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# Hunting through Log Data with Excel

*GIAC GCIH Gold Certification*

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## Abstract

Gathering and analyzing data during an incident can be a long and tedious process. The vast amounts of data involved in even a single system intrusion can be overwhelming. Larger and well-funded incident response teams typically have a Security Information and Event Management (SIEM) product at their disposal to help the responder sift through this data to find artifacts relevant to the intrusion. This paper will demonstrate to the reader how to use Microsoft Excel and some of its more advanced features during an intrusion if a SIEM or similar product is not available to the incident responder.

## 1. Introduction

This document will show you how to use Microsoft Excel to search through dissimilar data to find significant artifacts needed to respond to an intrusion. It may not be ideal to import thousands of log entries into Excel and root through them for a few nuggets that might give you insight into the adversary's exploitation of a network. However, if a SIEM product is not running in the enterprise, with a little knowledge and a small amount of coding, you can use Excel as a suitable substitute. There will still be a manual effort involved as there is no magic button that will produce all the artifacts that you wish to find, but the process described here will make it easier and more intuitive to filter out all the unwanted data.

When examining logs, you will look for indicators of compromise (IOCs) that can point you in the direction of other compromised systems. The examination of logs is not a deep dive forensic type of analysis. During an incident, there is not enough time to look at every log entry from every system. The method shown below will help find the obvious artifacts and identify the next system to examine.

This guide will contain up to three methods for each example presented. First, the paper will show some of the things you can do with Excel by just using the toolbar commands. Second, if available, an Excel Function will be created to show how it can be slightly automated. Third, to enhance the Excel Function process even further, Visual Basic for Applications (VBA) code will be provided. Knowing alternate ways of manipulating different types of data will allow you to incorporate the results into the standard output described below.

To prevent this paper from being overly long and difficult to search through, the VBA code will be made available on the GitHub website to make it easier to replicate. The GitHub URL is [https://github.com/gregory-lalla/GCIH\\_Gold/](https://github.com/gregory-lalla/GCIH_Gold/).

## 2. Requirements

### 2.1. Excel Version

The Excel Functions and VBA code in this paper were written and executed using Microsoft Excel 2010. Other versions of Microsoft Excel based on the Office Open XML (OOXML) specification (Excel 2007 and later) should have most of the same functionality. There are exceptions, such as “Making a Macro that changes the cell colors and making changes to other aspects of cells may not be backward compatible” (“Microsoft Excel”, 2016). Also, the location of some options may be in different menus or locations within a menu.

### 2.2. Developer Toolbar

To use the techniques described in this document, you will need to have the Developer Toolbar added to the Ribbon. For instructions on how to enable the Developer Toolbar, visit <https://msdn.microsoft.com/en-us/library/bb608625.aspx/>.

## 3. Organizational Concepts

Formatting, filtering, and organization are the core techniques in this paper for finding relevant information needed to respond to an incident. The following are suggestions on how to get Excel to display the data in a way that is easy to analyze. We will use these techniques when looking at each of the different types of logs discussed later in this paper.

### 3.1. System Time

First, depending on the geographic location of your systems, the time zone settings may need to be adjusted. If the location of all the systems is in the same time zone, then you may want to perform all your data correlation in the local time zone. If your systems span time zones, it is best to do all the analysis using the Coordinated Universal Time (UTC) time zone. Using UTC, all the data will line up chronologically. To make the process easier, the system time should be changed to UTC so that applications that use the computer’s time to display the timestamp will automatically produce the correct time format.

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Another setting to change is the Date and Time format of your analysis computer. Excel uses the Date/Time format of the system when it displays the information in the formula bar. To keep things consistent throughout the investigation and within reporting, have the Date/Time in the 'mm/dd/yyyy hh:mm:ss' format (without the quotes). This setting makes all the date and time values 19 characters long. To make this change, follow these instructions: <https://support.office.com/en-us/article/Change-the-Windows-regional-settings-to-modify-the-appearance-of-some-data-types-edf41006-f6e2-4360-bc1b-30e9e8a54989/>.

Finally, the dates and times in the Excel spreadsheets need to be formatted to display the same 'mm/dd/yyyy hh:mm:ss' format. In the below example, you change the Date/Time format by selecting Column A which contains the date and time values, then right clicking the column and selecting 'Format Cells...'. This process should bring up a new window titled 'Format Cells' with the 'Number' tab already selected. Under 'Category,' click 'Custom.' In dialogue box labeled 'Type:' enter mm/dd/yyyy hh:mm:ss (Figure 1).

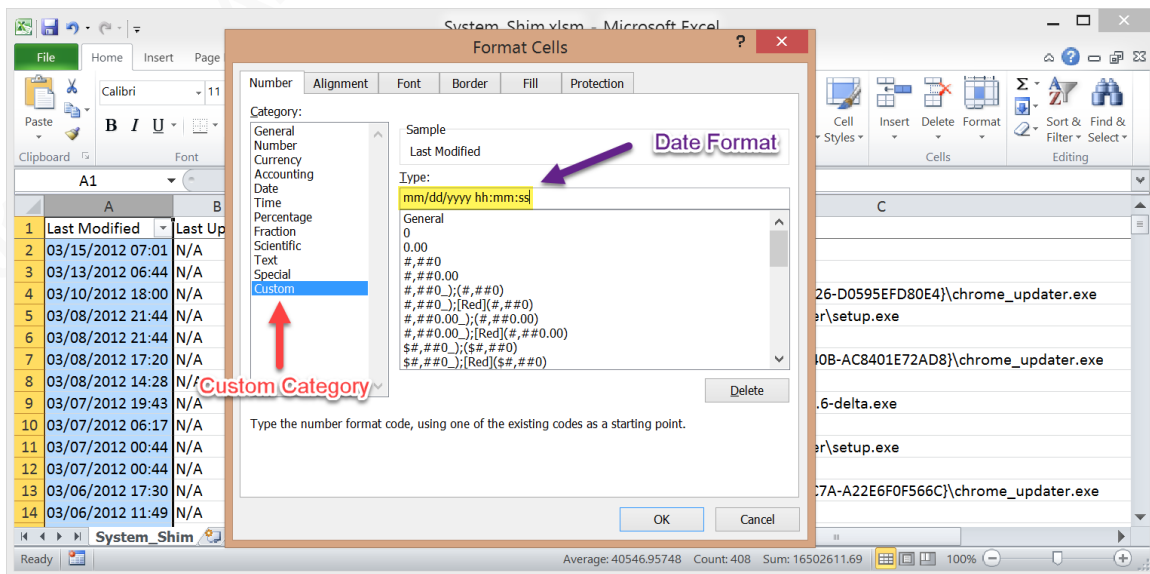


Figure 1. Date Format (Lee, 2014, digital case files)

### 3.2. Consistent Results

Other columns displaying data should also have a uniform appearance, which makes it easier to spot trends, inconsistencies, patterns, etc. In this paper, the following column headers will be used across all spreadsheets to achieve that consistent look:

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- Column A Header Name = Date/Time
- Column B Header Name = Account
- Column C Header Name = Computer
- Column D Header Name = Description
- Column E Header Name = Details
- Column F Header Name = Properties
- Column G Header Name = Miscellaneous
- Column H Header Name = Artifact

Note that it is acceptable to have empty columns to the spreadsheet if there is not enough data to fill all the suggested columns.

### 3.3. Formatting

To easily read the data, you will freeze the top row and apply a bold font to it; enable filters on the columns; set the column widths to 'Autofit'; and 'left justify' the entire spreadsheet. Reduce the data where possible and sort it by the Date/Time column from oldest to newest. Please see the GitHub page which has an Excel template of the standard format named 'Standard\_Format.xltm' ([https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Docs/Template/Standard\\_Format.xltm](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Docs/Template/Standard_Format.xltm)).

### 3.4. Keywords, Named Cells, and Filters

One of the common themes repeated in this paper is data reduction. Excel can handle a lot of data, but there is a cost in the time it takes to manipulate and analyze that data. Each log file examined will have unique entries which the responder must understand to reduce the data without losing critical items relevant to the incident.

One method of data reduction is the use of keywords. A list of keywords will be used to help pinpoint known or suspicious activity related to the intrusion. There should be two types of keyword lists maintained. One master list of all the terms discovered during the throughout the investigation and an event list for each type of log analyzed. Tailor the event keyword lists to the log files you are inspecting to minimize the output of the filtered data.

When reducing data, one issue faced is the location of the data you want to keep changes as rows and columns get adjusted. This shifting of data needs to be kept in mind when working with 'Named Cells' (Blue arrow in Figure 2) as the properties assigned to

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the cell stay with that cell, even if the data in the cell moves to a new location. Therefore, reduce and adjust all the data before using ‘Named Cells.’ If the data in a ‘Named Cell’ will change, a good way to keep track of that data is to use ‘Fill Colors.’ When a keyword search gets a match, highlight the cell or entire row with a particular color. Using filters, you can locate the ‘colored’ data with a few clicks of the mouse.

To manually work with keywords, the basic search feature can be used to find each instance of the keyword. Enter a unique identifier in the cell ‘Name Box’ (Blue arrow in Figure 2) when a keyword is found in a cell. The unique identifier name has the following rules: “The first character of a name must be a letter, an underscore character (\_), or a backslash (\). Remaining characters in the name can be letters, numbers, periods, and underscore characters” (“Define and use names in formulas – Excel”, 2017).

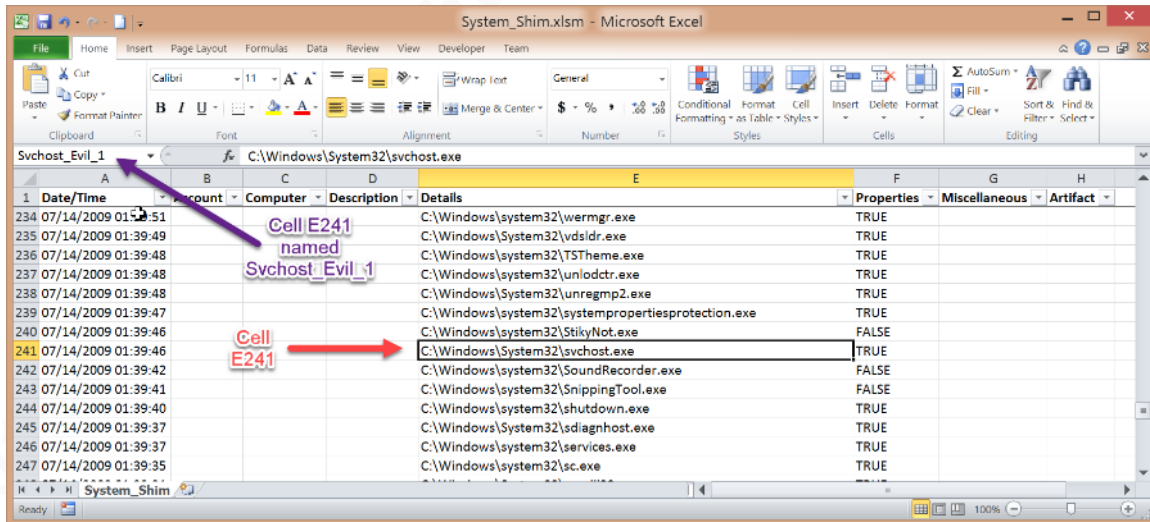


Figure 2. Named Cell. (Lee, 2014, digital case files)

After naming the cell, fill the entire row that contains the keyword with a color (Figure 3). For each unique keyword found you can continue to use the same color or change them to different colors distinctively associated with each keyword. Using the fill colors is helpful when using the filter tool, which will be discussed and demonstrated further into the paper.

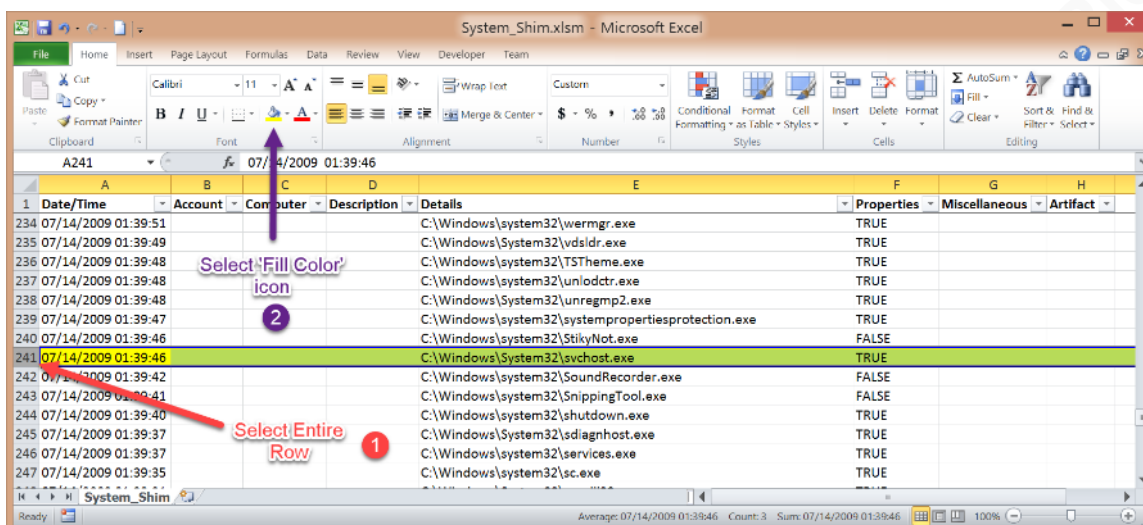


Figure 3. Fill Color. (Lee, 2014, digital case files)

Click 'Find Next' in the 'Find and Replace' window to find the next instance of the keyword. Once found, give that cell a similar, but unique name to distinguish it from the first keyword found and give it a 'Fill Color.' As an example, the first unique cell Name would be 'Svchost\_Evil\_1' and the second would be 'Svchost\_Evil\_2' for hits found on keyword 'svchost.exe.' After all the keywords are searched and found in this manner, you can navigate to those cells by clicking the dropdown arrow in the cell 'Name Box' and selecting one of the entries (Figure 4). You can also manage the 'Named Cells' and see their location by going to the 'Formulas' ribbon tab and selecting the 'Name Manager' icon (Figure 5).

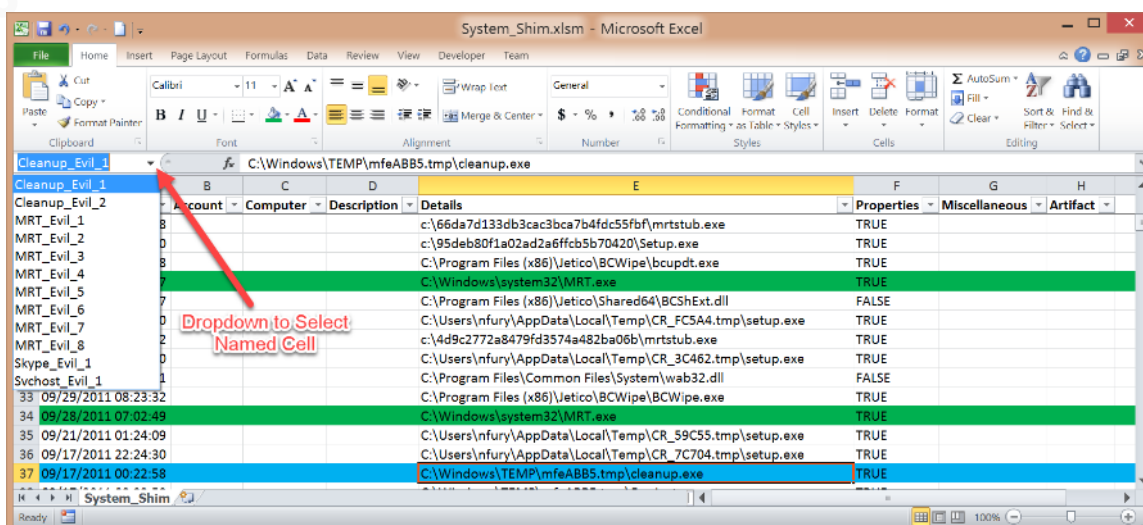


Figure 4. Selecting Named Cells. (Lee, 2014, digital case files)

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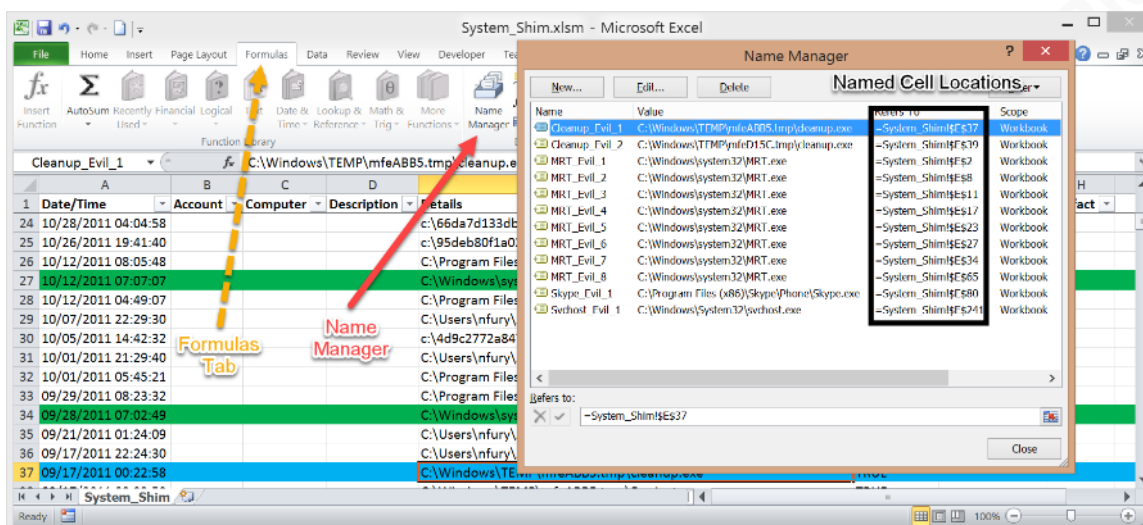


Figure 5. Name Manager. (Lee, 2014, digital case files)

Using ‘Named Cells’ is a quick way to locate known artifacts. It is also an excellent way to find more keywords by examining the data around those cells.

Filters are another technique to find data and visually reduced the data to only show those cells that the analyst wishes to view. These are particularly helpful when you know you’ll have many hits on your keywords and would like to see them without the clutter of all the other rows not associated with those keywords. There are two ways to use the filters. There is a basic filter where you can have up to two items filtered per column using AND OR operators. To filter on more than two items, there are Advanced Filters which can be used to search for data with more complex options.

We enabled basic filters already in an earlier example. To access them, on the column we are looking to search, click on the dropdown arrow in the header cell. Select the ‘Text Filters’ option and then choose one of the filter selections (See Figure 6).

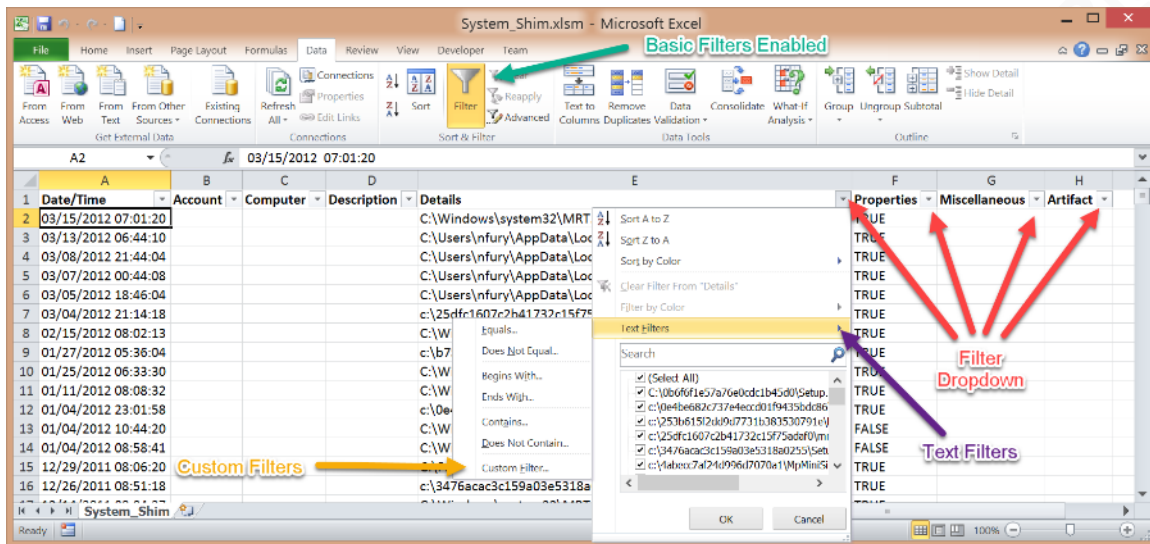


Figure 6. Filter Dropdown Menu. (Lee, 2014, digital case files)

When the filter window comes up, enter the word(s) you want to locate (or exclude) in the dialogue box. The filter will display only the rows that have (or don't have) the words in the column.

You can also search on the 'Fill Colors' used during the keyword search to filter only on those colors you wish to see (Figure 7).

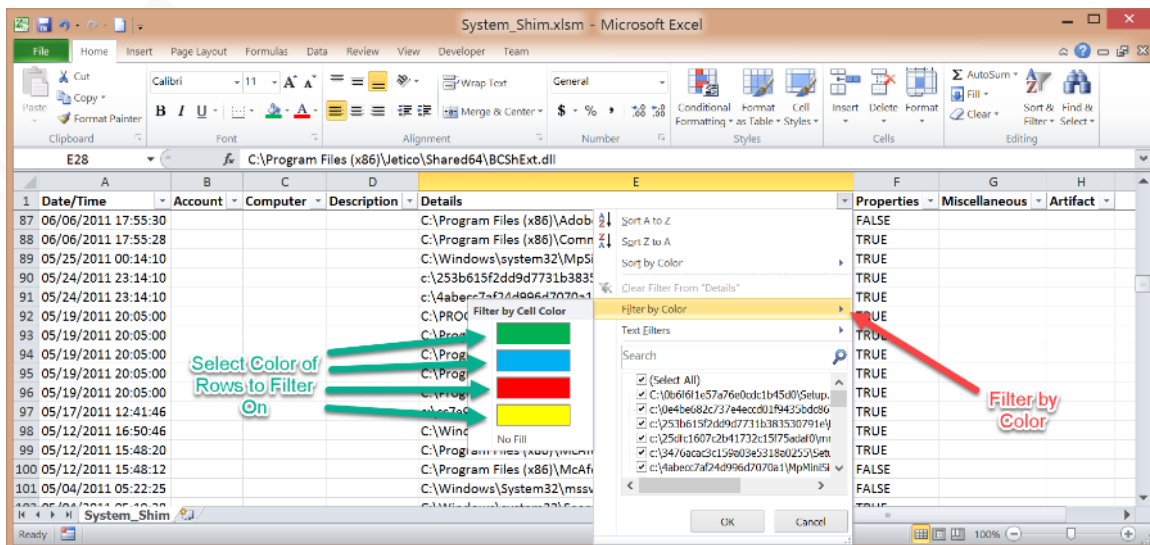


Figure 7. Search on Fill Color. (Lee, 2014, digital case files)

The advanced filters allow you to search for more than two keywords in a column. You enter the keywords into unused cells in the spreadsheet. The first cell is the column header name of the column to search. The cells underneath are the search terms.

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Words listed vertically use the OR operator and those listed horizontally use the AND operator. Figure 8 shows an example of an advanced filter, where you are searching the 'Details' column for five keywords. Surrounding the keyword with asterisks finds cells that CONTAIN the word. For details on filters, see <https://support.office.com/en-us/article/Filter-by-using-advanced-criteria-4c9222fe-8529-4cd7-a898-3f16abdf32b/>.

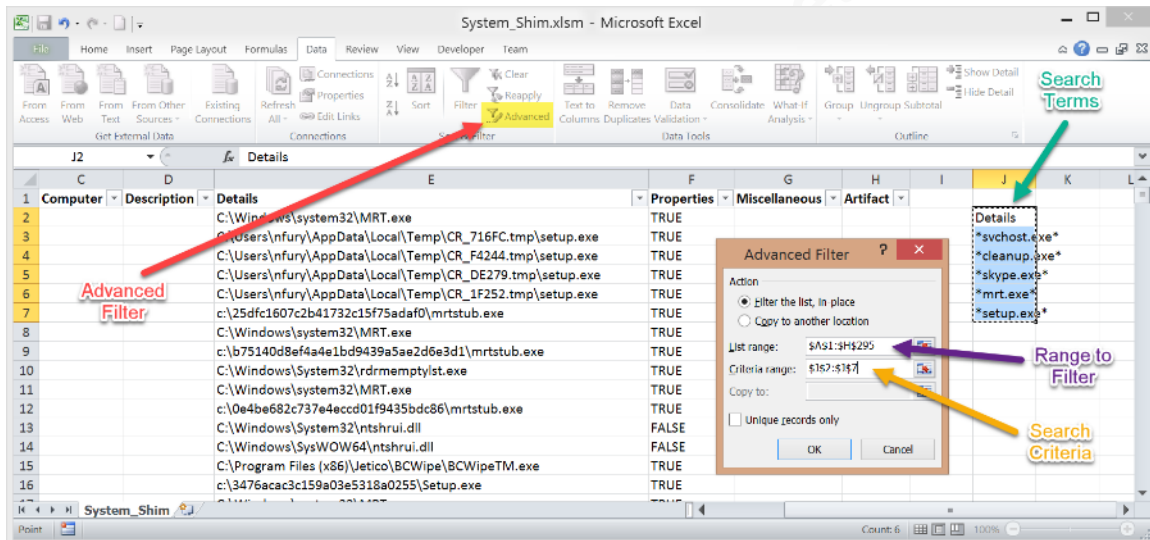


Figure 8. Advanced Filter. (Lee, 2014, digital case files)

Note the timeframe of the filtered keyword data. When looking at all the log files with tens of thousands of lines of data, this range will be important when deciding what to export for analysis (if given the option). The dropdown menu on the Date/Time column is used to filter by timeframe (Figure 9). Selecting the 'Between...' filter will allow you to capture all the data between two dates narrowing down what data you need to examine.

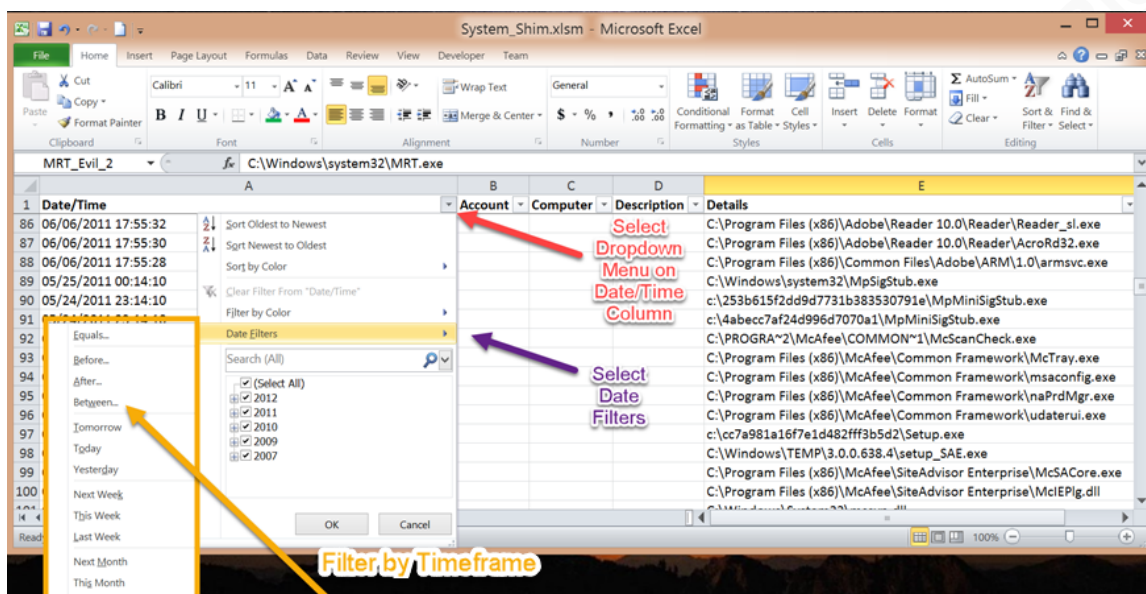


Figure 9. Search by Date/Time. (Lee, 2014, digital case files)

One thing to be aware of when filtering by timeframe is that artifacts may have timestamps that occur outside of the incident timeline. These timestamps can happen when the artifact is showing the file compile time instead of its execution time. Another example would be time-stomping, which is an anti-forensics technique to change the MFT timestamps of a file.

Any new entries found that are related to the intrusion should be 'Named' and 'Filled.' You should then copy off the highlighted rows onto a separate workbook which will contain all the rows of interest from all the logs collected.

### 3.5. Macros

Many of the tasks described above are tedious and repetitive. In such circumstances, it is easier to automate the tasks using VBA macros. You'll be provided with several VBA macros so you do not need to perform the task manually. To use macros, open the exported log file in Excel and then save it as an Excel macro-enabled workbook file with an XLSM file extension. Open the newly created .XLSM file to import the macro into the spreadsheet. Once the spreadsheet is open, you need to launch the VBA Editor window by hitting the Alt-F11 keys. With the VBA window open, select the 'File' dropdown menu and click on 'Import File.' Browse to the .BAS file with the code you are looking to run and select 'Open.' Close the VBA window and head back to

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the spreadsheet. Under the 'Developer' tab, select the 'Macros' button, highlight the newly imported macro in the popup window and select 'Run' (See Figure 10).

