

# Implementing and Testing a Web Application Firewall (WAF) – praktični dio

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Kolegij: Sigurnost informacijskih sustava

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# Sadržaj

- Cilj projekta
- Arhitektura sustava
- Mrežna konfiguracija
- WebGoat Aplikacija
- WAF konfiguracija
- Reverse proxy
- Testiranje
- Zaključak
- Literatura

# Cilj projekta

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Implementirati WAF koristeći Apache + ModSecurity + OWASP CRS

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Postaviti izolirano testno okruženje

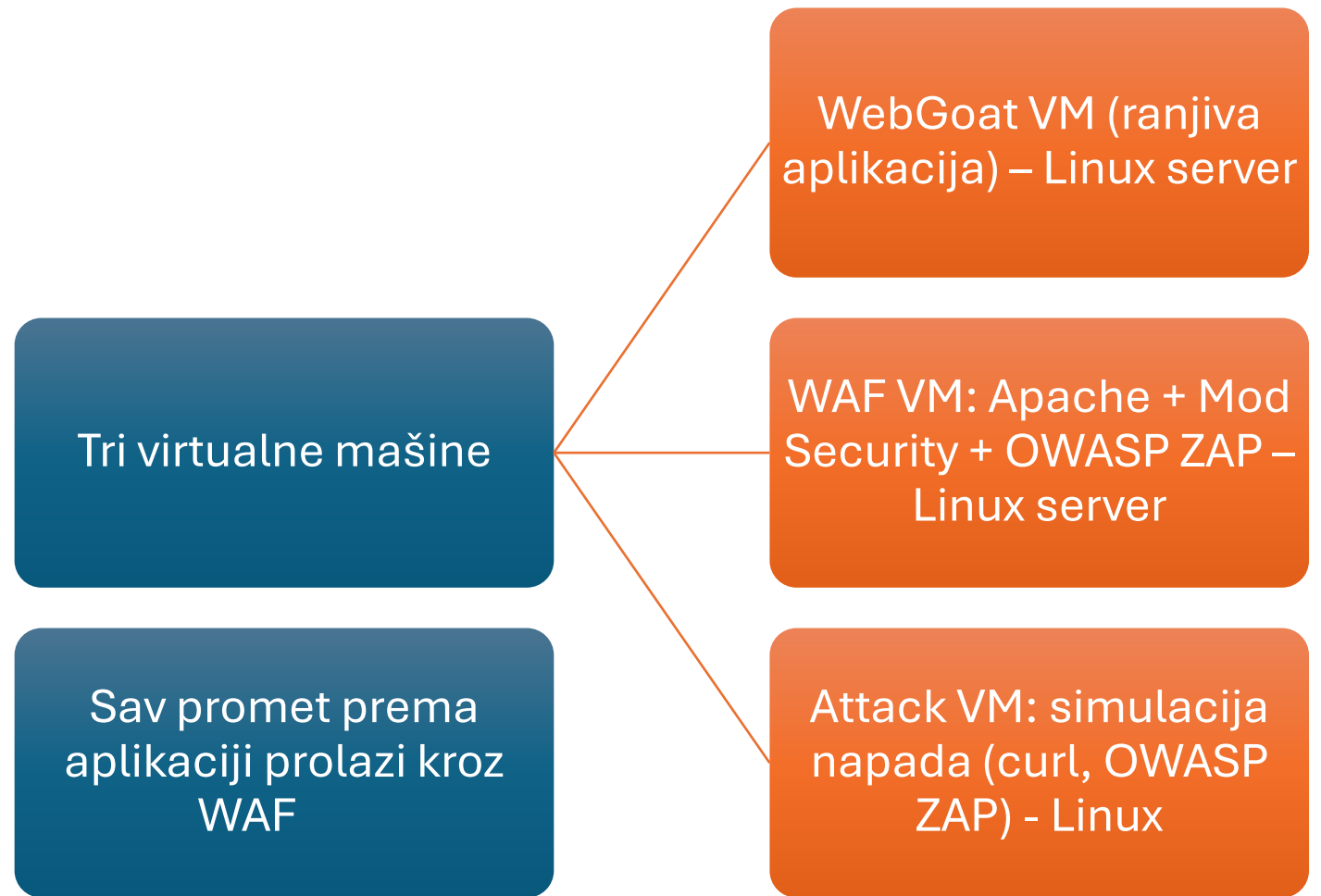
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Testirati reakciju WAF-a na zlonamjerne zahtjeve

