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Detecting Penetration Testers on a Windows Network with Splunk

GIAC (GCIA) Gold Certification

Author: Fred Speece, fredspeece@gmail.com

Advisor: Richard Carbone

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Abstract

Through data collection, reports, and alerts, an InfoSec team can have a better idea of what Penetration Testers are doing and hopefully in turn stop real bad guys that may get on their network. This paper discusses the configuration and setup of those alerts and the logging behind them. It also covers the thought process behind the alert and attack(s) it is trying to defend against. If an InfoSec department picked up this paper before their first Penetration Test, they would have better visibility into their network and alert on possible changes that an adversary could make. Splunk should not alert on everything, but it should alert on behavior that is abnormal. This paper is targeted for a Windows majority network with Active Directory in an organization with an immature security posture, using Splunk as their SIEM.

1. Introduction

Preventing or at least detecting breaches and other incidents on a network is a challenge for everyone. It is especially so for an immature information security (InfoSec) team in a small to mid-sized organization, or for an IT team in a culture that has not prioritized security in the past. An InfoSec team may not know where to start, but a critical piece is gaining visibility in a network. Log files are a key area for security information and hold a wealth of data (InfoWorld, 2009). Capturing, centralizing, correlating, searching, and alerting on the data from log files are a key step to defending a network. This paper is targeted for a majority Windows based network with Active Directory (AD) in an organization with an immature security posture, using Splunk as their Security Information and Event Management (SIEM) system.

1.1. Value of Penetration Testing

A Penetration Test (Pen-Test) should be designed to be real world, emulate an attacker, and provide the internal security team information to help protect their network (Cornelley, 2016). A Pen Test can be a real eye opener and find weaknesses in security that were not known or pointed out previously and therefore never addressed. Another key benefit of a Pen Test is prioritizing what to work on and secure. An InfoSec team may be working on one more advanced systems, say a Data Loss Prevention (DLP) or Intrusion Prevention System (IPS), but still need to cover the basics like password strength and patching systems (Williams, 2014). A great exercise to conduct while a Pen Test is ongoing is to have a Blue Team member do their best to watch and build alerts concerning the actions of the Pen Tester to try to "catch them." Tuning the alerts and reports based off of the Pen Tester's findings, tactics, and tools is a great way to build visibility.

1.2. Value of Splunk

Any Log Management or SIEM system used correctly can provide big value to an organization; this paper will focus on using Splunk. Splunk has a great community around it (Splunk Answers), it is easy to get helpful data out of it quickly, and well rated

Fred Speece, fredspeece@gmail.com

in the industry (Gartner, 2016). We will use a simple example of user account lockouts to show the ease with which one can get useful information. In comparison, Hewlett-Packard Enterprise's ArcSight, a popular and well-rated competitor, has a reputation of being much more challenging to get value out of quickly (Poor, 2016). The general steps we will follow are:

1. Install Splunk Enterprise with a trial license on a virtual machine (VM).
2. Install Splunk Universal Forwarders on all the Domain Controllers in the environment.
3. Install the Windows Security Operations Center by INFIGO IS and use the User Management > User Account Management prebuilt dashboard.
4. Drill into the reports to find the machine that is locking a user out.

It may only take a few hours to get to this point. Obviously, there is more work to be done, and this paper will explore creating some more advanced reports, dashboards, and alerted.

A SIEM can also assist with a few of the Center for Internet Security's (CIS) Top 20 Critical Security Controls, namely:

- 1 - Inventory of Authorized and Unauthorized Devices
- 2 - Inventory of Authorized and Unauthorized Software
- 4 - Continuous Vulnerability Assessment and Remediation
- 5 - Controlled Use of Administrative Privileges
- 6 - Maintenance, Monitoring, and Analysis of Audit Logs
- 16 - Account Monitoring and Control (Eubanks, 2011).

2. Log Collection Basics

There are many aspects to consider when discussing logs. The following are some of the advantages and disadvantages of sending logs to a SIEM. If one sends everything and saves it for a long time, the team will have the data to search and look back on, but there are costs associated with that. SIEM systems like Splunk are based on data per day, so licensing costs will go up as more data is sent, along with increased backend storage costs. Searching large amounts of data will require search clusters, faster storage,

compute, and more memory, driving up costs (Splunk, 2015). Searching for that security-event-needle in a haystack becomes harder. Filtering events at the forwarder or the indexer will help in all those cases. Figure out what events and what systems are most important, and just capture those, such as on domain controllers and sensitive file servers. A great resource for Event IDs is Randy Franklin Smith's <https://www.ultimatewindowssecurity.com>.

Capturing events from client machines can have very useful data, as it is often the compromise point. However, it can also generate extremely numerous log events, and managing thousands of end-point forwarders can be more complex (Anthony, 2013).

2.1. Splunk Configuration

High-level ideas will be covered quickly to get up and running with Splunk. Splunk has three main ways of providing information: dashboards, reports, and alerts. A dashboard is something that someone looks at interactively by searching, changing time frames, and drilling into data. Reports are larger sets of data, which could be emailed at specific intervals. Alerts are typically based off a trigger and could fire off for, example at every hour. They are used for different purposes, and all have their place.

Planning and sizing a SIEM is based on the number of concurrent searches, reports, and alerts at any point in time, and the amount of data coming into the system. Planning forwarder deployment and management is required to get the needed logs; the Distributed Management Console can assist. Larger instances of log management may require multiple indexers, a search cluster, and management components like licensing and deployment servers on separate physical or virtual machines. It is important to plan and think through designing which source types, indexes, permissions and other security aspects of the system. Most of these elements one can grow into, adding additional search heads and indexers, more indexes, and starting over from scratch by wiping out indexes if their historical data is not needed. Splunk's documentation and wiki pages have many great resources to get started (Splunk, Splunk Wiki, 2016). "Discovering Security Events of Interest Using Splunk" (Roberts, 2013) also covers many of these steps. The "Things I wish I knew then" Splunk Wiki page is another great resources for things to think about before, during and after deployment (Splunk Wiki, 2016).