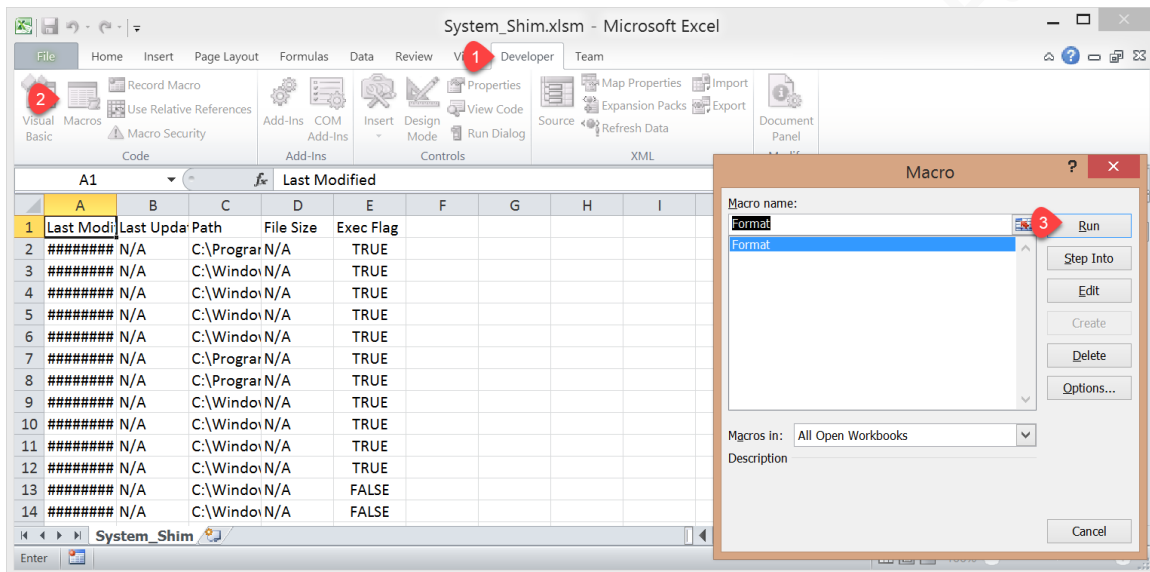


Figure 10. Run Macro. (Lee, 2014, digital case files)

There are several macros in the GitHub repository that can automate the processes described above. See Appendix C for a list of macros available in the repository and a description of what each one accomplishes.

### 3.6. Pivot Tables

Pivot Tables are an excellent way to sort data in a way that visually allows you to pick out artifacts of interest. “A pivot table allows you to create an interactive view of your dataset. With a pivot table report, you can quickly and easily categorize your data into meaningful information, and perform a wide variety of calculations in a fraction of the time it takes by hand” (Jelen, 2006, p. 9). This categorization of data is particularly true when working with Windows Event Viewer logs. Exporting the data in XML table format provides headers that can be used to categorize the data in ways that will allow you to see trends and commonalities. The GitHub site has a document named “Pivot\_Table\_Example.docx” that shows examples of how you can work with pivot tables to analyze data ([https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Docs/Supplement/Pivot\\_Table\\_Example.docx](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Docs/Supplement/Pivot_Table_Example.docx)).

## 4. Gathering the Data

Having explained the essentials of organizing logs with Excel, real understanding comes from seeing the techniques demonstrated on specific types of log files. This section will discuss examples of different log files that an incident responder may have to examine while investigating a compromised network. Then in the following section, a case study will be analyzed employing the techniques described in this paper. Appendix D provides a detailed explanation on how the Windows log files in the case study were formatted. A supplement document on the GitHub site named ‘Additional\_Log\_Formatting\_Instructions.docx’ ([https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Docs/Supplement/Additional\\_Log\\_Formatting\\_Instructions.docx](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Docs/Supplement/Additional_Log_Formatting_Instructions.docx)) provides a detailed explanation of the remaining log files mentioned in this section.

### 4.1. Windows Logs

#### 4.1.1. Event Viewer Logs

One of the primary sources of information/data gathered from a Windows operating system will come from Event Viewer logs, especially if recommended auditing settings are configured appropriately (see <https://technet.microsoft.com/en-us/library/ee513968%28WS.10%29.aspx> for recommendations). Unfortunately, a “Microsoft Windows event log is a binary file that consists of special records – Windows events” (“Windows event log essentials”, 2017) and parsing the data is not as simple as manipulating the file in a text editor. Also, when exporting the data from the native Windows Event Viewer tool, depending on the format chosen, different data is returned. Last, if you’ve ever tried to filter or search using the native Windows Event Viewer tool, you know that it has many limitations and is extremely slow.

Because Event Viewer logs can contain hundreds of thousands of entries, it is essential to reduce the data to a manageable level. Since the Event Viewer GUI is extremely slow, the native Windows command line utility named WEVTUTIL.EXE should be used to export the data. This tool comes with its challenges such as producing XML files that Excel cannot open. When running the command, there are several options

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to massage the data to a format that Excel accepts. To get the correct results, you may need to mix and match the switches until you get a compatible output.

#### 4.1.2. ShimCache Entries

The ShimCache or Application Compatibility Cache entries show executables that were likely run on the system. “The Windows Shimcache was created by Microsoft beginning in Windows XP to track compatibility issues with executed programs...It is important to understand there may be entries in the Shimcache that were not actually executed” (Parisi, 2015). “Microsoft designed the Shimcache in Windows Vista, 7, Server 2008 and Server 2012 to incorporate a ‘Process Execution Flag’ category for each entry” (Parisi, 2015). For further details on the Shimcache and the differences between XP/2003 and Vista+, see [https://www.fireeye.com/blog/threat-research/2015/06/caching\\_out\\_the\\_val.html](https://www.fireeye.com/blog/threat-research/2015/06/caching_out_the_val.html)

#### 4.1.3. Shellbags

Shellbags reflect the locations that the user has traversed using Windows Explorer. “Shellbags are found in the Windows Registry and store user preferences for folder display in Windows Explorer, such as the size of the window or how items were listed. For a folder to exist in the shellbags, it must have been opened in Windows Explorer at least one time by the user” (Cowen, 2013, ch. 13). The user’s `usrclass.dat` (Vista+) and `NTUSER.DAT` registry files contain the Shellbag artifacts.

#### 4.1.4. AutoRun Entries

Autorun entries refer to “software that runs automatically without being intentionally started by the user. These include drivers and services that start when the computer boots; application, utilities and shell extensions that start when a user logs on; and browser extensions that load when Internet Explorer is started” (Russovich, 2011, ch. 5). To parse autorun data, run the `autorunsc.exe` command against the registry files of a system. You can run the tool on a live system or offline by mounting an image of the hard drive and pointing the program to the newly mapped location.

#### 4.1.5. Web Browser Logs

The client browser may provide clues on how the adversary initially got onto a system, either through the user browsing the internet or by clicking on a link in an email or document. That information may be quite valuable in targeted attacks against the employees of a company. This section will examine Internet Explorer (IE) history/cache logs in index.dat files (IE 9 and below). Newer versions of IE browsers store their data in an Extensible Storage Engine (ESE) database. There are still other browsers that use SQLite databases. However, the data represented should still be similar once exported out of the database and into a plaintext format.

#### 4.1.6. MFT Entries

“The Master File Table (MFT) is the heart of NTFS because it contains the information about all files and directories. Every file and directory has at least one entry in the table, and the entries by themselves are very simple” (Carrier, 2005, p. 274).

#### 4.1.7. Prefetch Entries

“Application prefetch is intended to enable a better user experience within Windows systems by monitoring an application as it’s launched, and then ‘prefetching’ the necessary code to a single location so that the next time the application is launched, it launches faster. This way, the system doesn’t have to seek across the file system for DLLs and other data that it needs to start the application – it knows where to find it” (Carvey, 2014, p. 98).

### 4.2. Other Log File Types

#### 4.2.1. Linux System Logs

The formatting of logs produced by many applications and services in Linux make importing the data into Excel challenging. The manual massaging of the data is not difficult but must be done in several stages using a variety of tools. Many of the tools originated on the UNIX operating system, but the ones used in this document have all been ported over to Windows. These tools are from the GNU utilities run under the Open Source tools package CYGWIN.

Linux produces several plain text system logs that may have value to the incident response analyst and which all have the same log format. In the supplement, we will look specifically at the Syslog, Auth.log and Cron.log files, but we can use the same techniques against the Daemon.log, Boot.log, Mail.log and other system log files. See <http://www.thegeekstuff.com/2011/08/linux-var-log-files/> for a listing of system logs that may appear on a Linux host.

The syslog daemon handles messages from the entire system to include many of the system logs mentioned above. Depending on the configuration of the logging in the syslog.conf configuration file, the bulk of the message usually are sent to the 'syslog' (often named 'messages') log file. The Auth.log file contains user authentication information, and the Cron logs record the activity of the cron jobs (scheduled tasks) run on the system.

#### **4.2.2. Apache Access and Error Logs**

Another log you may find on a Linux server is the Apache www-access.log file which records connections made from a client to the web services of the system. Web servers are often exploited and could provide the adversary with an initial stepping stone into a network. What gets logged can vary based on the configuration of the web server.

The Apache Error logs contain web server error and resource alerts. The formatting of this log is similarly to the Linux system logs discussed previously. The log should have the dates and delimiters corrected, so each field is in its proper column.

#### **4.2.3. IIS Web and FTP Logs**

The native format of the IIS Web log allows for easy importing of data into Excel. However, the scattering of headers throughout a log file presents the only real issue. By filtering on the Date/Time column for entries that are not in the Date/Time format, the extra headings can be found and removed.

#### **4.2.4. IPTables Firewall Logs**

Scrutinizing network traffic when combined with other types of artifacts may also be beneficial to your investigation by identifying communications associated with the event and adding those IP addresses to your keywords for further examination.

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IPTables and most other firewalls will produce logs that can be exported and examined. IPTables is run on Unix/Linux systems and has logs similar in format to the Linux system logs discussed earlier in this paper. Therefore, the same steps are used to fix the dates and set the delineation of the fields.

#### **4.2.5. Packet Captures**

Packet Captures can be included as well into the analysis of the incident. For the packets to get formatted correctly when exported, the columns in Wireshark need to be changed to produce the results desired.

#### **4.2.6. Snort and Bro IDS Logs**

Host-based and network-based IDS logs are critical to incorporate into the analysis as it may be the primary reason you are aware of the intrusion in the first place. These logs usually contain data from the best vantage point, either from the network or host perspective.

Snort is an open source product that “supports sending real-time alerts when an intrusion event is detected and can even be used as an inline ‘intrusion prevention system’ that enables you to receive alerts in real time and in several different medium, rather than having to continuously sit at a desk monitoring your Snort system 24 hours a day” (Caswell, 2007, ch. 2).

The supplement will look at the logs produced by running snort in Fast alert mode which “writes the alert in a simple format with a timestamp, alert message, source and destination IPs/ports” (Roesch, 2003).

Bro is another open source intrusion detection system. “Bro inspects all traffic flowing into and out of a network. It can operate in passive mode, in which it generates alerts for suspicious activity, or in active mode, in which it injects traffic to disrupt malicious activity ... Unlike other NIDSs, Bro monitors traffic flows rather than just matching patterns inside individual packets. This method of operation means that Bro can detect suspicious activity based on who talks to whom, even without matching any particular string or pattern” (Nemeth, 2010, ch. 22). Bro produces several logs, each of which can use the technique described in the supplement to achieve our standard layout.

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Here are some of the logs Bro generates: Conn, DHCP, DNS, Files, HTTP, Weird, etc. The supplement will examine the Bro Connect log (conn.log) which records TCP, UDP and ICMP connections.

## 5. Case Study

### 5.1. SANS Stark Research Labs

The techniques for extracting and importing the relevant log files in this Case Study are shown in Appendix D. Macros to automate the manipulation of the data are listed in Appendix C. The application of these tools and techniques will be demonstrated by examining an incident presented in the SANS Forensic 508 Advanced Computer Forensic Analysis and Incident Response exercise workbook titled ‘Stark Research Labs Intrusion.’ The scenario describes how a company received a phone call on April 06, 2012 @ 5 PM EDT from a 3-4 letter government agency stating “We have seen a few hundred megabytes of sensitive data leave your network bound for a foreign country. Don’t ask how we know, but you might want to check 10.3.58.7 on your network” (Lee, 2014, ex. 0 p. 2).

Given other information about the company and its assets, a preliminary keyword list is compiled by the incident response team to include the following terms: hydra, star fury, agents, secret and formula. When discussing log files and artifacts below, you can assume that the files have already been imported into Excel with the standard format.

#### 5.1.1. WinXP-TDugan (WKS-WINXP32BIT)

The host reported as leaking data (IP address of 10.3.58.7) is a machine running Windows XP. Since data appears to be actively leaving the host, the first step would be to see what applications have been running on the system. There are two artifacts made available to us that can show what was running on the workstation. The first is the Prefetch files. Applying our initial keyword list against the output gives us one hit on HYDRAKATZ.EXE. The name of the file is similar to Mimikatz, which is a post exploitation tool to capture user credentials. We will flag this suspicious executable by giving the hit a ‘Named Cell’ of ‘HYDRAKATZ\_1’ and highlighting the row in yellow (Figure 11).

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	A	B	C	D	E	F	G	H
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
23	04/02/2012 22:24:04	N/A	TDUNGAN	HELPER.EXE-0415776D.pf	HELPER.EXE	Number of Time Run: 1		Prefetch Entry
24	04/03/2012 00:33:17	N/A	TDUNGAN	PKXEZY1TJI98.EXE-0BCBF29B.pf	PKXEZY1TJI98.EXE	Number of Time Run: 1		Prefetch Entry
25	04/03/2012 01:03:30	N/A	TDUNGAN	FIREFOX.EXE-28641590.pf	FIREFOX.EXE	Number of Time Run: 17		Prefetch Entry
26	04/03/2012 01:05:20	N/A	TDUNGAN	PLUGIN-CONTAINER.EXE-15EDC9DD.pf	PLUGIN-CONTAINER.EXE	Number of Time Run: 4		Prefetch Entry
27	04/03/2012 14:44:02	N/A	TDUNGAN	SLLAUNCHER.EXE-0E3D1802.pf	SLLAUNCHER.EXE	Number of Time Run: 18		Prefetch Entry
28	04/03/2012 16:07:49	N/A	TDUNGAN	FTP.EXE-0FFF85A3.pf	FTP.EXE	Number of Time Run: 1		Prefetch Entry
29	04/03/2012 17:15:10	N/A	TDUNGAN	HYVY.EXE-2A94EF14.pf	HYVY.EXE	Number of Time Run: 5		Prefetch Entry
30	04/03/2012 18:22:55	N/A	TDUNGAN	RUNDLL32.EXE-2576181F.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry
31	04/03/2012 18:22:59	N/A	TDUNGAN	SSSTARS.SCR-2D6FC20D.pf	SSSTARS.SCR	Number of Time Run: 1		Prefetch Entry
32	04/03/2012 23:30:35	N/A	TDUNGAN	HYDRAKATZ.EXE-27B49502.pf	HYDRAKATZ.EXE	Number of Time Run: 4		Prefetch Entry
33	04/04/2012 03:31:07	N/A	TDUNGAN	RUNDLL32.EXE-48E48F0A.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry
34	04/04/2012 12:16:00	N/A	TDUNGAN	MSFEEDSSYNC.EXE-25E13438.pf	MSFEEDSSYNC.EXE	Number of Time Run: 242		Prefetch Entry
35	04/04/2012 12:22:40	N/A	TDUNGAN	A.EXE-0F3A0E12.pf	A.EXE	Number of Time Run: 67		Prefetch Entry
36	04/04/2012 12:22:56	N/A	TDUNGAN	RUNDLL32.EXE-13CC3015.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry
37	04/04/2012 17:22:57	N/A	TDUNGAN	RUNDLL32.EXE-2CC11B9D.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry

Figure 11. Named Cell and Highlight keyword hits. (Lee, 2014, digital case files)

This keyword hit also gives us an initial timeframe of the incident. The file Hydrakatz ran on 04/03/2012, and a notification was sent to the company regarding a data leak on 04/06/2012. Looking at the Prefetch entries around that timeframe gives us additional clues. Right around hydrakatz.exe, there is a file that appears to be a randomly generated name, PKXEZY1TJI98.EXE; two files with unusual names, HYVY.EXE and A.EXE; and the execution of FTP.EXE. These are all ‘Named’ and highlighted (Figure 12).

	A	B	C	D	E	F	G	H
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
24	04/03/2012 00:33:17	N/A	TDUNGAN	PKXEZY1TJI98.EXE-0BCBF29B.pf	PKXEZY1TJI98.EXE	Number of Time Run: 1		Prefetch Entry
25	04/03/2012 01:03:30	N/A	TDUNGAN	FIREFOX.EXE-28641590.pf	FIREFOX.EXE	Number of Time Run: 17		Prefetch Entry
26	04/03/2012 01:05:20	N/A	TDUNGAN	PLUGIN-CONTAINER.EXE-15EDC9DD.pf	PLUGIN-CONTAINER.EXE	Number of Time Run: 4		Prefetch Entry
27	04/03/2012 14:44:02	N/A	TDUNGAN	SLLAUNCHER.EXE-0E3D1802.pf	SLLAUNCHER.EXE	Number of Time Run: 18		Prefetch Entry
28	04/03/2012 16:07:49	N/A	TDUNGAN	FTP.EXE-0FFF85A3.pf	FTP.EXE	Number of Time Run: 1		Prefetch Entry
29	04/03/2012 17:15:10	N/A	TDUNGAN	HYVY.EXE-2A94EF14.pf	HYVY.EXE	Number of Time Run: 5		Prefetch Entry
30	04/03/2012 18:22:55	N/A	TDUNGAN	RUNDLL32.EXE-2576181F.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry
31	04/03/2012 18:22:59	N/A	TDUNGAN	SSSTARS.SCR-2D6FC20D.pf	SSSTARS.SCR	Number of Time Run: 1		Prefetch Entry
32	04/03/2012 23:30:35	N/A	TDUNGAN	HYDRAKATZ.EXE-27B49502.pf	HYDRAKATZ.EXE	Number of Time Run: 4		Prefetch Entry
33	04/04/2012 03:31:07	N/A	TDUNGAN	RUNDLL32.EXE-48E48F0A.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry
34	04/04/2012 12:16:00	N/A	TDUNGAN	MSFEEDSSYNC.EXE-25E13438.pf	MSFEEDSSYNC.EXE	Number of Time Run: 242		Prefetch Entry
35	04/04/2012 12:22:40	N/A	TDUNGAN	A.EXE-0F3A0E12.pf	A.EXE	Number of Time Run: 67		Prefetch Entry
36	04/04/2012 12:22:56	N/A	TDUNGAN	RUNDLL32.EXE-13CC3015.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry
37	04/04/2012 12:22:57	N/A	TDUNGAN	RUNDLL32.EXE-2CC11B9D.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry
38	04/04/2012 17:22:57	N/A	TDUNGAN	RUNDLL32.EXE-470F11B9D.pf	RUNDLL32.EXE	Number of Time Run: 1		Prefetch Entry

Figure 12. Unusual File Names. (Lee, 2014, digital case files)

Looking within the timeframe, we see activities that suggest the adversary ran commands on the system (Figure 13). There is also another suspicious file named PE.EXE. These are all ‘Named’ and highlighted as well (Figure 13).

Microsoft Office UserMicrosoft Office UserGreg Lalla, greg.lalla@mail.comMicrosoft Office User



	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
35	04/04/2012 12:22:40	N/A	TDUNGAN	A.EXE-0F3A0E12.pf	A.EXE	Number of Time Run: 67		Prefetch Entry
41	04/04/2012 14:01:32	N/A	TDUNGAN	A.EXE-0FBE37C1.pf	A.EXE	Number of Time Run: 390		Prefetch Entry
58	04/04/2012 18:05:29	N/A	TDUNGAN	WMIC.EXE-3B772CC6.pf	WMIC.EXE	Number of Time Run: 6		Prefetch Entry
59	04/05/2012 13:28:01	N/A	TDUNGAN	A.EXE-2E0C27A0.pf	A.EXE	Number of Time Run: 490		Prefetch Entry
60	04/05/2012 14:18:24	N/A	TDUNGAN	FIND.EXE-0EC32F1E.pf	FIND.EXE	Number of Time Run: 1		Prefetch Entry
67	04/05/2012 17:12:12	N/A	TDUNGAN	IPCONFIG.EXE-2395F30B.pf	IPCONFIG.EXE	Number of Time Run: 4		Prefetch Entry
68	04/05/2012 17:38:21	N/A	TDUNGAN	REG.EXE-0D2A95F7.pf	REG.EXE	Number of Time Run: 16		Prefetch Entry
69	04/05/2012 17:44:17	N/A	TDUNGAN	NETL.EXE-029B9DB4.pf	NETL.EXE	Number of Time Run: 23		Prefetch Entry
70	04/05/2012 17:46:11	N/A	TDUNGAN	TASKLIST.EXE-10D94B23.pf	TASKLIST.EXE	Number of Time Run: 8		Prefetch Entry
78	04/06/2012 18:55:35	N/A	TDUNGAN	AT.EXE-2770DD18.pf	AT.EXE	Number of Time Run: 14		Prefetch Entry
103	04/06/2012 19:20:22	N/A	TDUNGAN	CMD.EXE-087B4001.pf	CMD.EXE	Number of Time Run: 60		Prefetch Entry
104	04/06/2012 19:21:27	N/A	TDUNGAN	NET.EXE-01A53C2F.pf	NET.EXE	Number of Time Run: 66		Prefetch Entry
105	04/06/2012 19:22:20	N/A	TDUNGAN	PE.EXE-0DC593C2.pf	PE.EXE	Number of Time Run: 30		Prefetch Entry
112	04/07/2012 01:23:52	N/A	TDUNGAN	A.EXE-239305EA.pf	A.EXE	Number of Time Run: 174		Prefetch Entry

Figure 13. Suspicious activity. (Lee, 2014, digital case files)

The keyword lists should contain the newly found keywords identified in the Prefetch output. As new ones get found, those will be added as well to help locate other indicators of compromise. The second artifact containing the execution of files is the ShimCache entries from the registry.

Running the keywords against the ShimCache artifacts produced one hit on file PE.EXE. Though the dates of the artifact don't show the time of execution, executables with the same write timestamp may be related. In this output, there is another executable, located in a strange location, which has the same timestamp as PE.EXE. Normally svchost.exe will reside in C:\Windows\System32. Its location in C:\Windows\System32\dlldhost, makes it suspicious. Since the legitimate svchost.exe file shows up in a lot of logs, the keyword for this IOC will be 'dlldhost'. Both entries are 'Named' and highlighted (Figure 14).

	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
29	04/14/2008 00:12:11	N/A	TDUNGAN	User ShimCache Entry C:\WINDOWS\system32\zipfldr.dll		Executed: N/A		ShimCache
30	04/14/2008 00:12:17	N/A	TDUNGAN	User ShimCache Entry C:\WINDOWS\system32\dmrremote.exe		Executed: N/A		ShimCache
31	04/14/2008 00:12:17	N/A	TDUNGAN	User ShimCache Entry C:\WINDOWS\system32\dmadmin.exe		Executed: N/A		ShimCache
32	04/14/2008 00:12:34	N/A	TDUNGAN	User ShimCache Entry C:\Program Files\Outlook Express\setup50.exe		Executed: N/A		ShimCache
33	04/14/2008 00:12:36	N/A	TDUNGAN	User ShimCache Entry C:\WINDOWS\system32\dlldhost\svchost.exe		Executed: N/A		ShimCache
34	04/14/2008 00:12:36	N/A	TDUNGAN	User ShimCache Entry C:\WINDOWS\system32\pe.exe		Executed: N/A		ShimCache
35	04/14/2008 00:12:38	N/A	TDUNGAN	User ShimCache Entry C:\WINDOWS\system32\verclsid.exe		Executed: N/A		ShimCache

Figure 14. Identical Timestamps. (Lee, 2014, digital case files)

Next, we'll look at the MFT file. After running our keywords against this file's output, we can now see the full paths of the suspicious artifacts (Figure 15).

	A	B	C	D	E	F
	Date/Time	Accd	Compute	Description	Details	Properties
50030	04/03/2012 00:33:15	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Temp\pkxezy1tj98.exe	Std Info - Create: 04/03/2012 00:33:15
50070	04/03/2012 01:03:04	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Temp\pkxezy1tj98.exe	Std Info - Create: 04/03/2012 01:03:04
50604	04/03/2012 15:19:50	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\hydrakatz.exe	Std Info - Create: 03/31/2003 12:00:00
50605	04/03/2012 15:26:01	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\pe.exe	Std Info - Create: 03/31/2003 12:00:00
50616	04/03/2012 16:30:02	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\hyvy.exe	Std Info - Create: 03/31/2003 12:00:00
50617	04/03/2012 16:30:02	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\hyvy.exe:Zone.Identifier	Std Info - Create: 03/31/2003 12:00:00
50714	04/03/2012 20:43:44	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Temp\pkxezy1tj98.exe	Std Info - Create: 04/03/2012 20:43:44
50953	04/04/2012 12:26:24	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Temp\pkxezy1tj98.exe	Std Info - Create: 04/04/2012 12:26:24
51200	04/04/2012 16:41:47	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Temp\pkxezy1tj98.exe	Std Info - Create: 04/04/2012 16:41:47
52211						

Figure 15. Paths of suspicious files are displayed. (Lee, 2014, digital case files)

When looking at the keyword hits, you'll notice that they often appear in clusters. Looking at one of the clusters, we see a new artifact named SEKURLSA.DLL in the middle of several suspicious executables (Figure 16). Googling this file name shows us that it belongs to the Mimikatz tool mentioned previously. This discovery substantiates our guess that file hydrakatz.exe is Mimikatz in disguise. Therefore, we'll add Sekurlsa.dll to our keyword list.

FILEHOMEINSERTPAGE LAYOUTFORMULASDATAREVIEWVIEW

sekurlsa\_1 : C:\WINDOWS\system32\sekurlsa.dll

1A B C D E

	Date/Time	Accd	Compute	Description	Details	Properties
50604	04/03/2012 15:19:50	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\hydrakatz.exe	Std Info - Create: 03/31/2003 12:00:00
50605	04/03/2012 15:26:01	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\pe.exe	Std Info - Create: 03/31/2003 12:00:00
50606	04/03/2012 15:30:13	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\sekurlsa.dll	Std Info - Create: 03/31/2003 12:00:00
50607	04/03/2012 15:33:20	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\Prefetch\HYDRAKATZ.EXE-27B49502.pf	Std Info - Create: 04/03/2012 15:33:20
50608	04/03/2012 15:40:31	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\Prefetch\NET.EXE-01A53C2F.pf	Std Info - Create: 04/03/2012 15:40:31
50609	04/03/2012 15:40:31	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\Prefetch\NET1.EXE-029B9DB4.pf	Std Info - Create: 04/03/2012 15:40:31
50610	04/03/2012 16:02:15	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\Prefetch\HYVY.EXE-2A94EF14.pf	Std Info - Create: 04/03/2012 16:02:15
50611	04/03/2012 16:06:55	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Application Data\Skype\phoned.xml	Std Info - Create: 08/25/2011 21:55:40
50612	04/03/2012 16:08:00	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\Prefetch\FTP.EXE-0FFB5A3.pf	Std Info - Create: 04/03/2012 16:08:00
50613	04/03/2012 16:09:29	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Application Data\Mozilla\Std Info - Create: 04/03/2012 16:09:29	
50614	04/03/2012 16:09:29	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Application Data\Mozilla\Std Info - Create: 04/03/2012 16:09:29	
50615	04/03/2012 16:29:56	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Application Data\Dropbox\shell.txt\Std Info - Create: 04/03/2012 16:29:56	
50616	04/03/2012 16:30:02	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\hyvy.exe	Std Info - Create: 03/31/2003 12:00:00
50617	04/03/2012 16:30:02	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\hyvy.exe:Zone.Identifier	Std Info - Create: 03/31/2003 12:00:00
50618	04/03/2012 16:39:28	N/A	TDUNGAN	Create Date (FN Info)	C:\Documents and Settings\tdungan\Local Settings\Application Data\Mozilla\Std Info - Create: 04/03/2012 16:39:28	

MFT\_Tdungan

Suspicious File in Keyword Grouping

Figure 16. Mimikatz .dll file. (Lee, 2014, digital case files)

Finally, it is easy to filter the data on a particular path to see if there are any other files of interest in the same directories. Looking at c:\windows\system32\dllhost\, we find the file WINCLIENT.REG, which we'll add to the keyword list (Figure 17).

	Date/Time	Account	Computer	Description	Details	Properties
50034	04/03/2012 00:34:26	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\dlhost	Std Info - Create: 04/03/2012 00:34:26
50035	04/03/2012 00:35:03	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\dlhost\svchost.exe	Std Info - Create: 03/31/2003 12:00:00
50036	04/03/2012 00:35:10	N/A	TDUNGAN	Create Date (FN Info)	C:\WINDOWS\system32\dlhost\winclient.reg	Std Info - Create: 04/03/2012 00:35:10

Figure 17. Winclient artifact. (Lee, 2014, digital case files)

Using the keywords or IOCs discovered so far, we can start to look for other compromised systems on the network.

### 5.1.2. Win7-32-NROMANOFF (WKS-WIN732BITA)

Running our keyword list against workstation WKS-WIN732BITA (10.3.58.7) prefetch files generates hits on A.EXE and HYDRAKATX.EXE. Within the intrusion timeframe established earlier, we see the adversary possibly using native Windows tools to explore the host and network (Figure 18).

	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
17	04/03/2012 21:50:44	N/A	NROMANOFF	WMIC.EXE-B77E8CD6.pf	WMIC.EXE	Number of Time Run: 2		Prefetch
22	04/03/2012 23:10:02	N/A	NROMANOFF	NETSTAT.EXE-6D34D712.pf	NETSTAT.EXE	Number of Time Run: 3		Prefetch
25	04/04/2012 00:43:06	N/A	NROMANOFF	A.EXE-8D56B1C4.pf	A.EXE	Number of Time Run: 26		Prefetch
26	04/04/2012 01:52:26	N/A	NROMANOFF	SC.EXE-BC6DAF49.pf	SC.EXE	Number of Time Run: 12		Prefetch
27	04/04/2012 01:55:42	N/A	NROMANOFF	REG.EXE-26976709.pf	REG.EXE	Number of Time Run: 9		Prefetch
62	04/04/2012 15:48:46	N/A	NROMANOFF	TASKLIST.EXE-9811F41E.pf	TASKLIST.EXE	Number of Time Run: 1		Prefetch
79	04/05/2012 13:20:48	N/A	NROMANOFF	HYDRAKATZ.EXE-A0DADA85.pf	HYDRAKATZ.EXE	Number of Time Run: 2		Prefetch
80	04/05/2012 13:24:24	N/A	NROMANOFF	IPCONFIG.EXE-62724FE6.pf	IPCONFIG.EXE	Number of Time Run: 6		Prefetch
84	04/06/2012 13:25:06	N/A	NROMANOFF	NET1.EXE-B8A8247B.pf	NET1.EXE	Number of Time Run: 9		Prefetch
85	04/06/2012 13:41:09	N/A	NROMANOFF	AT.EXE-E3131BD4.pf	AT.EXE	Number of Time Run: 9		Prefetch
86	04/06/2012 14:03:14	N/A	NROMANOFF	NET.EXE-1DF3A2F6.pf	NET.EXE	Number of Time Run: 14		Prefetch
87	04/06/2012 19:00:47	N/A	NROMANOFF	CMD.EXE-89305D47.pf	CMD.EXE	Number of Time Run: 25		Prefetch
88	04/06/2012 19:00:55	N/A	NROMANOFF	PING.EXE-B29F6629.pf	PING.EXE	Number of Time Run: 14		Prefetch
121	04/07/2012 16:22:10	N/A	NROMANOFF	A.EXE-F91CBA0E.pf	A.EXE	Number of Time Run: 1541		Prefetch

Figure 18. Possible native Windows tools used by the adversary. (Lee, 2014, digital case files)

Executing one after the other are two suspicious files with randomly generated names (Figure 19).

