

## 4.3.4 Lab - Linux Servers



This lab has been updated for use on NETLAB+.  
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### Objectives

In this lab, you will use the Linux command line to identify servers running on a given computer.

#### Part 1: Servers

#### Part 2: Using Telnet to Test TCP Services

### Instructions

#### Part 1: Servers

Servers are essentially programs written to provide specific information upon request. Clients, which are also programs, reach out to the server, place the request, and wait for the server response. Many different client-server communication technologies can be used, with the most common being IP networks. This lab focuses on IP network-based servers and clients.

#### Step 1: Access the command line.

- Log on to the Workstation VM as the **analyst**, using the password **cyberops**. The account *analyst* is used as the example user account throughout this lab.
- To access the command line, click the **terminal** icon located in the Dock, at the bottom of VM screen. The terminal emulator opens.



#### Step 2: Display the services currently running.

Many different programs can be running on a given computer, especially a computer running a Linux operating system. Many programs run in the background so users may not immediately detect what programs are running on a given computer. In Linux, running programs are also called *processes*.

**Note:** The output of your *ps* command will differ because it will be based on the state of your CyberOps Workstation VM.

- Use the **ps** command to display all the programs running in the background. If prompted, enter **cyberops** as the password.

```
[analyst@secOps ~]$ sudo ps -elf
```

```
[sudo] password for analyst:
```

F	S	UID	PID	PPID	C	PRI	NI	ADDR	SZ	WCHAN	STIME	TTY	TIME	CMD
4	S	root	1	0	0	80	0	-	2250	Sys_ep	Feb27	?	00:00:00	/sbin/init
1	S	root	2	0	0	80	0	-	0	kthrea	Feb27	?	00:00:00	[kthreadd]
1	S	root	3	2	0	80	0	-	0	smpboo	Feb27	?	00:00:00	

[ksoftirqd/0]

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```
1 S root          5      2  0  60 -20 -      0 worker Feb27 ?      00:00:00
[kworker/0:0H]
1 S root          7      2  0  80   0 -      0 rcu_gp Feb27 ?      00:00:00
[rcu_preempt]
1 S root          8      2  0  80   0 -      0 rcu_gp Feb27 ?      00:00:00 [rcu_sched]
1 S root          9      2  0  80   0 -      0 rcu_gp Feb27 ?      00:00:00 [rcu_bh]
1 S root         10      2  0 -40   - -      0 smpboo Feb27 ?      00:00:00
[migration/0]
1 S root         11      2  0  60 -20 -      0 rescue Feb27 ?      00:00:00 [lru-add-
drain]
5 S root         12      2  0 -40   - -      0 smpboo Feb27 ?      00:00:00
[watchdog/0]
1 S root         13      2  0  80   0 -      0 smpboo Feb27 ?      00:00:00 [cpuhp/0]
5 S root         14      2  0  80   0 -      0 devtmp Feb27 ?      00:00:00 [kdevtmpfs]
1 S root         15      2  0  60 -20 -      0 rescue Feb27 ?      00:00:00 [netns]
1 S root         16      2  0  80   0 -      0 watchd Feb27 ?      00:00:00
[khungtaskd]
1 S root         17      2  0  80   0 -      0 oom_re Feb27 ?      00:00:00
[oom_reaper]
<some output omitted>
```

Why was it necessary to run *ps* as root (prefacing the command with *sudo*)?

- b. In Linux, programs can also call other programs. The *ps* command can also be used to display such process hierarchy. Use *-ejH* options to display the currently running process tree after starting the nginx webserver with elevated privileges.

**Note:** The process information for the *nginx* service is highlighted. Your PID values will be different.

```
[analyst@secOps ~]$ sudo /usr/sbin/nginx
[analyst@secOps ~]$ sudo ps -ejH
[sudo] password for analyst:
  PID  PGID  SID  TTY          TIME CMD
    1     1    1  ?        00:00:00 systemd
   167   167  167  ?        00:00:01 systemd-journal
   193   193  193  ?        00:00:00 systemd-udevd
   209   209  209  ?        00:00:00 rsyslogd
   210   210  210  ?        00:01:41 java
   212   212  212  ?        00:00:01 ovssdb-server
   213   213  213  ?        00:00:00 start_pox.sh
   224   213  213  ?        00:01:18 python2.7
   214   214  214  ?        00:00:00 systemd-logind
   216   216  216  ?        00:00:01 dbus-daemon
   221   221  221  ?        00:00:05 filebeat
   239   239  239  ?        00:00:05 VBoxService
   287   287  287  ?        00:00:00 ovs-vswitchd
   382   382  382  ?        00:00:00 dhcpcd
   387   387  387  ?        00:00:00 lightdm
   410   410  410  tty7     00:00:10 Xorg
   460   387  387  ?        00:00:00 lightdm
   492   492  492  ?        00:00:00 sh
```

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```
503  492  492  ?      00:00:00      xfce4-session
513  492  492  ?      00:00:00      xfwm4
517  492  492  ?      00:00:00      Thunar
1592 492  492  ?      00:00:00      thunar-volman
519  492  492  ?      00:00:00      xfce4-panel
554  492  492  ?      00:00:00      panel-6-systray
559  492  492  ?      00:00:00      panel-2-actions
523  492  492  ?      00:00:01      xfdesktop
530  492  492  ?      00:00:00      polkit-gnome-au
395  395  395  ?      00:00:00      nginx
396  395  395  ?      00:00:00      nginx
408  384  384  ?      00:01:58      java
414  414  414  ?      00:00:00      accounts-daemon
418  418  418  ?      00:00:00      polkitd
<some output omitted>
```

