The University of Texas at San Antonio™

The Cyber Center for Security and Analytics

UNIVERSITY OF SOUTH CAROLINA

ZEEK INSTRUSION DETECTION SERIES

Lab 10: Application of the Zeek IDS for Real-Time Network Protection

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Award 1829698
“CyberTraining CIP: Cyberinfrastructure Expertise on High-throughput Networks for Big Science Data Transfers”

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Overview

This lab introduces Zeek's real-time packet analysis for intrusion prevention. By combining the various Zeek-specific events that were introduced and reviewed in previous labs, we are able to identify and mitigate malicious traffic in real-time.

Objectives

By the end of this lab, students should be able to:

1. Run Zeek in live mode to process network traffic *on the wire*.
2. Understand the Zeek NetControl framework.
3. Leverage advanced Zeek scripts for anomaly event detection.

Lab topology

Figure 1 shows the lab topology. The topology uses 10.0.0.0/8 which is the default network assigned by Mininet. The *zeek1* and *zeek2* virtual machines will be used to generate and collect network traffic.

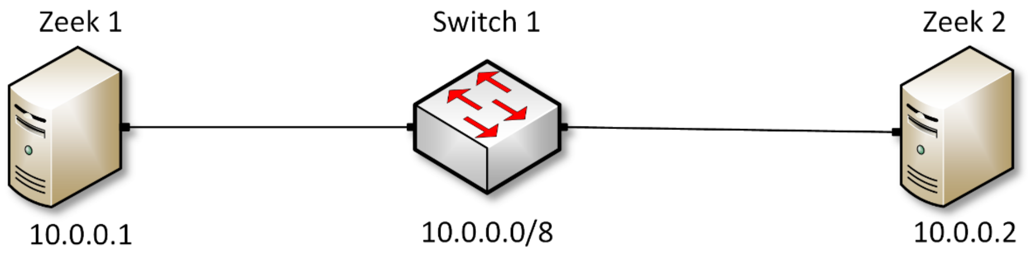


Figure 1. Lab topology.

Lab settings

The information (case-sensitive) in the table below provides the credentials necessary to access the machines used in this lab.

Table 1. Credentials to access the Client machine

Device	Account	Password
Client	admin	password

Table 2. Shell variables and their corresponding absolute paths.

Variable Name	Absolute Path
$ZEEK_INSTALL	/usr/local/zeek
$ZEEK_TESTING_TRACES	/home/zeek/zeek/testing/btest/Traces
$ZEEK_PROTOCOLS_SCRIPT	/home/zeek/zeek/scripts/policy/protocols

Lab roadmap

This lab is organized as follows:

1. Section 1: Introduction to real-time network traffic analysis using Zeek.
2. Section 2: Introduction to the Zeek NetControl framework.
3. Section 3: Identifying SSH attacks by leveraging the Zeek NetControl framework.

1 Introduction to real-time network traffic analysis using Zeek

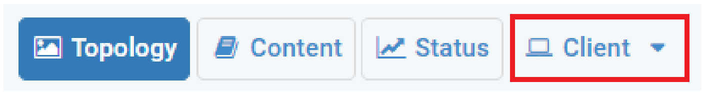
The previous labs within this lab series have leveraged the *tcpdump* terminal utility for capturing network traffic and generating packet capture files. However, Zeek is capable of collecting and analyzing such network traffic in real-time, with the ability to apply signature-matching and event-based Zeek scripts for malicious event detection.

This section will introduce leveraging Zeek for real-time network traffic analysis, without needing to save the packets captured by the receiving interface.

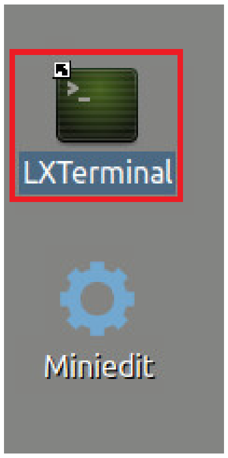
In contrast to the previous `-r` terminal option used for offline packet analysis, this lab will be using the `-i` terminal option to indicate the receiving interface for real-time network traffic analysis.

1.1 Starting a new instance of Zeek

Step 1. From the top of the screen, click on the *Client* button as shown below to enter the *Client* machine.

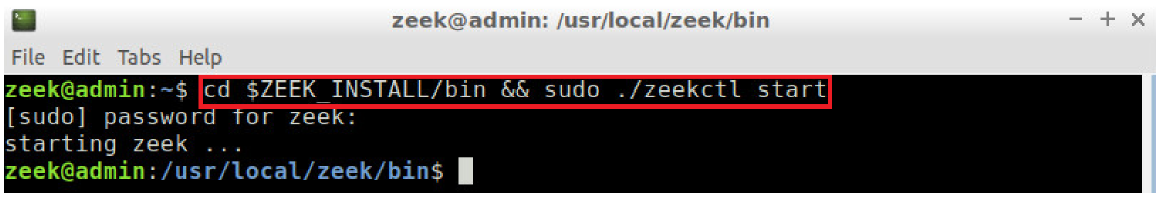


Step 2. The *Client* machine will now open, and the desktop will be displayed. On the left side of the screen, click on the LXTerminal icon as shown below.



Step 3. Start Zeek by entering the following command on the terminal. This command enters Zeek's default installation directory and invokes `Zeekctl` tool to start a new instance. To type capital letters, it is recommended to hold the `Shift` key while typing rather than using the `Caps` key. When prompted for a password, type `password` and hit `Enter`.

```
cd $ZEEK_INSTALL/bin && sudo ./zeekctl start
```

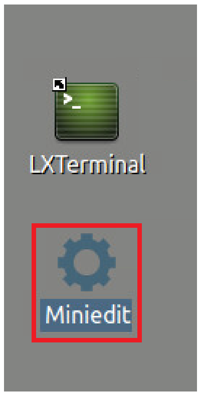


```
zeek@admin:~$ cd $ZEEK_INSTALL/bin && sudo ./zeekctl start
[sudo] password for zeek:
starting zeek ...
zeek@admin:/usr/local/zeek/bin$
```

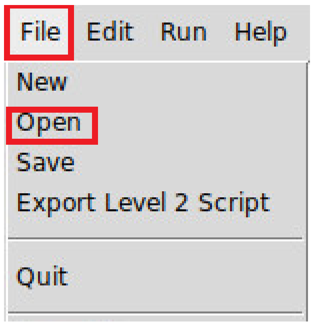
A new instance of Zeek is now active, and we are ready to proceed to the next section of the lab.

1.2 Launching Mininet

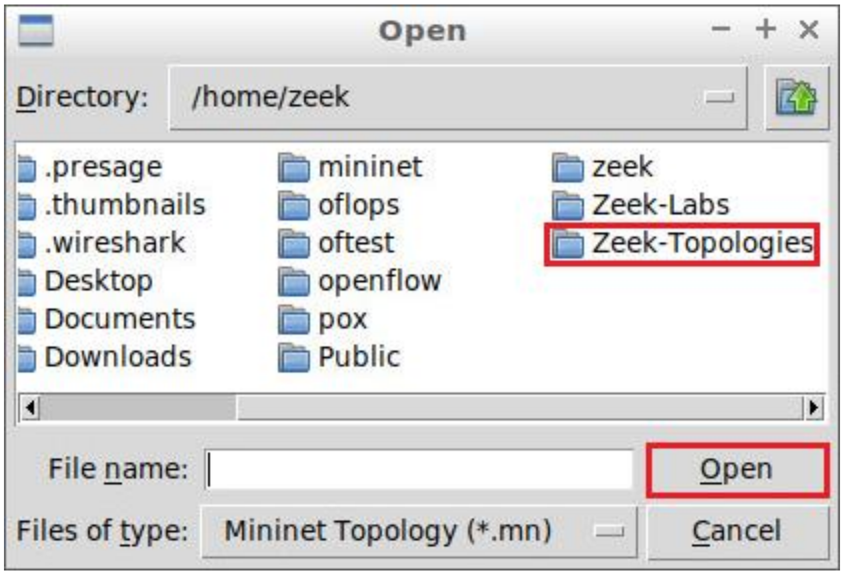
Step 1. From the *Client* machine's desktop, on the left side of the screen, click on the MiniEdit icon as shown below. When prompted for a password, type `password` and hit `Enter`. The MiniEdit editor will now launch.



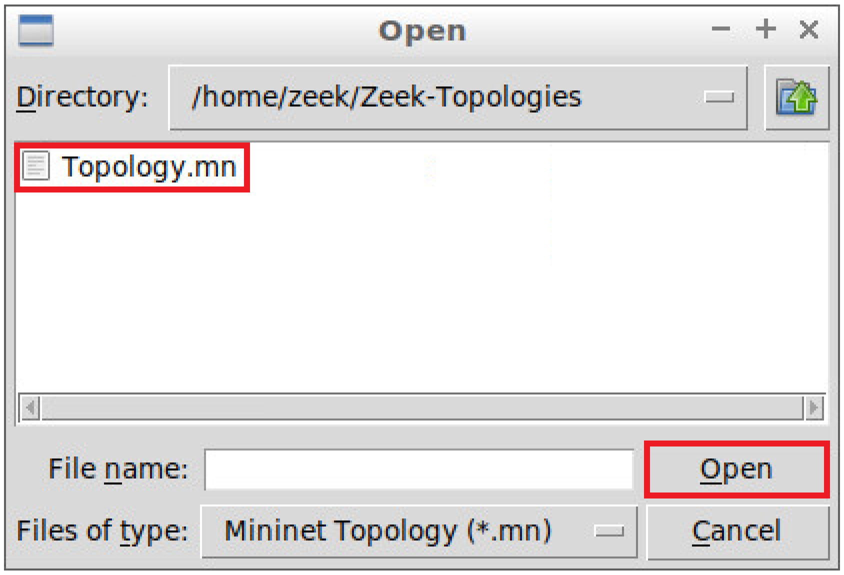
Step 2. The MiniEdit editor will now launch and allow for the creation of new, virtualized lab topologies. Load the correct topology by clicking the `Open` button within the `File` tab on the top left of the MiniEdit editor.



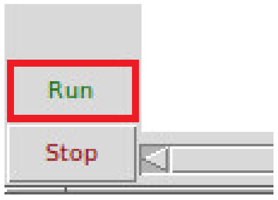
Step 3. Navigate to the Zeek-Topologies directory by scrolling to the right of the active directories and double clicking the Zeek-Topolgies icon, or by clicking the `Open` button.