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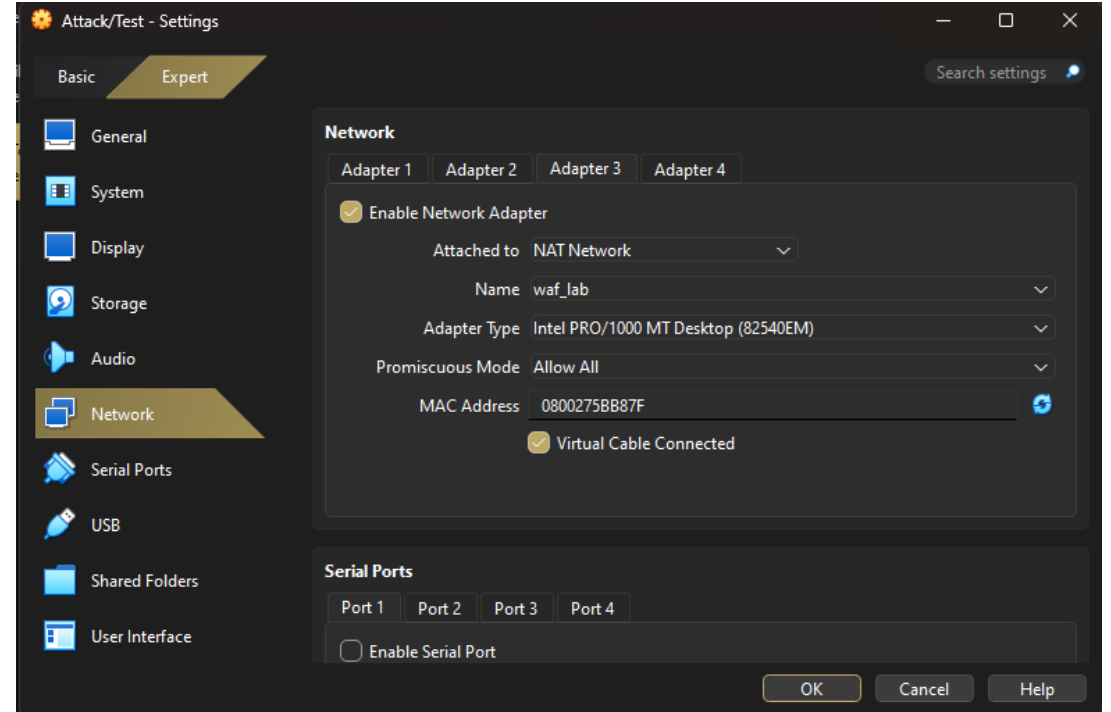
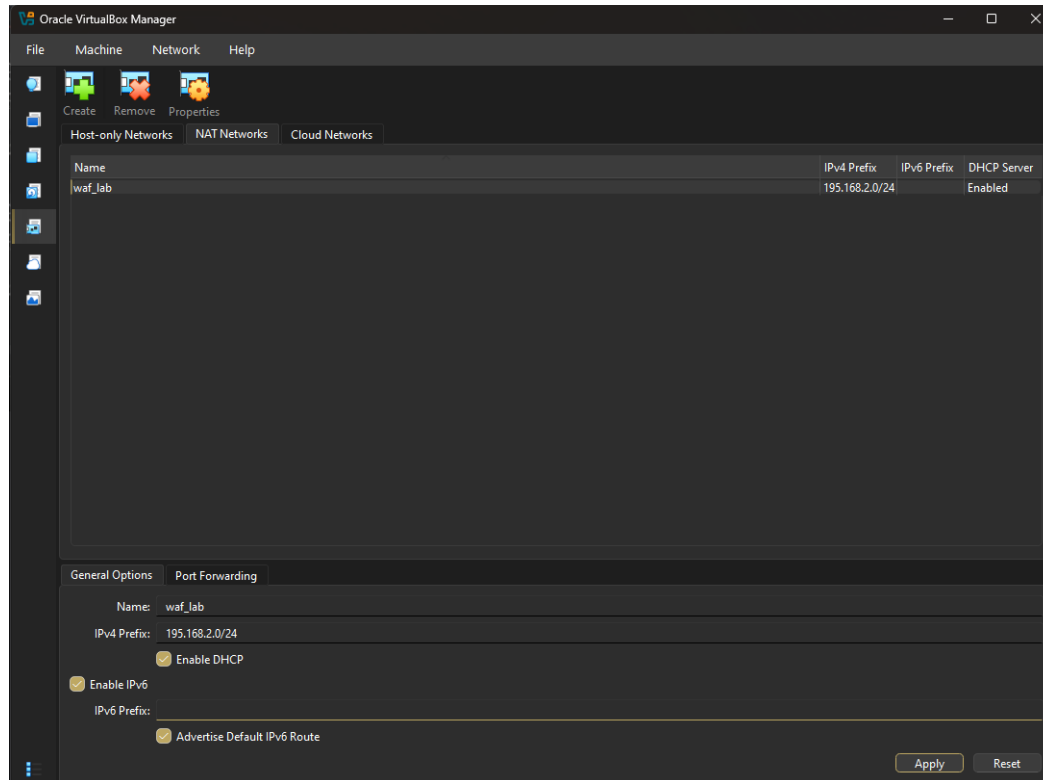
Usporediti ponašanje sustava sa i bez WAF-a

