Unix Incident Guide: How to Detect an Intrusion

CIAC-2305 R.1

by Karyn Pichnarczyk, Steve Weeber, & Richard Feingold

and the other members of the CIAC team

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### Performer(s)
Booz Allen & Hamilton 8283 Greensboro Drive McLean, VA 22102

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### Abstract

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Unix Incident Guide: How to Detect an Intrusion CIAC-2305 R.1

This document contains step-by-step instructions to follow if you are investigating an actual security incident. It can also be used as a tutorial in general techniques for use if an attack occurs.
CIAC is the U.S. Department of Energy’s Computer Incident Advisory Capability. Established in 1989, shortly after the Internet Worm, CIAC provides various computer security services free of charge to employees and contractors of the DOE, such as:

- Incident Handling consulting
- Computer Security Information
- On-site Workshops
- White-hat Audits

CIAC is located at Lawrence Livermore National Laboratory and is a part of its Computer Security Technology Center. CIAC is also a founding member of FIRST, the Forum of Incident Response and Security Teams, a global organization established to foster cooperation and coordination among computer security teams worldwide.

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Introduction

Overview

If you suspect or have been notified that your computer system has been or is under attack, you must determine:

• if there really is or was an attack
• if the attack was successful
• and, to what degree the attack compromised the system

This can be routine, quite challenging, or extremely difficult. Modern operating systems are large, complex, and imperfect dynamic systems, with many places for attackers to hide and many opportunities for them to cover their tracks.

CIAC has collected and developed techniques to discover traces of an attack. Almost all attacks leave detectable remnants that may be uncovered and used in an investigation.
This document contains step-by-step instructions to follow if you are investigating an actual security incident. It can also be used as a tutorial in general techniques for use if an attack occurs.

### What’s in This Guide

<table>
<thead>
<tr>
<th>This guide helps you with these security scenarios...</th>
<th>By providing you with detailed information on these topics...</th>
</tr>
</thead>
<tbody>
<tr>
<td>A person’s system is linked to the Internet; there is “a feeling” that something is wrong. A security problem might exist, but you can’t be sure.</td>
<td>• displaying the users logged in to your system</td>
</tr>
<tr>
<td>You are notified by CIAC that someone from another site that had an intruder found your site’s name in an intruder’s log file. You know that an intruder has at least “touched” your system. The extent of the contact is unknown.</td>
<td>• displaying active processes</td>
</tr>
<tr>
<td>An incident response team informs you that an intruder was located, and the team’s log files indicate the intruder came from your site.</td>
<td>• finding the footprints left by an intruder</td>
</tr>
<tr>
<td>You get a call that someone is performing an illegal action (either breaking into another system, or breaking into that particular system) right NOW. Action must be swift in order to minimize damage.</td>
<td>• detecting a sniffer</td>
</tr>
<tr>
<td>You suspect you have a sniffer on your system, but don’t have the slightest idea where to start looking for it.</td>
<td>• finding files and other intrusions left by an intruder</td>
</tr>
</tbody>
</table>

### Other Situations

This guide will help you investigate the situations described above. However, additional scenarios can occur. If your experience doesn’t quite fit any of the situations listed, call CIAC at (510) 422-8193 for assistance.
Displaying the Users Logged in to Your System

Overview
If you suspect that there is an active intruder on your system, first determine where they are and what they are doing. This section shows you how to use these commands to find out who is on your system:

- the "w" command
- the "finger" command
- the "who" command

These commands are only useful when a suspected intruder is logged in to your system.

The "w" Command
The "w" command gives you a general overview of all users and their active programs on the system. A sample output is shown here.

```
Prompt % w
3:47pm up 18 days, 3:02, 7 users, load average: 0.02, 0.00, 0.00
User   tty    login@    idle  JCPU  PCPU     what
user1  tttyp0 25Mar94  2:08  39:15    4 -tcsh
user2  tttyp1  5Apr94  8     5:51  5:28      emacs
user2  tttyp2  3:46pm  8     1       0 -csh
user3  tttyp3  Mon 2pm    2:04    1 -csh
user3  tttyp4  Mon 3pm    21   1 -csh
user2  tttyp6  5Apr94  3     1:38    6 -tcsh
user2  tttyp7  Wed 2pm  5:31  17    1 -tcsh
Prompt %
```

The first line displayed, the status line, gives general information: the present time, how long the system has been running, and the load on the system for various periods of time. The rest of the output from the "w" command shows you who is currently logged in to the system, which TTY they are using, and what each user is currently doing.
Displaying the Users Logged in to Your System, Continued

What to Look For

Verify that:

• all users are valid

• users have not been logged in for an abnormal length of time

• users are not running suspicious software

Vulnerabilities

The output listing from the “w” command can be easily modified to hide a skilled intruder’s existence on the system.

The “finger” Command

Another command that displays who is on the system is the “finger” command. A sample output is shown here.