Step 4. Select the *Topology.mn* file by double clicking the *Topolgies.mn* icon, or by clicking the `Open` button.

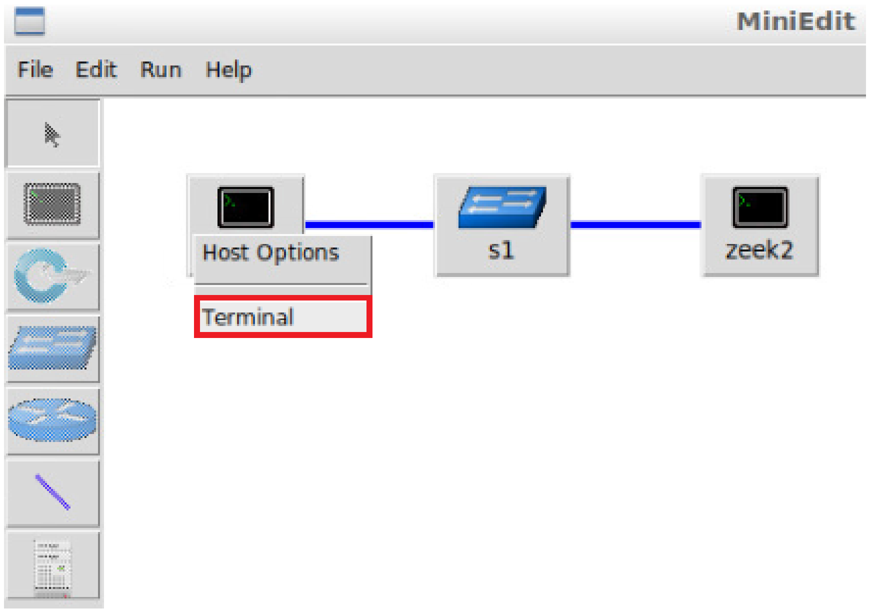

Open
Directory: /home/zeek/Zeek-Topologies
Topology.mn
File name:
Open
Files of type: Mininet Topology (*.mn)
Cancel

Step 5. To begin running the virtual machines, navigate to the `Run` button, found on the bottom left of the Miniedit editor, and select the `Run` button, as seen in the image below.



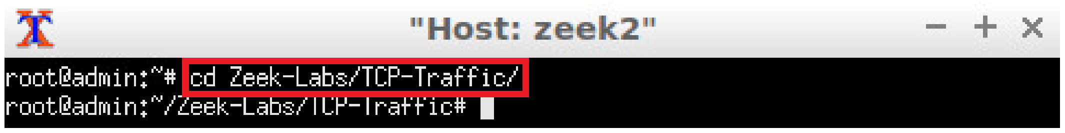
1.3 Setting up the zeek1 virtual machine for live network capture

Step 1. Launch the *zeek1* terminal by holding the right mouse button on the desired machine and clicking the *Terminal* button.



Step 2. Navigate to the TCP-Traffic directory.

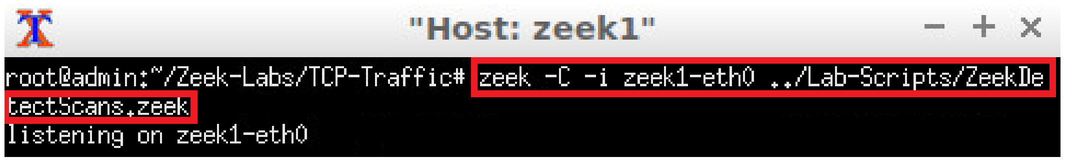
```
cd Zeek-Labs/TCP-Traffic/
```



```
root@admin:~# cd Zeek-Labs/TCP-Traffic/
root@admin:~/Zeek-Labs/TCP-Traffic#
```

Step 3. Start an instance of Zeek live packet capture on interface *zeek1-eth0* while applying the advanced Zeek script *ZeekDetectScans.zeek.* It is possible to use the `tab` key to autocomplete the longer paths.

```
zeek -C -i zeek1-eth0 ../Lab-Scripts/ZeekDetectScans.zeek
```



```
root@admin:~/Zeek-Labs/TCP-Traffic# zeek -C -i zeek1-eth0 ../Lab-Scripts/ZeekDe
tectScans.zeek
listening on zeek1-eth0
```

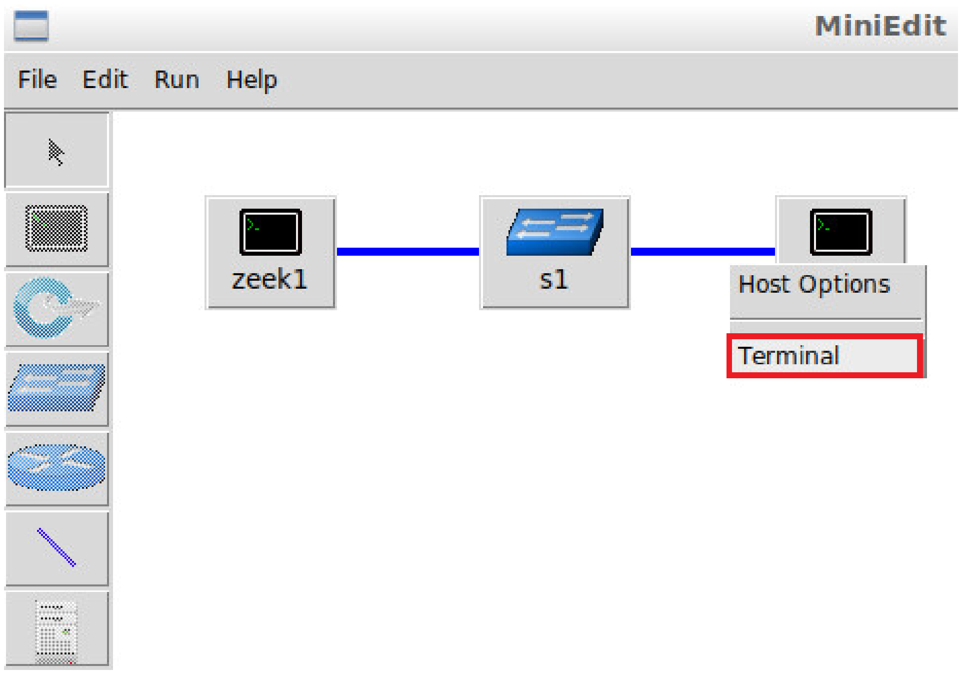
The *ZeekDetectScans.zeek* scripting file was introduced in Lab 8 of this lab series and will be used by the Zeek event-based engine to identify scan-based traffic. During live network traffic analysis, alternative scripts and signature files can be leveraged to identify specific anomalies and malicious attacks.

The *zeek1* virtual machine is now ready to begin collecting live network traffic. Next, we will use the *zeek2* machine to generate scan-based network traffic.

1.4 Using the zeek2 virtual machine for network scanning activities

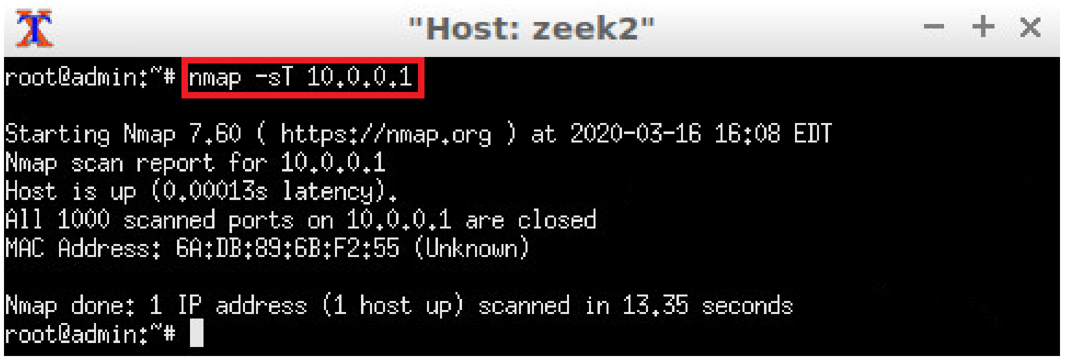
In this section we use the `nmap` software to generate TCP-based scan traffic in order to trigger Zeek's logging notices.

Step 1. Minimize the *zeek1* `Terminal` and open the *zeek2* `Terminal` by following the previous steps. If necessary, right click within the Miniedit editor to activate your cursor.



Step 2. Launch a fragmented TCP scan against the *zeek1* machine.

```
nmap -sT 10.0.0.1
```

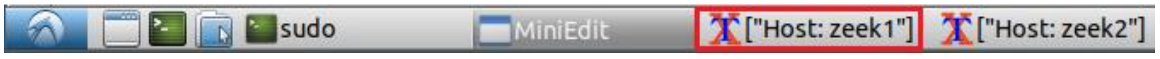


```
root@admin:~# nmap -sT 10.0.0.1

Starting Nmap 7.60 ( https://nmap.org ) at 2020-03-16 16:08 EDT
Nmap scan report for 10.0.0.1
Host is up (0.00013s latency).
All 1000 scanned ports on 10.0.0.1 are closed
MAC Address: 6A:DB:89:6B:F2:55 (Unknown)

Nmap done: 1 IP address (1 host up) scanned in 13.35 seconds
root@admin:~#
```

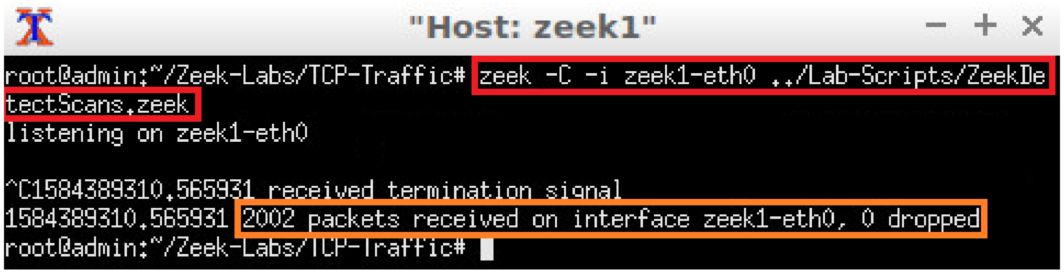
Now that we have generated scan-based traffic, we can verify that Zeek was able to identify such malicious events in real-time, while generating corresponding log files.

1.4.1 Terminating live network capture

Step 1. Minimize the *zeek2 Terminal* and open the *zeek1 Terminal* using the navigation bar at the bottom of the screen. If necessary, right click within the Miniedit editor to activate your cursor.