	A	B	C	D	E	F	G	H
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
5	03/26/2012 04:00:00	N/A		NROMANOFF WSQMCONS.EXE-E2CE6542.pf	WSQMCONS.EXE	Number of Time Run: 1		Prefetch
6	03/29/2012 22:44:42	N/A		NROMANOFF NAPRDMGR.EXE-55F08014.pf	NAPRDMGR.EXE	Number of Time Run: 2		Prefetch
7	03/31/2012 17:18:51	N/A		NROMANOFF SCRNSAVE.SCR-225A7D32.pf	SCRNSAVE.SCR	Number of Time Run: 12		Prefetch
8	04/01/2012 05:00:02	N/A		NROMANOFF SDIAGNHOST.EXE-67CD1457.pf	SDIAGNHOST.EXE	Number of Time Run: 2		Prefetch
9	04/01/2012 05:00:38	N/A		NROMANOFF CSC.EXE-4EF173D0.pf	CSC.EXE	Number of Time Run: 4		Prefetch
10	04/01/2012 05:00:38	N/A		NROMANOFF CVTRES.EXE-419E4E46.pf	CVTRES.EXE	Number of Time Run: 4		Prefetch
11	04/01/2012 14:17:38	N/A		NROMANOFF ACORD32.EXE-33939BD1.pf	ACORD32.EXE	Number of Time Run: 4		Prefetch
12	04/03/2012 20:38:05	N/A		NROMANOFF MMC.EXE-2E157AE5.pf	MMC.EXE	Number of Time Run: 1		Prefetch
13	04/03/2012 21:03:30	N/A		NROMANOFF TOPLZAGU.EXE-4EFD8FD3.pf	TOPLZAGU.EXE	Number of Time Run: 1		Prefetch
14	04/03/2012 21:18:21	N/A		NROMANOFF OSCMPGPK.EXE-DDCC6901.pf	OSCMPGPK.EXE	Number of Time Run: 1		Prefetch
15	04/03/2012 21:18:21	N/A		NROMANOFF RUNDLL32.EXE-6706170E.pf	RUNDLL32.EXE	Number of Time Run: 2		Prefetch

Figure 19. Randomly generated file names. (Lee, 2014, digital case files)

Finally, there is a well-known artifact associated with the remote administrative command tool named PSEXEC by Microsoft. Administrators of the system could have used this tool to manage the system, but since it appears in our timeframe and may be an indication of lateral movement of the adversary, the keyword PSEXEC will be added to our list to spot the 'Client' executable of PSEXEC.EXE and the 'Service' executable of PSEXESRV.EXE. Right below PSEXESRV.EXE is another artifact observed on workstation WKS-WINXP32BIT (but not noted), named SPINLOCK.EXE. Since this executable was run two minutes after PSEXEC and since the name of the file is not familiar to us, it will be added to the keyword list as well (Figure 20).

	A	B	C	D	E	F	G	H
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
62	04/04/2012 15:48:46	N/A		NROMANOFF TASKLIST.EXE-9811F41E.pf	TASKLIST.EXE	Number of Time Run: 1		Prefetch
63	04/04/2012 18:51:15	N/A		NROMANOFF SVCHOST.EXE-CD257EB2.pf	SVCHOST.EXE	Number of Time Run: 1		Prefetch
64	04/04/2012 18:52:11	N/A		NROMANOFF PSEXESVC.EXE-51BA46F2.pf	PSEXESVC.EXE	Number of Time Run: 9		Prefetch
65	04/04/2012 18:54:51	N/A		NROMANOFF SPINLOCK.EXE-1610A75A.pf	SPINLOCK.EXE	Number of Time Run: 16		Prefetch
66	04/04/2012 19:40:29	N/A		NROMANOFF FIRETRAY.EXE-83604477.pf	FIRETRAY.EXE	Number of Time Run: 3		Prefetch

Figure 20. The keyword list has two more files added to it. (Lee, 2014, digital case files)

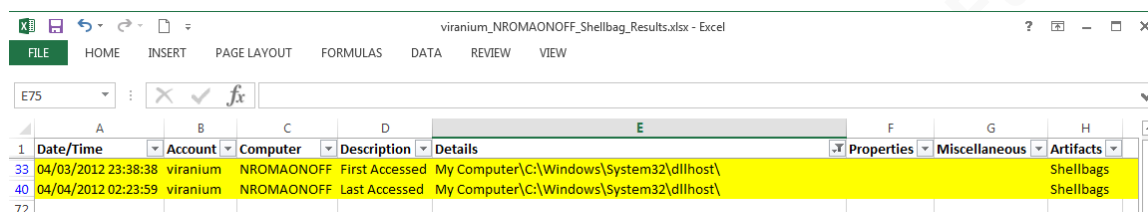
Keywords run against the Autoruns output gives us two hits. One on PSEXESRV.EXE and one for C:\Windows\System32\dlh\host\svchost.exe (Figure 21).

	A	B	C	D	E	F	G
	Date	Acc	Computer	Description	Details	Properties	Miscellaneous
194	N/A	N/A		NROMANOFF HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run - svchost		c:\windows\system32\dlh\host\svchost.exe	Launch String: c:\windows
485	N/A	N/A		NROMANOFF HKLM\System\CurrentControlSet\Services - PSEXESVC	PsExec Service	c:\windows\psexesvc.exe	Launch String: %SystemRo

Figure 21. Two keyword hits on Autorun entries. (Lee, 2014, digital case files)

Microsoft Office User  
Microsoft Office User  
Greg Lalla, greg.lalla@mail.com  
Microsoft Office User

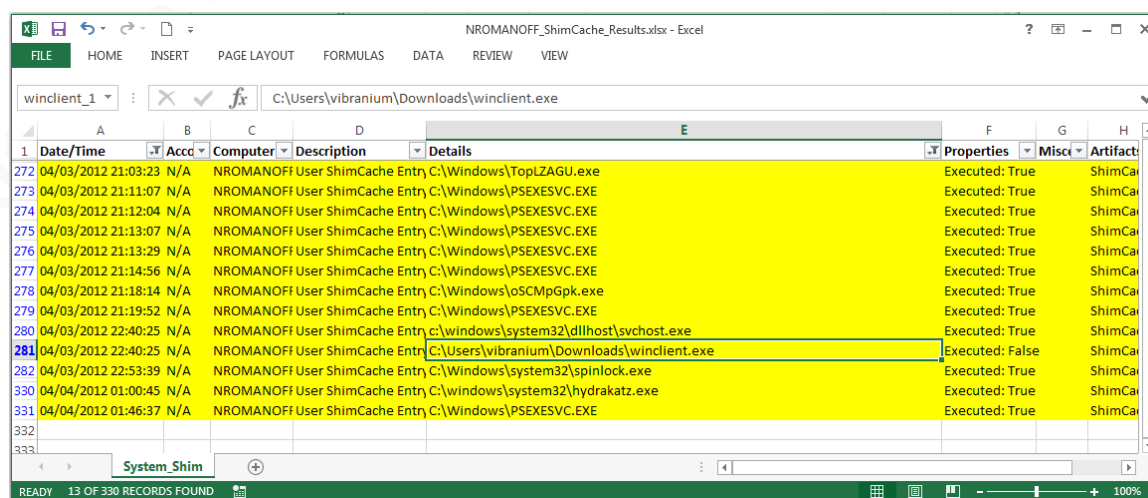
We find two additional hits when examining the Shellbag entries of user Vibranium (Figure 22).



	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
33	04/03/2012 23:38:38	vibranium	NROMANOFF	First Accessed	My Computer\C:\Windows\System32\dlhhost\			Shellbags
40	04/04/2012 02:23:59	vibranium	NROMANOFF	Last Accessed	My Computer\C:\Windows\System32\dlhhost\			Shellbags

Figure 22. Shellbag keyword hits. (Lee, 2014, digital case files)

Running the keywords against the ShimCache entries yields several interesting artifacts. First, we see that C:\Windows\Temp\a.exe is executed 47 times in one hour. Next, we find an entry with a file name from our keyword list, but with a different file extension. Recall that we saw a suspicious file called WINCLIENT.REG. The keyword list contained only the word WINCLIENT as the search term. This shortened keyword produced a hit on WINCLIENT.EXE which we found in user Vibranium's download folder (Figure 23). This user account is the same one seen above accessing the C:\Windows\System32\dlhhost\ directory which contained the WINCLIENT.REG file from before.



	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
272	04/03/2012 21:03:23	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\TopLZAGU.exe	Executed: True		ShimCa
273	04/03/2012 21:11:07	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
274	04/03/2012 21:12:04	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
275	04/03/2012 21:13:07	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
276	04/03/2012 21:13:29	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
277	04/03/2012 21:14:56	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
278	04/03/2012 21:18:14	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\oSCMPGpk.exe	Executed: True		ShimCa
279	04/03/2012 21:19:52	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
280	04/03/2012 22:40:25	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\system32\dlhhost\svchost.exe	Executed: True		ShimCa
281	04/03/2012 22:40:25	N/A	NROMANOFF	User ShimCache Entry	C:\Users\vibranium\Downloads\winclient.exe	Executed: False		ShimCa
282	04/03/2012 22:53:39	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\system32\spinlock.exe	Executed: True		ShimCa
330	04/04/2012 01:00:45	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\system32\hydrakatz.exe	Executed: True		ShimCa
331	04/04/2012 01:46:37	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa

Figure 23. Winclient keyword hit. (Lee, 2014, digital case files)

Last, every entry from 04/03/2012 onward is a hit, except three files. Looking at these three files, they appear suspicious and are flagged (Figure 24).

**Suspicious Entries in Time Frame**

Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
04/03/2012 21:36:21	N/A	NROMANOFF	User ShimCache Entry	C:\Users\NROMANOFF\AppData\Local\Temp\AIR4C32.tmp\Adobe AIR Installer.exe	Executed: True		ShimCa
04/03/2012 18:08:50	N/A	NROMANOFF	User ShimCache Entry	C:\\$Recycle.Bin\S-1-5-21-2036804247-3058324640-2116585241-1673\\$\RR3GW21.exe	Executed: False		ShimCa
04/03/2012 18:08:50	N/A	NROMANOFF	User ShimCache Entry	C:\dllhot.exe	Executed: True		ShimCa
04/03/2012 18:08:50	N/A	NROMANOFF	User ShimCache Entry	C:\dllhost.exe	Executed: True		ShimCa
04/03/2012 21:03:23	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\TopLZAGU.exe	Executed: True		ShimCa
04/03/2012 21:11:07	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
04/03/2012 21:12:04	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
04/03/2012 21:13:07	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
04/03/2012 21:13:29	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
04/03/2012 21:14:56	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
04/03/2012 21:18:14	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\osCmpGpk.exe	Executed: True		ShimCa
04/03/2012 21:19:52	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\PSEXESVC.EXE	Executed: True		ShimCa
04/03/2012 22:40:25	N/A	NROMANOFF	User ShimCache Entry	c:\windows\system32\dllhost\svchost.exe	Executed: True		ShimCa
04/03/2012 22:40:25	N/A	NROMANOFF	User ShimCache Entry	C:\Users\vibranium\Downloads\winclient.exe	Executed: False		ShimCa
04/03/2012 22:53:39	N/A	NROMANOFF	User ShimCache Entry	C:\Windows\system32\spnlock.exe	Executed: True		ShimCa

Figure 24. Suspicious Entries found in the Time Frame. (Lee, 2014, digital case files)

Running the keywords against the MFT file shows us the paths of the artifacts of interest on this system (Figure 25).

Date/Time	Account	Computer	Description	Details	Properties
04/03/2012 21:03:30	N/A	NROMANOFF	Create Date	\Windows\Prefetch\TOPLZAGU.EXE-4EFD8FD3.pf	Std Info - Create: 04/03/2012 21:03:30
04/03/2012 21:11:09	N/A	NROMANOFF	Create Date	\Windows\Prefetch\PSEXESVC.EXE-51BA46F2.pf	Std Info - Create: 04/03/2012 21:11:09
04/03/2012 21:17:57	N/A	NROMANOFF	Create Date	\Windows\osCmpGpk.exe	Std Info - Create: 04/03/2012 21:17:57
04/03/2012 21:18:21	N/A	NROMANOFF	Create Date	\Windows\Prefetch\OSCMGPKE.EXE-DDCC6901.pf	Std Info - Create: 04/03/2012 21:18:21
04/03/2012 22:59:43	N/A	NROMANOFF	Create Date	\Windows\System32\spnlock.exe	Std Info - Create: 04/03/2012 22:59:43
04/03/2012 23:09:17	N/A	NROMANOFF	Create Date	\Users\vibranium\AppData\Local\Temp\_MEI138842\spnlock.exe.manifest	Std Info - Create: 04/03/2012 23:09:17
04/03/2012 23:09:26	N/A	NROMANOFF	Create Date	\Windows\Prefetch\SPINLOCK.EXE-1610A75A.pf	Std Info - Create: 04/03/2012 23:09:26
04/03/2012 23:54:46	N/A	NROMANOFF	Create Date	\Windows\Temp\A.exe	Std Info - Create: 04/03/2012 23:54:46
04/03/2012 23:54:48	N/A	NROMANOFF	Create Date	\Windows\Prefetch\A.EXE-8D56B1C4.pf	Std Info - Create: 04/03/2012 23:54:48
04/04/2012 00:01:45	N/A	NROMANOFF	Create Date	\Users\vibranium\AppData\Local\Temp\_MEI57722\spnlock.exe.manifest	Std Info - Create: 04/04/2012 00:01:45
04/04/2012 00:06:41	N/A	NROMANOFF	Create Date	\Users\vibranium\AppData\Local\Temp\_MEI111242\spnlock.exe.manifest	Std Info - Create: 04/04/2012 00:06:41
04/04/2012 01:00:07	N/A	NROMANOFF	Create Date	\Windows\System32\hydrakatz.exe	Std Info - Create: 04/04/2012 01:00:07
04/04/2012 01:01:15	N/A	NROMANOFF	Create Date	\Windows\System32\pe.exe	Std Info - Create: 04/04/2012 01:01:15
04/04/2012 01:02:10	N/A	NROMANOFF	Create Date	\Windows\System32\sekurlsa.dll	Std Info - Create: 04/04/2012 01:02:10
04/04/2012 01:09:03	N/A	NROMANOFF	Create Date	\Windows\Prefetch\HYDRAKATZ.EXE-ADDAD85.pf	Std Info - Create: 04/04/2012 01:09:03

Figure 25. File paths for keyword hits. (Lee, 2014, digital case files)

Running the keywords against the Application Event Viewer log produced two hits (Figure 26).

Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
04/04/2012 01:18:15	N/A	NROMANOFF	Application Error	c:\windows\system32\dllhost\svchost.exe	Evt ID: 1000   Evt Record #: 6103		Application Event Log
04/04/2012 01:18:15	N/A	NROMANOFF	Application Error	c:\windows\system32\dllhost\svchost.exe	Evt ID: 1000   Evt Record #: 6103		Application Event Log

Figure 26. The keyword hits in the Application Event Viewer log. (Lee, 2014, digital case files)

Microsoft Office UserMicrosoft Office UserGreg Lalla, greg.lalla@mail.comMicrosoft Office User



The Security Event Viewer log has several keywords in it (Figure 27).

1	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
25168	04/03/2012 21:11:08	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4625	Evt Record #: 526080 Sec	
25248	04/03/2012 21:12:07	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4625	Evt Record #: 526086 Sec	
25320	04/03/2012 21:13:08	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4625	Evt Record #: 526092 Sec	
25375	04/03/2012 21:13:29	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4625	Evt Record #: 526097 Sec	
25430	04/03/2012 21:14:56	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4625	Evt Record #: 526102 Sec	
25519	04/03/2012 21:19:53	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4624	Evt Record #: 526111 Sec	
25539	04/03/2012 21:19:53	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4624	Evt Record #: 526110 Sec	
25553	04/03/2012 21:19:53	-	NROMANO	Microsoft-Win C:\Windows\PSEXESVC.EXE		ProcessName Evt ID: 4648	Evt Record #: 526109 Sec	
37730	04/05/2012 05:19:11	-	NROMANO	Microsoft-Win \device\harddiskvolume1\windows\system32\dlhost\svchost.exe		Application Evt ID: 5156	Evt Record #: 527370 Sec	
37743	04/05/2012 05:19:11	-	NROMANO	Microsoft-Win \device\harddiskvolume1\windows\system32\dlhost\svchost.exe		Application Evt ID: 5158	Evt Record #: 527369 Sec	
37751	04/05/2012 05:19:11	-	NROMANO	Microsoft-Win \device\harddiskvolume1\windows\system32\dlhost\svchost.exe		Application Evt ID: 5156	Evt Record #: 527368 Sec	
37764	04/05/2012 05:19:11	-	NROMANO	Microsoft-Win \device\harddiskvolume1\users\vibranium\appdata\local\temp\*.exe		Application Evt ID: 5156	Evt Record #: 527367 Sec	
37777	04/05/2012 05:19:11	-	NROMANO	Microsoft-Win \device\harddiskvolume1\users\vibranium\appdata\local\temp\*.exe		Application Evt ID: 5158	Evt Record #: 527366 Sec	

Figure 27. The keyword hits in the Security Event Viewer log. (Lee, 2014, digital case files)

And finally, the System Event Viewer log has a bunch of hits (Figure 28).

1	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
8882	04/03/2012 21:03:27	S-1-5-21-2036	NROMANO	Service Control	%SYSTEMROOT%\TopLZAGU.exe	Evt ID: 7045	Evt Record #: 14789	Syst
8899	04/03/2012 21:11:07	S-1-5-21-2036	NROMANO	Service Control	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045	Evt Record #: 14794	Syst
8910	04/03/2012 21:12:04	S-1-5-21-2036	NROMANO	Service Control	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045	Evt Record #: 14797	Syst
8924	04/03/2012 21:13:08	S-1-5-21-2036	NROMANO	Service Control	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045	Evt Record #: 14800	Syst
8935	04/03/2012 21:13:29	S-1-5-21-2036	NROMANO	Service Control	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045	Evt Record #: 14803	Syst
8946	04/03/2012 21:14:56	S-1-5-21-2036	NROMANO	Service Control	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045	Evt Record #: 14806	Syst
8952	04/03/2012 21:18:18	S-1-5-21-2036	NROMANO	Service Control	%SYSTEMROOT%\oSCmpGpk.exe	Evt ID: 7045	Evt Record #: 14809	Syst
8966	04/03/2012 21:19:53	S-1-5-21-2036	NROMANO	Service Control	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045	Evt Record #: 14813	Syst
9071	04/03/2012 23:52:47	S-1-5-21-2036	NROMANO	Service Control	c:\windows\system32\cmd.exe /k c:\windows\system32\dlhost\svchost.exe	Evt ID: 7045	Evt Record #: 14848	Syst
9092	04/04/2012 00:07:23	S-1-5-21-2036	NROMANO	USER32	spinlock.exe	Evt ID: 1074	Evt Record #: 14856	Syst
10485	04/04/2012 18:52:11	S-1-5-21-2036	NROMANO	Service Control	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045	Evt Record #: 15316	Syst

Figure 28. The keyword hits in the System Event Viewer log. (Lee, 2014, digital case files)

Examining the Event Viewer logs using Event IDs instead of keywords, also yields some information that was not previously known. Pivoting on Event ID 5156 (“The Windows Filtering Platform has permitted a connection”) shows an outbound connection from one of the suspicious executables to IP address 12.190.135.235 (Figure 29). This address will be added to the keyword list and possibly added to the company’s network devices to log or block any connections still going to this location.

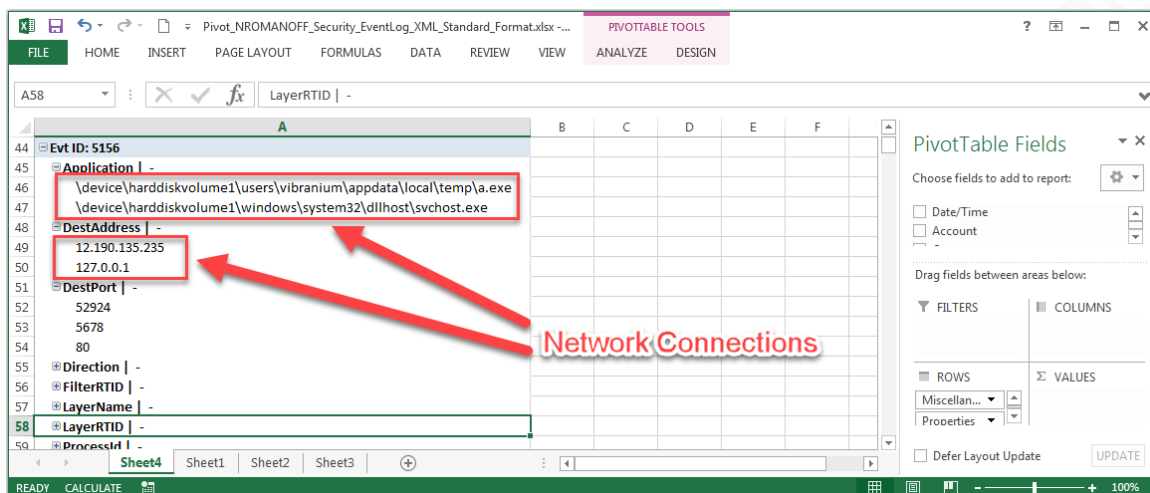


Figure 29. Outbound connection. (Lee, 2014, digital case files)

Examining the Event IDs in the CSV output of the Event Viewer Security log shows us some other activity that could be related to the intrusion. First, we filter on Event ID 4624 (“An account was successfully logged on”) Type 10 (“RemoteInteractive”), which shows us possible lateral movement using the Remote Desktop protocol (Figure 30).

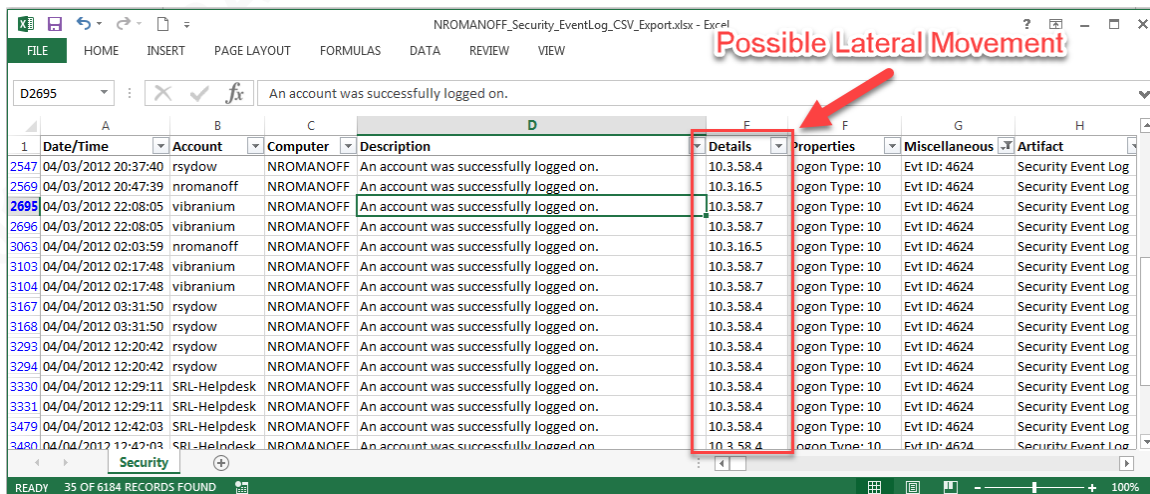


Figure 30. Possible lateral movement. (Lee, 2014, digital case files)

Next, we apply a filter on Event IDs 4717, 4724, 4732, 4733, and 4738. These Event IDs relate to changes made to user accounts. The results of the filter show activity by account RSYDOW against account SRL-Helpdesk (Figure 31).

Microsoft Office UserMicrosoft Office UserGreg Lalla, greg.lalla@mail.comMicrosoft Office User



	A	B	C	D	E	F	G
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous
2531	04/03/2012 20:26:18	rsydow	NROMANOFF	A member was added to a security-enabled local group.	BUILTIN\Administrators	Target Account: SRL-Helpdesk	Evt ID: 4732
2532	04/03/2012 20:26:18	rsydow	NROMANOFF	A member was removed from a security-enabled local group.	BUILTIN\Users	Target Account: SRL-Helpdesk	Evt ID: 4733
2533	04/03/2012 20:26:18	rsydow	NROMANOFF	A member was removed from a security-enabled local group.	BUILTIN\Administrators	Target Account: SRL-Helpdesk	Evt ID: 4733
2561	04/03/2012 20:40:38	SYSTEM	NROMANOFF	System security access was granted to an account.	SeRemoteInteractiveLogon	Target Account: Everyone	Evt ID: 4717
3314	04/04/2012 12:22:15	rsydow	NROMANOFF	An attempt was made to reset an account's password.		Target Account: SRL-Helpdesk	Evt ID: 4724
3315	04/04/2012 12:22:15	rsydow	NROMANOFF	A user account was changed.	Password Last Set: 4/4/2012	Target Account: SRL-Helpdesk	Evt ID: 4738
3466	04/04/2012 12:35:57	rsydow	NROMANOFF	An attempt was made to reset an account's password.		Target Account: SRL-Helpdesk	Evt ID: 4724
3467	04/04/2012 12:35:57	rsydow	NROMANOFF	A user account was changed.	Password Last Set: 4/4/2012	Target Account: SRL-Helpdesk	Evt ID: 4738

Figure 31. User account changes. (Lee, 2014, digital case files)

Finally, examining the System Event Viewer log by Event ID produces several more keywords. The Event ID filtered on is 7045 (“A service was installed in the system”). This filter shows us hits on several suspicious executables that we’ve already seen, but also provides us with unique Service Names of Mys, winsvchost, and MqlXmtLRaYQDMsvljY (Figure 32). We added these three new terms to the keyword list.

FILE

HOME

INSERT

PAGE LAYOUT

FORMULAS

DATA

REVIEW

VIEW

Clipboard

Font

Alignment

Number

General

Conditional Formatting

Table Styles

Cell Styles

Delete

Format

Sort & Filter

Find & Select

F2967

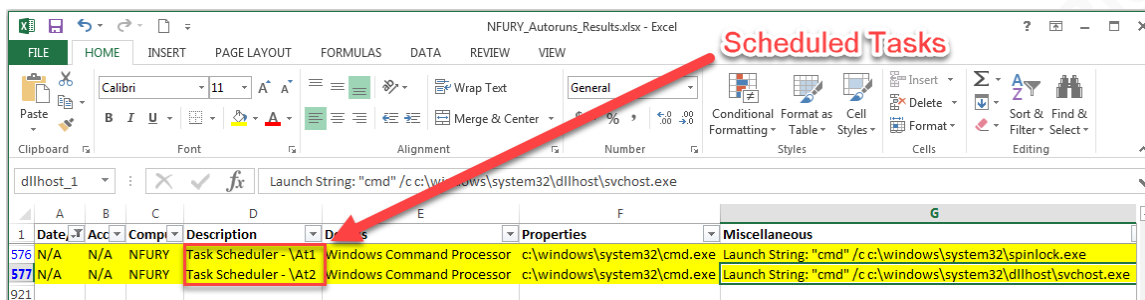
c:\windows\system32\cmd.exe /k c:\windows\system32\dlhost\svchost.exe

Figure 32. The keyword list has Service names added to it. (Lee, 2014, digital case files)

### 5.1.3. Win7-64-NFURRY (WKS-WIN764BITB)

Running our keyword list against workstation WKS-WIN764BITB (10.3.58.6) Autorun entries shows us Scheduled Tasks that run two of the suspicious executables that we have seen on other machines on this network (Figure 33).

Microsoft Office User  
Microsoft Office User  
Greg Lalla, greg.lalla@mail.com  
Microsoft Office User

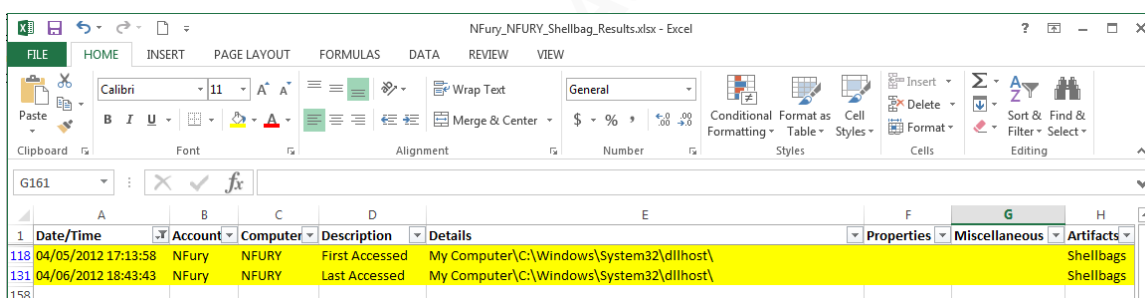


The screenshot shows an Excel spreadsheet titled 'NFURY\_Autoruns\_Results.xlsx'. A red arrow points to the 'Task Scheduler - \AT1' entry in the 'Description' column. The 'Launch String' is 'cmd" /c c:\windows\system32\dlh\svchost.exe'. The 'Properties' column shows 'Launch String: "cmd" /c c:\windows\system32\spinlock.exe' and 'Launch String: "cmd" /c c:\windows\system32\dlh\svchost.exe'.