<table>
<thead>
<tr>
<th>Prompt</th>
<th>% finger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Login</td>
<td>Name</td>
</tr>
<tr>
<td>user1</td>
<td>user name</td>
</tr>
<tr>
<td>user2</td>
<td>user name</td>
</tr>
<tr>
<td>user4</td>
<td>user name</td>
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<tr>
<td>user3</td>
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<tr>
<td>user3</td>
<td>user name</td>
</tr>
<tr>
<td>user3</td>
<td>user name</td>
</tr>
<tr>
<td>Prompt</td>
<td>%</td>
</tr>
</tbody>
</table>

The “finger” command shows you who is currently logged in to the system, which TTY they are using, the time they logged in, and where they are logged in from.

What to Look For

Verify that:

• all users are valid

• users have not been logged in for an abnormal length of time

• the login location of each user is valid

Vulnerabilities

The output from the “finger” command can easily be modified to hide a skilled intruder’s existence.
Displaying the Users Logged in to Your System, Continued

The “who” Command

The “who” command lists information about the users currently on the system. This information is retrieved from the /etc/utmp file. A sample output is shown here.

```
Prompt % who
user1    tty0    Mar    25    11:46    (host1.sub.domain)
user2    tty1    Apr     5     10:42    (host2.sub.domain)
user4    tty2    Apr    18     14:04    (host3.sub.domain)
user3    tty3    Apr    11     14:06    (host5.sub.domain)
user2    tty4    Apr    18     16:43    (host4.sub.domain)
user2    tty6    Apr     5     11:06    (host2.sub.domain)
user2    tty7    Apr     6     14:47    (host2.sub.domain)
user3    tty8    Apr    14     11:04    (host5.sub.domain)
user3    tty9    Apr    15     13:52    (host5.sub.domain)
Prompt %
```

This command lists who is currently logged in to the system, which TTY they are using, login time, and where they are logged in from.

What to Look For

Verify that:

- all users are valid
- users have not been logged in for an abnormal length of time
- the login location of each user is valid

Vulnerabilities

The output from the “who” command can easily be modified to hide a skilled intruder’s existence, as the command gets its information from the /etc/utmp file.
Displaying Active Processes

Overview

Even if an intruder is no longer logged in to a (potentially) penetrated system, a process may have been left running by the intruder to continue performing tasks. This section shows you how to use these commands to display the active processes running on your system:

• the “ps” command

• the “crash” command

The “ps” Command

The “ps -agux” command lists the processes that are executing on your system.

• The command’s “a” parameter displays all processes running on the system, not just those owned by you.

• The command’s “g” parameter displays all processes, as opposed to those which “ps” decides are simply “interesting” (refer to the “ps” man page for the definition of “interesting”).

• The “u” parameter displays user-oriented output.

• The “x” parameter includes processes without control terminals.

The “ps” command is a reliable way to see what programs are being executed on the system. A shortened sample output is shown here.

```
Prompt % ps -agux
USER   PID  %CPU  %MEM  SZ  RSS   TT  STAT  START   TIME COMMAND
user5  28206  8.1   0.4  48  280   p4   S     13:55   0:00  man inetd.conf
user5  28208  3.9   0.5  56  312   p4   S     13:55   0:00  more -s /usr/man/cat5/in
root   2     0.0   0.0   0   0    ?    D     Mar 25  0:02  pagedaemon
root   87    0.0   0.0  176  0    ?    I    Mar 25  0:16  sendmail: accepting conn
root   1     0.0   0.0  56   0    ?    I    Mar 25  0:04  /sbin/init -
user3  15547  0.0   0.0  192  0    p0   IW   Apr 5   0:06  selection_svc
user1  184    0.0   0.0  192  0    p0   IW   Mar 25  0:06  -tcsh (tcsh)
user2  28209  0.0   0.8  208  520   p5   R     13:55   0:00  ps -agux
user2  21674  0.0   0.4  112  248   p5   S     16:24   0:00  -tcsh (tcsh)
user3  16834  0.0   0.0  88   0    ?    I    Apr 5   0:00  selection_svc
user3  27350  0.0   0.0  112  0    p3   IW   Apr 11  0:01  -csh (csh)
user4  23846  0.0   0.0  80   0    p3   IW   11:12   0:00  -csh (csh)
user3  23801  0.0   0.0  80   0    p8   IW   11:04   0:00  -csh (csh)
user2  18590  0.0   0.0  120  0    p7   IW   Apr 6   0:01  -tcsh (tcsh)
user2  15591  0.0   0.0  120  0    p6   IW   Apr 5   0:06  -tcsh (tcsh)
user2  15588  0.0   0.1  9288 72   p1   I    Apr 5   7:08  emacs
user2  15496  0.0   0.0  112  0    p1   IW   Apr 5   0:00  -tcsh (tcsh)
```

Prompt %
What to Look For

The following may indicate undesired activity:

- processes that take a long time
- unusual start times (such as 3:00 a.m.)
- unusual names
- a process that has an extremely high percentage of CPU (this may indicate a sniffer process)
- processes without a controlling terminal (a “?” in the TT column) that are executing unusual programs

Vulnerabilities

In some cases, compromised systems have been found to contain a Trojaned version of “ps” which does not display intruder processes. Also, if an invalid process is running but has a valid process name, it may be difficult to distinguish the suspicious process. For example, intruders often run sniffer processes under names such as “sendmail” or “inetd”.