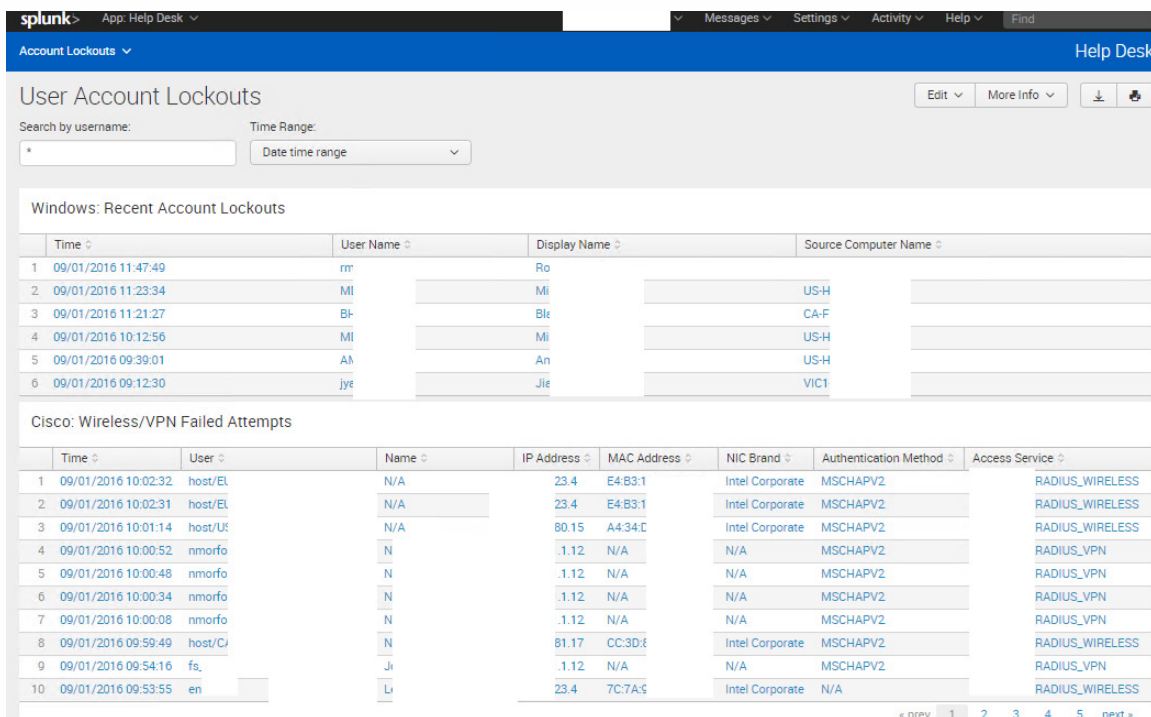
Fred Speece, fredspeece@gmail.com

Jessica Petrakovic created most of the following Splunk search strings, which are the basis for the reports, dashboards, and alerts. Many were influenced by events that happened during a Pen Test and were built to catch the events that lead to compromise. Other searches are designed to catch security lapses or mistakes that would decrease an organization's security stance. All searches should be customized for an organization. Let's get Splunking!

3. Reports and Dashboards

Reports are similar to Alerts, which will be covered in a later section. A report is something typically viewed by a person. Dashboards can be the "single pane of glass" marketing people usually tout, used for troubleshooting a certain issue, or viewing-related data on one page (Splunk Answers, 2014). Figure 1 shows an example of a useful dashboard for a Help Desk to use for troubleshooting the source of lockouts. Each panel is generated from a different search string, and the second panel shows logs from a Cisco RADIUS system. Sending RADIUS logs can be configured a few ways: syslog to send to the Splunk indexer directly, to an intermediary syslog collector, or put a universal forwarder on the RADIUS system or collector point, to name a few. Each has its pros and cons, check the wiki syslog best practices page for more detail (Splunk Wiki, 2015).

3.1. User Account Lockouts



Windows: Recent Account Lockouts

Time	User Name	Display Name	Source Computer Name
09/01/2016 11:47:49	rm	Ro	
09/01/2016 11:23:34	MI	MI	US-H
09/01/2016 11:21:27	Bl	Bl	CA-F
09/01/2016 10:12:56	MI	MI	US-H
09/01/2016 09:39:01	AM	An	US-H
09/01/2016 09:12:30	jye	Jie	VIC1

Cisco: Wireless/VPN Failed Attempts

Time	User	Name	IP Address	MAC Address	NIC Brand	Authentication Method	Access Service
09/01/2016 10:02:32	host/El	N/A	23.4	E4:B3:1	Intel Corporate	MSCHAPV2	RADIUS_WIRELESS
09/01/2016 10:02:31	host/El	N/A	23.4	E4:B3:1	Intel Corporate	MSCHAPV2	RADIUS_WIRELESS
09/01/2016 10:01:14	host/U	N/A	80.15	A4:34:C	Intel Corporate	MSCHAPV2	RADIUS_WIRELESS
09/01/2016 10:00:52	nmorfo	N	1.12	N/A	N/A	MSCHAPV2	RADIUS_VPN
09/01/2016 10:00:48	nmorfo	N	1.12	N/A	N/A	MSCHAPV2	RADIUS_VPN
09/01/2016 10:00:34	nmorfo	N	1.12	N/A	N/A	MSCHAPV2	RADIUS_VPN
09/01/2016 10:00:08	nmorfo	N	1.12	N/A	N/A	MSCHAPV2	RADIUS_VPN
09/01/2016 09:59:49	host/C	N	81.17	CC:3D:8	Intel Corporate	MSCHAPV2	RADIUS_WIRELESS
09/01/2016 09:54:16	fs	Ji	1.12	N/A	N/A	MSCHAPV2	RADIUS_VPN
09/01/2016 09:53:55	en	Li	23.4	7C:7A:5	Intel Corporate	N/A	RADIUS_WIRELESS

Figure 1-A: User Account Lockouts Dashboard.