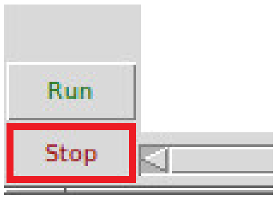
Step 2. Use the `Ctrl+c` key combination to stop live traffic capture. Statistics of the capture session will we be displayed. 2002 packets were recorded by the interface, which were continually analyzed by the Zeek event-based engine.



```
root@admin:~/Zeek-Labs/TCP-Traffic# zeek -C -i zeek1-eth0 ../Lab-Scripts/ZeekDe
tectScans.zeek
listening on zeek1-eth0

^C1584389310.565931 received termination signal
1584389310.565931 2002 packets received on interface zeek1-eth0, 0 dropped
root@admin:~/Zeek-Labs/TCP-Traffic# 
```

Within the previous image, the red box denotes the live capture command while the orange box indicates the number of packets received on the *zeek1-eth0* interface. 2002 packets were generated by the *zeek2* virtual machine, and no packets were dropped during analysis.

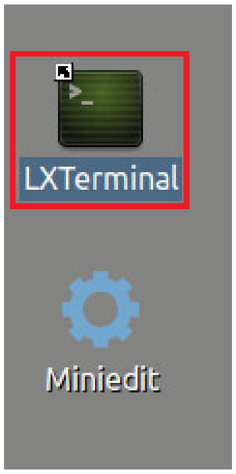
Step 3. Stop the current Mininet session by clicking the `Stop` button on the bottom left of the MiniEdit editor, and close the MiniEdit editor by clicking the `x` on the top right of the editor.



1.5 Analyzing the generated Zeek log files

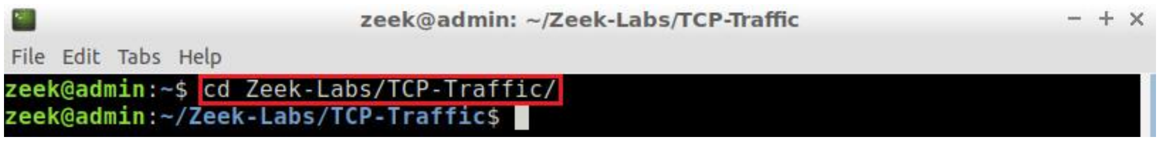
To verify the success of our real time application of Zeek's event-based engine, we will return to the *Client* machine.

Step 1. On the left side of the *Client* desktop, click on the LXTerminal icon as shown below.



Step 2. Navigate to the TCP-Traffic directory to find the log files.

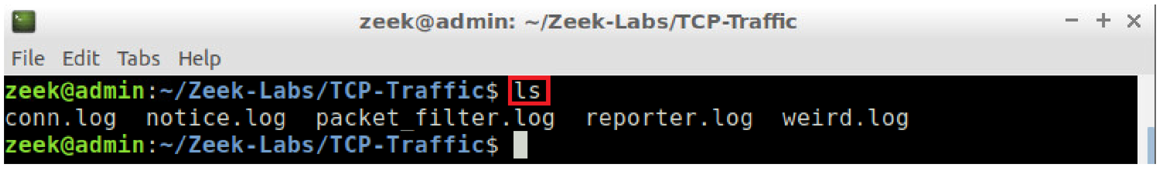
```
cd Zeek-Labs/TCP-Traffic/
```



```
zeek@admin:~$ cd Zeek-Labs/TCP-Traffic/
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

Step 3. View the file contents of the *TCP-Traffic* directory to ensure that Zeek generated log files based on the real-time network traffic analysis.

```
ls
```

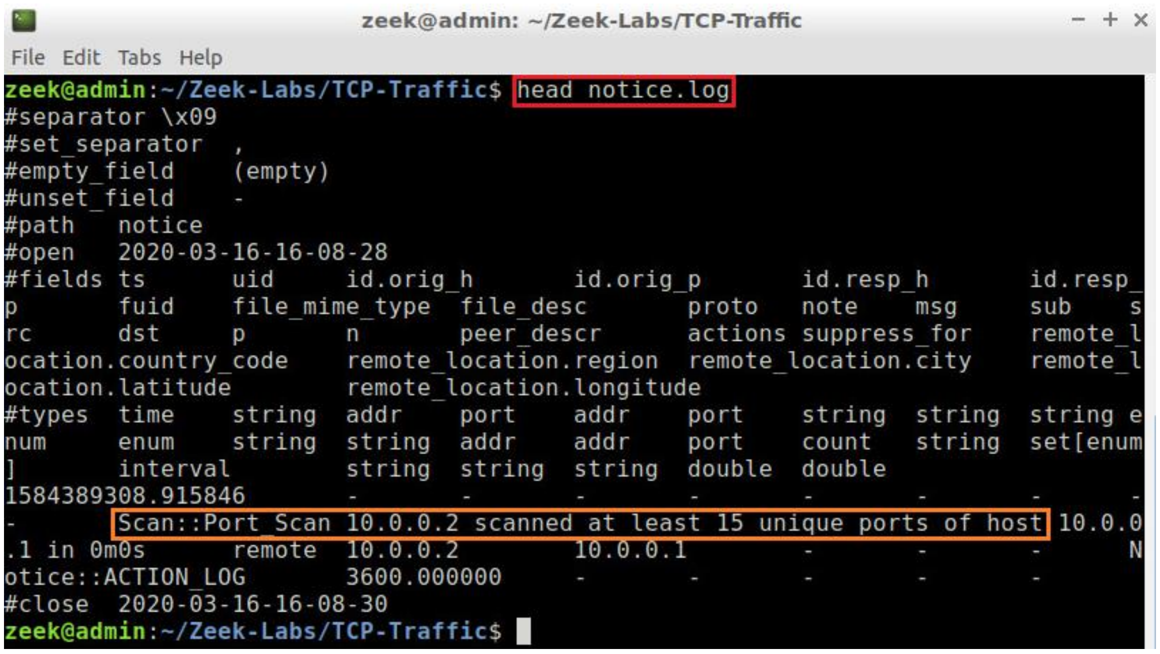


```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ ls
conn.log  notice.log  packet_filter.log  reporter.log  weird.log
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

A number of log files have been generated, specifically, the *notice.log* file which will contain the event's triggered by the *ZeekDetectScans.zeek* script file.

Step 4. View the file contents of the *notice.log* file to verify scan-based traffic was correctly identified and recorded by the Zeek event-based engine.

```
head notice.log
```



```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ head notice.log
#separator \x09
#set_separator  ,
#empty_field    (empty)
#unset_field    -
#path   notice
#open   2020-03-16-16-08-28
#fields ts      uid     id.orig_h       id.orig_p       id.resp_h       id.resp_
p       fuid    file_mime_type  file_desc       proto   note    msg     sub     s
rc      dst     p       n       peer_descr      actions suppress_for    remote_l
ocation.country_code    remote_location.region  remote_location.city    remote_l
ocation.latitude        remote_location.longitude
#types  time    string  addr    port    addr    port    string  string  string e
num     enum    string  string  addr    addr    port    count   string  set[enum
]       interval        string  string  string  double  double
1584389308.915846       -       -       -       -       -       -       -       -
-       Scan::Port_Scan 10.0.0.2 scanned at least 15 unique ports of host 10.0.0
.1 in 0m0s      remote  10.0.0.2        10.0.0.1        -       -       -       N
otice::ACTION_LOG       3600.000000     -       -       -       -       -
#close  2020-03-16-16-08-30
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

Within the previous image, the red box denotes the terminal command while the orange box indicates the resulting notice generated by Zeek due to the *ZeekDetectScans.zeek* script file. The *zeek2* virtual machine, with an IP address of 10.0.0.2, was recorded to have scanned at least 15 unique ports on the *zeek1* virtual machine.

Concluding this section, we have reviewed the capabilities of Zeek for conducting packet analysis during live network traffic capture. The signature and script files reviewed in previous labs can be leveraged during such real-time analysis, allowing for Zeek to monitor and protect a network in real-time.

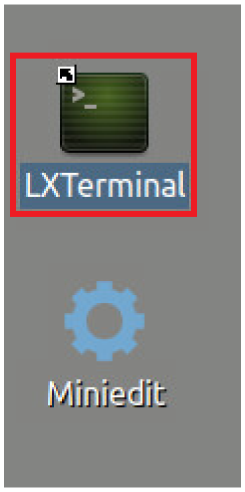
In the following section, we will review Zeek's NetControl framework, which is used to create a *backend* communication channel with application firewalls and related monitoring systems.

2 Introduction to the Zeek NetControl framework

The Zeek NetControl framework is used to create a flexible, unified interface for active mitigation and response against anomalous traffic. The framework allows for connectivity between a large number of devices, removing the heterogeneity of such configurations through creating a task-oriented API. This API is developed using the Zeek scripting language, consisting of a number of high-level calls and lower-level rule syntax. This section will introduce and review basic Zeek NetControl calls and their implementation for network traffic analysis in real-time.

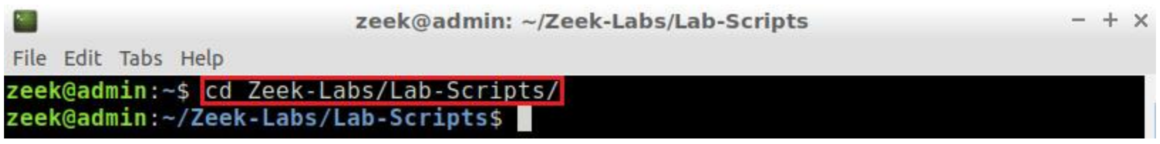
2.1 Viewing Zeek NetControl within a script file

Step 1. On the left side of the *Client* desktop, click on the LXTerminal icon as shown below.



Step 2. Navigate to the *Lab-Scripts* directory.

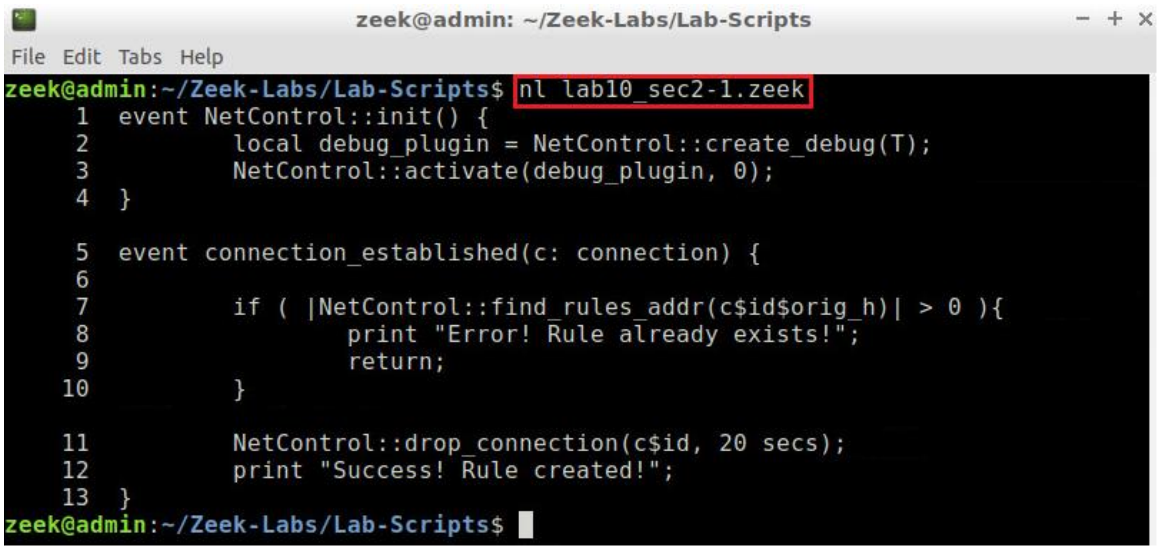
```
cd Zeek-Labs/Lab-Scripts/
```