The “crash” Command

You can use the “crash” command to list all processes. This functions as a cross-check against the “ps” command. That is, finding a process with “crash” output that does not appear in “ps” output (matching pids). Once you execute “crash,” you will receive a “>” prompt. Type proc in response and quit when you are finished running “crash”.

```
Prompt % crash
dumpfile = /dev/mem, namelist = /vmunix, outfile = stdout
> proc
PROC TABLE SIZE = 522
SLOT ST PID PPID PGRP UID PRI CPU EVENT NAME FLAGS
 0 s 0 0 0 0 0 f8172698 load sys
 1 s 1 0 0 0 30 0 f82b5494 init load pagi
 2 s 2 0 0 0 1 0 f82b5550 load sys
 3 s 965 141 965 0 26 0 f81721f8 in.rlogind swapped pagi
 4 s 56 1 56 0 26 0 f81721f8 portmap swapped pagi
 6 s 59 1 42 0 26 0 f81721f8 keyserv swapped pagi
 7 s 11039 1 11039 0 28 0 ff12a2d0 getty swapped pagi
 8 s 73 1 73 0 26 0 f81721f8 in.named load pagi
 9 s 76 1 75 0 26 0 f8152d2c biod load pagi
10 s 77 1 75 0 26 0 f8152d2c biod load pagi
11 s 78 1 75 0 26 0 f8152d2c biod load pagi
12 s 79 1 75 0 26 0 f8152d2c biod load pagi
13 s 90 1 90 0 26 0 f81721f8 syslogd load pagi
14 s 98 1 98 0 26 0 ff648d2e sendmail load pagi
> quit
Prompt %
```
## Displaying Active Processes, Continued

<table>
<thead>
<tr>
<th>What to Look For</th>
<th>The following may indicate undesired activity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• processes that do not appear in the ps list (use the PID column to identify)</td>
<td></td>
</tr>
<tr>
<td>• a high value in the CPU column</td>
<td></td>
</tr>
<tr>
<td>• unusual commands in the NAME column</td>
<td></td>
</tr>
</tbody>
</table>

| Vulnerabilities | Names can be faked. Like any command, “crash” can be Trojaned. |
Overview

If you suspect that an intruder has been on your system but is gone, use the commands and files described in this section to find the “footprints” the intruder may have left behind. This section shows you how to use these commands and files:

- the “last” command
- the “lastcomm” command
- the “/var/log/syslog” file
- the “netstat” command

The “last” Command

The “last” command displays information about logins and logouts on the system from the /var/adm/wtmp file. If you can determine the username the intruder used to log in, this command can show you how long the intruder was logged in and where they logged in from.

- The command’s “-n” parameter is used to display the last $n$ entries in the /var/adm/wtmp file.

A sample output is shown here.

```
Prompt % last -20
user1  ftp   host1.sub.domain   Fri Apr 15 15:09 - 15:10 (00:00)
user3  tty9  host5.sub.domain   Fri Apr 15 13:52 still logged in
user6  tty2  host7.sub.domain   Fri Apr 15 10:34 - 10:34 (00:00)
user6  ftp   host7.sub.domain   Fri Apr 15 10:32 - 10:33 (00:01)
user4  tty4  host3.sub.domain   Fri Apr 15 09:20 - 10:29 (01:09)
user1  ttyh1                        Thu Apr 14 20:33 - 22:00 (01:26)
user4  ftp   host3.sub.domain   Thu Apr 14 14:21 - 14:22 (00:01)
user4  tty2  host3.sub.domain   Thu Apr 14 14:01 - 16:36 (02:35)
user4  ftp   host3.sub.domain   Thu Apr 14 13:43 - 13:44 (00:00)
user5  tty4  host6.sub.domain   Thu Apr 14 13:38 - 14:56 (01:18)
user4  tty2  host3.sub.domain   Thu Apr 14 13:37 - 13:47 (00:10)
user4  ftp   host3.sub.domain   Thu Apr 14 13:16 - 13:18 (00:02)
user4  tty2  host3.sub.domain   Thu Apr 14 13:12 - 13:18 (00:06)
user4  tty9  host3.sub.domain   Thu Apr 14 11:13 - 15:05 (03:52)
user4  tty9  host3.sub.domain   Thu Apr 14 11:12 - 13:08 (01:55)
user3  tty8  host5.sub.domain   Thu Apr 14 11:04 still logged in
user1  ftp   host1.sub.domain   Thu Apr 14 11:01 - 11:02 (00:00)
Prompt %
```
Finding the Footprints Left by an Intruder, Continued

The first column contains the username, followed by the terminal device the user is connected to. If the connection used a network device, the name of a remote system is displayed in the next column. For serial devices such as dial-up modems, the column will be blank. This is followed by the login and logout time and an indication of the length of the session.