Windows: Failed Logons

Time	Username	Source Workstation	Failure Reason	Logon Method
09/01/2016 11:59:50	so	NE	Username does not exist	NTLM
09/01/2016 11:59:45	so	NE	Username does not exist	NTLM
09/01/2016 11:59:36	JF	US-	Incorrect password	NTLM
09/01/2016 11:59:24	hc		Incorrect Password	Kerberos
09/01/2016 11:59:17	vic	us-l	Incorrect Password	Kerberos
09/01/2016 11:59:14	MI	us-l	Incorrect Password	Kerberos
09/01/2016 11:58:41	dh	US-	Incorrect password	NTLM
09/01/2016 11:58:40	DF	eu-l	Incorrect Password	Kerberos
09/01/2016 11:58:24	hc		Incorrect Password	Kerberos
09/01/2016 11:58:15	sn	LTS	Incorrect password	NTLM

AD: User Password Information

User Name	Display Name	Password Last Set	Password Expiration Date	Password Expires In (days)
10_1	10_	09/22/2015 18:01:00	Password Never Expires	Password Never Expires
411i	411	02/13/2015 19:11:45	Password Never Expires	Password Never Expires
AAIF	Alie	08/16/2016 12:29:20	Monday, 11/14/2016 11:29:20	72
AAII	Ash	08/27/2015 19:35:22	Wednesday, 11/25/2015 18:35:22	-283
AAAs	Ant	06/13/2016 11:49:49	Sunday, 09/11/2016 11:49:49	8
AAy	Ash	06/06/2016 19:40:48	Sunday, 09/04/2016 19:40:48	1
ABa	Anr	06/20/2016 04:46:36	Sunday, 09/18/2016 04:46:36	14
ABa	Alis	07/15/2016 09:29:32	Thursday, 10/13/2016 09:29:32	39
ABa	Apr	07/18/2016 10:52:04	Sunday, 10/16/2016 10:52:04	42
ABir	Ade	07/14/2016 11:53:13	Wednesday, 10/12/2016 11:53:13	39

Figure 1-B: User Account Lockouts Dashboard.

Figure 1 is a custom Splunk App ("Help Desk"), with a Dashboard as the Main page. Basic steps on creating a dashboard: Splunk > Search & Reporting app >

Fred Speece, fredspeece@gmail.com

Dashboards > Create New Dashboard. Give the dashboard a name, then add panels and inputs. The Inputs are "Text," for searching on a name, and "Time," for the time picker.

Lookups are used in some of the searches and are a slightly more advanced topic. The lookup definition "dnslookup" is used for translating IPs to DNS names, and it comes with Splunk. It only has two columns of data and is straight forward to use. The lookup "macLookup" is not native to Splunk, created off of "mac_address_assignments.csv," which is a lookup table file and resides in "D:\Program Files\Splunk\etc\apps\help_desk\lookups\." The data was pulled from a media access control (MAC) address lookup site that supplies MAC Address information for manufacture's Organizationally Unique Identifier (OUI) to help in locating devices in comma separated value (CSV) form. Helps answer questions like "Is this MAC address an Apple Device or Dell Laptop," for example.

The search strings that make up the panels of the Dashboard are as follows, they will need to be adjusted to fit a specific environment, but are a good starting point:

Recent Account Lockouts

```
index=wineventlog sourcetype=WinEventLog:Security
Account_Name="$username$" "EventCode=4740" NOT
(Account_Name="Guest" OR Account_Name="Administrator") | fields * | eval
Locked_Account=mvindex(Account_Name,1) | transaction Locked_Account
maxpause=5s | eval Time=strftime(_time, "%m/%d/%Y %H:%M:%S") | lookup
userInfo sAMAccountName as Locked_Account OUTPUT displayName | rex
field=Caller_Computer_Name "\\\\\\\\\\\\(?!<Caller_Computer_Name>.*)" | table
Time, Locked_Account, displayName, Caller_Computer_Name | rename
Locked_Account as "User Name", displayName as "Display Name",
Caller_Computer_Name as "Source Computer Name"
```

Cisco: Wireless/VPN Failed Attempts

```
index=cisco_acs | rex
"(CSCOacs_Passed_Authentications|CSCOacs_Failed_Attempts)
(?P<message_id>[0-9]+)" | transaction message_id | where event_reason!="*
Request dropped" AND event_reason!="EAP session timed out" | search *Fail* |
eval mac_address=coalesce(mac_address,Calling_Station_ID) | eval
mac=replace(mac_address,"\\.|:-","") | eval mac_add=tostring(upper(mac)) | rex
mode=sed field=mac_add "s/([A-Z0-9]{2})([A-Z0-9]{2})([A-Z0-9]{2})([A-Z0-9]{2})([A-Z0-9]{2})([A-Z0-9]{2})/1:2:3:4:5:6/" | eval
mac=upper(substr(mac,1,6)) | lookup macLookup mac_assignment as mac
OUTPUT company_name | eval mac_add=if(access_service=="RADIUS_VPN",
```



```
"N/A",mac_add) | rex field=UserName "[a-zA-Z]{9}\\\\\\\\\\\\\\\\(?<UserName>.*)" |
rex field=UserName "(?<UserName>.*@contoso\\.com)" | search
UserName=$username$ | lookup userInfo sAMAccountName as UserName
OUTPUT displayName | eval Device_IP_Address=NAS_IP_Address | eval
Time=strftime(_time,"%m/%d/%Y %H:%M:%S") | table Time UserName
displayName Device_IP_Address mac_add company_name
AuthenticationMethod access_service | fillnull value="N/A" | rename
UserName as "User", Device_IP_Address as "IP Address",
AuthenticationMethod as "Authentication Method", access_service as "Access
Service", displayName as "Name", mac_add as "MAC Address" company_name
as "NIC Brand"
```