# Arhitektura sustava



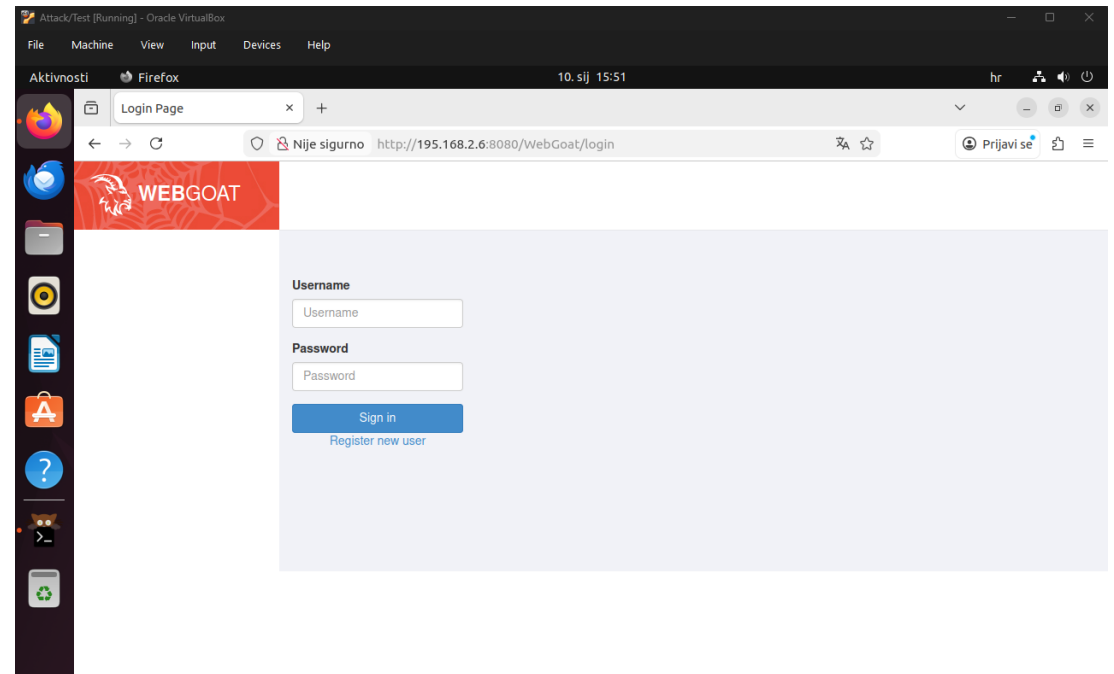
# Mrežna konfiguracija

- Nat Network
- Subnet: 195.168.2.0/24
- DHCP omogućen
- Sve VM u istoj mreži



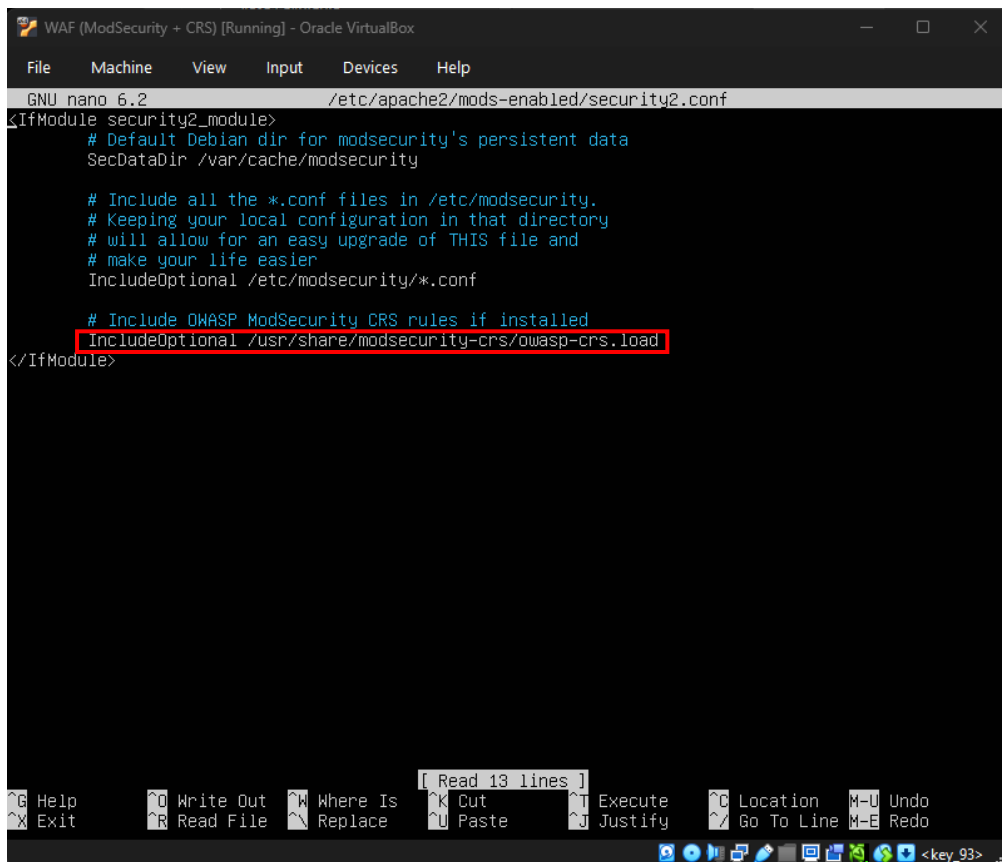
# WebGoat aplikacija

- Testna aplikacija
- Namjerno ranjiva
- Kod za pokretanje: `java -jar webgoat-server-8.2.2.jar --server.address=0.0.0.0 --server.port=8080`
- Dostupna samo unutar interne mreže