```
zeek@admin:~$ cd Zeek-Labs/Lab-Scripts/
zeek@admin:~/Zeek-Labs/Lab-Scripts$
```

Step 3. View the contents of the *lab10_sec2-1.zeek* file using `nl`.

```
nl lab10_sec2-1.zeek
```



```
zeek@admin:~/Zeek-Labs/Lab-Scripts$ nl lab10_sec2-1.zeek
     1  event NetControl::init() {
     2          local debug_plugin = NetControl::create_debug(T);
     3          NetControl::activate(debug_plugin, 0);
     4  }

     5  event connection_established(c: connection) {
     6
     7          if ( |NetControl::find_rules_addr(c$id$orig_h)| > 0 ){
     8                  print "Error! Rule already exists!";
     9                  return;
    10          }

    11          NetControl::drop_connection(c$id, 20 secs);
    12          print "Success! Rule created!";
    13  }
zeek@admin:~/Zeek-Labs/Lab-Scripts$
```

The script is explained as follows. Each number represents the respective line number:

1. Initializes the NetControl API framework.
2. Creates a local variable to contain debug information.
3. Uses the NetControl API to activate debugging and display notifications and/or error messages.
5. Zeek event in which a connection between a source and destination is formed. This can be initialized by the TCP handshake or a series of UDP Request and Reply packets.
7. Checks if a NetControl rule already exists based on the source address requesting a connection.
8. Prints a debug error message if the rule exists.
9. Exits the function and begins checking for the next connection within the packet stream.
11. If a rule has not been created, add a rule to drop any connections made by the current source address that lasts over 20 seconds.
12. Prints a debug message that a new rule was created.

This script is relatively basic and straightforward yet shows the steps necessary to initialize the NetControl API. Without calling its initialization function, Zeek will be unable to communicate to various hardware devices through its backend.

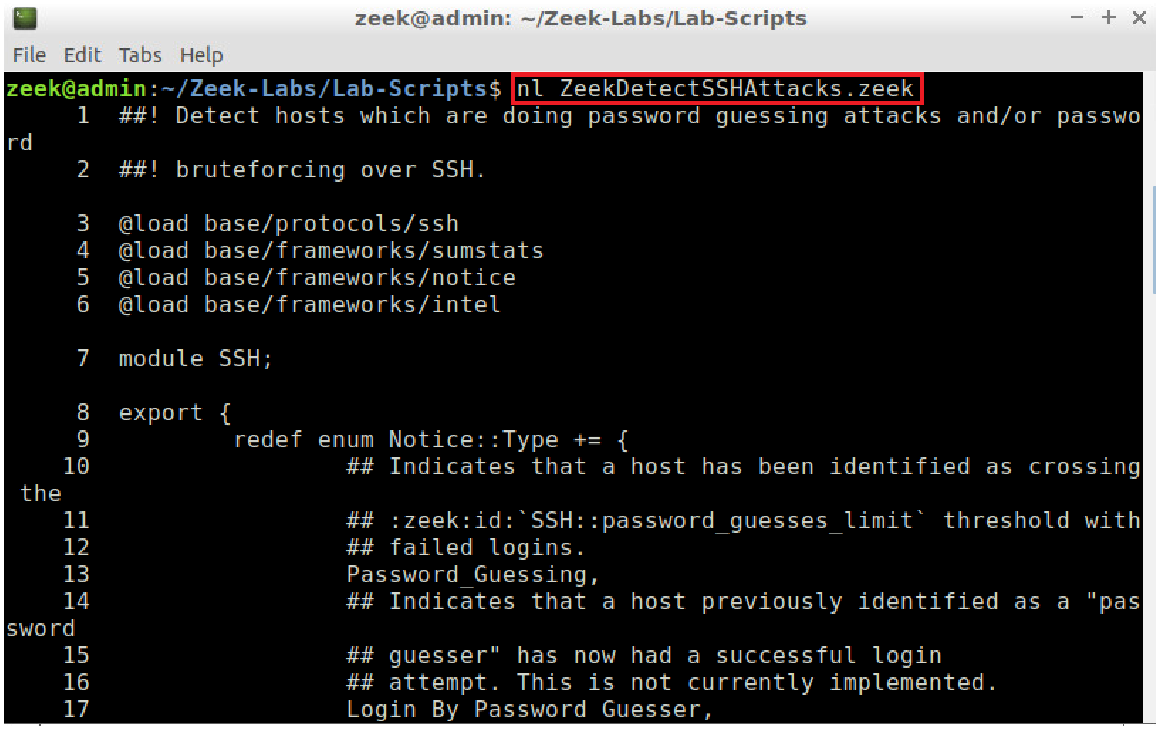
Step 4. View the contents of the *ZeekDetectSSHAttacks.zeek* file using `nl`.

This script is very similar to the *ZeekDetectScans.zeek* default script reviewed in Lab 8 of this lab series. The following images will briefly review the file contents, while the Zeek documentation and previous lab provide a more in-depth analysis of this Zeek script. To access the following link, users must have access to an external computer connected to the Internet, because the Zeek Lab topology does not have an active Internet connection.

```
https://docs.zeek.org/en/master/scripts/policy/protocols/ssh/detect-
bruteforcing.zeek.html
```

Command:

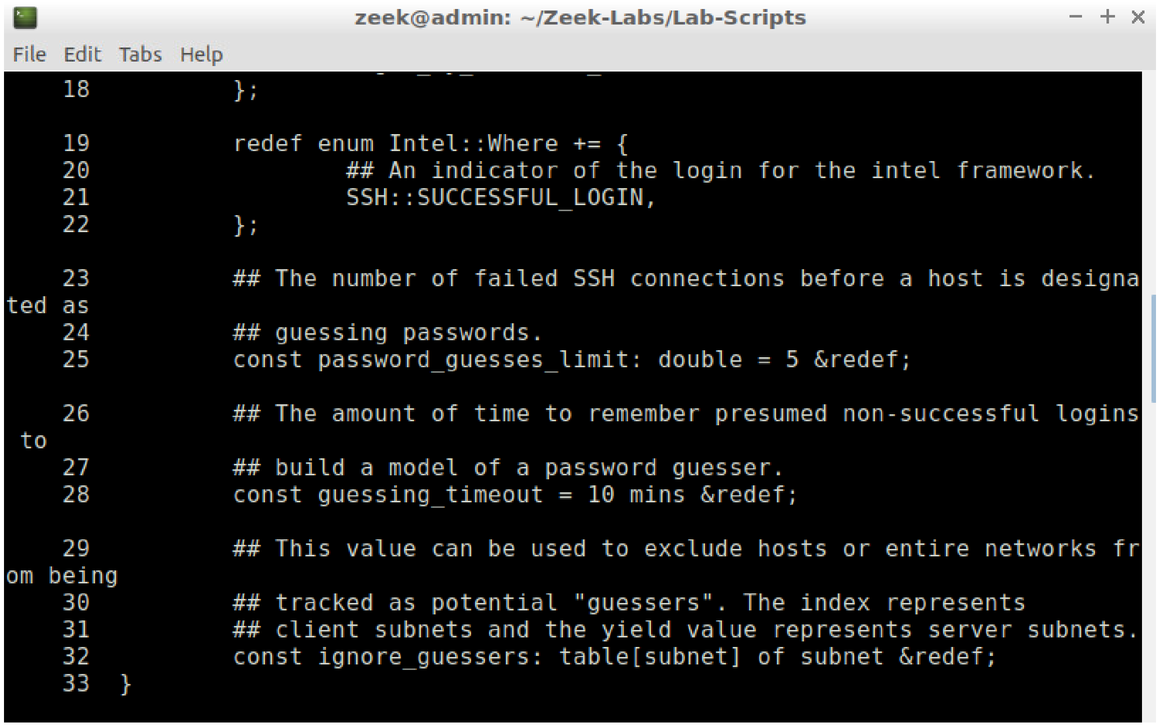
```
nl ZeekDetectSSHAttacks.zeek
```



```
zeek@admin:~/Zeek-Labs/Lab-Scripts$ nl ZeekDetectSSHAttacks.zeek
     1  ##! Detect hosts which are doing password guessing attacks and/or passwo
rd
     2  ##! bruteforcing over SSH.