	Date	Acc	Comp	Description	Details	Properties	Miscellaneous
576	N/A	N/A	NFURY	Task Scheduler - \AT1	Windows Command Processor	c:\windows\system32\cmd.exe	Launch String: "cmd" /c c:\windows\system32\spinlock.exe
577	N/A	N/A	NFURY	Task Scheduler - \AT2	Windows Command Processor	c:\windows\system32\cmd.exe	Launch String: "cmd" /c c:\windows\system32\dlh\svchost.exe

Figure 33. Suspicious scheduled tasks. (Lee, 2014, digital case files)

A search against NFurry's Shellbag entries shows the directory C:\Windows\System32\dlh\ where several suspicious executables reside (Figure 34).

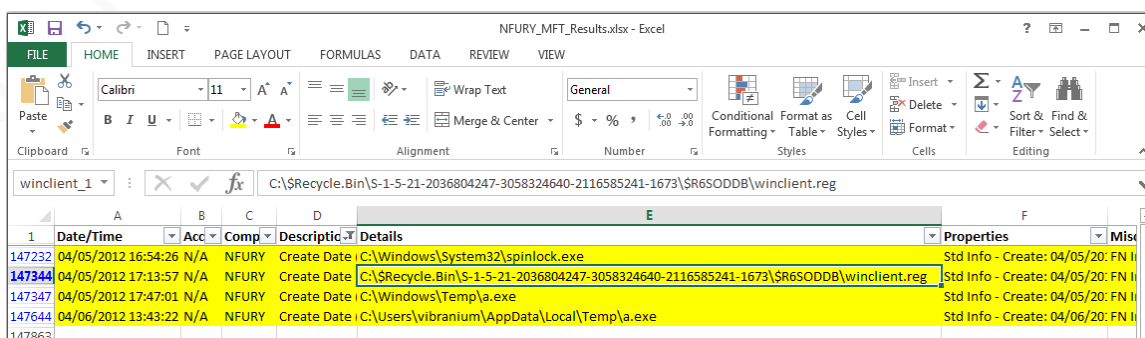


The screenshot shows an Excel spreadsheet titled 'NFury\_NFURY\_Shellbag\_Results.xlsx'. A red arrow points to the 'First Accessed' entry in the 'Description' column. The 'Details' column shows 'My Computer\C:\Windows\System32\dlh\'. The 'Artifacts' column shows 'Shellbags'.

	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
118	04/05/2012 17:13:58	NFury	NFURY	First Accessed	My Computer\C:\Windows\System32\dlh\			Shellbags
131	04/06/2012 18:43:43	NFury	NFURY	Last Accessed	My Computer\C:\Windows\System32\dlh\			Shellbags

Figure 34. Shellbag keyword hits. (Lee, 2014, digital case files)

A keyword search against the MFT entries on the system shows the suspicious WINCLIENT.REG file in a user's Recycle Bin (Figure 35).



The screenshot shows an Excel spreadsheet titled 'NFURY\_MFT\_Results.xlsx'. A red arrow points to the 'Create Date' entry in the 'Description' column. The 'Details' column shows 'C:\\$Recycle.Bin\S-1-5-21-2036804247-3058324640-2116585241-1673\SR6SODDB\winclient.reg'. The 'Properties' column shows 'Std Info - Create: 04/05/20: FN II'.

	Date/Time	Acc	Comp	Description	Details	Properties	Miscellaneous
147232	04/05/2012 16:54:26	N/A	NFURY	Create Date	C:\Windows\System32\spinlock.exe	Std Info - Create: 04/05/20: FN II	
147344	04/05/2012 17:13:57	N/A	NFURY	Create Date	C:\\$Recycle.Bin\S-1-5-21-2036804247-3058324640-2116585241-1673\SR6SODDB\winclient.reg	Std Info - Create: 04/05/20: FN II	
147347	04/05/2012 17:47:01	N/A	NFURY	Create Date	C:\Windows\Temp\*.exe	Std Info - Create: 04/05/20: FN II	
147644	04/06/2012 13:43:22	N/A	NFURY	Create Date	C:\Users\vibranium\AppData\Local\Temp\*.exe	Std Info - Create: 04/06/20: FN II	

Figure 35. Winclient in user's recycle bin. (Lee, 2014, digital case files)

When we look at the Application Event Viewer log, two entries show up for the suspicious SVCHOST.EXE file (Figure 36).

	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
611	04/05/2012 19:30:40	-	NFURY	Application Error	-	c:\windows\system32\dlhost\svchost.exe	Evt ID: 1000   Evt Record #: 7697	Application E
612	04/05/2012 19:30:40	-	NFURY	Application Error	-	c:\windows\system32\dlhost\svchost.exe	Evt ID: 1000   Evt Record #: 7697	Application E

Figure 36. Keyword hits in the Application Event Viewer log. (Lee, 2014, digital case files)

And finally for this host, in the System Event Viewer log, several instances of PSEXEC and PSEXESVC are found running as services (Figure 37).

	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous
3949	04/05/2012 17:03:51	S-1-5-21-2036804247-3058324640-2116585241-1673	NFURY	Service Control Manager	-	PSEXEC	Evt ID: 7045   Evt Record #: 7697
3950	04/05/2012 17:03:51	S-1-5-21-2036804247-3058324640-2116585241-1673	NFURY	Service Control Manager	-	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045   Evt Record #: 7697
3954	04/05/2012 17:03:52	-	NFURY	Service Control Manager	-	PSEXEC	Evt ID: 7036   Evt Record #: 7697
3956	04/05/2012 17:03:52	-	NFURY	Service Control Manager	-	PSEXESVC/4	Evt ID: 7036   Evt Record #: 7697
3957	04/05/2012 17:03:52	-	NFURY	Service Control Manager	-	PSEXEC	Evt ID: 7036   Evt Record #: 7697
3959	04/05/2012 17:03:55	-	NFURY	Service Control Manager	-	PSEXESVC/1	Evt ID: 7036   Evt Record #: 7697
3962	04/05/2012 17:07:15	-	NFURY	Service Control Manager	-	PSEXESVC/4	Evt ID: 7036   Evt Record #: 7697
3963	04/05/2012 17:07:15	S-1-5-21-2036804247-3058324640-2116585241-1673	NFURY	Service Control Manager	-	PSEXEC	Evt ID: 7045   Evt Record #: 7697
3964	04/05/2012 17:07:15	S-1-5-21-2036804247-3058324640-2116585241-1673	NFURY	Service Control Manager	-	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045   Evt Record #: 7697
3971	04/05/2012 17:22:41	-	NFURY	Service Control Manager	-	PSEXEC	Evt ID: 7036   Evt Record #: 7697

Figure 37. Keyword hits in the System Event Viewer log. (Lee, 2014, digital case files)

#### 5.1.4. Win2008R2-Controller (CONTROLLER)

The last host (IP Address 10.3.58.4) examined in this case study is the domain controller. When we look at the Autorun entries, we discover a scheduled task to run SPINLOCK.EXE (Figure 38).

	Date	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
573	N/A	N/A	Controller Task Scheduler	-	At2	Windows Command Processor	c:\windows\system32\cmd.exe	Launch String: "cmd" /c c:\windows\system32\spinlock.exe

Figure 38. Suspicious scheduled task. (Lee, 2014, digital case files)

Examining the MFT log shows PSEXEC and Spinlock on the system (Figure 39).

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Microsoft Office User

	A	B	C	D	E	F
	Date/Time	Account	Computer	Description	Details	Properties
66014	04/27/2010 19:04:06	N/A	CONTROLLER	Create Date	\\Tools\SysInternals\Psexec.exe	Std Info - Create: 04/27/2010 19:04:06
175055	04/04/2012 18:28:42	N/A	CONTROLLER	Create Date	\\ProgramData\Microsoft\Windows\WER\ReportQueue\NonCritical_spinlock.exe	Std Info - Create: 04/04/2012 18:28:42
175056	04/04/2012 18:28:42	N/A	CONTROLLER	Create Date	\\ProgramData\Microsoft\Windows\WER\ReportQueue\NonCritical_spinlock.exe	Std Info - Create: 04/04/2012 18:28:42
175057	04/04/2012 18:28:42	N/A	CONTROLLER	Create Date	\\ProgramData\Microsoft\Windows\WER\ReportQueue\NonCritical_spinlock.exe	Std Info - Create: 04/04/2012 18:28:42
175058	04/04/2012 18:28:42	N/A	CONTROLLER	Create Date	\\ProgramData\Microsoft\Windows\WER\ReportQueue\NonCritical_spinlock.exe	Std Info - Create: 04/04/2012 18:28:42

Figure 39. Keyword hits in MFT file. (Lee, 2014, digital case files)

The Application Event Viewer records the same SPINLOCK.EXE file in Windows Error Reporting (WER) (Figure 40).

	A	B	C	D	E	F	G	H
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
13315	04/04/2012 18:28:42	-	CONTROLLER	Windows Error Reporting	spinlock.exe	-	Evt ID: 1001   Evt Record #: 221250	Application
13317	04/04/2012 18:28:42	-	CONTROLLER	Windows Error Reporting	spinlock.exe	-	Evt ID: 1001   Evt Record #: 221250	Application
13326	04/04/2012 18:28:42	-	CONTROLLER	Windows Error Reporting	C:\ProgramData\Microsoft\Windows\WER\Rej	-	Evt ID: 1001   Evt Record #: 221250	Application
13336	04/04/2012 18:28:42	-	CONTROLLER	Windows Error Reporting	spinlock.exe	-	Evt ID: 1001   Evt Record #: 221249	Application
13338	04/04/2012 18:28:42	-	CONTROLLER	Windows Error Reporting	spinlock.exe	-	Evt ID: 1001   Evt Record #: 221249	Application

Figure 40. Keyword hits in the Application Event Viewer log. (Lee, 2014, digital case files)

The Security Event Viewer log (Figure 41) and the System Event Viewer log (Figure 42), both show the PSEXESVC.EXE service running.

	A	B	C	D	E	F	G	H
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
44908	04/04/2012 18:00:44	-	CONTROLLER	Microsoft-Windows-S C:\Windows\PSEXESVC.EXE	ProcessName	-	Evt ID: 4648   Evt Record #: 12509850	Security Ev
44928	04/04/2012 18:00:44	-	CONTROLLER	Microsoft-Windows-S C:\Windows\PSEXESVC.EXE	ProcessName	-	Evt ID: 4624   Evt Record #: 12509851	Security Ev
44948	04/04/2012 18:00:44	-	CONTROLLER	Microsoft-Windows-S C:\Windows\PSEXESVC.EXE	ProcessName	-	Evt ID: 4624   Evt Record #: 12509852	Security Ev

Figure 41. Keyword hits in the Security Event Viewer log. (Lee, 2014, digital case files)

	A	B	C	D	E	F	G
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous
51903	04/04/2012 17:29:33	-	CONTROLLER	Service Control Manager	-	PsExec   PSEXESVC/4	Evt ID: 7036   Evt Rec
51904	04/04/2012 17:29:33	-	CONTROLLER	Service Control Manager	-	running   PSEXESVC/4	Evt ID: 7036   Evt Rec
51905	04/04/2012 17:29:33	S-1-5-21-2036804247-3058324640-2116585241-1673	CONTROLLER	Service Control Manager	-	PsExec	Evt ID: 7045   Evt Rec
51906	04/04/2012 17:29:33	S-1-5-21-2036804247-3058324640-2116585241-1673	CONTROLLER	Service Control Manager	-	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045   Evt Rec
51910	04/04/2012 17:29:34	-	CONTROLLER	Service Control Manager	-	PsExec   PSEXESVC/1	Evt ID: 7036   Evt Rec
51911	04/04/2012 17:29:34	-	CONTROLLER	Service Control Manager	-	stopped   PSEXESVC/1	Evt ID: 7036   Evt Rec
51920	04/04/2012 17:30:09	-	CONTROLLER	Service Control Manager	-	PsExec   PSEXESVC/4	Evt ID: 7036   Evt Rec
51921	04/04/2012 17:30:09	-	CONTROLLER	Service Control Manager	-	running   PSEXESVC/4	Evt ID: 7036   Evt Rec
51922	04/04/2012 17:30:09	S-1-5-21-2036804247-3058324640-2116585241-1673	CONTROLLER	Service Control Manager	-	PsExec	Evt ID: 7045   Evt Rec
51923	04/04/2012 17:30:09	S-1-5-21-2036804247-3058324640-2116585241-1673	CONTROLLER	Service Control Manager	-	%SystemRoot%\PSEXESVC.EXE	Evt ID: 7045   Evt Rec

Figure 42. Keyword hits in the System Event Viewer log. (Lee, 2014, digital case files)

### 5.1.5. Master IOC Spreadsheet

Taking all the hits found from each of the workstations and combining them into one master spreadsheet allows the responder to see, among other benefits, what the adversary is doing chronologically; what artifacts they used across systems; and what capabilities they deployed. To demonstrate the techniques outlined in this paper, the standard output in the below images have been manipulated to fit the relevant information into the screenshots.

When we look at the timeline of events, the incident appears to have started on 04/03/2012 with the exploitation of host TGUNGAN (WKS-WINXP32BIT), then laterally moving to host NROMANOFF (WKS-WIN732BITA), then on to the Domain Controller (CONTROLLER) and finally to NFURY (WKS-WIN764BITB) (Figure 43).

Stark IOC All Modified.xlsx - Microsoft Excel

Date/Time	Computer	Details	Properties	Artifacts
04/03/2012 00:33:15	TDUNGAN	C:\Documents and Settings\tdungan\Local Settings\Temp\pkxezy1tj98.exe	FN Info - Modify: 04/03/2012 00:33:15, Entry: 04/03/20 MFT Entry	
04/03/2012 00:33:17	TDUNGAN	PKX\TY1TJ98.EXE-0BCBF29B.pf	Number of Time Run: 1	Prefetch Entry
04/03/2012 00:34:26	TDUNGAN	C:\WINDOWS\system32\dlhost	FN Info - Modify: 04/03/2012 00:34:26, Entry: 04/03/20 MFT Entry	
04/03/2012 18:08:50	NROMANOFF	C:\\$Recycle.Bin\S-1-5-21-2036804247-3058324640-2116585241-1673\SR65ODDB\winclient.reg	Executed: False	ShimCache
04/03/2012 18:08:50	NROMANOFF	C:\dlhost.exe	Executed: True	ShimCache
04/03/2012 18:08:50	NROMANOFF	C:\dlhost.exe	Executed: True	ShimCache
04/03/2012 20:26:18	NROMANOFF	A member was added to security-enabled local group.	BUILTIN\Administrators	Security Event Log
04/04/2012 18:00:44	CONTROLLER	C:\Windows\PSEXESVC.EXE	ProcessName	Security Event Log
04/04/2012 18:28:42	CONTROLLER	spinlock.exe	Windows Error Reporting	Application Event
04/05/2012 16:54:26	NFURY	C:\Windows\System32\spinlock.exe	FN Info - Modify: 04/05/2012 16:54:26, Entry: 04/05/20 MFT Entry	
04/05/2012 17:07:15	NFURY	%SystemRoot%\PSEXESVC.EXE	Service Control Manager	Application Event
04/05/2012 17:13:57	NFURY	C:\\$Recycle.Bin\S-1-5-21-2036804247-3058324640-2116585241-1673\SR65ODDB\winclient.reg	FN Info - Modify: 04/05/2012 17:13:57, Entry: 04/05/20 MFT Entry	
04/05/2012 17:13:58	NFURY	My Computer\C:\Windows\System32\dlhost	First Accessed	Shellbags

Timeline of Lateral Movement

Figure 43. A timeline of events. (Lee, 2014, digital case files)

Tools used across hosts by the adversary include svchost.exe (Figure 44), a.exe (Figure 45), spinlock.exe (Figure 46), winclient (Figure 47), and psexesvc (Figure 48).

Stark IOC All Modified.xlsx - Microsoft Excel

Date/Time	Computer	Details	Properties	Artifacts
04/03/2012 00:35:03	TDUNGAN	C:\WINDOWS\system32\dlhost\svchost.exe	FN Info - Modify: 04/03/2012 00:35:04, Entry: 04/03/20 MFT Entry	
04/03/2012 22:40:25	NROMANOFF	c:\windows\system32\dlhost\svchost.exe	Executed: True	ShimCache
04/03/2012 23:52:47	NROMANOFF	Service Name: winsvchost	c:\windows\system32\cmd.exe /k c:\windows\system32\System Ev	
04/04/2012 01:18:15	NROMANOFF	c:\windows\system32\dlhost\svchost.exe	Application Error	Application
04/05/2012 05:19:11	NROMANOFF	C:\windows\system32\dlhost\svchost.exe	Microsoft-Windows-Security-Auditing	Application
04/05/2012 05:19:11	NROMANOFF	C:\windows\system32\dlhost\svchost.exe	Dst IP: 12.190.135.235   Dst Prt: 80	Security Event
04/05/2012 19:30:40	NFURY	c:\windows\system32\dlhost\svchost.exe	Application Error	Application
N/A	NROMANOFF	HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run - svchost	c:\windows\system32\dlhost\svchost.exe	Autoruns
N/A	NFURY	HKLM\SOFTWARE\Wow6432Node\Microsoft\Windows\CurrentVersion\Run - svchost	c:\windows\system32\dlhost\svchost.exe	Autoruns

Figure 44. SVCHOST.EXE keyword hits. (Lee, 2014, digital case files)



Date/Time	Computer	Details	Properties	Artifacts
04/03/2012 20:43:54	TDUNGAN	C:\WINDOWS\Prefetch\A.EXE-0F3A0E12.pf	FN Info - Modify: 04/03/2012 20:43:54, Entry: 04/03/2012 20:43:54	MFT Entry
04/03/2012 23:54:46	NROMANOFF	C:\Windows\Temp\A.exe	FN Info - Modify: 04/03/2012 23:54:46, Entry: 04/03/2012 23:54:46	MFT Entry
04/03/2012 23:54:48	NROMANOFF	C:\Windows\Prefetch\A.EXE-8D56B1C4.pf	FN Info - Modify: 04/03/2012 23:54:48, Entry: 04/03/2012 23:54:48	MFT Entry
04/04/2012 00:01:20	NROMANOFF	C:\Windows\Temp\A.exe	Executed: True	ShimCache
04/04/2012 00:43:06	NROMANOFF	A.EXE-8D56B1C4.pf	Number of Time Run: 26	Prefetch Entry
04/04/2012 00:44:11	NROMANOFF	C:\Windows\Temp\A.exe	Executed: True	ShimCache
04/04/2012 02:22:00	NROMANOFF	C:\Users\vibranium\AppData\Local\Temp\A.exe	FN Info - Modify: 04/04/2012 02:22:00, Entry: 04/04/2012 02:22:00	MFT Entry
04/04/2012 02:22:02	NROMANOFF	C:\Windows\Prefetch\A.EXE-F91CBA0E.pf	FN Info - Modify: 04/04/2012 02:22:02, Entry: 04/04/2012 02:22:02	MFT Entry
04/04/2012 12:22:40	TDUNGAN	A.EXE-0F3A0E12.pf	Number of Time Run: 67	Prefetch Entry
04/04/2012 12:26:24	TDUNGAN	C:\Documents and Settings\SR\Local Settings\Temp\A.exe	FN Info - Modify: 04/04/2012 12:26:24, Entry: 04/04/2012 12:26:24	MFT Entry
04/04/2012 12:26:30	TDUNGAN	C:\WINDOWS\Prefetch\A.EXE-239305EA.pf	FN Info - Modify: 04/04/2012 12:26:30, Entry: 04/04/2012 12:26:30	MFT Entry
04/04/2012 14:01:32	TDUNGAN	A.EXE-0FBE37C1.pf	Number of Time Run: 390	Prefetch Entry
04/04/2012 16:41:47	TDUNGAN	C:\Documents and Settings\vibranium\Local Settings\Temp\A.exe	FN Info - Modify: 04/04/2012 16:41:47, Entry: 04/04/2012 16:41:47	MFT Entry
04/04/2012 16:41:58	TDUNGAN	C:\WINDOWS\Prefetch\A.EXE-2E0C27A0.pf	FN Info - Modify: 04/04/2012 16:41:58, Entry: 04/04/2012 16:41:58	MFT Entry
04/05/2012 05:19:11	NROMANOFF	C:\Users\vibranium\AppData\Local\Temp\A.exe	Microsoft-Windows-Security-Auditing	Application Event Log
04/05/2012 13:28:01	TDUNGAN	A.EXE-2E0C27A0.pf	Number of Time Run: 490	Prefetch Entry
04/05/2012 17:47:01	NFURY	C:\Windows\Temp\A.exe	FN Info - Modify: 04/05/2012 17:47:01, Entry: 04/05/2012 17:47:01	MFT Entry
04/06/2012 13:43:22	NFURY	C:\Users\vibranium\AppData\Local\Temp\A.exe	FN Info - Modify: 04/06/2012 13:43:22, Entry: 04/06/2012 13:43:22	MFT Entry

Figure 45. A.EXE keyword hits. (Lee, 2014, digital case files)

Date/Time	Computer	Details	Properties	Artifacts
04/03/2012 22:53:39	NROMANOFF	C:\Windows\system32\spinlock.exe	Executed: True	ShimCache
04/03/2012 22:59:43	NROMANOFF	C:\Windows\System32\spinlock.exe	FN Info - Modify: 04/03/2012 22:59:43, Entry: 04/03/2012 22:59:43	MFT Entry
04/03/2012 23:09:26	NROMANOFF	C:\Windows\Prefetch\SPINLOCK.EXE-1610A75A.pf	FN Info - Modify: 04/03/2012 23:09:26, Entry: 04/03/2012 23:09:26	MFT Entry
04/04/2012 00:01:45	NROMANOFF	C:\Users\vibranium\AppData\Local\Temp\_MEI57722\spinlock.exe.manifest	FN Info - Modify: 04/04/2012 00:01:45, Entry: 04/04/2012 00:01:45	MFT Entry
04/04/2012 00:06:41	NROMANOFF	C:\Users\vibranium\AppData\Local\Temp\_MEI111242\spinlock.exe.manifest	FN Info - Modify: 04/04/2012 00:06:41, Entry: 04/04/2012 00:06:41	MFT Entry
04/04/2012 00:07:23	NROMANOFF	spinlock.exe	USER32	Application Event Log
04/04/2012 01:46:40	NROMANOFF	C:\Users\vibranium\AppData\Local\Temp\_MEI39242\spinlock.exe.manifest	FN Info - Modify: 04/04/2012 01:46:40, Entry: 04/04/2012 01:46:40	MFT Entry
04/04/2012 15:07:33	NROMANOFF	C:\Users\vibranium\AppData\Local\Temp\_MEI25602\spinlock.exe.manifest	FN Info - Modify: 04/04/2012 15:07:33, Entry: 04/04/2012 15:07:33	MFT Entry
04/04/2012 17:04:44	TDUNGAN	C:\Windows\system32\spinlock.exe	FN Info - Modify: 04/04/2012 17:04:44, Entry: 04/04/2012 17:04:44	MFT Entry
04/04/2012 17:06:37	TDUNGAN	C:\WINDOWS\system32\spinlock.exe	Executed: N/A	ShimCache
04/04/2012 18:28:42	CONTROLLER	spinlock.exe	Windows Error Reporting	Application Event Log
04/04/2012 18:54:51	NROMANOFF	SPINLOCK.EXE-1610A75A.pf	Number of Time Run: 16	Prefetch Entry
04/04/2012 18:54:52	NROMANOFF	C:\Users\vibranium\AppData\Local\Temp\_MEI29562\spinlock.exe.manifest	FN Info - Modify: 04/04/2012 18:54:52, Entry: 04/04/2012 18:54:52	MFT Entry
04/05/2012 16:54:26	NFURY	C:\Windows\system32\spinlock.exe	FN Info - Modify: 04/05/2012 16:54:26, Entry: 04/05/2012 16:54:26	MFT Entry
04/05/2012 17:15:57	TDUNGAN	C:\WINDOWS\Prefetch\SPINLOCK.EXE-1F9810CF.pf	FN Info - Modify: 04/05/2012 17:15:57, Entry: 04/05/2012 17:15:57	MFT Entry
04/05/2012 17:16:02	TDUNGAN	C:\Documents and Settings\vibranium\Local Settings\Temp\_MEI122362\spinlock.exe.manifest	FN Info - Modify: 04/05/2012 17:16:02, Entry: 04/05/2012 17:16:02	MFT Entry
04/06/2012 13:25:01	TDUNGAN	SPINLOCK.EXE-1F9810CF.pf	Number of Time Run: 4	Prefetch Entry

Figure 46. SPINLOCK.EXE keyword hits. (Lee, 2014, digital case files)

Date/Time	Computer	Details	Properties	Artifacts
04/03/2012 00:35:10	TDUNGAN	C:\WINDOWS\system32\dlhost\winclient.reg	FN Info - Modify: 04/03/2012 00:35:10, Entry: 04/03/2012 00:35:10	MFT Entry
04/03/2012 22:40:25	NROMANOFF	C:\Users\vibranium\Downloads\winclient.exe	Executed: False	ShimCache
04/05/2012 17:13:57	NFURY	C:\\$Recycle.Bin\S-1-5-21-2036804247-3058324640-2116585241-1673\SR65ODDB\winclient.reg	FN Info - Modify: 04/05/2012 17:13:57, Entry: 04/05/2012 17:13:57	MFT Entry

Figure 47. WINCLIENT keyword hits. (Lee, 2014, digital case files)

	A	B	C	D	E
	Date/Time	Computer	Details	Properties	Artifacts
31	04/03/2012 21:11:09	NROMANOFF	C:\Windows\Prefetch\PSEXESVC.EXE-51BA46F2.pf	FN Info - Modify: 04/03/2012 21:11:09, Entry: 04/03/2012 MFT E	
32	04/03/2012 21:14:56	NROMANOFF	C:\Windows\PSEXESVC.EXE	Executed: True	ShimC
37	04/03/2012 21:19:52	NROMANOFF	C:\Windows\PSEXESVC.EXE	Executed: True	ShimC
38	04/03/2012 21:19:53	NROMANOFF	Service Name: PsExec	%SystemRoot%\PSEXESVC.EXE	Syster
64	04/04/2012 01:46:37	NROMANOFF	C:\Windows\PSEXESVC.EXE	Executed: True	ShimC
66	04/04/2012 01:48:01	NROMANOFF	PsExec	Service Control Manager	Applic
80	04/04/2012 14:37:19	NROMANOFF	PSEXESVC	Service Control Manager	Applic
87	04/04/2012 18:00:44	CONTROLLER	C:\Windows\PSEXESVC.EXE	ProcessName	Securi
90	04/04/2012 18:52:11	NROMANOFF	C:\Windows\PSEXESVC.EXE	FN Info - Modify: 04/04/2012 18:52:11, Entry: 04/04/2012 MFT E	
91	04/04/2012 18:52:11	NROMANOFF	PSEXESVC.EXE-51BA46F2.pf	Number of Time Run: 9	Prefet
101	04/05/2012 17:07:15	NFURY	%SystemRoot%\PSEXESVC.EXE	Service Control Manager	Applic
106	04/05/2012 17:23:04	NFURY	%SystemRoot%\PSEXESVC.EXE	Service Control Manager	Applic
117	04/06/2012 18:09:48	NFURY	%SystemRoot%\PSEXESVC.EXE	Service Control Manager	Applic
128	N/A	NROMANOFF	PsExec Service	%SystemRoot%\PSEXESVC.EXE	Author

Figure 48. PSEXESVC.EXE keyword hits. (Lee, 2014, digital case files)

The capabilities of the adversary are also significant to know to defend and respond to the intrusion. Figure 48 has already shown that the intruder is likely using PSEXEC from Microsoft to assist in moving laterally. There is also evidence that the adversary is running malware through Scheduled Tasks (Figure 49) and is using the tool Mimiatz tool to steal user credentials (Figure 50).

	A	B	C	D	E
	Date/Time	Computer	Details	Properties	Artifacts
86	04/04/2012 17:24:44	TDUNGAN	C:\WINDOWS\Prefetch\AT.EXE-2770DD18.pf	FN Info - Modify: 04/04/2012 17:24:44, Entry: 04/04/2012 17:24:44	MFT Entry
114	04/06/2012 13:41:09	NROMANOFF	AT.EXE-E31318D4.pf	Number of Time Run: 9	Prefetch Entry
119	04/06/2012 18:55:35	TDUNGAN	AT.EXE	Number of Time Run: 14	Prefetch Entry
130	N/A	NFURY	Task Scheduler - \At1	"cmd" /c c:\windows\system32\spinlock.exe	Autoruns
131	N/A	NFURY	Task Scheduler - \At2	"cmd" /c c:\windows\system32\dlhost\svchost.exe	Autoruns
132	N/A	Controller	Task Scheduler - \At2	"cmd" /c c:\windows\system32\spinlock.exe	Autoruns

Figure 49. Scheduled Tasks. (Lee, 2014, digital case files)

	A	B	C	D	E
	Date/Time	Computer	Details	Properties	Artifacts
9	04/03/2012 15:19:50	TDUNGAN	C:\WINDOWS\system32\hydrakatz.exe	FN Info - Modify: 04/03/2012 15:20:27, Entry: 04/03/2012 15:20:27	MFT Entry
11	04/03/2012 15:30:13	TDUNGAN	C:\WINDOWS\system32\sekurlsa.dll	FN Info - Modify: 04/03/2012 15:30:13, Entry: 04/03/2012 15:30:13	MFT Entry
12	04/03/2012 15:33:20	TDUNGAN	C:\WINDOWS\Prefetch\HYDRAKATZ.EXE-27B49502.pf	FN Info - Modify: 04/03/2012 15:33:20, Entry: 04/03/2012 15:33:20	MFT Entry
45	04/03/2012 23:30:35	TDUNGAN	HYDRAKATZ.EXE-27B49502.pf	Number of Time Run: 4	Prefetch Entry
59	04/04/2012 01:00:45	NROMANOFF	C:\windows\system32\hydrakatz.exe	Executed: True	ShimCache
61	04/04/2012 01:02:10	NROMANOFF	C:\Windows\System32\sekurlsa.dll	FN Info - Modify: 04/04/2012 01:02:10, Entry: 04/04/2012 01:02:10	MFT Entry
62	04/04/2012 01:09:03	NROMANOFF	C:\Windows\Prefetch\HYDRAKATZ.EXE-A0DADA85.pf	FN Info - Modify: 04/04/2012 01:09:03, Entry: 04/04/2012 01:09:03	MFT Entry
97	04/05/2012 13:20:48	NROMANOFF	HYDRAKATZ.EXE-A0DADA85.pf	Number of Time Run: 2	Prefetch Entry

Figure 50. Mimikatz artifacts. (Lee, 2014, digital case files)

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## 6. Conclusion

Using Microsoft Excel in your investigation during an incident can help bring lots of different data sources together into one location with a standard format for quick and easy analysis of the data. It also allows the analyst to manipulate the data in ways that can bring out indicators of compromise missed when buried in unrelated events contained in the original log files. This paper only touched on a few of Microsoft Excel's features and capabilities. The more you can automate the processes involved in analyzing the data, the better the tool becomes. To take it to a higher level, consider learning more advanced concepts in programming in VBA and taking advantage of add-ins/plugins that Microsoft and third party entities offer that can expand the analysis of your data even further.