Windows: Failed Logons

```
index=wineventlog sourcetype=WinEventLog:Security ((EventCode=4776 AND
Keywords="Audit Failure") OR (EventCode=4771 AND Keywords="Audit
Failure")) $username$ NOT (Administrator OR Account_Name=*$)$ | rex
field=Client_Address "::.ffff:(?<Client_Address>.*)" | lookup dnslookup clientip
as Client_Address | rex field=clienthost "(?<clienthost>.*).contoso.com" | eval
Source_Workstation=coalesce(Source_Workstation, clienthost) | eval
Logon_Account=coalesce(Account_Name, Logon_Account) | transaction
Logon_Account maxpause=5s | eval Source_Workstation2 =
mvfilter(!match(Source_Workstation,"-dc")) | eval Source_Workstation =
coalesce(Source_Workstation2,Source_Workstation) | eval
Error_Code=coalesce(Error_Code, Failure_Code) | eval
Error_Code=upper(Error_Code) | eval
failure_reason=case(Error_Code=="0XC0000071", "Expired password",
Error_Code=="0XC0000064", "Username does not exist",
Error_Code=="0XC000006A", "Incorrect
password", Error_Code=="0XC0000234", "Account is locked
out", Error_Code=="0XC0000072", "Account is
disabled", Error_Code=="0XC0000071", "Expired
password", Error_Code=="0X18", "Incorrect
Password", Error_Code=="0X17", "Expired
password", Error_Code=="0X12", "Disabled/expired/locked out
account", Error_Code=="0XC0000224", "Change password at next logon") | rex
field=Source_Workstation "\\\\\\\\\\\\\\\\(?P<Source_Workstation>.*)" | eval
logon_type=case(EventCode==4771, "Kerberos", EventCode==4776, "NTLM") |
eval Time=strftime(_time,"%m/%d/%Y %H:%M:%S") | table Time
Logon_Account Source_Workstation failure_reason logon_type | rename
Logon_Account as "Username" Source_Workstation as "Source Workstation"
failure_reason as "Failure Reason" logon_type as "Logon Method"
```

AD: User Password Information

```
| inputlookup ad_userInformation.csv | where
(!like(userAccountControl,"%DISABLE%")) | search
sAMAccountName=$username$ expiresIn=* | eval pwdLastSet
```

```
=strftime(strptime(pwdLastSet,"%Y-%m-%dT%H:%M:%S.%QZ"),"%m/%d/%Y
%H:%M:%S") | eval expiresIn=if(like(userAccountControl,
"DONT_EXPIRE_PASSWD%"), "Password Never Expires",expiresIn) | eval
passwordExpires=if(like(userAccountControl, "DONT_EXPIRE_PASSWD%"),
"Password Never Expires",passwordExpires) | table sAMAccountName
displayName pwdLastSet passwordExpires expiresIn | sort sAMAccountName |
rename displayName as "Display Name" sAMAccountName as " User Name"
passwordExpires as "Password Expiration Date", expiresIn as "Password Expires
In (days)", pwdLastSet as "Password Last Set"
```

A large part of these searches are formatting the results, terms such as “sort” and “rename” help with ordering and creating friendly names for the columns (Bolded for clarity). “Eval” converts the default Splunk time output to more human readable output. The “Table” command selects the fields we care about that then get sorted and renamed in the final result. The “coalesce” command combines multiple fields into one column. More advanced topics such as regular expressions (“rex”) will take some reading and experimenting to understand as Splunk does it a bit differently than others (Splunk, 2016).

Another use of a dashboard would be a user or computer search that showed all data relevant to that object. For example, a user search may show various data about the user from AD: their assigned computers, login times/locations/failures, failed passwords, etc. It would also include data from a web filtering system, host based anti-malware, activity in an IPS, single sign-on (SSO) or multi-factor authentication (MFA) system, or data from other applications like a mail filtering system. A computer-based dashboard could have similar data, plus vulnerability scan results.

Hardware Inventory

Computer Name:

System Inventory

Inventory for us-hq-it*

Computer Name	Active Directory	SecurityCenter	Last Known IP	Operating System	Listening Ports (Nessus)
-IT3850	--	--	Last scanned 10/14/2016	4 - 10/14/2016	No OS Information Available
-T001	Enabled, Last Logon Timestamp: 10-13-2016	Managed, Up to Date	--	2 - 10/17/2016	AD: Windows 7 Enterprise
-T002	Enabled, Last Logon Timestamp: 08-12-2016	Unmanaged	--	No IP Available	AD: Windows 10 Enterprise
-T003	Enabled, Last Logon Timestamp: 10-10-2016	Managed, Up to Date	Last scanned 10/13/2016	7 - 10/17/2016	SecurityCenter: Microsoft Windows 7 Enterprise
-T004	Enabled, Last Logon Timestamp: 10-17-2016	Managed, Up to Date	Last scanned 10/14/2016	5 - 10/17/2016	SecurityCenter: Microsoft Windows 7 Enterprise
-T005	Enabled, Last Logon Timestamp: 10-10-2016	Managed, Up to Date	Last scanned 10/14/2016	8 - 10/17/2016	SecurityCenter: Microsoft Windows 7 Enterprise
-T006	Enabled, Last Logon Timestamp: 04-13-2016	Unmanaged	--	No IP Available	AD: Windows 7 Enterprise
-T007	Enabled, Last Logon Timestamp: 10-10-2016	Managed, Up to Date	Last scanned 10/14/2016	8 - 10/14/2016	SecurityCenter: Microsoft Windows 10 Enterprise

Figure 2: Hardware Inventory Dashboard.

These dashboards can give a clearer picture about the current security of a device or hints on if a user account is compromised or doing something it should not be. Alerts, discussed next, are what wake up the analyst and gets their attention.

3.2. Suspicious Failed Logons

The next dashboard example is two searches, login attempts to accounts that do not exist and accounts that are expired or disabled. A high number of these results may be misconfigurations and more operational than pure security but can help one understand what normal is in an environment.

```
source="WinEventLog:security" sourcetype="WinEventLog:Security"
EventCode=4625 Sub_Status=0xC0000064 Account_Name!=*$$ | eval
Date=strftime(_time, "%m/%d/%Y") | eval uacct=mindex(Account_Name,1) |
stats count by Date, uacct, host, Workstation_Name | rename count as "Attempts"
| sort -Date -Attempts | rename uacct as "Target Account" host as "Host"
```

```
source="WinEventLog:security" sourcetype="WinEventLog:Security"
EventCode=4625 (Sub_Status=0xC0000072 OR Sub_Status=0xC0000193) | eval
Account_Name=mindex(Account_Name, 1) | where !like(Account_Name,"%$")
| eval Date=strftime(_time, "%m/%d/%Y") | stats count by Date, Account_Name,
Workstation_Name, Failure_Reason | sort -Date -count | rename Account_Name
as "Target Account" Workstation_Name as "Target Workstation" Failure_Reason
as "Failure Reason" count as "Count"
```

AD: Suspicious Failed Logons

Failed Logons to Non-existent Accounts

Select time range:
Last 7 days

Date	Target Account	Host	Workstation_Name	Attempts
09/23/2016	Healt	et	01	7106
09/23/2016	Healt	et	01	1419
09/23/2016	Healt	et	01	1419
09/23/2016	eegil	us	ig-smtp	18
09/23/2016	me	us	ig-smtp	15
09/23/2016	a	us		5
09/23/2016	a	vi		5
09/23/2016	oracle	vi		3
09/23/2016	W	Et		2
09/23/2016	W	Et		2

« prev 1 2 3 4 5 6 7 8 9 10 next »

Logon Attempts to Disabled/Expired Accounts

Select a time range:
Last 7 days

Date	Target Account	Target Workstation	Failure Reason	Count
09/19/2016	lr	er	Account currently disabled.	5
09/18/2016	lr	er	Account currently disabled.	2

Figure 3: Suspicious Failed Logons Dashboard.