# WAF konfiguracija

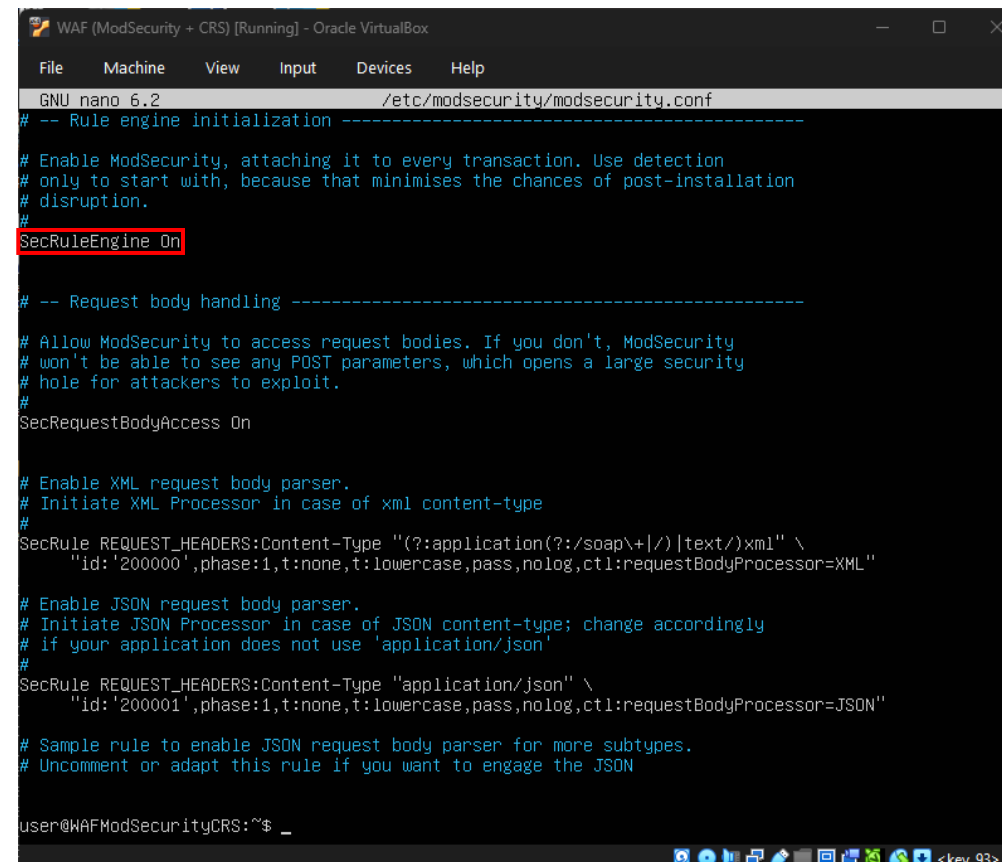
- Apache webserver - Kod: `sudo apt install -y apache2 libapache2-mod-security2 modsecurity-crs`
- ModSecurity modul - Kod: `sudo cp /etc/modsecurity/modsecurity.conf-recommended /etc/modsecurity/modsecurity.conf`
- OWASP Core Rule Set (CRS) -KOD: `sudo nano /etc/apache2/mods-enabled/security2.conf`



```
GNU nano 6.2 /etc/apache2/mods-enabled/security2.conf
<IfModule security2_module>
    # Default Debian dir for modsecurity's persistent data
    SecDataDir /var/cache/modsecurity

    # Include all the *.conf files in /etc/modsecurity.
    # Keeping your local configuration in that directory
    # will allow for an easy upgrade of THIS file and
    # make your life easier
    IncludeOptional /etc/modsecurity/*.conf

    # Include OWASP ModSecurity CRS rules if installed
    IncludeOptional /usr/share/modsecurity-crs/owasp-crs.load
</IfModule>
```



```
GNU nano 6.2 /etc/modsecurity/modsecurity.conf
# -- Rule engine initialization -----
# Enable ModSecurity, attaching it to every transaction. Use detection
# only to start with, because that minimises the chances of post-installation
# disruption.
#
SecRuleEngine On

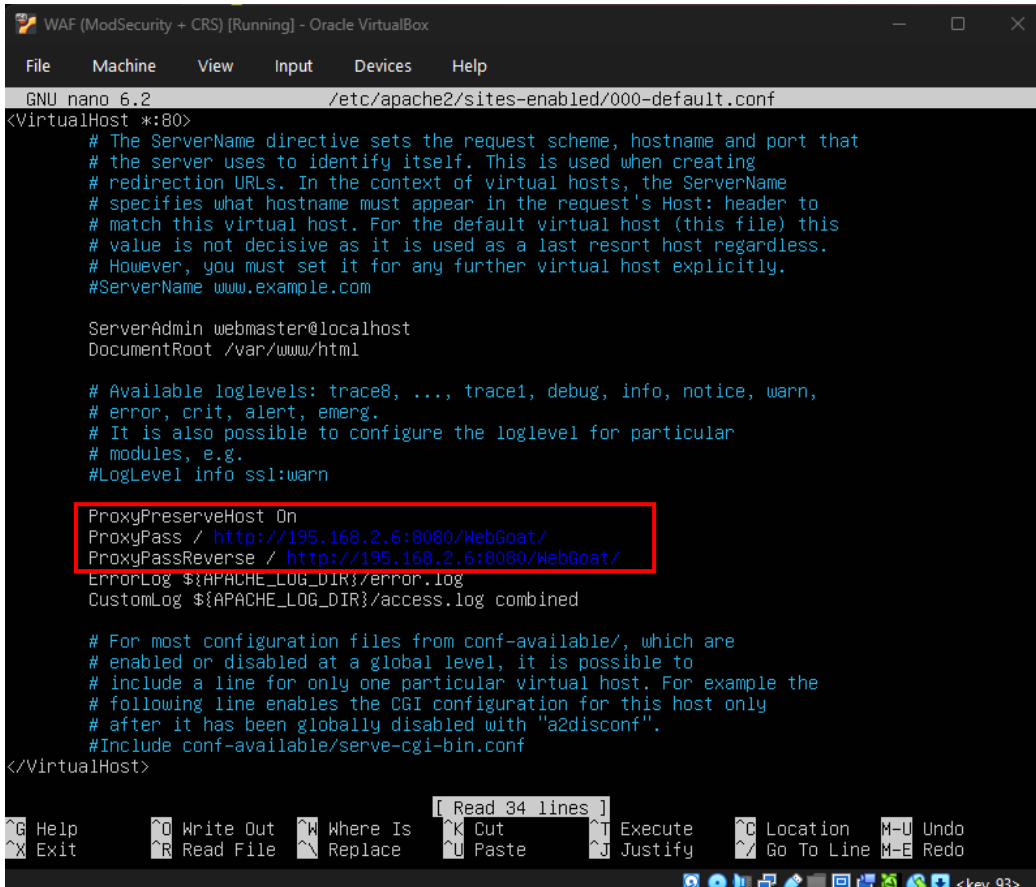
# -- Request body handling -----
# Allow ModSecurity to access request bodies. If you don't, ModSecurity
# won't be able to see any POST parameters, which opens a large security
# hole for attackers to exploit.
#
SecRequestBodyAccess On

# Enable XML request body parser.
# Initiate XML Processor in case of xml content-type
#
SecRule REQUEST_HEADERS:Content-Type "(?:application(?:/soap\+|/)|text/xml)" \
    "id:'200000',phase:1,t:none,t:lowercase,pass,nolog,ctl:requestBodyProcessor=XML"

# Enable JSON request body parser.
# Initiate JSON Processor in case of JSON content-type; change accordingly
# if your application does not use 'application/json'
#
SecRule REQUEST_HEADERS:Content-Type "application/json" \