## 7. References

### References

- Carrier, B. (2005). *File System Forensic Analysis*. Addison-Wesley Professional
- Carvey, H. (2014). *Windows Forensic Analysis Toolkit, 4th Edition*. Syngress
- Caswell, B., Beale, J., & Baker, A. (2007). *Snort Intrusion Detection and Prevention Toolkit*. Syngress
- Cowen, D. (2013). *Computer Forensic InfoSec Pro Guide*. McGraw-Hill
- Define and use names in formulas - Excel. (n.d.). Retrieved from <https://support.office.com/en-us/article/Define-and-use-names-in-formulas-4d0f13ac-53b7-422e-afd2-abd7ff379c64>
- Jelen, B., & Alexander, M. (2006). *Pivot Table Data Crunching*. Indianapolis, IN: Que Publishing
- Lee, R. (2014). *SANS Forensic 508 Advanced Computer Forensic Analysis and Incident Response, Stark Research Labs Intrusion: Exercise Workbook*.
- Microsoft Excel. (n.d.). In Wikipedia. Retrieved November 18, 2016, from [https://en.wikipedia.org/wiki/Microsoft\\_Excel#Macro\\_programming](https://en.wikipedia.org/wiki/Microsoft_Excel#Macro_programming)
- Nemeth, E., Snyder, G., Hein, T., & Whaley, B. (2010). *Unix and Linux System Administration Handbook, Fourth Edition*. Prentice Hall
- Parisi, T. (2015, June 17). *Caching out: The value of shimcache for investigators* « *Threat Research Blog | FireEye Inc*. Retrieved from [https://www.fireeye.com/blog/threat-research/2015/06/caching\\_out\\_the\\_val.html](https://www.fireeye.com/blog/threat-research/2015/06/caching_out_the_val.html)
- Roesch, M. (2003). *Network intrusion detection system mode | NIDS mode output options*. Retrieved from <http://manual-snort-org.s3-website-us-east-1.amazonaws.com/node6.html>
- Russinovich, M., & Margosis, A. (2011). *Windows Sysinternals Administrator's Reference*. McGraw-Hill
- Windows event log essentials - Windows event log FAQ. Basic explanation of Windows event logs. (n.d.). Retrieved from <https://eventlogxp.com/essentials/windowseventlog.html>

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## 8. Appendix

### 8.1. Appendix A - Open Source Tools

Here is a listing of the tools used in this document:

- NOTEPAD++, v7.3.2 (<https://notepad-plus-plus.org/>)
- Shellbags Explorer, v0.7.0.0 (<http://binaryforay.blogspot.com/p/software.html>)
- Bro, v2.5 (<https://www.bro.org/>)
- Snort, v2.9.9.0 (<https://www.snort.org/>)
- IPTables, v1.6.1 (<https://git.netfilter.org/iptables/>)
- Wevtutil.exe, v6.1.7600.16385 (Native Windows 7 tool)
- Autorunsc.exe, v13.7 (<https://technet.microsoft.com/en-us/sysinternals/bb842062>)
- Shimcacheparser.py, v1.0 (<https://github.com/mandiant/ShimCacheParser>)
- Pasco.exe, v1.0 (<https://www.mcafee.com/us/downloads/free-tools/pasco.aspx>)
- analyzeMFT, v2.0.18 (<https://github.com/dkovar/analyzeMFT>)
- parse\_prefetch\_info, v1.5 (<http://redwolfcomputerforensics.com> – dead link)
- Wireshark, v2.2.4 (<https://www.wireshark.org/>)
- CYGWIN, v2.7.0. (<https://www.cygwin.com/>)

Within CYGWIN Environment:

- SED - <https://www.gnu.org/software/sed/>
- CUT – part of <https://www.gnu.org/software/coreutils/coreutils.html>
- CAT – part of <https://www.gnu.org/software/coreutils/coreutils.html>

## 8.2. Appendix B – Resources

Here is a listing of books and blog web sites that I have found beneficial in learning Excel and VBA Programming:

- Excel 2013 Power Programming with VBA by John Walkenback
- Excel 2013 Bible by John Walkenback
- <http://analysistabs.com/>
- <https://powerspreadsheets.com/>
- <http://stackoverflow.com/>
- <http://wellsr.com/>
- <https://www.ablebits.com/>
- <http://www.mrexcel.com/>
- <https://www.techonthenet.com/excel/index.php>
- <https://www.thespreadsheetguru.com>

## 8.3. Appendix C – Files Available on GitHub

I have provided code to automate much of the processes described in this document. If there are issues running the code, check to make sure you are using the same version of software listed in Appendix A.

The VBA code is separated up into two categories. One category contains individual code for each of the log files mentioned in this document along with a few miscellaneous scripts for specific tasks. The other category contains two ‘Master’ spreadsheets that comprise many of the individual scripts into one document for ease of execution. You can find the code at [https://github.com/gregory-lalla/GCIH\\_Gold](https://github.com/gregory-lalla/GCIH_Gold) under the ‘Code’ directory. Each category has two sub-categories. The sub-categories are explained below.

### Module Files:

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The files under this sub-category are individual modules that can be added to macro-enabled spreadsheets (see Section 3.5 for directions on adding macros to a spreadsheet). You can find the code at GitHub site under the Code/Singles/Module\_BAS\_Files directory. Each log file has code designed specifically for the output shown in this paper. There are four types of modules. The first type will search the data for specific keywords and will have the word 'keyword' in the file name. The second type will search the data for specific Event IDs and will have the word 'EventID' in the file name. The third type will format the data per the instructions provide in this paper and will contain the words 'Standard\_Format' in the file name. The last type will be code which is designed to perform a specific task and will not have any of the words mentioned above in the file name. The following is a list of the task specific macros and a description of each:

- Binary\_Hex2Ascii\_Conversion\_Module:

This script will convert a column of hexadecimal encoded characters to human readable ASCII encoding. This script will work on an XML export of Microsoft Event Viewer data.

- Insert\_Headers\_Module:

This script will insert the standard headers described in this paper to the spreadsheets first row.

- EventLogs\_Application\_CSV\_Unique\_IDs\_per\_Sheet\_Module:

This script will take each unique Event ID and create an individual spreadsheet (tab) containing only those Event IDs. This script will work on a CSV export of Microsoft Event Viewer Application log data.

- EventLogs\_Security\_CSV\_Unique\_IDs\_per\_Sheet\_Module:

This script will take each unique Event ID and create an individual spreadsheet (tab) containing only those Event IDs. This script will work on a CSV export of Microsoft Event Viewer Security log data.

- EventLogs\_System\_CSV\_Unique\_IDs\_per\_Sheet\_Module:

This script will take each unique Event ID and create an individual spreadsheet (tab) containing only those Event IDs. This script will work on a CSV export of Microsoft Event Viewer System log data.

### **Macro Files:**

The files under this sub-category also contain individual scripts designed specifically for each log file. The scripts here, however, are contained within a Macro-enabled Excel file. There is a button on the first spreadsheet that will prompt the user to specify the log file they wish to process. The script will then run and produce a unique output file name based on the hostname that produced the log. These Excel files contain the same types of scripts mentioned above, except there are no task-specific modules for hexadecimal to ASCII conversion or inserting of headers. You can find the code at the GitHub site under the Code/Singles/Excel\_Macro\_Files directory.

### **Singles Combined:**

The file under this sub-category is named 'Master-Single.xlsm' and combines all the code from the Macro Files sub-category. Each log file has its own button that when pushed will run the same code as the Macro Files sub-category. This file is available on the GitHub site at [https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Code/Combined/Singles\\_Combined/Master-Single.xlsm](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Code/Combined/Singles_Combined/Master-Single.xlsm).

### **Master IOC Combined:**

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The file under this sub-category is named 'Master-IOC.xlsm' and has two differences from the 'Master-Single.xlsm' document. First, the result of the script not only writes to a unique file, but is appended to an overall Master IOC Excel file. When opening the document, the user is prompted to either select a previously created Master IOC file or to create a new one. This file is then used to hold the results of all the scripts run. The other difference is that instead of a standard format button, there is a button to filter the results of each log file by date to remove data that is outside the timeframe of an incident. This file is available on the GitHub site at [https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Code/Combined/Master\\_IOC\\_Combined/Master-IOC.xlsm](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Code/Combined/Master_IOC_Combined/Master-IOC.xlsm).

There is also a documents directory located at [https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Docs](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Docs) with several subdirectories. The 'Supplement' subdirectory contains a document named 'Additional\_Log\_Formatting\_Instructions.docx' which covers instructions for formatting the logs mentioned in Section 4.2 of this paper. It also contains a file named 'Pivote\_Table\_Example.docx' which shows examples of the content discussed in Section 3.6 of this paper. Last, there is a file named 'Complete\_GIAC\_GCIH\_Gold\_Paper\_Greg\_Lalla.docx' which is the original document before it was edited to fit the requirements of a GIAC Gold Paper (Because of file size limits on Github, the document has been compressed and split into three files. You can recombine the compressed files with 7-zip). The 'Template' subdirectory contains an Excel Macro-Enabled Template named 'standard\_format.xltn' you can use when manipulating data from log files not discussed in this paper. The last subdirectory in the 'Docs' folder is 'Worksheet\_Functions.' This folder contains a document named 'Worksheet\_Functions\_in\_Paper.docx' which contains the worksheet functions used in this paper, along with a description of what each one accomplishes.

The last directory at the root of the GitHub page is named 'Misc' and contains the SED script file named 'months.sed,' which fixes the Date/Time fields of Linux system

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Microsoft Office User

logs. You can find the SED script at [https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Misc/SED\\_Month\\_Replacement\\_Filter/months.sed](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Misc/SED_Month_Replacement_Filter/months.sed).

## 8.4. Appendix D: Windows Logs Explained

For brevity, anything discussed previously will be not be explained again but only referenced.

### 8.4.1. Event Viewer Logs

Because Event Viewer logs can contain hundreds of thousands of entries, it is essential to reduce the data to a manageable level before importing it into Excel. One way to do this is to use XML filtering in Event Viewer Custom Views which is more efficient than filtering through the GUI. There are many types of expressions you can use, but two of the more useful are sorting by timeframe and sorting by a username (See Figure 51 and 52). For more information about XML filtering, see the article at <https://blogs.technet.microsoft.com/askds/2011/09/26/advanced-xml-filtering-in-the-windows-event-viewer/>.

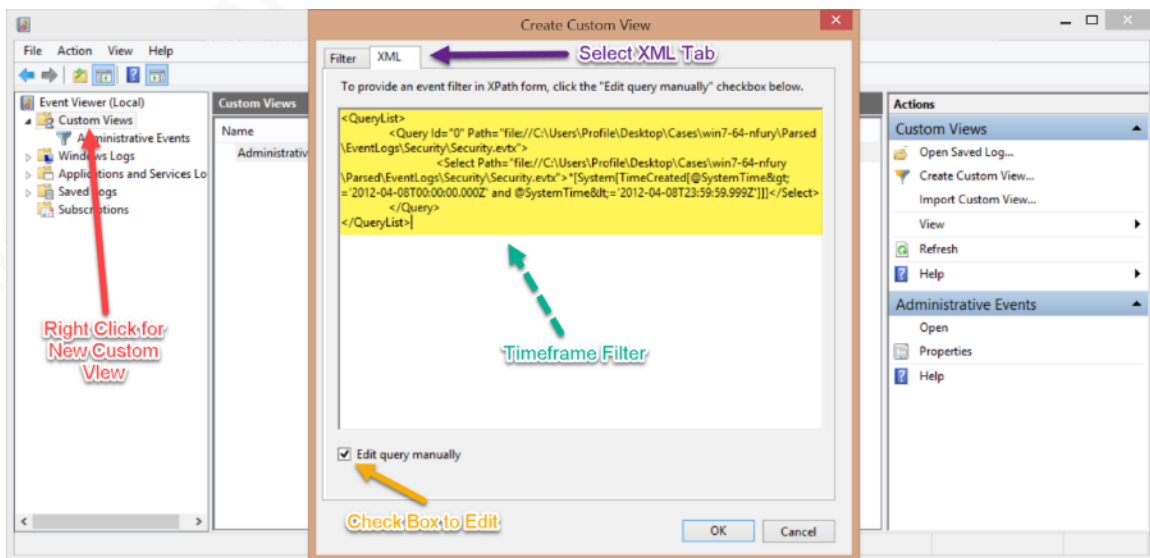


Figure 51. Event Viewer XML Timeframe Filter. (Lee, 2014, digital case files)



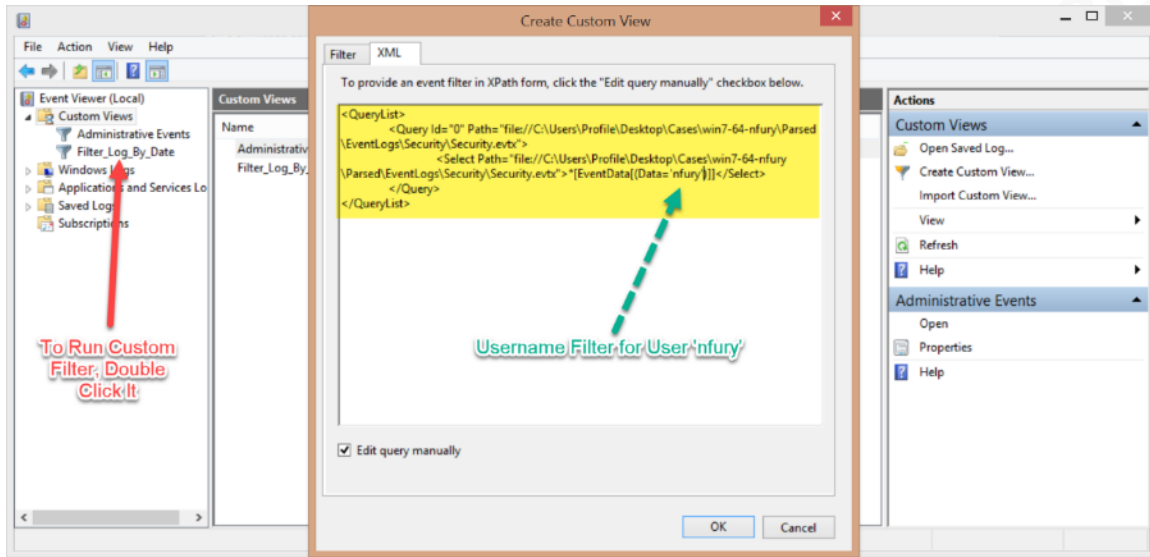


Figure 52. Event Viewer XML Username Filter. (Lee, 2014, digital case files)

An even easier method, avoiding the slow GUI, is to use the native command line utility called WEVTUTIL.EXE to export the logs. This tool comes with its challenges such as producing XML files that Excel cannot open. When running the command, there are several options to massage the data to a format that Excel accepts. To get the correct results, you may need to mix and match the switches until you get an XML file that imports into Excel. Here is an example of a command that you can run which filters the data based on a timeframe:

```
wevtutil qe "<path_to_system.evtx>" /f:true
/q:"*[System[TimeCreated[@SystemTime>='2015-07-10T00:00:00.000Z' and
@SystemTime<='2015-07-13T23:59:59.999Z']]]" /f:RenderedXML /e:root > System.xml
```

A final way to get the output you want from Event Viewer logs is to use Powershell, which is a topic beyond this paper, but well worth the effort to try and learn.

Once you have reduced the data, you should then export it from the utility. Event Viewer offers four different formats to export the data: .EVTX, .TXT, .CSV, and .XML (See Figure 33). This paper will look at the .CSV format and the .XML format. Neither of these formats includes all the information from the Event Viewer logs, and the data may need to be combined to get a full picture of what occurred during each event.

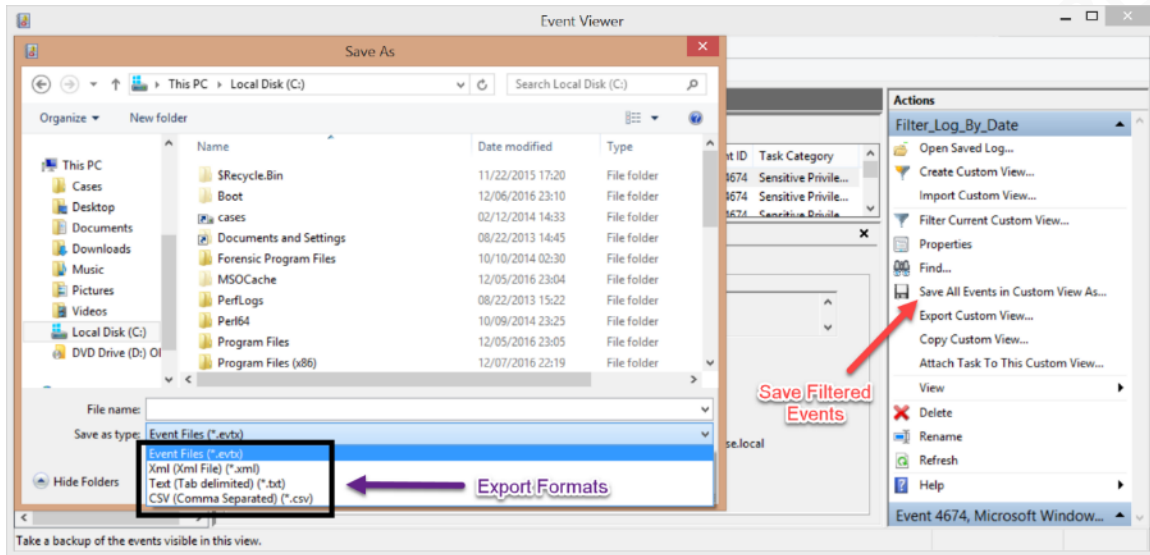


Figure 53. Save Filtered Event Viewer logs. (Lee, 2014, digital case files)

In this section, two event logs are shown, each with a slightly different output. With these two examples, you can manipulate other Event Viewer logs in a similar manner. First, the Security.evtx log, when exported as a .CSV file produces cells with newline and carriage returns, which makes the data unwieldy. You will remove the carriage return character (ASCII Code 13), and replace the newline character (ASCII Code 10) with the '#' character which will be used as a delimiter to split the data into columns. You can automate this task with the following Excel Function:

$$=SUBSTITUTE(SUBSTITUTE(F2,CHAR(13),""),CHAR(10),"#")$$

Place the above function in an empty cell adjacent to the cell that needs to have the newline and carriage return characters replaced (Figure 54). The blank cell will then contain the new contents as its value, but will also contain the formula used in the function.

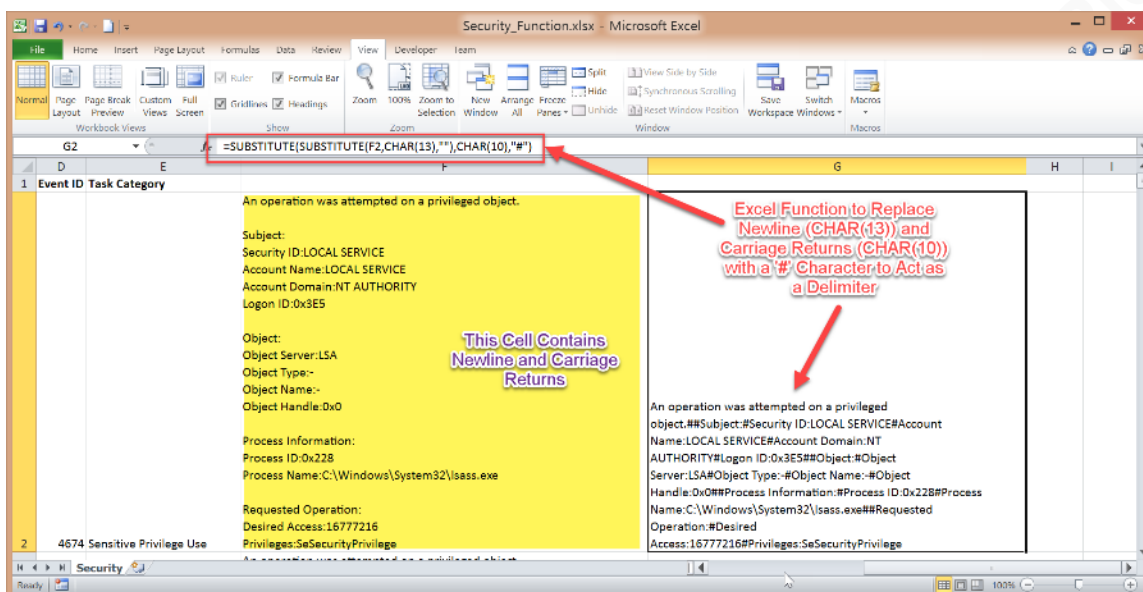


Figure 54. Remove Newline and Carriage Return Characters from Cell Contents. (Lee, 2014, digital case files)

To produce a similar result in every cell in the column, highlight the cell with the function and double-click on the bottom right-hand corner of the cell. This action will copy the function to every cell in the column. The arguments used by the function will be updated to reflect the correct cell locations (Figure 55).

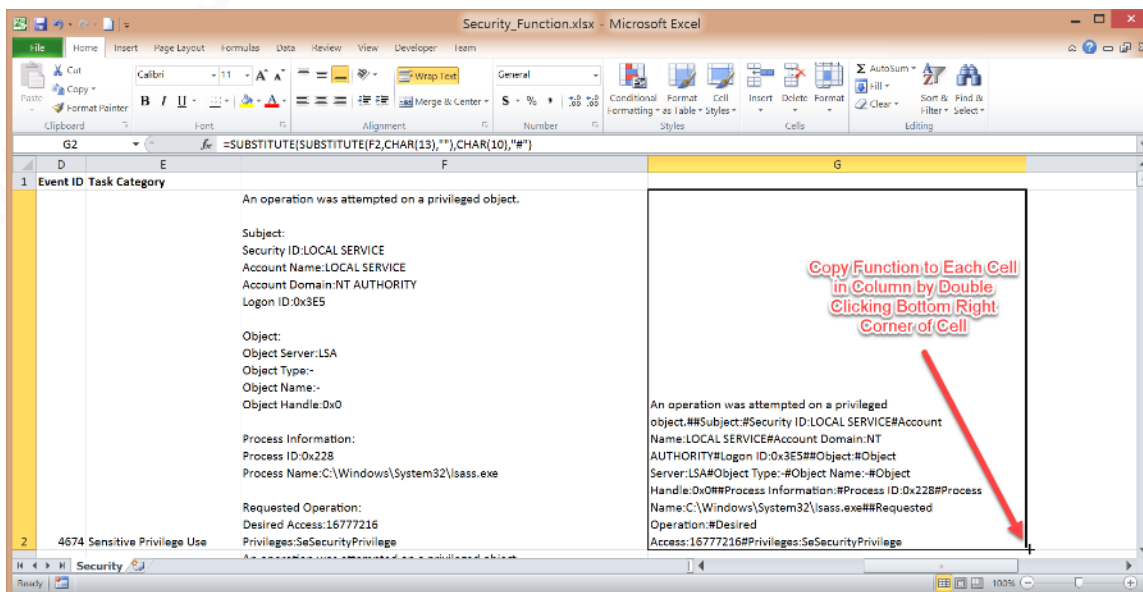


Figure 55. Copy Function to All Cells in Column. (Lee, 2014, digital case files)

To prevent the function from being accidentally changed and to make it easier to manipulate the contents of the cell, the values within the new cells will be copied and

pasted over the formula. To perform this action, select the entire column that contains the functions, right click the highlighted cells, select 'Copy,' right click the highlighted cells again and select the 'Paste Value' icon which has the numbers 123 in the image (Figure 56).

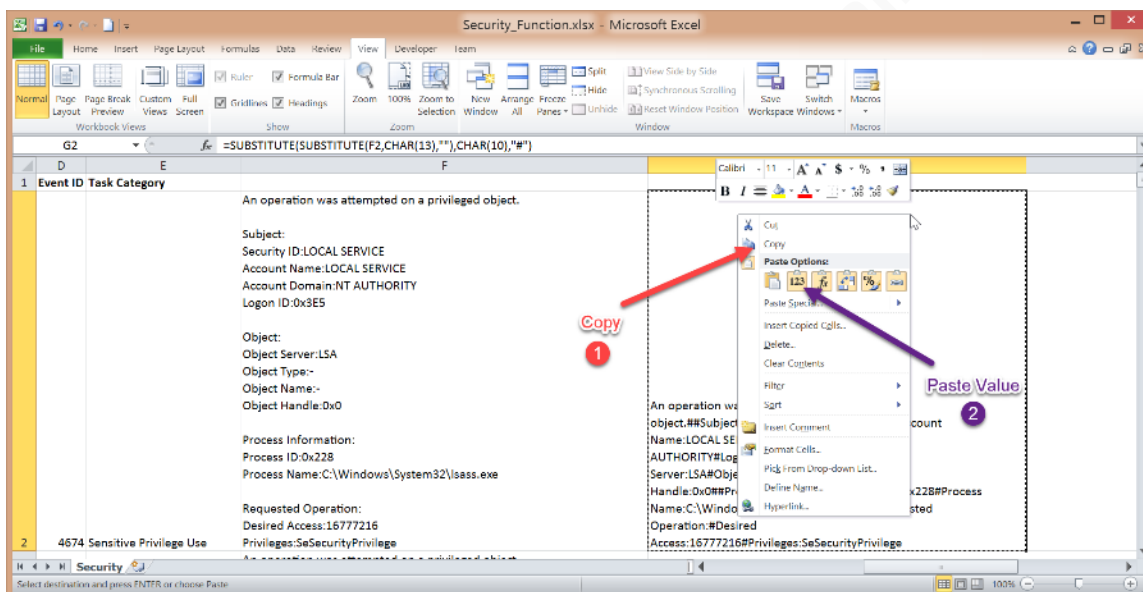


Figure 56. Copy and Paste Value of cell over the Function in the cell. (Lee, 2014, digital case files)

With the data copied to a new column in the correct format, you can delete the original column. Since the new column has a delimiter of '#' in the data, the 'Text to Column' feature on the 'Data' ribbon can be used to separate the data into multiple columns (Figure 57).

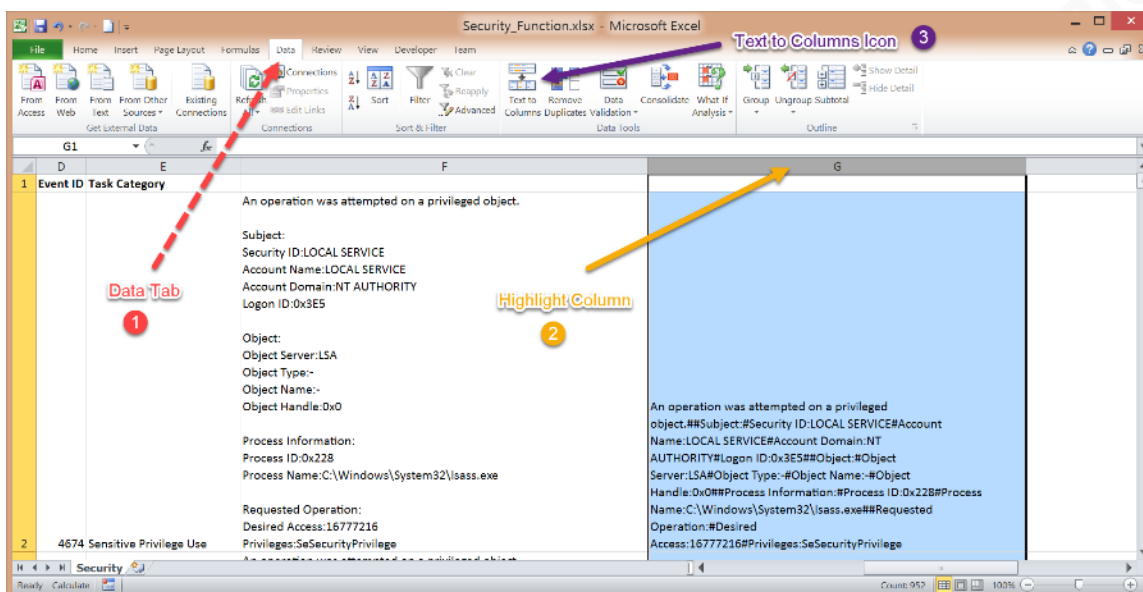


Figure 57. Text to Columns. (Lee, 2014, digital case files)

On the 'Text to Columns' wizard, select the defaults on Step 1 and 3. On 'Convert Text to Columns Wizard – Step 2 of 3' only check 'Other:' under 'Delimiters.' In the box next to 'Other:' type the '#' character. Also, make sure the 'Treat consecutive delimiters as one' checkbox is unchecked to keep data of a similar nature in the same columns (Figure 58).