3.3. Inactive Account Management

Our third example dashboard is around account management. It is important to make sure that AD is cleaned up and stale objects pruned out if only to keep things clean and organized. This report can help pinpoint stale user and computer objects. The report utilizes lookups off CSVs that are generated nightly.

```
| inputlookup ad_userInformation.csv | eval lastLogonTimestamp =
strftime(lastLogonTimestamp, "%Y-%m-%dT%H:%M:%S.%QZ") | where
lastLogonTimestamp < (now() - (86400 * 180)) | sort -lastLogonTimestamp | eval
last_logon = strftime(lastLogonTimestamp, "%m-%d-%Y %H:%M %p") | table
sAMAccountName displayName last_logon | rename sAMAccountName as
"Username" displayName as "Name" last_logon as "Last Logon"
```

```
| inputlookup ad_computerInformation.csv | eval lastLogonTimestamp =
strptime(lastLogonTimestamp, "%Y-%m-%dT%H:%M:%S.%QZ") | where
lastLogonTimestamp < (now() - (86400 * 180)) | sort -lastLogonTimestamp | eval
last_logon = strftime(lastLogonTimestamp, "%m-%d-%Y %H:%M %p") | table
computer_name description last_logon | rename computer_name as "Computer
Name", description as "Description" last_logon as "Last Logon"
```

AD: Inactive Account Management

Inactive User Accounts (No Logon in 6 Months)

	Username	Name	Last Logon
1	Ri	Ric	12-31-2014 15:09 PM
2	si	Sie	12-30-2010 07:58 AM
3	ar	Aar	12-28-2015 15:34 PM
4	Cl	Chi	12-28-2015 07:54 AM
5	sv	svc	12-28-2011 11:47 AM
6	m	Me	12-26-2013 19:43 PM
7	Bl	Bre	12-24-2015 12:45 PM
8	Cl	Car	12-23-2015 21:00 PM
9	jm	Joy	12-22-2014 12:15 PM
10	Ti	Tyl	12-21-2015 13:26 PM

Inactive Computer Accounts (No Logon in 6 Months)

Computer Name	Description	Last Logon
U:	Ma	12-29-2015 18:05 PM
U:	Ale	12-28-2015 13:10 PM
Cl	PV:	12-28-2015 04:52 AM
EL	IT I	12-23-2015 11:13 AM
U:	Rai	12-22-2014 13:30 PM
U:	Ber	12-21-2015 17:22 PM
U:	Tyl	12-21-2015 13:29 PM
U:	Me	12-21-2014 08:20 AM
U:	Mic	12-19-2014 11:17 AM
U:	TX	12-18-2015 15:15 PM

Figure 4: Inactive Account Management Dashboard.

4. Alerts

Alerts can be configured in many ways depending on how often they want the information to be sent, how the info is displayed, who to send to, and other parameters shown below. A few examples follow.

4.1. Created Accounts

A basic example of a useful daily email based on an alert could be “Created accounts in the past day” (Figure 4). The InfoSec team or team lead of those creating accounts in the organization could receive this report daily, for more oversight and

control over accounts created in the domain. If local users on servers are a concern, a similar report should be created for that. Someone could match created accounts with the ticketing system or audit accounts after creation to make sure users conform to the user account creation standards. If an account is created by someone that should not be creating accounts, that is cause for an investigation. If an Identity and Access Management (IAM) system is used, those logs should be sent to Splunk also.

Created AD Accounts

```
EventCode=4722 (NOT (User_Name="*$" OR Account_Name="*$")) | eval
Date=strftime(_time, "%Y/%m/%d %H:%M:%S") | table Date, src_user, user,
EventCodeDescription | sort - Date | rename src_user as "Who Created"
```

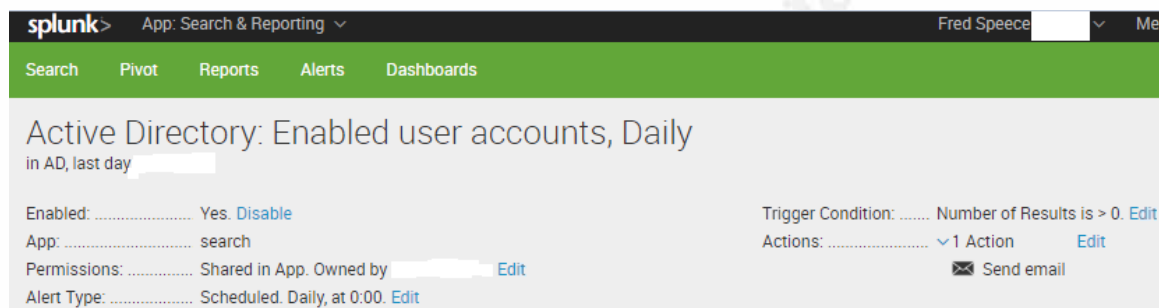


Figure 5: Example Alert Summary Page.