    "id:'200001',phase:1,t:none,t:lowercase,pass,nolog,ctl:requestBodyProcessor=JSON"

# Sample rule to enable JSON request body parser for more subtypes.
# Uncomment or adapt this rule if you want to engage the JSON

user@WAFModSecurityCRS:~$
```



```
WAF (ModSecurity + CRS) [Running] - Oracle VirtualBox
File Machine View Input Devices Help
GNU nano 6.2 /etc/apache2/sites-enabled/000-default.conf
<VirtualHost *:80>
# The ServerName directive sets the request scheme, hostname and port that
# the server uses to identify itself. This is used when creating
# redirection URLs. In the context of virtual hosts, the ServerName
# specifies what hostname must appear in the request's Host: header to
# match this virtual host. For the default virtual host (this file) this
# value is not decisive as it is used as a last resort host regardless.
# However, you must set it for any further virtual host explicitly.
#ServerName www.example.com

ServerAdmin webmaster@localhost
DocumentRoot /var/www/html

# Available loglevels: trace8, ..., trace1, debug, info, notice, warn,
# error, crit, alert, emerg.
# It is also possible to configure the loglevel for particular
# modules, e.g.
#LogLevel info ssl:warn

ProxyPreserveHost On
ProxyPass / http://195.168.2.6:8080/WebGoat/
ProxyPassReverse / http://195.168.2.6:8080/WebGoat/
ErrorLog ${APACHE_LOG_DIR}/error.log
CustomLog ${APACHE_LOG_DIR}/access.log combined

# For most configuration files from conf-available/, which are
# enabled or disabled at a global level, it is possible to
# include a line for only one particular virtual host. For example the
# following line enables the CGI configuration for this host only
# after it has been globally disabled with "a2disconf".
#Include conf-available/serve-cgi-bin.conf
</VirtualHost>

[ Read 34 lines ]
Help Write Out Where Is Cut Execute Location M-U Undo
Exit Read File Replace Paste Justify Go To Line M-E Redo
<key 93>
```