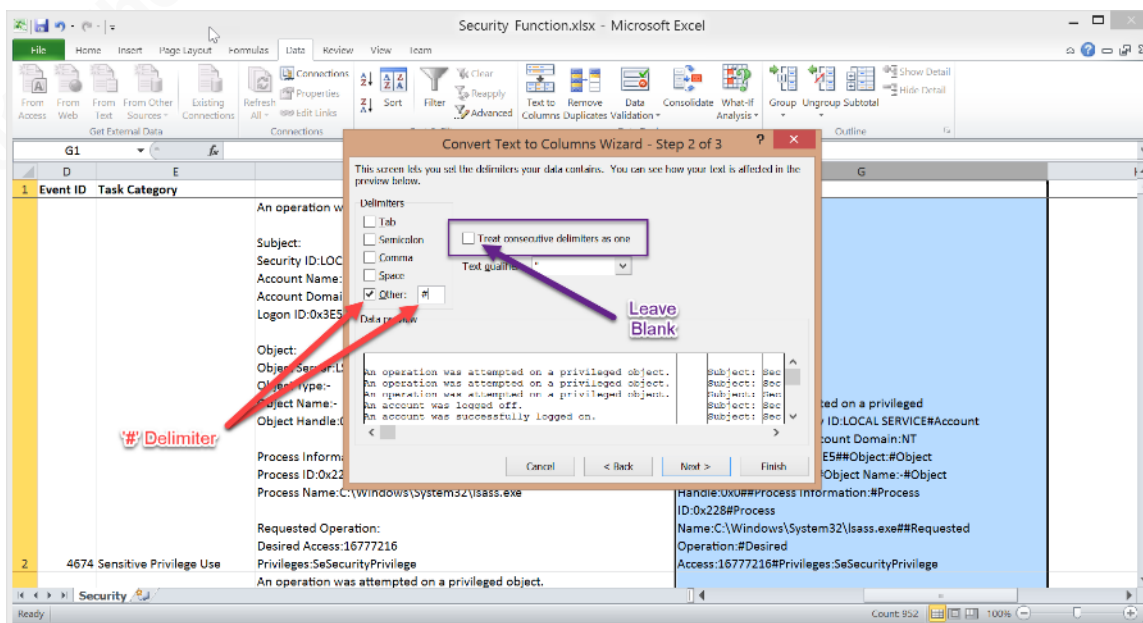


Figure 58. Text to Columns Delimited (Lee, 2014, digital case files)

The result should look like Figure 59 after ‘Wrap Text’ has been removed from the worksheet cells.

Task Category	Description	Subject	ID/Object Path
Sensitive Privilege Use	An operation was attempted on a privileged object.	Subject:	Security IC Account N Account D Logon ID: Object:
Sensitive Privilege Use	An operation was attempted on a privileged object.	Subject:	Security IC Account N Account D Logon ID: Object:
Sensitive Privilege Use	An operation was attempted on a privileged object.	Subject:	Security IC Account N Account D Logon ID: Object:
Logoff	An account was logged off.	Subject:	Security IC Account N Account D Logon ID: Logon Ty
Logon	An account was successfully logged on.	Subject:	Security IC Account N Account D Logon ID: Logon Ty
Special Logon	An account was successfully logged on.	Subject:	Security IC Account N Account D Logon ID: Logon Ty
Logoff	Special privileges assigned to new logon.	Subject:	Security IC Account N Account D Logon ID: Privilege
Logon	An account was logged off.	Subject:	Security IC Account N Account D Logon ID: Logon Ty
Special Logon	An account was successfully logged on.	Subject:	Security IC Account N Account D Logon ID: Logon Ty
Logon	Special privileges assigned to new logon.	Subject:	Security IC Account N Account D Logon ID: Privilege
Logoff	A logon was attempted using explicit credentials.	Subject:	Security IC Account N Account D Logon ID: Logon GL
Logon	An account was logged off.	Subject:	Security IC Account N Account D Logon ID: Logon Ty
Special Logon	An account was successfully logged on.	Subject:	Security IC Account N Account D Logon ID: Logon Ty
Logon	Special privileges assigned to new logon.	Subject:	Security IC Account N Account D Logon ID: Privilege
File System	A logon was attempted using explicit credentials.	Subject:	Security IC Account N Account D Logon ID: Logon GL
File System	The state of a transaction has changed.	Subject:	Security IC Account N Account D Logon ID: Transacti
File System	The state of a transaction has changed.	Subject:	Security IC Account N Account D Logon ID: Transacti
File System	The state of a transaction has changed.	Subject:	Security IC Account N Account D Logon ID: Transacti
Sensitive Privilege Use	The state of a transaction has changed.	Subject:	Security IC Account N Account D Logon ID: Transacti
Sensitive Privilege Use	An operation was attempted on a privileged object.	Subject:	Security IC Account N Account D Logon ID: Object:
Sensitive Privilege Use	An operation was attempted on a privileged object.	Subject:	Security IC Account N Account D Logon ID: Object:

Figure 59. Text to Columns Result. (Lee, 2014, digital case files)

These actions should line up most of the data correctly, but you will find there are some columns with extra data or missing data. Here you'll need to do some manual work to get the data correctly aligned. First, run the Standard Format macro to better view the data. You need to keep in mind the data you want to retain, relative the Column Header names. Of the five headers already present, keep the ‘Date and Time’; ‘Source’; and ‘Event ID’ columns. The other two columns can be deleted (Figure 60).



Date and Time	Source	Event ID	Description
04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	4674	An operation was attempted on a privileged object.
04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	4674	An operation was attempted on a privileged object.
04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	4674	An operation was attempted on a privileged object.
04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	4634	An account was logged off.
04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	4624	An account was successfully logged on.
04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	4672	An account was successfully logged on.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	4634	Special privileges assigned to new logon.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	4624	An account was logged off.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	4672	An account was successfully logged on.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	4648	Special privileges assigned to new logon.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	4634	A logon was attempted using explicit credentials.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	4624	An account was logged off.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	4672	An account was successfully logged on.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	4648	Special privileges assigned to new logon.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	4985	A logon was attempted using explicit credentials.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	4985	The state of a transaction has changed.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	4985	The state of a transaction has changed.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	4985	The state of a transaction has changed.

Figure 60. Keep the 'Date and Time' column and 'Event ID' column. (Lee, 2014, digital case files)

Change the 'Date and Time' column header to 'Date/Time,' the 'Source' header to 'Artifact' and the 'Event ID' header to 'Properties.' To understand what the value of the cells under 'Properties' represent, prefix each cell with the string 'Event ID: ' (Figure 61). You can do this by using the following function:

= "Event ID: " & B2

Date and Time	Source	Event ID	Description
04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	Event ID: 4674	An operation was attempted on a privileged object.
04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	Event ID: 4674	An operation was attempted on a privileged object.
04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	Event ID: 4674	An operation was attempted on a privileged object.
04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	Event ID: 4634	An account was logged off.
04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	Event ID: 4624	An account was successfully logged on.
04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	Event ID: 4672	An account was successfully logged on.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4634	Special privileges assigned to new logon.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4624	An account was logged off.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4672	An account was successfully logged on.
04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4648	Special privileges assigned to new logon.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4634	A logon was attempted using explicit credentials.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4624	An account was logged off.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4672	An account was successfully logged on.
04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4648	Special privileges assigned to new logon.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	A logon was attempted using explicit credentials.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	The state of a transaction has changed.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	The state of a transaction has changed.
04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	The state of a transaction has changed.

Figure 61. Prefix cell value with a string. (Lee, 2014, digital case files)

Microsoft Office UserMicrosoft Office UserGreg Lalla, greg.lalla@mail.comMicrosoft Office User

Follow the steps outlined previously (the substitute function instructions near Figure 54) to get the desired results as shown in Figure 62.

	A	B	C	D	E
1	Date/Time	Artifact	Properties		
2	04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	Event ID: 4674	An operation was attempted on a privileged object.	Subject: Security ID:LOCAL SERVI
3	04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	Event ID: 4674	An operation was attempted on a privileged object.	Subject: Security ID:LOCAL SERVI
4	04/08/2012 11:32:37	Microsoft-Windows-Security-Auditing	Event ID: 4674	An operation was attempted on a privileged object.	Subject: Security ID:LOCAL SERVI
5	04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	Event ID: 4634	An account was logged off.	Subject: Security ID:SYSTEM
6	04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	Event ID: 4624	An account was successfully logged on.	Subject: Security ID:NULL SID
7	04/08/2012 11:32:36	Microsoft-Windows-Security-Auditing	Event ID: 4672	An account was successfully logged on.	Subject: Security ID:NULL SID
8	04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4634	Special privileges assigned to new logon.	Subject: Security ID:SYSTEM
9	04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4624	An account was logged off.	Subject: Security ID:SYSTEM
10	04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4672	An account was successfully logged on.	Subject: Security ID:NULL SID
11	04/08/2012 11:12:35	Microsoft-Windows-Security-Auditing	Event ID: 4648	Special privileges assigned to new logon.	Subject: Security ID:SYSTEM
12	04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4634	A logon was attempted using explicit credentials.	Subject: Security ID:SYSTEM
13	04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4624	An account was logged off.	Subject: Security ID:SYSTEM
14	04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4672	An account was successfully logged on.	Subject: Security ID:NULL SID
15	04/08/2012 11:12:34	Microsoft-Windows-Security-Auditing	Event ID: 4648	Special privileges assigned to new logon.	Subject: Security ID:SYSTEM
16	04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	A logon was attempted using explicit credentials.	Subject: Security ID:SYSTEM
17	04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	The state of a transaction has changed.	Subject: Security ID:SYSTEM
18	04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	The state of a transaction has changed.	Subject: Security ID:SYSTEM
19	04/08/2012 11:12:31	Microsoft-Windows-Security-Auditing	Event ID: 4985	The state of a transaction has changed.	Subject: Security ID:SYSTEM

Figure 62. Date/Time and Properties columns. (Lee, 2014, digital case files)

Using the filter dropdown arrows in each column header cell, delete columns that clearly don't contain information of value. Next, find the columns that correspond to the remaining Column Headers and label them accordingly. Finally, delete the columns that are not labeled. Remember, to make this process immensely easier, reduce as much data first by getting rid of rows based off the timeframe, keywords, and Event IDs you know will not contain information related to the intrusion. The final output would look like Figure 63 after putting the columns in the correct order.



	A	B	C	D	E	F	G
	Date/Time	Account	Computer	Description	Details	Properties	Misc
1	04/08/2012 11:12:31	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4985	
2	04/08/2012 11:12:31	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4985	
3	04/08/2012 11:12:31	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4985	
4	04/08/2012 09:45:36	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4674	
5	04/08/2012 05:00:26	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
6	04/08/2012 05:00:26	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
7	04/08/2012 05:00:23	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
8	04/08/2012 05:00:21	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
9	04/08/2012 05:00:17	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
10	04/08/2012 05:00:16	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
11	04/08/2012 05:00:14	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
12	04/08/2012 05:00:14	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
13	04/08/2012 05:00:12	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
14	04/08/2012 05:00:12	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
15	04/08/2012 05:00:12	SYSTEM	WKS-WIN764BITBS	An attempt was made to access an object.	Process ID:0x6b8	Event ID: 4663	Proc
16	04/08/2012 03:12:30	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4985	
17	04/08/2012 03:12:30	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4985	
18	04/08/2012 02:49:31	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4674	
19	04/08/2012 01:12:03	SYSTEM	WKS-WIN764BITBS	The state of a transaction has changed.	Process Name:C:\Windows\System32\svchost.exe	Event ID: 4985	

Figure 63. The final output of the CSV export data. (Lee, 2014, digital case files)

The second type of export from an Event Viewer log that we will look at is the XML format. This output is a lot easier to examine since there are already tags defining each column. As before, you export Event Viewer logs in the XML format by selecting ‘Save All Events As...’ or ‘Save Filtered Log File As...’ and choosing XML in the ‘Save as type’ dropdown list (Figure 53). Import the resulting .XML file into Microsoft Excel. You will get a popup box asking how to import the data. Select ‘As an XML Table’ and click on the ‘OK’ button (Figure 64).

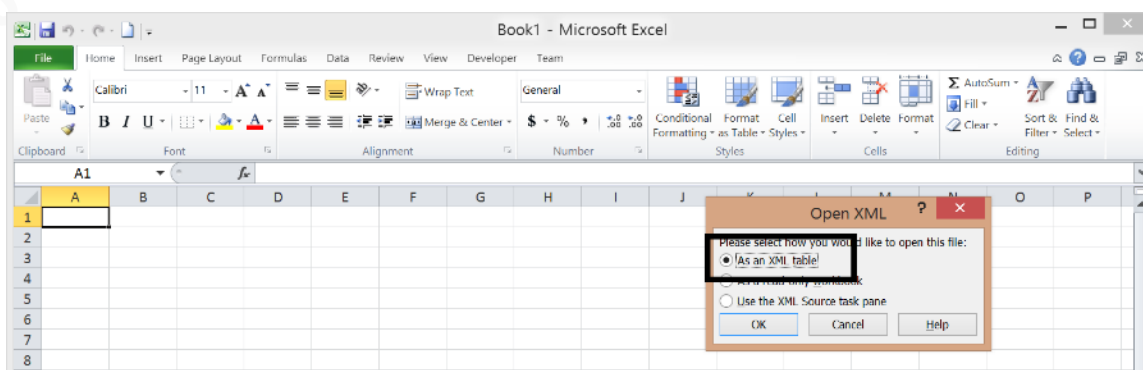


Figure 64. Open .xml file as an XML Table. (Lee, 2014, digital case files)

Once you have imported the data, it will look like Figure 65.

1	Name	Guid	ns1:EventID	ns1:Version	ns1:Level	ns1:Task	ns1:Opcode	ns1:Keywords
2	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
3	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
4	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
5	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
6	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
7	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
8	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
9	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
10	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
11	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
12	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
13	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
14	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
15	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
16	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
17	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
18	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000
19	Microsoft-Windows-Security-Auditing	{54849625-5478-4994-A5BA-3E3B0328C30D}	4674	0	0	13056	0	0x80100000

Figure 65. Imported XML file as a Table. (Lee, 2014, digital case files)

One issue is the Date/Time format, which separates the date and time with the letter ‘T’ and includes milliseconds followed by the letter ‘Z.’ A function will be used to get the correct format of ‘mm/dd/yyyy hh:mm:ss’. To make manipulating the data easier, you will convert the table to a normal range. This conversion can be done by selecting the ‘Convert to Range’ button on the ‘Table Tools’ ribbon and selecting ‘Yes’ on the popup window (Figure 66).

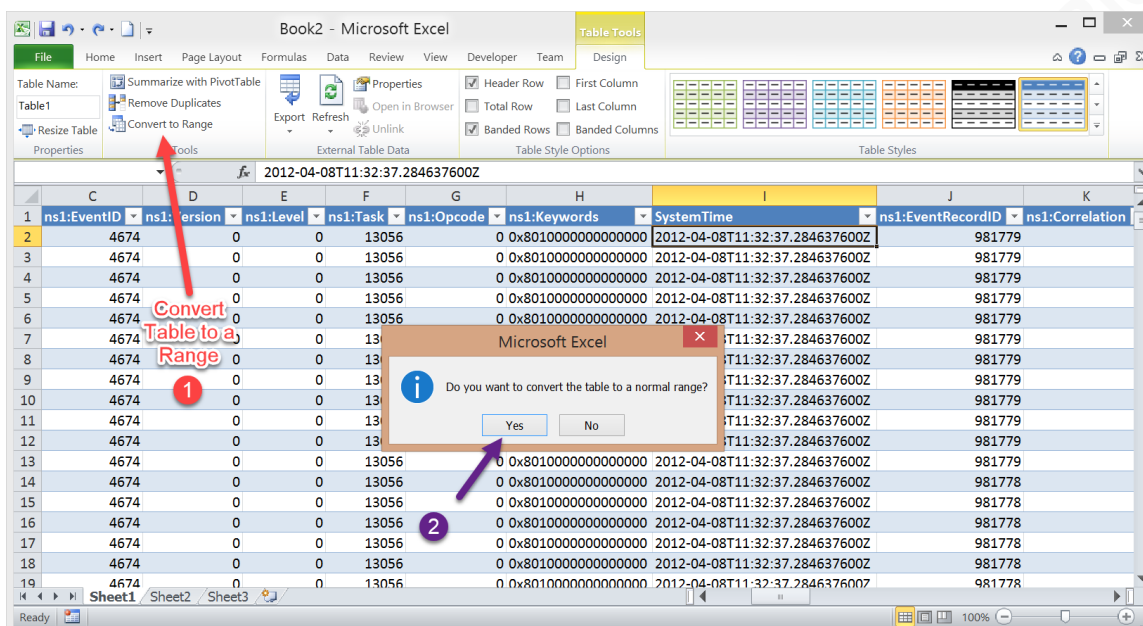


Figure 66. Convert Table to a Range. (Lee, 2014, digital case files)

In order prevent confusion from the highlighting of artifacts related to the incident, you should remove the formatting left over from the table layout (Figure 67).

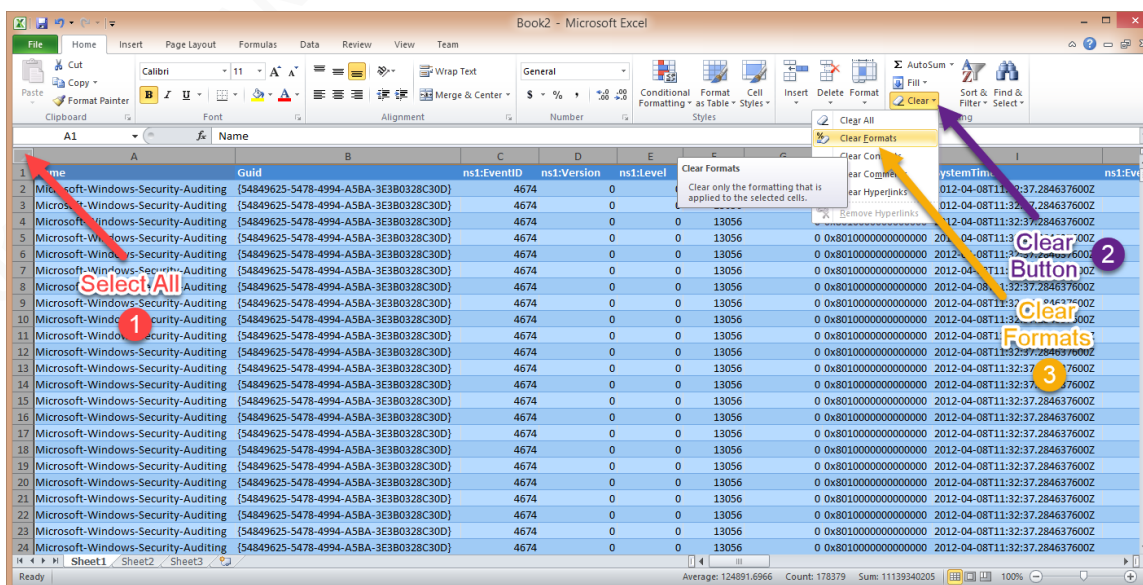


Figure 67. Clear Table Formatting. (Lee, 2014, digital case files)

To fix the Date/Time formatting, you can use the following function (Figure 68):

$$=0+SUBSTITUTE(SUBSTITUTE((MID(I2,1,19)), "T", " "), "-", "/")$$

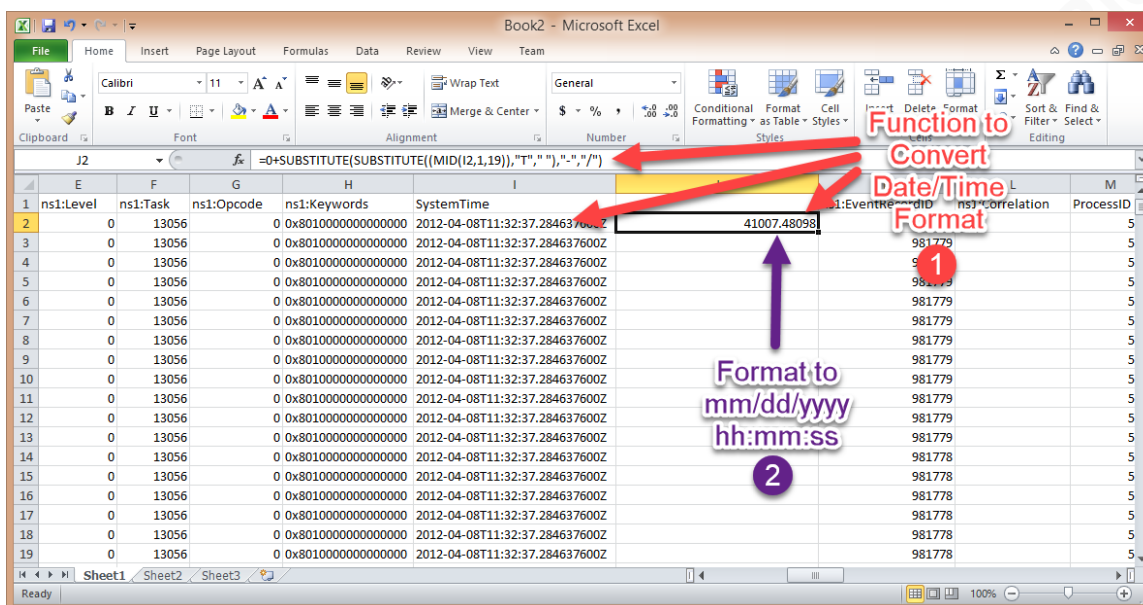


Figure 68. Function for Date/Time Formatting. (Lee, 2014, digital case files)

This function will display the Date/Time in number format. Apply the ‘mm/dd/yyyy hh:mm:ss’ format to the column for proper display.

Another issue you may run into is that some of the data is hex encoded (Figure 69). To convert the hex data to human readable ASCII data, you can run the ‘Binary\_Hex2Ascii\_Conversion\_Module.bas’ code ([https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Code/Singles/Module\\_BAS\\_Files/Misc/Binary\\_Hex2Ascii\\_Conversion\\_Module.bas](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Code/Singles/Module_BAS_Files/Misc/Binary_Hex2Ascii_Conversion_Module.bas)) (Figure 70).

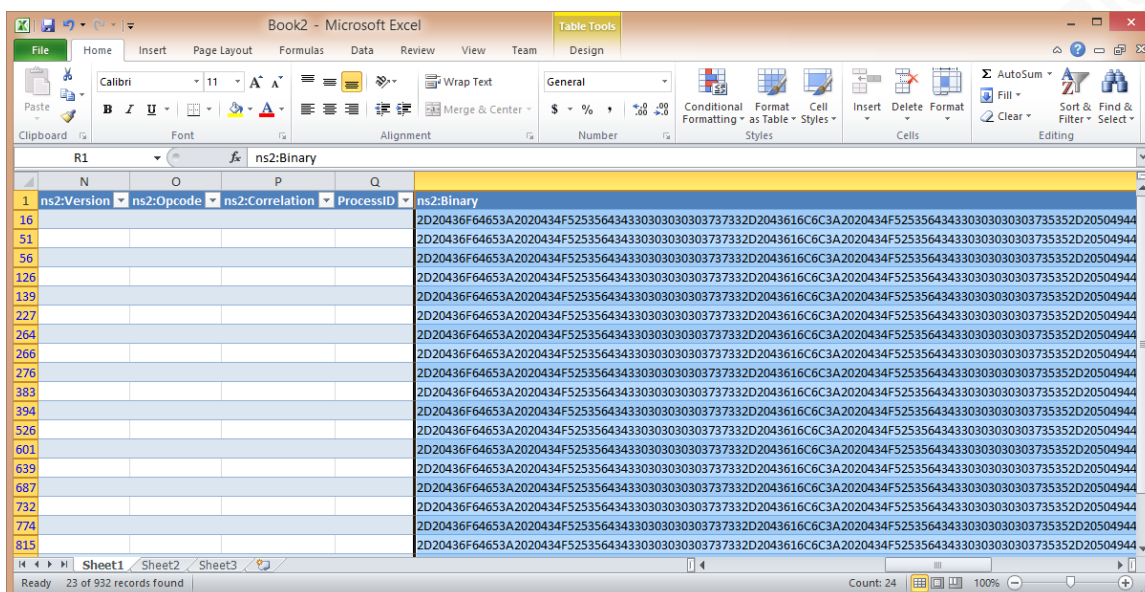


Figure 69. Hex Encoded Data. (Lee, 2014, digital case files)

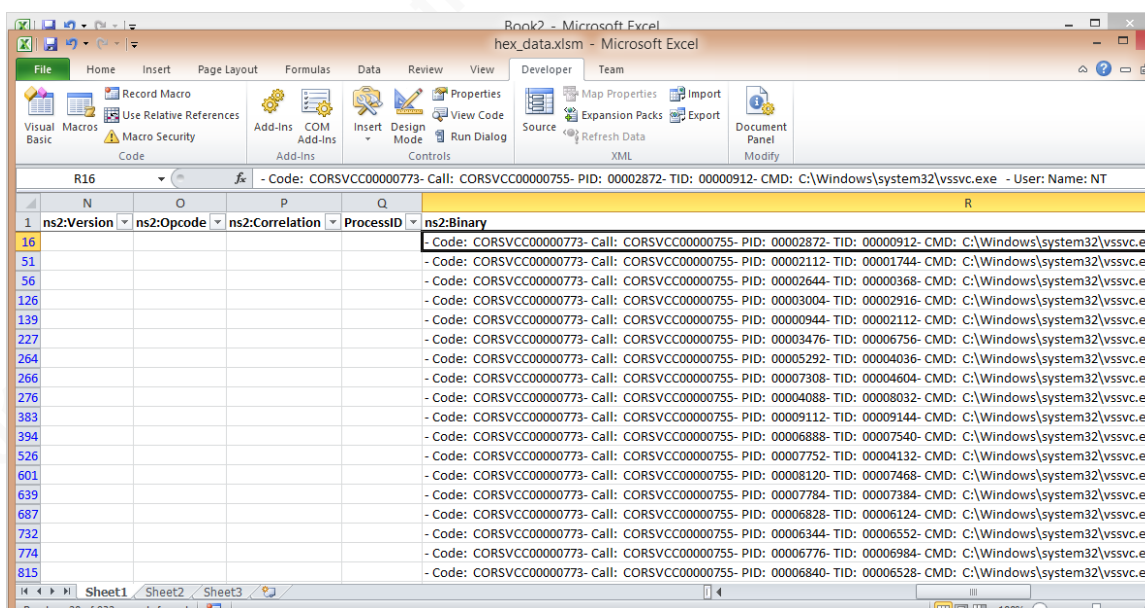


Figure 70. Hex Data Converted to ASCII Data. (Lee, 2014, digital case files)

Once you have fixed all the data conversion issues, it is a simple matter of finding the columns to keep, applying the headers, formatting the spreadsheet and putting the columns in the correct order (Figure 71). Once complete, you can begin to search for artifacts of interest.



Date/Time	Account	Computer	Description	Details
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectUserSid	S-1-5-19
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectUserName	LOCAL SERVICE
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectDomainName	NT AUTHORITY
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectLogonId	0x3e5
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	ObjectServer	LSA
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	ObjectType	-
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	ObjectName	-
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	HandleId	0x0
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	AccessMask	16777216
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	PrivilegeList	SeSecurityPrivilege
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	ProcessId	0x228
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	ProcessName	C:\Windows\System32\lsass.exe
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectUserSid	S-1-5-19
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectUserName	LOCAL SERVICE
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectDomainName	NT AUTHORITY
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	SubjectLogonId	0x3e5
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	ObjectServer	LSA
04/08/2012 11:32:37		WKS-WIN764BITB.shieldbase.local	ObjectType	-

Figure 71. Final Formatted Spreadsheet from XML Data. (Lee, 2014, digital case files)

One last note on XML exported data. Each row does not correspond with only one Event Viewer log entry. There are multiple rows for each Event Viewer log entry identified by an 'EventRecordID' as shown in Figure 72. Therefore, when there is a hit on a keyword search, don't just copy over that one row to the master IOC file, but all the rows that have the same 'EventRecordID' number.

Description	Details	Properties	Miscellaneous	Artifact
104 TargetDomainName	SHIELDDBASE.LOCAL	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
105 TargetLogonGuid	{E8809E1A-5A8D-2B38-DF63-943347931D69}	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
106 TargetServerName	wks-win764bitb\$	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
107 TargetInfo	wks-win764bitb\$	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
108 ProcessId	0x514	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
109 ProcessName	C:\Windows\System32\taskhost.exe	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
110 IpAddress	-	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
111 IpPort	-	Event ID: 4648	EventRecordID: 981770	Microsoft-Windows-Security-Auditing
112 TargetUserSid	S-1-5-18	Event ID: 4634	EventRecordID: 981769	Microsoft-Windows-Security-Auditing
113 TargetUserName	WKS-WIN764BITB\$	Event ID: 4634	EventRecordID: 981769	Microsoft-Windows-Security-Auditing
114 TargetDomainName	SHIELDDBASE	Event ID: 4634	EventRecordID: 981769	Microsoft-Windows-Security-Auditing
115 TargetLogonId	0x881120	Event ID: 4634	EventRecordID: 981769	Microsoft-Windows-Security-Auditing
116 LogonType	3	Event ID: 4634	EventRecordID: 981769	Microsoft-Windows-Security-Auditing
117 SubjectUserSid	S-1-0-0	Event ID: 4624	EventRecordID: 981768	Microsoft-Windows-Security-Auditing
118 SubjectUserName	-	Event ID: 4624	EventRecordID: 981768	Microsoft-Windows-Security-Auditing
119 SubjectDomainName	-	Event ID: 4624	EventRecordID: 981768	Microsoft-Windows-Security-Auditing
120 SubjectLogonId	0x0	Event ID: 4624	EventRecordID: 981768	Microsoft-Windows-Security-Auditing
121 TargetUserSid	S-1-5-18	Event ID: 4624	EventRecordID: 981768	Microsoft-Windows-Security-Auditing

Figure 72. Event Record IDs in XML Exported Data. (Lee, 2014, digital case files)

### 8.4.2. ShimCache Entries

We produced the ShimCache output used in this example by running the ShimCacheParser python tool against a Windows 7 SYSTEM registry file:

```
ShimCacheParser.py -i system -o System_Shim.csv
```

Open the .CSV output file in Excel and then save it as an Excel macro-enabled workbook file with an .XLSM file extension. Apply the Standard Format macro for a consistent look. (Figure 73).