     3  @load base/protocols/ssh
     4  @load base/frameworks/sumstats
     5  @load base/frameworks/notice
     6  @load base/frameworks/intel

     7  module SSH;

     8  export {
     9          redef enum Notice::Type += {
    10                  ## Indicates that a host has been identified as crossing
 the
    11                  ## :zeek:id:`SSH::password_guesses_limit` threshold with
    12                  ## failed logins.
    13                  Password_Guessing,
    14                  ## Indicates that a host previously identified as a "pas
sword
    15                  ## guesser" has now had a successful login
    16                  ## attempt. This is not currently implemented.
    17                  Login_By_Password_Guesser,
```

The script is explained as follows. Each number represents the respective line number:

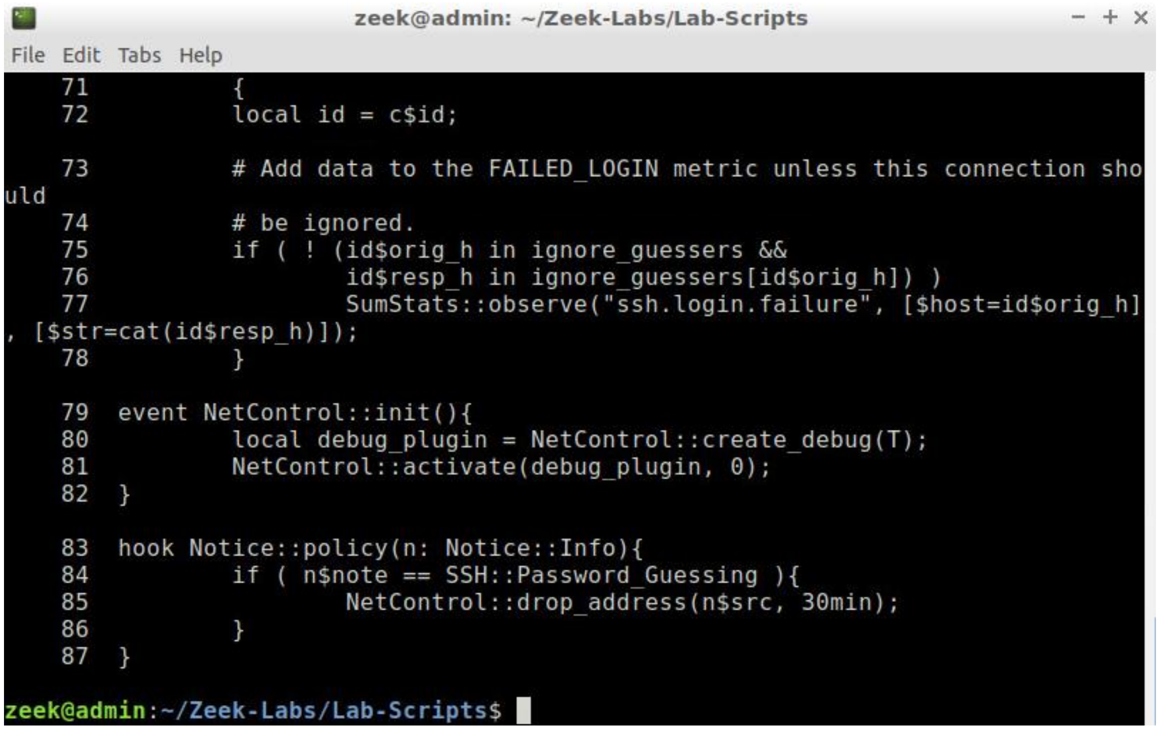
3-6. Zeek pre-directives to load SSH, summary and notice-specific script functionality.
7. Sets the module namespace to SSH.
8-17. Creates the export block to define the variables used throughout this script, specifically, the *Password_Guessing* variable on line 13 that will store the number of failed SSH password attempts.



```
    18          };

    19          redef enum Intel::Where += {
    20                  ## An indicator of the login for the intel framework.
    21                  SSH::SUCCESSFUL_LOGIN,
    22          };

    23          ## The number of failed SSH connections before a host is designa
ted as
    24          ## guessing passwords.
    25          const password_guesses_limit: double = 5 &redef;

    26          ## The amount of time to remember presumed non-successful logins
 to
    27          ## build a model of a password guesser.
    28          const guessing_timeout = 10 mins &redef;

    29          ## This value can be used to exclude hosts or entire networks fr
om being
    30          ## tracked as potential "guessers". The index represents
    31          ## client subnets and the yield value represents server subnets.
    32          const ignore_guessers: table[subnet] of subnet &redef;
    33  }
```

Scroll down on the Terminal to view more of the script. Each number represents the respective line number:

25. Variable named *password_guesses_limit* that stores a numerical threshold for total number of failed SSH connections before marking a host as launching a brute-force attack.
28. Variable named *guessing_timeout* that stores a time-based threshold before resetting the *password_guesses_limit* variable back to 0.
29. Variable named *ignore_guessers* that stores a table of IP addresses identified to be launching SSH brute-force attacks. These addresses can be blocked or partially filtered.



```
    71          {
    72          local id = c$id;

    73          # Add data to the FAILED_LOGIN metric unless this connection sho
uld
    74          # be ignored.
    75          if ( ! (id$orig_h in ignore_guessers &&
    76                  id$resp_h in ignore_guessers[id$orig_h]) )
    77                  SumStats::observe("ssh.login.failure", [$host=id$orig_h]
, [$str=cat(id$resp_h)]);
    78          }

    79  event NetControl::init(){
    80          local debug_plugin = NetControl::create_debug(T);
    81          NetControl::activate(debug_plugin, 0);
    82  }

    83  hook Notice::policy(n: Notice::Info){
    84          if ( n$note == SSH::Password_Guessing ){
    85                  NetControl::drop_address(n$src, 30min);
    86          }
    87  }

zeek@admin:~/Zeek-Labs/Lab-Scripts$ 
```

Scroll down on the Terminal to view more of the script. Each number represents the respective line number:

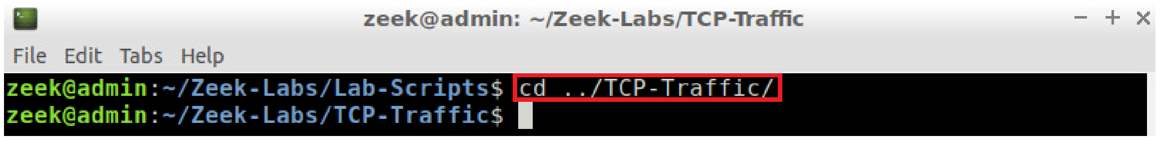
79. Initializes the NetControl API framework.
80. Creates a local variable to contain debug information.
81. Uses the NetControl API to activate debugging and display notifications and/or error messages.
83. Zeek hook to the Notice logging stream so that we can append new information with default information.
84. Checks the *Password_Guessing* variable to determine if the current source address has been identified to be launching SSH brute-force attacks.
85. If the current source address was launching SSH brute-force attacks, create a new rule that will drop all network traffic from this source for the next 30 minutes.

Now that we have reviewed both scripts that will be used within the remainder of the lab, we can see the value of Zeek's NetControl framework. By leveraging Zeek scripts we are able to identify anomalous network traffic events, detect malicious sources and finally leverage NetControl to mitigate their attacks. The remainder of this lab will include examples of executing the aforementioned Zeek scripts.

2.2 Executing Zeek NetControl within a script file

Step 1. Navigate to the *TCP-Traffic* directory.

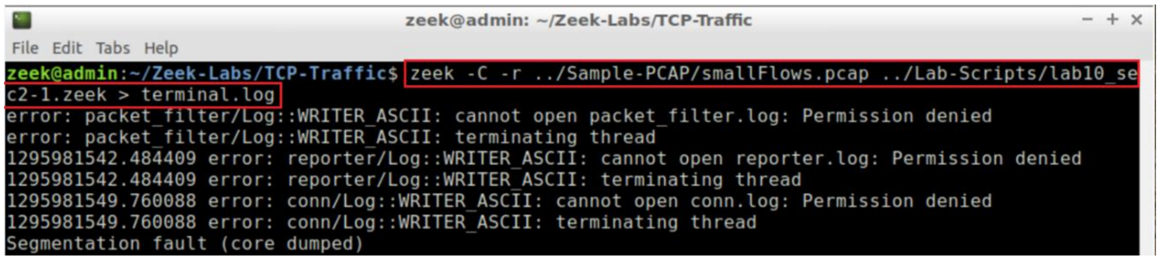
```
cd ../TCP-Traffic/
```



```
zeek@admin:~/Zeek-Labs/Lab-Scripts$ cd ../TCP-Traffic/
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

Step 2. Process the *smallFlows.pcap* packet capture file using the *lab10_sec2-1.zeek* script. To type capital letters, it is recommended to hold the `Shift` key while typing rather than using the `Caps` key. It is possible to use the `tab` key to autocomplete the longer paths.

```
zeek -C -r ../Sample-PCAP/smallFlows.pcap ../Lab-Scripts/lab10_sec2-1.zeek >
terminal.log
```



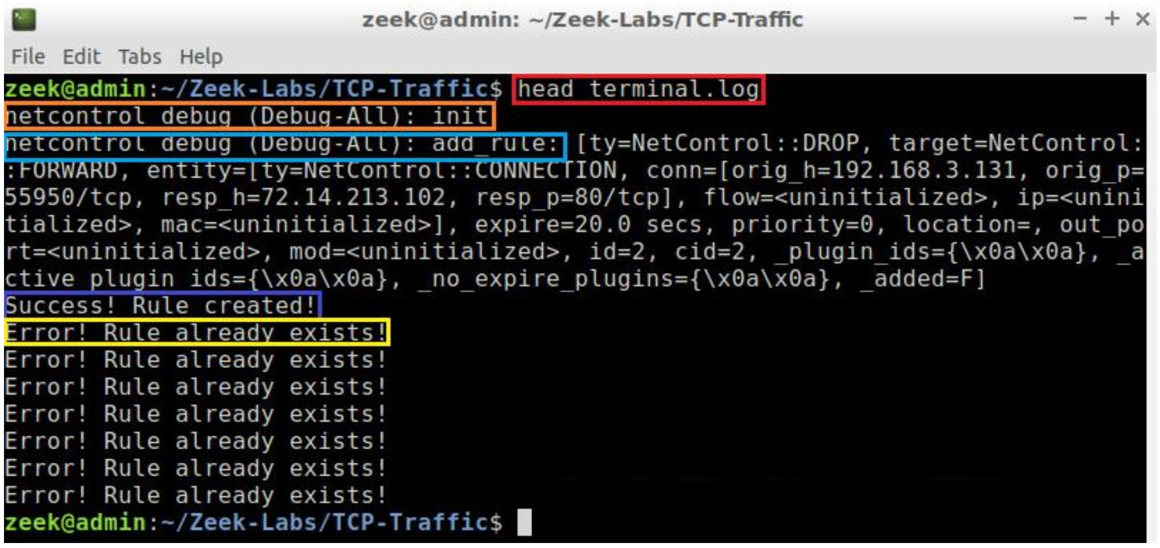
```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ zeek -C -r ../Sample-PCAP/smallFlows.pcap ../Lab-Scripts/lab10_se
c2-1.zeek > terminal.log
error: packet_filter/Log::WRITER_ASCII: cannot open packet_filter.log: Permission denied
error: packet_filter/Log::WRITER_ASCII: terminating thread
1295981542.484409 error: reporter/Log::WRITER_ASCII: cannot open reporter.log: Permission denied
1295981542.484409 error: reporter/Log::WRITER_ASCII: terminating thread
1295981549.760088 error: conn/Log::WRITER_ASCII: cannot open conn.log: Permission denied
1295981549.760088 error: conn/Log::WRITER_ASCII: terminating thread
Segmentation fault (core dumped)
```

Because we have NetControl debugging enabled, we are going to save all error messages and notifications to the file *terminal.log*. By saving these notifications to a separate file, it is easier to view them in an organized fashion.