What to Look For

- examine the log entries made around the time of the suspected attack for ones that appear to be out of the ordinary, including logins to accounts that had previously been dormant, logins from unexpected locations, logins at unusual times, and short login times

- a missing /var/adm/wtmp file or one with gaps in the output (this may indicate that an intruder attempted to hide their existence)

As a general rule, many system administrators never delete this file. Therefore, it can be quite large and include activity from when the system was first loaded.

Vulnerabilities

An intruder who breaks into a system can hide their tracks by deleting or modifying the /var/adm/wtmp file.

The “lastcomm” Command

The “lastcomm” command displays the last commands executed. This command is only available if you have process accounting turned on. With this command, you can see every command issued by anyone on the system. A sample output is shown here.

```
Prompt % lastcomm
nroff    user1    ttypl    0.39 secs Thu Sep  8 12:31
man      user1    ttypl    0.00 secs Thu Sep  8 12:31
sh       user1    ttypl    0.00 secs Thu Sep  8 12:31
page     user1    ttypl    0.03 secs Thu Sep  8 12:31
col      user1    ttypl    0.02 secs Thu Sep  8 12:31
tbl      user1    ttypl    0.02 secs Thu Sep  8 12:31
head     user1    ttypl    0.00 secs Thu Sep  8 12:31
lastcomm X user1    ttypl    0.06 secs Thu Sep  8 12:31
lastcomm X user1    ttypl    0.05 secs Thu Sep  8 12:31
csh      F user1    ttypl    0.00 secs Thu Sep  8 12:31
lastcomm X user1    ttypl    2.97 secs Thu Sep  8 12:28
sh       root     __       0.00 secs Thu Sep  8 12:30
atrun    root     __       0.00 secs Thu Sep  8 12:30
cron     F root     __       0.00 secs Thu Sep  8 12:30
sh       root     __       0.00 secs Thu Sep  8 12:15
atrun    root     __       0.00 secs Thu Sep  8 12:15
cron     F root     __       0.00 secs Thu Sep  8 12:15
sh       root     __       0.00 secs Thu Sep  8 12:15
atrun    root     __       0.00 secs Thu Sep  8 12:15
cron     F root     __       0.00 secs Thu Sep  8 12:15
Prompt %
```
Finding the Footprints Left by an Intruder, Continued

What to Look For
This command is an excellent way of seeing what a user did while on your system because it lists all commands executed by all users.

Vulnerabilities
This command produces a file that tends to get quite large very quickly as it saves the data needed to track the commands issued by every user. You should periodically rename it so that you can manage smaller files.

The “lastcomm” command only tracks the command that ran a program, but not what actions were taken after the program started (for example, it may show the editor being run, but not which files were opened after the initialization of the editor).

Many times, attacks are not discovered until days after the actual event. And in these cases, the accounting logs may have been purged by the time the attack is discovered. The biggest potential intruder-style vulnerability is that the data is kept in the file /var/adm/pacct, which the intruder can easily delete and perhaps modify if the proper privileges are obtained.

The /var/log/syslog File
The /var/log/syslog file is a file that contains messages relating to various types of connections to your system. The content of this file is defined by the /etc/syslog.conf file. The results of this command contain extremely long lines; a shortened sample of this file is shown here.

Prompt % more /var/log/syslog
Apr 20 13:04:22 host8 sendmail[15026]: NAA15025:to=user8@sub.domain, user7@sub.domain,user3@sub.domain, delay=00:00:02, mailer=smtp, relay=computer.sub.domain. [128.xxx.xx.xx], stat=Sent (Mail accepted)
Apr 20 13:04:23 host8 sendmail[15026]: NAA15025: to=user5,user2, delay=00:00:03, mailer=local, stat=Sent
Apr 20 13:04:23 host8 sendmail[15026]: NAA15025: to=user1@host1.sub.domain, delay=00:00:03, mailer=smtp, relay=host1.sub.domain. [198.128.36.1], stat=Sent (Ok)
Apr 20 13:06:20 host8 in.telnetd[15032]: connect from computer.sub.domain (198.xxx.xx.xx)
Finding the Footprints Left by an Intruder, Continued

Most messages are from the sendmail program, and display the status of messages sent and received by your system. This file may also contain in.telnetd connection messages and other previously defined messages.

What to Look For

• Since this file saves data on incoming as well as outgoing information, especially sendmail information, one of the things to look for is outbound E-mail to suspicious hosts. This may indicate that an intruder sent out information from your system to a remote system.

• Telnet connections, both incoming and outgoing, should be examined.