	A	B	C	D	E
	Last Modified	Last Update	Path	File Size	Exec Flag
1	01/12/2011 12:08:00	N/A	C:\Program Files (x86)\McAfee\VirusScan Enterprise\mfeann.exe	N/A	TRUE
2	11/20/2010 13:24:52	N/A	C:\Windows\system32\LogonUI.exe	N/A	TRUE
3	05/04/2011 05:19:28	N/A	C:\Windows\system32\SearchFilterHost.exe	N/A	TRUE
4	05/04/2011 05:19:28	N/A	C:\Windows\system32\SearchProtocolHost.exe	N/A	TRUE
5	07/14/2009 01:39:11	N/A	C:\Windows\system32\gpscript.exe	N/A	TRUE
6	12/29/2011 08:06:20	N/A	C:\Program Files (x86)\Jetico\BCWipe\BCWipeTM.exe	N/A	TRUE
7	03/28/2011 11:26:14	N/A	C:\Program Files (x86)\Jetico\BCWipe\BCWipeSvc.exe	N/A	TRUE
8	06/23/2011 03:08:24	N/A	C:\Windows\BCUninstall.exe	N/A	TRUE
9	07/14/2009 01:14:18	N/A	C:\Windows\SysWOW64\DllHost.exe	N/A	TRUE
10	07/14/2009 01:39:06	N/A	C:\Windows\system32\DllHost.exe	N/A	TRUE
11	11/20/2010 13:32:57	N/A	C:\Windows\system32\consent.exe	N/A	TRUE
12	11/20/2010 13:24:22	N/A	C:\Windows\System32\appwiz.cpl	N/A	FALSE
13	01/04/2012 10:44:20	N/A	C:\Windows\System32\ntshrui.dll	N/A	FALSE
14	11/20/2010 13:25:59	N/A	C:\Windows\System32\csui.dll	N/A	FALSE
15	07/14/2009 01:40:36	N/A	C:\Windows\System32\EhStorShell.dll	N/A	FALSE
16	07/14/2009 01:39:46	N/A	C:\Windows\System32\svchost.exe	N/A	TRUE
17	11/20/2010 13:25:27	N/A	C:\Windows\system32\vssvc.exe	N/A	TRUE
18	11/20/2010 13:27:24	N/A	C:\Windows\System32\remotevg.dll	N/A	FALSE

Figure 73. Parsed ShimCache Data Standard Look. (Lee, 2014, digital case files)

In this data, there are a few things to note. First, since the date and time represent the Last Modified date of the executable, in the ‘Miscellaneous’ column it will be noted as such so that there is less confusion when looking at the final data in a timeline of events. Second, the ‘Exec Flag’ column needs to express that statement to understand what the ‘TRUE’ and ‘FALSE’ entries represent. Third, since there are not enough columns to match the headers we want, it is OK to leave the cells blank under those extra headers. Finally, we need to insert a column for the name of the computer. The final view of the ShimCache Excel spreadsheet should look like Figure 74.

	A	B	C	D	E	F	G
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous
14	07/14/2009 01:14:31		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\SysWOW64\rundll32.exe		Date/Time reflects Last Modified date
15	07/14/2009 01:14:42		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\SysWOW64\tasklist.exe		Date/Time reflects Last Modified date
16	07/14/2009 01:14:42		WKS-WIN764BITB	File Execution: FALSE	C:\Windows\system32\tasklist.exe		Date/Time reflects Last Modified date
17	07/14/2009 01:14:45		WKS-WIN764BITB	File Execution: TRUE	C:\Program Files (x86)\Windows Mail\WinMail.exe		Date/Time reflects Last Modified date
18	07/14/2009 01:15:14		WKS-WIN764BITB	File Execution: FALSE	C:\Windows\SysWOW64\ehstorshell.dll		Date/Time reflects Last Modified date
19	07/14/2009 01:38:52		WKS-WIN764BITB	File Execution: FALSE	C:\Windows\System32\wscui.cpl		Date/Time reflects Last Modified date
20	07/14/2009 01:38:53		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\system32\scrnsave.scr		Date/Time reflects Last Modified date
21	07/14/2009 01:38:57		WKS-WIN764BITB	File Execution: FALSE	C:\Windows\system32\calc.exe		Date/Time reflects Last Modified date
22	07/14/2009 01:39:01		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\system32\control.exe		Date/Time reflects Last Modified date
23	07/14/2009 01:39:02		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\system32\defrag.exe		Date/Time reflects Last Modified date
24	07/14/2009 01:39:06		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\system32\DIHHost.exe		Date/Time reflects Last Modified date
25	07/14/2009 01:39:06		WKS-WIN764BITB	File Execution: FALSE	C:\Windows\system32\displayswitch.exe		Date/Time reflects Last Modified date
26	07/14/2009 01:39:07		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\system32\Drvinst.exe		Date/Time reflects Last Modified date
27	07/14/2009 01:39:08		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\system32\Dwm.exe		Date/Time reflects Last Modified date
28	07/14/2009 01:39:08		WKS-WIN764BITB	File Execution: FALSE	C:\Program Files\DVD Maker\DVDMaker.exe		Date/Time reflects Last Modified date
29	07/14/2009 01:39:09		WKS-WIN764BITB	File Execution: FALSE	C:\Windows\ehome\ehshell.exe		Date/Time reflects Last Modified date
30	07/14/2009 01:39:11		WKS-WIN764BITB	File Execution: TRUE	C:\Windows\system32\gpscript.exe		Date/Time reflects Last Modified date
31	07/14/2009 01:39:13		WKS-WIN764BITB	File Execution: FALSE	C:\Windows\system32\iscsipl.exe		Date/Time reflects Last Modified date

Figure 74. ShimCache Final Formatting. (Lee, 2014, digital case files)

### 8.4.3. Shellbags

We produced the Shellbags output used in this example by running the Shellbags Explorer tool against a Windows 7 USRCLASS.DAT registry file:

```
Sbcmd.exe --timezone="UTC" -d <path to directory containing usrclass.dat>
```

The output of the above command produces a tab delimited file with a .TSV extension. Import the file into Excel, choose TAB as the delimiter in the 'Text Import Wizard' and save it as an .XLSM file to run Macro's against the data (Figure 75).

nfury.xlsm - Microsoft Excel

FileHomeInsertPage LayoutFormulasDataReviewViewDeveloperTeam

Paste

Clipboard

Calibri11

Figure 75. Shellbags .TSV file imported into Excel. (Lee, 2014, digital case files)

Microsoft Office UserMicrosoft Office UserGreg Lalla, greg.lalla@mail.comMicrosoft Office User



Apply the Standard Format macro and delete the following columns in this order: R, O, N, M, J, I, H, G, F, D, C, B, A. You'll notice that the dates include a UTC offset value of '+00:00' (Figure 76). This value will need to be removed to have the Date/Time column properly formatted. The removal of the offset can be done with a simple search and replace.

AbsolutePath	CreatedOn	ModifiedOn	AccessedOn	LastWriteTime
Desktop\Control Panel\System and Security\Windows Update				03/05/2012 13:41:32
Desktop\Control Panel\System and Security\System				03/05/2012 13:41:32
Desktop\Control Panel\System and Security\Windows Update\Change settings				09/08/2011 20:54:30
Desktop\Control Panel\System and Security\Windows Update\Select updates to install				09/08/2011 20:54:30
Desktop\Control Panel\Programs\Programs and Features				09/08/2011 20:48:15
Desktop\Shared Documents Folder (Users Files)\Downloads				04/01/2012 13:33:27
Desktop\Shared Documents Folder (Users Files)\AppData	11/10/2010 07:50:38 +00:00	11/10/2010 07:50:40 +00:00	11/10/2010 07:50:40 +00:00	04/01/2012 13:33:27
Desktop\Shared Documents Folder (Users Files)\Documents				04/01/2012 13:33:27
Desktop\Shared Documents Folder (Users Files)\AppData\Roaming	11/10/2010 07:50:38 +00:00	08/28/2011 20:38:04 +00:00	08/28/2011 20:38:04 +00:00	08/28/2011 22:42:03
Desktop\Shared Documents Folder (Users Files)\AppData\Roaming\Skype	08/25/2011 21:52:38 +00:00	08/28/2011 22:41:58 +00:00	08/28/2011 22:41:58 +00:00	08/28/2011 22:42:03
Desktop\Shared Documents Folder (Users Files)\AppData\Roaming\Skype\Pictures	08/25/2011 21:56:24 +00:00	08/25/2011 21:56:24 +00:00	08/25/2011 21:56:24 +00:00	08/28/2011 22:42:03
Desktop\Shared Documents Folder (Users Files)\Documents\StarFury				04/01/2012 13:34:55
Desktop\Shared Documents Folder (Users Files)\Documents\StarFury\StarFury	03/12/2012 20:50:08 +00:00	03/12/2012 20:50:16 +00:00	03/12/2012 20:50:16 +00:00	03/12/2012 20:50:19
Desktop\Computers and Devices\controller				03/15/2012 22:12:38
Desktop\Computers and Devices\System and Security				03/15/2012 22:12:38
Desktop\Computers and Devices\All Control Panel Items				03/15/2012 22:12:38
Desktop\Computers and Devices\controller\controller\WebDavShare				03/15/2012 22:12:38
Desktop\Computers and Devices\controller\Network Connections				03/15/2012 22:12:38

Figure 76. Dates contain a UTC Offset. (Lee, 2014, digital case files)

After removing the offset and formatting the date and times correctly, the result should look like Figure 77.

AbsolutePath	CreatedOn	ModifiedOn	AccessedOn	LastWriteTime	FirstExplored
Desktop\Control Panel\All Control Panel Items\System				03/15/2012 22:12:38	11/10/2010 08:16:02
Desktop\Control Panel\All Control Panel Items\Security Tools	08/24/2011 16:47:00	03/15/2012 22:07:04	03/15/2012 22:07:04	03/15/2012 22:12:38	
Desktop\Control Panel\All Control Panel Items\Security Tools\BC Wipe	03/15/2012 22:07:00	03/15/2012 22:07:08	03/15/2012 22:07:08	03/15/2012 22:12:38	
Desktop\Control Panel\System and Security\Windows Update				03/05/2012 13:41:32	
Desktop\Control Panel\System and Security\System				03/05/2012 13:41:32	
Desktop\Control Panel\System and Security\Windows Update\Change settings				09/08/2011 20:54:30	
Desktop\Control Panel\System and Security\Windows Update\Select updates to install				09/08/2011 20:54:30	
Desktop\Control Panel\Programs\Programs and Features				09/08/2011 20:48:15	
Desktop\Shared Documents Folder (Users Files)\Downloads				04/01/2012 13:33:27	
Desktop\Shared Documents Folder (Users Files)\AppData	11/10/2010 07:50:38	11/10/2010 07:50:40	11/10/2010 07:50:40	04/01/2012 13:33:27	
Desktop\Shared Documents Folder (Users Files)\Documents				04/01/2012 13:33:27	
Desktop\Shared Documents Folder (Users Files)\AppData\Roaming	11/10/2010 07:50:38	08/28/2011 20:38:04	08/28/2011 20:38:04	08/28/2011 22:42:03	
Desktop\Shared Documents Folder (Users Files)\AppData\Roaming\Skype	08/25/2011 21:52:38	08/28/2011 22:41:58	08/28/2011 22:41:58	08/28/2011 22:42:03	
Desktop\Shared Documents Folder (Users Files)\AppData\Roaming\Skype\Pictures	08/25/2011 21:56:24	08/25/2011 21:56:24	08/25/2011 21:56:24	08/28/2011 22:42:03	
Desktop\Shared Documents Folder (Users Files)\Documents\StarFury				04/01/2012 13:34:55	
Desktop\Shared Documents Folder (Users Files)\Documents\StarFury\StarFury	03/12/2012 20:50:08	03/12/2012 20:50:16	03/12/2012 20:50:16	03/12/2012 20:50:19	
Desktop\Computers and Devices\controller				03/15/2012 22:12:38	
Desktop\Computers and Devices\System and Security				03/15/2012 22:12:38	

Figure 77. Standard Format with Dates and Times fixed. (Lee, 2014, digital case files)

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There are six columns of Dates and Times. For this paper, the information sought is the first date the resource was accessed and the last date the resource was accessed. Manually going through all the entries and getting those two dates for each resource would consume too much time. To make finding the two dates and sorting the Date/Time column easier, we have provided VBA code on the GitHub site called ‘Shellbags\_Standard\_Format\_Module.bas’ ([https://github.com/gregory-lalla/GCIH\\_Gold/blob/master/Code/Singles/Module\\_BAS\\_Files/Shellbags/Shellbags\\_Standard\\_Format\\_Module.bas](https://github.com/gregory-lalla/GCIH_Gold/blob/master/Code/Singles/Module_BAS_Files/Shellbags/Shellbags_Standard_Format_Module.bas)) which will automatically do the work for you. The script will produce two rows for each entry. One for the first time it was accessed and one for the last time it was accessed. If there is only one date for the entry or the dates shown are the same or within 3 seconds of each other, then only one row will be produced for that entry. Figure 78 shows the result of running the VBA code.

A	B	C	D	E	F	G	H
Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifact
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\Control Panel			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\Shared Documents Folder (Users Files)			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\Computers and Devices			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\My Computer			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\User Libraries			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\Recycle bin			Shellbags
08/22/2011 16:59:13	nfury	Win764bitb	First Accessed	Desktop\Recycle bin			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\Recent Places			Shellbags
04/01/2012 13:35:32	nfury	Win764bitb	First Accessed	Desktop\Recent Places			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\Common Places			Shellbags
04/01/2012 13:36:20	nfury	Win764bitb	First Accessed	Desktop\Common Places			Shellbags
04/06/2012 18:52:10	nfury	Win764bitb	Last Accessed	Desktop\Search Folder			Shellbags
04/06/2012 18:42:33	nfury	Win764bitb	First Accessed	Desktop\Search Folder			Shellbags
04/06/2012 13:10:45	nfury	Win764bitb	Last Accessed	Desktop\Control Panel\Appearance and Personalization			Shellbags
04/06/2012 13:10:45	nfury	Win764bitb	Last Accessed	Desktop\Control Panel\All Control Panel Items			Shellbags
04/06/2012 13:10:45	nfury	Win764bitb	Last Accessed	Desktop\Control Panel\System and Security			Shellbags
04/06/2012 13:10:45	nfury	Win764bitb	Last Accessed	Desktop\Control Panel\Programs			Shellbags
04/06/2012 13:10:45	nfury	Win764bitb	Last Accessed	Desktop\Control Panel\Hardware and Sound			Shellbags

Figure 78. Shellbags View after running Shellbags\_Date\_Sorter code. (Lee, 2014, digital case files)

#### 8.4.4. AutoRun Entries

To parse autorun data, we run the autorunsc.exe command against the registry files of a system. This parsing can be done offline by mounting an image of the system and pointing the tool to the mapped drive:

```
Autorunsc.exe -a * -c -m -s -z M:\Windows M:\Users\<profilename> >
autoruns_profilename.csv
```

The options in the above command are:

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- a \*: Check All
- c: CVS output - need to direct to a file
- m: Hide Microsoft Verified Signed
- s: Check signature
- z: offline analysis

Open the resulting .CSV file in Excel and apply the standard formatting (Figure 79).

	A	B	C	D	E	F
	Entry Location	Entry	Enabled	Category	Description	Publisher
535	HKLM\SOFTWARE\Classes\Protocols\Filter	application/octet-stream	enabled	Explorer	Microsoft .NET Runtime Execution Engine	(Verified) Microsoft Windows
536	HKLM\SOFTWARE\Classes\Protocols\Filter	application/x-complus	enabled	Explorer	Microsoft .NET Runtime Execution Engine	(Verified) Microsoft Windows
537	HKLM\SOFTWARE\Classes\Protocols\Filter	application/x-msdownload	enabled	Explorer	Microsoft .NET Runtime Execution Engine	(Verified) Microsoft Windows
538	HKLM\SOFTWARE\Classes\Protocols\Filter	text/xml	enabled	Explorer	Microsoft Office XML MIME Filter	(Verified) Microsoft Corporation
539	HKLM\SOFTWARE\Classes\Protocols\Handler	about	enabled	Explorer	Microsoft (R) HTML Viewer	(Verified) Microsoft Windows
540	HKLM\SOFTWARE\Classes\Protocols\Handler	cdl	enabled	Explorer	OLE32 Extensions for Win32	(Verified) Microsoft Windows
541	HKLM\SOFTWARE\Classes\Protocols\Handler	dvd	enabled	Explorer	ActiveX control for streaming video	(Verified) Microsoft Windows
542	HKLM\SOFTWARE\Classes\Protocols\Handler	file	enabled	Explorer	OLE32 Extensions for Win32	(Verified) Microsoft Windows
543	HKLM\SOFTWARE\Classes\Protocols\Handler	ftp	enabled	Explorer	OLE32 Extensions for Win32	(Verified) Microsoft Windows
544	HKLM\SOFTWARE\Classes\Protocols\Handler	http	enabled	Explorer	OLE32 Extensions for Win32	(Verified) Microsoft Windows
545	HKLM\SOFTWARE\Classes\Protocols\Handler	https	enabled	Explorer	OLE32 Extensions for Win32	(Verified) Microsoft Windows
546	HKLM\SOFTWARE\Classes\Protocols\Handler	its	enabled	Explorer	Microsoft® InfoTech Storage System Library	(Verified) Microsoft Windows
547	HKLM\SOFTWARE\Classes\Protocols\Handler	javascript	enabled	Explorer	Microsoft (R) HTML Viewer	(Verified) Microsoft Windows
548	HKLM\SOFTWARE\Classes\Protocols\Handler	local	enabled	Explorer	OLE32 Extensions for Win32	(Verified) Microsoft Windows
549	HKLM\SOFTWARE\Classes\Protocols\Handler	mailto	enabled	Explorer	Microsoft (R) HTML Viewer	(Verified) Microsoft Windows
550	HKLM\SOFTWARE\Classes\Protocols\Handler	mhtml	enabled	Explorer	Microsoft Internet Messaging API Resources	(Verified) Microsoft Windows
551	HKLM\SOFTWARE\Classes\Protocols\Handler	mk	enabled	Explorer	OLE32 Extensions for Win32	(Verified) Microsoft Windows
552	HKLM\SOFTWARE\Classes\Protocols\Handler	ms-help	enabled	Explorer	Microsoft® Help Data Services Module	(Not verified) Microsoft Corporation

Figure 79. Autoruns Standard Formatting. (Lee, 2014, digital case files)

You should delete the following columns: Enabled, Category, Publisher, MD5, SHA-1, and SHA-256. Two columns, 'Entry Location' and 'Entry' can be combined into one column to preserve data that might not fit into the suggested columns used in this paper (Figure 80).

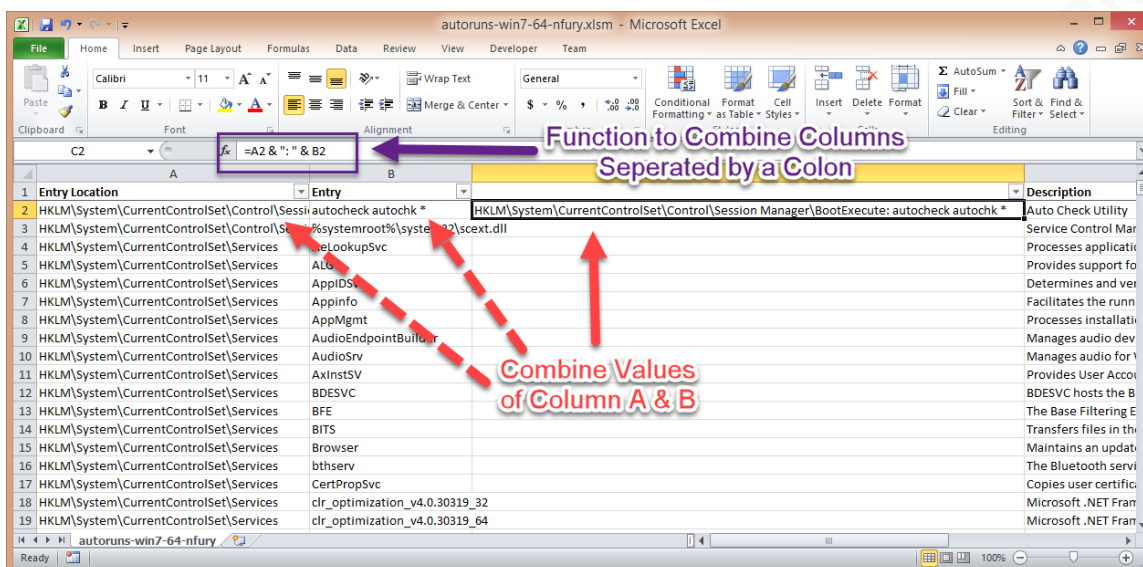


Figure 80. Combine Entry Location and Entry. (Lee, 2014, digital case files)

The combined columns should look like Column A in Figure 81.

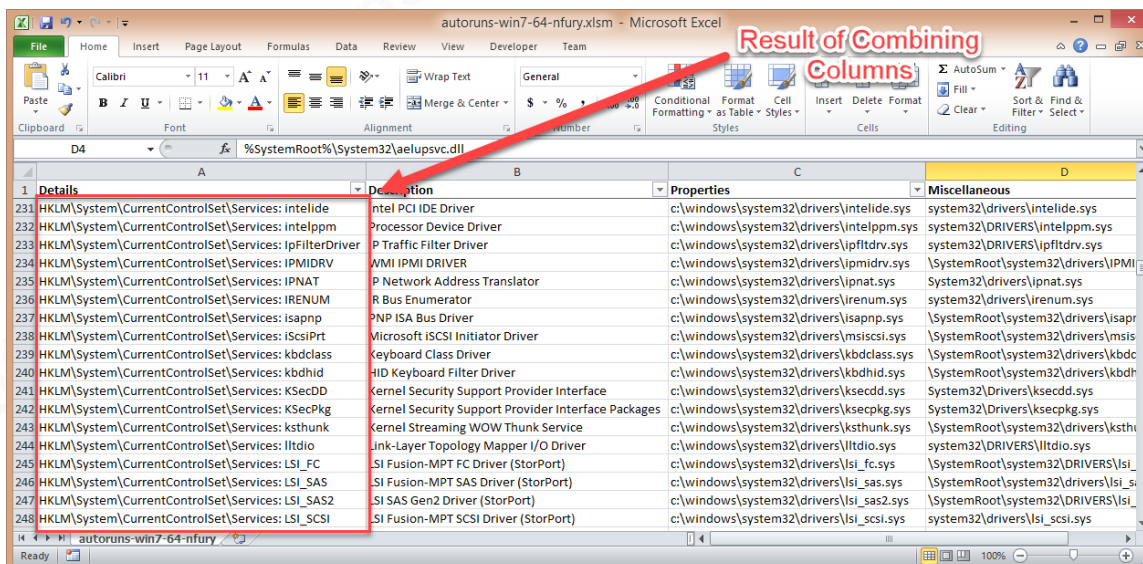


Figure 81. The result of Combining Columns. (Lee, 2014, digital case files)

#### 8.4.5. Web Browser Logs

The example in this section will use the tool PASCO to parse the Internet Explorer files:

*pasco.exe <path>*

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After you run the above command, open the resulting TSV file in Excel using tab as the delimiter. You should manually delete the first two rows which are not needed (Figure 82).

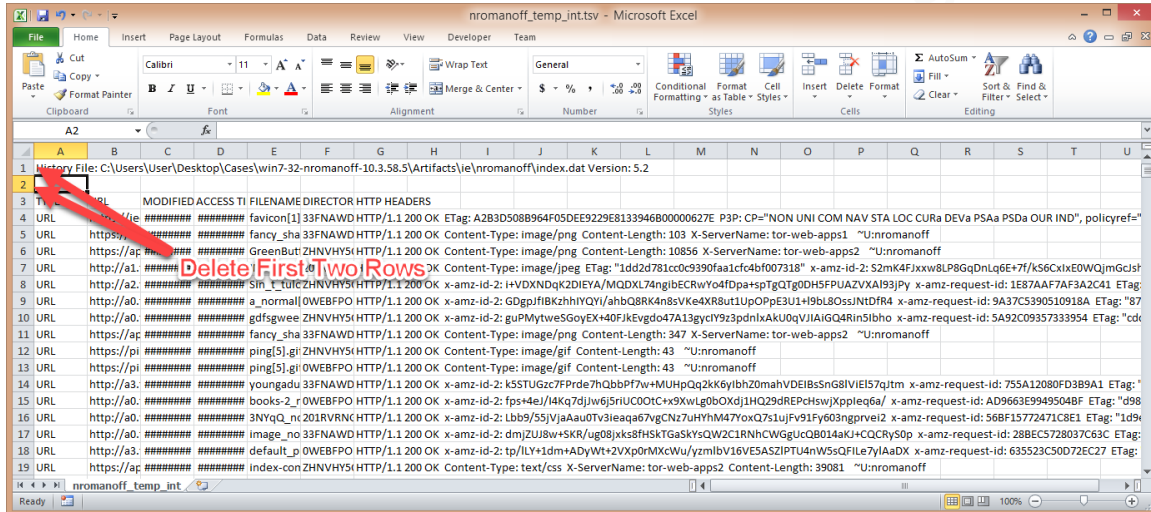


Figure 82. Delete first two rows. (Lee, 2014, digital case files)

You should delete the following columns: Modified Time, and Directory. Change the 'ACCESS TIME' column formatting to 'mm/dd/yyyy hh:mm:ss' and move that column to Column 'A.' Apply the standard formatting and headers and then manually fill in the missing values in the empty columns. Once complete, it should appear like Figure 83.

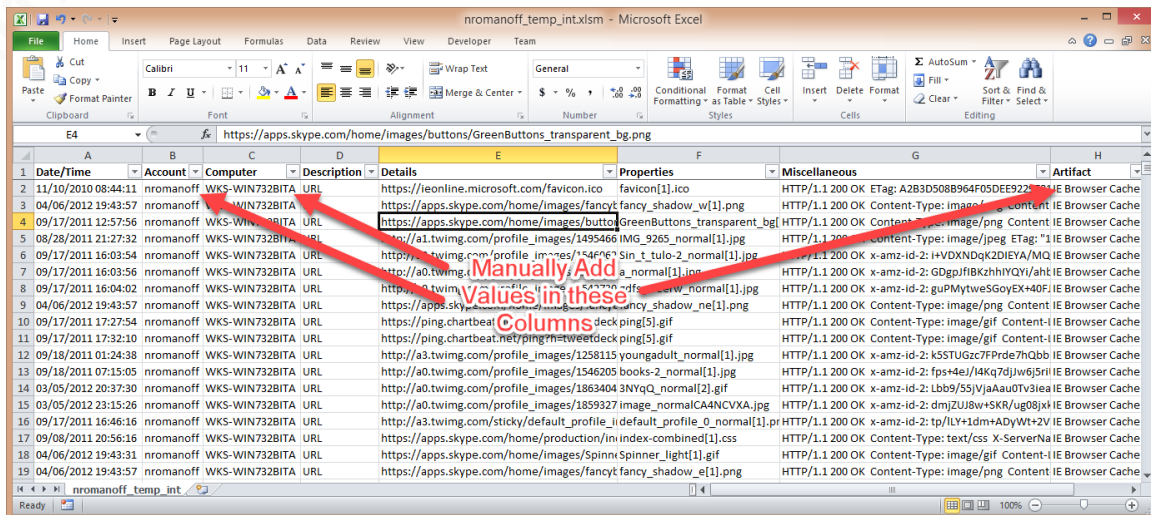


Figure 83. Final look. (Lee, 2014, digital case files)

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### 8.4.6. MFT Entries

We produced the MFT output used in this example by running the analyzeMFT python tool against a Windows 7 \$MFT file:

```
C:\Python27\python.exe analyzeMFT.py -f $MFT -w -o MFT.csv
```

After running this command and importing the .CSV output file into Excel, you'll notice that there is a lot of data. You'll also notice that the Date/Time values are not in the correct format which will need to be corrected (Figure 84).

Microsoft Excel

FileHomeInsertPage LayoutFormulasDataReviewViewDeveloperTeam

CutCopyFormat Painter

Clipboard

Calibri11

Figure 84. Correct Date/Time values. (Lee, 2014, digital case files)

You will delete most of the columns in this spreadsheet as they will not be used in the analysis. The only columns you should keep are those titled: Record Number; Filename #1; Std Info Creation date; Std Info Modification date; Std Info Entry date; FN Info Creation date; FN Info Modification date; and FN Info Entry date (Figure 85).

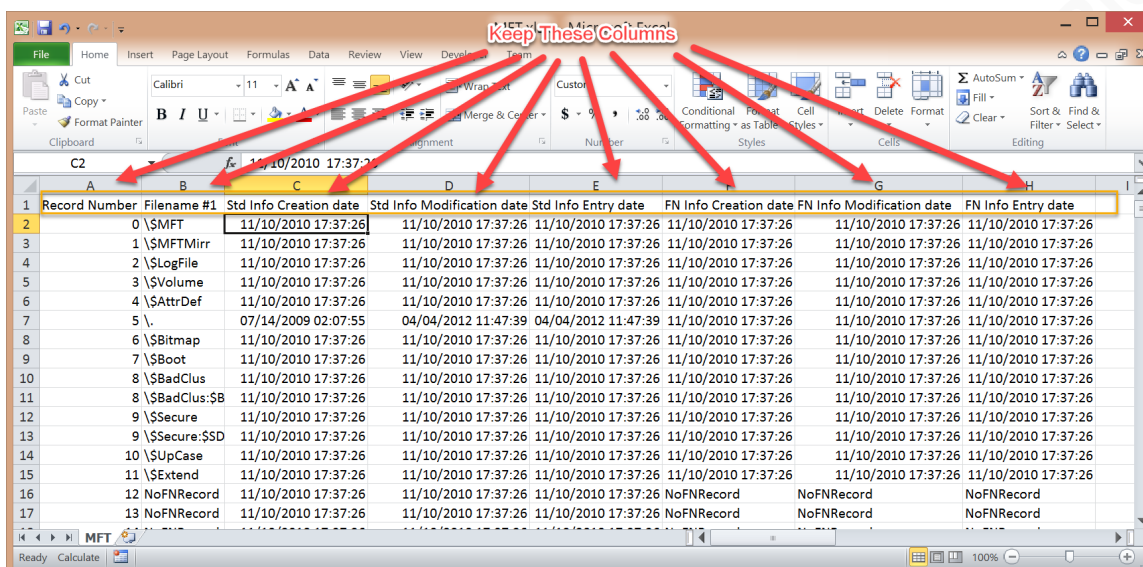


Figure 85. Columns to keep. (Lee, 2014, digital case files)

The output from parsing the MFT file will most likely contain missing or corrupt information. You can identify rows containing this bad data by examining the 'Filename #1' column for cells that contain either the string "NoFNRecord" or "Corrupt MFT Record" (Figure 86).