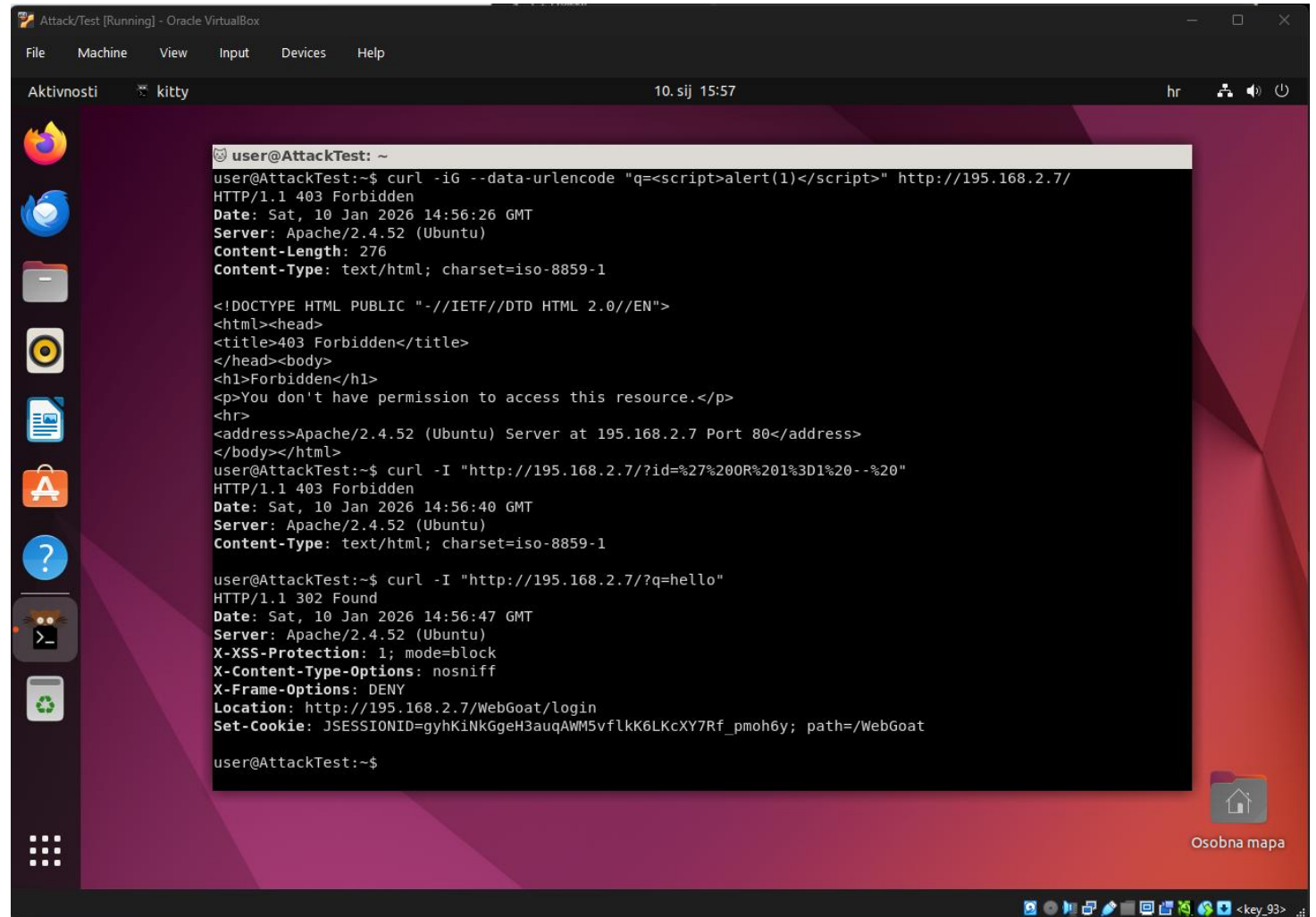
# Reverse proxy

- Apache prima sve HTTP zahtjeve
- Prosljeđuje ih WebGoat aplikaciji
- Omogućuje filtriranje prometa
- Kod: `sudo nano /etc/apache2/sites-enabled/000-default.conf`