How is the process hierarchy represented by *ps*?

- c. As mentioned before, servers are essentially programs, often started by the system itself at boot time. The task performed by a server is called a *service*. In such fashion, a web server provides web services.

The *netstat* command is a great tool to help identify the network servers running on a computer. The power of *netstat* lies on its ability to display network connections.

**Note:** Your output maybe different depending on the number of open network connections on your VM.

In the terminal window, type **netstat**.

```
[analyst@secOps ~]$ netstat
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 localhost.localdo:48746 localhost.local:wap-wsp ESTABLISHED
tcp        0      0 localhost.localdo:48748 localhost.local:wap-wsp ESTABLISHED
tcp6       0      0 localhost.local:wap-wsp localhost.localdo:48748 ESTABLISHED
tcp6       0      0 localhost.local:wap-wsp localhost.localdo:48746 ESTABLISHED
tcp6       0      0 localhost.local:wap-wsp localhost.localdo:48744 ESTABLISHED
tcp6       0      0 localhost.localdo:48744 localhost.local:wap-wsp ESTABLISHED
Active UNIX domain sockets (w/o servers)
Proto RefCnt Flags       Type       State       I-Node  Path
unix    3      [ ]         DGRAM          8472    /run/systemd/notify
unix    2      [ ]         DGRAM          8474    /run/systemd/cgroups-agent
<some output omitted>
```

As seen above, *netstat* returns lots of information when used without options. Many options can be used to filter and format the output of *netstat*, making it more useful.

- d. Use **netstat** with the **-tunap** options to adjust the output of *netstat*. Notice that *netstat* allows multiple options to be grouped together under the same “-” sign.

The information for the *nginx* server is highlighted.

```
[analyst@secOps ~]$ sudo netstat -tunap
[sudo] password for analyst:
Active Internet connections (servers and established)
```

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Proto	Recv-Q	Send-Q	Local Address	Foreign Address	State
PID/Program name					
tcp	0	0	0.0.0.0:6633	0.0.0.0:*	LISTEN
257/python2.7					
tcp	0	0	0.0.0.0:80	0.0.0.0:*	LISTEN
395/nginx: master					
tcp	0	0	0.0.0.0:21	0.0.0.0:*	LISTEN
279/vsftpd					
tcp	0	0	0.0.0.0:22	0.0.0.0:*	LISTEN
277/sshd: /usr/bin					
tcp6	0	0	:::22	:::*	LISTEN
277/sshd: /usr/bin					
udp	0	0	192.168.1.15:68	0.0.0.0:*	
237/systemd-network					

What is the meaning of the *-t*, *-u*, *-n*, *-a* and *-p* options in *netstat*? (use *man netstat* to answer)

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Is the order of the options important to *netstat*?

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Clients will connect to a port and, using the correct protocol, request information from a server. The *netstat* output above displays a number of services that are currently listening on specific ports. Interesting columns are:

- o The first column shows the Layer 4 protocol in use (UDP or TCP, in this case).
- o The third column uses the *<ADDRESS:PORT>* format to display the local IP address and port on which a specific server is reachable. The IP address 0.0.0.0 signifies that the server is currently listening on all IP addresses configured in the computer.
- o The fourth column uses the same socket format *<ADDRESS:PORT>* to display the address and port of the device on the remote end of the connection. 0.0.0.0:\* means that no remote device is currently utilizing the connection.
- o The fifth column displays the state of the connection.
- o The sixth column displays the process ID (PID) of the process responsible for the connection. It also displays a short name associated to the process.

Based on the *netstat* output shown in item (d), what is the Layer 4 protocol, connection status, and PID of the process running on port 80?

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While port numbers are just a convention, can you guess what kind of service is running on port 80 TCP?