Ignore the permission denied error messages.

Step 3. View the file contents of the *terminal.log* file using `head`.

```
head terminal.log
```

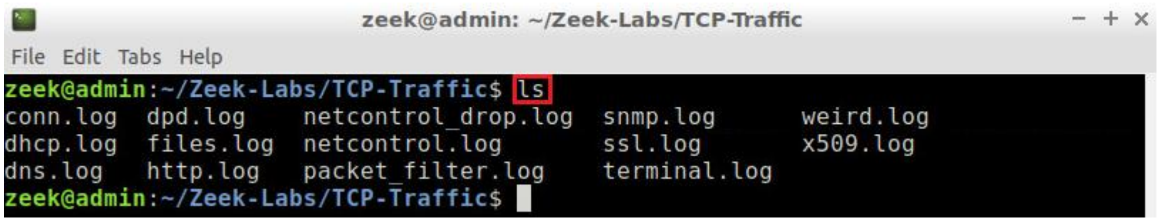


```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ head terminal.log
netcontrol debug (Debug-All): init
netcontrol debug (Debug-All): add_rule: [ty=NetControl::DROP, target=NetControl:
:FORWARD, entity=[ty=NetControl::CONNECTION, conn=[orig_h=192.168.3.131, orig_p=
55950/tcp, resp_h=72.14.213.102, resp_p=80/tcp], flow=<uninitialized>, ip=<unini
tialized>, mac=<uninitialized>], expire=20.0 secs, priority=0, location=, out_po
rt=<uninitialized>, mod=<uninitialized>, id=2, cid=2, _plugin_ids={\x0a\x0a}, _a
ctive_plugin_ids={\x0a\x0a}, _no_expire_plugins={\x0a\x0a}, _added=F]
Success! Rule created!
Error! Rule already exists!
Error! Rule already exists!
Error! Rule already exists!
Error! Rule already exists!
Error! Rule already exists!
Error! Rule already exists!
Error! Rule already exists!
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

Reviewing this image, the red box indicates the terminal command used to view the file. The orange box indicates the NetControl debug message that it has been initialized. The blue box indicates that a new rule has been created to drop all packets from the specified IP address for passing the connection-length threshold. The dark blue box indicates the Zeek event message that the rule was created successfully, while the yellow box indicates the Zeek event message that the rule already existed and a duplicate was not created.

Step 4. View the contents of the *TCP-Traffic* directory using `ls`.

```
ls
```

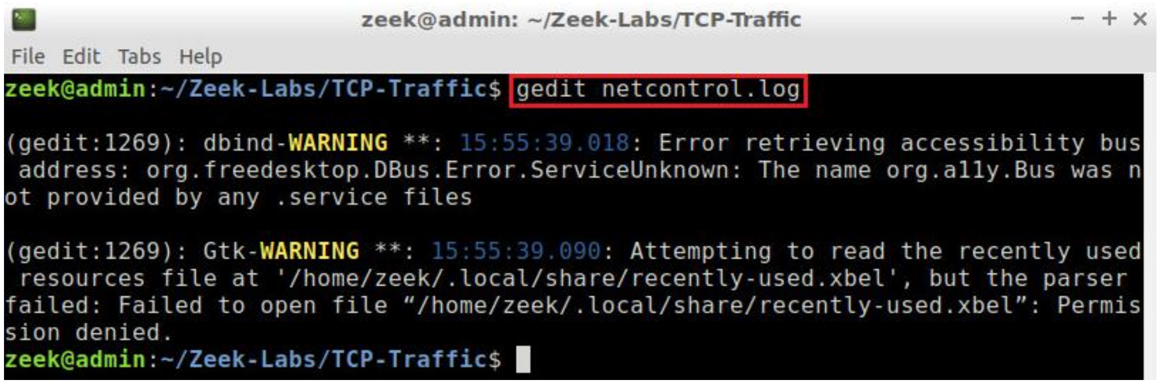


```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ ls
conn.log  dpd.log    netcontrol_drop.log  snmp.log      weird.log
dhcp.log  files.log  netcontrol.log       ssl.log       x509.log
dns.log   http.log   packet_filter.log    terminal.log
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

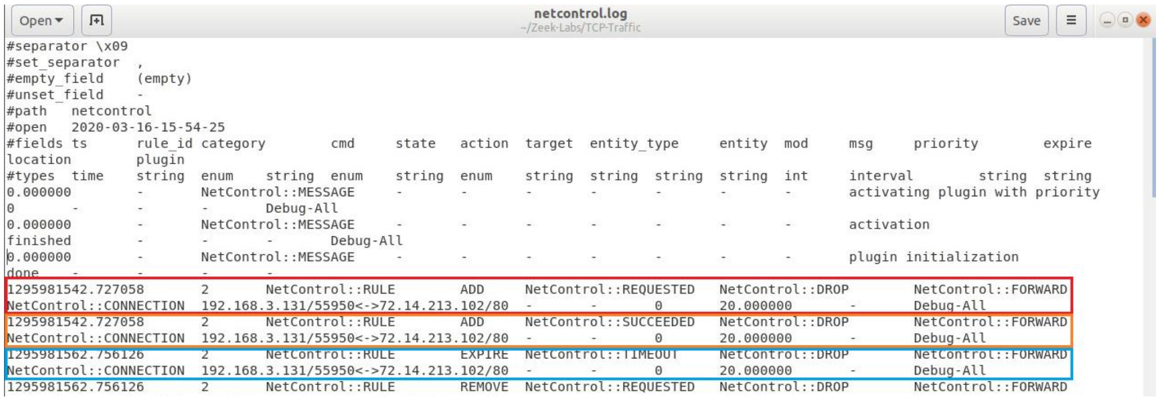
The two log files are interested in are the *netcontrol.log* and *netcontrol_drop.log* files. The *netcontrol.log* file will contain all information related to adding and removing rules, while the *netcontrol_drop.log* file will contain information regarding to when each rule was triggered and by which source address.

Step 5. View the file contents of the *netcontrol.log* file using `gedit`.

```
gedit netcontrol.log
```



```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ gedit netcontrol.log

(gedit:1269): dbind-WARNING **: 15:55:39.018: Error retrieving accessibility bus
 address: org.freedesktop.DBus.Error.ServiceUnknown: The name org.a11y.Bus was n
ot provided by any .service files

(gedit:1269): Gtk-WARNING **: 15:55:39.090: Attempting to read the recently used
 resources file at '/home/zeek/.local/share/recently-used.xbel', but the parser
failed: Failed to open file “/home/zeek/.local/share/recently-used.xbel”: Permis
sion denied.
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

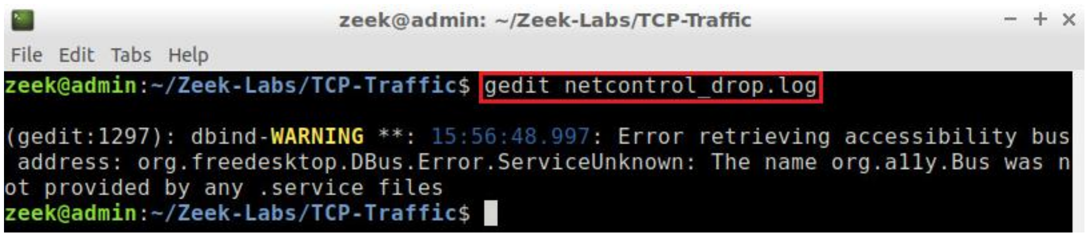


```
#separator \x09
#set_separator  ,
#empty_field    (empty)
#unset_field    -
#path   netcontrol
#open   2020-03-16-15-54-25
#fields ts      rule_id category        cmd     state   action  target  entity_type     entity  mod     msg     priority        expire
location        plugin
#types  time    string  enum    string  enum    string  enum    string  string  string  string  int     interval        string  string
0.000000        -       NetControl::MESSAGE     -       -       -       -       -       -       -       activating plugin with priority
0       -       -       -       Debug-All
0.000000        -       NetControl::MESSAGE     -       -       -       -       -       -       -       activation
finished        -       -       -       Debug-All
0.000000        -       NetControl::MESSAGE     -       -       -       -       -       -       -       plugin initialization
done    -       -       -       -
1295981542.727058       2       NetControl::RULE        ADD     NetControl::REQUESTED   NetControl::DROP        NetControl::FORWARD
NetControl::CONNECTION  192.168.3.131/55950<->72.14.213.102/80  -       -       0       20.000000       -       Debug-All
1295981542.727058       2       NetControl::RULE        ADD     NetControl::SUCCEEDED   NetControl::DROP        NetControl::FORWARD
NetControl::CONNECTION  192.168.3.131/55950<->72.14.213.102/80  -       -       0       20.000000       -       Debug-All
1295981562.756126       2       NetControl::RULE        EXPIRE  NetControl::TIMEOUT     NetControl::DROP        NetControl::FORWARD
NetControl::CONNECTION  192.168.3.131/55950<->72.14.213.102/80  -       -       0       20.000000       -       Debug-All
1295981562.756126       2       NetControl::RULE        REMOVE  NetControl::REQUESTED   NetControl::DROP        NetControl::FORWARD
```

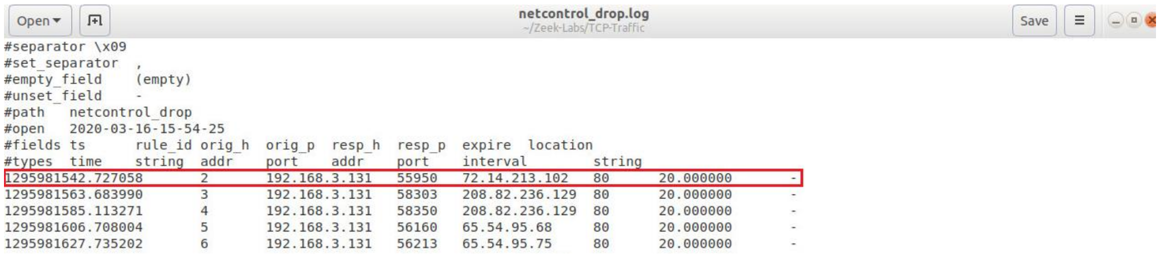
Reviewing this image, the red box indicates that a Connection request was made by the source address *192.168.3.131* to the destination address *72.14.213.102*. The orange box indicates that the connection was established while the blue box indicates that the connection was dropped and forced to time-out because of NetControl filtering packets from this source destination.

Step 6. Close the gedit by clicking the `x` on the top right of the gedit window, then view the file contents of the *netcontrol_drop.log* file using `gedit`.