# Testiranje

- Sa WAF-om
- SecRuleEngine On
- Legitimni promet dopušten
- Blokira XSS i SQL Injection



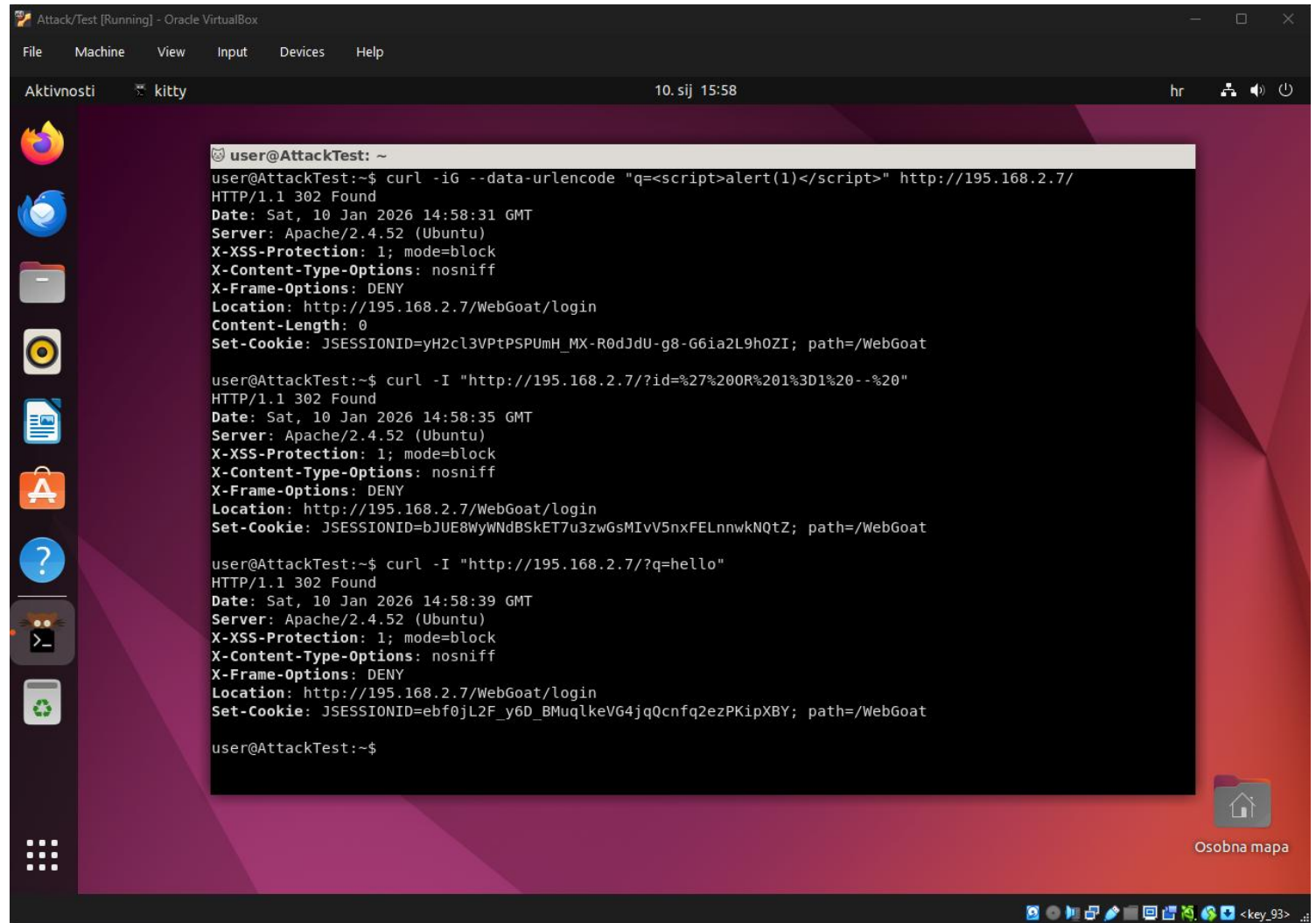
The screenshot shows a terminal window titled "Attack/Test [Running] - Oracle VirtualBox" with a menu bar (File, Machine, View, Input, Devices, Help) and a status bar (Aktivnosti, kitty, 10. sij 15:57, hr, icons). The terminal displays the following commands and outputs:

```
user@AttackTest: ~  
user@AttackTest:~$ curl -iG --data-urlencode "q=<script>alert(1)</script>" http://195.168.2.7/  
HTTP/1.1 403 Forbidden  
Date: Sat, 10 Jan 2026 14:56:26 GMT  
Server: Apache/2.4.52 (Ubuntu)  
Content-Length: 276  
Content-Type: text/html; charset=iso-8859-1  
  
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">  
<html><head>  
  <title>403 Forbidden</title>  
</head><body>  
  <h1>Forbidden</h1>  
  <p>You don't have permission to access this resource.</p>  
  <hr>  
  <address>Apache/2.4.52 (Ubuntu) Server at 195.168.2.7 Port 80</address>  
</body></html>  
user@AttackTest:~$ curl -I "http://195.168.2.7/?id=%27%20OR%201%3D1%20--%20"  
HTTP/1.1 403 Forbidden  
Date: Sat, 10 Jan 2026 14:56:40 GMT  
Server: Apache/2.4.52 (Ubuntu)  
Content-Type: text/html; charset=iso-8859-1  
  
user@AttackTest:~$ curl -I "http://195.168.2.7/?q=hello"  
HTTP/1.1 302 Found  
Date: Sat, 10 Jan 2026 14:56:47 GMT  
Server: Apache/2.4.52 (Ubuntu)  
X-XSS-Protection: 1; mode=block  
X-Content-Type-Options: nosniff  
X-Frame-Options: DENY  
Location: http://195.168.2.7/WebGoat/login  
Set-Cookie: JSESSIONID=gyhKiNKGgeH3auqAWM5vflkK6LKcXY7Rf_pmoh6y; path=/WebGoat  
  
user@AttackTest:~$
```

