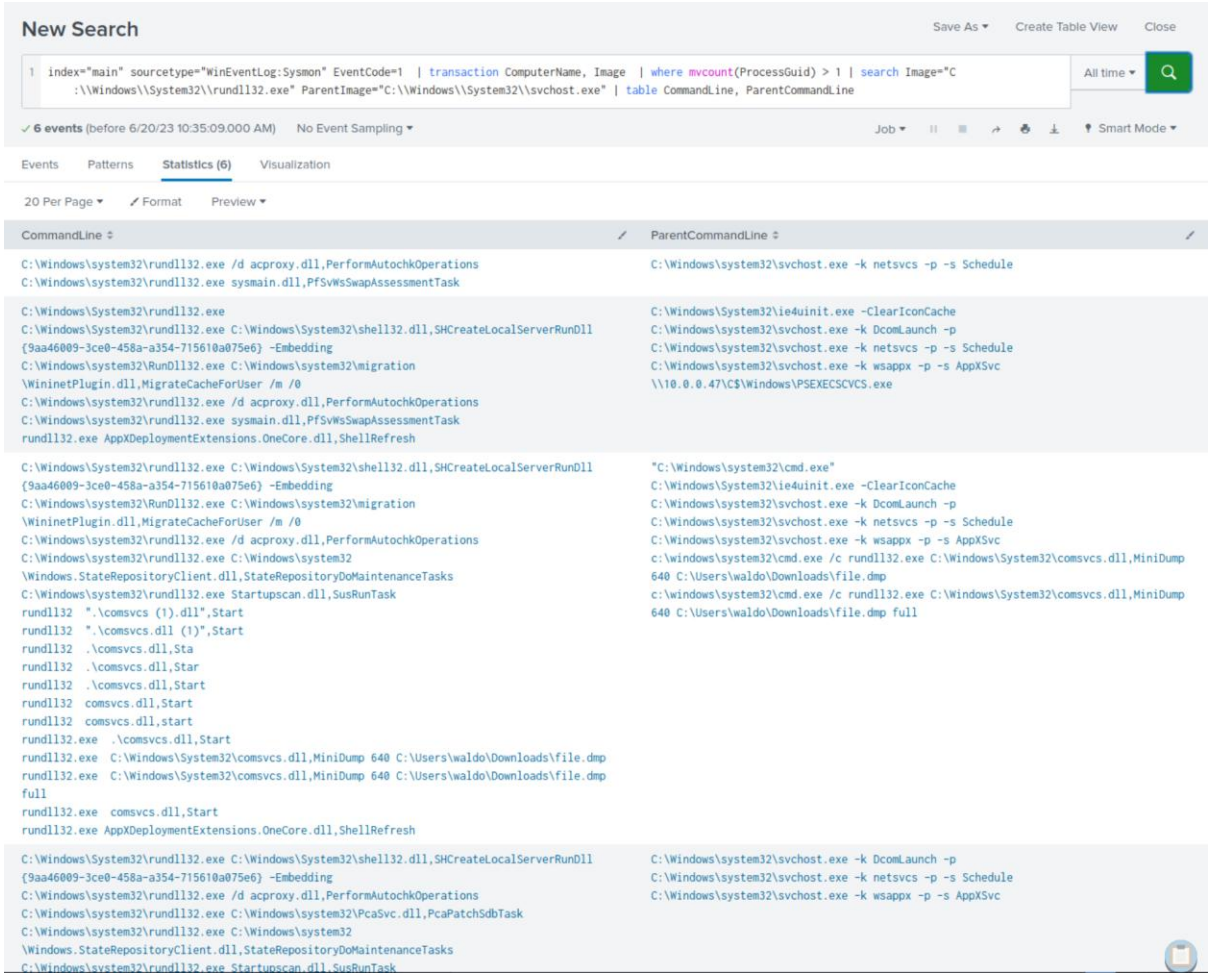
same ComputerName and Image values. This can help to link together all the process creation events associated with a specific program on a specific computer.

- | where mvcount(ProcessGuid) > 1: This command filters the results to only include transactions where more than one unique process GUID (ProcessGuid) is associated with the same program image (Image) on the same computer (ComputerName). This would typically represent instances where the same program was started more than once.
- | stats count by Image, ParentImage: Finally, this stats command is used to count the number of such instances by the program image (Image) and its parent process image (ParentImage).



Let's dive deeper into the relationship between rundll32.exe and svchost.exe (since this pair has the highest count number).

index="main" sourcetype="WinEventLog:Sysmon" EventCode=1 | transaction ComputerName, Image | where mvcount(ProcessGuid) > 1 | search Image="C:\\Windows\\System32\\rundll32.exe" ParentImage="C:\\Windows\\System32\\svchost.exe" | table CommandLine, ParentCommandLine



After careful scrutiny of the results, it becomes apparent that we not only identify the presence of previously identified suspicious commands but also new ones.

By establishing a profile of "normal" behavior and utilizing a statistical model to identify deviations from a baseline, we could have detected the compromise of our environment more rapidly, especially with a thorough understanding of attacker tactics, techniques, and procedures (TTPs). However, it is important to acknowledge that relying solely on this approach when crafting queries is inadequate.