```
gedit netcontrol_drop.log
```



```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ gedit netcontrol_drop.log

(gedit:1297): dbind-WARNING **: 15:56:48.997: Error retrieving accessibility bus
 address: org.freedesktop.DBus.Error.ServiceUnknown: The name org.a11y.Bus was n
ot provided by any .service files
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

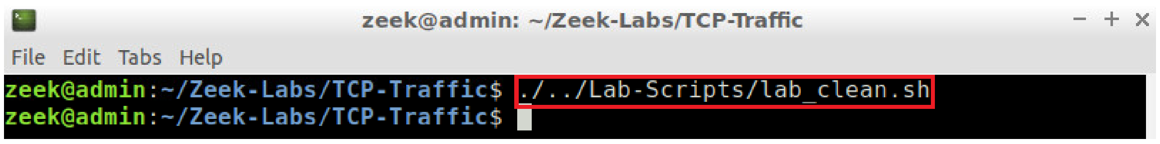


```
#separator \x09
#set_separator  ,
#empty_field    (empty)
#unset_field    -
#path   netcontrol_drop
#open   2020-03-16-15-54-25
#fields ts      rule_id orig_h  orig_p  resp_h  resp_p  expire  location
#types  time    string  addr    port    addr    port    interval        string
1295981542.727058       2       192.168.3.131   55950   72.14.213.102   80      20.000000       -
1295981563.683990       3       192.168.3.131   58303   208.82.236.129  80      20.000000       -
1295981585.113271       4       192.168.3.131   58350   208.82.236.129  80      20.000000       -
1295981606.708004       5       192.168.3.131   56160   65.54.95.68     80      20.000000       -
1295981627.735202       6       192.168.3.131   56213   65.54.95.75     80      20.000000       -
```

Reviewing this image, the red box indicates that a source address attempted to create a connection, breaking the NetControl rule we had previously implemented. Therefore, all packets were dropped from this source host during the time-out interval we declared within the *lab10_sec2-1.zeek* script.

Step 7. Clear the *TCP-Traffic* directory by using the *lab_clean.sh* shell script.

```
./../Lab-Scripts/lab_clean.sh
```



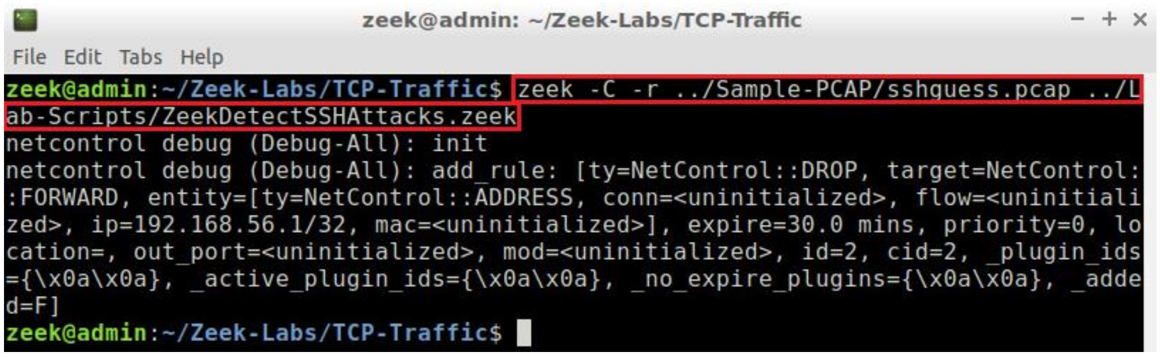
```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ ./../Lab-Scripts/lab_clean.sh
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

3 Identifying SSH attacks by leveraging the Zeek NetControl framework

Now that we have reviewed a basic implementation of the NetControl framework, creating a connection-based rule and identifying source addresses that broke the rule, we will conduct a more in-depth analysis on SSH brute-force password attacks.

Step 1. Process the *sshguess.pcap* packet capture file using *ZeekDetectSSHAttacks.zeek*. To type capital letters, it is recommended to hold the `Shift` key while typing rather than using the `Caps` key. It is possible to use the `tab` key to autocomplete the longer paths.

```
zeek -C -r ../Sample-PCAP/sshguess.pcap ../Lab-
Scripts/ZeekDetectSSHAttacks.zeek
```

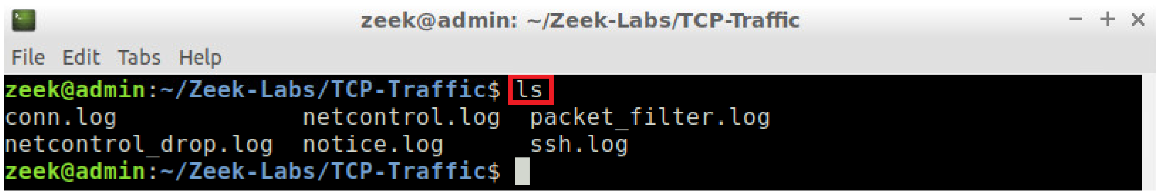


```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ zeek -C -r ../Sample-PCAP/sshguess.pcap ../L
ab-Scripts/ZeekDetectSSHAttacks.zeek
netcontrol debug (Debug-All): init
netcontrol debug (Debug-All): add_rule: [ty=NetControl::DROP, target=NetControl:
:FORWARD, entity=[ty=NetControl::ADDRESS, conn=<uninitialized>, flow=<uninitiali
zed>, ip=192.168.56.1/32, mac=<uninitialized>], expire=30.0 mins, priority=0, lo
cation=, out_port=<uninitialized>, mod=<uninitialized>, id=2, cid=2, _plugin_ids
={\x0a\x0a}, _active_plugin_ids={\x0a\x0a}, _no_expire_plugins={\x0a\x0a}, _adde
d=F]
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

Similar to the previous section, we can see the *NetControl* debug messages including its initialization and creation of a new rule.

Step 2. View the contents of the *TCP-Traffic* directory using `ls`.

```
ls
```

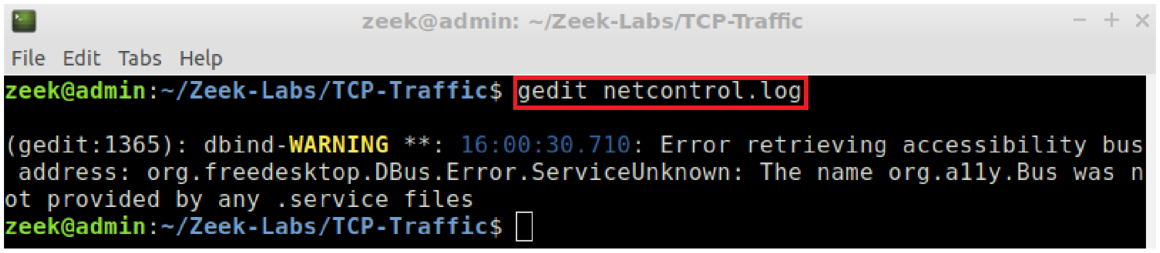


```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ ls
conn.log               netcontrol.log  packet_filter.log
netcontrol_drop.log    notice.log      ssh.log
zeek@admin:~/Zeek-Labs/TCP-Traffic$
```

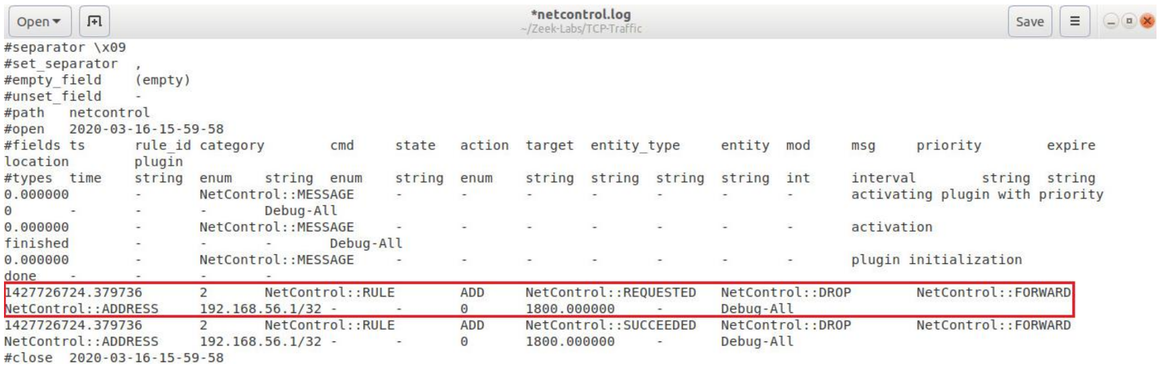
We can see that the *netcontrol.log, netcontrol_drop.log* and *notice.log* files were created during packet capture analysis.