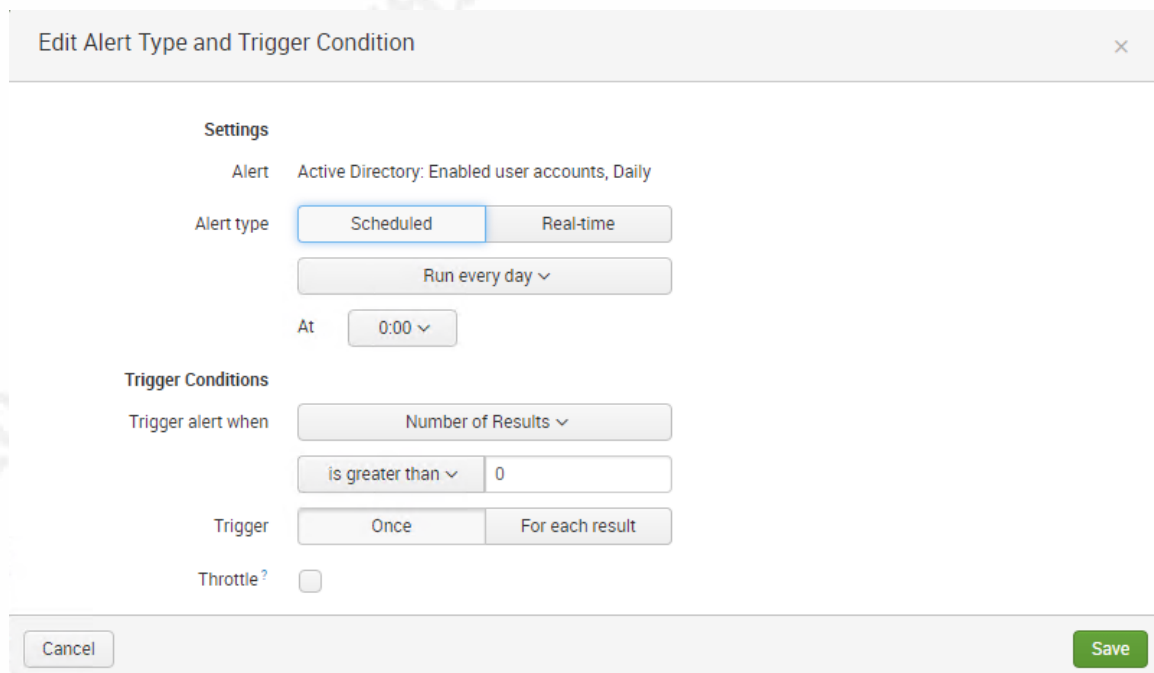


Figure 6: Alert Type and Trigger Condition.

Edit Actions

Alert Active Directory: Enabled user accounts, Daily

Trigger Actions

+ Add Actions

When triggered

Send email

Remove

To

fred.speece@contoso.com

Comma separated list of email addresses. Show CC and BCC

Priority

Normal

Subject

Splunk Alert: \$name\$

The email subject, recipients and message can include tokens that insert text based on the results of the search. [Learn More](#)

Message

The alert condition for '\$name\$' was triggered.

Include

Link to Alert

Link to Results

Search String

Inline Table

Trigger Condition

Attach CSV

Trigger Time

Attach PDF

Type

HTML & Plain Text

Plain Text

Cancel

Save

Figure 7: Alert Actions.

splunk> App: Search & Reporting

Messages Settings Activity Help Find

Search Pivot Reports Alerts Dashboards

Search & Reporting

Active Directory: Enabled user accounts, Daily

Save Save As View Close

EventCode=4722 (NOT (User_Name="" OR Account_Name="")) | eval Date=strftime(_time, "%Y/%m/%d %H:%M:%S") | table Date, src_user, user, EventCodeDescription | sort - Date | rename src_user as "Who Created"

Last 7 days

5 events (8/28/16 11:00:00 AM to 9/4/16 11:22:46 AM) No Event Sampling

Job Visualization

Verbose Mode

100 Per Page Format Preview

Date	Who Created	user	EventCodeDescription
2016/08/30 16:18:04			A user account was enabled
2016/08/29 14:40:09			A user account was enabled
2016/08/29 12:12:48			A user account was enabled
2016/08/29 10:31:22			A user account was enabled
2016/08/29 10:30:45			A user account was enabled

Figure 8: Search Results that Alert Fires Off Of.

Fred Speece, fredspeece@gmail.com

4.2. Failed Logins

Some reports that could get noisy but also provide valuable information are Failed Logins. A daily report could be created looking at important accounts and their activity. This type of report can get noisy with passwords simply typed wrong by mistake, and the focus should be on important accounts such as privileged admin accounts for people like domain admins. While not perfect, these reports will at least gather a baseline and show what is normal on a network, and show high amounts of failures.

Failed Admin Logins

```
index=wineventlog sourcetype="*wineventlog:security" EventCode=4625 Failure
".adm" | eval
logont=case(Logon_Type=="3","Network",Logon_Type=="7","Screen Unlock",
Logon_Type=="10","RDP",Logon_Type=="2","Interactive",Logon_Type=="11","
Cached Interactive") | eval User = if(isnull(Account_Name), User_Name,
mvindeix(Account_Name,1)) | eval change_time=strftime(_time, "%m-%d-%Y
%H:%M:%S") | lookup dnslookup clientip as Source_Network_Address
OUTPUT clienthost as address | rex field=address
"(?P<address>.*).contoso.com" | eval address=upper(address) | rex field=dest
"(?P<dest>.*).contoso.com" | eval dest=upper(dest) | table change_time User
Failure_Reason address src_ip dest logont | rename change_time as Time, logont
as "Logon Type" address as "Source Computer Name" src_ip as "Source IP
Address" dest as "Target Computer Name" Failure_Reason as "Failure Reason" |
fillnull value="N/A"
```

Active Directory: Failed Admin Logins - Daily

```
index=wineventlog sourcetype="*wineventlog:security" ".adm"
(EventCode=4771 AND "Audit Failure") OR ("EventCode=4776" AND
Keywords="Audit Failure") NOT (User_Name="*$" OR Account_Name="*$")
NOT Failure_Code=0x19 NOT (Logon_Account="*$" OR Logon_account="*$")
| rex field=Client_Address "::ffff:(?P<Client_Address>.*)" | lookup dnslookup
clientip as Client_Address OUTPUT clienthost | rex field=clienthost
"(?<clienthost>.*).contoso.com" | search clienthost!=*-dc* | transaction
Account_Name maxpause=5s | eval change_time=strftime(_time, "%m-%d-%Y
%H:%M:%S") | eval "User
Account"=coalesce(User_Name,Account_Name,Logon_Account,Logon_account)
| table change_time "User Account" Client_Address clienthost | Rename
change_time as Time Client_Address as "Source IP Address" clienthost as
"Source Computer Name"
```

4.3. Sensitive Groups

Monitor and alert on changes to any Sensitive Groups. Additions to a group such as Domain Admins is a significant change and should be audited. If there is a change

control process for that, this can assist in monitoring additions and removals. An attacker may just compromise the user in one of these groups and not add to them, but it will cover a scenario where they add a new user to these powerful groups for persistence purposes. This alert helps enforce the principle of minimum privileges at least for the AD groups and increases security by adding auditing and visibility.