The desktop background is a red and purple geometric pattern. On the left is a dock with icons for Firefox, Telegram, Files, Docker Desktop, LibreOffice Writer, App Store, a question mark, a terminal, and a recycling bin. The bottom right corner shows a taskbar with various system icons and a window titled "<key\_93>".

# Testiranje

- Bez WAF-a
- SecRuleEngine Off
- Prolaze svi zahtjevi
- Aplikacija nije zaštićena



```
user@AttackTest: ~  
user@AttackTest:~$ curl -iG --data-urlencode "q=<script>alert(1)</script>" http://195.168.2.7/  
HTTP/1.1 302 Found  
Date: Sat, 10 Jan 2026 14:58:31 GMT  
Server: Apache/2.4.52 (Ubuntu)  
X-XSS-Protection: 1; mode=block  
X-Content-Type-Options: nosniff  
X-Frame-Options: DENY  
Location: http://195.168.2.7/WebGoat/login  
Content-Length: 0  
Set-Cookie: JSESSIONID=yH2cl3VPtPSPUmH_MX-R0dJdU-g8-G6ia2L9h0ZI; path=/WebGoat  
  
user@AttackTest:~$ curl -i "http://195.168.2.7/?id=%27%20R%201%3D1%20--%20"  
HTTP/1.1 302 Found  
Date: Sat, 10 Jan 2026 14:58:35 GMT  
Server: Apache/2.4.52 (Ubuntu)  
X-XSS-Protection: 1; mode=block  
X-Content-Type-Options: nosniff  
X-Frame-Options: DENY  
Location: http://195.168.2.7/WebGoat/login  
Set-Cookie: JSESSIONID=bJUE8WyWNdBSKET7u3zwGsMIvV5nxFELnnwKNQtZ; path=/WebGoat  
  
user@AttackTest:~$ curl -i "http://195.168.2.7/?q=hello"  
HTTP/1.1 302 Found  
Date: Sat, 10 Jan 2026 14:58:39 GMT  
Server: Apache/2.4.52 (Ubuntu)  
X-XSS-Protection: 1; mode=block  
X-Content-Type-Options: nosniff  
X-Frame-Options: DENY  
Location: http://195.168.2.7/WebGoat/login  
Set-Cookie: JSESSIONID=ebf0jL2F_y6D_BMuqlkeVG4jqQcnfq2ezPKipXBY; path=/WebGoat  
  
user@AttackTest:~$
```

# Zaključak

- WAF uspješno detektira i blokira napade
- OWASP CRS pruža osnovnu, ali učinkovitu zaštitu
- Sustav se može dodatno prilagoditi smanjenjem false positive-a
- Usporedba Sa WAF-om i bez WAF-a

Sa WAF-om	Bez WAF-a
XSS i SQL injection blokirani	XSS i SQL injection prolazi
Aktivna zaštita	Nema filtriranja
Zaštićen pristup	Ranjiva aplikacija

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