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- e. Sometimes it is useful to cross the information provided by *netstat* with *ps*. Based on the output of item (d), it is known that a process with *PID* 395 is bound to TCP port 80. Port 395 is used in this example. Use **ps** and **grep** to list all lines of the *ps* output that contain **PID 395**. Replace 395 with the PID number for your particular running instance of nginx:

```
[analyst@secOps ~]$ sudo ps -elf | grep 395
```

```
[sudo] password for analyst:
```

```
1 S root          395      1  0  80   0 - 1829   19:33 ?           00:00:00 nginx: master
process /usr/bin/nginx
5 S http          396    395  0  80   0 - 1866   19:33 ?           00:00:00 nginx: worker
process
0 S analyst      3789   1872  0  80   0 - 1190   19:53 pts/0    00:00:00 grep 395
```

In the output above, the *ps* command is piped through the *grep* command to filter for only the lines containing the number 395. The result is three lines with text wrapping.

The first line shows a process owned by the *root* user (third column), started by another process with PID 1 (fifth column), at 19:33 (twelfth column)

The second line shows a process with PID 396, owned by the *http* user, started by process 395, at 19:33.

The third line shows a process owned by the *analyst* user, with *PID* 3789, started by a process with PID 1872, as the *grep 395* command.

The process PID 395 is *nginx*. How could that be concluded from the output above?

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What is *nginx*? What is its function? (Use google to learn about *nginx*)

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The second line shows that process 396 is owned by a user named *http* and has process number 395 as its parent process. What does that mean? Is this common behavior?

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Why is the last line showing *grep 395*?

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## Part 2: Using Telnet to Test TCP Services

Telnet is a simple remote shell application. *Telnet* is considered insecure because it does not provide encryption. Administrators who choose to use *Telnet* to remotely manage network devices and servers will expose login credentials to that server, as Telnet will transmit session data in clear text. While Telnet is not recommended as a remote shell application, it can be very useful for quickly testing or gathering information about TCP services.

The Telnet protocol operates on port 23 using TCP by default. The *telnet* client, however, allows for a different port to be specified. By changing the port and connecting to a server, the *telnet* client allows for a network analyst to quickly assess the nature of a specific server by communicating directly to it.

**Note:** It is strongly recommended that *ssh* be used as remote shell application instead of *telnet*.

- a. In Part 1, *nginx* was found to be running and assigned to port 80 TCP. Although a quick internet search revealed that *nginx* is a lightweight web server, how would an analyst be sure of that? What if an attacker changed the name of a malware program to *nginx*, just to make it look like the popular webserver? Use *telnet* to connect to the local host on port 80 TCP:

```
[analyst@secOps ~]$ telnet 127.0.0.1 80
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^]'.
```

- b. Press a few letters on the keyboard. Any key will work. After a few keys are pressed, press **ENTER**. Below is the full output, including the Telnet connection establishment and the random keys pressed (fdsafsdaf, this case):

```
fdsafsdaf
HTTP/1.1 400 Bad Request
Server: nginx/1.16.1
Date: Tue, 28 Apr 2020 20:09:37 GMT
Content-Type: text/html
Content-Length: 173
Connection: close

<html>
<head><title>400 Bad Request</title></head>
<body bgcolor="white">
<center><h1>400 Bad Request</h1></center>
<hr><center>nginx/1.16.1</center>
</body>
</html>
Connection closed by foreign host.
```

Thanks to the *Telnet* protocol, a clear text *TCP* connection was established, by the *Telnet* client, directly to the *nginx* server, listening on *127.0.0.1 port 80 TCP*. This connection allows us to send data directly to the server. Because *nginx* is a web server, it does not understand the sequence of random letters sent to it and returns an error in the format of a web page.

Why was the error sent as a web page?

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While the server reported an error and terminated the connection, we were able to learn a lot. We learned that:

- 1) The *nginx* with *PID 395* is in fact a web server.
- 2) The version of *nginx* is 1.16.1.
- 3) The network stack of our CyberOps Workstation VM is fully functional all the way to Layer 7.

Not all services are equal. Some services are designed to accept unformatted data and will not terminate if garbage is entered via keyboard. Below is an example of such a service:

- c. Looking at the *netstat* output presented earlier, it is possible to see a process attached to port 22. Use **Telnet** to connect to it.

*Port 22 TCP* is assigned to *SSH* service. *SSH* allows an administrator to connect to a remote computer securely.

Below is the output:

```
[analyst@secOps ~]$ telnet 127.0.0.1 22
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^]'.
SSH-2.0-OpenSSH_8.2
sdfjlskj
Invalid SSH identification string.
Connection closed by foreign host.
```

Use Telnet to connect to port 68. What happens? Explain.

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### Reflection Questions

1. What are the advantages of using netstat?

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2. What are the advantages of using Telnet? Is it safe?
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