Time	Changed By	Affected User	ComputerName	Group Name	EventCodeDescription
10/1	fs	\di	cp	Administrators	A member was removed from a security-enabled local group
10/1	fs	\rp	cp	Administrators	A member was removed from a security-enabled local group
10/1	fs	\Si	us	Li	A member was removed from a security-enabled global group
10/1	fs	\A	us	H	A member was removed from a security-enabled global group
10/1	fs	\A	us	Ei	A member was removed from a security-enabled global group
10/1	fs	\bi	us	H	A member was removed from a security-enabled global group
10/1	Cl	\C	Ch	O	A member was added to a security-enabled local group
10/1	Cl	\C	Ch	O	A member was removed from a security-enabled local group
10/1	fs	\P	Ch	A	A member was removed from a security-enabled local group
10/1	fs	\P	Ch	A	A member was added to a security-enabled local group
10/1	m	\m	us	B	A member was removed from a security-enabled local group
10/1	m	\m	us	B	A member was added to a security-enabled local group

Figure 9: Active Directory: Sensitive Group Change Search Results.

Sensitive Groups

```
* "IMPORTANT GROUPS" OR Administrators OR "Domain Admins" OR
"Enterprise Admins" OR "Schema Admins" OR "Backup Operators" OR
"Account Operators" OR "Print Operators" OR "Group Policy" OR DnsAdmins
OR "DHCP Administrators" OR "Remote Desktop Users" AND EventCode=4728
OR EventCode=4729 OR EventCode=4732 OR EventCode=4733 OR
EventCode=4756 OR EventCode=4757 | eval
source_user=mvindex(Account_Name, 0) | eval
affected_user=mvindex(Security_ID,1) | eval Time=strftime(_time,"%m/%d/%Y
%H:%M:%S") | table Time, source_user, affected_user, ComputerName,
Group_Name, EventCodeDescription | sort - Time | rename source_user as
"Changed By" affected_user as "Affected User" Group_Name as "Group Name"
status as "Action Taken"
```

4.4. C\$, ADMIN\$

Alert on crawling local machine shares. This alert is dependent on the log sources, so make sure any critical systems have Splunk Universal Forwarders installed on them, especially file shares. Here is an example of a Pen Tester testing access via Invoke-Sharefinder with a compromised user account:

Windows: C\$ Share Accessed

index=wineventlog (EventCode=5140 OR EventCode=560) (C\$ OR ADMIN\$) Account_Name!=scans Source_Address!="::1" | lookup userinfo sAMAccountName as Account_Name | rex field=Source_Address "::ffff:(?<Source_Address>.*)" | lookup dnslookup clientip as Source_Address | rex field=clienthost "(?<clienthost>.*).contoso.com" | eval Time=strftime(_time,"%m/%d/%Y %H:%M:%S") | table Time Account_Name displayName host Source_Address clienthost Share_Name Keywords | rename Account_Name as "Account Name", displayName as "User" host as "Target Computer" clienthost as "Source Computer" Keywords as "Success/Failure" Share_Name as "Share" Source_Address as "Source Address"

4,284 events (6 12:00:00.000 AM) No Event Sampling

Time	Account Name	User	Target Computer	Source Address	Source Computer	Share	Success/Failure
09:07:06	a	ers	n	.193	39	*ICS	Audit Failure
09:07:06	a	ers	n	.193	39	*ICS	Audit Failure
09:07:06	a	ers	n	.193	39	*ADMIN\$	Audit Failure
09:07:06	a	ers	n	.193	39	*ADMIN\$	Audit Failure
09:06:53	a	ers	on	.193	39	*ICS	Audit Failure
09:06:53	a	ers	on	.193	39	*ICS	Audit Failure
09:06:53	a	ers	on	.193	39	*ADMIN\$	Audit Failure
09:06:53	a	ers	on	.193	39	*ADMIN\$	Audit Failure
09:05:15	a	ers	2	.193	39	*ICS	Audit Failure
09:05:15	a	ers	2	.193	39	*ICS	Audit Failure
09:05:15	a	ers	2	.193	39	*ADMIN\$	Audit Failure
09:05:15	a	ers	2	.193	39	*ADMIN\$	Audit Failure
09:04:34	a	ers	it-	.193	39	*ICS	Audit Failure
09:04:34	a	ers	it-	.193	39	*ICS	Audit Failure
09:04:34	a	ers	it-	.193	39	*ADMIN\$	Audit Failure
09:04:34	a	ers	it-	.193	39	*ADMIN\$	Audit Failure
09:04:34	a	ers	ai	.193	39	*ICS	Audit Failure
09:04:34	a	ers	ai	.193	39	*ICS	Audit Failure
09:04:34	a	ers	ai	.193	39	*ADMIN\$	Audit Failure

Figure 10: C\$ Share Accessed Search Results.

```
index=wineventlog (EventCode=5140) (C$ OR ADMIN$)
Source_Address!="::1" | lookup userinfo sAMAccountName as Account_Name |
rex field=Source_Address "::ffff:(?<Source_Address>.*)" | lookup dnslookup
clientip as Source_Address | rex field=clienthost "(?<clienthost>.*).contoso.com"
|eval Time=strftime(_time,"%m/%d/%Y %H:%M:%S") | table Time
Account_Name displayName host Source_Address clienthost Share_Name
Keywords | rename Account_Name as "Account Name", displayName as "User"
host as "Target Computer" clienthost as "Source Computer" Keywords as
"Success/Failure" Share_Name as "Share" Source_Address as "Source Address"
```

4.5. Clearing Logs

Alert on Cleared Log files as shown in Figure 9. Log files should not be cleared by a person, only by the system. It may indicate someone trying to cover their tracks.