• A short file may be suspicious, as it may indicate that this file has been edited or deleted. A ‘hole’ in the file (a large chunk of time when no messages occur) may indicate that an intruder deleted the messages related to their time on the system. Note that this ‘hole’ may be useful in tracking down when the intruder used the system.

• In general, look for things that may appear out of the ordinary.

Vulnerabilities

In many cases, the /var/log/syslog file is world writable and must remain so for operational reasons. Therefore, its data may be suspect and untrustworthy.

This file tends to be very long. Investigating all connections, especially sendmail messages, can be difficult. This is because at least one line is written to the /var/log/syslog file for each mail message. In addition, users tend to delete messages and forget exactly who sent them the messages, when they were received, and what they were about.
Finding the Footprints Left by an Intruder, Continued

The /var/adm/messages File

The /var/adm/messages file usually contains a listing of all messages that are sent to the console. The actual content of this file is defined in the /etc/syslog.conf file. A sample of this file is shown here.

```
Prompt % more /var/adm/messages
Mar 21 10:36:04 host8 su: ‘su root’ failed for user1 on /dev/ttyp2
Mar 21 10:36:08 host8 su: ‘su aaa’ succeeded for user1 on /dev/ttyp2
Mar 21 16:00:59 host8 xntpd[121]: Previous time adjustment didn’t complete
Mar 24 15:01:44 host8 login: REPEATED LOGIN FAILURES ON console, user3
Mar 25 11:42:51 host8 shutdown: reboot by user1
Mar 25 11:42:53 host8 syslogd: going down on signal 15
Mar 25 11:48:04 host8 su: ‘su aaa’ succeeded for user1 on /dev/ttyp0
Mar 28 15:47:19 host8 login: ROOT LOGIN REFUSED ON tty3 FROM machine.sub.domain
Mar 28 16:12:12 host8 login: ROOT LOGIN console
Apr 13 15:58:35 host8 su: ‘su aaa’ failed for user1 on /dev/ttyp0
Apr 13 15:58:55 host8 su: ‘su aaa’ succeeded for user1 on /dev/ttyp0
Apr 15 08:48:22 host8 named[2682]: starting. named 4.9.2 Wed
Nov 17 13:17:49 PST 1993
Apr 15 08:48:22 host8 named[2683]: Ready to answer queries.
Prompt %
```

What to Look For

The following may indicate undesired activity:

- an unauthorized user logging into the root directory
- attempts to “su” to root or a privileged account
- failed login attempts may be from a valid user making mistakes or from an intruder

In the sample file above, you would make sure that “user1” is a valid user logging into the aaa root privileged account.

Vulnerabilities

Once an intruder obtains root access, this file can be modified or deleted quite easily. Also, if the syslog.conf file is compromised, logging to this file may be discontinued.
Finding the Footprints Left by an Intruder, Continued

The “netstat” Command

The “netstat” command displays listening and connected processes. You should compare the output from this command with the output from the “last -n” command.

- The command’s “-a” parameter is used to display the status of all sockets.

A sample output is shown here.

```
Prompt % netstat -a
Active Internet connections (including servers)
PROTO Recv-Q Send-Q Local Address          Foreign Address        (state)
tcp 0 0 host6.sub.domain.pop host1.sub.domain.1809 TIME_WAIT
tcp 0 78 host6.sub.domain.telnet host9.sub.domain.54641 ESTABLISHED
tcp 0 0 host6.sub.domain.telnet host7.sub.domain.1434 ESTABLISHED
tcp 0 0 host6.sub.domain.login host3.sub.domain.1022 ESTABLISHED
tcp 0 0 host6.sub.domain.login host3.sub.domain.1023 ESTABLISHED
tcp 0 0 host6.sub.domain.telnet host5.sub.domain.1021 ESTABLISHED
tcp 0 0 host6.sub.domain.telnet host5.sub.domain.1957 ESTABLISHED
tcp 0 0 host6.sub.domain.login host2.sub.domain.1023 ESTABLISHED
tcp 0 0 port5.printer *.printer LISTEN
tcp 0 0 port5.pop *.pop LISTEN
tcp 0 0 port5.chargen *.chargen LISTEN
tcp 0 0 port5.daytime *.daytime LISTEN
tcp 0 0 port5.discard *.discard LISTEN
tcp 0 0 port5.echo *.echo LISTEN
tcp 0 0 port5.time *.time LISTEN
tcp 0 0 port5.finger *.finger LISTEN
udp 0 0 port5.1022 *.1022 LISTEN
udp 0 0 port5.1023 *.1023 LISTEN
udp 0 0 port5.16517 *.16517 LISTEN
udp 0 0 port5.16516 *.16516 LISTEN
udp 0 0 port5.16515 *.16515 LISTEN
udp 0 0 port5.772 *.772 LISTEN
udp 0 0 port5.16514 *.16514 LISTEN
udp 0 0 port5.16513 *.16513 LISTEN
Active UNIX domain sockets
Address Type Recv-Q Send-Q Vnode Conn Refs Nextref Addr
ff65340c dgram 0 0 0 0 0 0 /dev/log
ff64978c dgram 0 0 0 0 0 0 /dev/log
ff64920c dgram 0 0 0 0 0 0 /dev/log
ff64808c dgram 0 0 0 0 0 0 /dev/log
Prompt %
```