Step 3. View the file contents of the *netcontrollog* file using `gedit`.

```
gedit netcontrol.log
```



```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ gedit netcontrol.log

(gedit:1365): dbind-WARNING **: 16:00:30.710: Error retrieving accessibility bus
 address: org.freedesktop.DBus.Error.ServiceUnknown: The name org.a11y.Bus was n
ot provided by any .service files
zeek@admin:~/Zeek-Labs/TCP-Traffic$ 
```

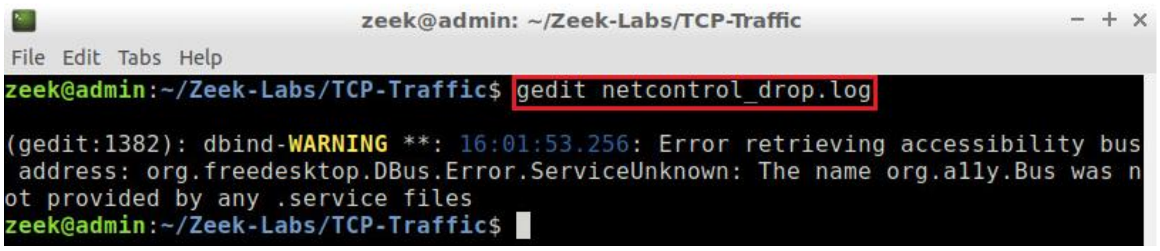


```
#separator \x09
#set_separator  ,
#empty_field    (empty)
#unset_field    -
#path   netcontrol
#open   2020-03-16-15-59-58
#fields ts      rule_id category        cmd     state   action  target  entity_type     entity  mod     msg     priority        expire
location        plugin
#types  time    string  enum    string  enum    string  enum    string  string  string  string  int     interval        string  string
0.000000        -       NetControl::MESSAGE     -       -       -       -       -       -       -       activating plugin with priority
0       -       -       -       Debug-All
0.000000        -       NetControl::MESSAGE     -       -       -       -       -       -       -       activation
finished        -       -       -       Debug-All
0.000000        -       NetControl::MESSAGE     -       -       -       -       -       -       -       plugin initialization
done    -       -       -       -
1427726724.379736       2       NetControl::RULE        ADD     NetControl::REQUESTED   NetControl::DROP        NetControl::FORWARD
NetControl::ADDRESS     192.168.56.1/32 -       -       0       1800.000000     -       Debug-All
1427726724.379736       2       NetControl::RULE        ADD     NetControl::SUCCEEDED   NetControl::DROP        NetControl::FORWARD
NetControl::ADDRESS     192.168.56.1/32 -       -       0       1800.000000     -       Debug-All
#close  2020-03-16-15-59-58
```

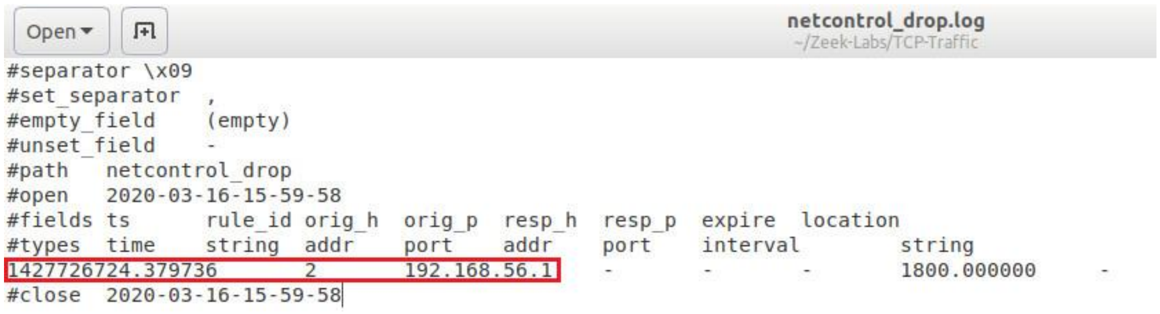
Reviewing the previous image, the red box indicates that a new rule was created due to the address *192.168.56.1* surpassing the incorrect SSH password guessing threshold.

Step 4. Close the gedit by clicking the x on the top right of the gedit window, then view the file contents of the *netcontrol_drop.log* file using `gedit`.

```
gedit netcontrol_drop.log
```



```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ gedit netcontrol_drop.log

(gedit:1382): dbind-WARNING **: 16:01:53.256: Error retrieving accessibility bus
 address: org.freedesktop.DBus.Error.ServiceUnknown: The name org.a11y.Bus was n
ot provided by any .service files
zeek@admin:~/Zeek-Labs/TCP-Traffic$ 
```

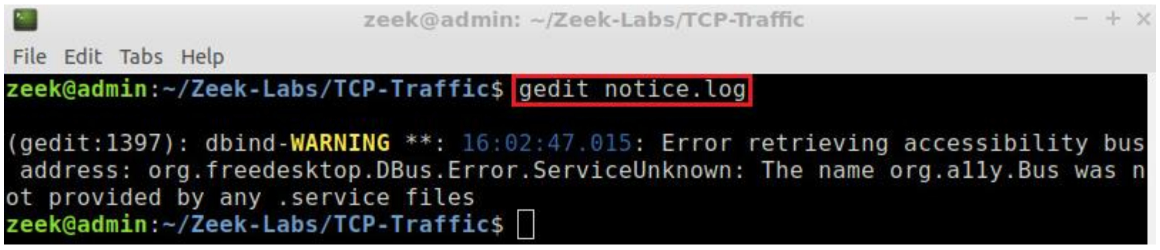


```
#separator \x09
#set_separator  ,
#empty_field    (empty)
#unset_field    -
#path   netcontrol_drop
#open   2020-03-16-15-59-58
#fields ts      rule_id orig_h  orig_p  resp_h  resp_p  expire  location
#types  time    string  addr    port    addr    port    interval        string
1427726724.379736       2       192.168.56.1    -       -       -       1800.000000     -
#close  2020-03-16-15-59-58
```

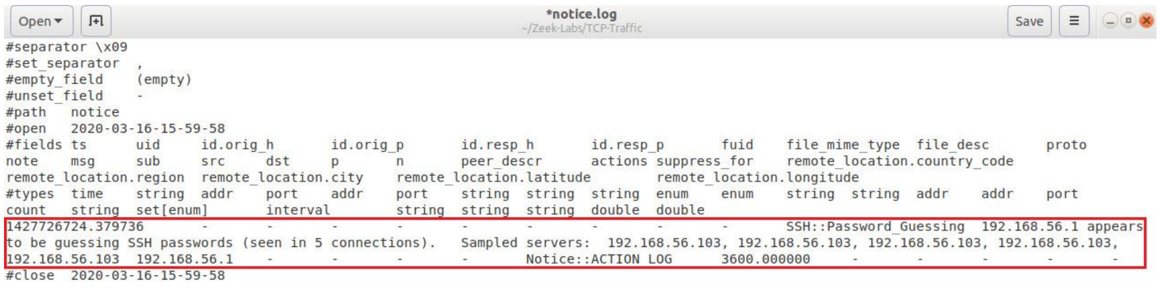
Reviewing the previous image, the red box indicates which addresses were discovered to break the NetControl rules. In this example, only one address was discovered, *192.168.56.1*.

Step 5. Close the gedit by clicking the `x` on the top right of the gedit window then, view the file contents of the *notice.log* file using `gedit`.

```
gedit notice.log
```



```
zeek@admin:~/Zeek-Labs/TCP-Traffic$ gedit notice.log

(gedit:1397): dbind-WARNING **: 16:02:47.015: Error retrieving accessibility bus
 address: org.freedesktop.DBus.Error.ServiceUnknown: The name org.ally.Bus was n
ot provided by any .service files
zeek@admin:~/Zeek-Labs/TCP-Traffic$ 
```



```
#separator \x09
#set_separator  ,
#empty_field    (empty)
#unset_field    -
#path   notice
#open   2020-03-16-15-59-58
#fields ts      uid     id.orig_h       id.orig_p       id.resp_h       id.resp_p       fuid    file_mime_type  file_desc       proto
note    msg     sub     src     dst     p       n       peer_descr      actions suppress_for    remote_location.country_code
remote_location.region  remote_location.city    remote_location.latitude        remote_location.longitude
#types  time    string  addr    port    addr    port    string  string  string  enum    enum    string  string  addr    addr    port
count   string  set[enum]       interval        string  string  string  double  double
1427726724.379736       -       -       -       -       -       -       -       -       -       SSH::Password_Guessing  192.168.56.1 appears
to be guessing SSH passwords (seen in 5 connections).   Sampled servers:  192.168.56.103, 192.168.56.103, 192.168.56.103, 192.168.56.103,
192.168.56.103  192.168.56.1    -       -       -       -       Notice::ACTION_LOG      3600.000000     -       -       -       -       -
#close  2020-03-16-15-59-58
```

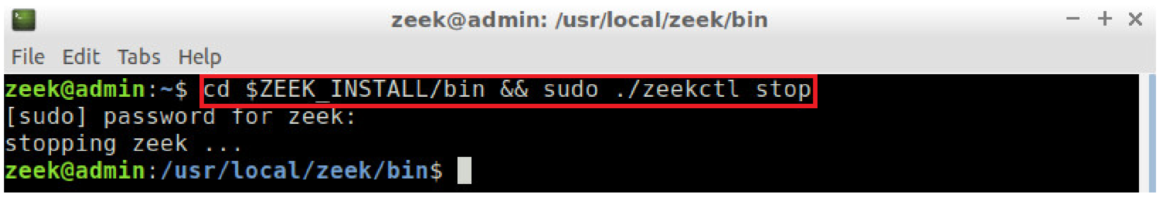
Recall that the *notice.log* file is generated by the *ZeekDetectSSHAttacks.zeek* script. The red box indicates which IP address was logged to have broken the SSH password guessing threshold.

3.1 Closing the current instance of Zeek

After you have finished the lab, it is necessary to terminate the currently active instance of Zeek. Shutting down a computer while an active instance persists will cause Zeek to shut down improperly and may cause errors in future instances.

Step 1. Stop Zeek by entering the following command on the terminal. If required, type `password` as the password. If the Terminal session has not been terminated or closed, you may not be prompted to enter a password. To type capital letters, it is recommended to hold the *Shift* key while typing rather than using the *Caps* key.

```
cd $ZEEK_INSTALL/bin && sudo ./zeekctl stop
```



```
zeek@admin:~$ cd $ZEEK_INSTALL/bin && sudo ./zeekctl stop
[sudo] password for zeek:
stopping zeek ...
zeek@admin:/usr/local/zeek/bin$ 
```

Concluding this lab, we have introduced the Zeek NetControl framework and Zeek's live processing of real-time network traffic. While the NetControl examples were performed on offline packet capture files, by combining Zeek's live analysis from Section 1 with the examples from Section 2 and 3, active measures can be taken for identifying malicious network traffic and blocking such sources.

References

1. "NetControl Framework", Zeek user manual, [Online], Available: https://docs.zeek.org/en/stable/frameworks/netcontrol.html
2. "Logging framework", Zeek user manual, [Online], Available: https://docs.zeek.org/en/stable/frameworks/logging.html
3. "Writing scripts", Zeek user manual, [Online], Available: https://docs.zeek.org/en/stable/examples/scripting/#the-event-queue-and-event-handlers
4. "Quick start Guide", Zeek user manual, [Online], Available: https://docs.zeek.org/en/current/quickstart