Windows: Log File Cleared

index=wineventlog (sourcetype=WinEventLog:Security EventCode=1102) Message!=*Microsoft-Exchange* | rex field=Message "(?<Message>.*)." | transaction host | mvexpand Message | eval Time=strftime(_time,"%m/%d/%Y %H:%M:%S") | table Time host Message Account_Name | rename host as "Computer Name" Account_Name as "Cleared By" Message as "Logs Cleared"

3 events (8/5/16 12:00:00.000 AM to 9/4/16 11:43:22.000 AM) No Event Sampling

Time	Computer Name	Logs Cleared	Cleared By
08/17/2016 08:32:42	n	The Application log file was cleared	fs
08/17/2016 08:32:42	n	The Windows PowerShell log file was cleared	fs
08/17/2016 08:32:42	n	The audit log was cleared	fs

Figure 11: Log File Cleared Search Results.

```
index=wineventlog OR (sourcetype=WinEventLog:Security EventCode=1102)
Message!=*Microsoft-Exchange* | rex field=Message "(?<Message>.*).\." |
transaction host | mvexpand Message | eval Time=strftime(_time,"%m/%d/%Y
%H:%M:%S") | table Time host Message Account_Name | rename host as "Computer
Name" Account_Name as "Cleared By" Message as "Logs Cleared"
```

4.6. Powershell Bypass

Alert for Windows Powershell bypass. In Group Policy first Enable Audit Process Creation: Success under Computer Config > Policies > Windows Settings > Security Settings > Advanced Audit Policy > Audit Policies > Detailed Tracking. Then Enable Process Auditing under Computer Config > Policies > Admin Templates > System > Audit Process Creation.

This auditing is an example of the power of auditing command execution and may be useful for catching Powershell scripts from non-IT users (Metcalf, 2015).

List ▾ Format ▾ 20 Per Page ▾		
#	Time	Event
1	7/30/2016 10:00:01 AM	LogName=Security SourceName=Microsoft Windows security auditing. EventCode=4688 EventType=0 Type=Information ComputerName= TaskCategory=Process Creation OpCode=Info RecordNumber=4026161 Keywords=Audit Success Message=A new process has been created. Subject: Security ID: Account Name: Account Domain: Logon ID: 0x4025A54 Process Information: New Process ID: 0x299c New Process Name: C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe Token Elevation Type: TokenElevationTypeLimited (3) Creator Process ID: 0x2b28 Process Command Line: "C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe" -ExecutionPolicy Bypass -File .\test.ps1 Token Elevation Type indicates the type of token that was assigned to the new process in accordance with User Account Control policy. Type 1 is a full token with no privileges removed or groups disabled. A full token is only used if User Account Control is disabled or if the user is the built-in Administrator account or a service account. Type 2 is an elevated token with no privileges removed or groups disabled. An elevated token is used when User Account Control is enabled and the user chooses to start the program using Run as administrator. An elevated token is also used when an application is configured to always require administrative privilege or to always require maximum privilege, and the user is a member of the Administrators group. Type 3 is a limited token with administrative privileges removed and administrative groups disabled. The limited token is used when User Account Control is enabled, the application does not require administrative privilege, and the user does not choose to start the program using Run as administrator.

Figure 12: Powershell Bypass Search Results

```
index=wineventlog sourcetype="WinEventLog:Security" (EventCode=4688)
(powershell* AND -ExecutionPolicy) OR (powershell* AND bypass) OR
(powershell* AND -noprofile) | eval Time=strftime(_time,"%m/%d/%Y
%H:%M:%S") | table Time, host, Account_Name, New_Process_Name,
Process_Command_Line | rename host as "Server Name", Account_Name as
"User", New_Process_Name as "Process Name", Process_Command_Line as
"Command Line"
```

4.7. NTDS.dit on DCs

Lastly, we will alert on the potential compromise of a domain controller by grabbing NTDS.dit (AD Database file) from a Volume Shadow Copy or an Install From Media (IFM) set (Metcalf, 2014). The following will alert on the use of "ntdsutil.exe" or

"reg.exe" and show who ran it. Monitoring the Volume Shadow Copy service start and stop events generates too many false positives, use of ntdsutil.exe should be rare.

Legitimate use of ntdsutil can be verified with the server admin working with the tool.

Time	User Account	Target Computer	Process Created	Command Line
15:52:53	d	dc2	C:\Windows\System32\reg.exe	reg.exe save HKLM\SAM c:\temp\2\sam.save
15:52:38	d	dc2	C:\Windows\System32\reg.exe	reg.exe save HKLM\SYSTEM c:\temp\2\system.save
15:48:52	d	dc2	C:\Windows\System32\ntdsutil.exe	ntdsutil
15:48:17	d	dc2	C:\Windows\System32\ntdsutil.exe	ntdsutil
15:42:40	d	dc2	C:\Windows\System32\ntdsutil.exe	ntdsutil
15:42:09	d	dc2	C:\Windows\System32\reg.exe	reg.exe query hklm\system\currentcontrolset\services\ntds\parameters
15:41:45	d	dc2	C:\Windows\System32\reg.exe	reg.exe query hklm\system\currentcontrolset\services\ntds\parameters

Figure 13: Powershell Bypass Search Results

```
index=wineventlog sourcetype=WinEventLog:Security EventCode=4688
("ntdsutil.exe" OR "reg.exe") Account_Name!=*$ | eval
Time=strftime(_time,"%m/%d/%Y %H:%M:%S") | table Time Account_Name host
New_Process_Name Process_Command_Line | fillnull value="N/A" | rename
Account_Name as "User Account" host as "Target Computer"
Process_Command_Line as "Command Line" New_Process_Name as "Process
Created"
```

There are many ways of grabbing the AD database off a domain controller, and this will just alert on one of them.

5. Conclusion

Log Management systems and SIEM systems can be complex to build, manage, and maintain, they also require at least a dedicated resource; the system admin cannot just set it and forget it. There will be a constant stream of requests for the addition of new log sources, dashboards, alerts and reports to be created. There is a large amount of work monitoring and maintaining the SIEM itself, managing the data coming into the system, monitoring forwarders and figuring out why certain systems stopped sending logs. However, an InfoSec team can get very useful information out of the system quickly if it is known what to put into it and what one wants to get out of it. Shadowing a Pen Test can help greatly in that regard. This paper has detailed some examples to get an InfoSec team up and running and getting actionable information out of the system quickly.

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