What to Look For

The following may indicate undesired activity:

- you have a telnet connection that does not correlate with the output from the “who” or “w” commands
- other network connections

Vulnerabilities

In some cases, compromised systems have been found to contain a Trojaned version of “netstat” that does not show connections to or from the source of the intrusion.
Detecting a Sniffer

Overview
Sniffers are a major source of contemporary attacks. This section shows you how to use the “ifconfig” command to determine if a sniffer has been installed.

The “ifconfig” Command
The “ifconfig” command displays the current configuration of your network interface. Most Ethernet adaptors are (and should be) configured to accept only messages intended for themselves. An attacker must set a computer’s adaptor to “promiscuous mode,” in order to listen to (and record) everything on its segment of the Ethernet.

A sample output of a system in promiscuous mode is shown here.

```
Prompt % ifconfig -a
ie0: flags=63<UP,BROADCAST,NOTRAILERS,RUNNING,PROMISC>
    inet 987.654.32.1 netmask ffffff00 broadcast 987.654.32.255
lo0: flags=49<UP,LOOPBACK,RUNNING>
    inet 127.0.0.1 netmask ff000000
Prompt %
```

Note “PROMISC” is the last parameter of the flag’s description.

What to Look For
In conjunction with positive results from the above command, the following may indicate undesired activity:

- newly created files
- a process that has an extremely high percentage of CPU

Vulnerabilities
Like any command, “ifconfig” can be Trojaned. If you suspect that a sniffer has been installed, obtain “cpm” from CIAC or CERT and run it. The cpm tool will test the network interface directly and report if it is in promiscuous mode.
Finding Files and Other Evidence Left by an Intruder

Overview
When an intruder breaks into a system, information related to the attack is occasionally left behind. This information includes, but is not limited to directories, shell scripts, programs, and text files.

This section describes various files that have been found on compromised systems. Because file names can be easily changed, the actual name of the file may be different than the file names listed in this section. Many times, intruders try to hide files; methods for achieving and detecting this will be also be described.

What to Look For
When you look for files left behind by an intruder, you should:

- obtain a baseline of what your normal operating system looks like
- find files and file and directory names commonly used by intruders
- examine system logs
- inspect log files
- inspect processes
- inspect targeted files
- look for X windows intrusions

Each of these tasks is described on the following pages.
Obtaining a Baseline of What Your Normal Operating System Looks Like

To obtain a baseline of your normal operating system, you should periodically run the commands described in this document. Record and become familiar with the output from these commands. Also, obtain and periodically use SPI and Tripwire.

Finding Files and File and Directory Names Commonly Used by Intruders

The file names given in this section are commonly used by intruders. Start by looking for these file names, but realize that, as intruders learn that their bogus file names are discovered, they will change them. You must ultimately look for a name or names that do not belong.

Suspicious Files

Often, the best indication of whether or not a system has been compromised comes from a thorough examination of its file systems. The creation or modification of files is often a strong indication of intruder activity on a system.

Occasionally, the intruder will modify (“Trojan”) system programs to hide the intrusion. Some system administrators have discovered that a command such as “ps” will be Trojaned to ignore the intruder’s processes. Keep this in mind when running any command, because if a command has been Trojaned, the results of the command will be questionable.

The “find” command, run preferably as root, will list all files that have been modified in the previous $n$ days:

```
Prompt # find / -mtime -ndays -ls
```

Note that many intruders routinely change file modification times to hide changes made to the system. Many of these modifications may still be detected by examining a file’s inode change time, which is more difficult for an intruder to forge. The following command will locate all files with inode change times that have changed in the last $n$ days:

```
Prompt # find / -ctime -ndays -ls
```
Finding Files and Other Evidence Left by an Intruder, Continued

While examining the results generated by the above commands, consider the hidden files and directories often used by attackers described in the next section, “Hidden Files and Directories.”

Hidden Files and Directories

Intruders often attempt to conceal their presence on a system by using hidden files or directories; that is, those with names that begin with a “.” (period). They are not displayed by the “ls” command, unless the “-a” parameter is used. The following names are commonly used by intruders:

“...” (period period period)
“...” (period period space)
“...” (period period space space)
“.hushlogin”
“.sh”
“.xx”
“.test”

Password Files and Crack

In many cases, intruders use compromised hosts to store and crack password files from other systems. Finding files that contain password entries from other systems or finding password cracking software (such as Crack) probably indicates intruder activity on your system.