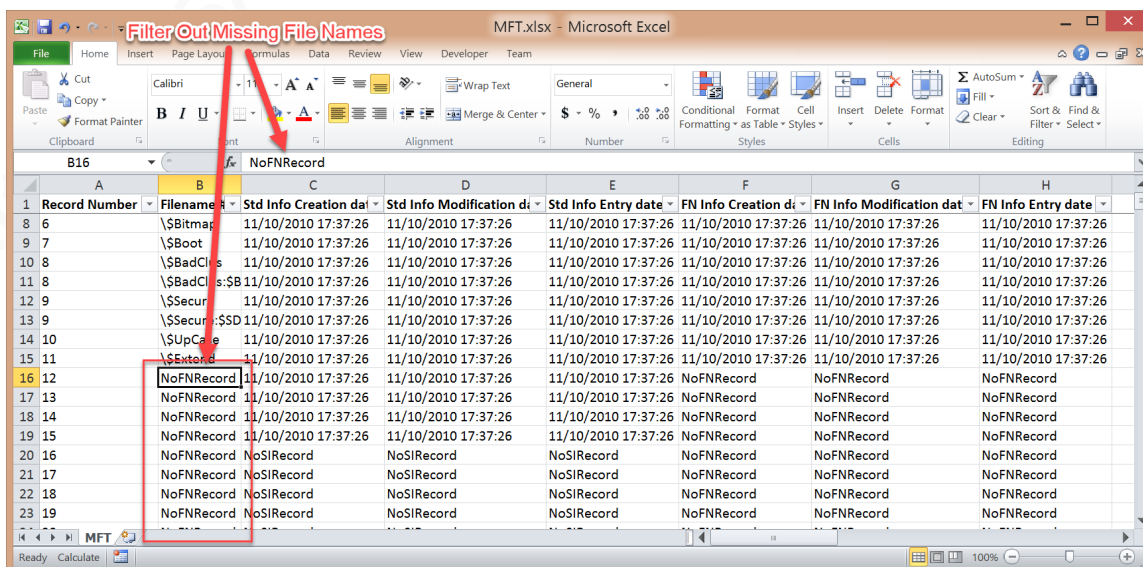


Figure 86. Corrupt data. (Lee, 2014, digital case files)

These entries can easily be removed by using the filter button on the 'Filename #1' column and filtering on those two phrases (Figure 87).



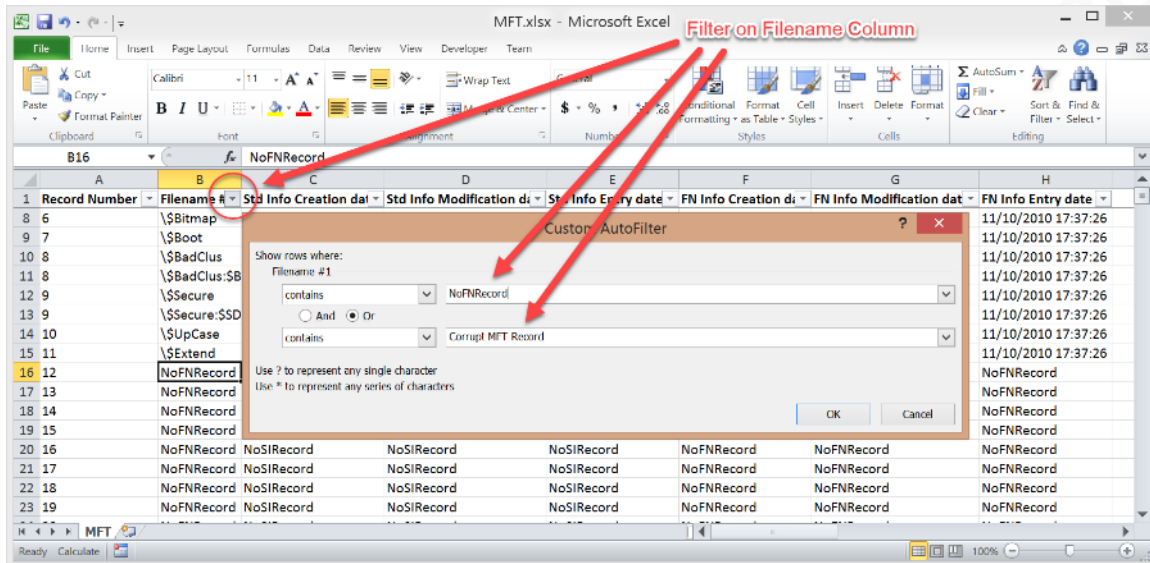


Figure 87. Filter out corrupt data. (Lee, 2014, digital case files)

Once you identify all the rows with those phrases, merely select them all and delete them (Figure 88).

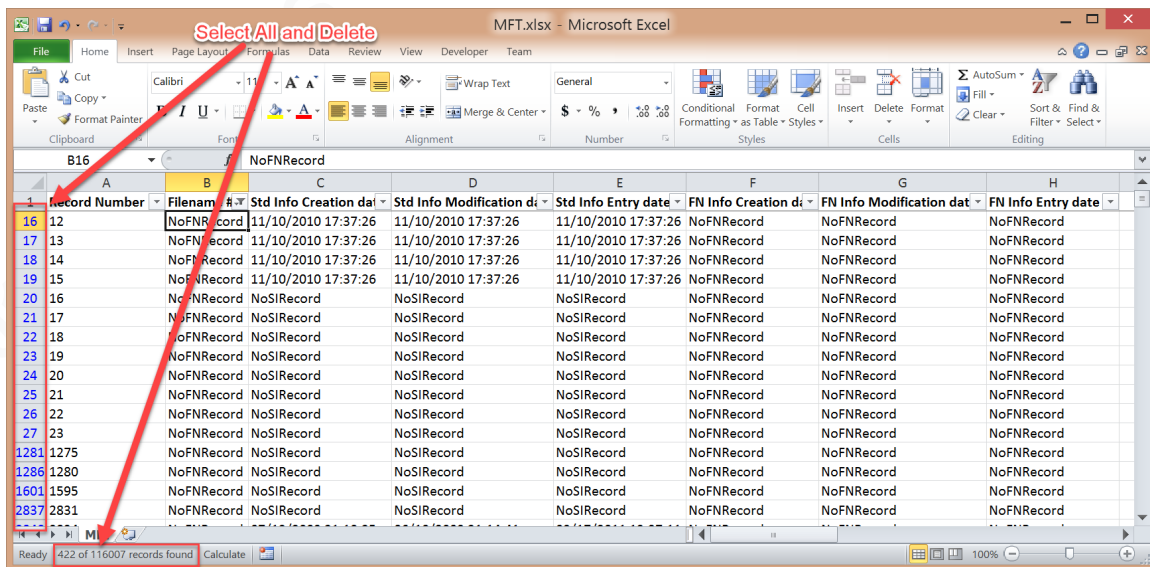


Figure 88. Delete corrupt data. (Lee, 2014, digital case files)

There are still too many columns to fit into our standard layout and too many timestamps to incorporate them all in a timeline chronology. To fix the layout, we select the 'FN Info Creation date' column to represent the chronology of the MFT entries, and we combine the remaining timestamps into two columns, one for the 'Std Info' timestamps and one for the remaining 'FN Info' timestamps (Figure 89).

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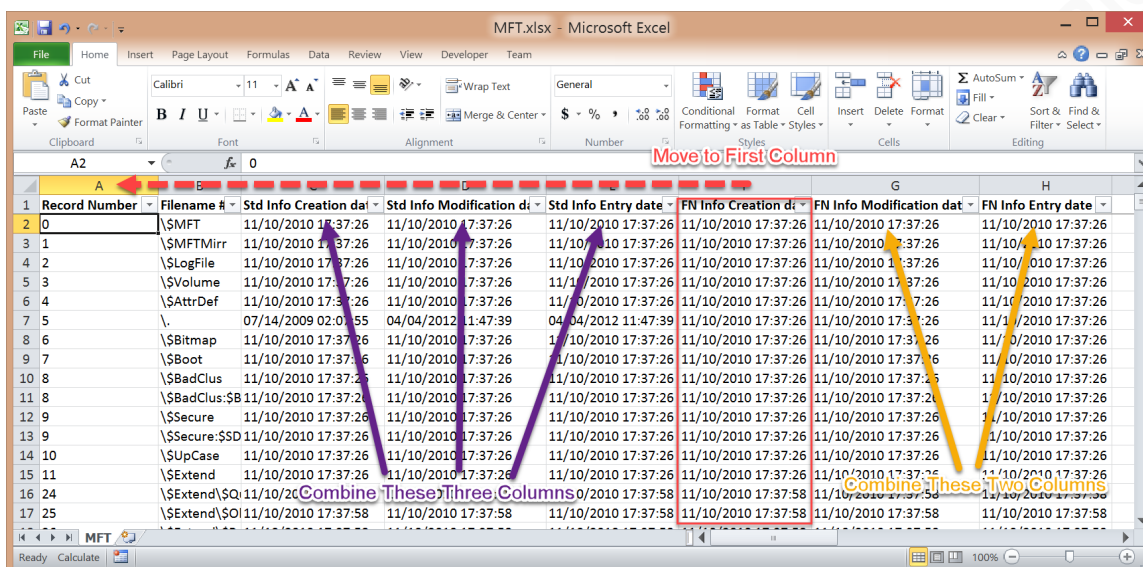


Figure 89. Combining Date/Time columns. (Lee, 2014, digital case files)

To combine the columns of timestamps and to display those timestamps in the correct format, a function will be used that specifically tells Excel how the values should look. The first function will combine the 'Std Info' timestamps (Figure 90).

= "Std Info - Create: " & TEXT(D2, "mm/dd/yyyy hh:mm:ss") & ", Modify: " & TEXT(E2, "mm/dd/yyyy hh:mm:ss") & ", Entry: " & TEXT(F2, "mm/dd/yyyy hh:mm:ss")

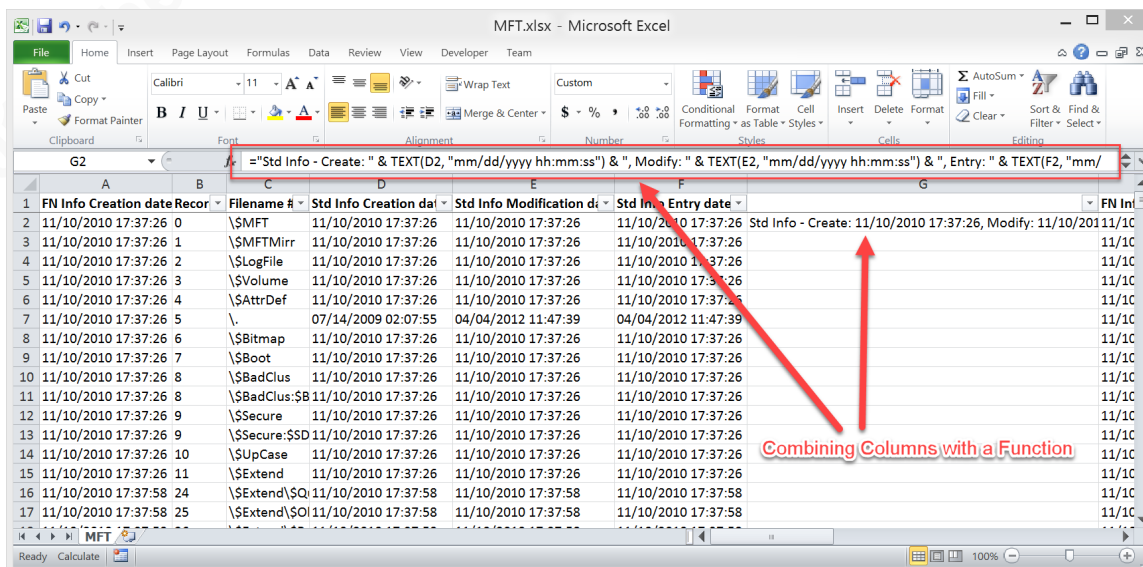


Figure 90. A function to combine columns. (Lee, 2014, digital case files)

The second function performs the same action, just on the 'FN Info' timestamps:

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= "FN Info - Modify: " & TEXT(G2, "mm/dd/yyyy hh:mm:ss") & ", Entry: " & TEXT(H2, "mm/dd/yyyy hh:mm:ss")

When dealing with a large set of data and filling a column with a function, you may run into an issue where the values in the cells do not match the formula applied to that cell (Figure 91 – Number 1). To fix this issue, on the 'Formula' ribbon, select the 'Calculate Now' button to refresh/recalculate the function formulas (Figure 91 – Number 2).

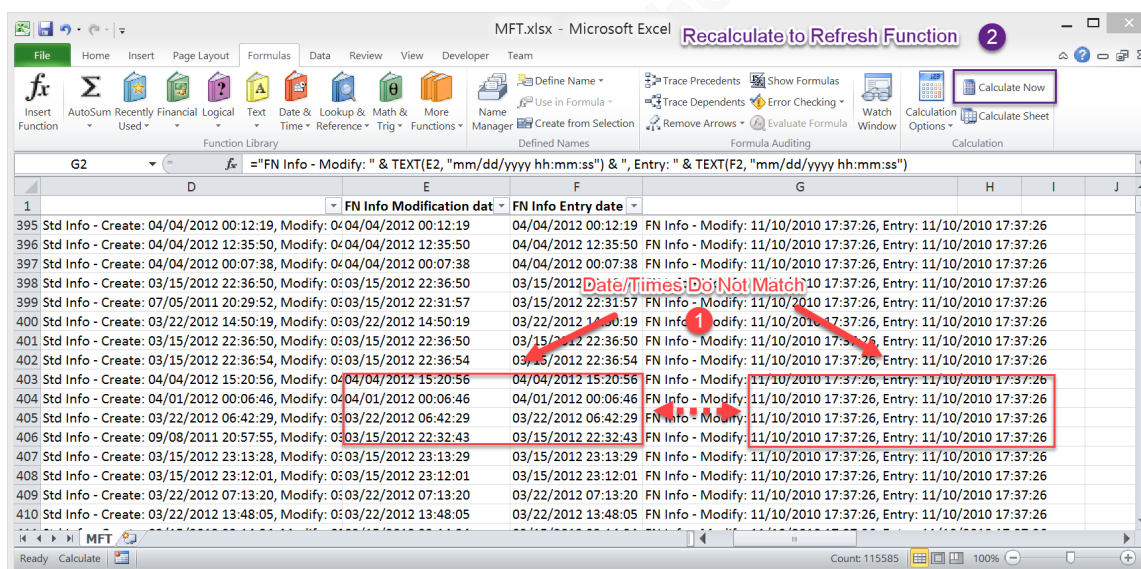


Figure 91. Recalculate function values. (Lee, 2014, digital case files)

The recalculated combined columns should look like Figure 92.

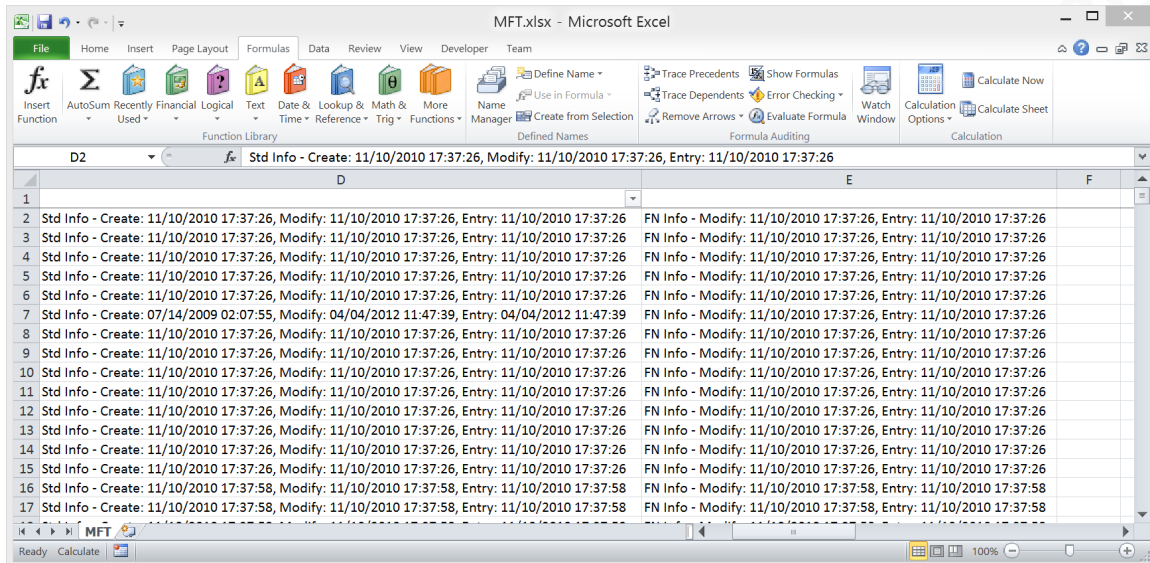


Figure 92. Date/Time column results. (Lee, 2014, digital case files)

A few final changes need to be made such as entering in the standard headers; creating and filling in the Artifacts column; moving the old ‘Record Number’ column to the ‘Miscellaneous’ column; and adding a prefix to the ‘Miscellaneous’ column for clarity (Figure 93).

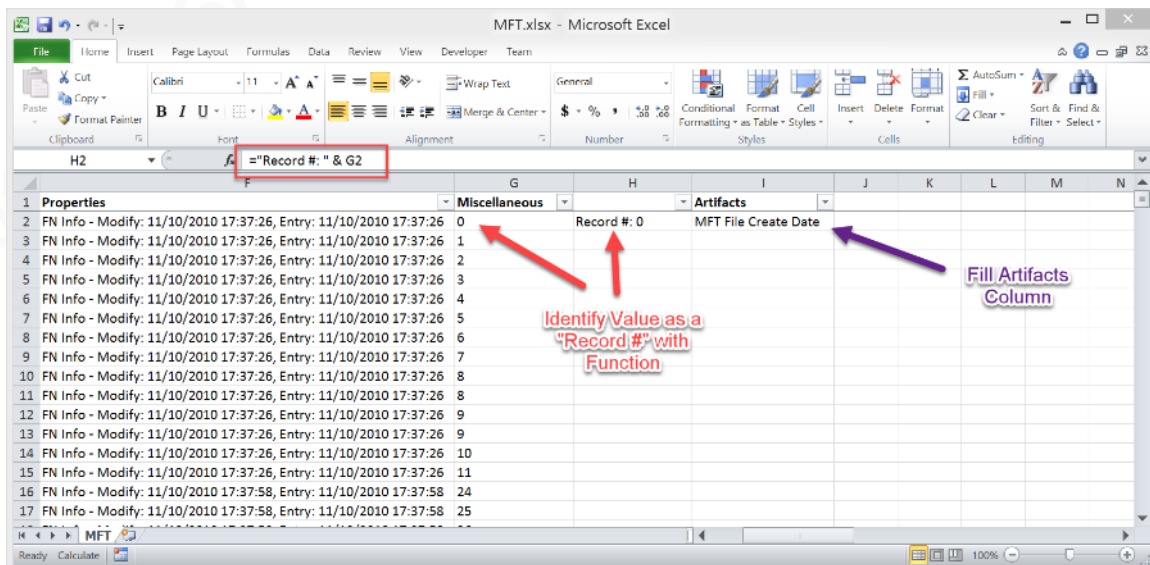


Figure 93. Moving ‘Record Number’ column and adding a prefix to columns. (Lee, 2014, digital case files)

The final output should look like Figure 94.

	A	B	C	D	E	F	G	H
	Date/Time	Account	Computer	Description	Details	Properties	Miscellaneous	Artifacts
1	11/10/2010 17:37:26			\\$MFT	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
2	11/10/2010 17:37:26			\\$MFTMirr	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
3	11/10/2010 17:37:26			\\$LogFile	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
4	11/10/2010 17:37:26			\\$Volume	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
5	11/10/2010 17:37:26			\\$AttrDef	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
6	11/10/2010 17:37:26			\.	Std Info - Create: 07/14/2009 02:07:55, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
7	11/10/2010 17:37:26			\\$Bitmap	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
8	11/10/2010 17:37:26			\\$Boot	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
9	11/10/2010 17:37:26			\\$BadClus	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
10	11/10/2010 17:37:26			\\$BadClus:\$Ba	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
11	11/10/2010 17:37:26			\\$Secure	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
12	11/10/2010 17:37:26			\\$Secure:\$SDS	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
13	11/10/2010 17:37:26			\\$UpCase	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
14	11/10/2010 17:37:26			\\$Extend	Std Info - Create: 11/10/2010 17:37:26, Mod FN Info - Modify: 11/10/2010 17:37:26			MFT File Create Date
15	11/10/2010 17:37:26			\\$Extend\\$(Qu	Std Info - Create: 11/10/2010 17:37:58, Mod FN Info - Modify: 11/10/2010 17:37:58			MFT File Create Date
16	11/10/2010 17:37:58			\\$Extend\\$(Obj	Std Info - Create: 11/10/2010 17:37:58, Mod FN Info - Modify: 11/10/2010 17:37:58			MFT File Create Date
17	11/10/2010 17:37:58							MFT File Create Date

Figure 94. Final output. (Lee, 2014, digital case files)

### 8.4.7. Prefetch Entries

We produced the Prefetch output used in this example by running the `parse_prefetch_info` tool against the prefetch directory of a Windows 7 system:

```
parse_prefetch_info.exe -p <Path to Prefetch Directory> -d <database_name> -w Vista -o <Path to Output Directory> -r csv
```

One of the files generated when running the above command is `prefetch_file_info.csv` which contains a nice summary of the prefetch file activities on the system. When you open the file and apply the standard formatting, you'll notice that the 'UTC time' column is not formatted properly (Figure 95).



Prefetch File Name	Actual File Name	Number Time Run	UTC time
A.EXE-8D56B1C4.pf	A.EXE	26	Wed Apr 4 00:43:06 2012
A.EXE-F91CBA0E.pf	A.EXE	1541	Sat Apr 7 16:22:10 2012
ACRORD32.EXE-33939BD1.pf	ACRORD32.EXE	4	Sun Apr 1 14:17:38 2012
ADOBEARM.EXE-ACA00A4A.pf	ADOBEARM.EXE	6	Fri Apr 6 19:43:04 2012
AT.EXE-E3131BD4.pf	AT.EXE	9	Fri Apr 6 13:41:09 2012
ATBROKER.EXE-FF58B71D.pf	ATBROKER.EXE	4	Wed Apr 4 12:21:04 2012
AUDIODG.EXE-D0D776AC.pf	AUDIODG.EXE	484	Fri Apr 6 19:42:18 2012
CMD.EXE-89305D47.pf	CMD.EXE	25	Fri Apr 6 19:00:47 2012
CONHOST.EXE-3218E401.pf	CONHOST.EXE	1436	Sat Apr 7 07:00:13 2012
CONSENT.EXE-65F6206D.pf	CONSENT.EXE	27	Wed Apr 4 20:05:23 2012
CONTROL.EXE-9459D5A0.pf	CONTROL.EXE	1	Wed Apr 4 20:03:16 2012
CSC.EXE-4EF173D0.pf	CSC.EXE	4	Sun Apr 1 05:00:38 2012
CSRSS.EXE-8C04D631.pf	CSRSS.EXE	39	Fri Apr 6 19:42:07 2012
CVTRES.EXE-419E4E46.pf	CVTRES.EXE	4	Sun Apr 1 05:00:38 2012
DEFRAG.EXE-738093E8.pf	DEFRAG.EXE	67	Thu Apr 5 11:54:26 2012
DLLHOST.EXE-6202E8F2.pf	DLLHOST.EXE	2	Wed Apr 4 15:37:11 2012
DLLHOST.EXE-6D52477E.pf	DLLHOST.EXE	1	Wed Apr 4 02:25:39 2012
DLLHOST.EXE-71214090.pf	DLLHOST.EXE	21	Thu Apr 5 15:51:47 2012

Figure 95. Fix date and times to match our standard format. (Lee, 2014, digital case files)

Unfortunately, Excel does not recognize these values as Dates or Times, so we'll need to fix it so that it does. All the information is there, but the order in which it appears is not quite right. To correct this, we will reorder the data. First, we highlight the 'UTC time' column and then click the 'Text to Columns' button on the 'Data' ribbon to separate the items using a 'Space' character as the delimiter (Figure 96).

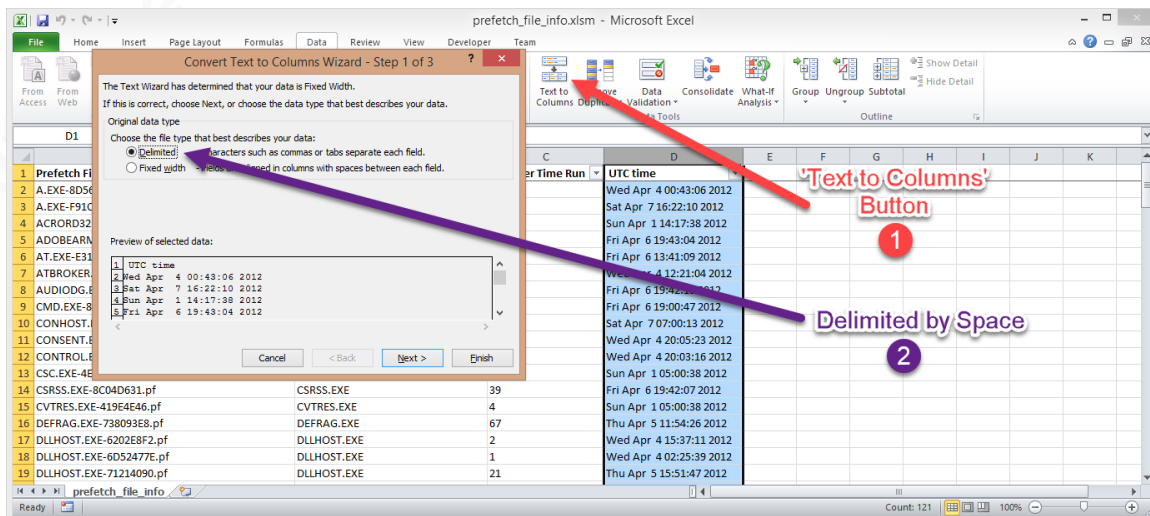


Figure 96. Text to columns to fix Date/Time. (Lee, 2014, digital case files)

Once each Date/Time item is in its own column, the following formula can be used to add them back together in the proper order (Figure 97):

$$=DATE(H2,MONTH(1&E2),F2) + G2$$

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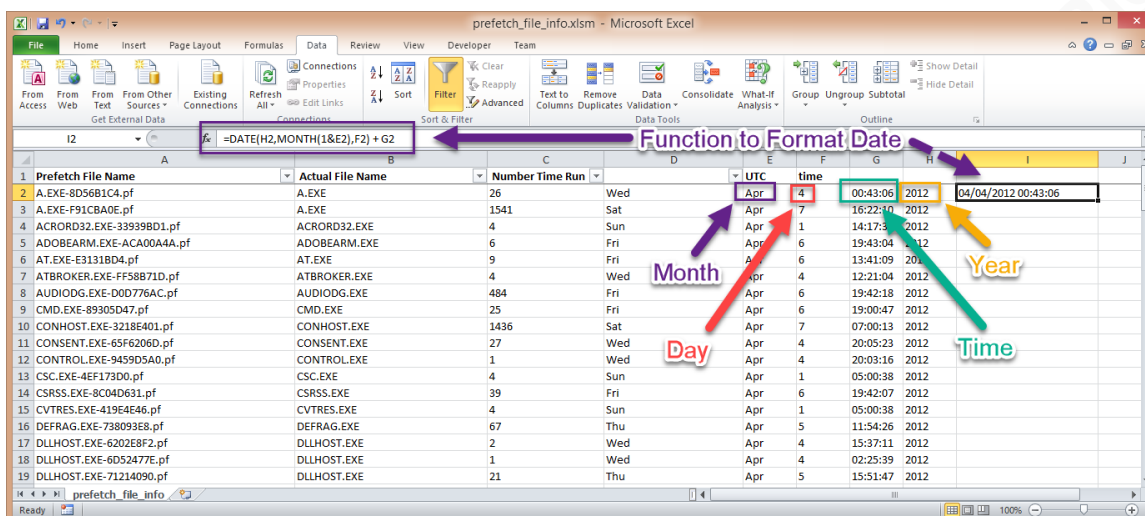


Figure 97. Reorder date and time fields. (Lee, 2014, digital case files)

After copying the cell values over the functions in the new column, you can delete the delimited columns you just created. Next, move the new Date/Time column to the beginning of the spreadsheet, insert columns where needed and modify the column headers to match our standard headers. Finally, prepend 'Number Time Runs' to the new 'Properties' column entries and manually enter the Artifact and Computer column values for a final result (Figure 98).

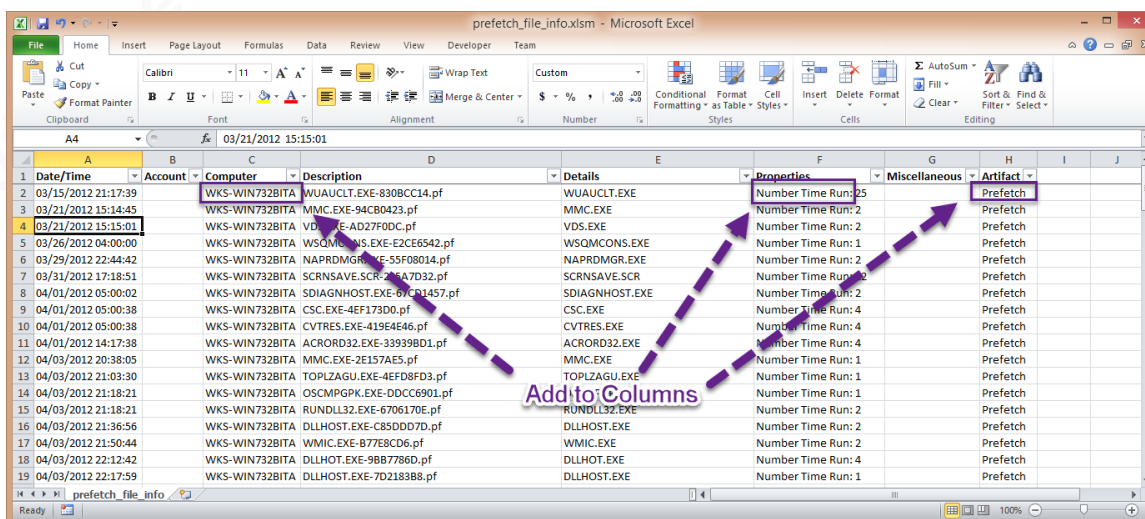


Figure 98. Prefetch results. (Lee, 2014, digital case files)