Setuid Files

Unix systems allow users to temporarily elevate their privileges through a mechanism called setuid. When a file with the setuid attribute is executed by a user, the program is given the effective access rights of the owner of the file. For example, the “login” program is typically a setuid file owned by root. When a user invokes “login”, the program is able to access the system with super-user privileges instead of the user’s normal privileges.

Intruders often create setuid files that enable them to quickly gain root access during later visits to the system. Often, the file is placed in a hidden directory or has a hidden filename (e.g., “.sh”).

Setuid files appear in directory lists with an “s” in place of the “x” in the execute bit position. For example, the output of the “ls -l .sh” command would display output similar to the following:

```bash
-r-sr-xr-x 1 root other 86012 Jun 2 01:09 .sh
```
Finding Files and Other Evidence Left by an Intruder, Continued

Note that a typical Unix system contains dozens of legitimate setuid programs necessary for normal operation of the system. Setuid files that should be suspected include:

- files that appear to have been modified recently
- unfamiliar files
- files stored in user or temporary directories

To list all setuid files on your system, use the following command:

Prompt # find / -user root -perm -4000 -print

Examining System Logs

All Unix systems provide some level of accounting, recording the actions of both users and system processes. The amount of information recorded can vary significantly depending on both the version of Unix and its configuration. The default for many systems is to record little more than login/logout times for users. At the other end of the spectrum, systems running at an Orange Book C2 level of assurance can easily generate several megabytes of log information per hour.

To detect an intrusion, begin by examining whatever logs are available on your system. Bear in mind, however, that if an intruder gained access to your system, the information stored in the logs may have been modified to hide the intruder’s tracks. Use the “last” and/or “lastcomm” commands discussed in the next two sections (and previously described above) to help you examine the logs.

The “last” Command

The “last” command, available on almost every version of Unix, displays login and logout activity for the system. This can be a useful place to begin an investigation. Check the login times and locations for all users and compare them to expected norms. Refer to the previous discussion of the “last” command for more information and a sample output.
Finding Files and Other Evidence Left by an Intruder, Continued

The “lastcomm” Command (Accounting)

On systems with process level accounting enabled, the “lastcomm” command will generate a detailed list of all commands executed by each user on the system. Unusual or inappropriate system activity can often be discovered in the results from this command. For example, “lastcomm” output indicating repeated executions of the “tftp” program might indicate attempts to steal password files using TFTP.

For information on enabling process accounting on a specific Unix system, refer to the man page for “acct”. Refer to the previous discussion of the “lastcomm” command for more information and a sample output.

Inspecting Log Files

Many system process events generate messages. For example, the “su” utility often makes a log entry when a user attempts to become the “super-user.” These messages may prove useful in discovering unusual activity possibly caused by an intruder.

These messages are often archived in log files for later examination. Commonly used files include /var/log/syslog and /var/adm/messages; however, the file names may vary from system to system. Refer to the sections about these files in this guide or to the man page for “syslog” for more information.

~/.history

Some shells, tcsh for example, keep a record of the most recently executed commands for each user. This information is usually stored in a file in the user’s home directory and is often called “.history”. Examining this file may allow the reconstruction of the recent activities of a specific user.

Inspecting Processes

Look for:

• process names that are unfamiliar
• processes using an unusual amount of CPU time
• processes with names such as Crack or ypsnarf
• an unusually large number of processes

Keep in mind that process names can be changed.
### Inspecting Targeted Files

<table>
<thead>
<tr>
<th>File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>/etc/passwd</code></td>
<td>Look for:</td>
</tr>
<tr>
<td></td>
<td>• new accounts</td>
</tr>
<tr>
<td></td>
<td>• changed uid</td>
</tr>
<tr>
<td></td>
<td>• no password</td>
</tr>
<tr>
<td></td>
<td>• a “+::” entry</td>
</tr>
<tr>
<td><code>~/.forward</code></td>
<td>The <code>~/.forward</code> file is used to manipulate E-mail forwarding. When examining this file, look for any suspicious entries (that is, would it make sense for a legitimate user to manipulate his or her E-mail in that manner?).</td>
</tr>
<tr>
<td><code>~/.rhosts</code> and <code>hosts.equiv</code></td>
<td>The <code>~/.rhosts</code> file can be used to allow remote access to a system and is sometimes used by intruders to create easy backdoors into a system. If this file has recently been modified, examine it for evidence of tampering. Initially and periodically verify that the remote host and user names in the files are consistent with local user access requirements. View with extreme caution a “+” entry; this allows users from any host to access the local system. An older vulnerability is systems set up with a single “+” in the <code>/etc/hosts.equiv</code> file. This allows any other system to log in to your system. The “+” should be replaced with specific system names. Note, however, that an intruder cannot gain root access through <code>/etc/rhosts</code> entries.</td>
</tr>
<tr>
<td><code>~/.ftp</code> Files</td>
<td>Directories which can be written to by anonymous FTP users are commonly used for storing and exchanging intruder files. Do not allow the user “ftp” to own any directories or files.</td>
</tr>
</tbody>
</table>
Finding Files and Other Evidence Left by an Intruder, Continued

System Executables in User Directories

Copies of what may appear to be system executables in user directories may actually be an attempt to conceal malicious software. For example, recent attacks have made use of binaries called “vi” and “sed”, two commonly used Unix utilities. However, these particular binaries were actually renamed intrusion software files, designed to scan systems for weaknesses.

System binaries found in unusual locations may be compared to the actual executable using the “cmp” command:

Prompt: % cmp /home/jdoe/sed /usr/bin/sed

Determining if System Executables Have Been Trojaned

SPI or Tripwire must be set up before an exposure in order to determine if your system executables have been Trojaned.

Use your CD-ROM to make sure you have a good copy of all your system executables, then run the above mentioned products according to the instructions that accompany them to create a basis for later comparison. Periodically, run SPI or Tripwire to detect any modification of the system executables.

/etc/inetd.conf

- Print a baseline listing of this file for comparison.
- Look for new services.

/etc/aliases

- Look for unusual aliases and those that redirect E-mail to unlikely places.
- Look for suspicious commands.

cron

- Look for new entries in cron tab, especially root’s.
- Look at each user’s table.
Finding Files and Other Evidence Left by an Intruder, Continued

/etc/rc*

- Look for additions to install or reinstall backdoors or sniffer programs.
- Use SPI or Tripwire to detect changes to files.

NFS Exports

- Use the “showmount -a” command to find users that have file systems mounted.
- Check the /etc/exports (or equivalent) file for modifications.
- Run SPI or Tripwire to detect changes.

Changes to Critical Binaries

- Run SPI or Tripwire initially and then periodically.
- Use the “ls -lc” command to determine if there have been inappropriate changes to these files.

Note that the change time displayed by the “ls -lc” command can be changed and the command itself can be Trojaned.

Looking for X windows Intrusions

X windows attacks are very difficult to detect because of a lack of security features. We suggest securing X systems before an attack occurs. Refer to the CIAC publication Security for Unix Systems (UCRL-ID-118615 or CIAC-2306) for additional information.
Appendix A: Software Tools

Introduction

What’s in This Appendix

This appendix summarizes the features and locations of several software packages mentioned in this document.

Software Tools

Check Promiscuous Mode (CPM)

The CPM tool provides an alternative means for testing the status of a network interface and determining if it is in promiscuous mode, a symptom of possible sniffer activity on the system. The CPM tool is of most use in cases where it is suspected that the standard ifconfig command has been Trojaned.

CPM is available via anonymous FTP from info.cert.org in the directory /pub/tools/cpm/.

Security Profile Inspector (SPI)

The Security Profile Inspector (SPI) tool performs security assessments of Unix- and VMS-based systems, reporting system configuration vulnerabilities, bad passwords, and violations of system file integrity. The SPI tool will also maintain a database of secure checksums for specified system directories and will alert the administrator to any changes to the contents of those directories.

For further information, call the SPI project lead at (510) 422-3881.

Tripwire

The Tripwire tool will monitor the integrity of a set of user-selected files and directories on a Unix system. The tool will detect and report to the system administrator any changes, additions, or deletions to these files.

Tripwire is available via anonymous FTP from coast.cs.purdue.edu in the directory /pub/tools/unix/Tripwire.
# Appendix B: Contacting CIAC

## Contacting CIAC

<table>
<thead>
<tr>
<th>Method</th>
<th>Information</th>
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<tbody>
<tr>
<td><strong>Phone</strong></td>
<td>(510) 422-8193</td>
</tr>
<tr>
<td><strong>Fax</strong></td>
<td>(510) 423-8002</td>
</tr>
<tr>
<td><strong>STU-III</strong></td>
<td>(510) 423-2604</td>
</tr>
<tr>
<td><strong>Electronic mail</strong></td>
<td><a href="mailto:ciac@llnl.gov">ciac@llnl.gov</a></td>
</tr>
<tr>
<td><strong>Emergency SKYPAGE</strong></td>
<td>800-SKYPAGE pin# 855-0070</td>
</tr>
<tr>
<td><strong>Anonymous FTP server</strong></td>
<td>ciac.llnl.gov (IP 128.115.19.53)</td>
</tr>
<tr>
<td><strong>BBS</strong></td>
<td>(510) 423-3331 (9600 Baud)</td>
</tr>
<tr>
<td></td>
<td>(510) 423-4753 (2400 Baud)</td>
</tr>
</tbody>
</table>
Reader Comments

CIAC updates and enhances the documentation it produces. If you find errors in or have suggestions to improve this document, please fill out this form. Mail it to CIAC, Lawrence Livermore National Laboratory, P.O. Box 808, Mail Stop L-303, Livermore, CA, 94551-9900. Thank you.

List errors you find here. Please include page numbers.

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