Welcome to

6. Web Application Security: Offensive and Defensive

Security in Web Development Elective, KEA

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Slides are available as PDF, kramse@Github

6-web-app-hacking-offensive-security-in-web.tex in the repo security-courses

Goals for today

Todays goals:

- Web Application Hacking – moving from offensive towards defensive
- Talk about a few tools for testing web applications
- Start doing defensive – using Nginx as example TLS endpoint, load balancer and filter
- Authentication on the web

Photo by Thomas Galler on Unsplash

Plan for today - part I

Subjects

- Offense against web application, finish up Denial of Service
- The list of offensive methods from the Web Application Security book

Exercises

- Try using a few web testing tools – performance / stress testing
- Nginx as TLS endpoint
- Nginx as Load Balancer
- Nginx for logging and filtering

Plan for today - part II

Subjects

- Overall securing modern web applications
- Processes involved in creating secure web applications
- Vulnerability management
- Mitigation Strategies

Exercises

- Github security features
- Password hashing speed
- Architecture exercise related to your exam project - you already have done this!

Time schedule

- 1) Denial of Service and stress testing,
  2) Defensive begin: Nginx exercises 2x 45min
- 3) Web Application Defensive: Veracode document and Architecture 45min
- 4) Web Application Defensive: Authentication 45 min

Exercises are also mixed in during all 4

What we learnt from the offensive part

Part II Summary

Ultimately, thoroughly testing a web application will require knowledge of common vulnerability archetypes, critical thinking skills, and domain knowledge so that deep logic vulnerabilities outside of the most common archetypes can be found. The foundational skills presented in Part I and Part II should be sufficient to get you up and running on any web application security pen-testing project you take part in in the future.

From this point forward, you should pay attention to the business model in any application you test. All applications are at risk of vulnerabilities like XSS, CSRF, or XXE, but only by gaining a deep understanding of the underlying business model and business logic in an application can you identify more advanced and specific vulnerabilities.

Source: *Web Application Security*, Andrew Hoffman, 2020, ISBN: 9781492053118

- Depending on data stored in your application, it may or may not be critical if there is a XSS vulnerability

14. Denial of Service (DoS)

Perhaps one of the most popular types of attacks, and the most widely publicized, is the distributed denial of service (DDoS) attack. This attack is a form of denial of service (DoS), in which a large network of devices flood a server with requests, slowing down the server or rendering it unusable for legitimate users.

DoS attacks come in many forms, from the well-known distributed version that involves thousands or more coordinated devices, to code-level DoS that affects a single user as a result of a faulty regex implementation, resulting in long times to validate a string of text. DoS attacks also range in seriousness from reducing an active server, to a functionless electric bill, to causing a user's web page to load slightly slower than usual or pausing their video midbuffer.

Because of this, it is very difficult to test for DoS attacks (in particular, the less severe ones). Most bug bounty programs outright ban DoS submissions to prevent bounty hunters from interfering with regular application usage.

- There has also been some hash-based attacks and attacks using data to create bad performance, see PHP security advisories

Riorey Taxonomy of DDoS Attacks

What are DDoS? and DoS?

Denial of Service attack - prevents authorized users access to resources

Can be a single request to HTTP service, sequence of network packets

Distributed Denial of Service attack - many (spoofed) sources

https://en.wikipedia.org/wiki/Denial-of-service_attack

Taxonomy of DDoS Attacks

RioRey Taxonomy of DDoS Attacks

	Attack Types		Attack Matrix Dimensions									
			Nature of IP	Handshake	Source IP Range	Packet Rate	Packet Size	Packet Content	Fragmenting	Session Rate	Session Duration	VERB Rate
TCP BASED	1	SYN Flood	Spoofed	None	Large	High	Small	---	---	---	---	---
	2	SYN-ACK Flood	Spoofed	None	Large	High	---	---	---	---	---	---
	3	ACK & PUSH ACK Flood	Spoofed	None	Large	High	---	---	---	---	---	---
	4	Fragmented ACK	Spoofed	None	Large	Moderate	Large	---	High	---	---	---
	5	RST or FIN Flood	Spoofed	None	Large	High	---	---	---	---	---	---
	6	Synonymous IP	Spoofed	None	Single IP	High	---	---	---	---	---	---
	7	Fake Session	Spoofed	None	Large	Low	---	---	---	---	---	---
	8	Session Attack	Non-Spoofed	Yes	Small	Low	---	---	---	Low	Long	---
	9	Misused Application	Non-Spoofed	Yes	Small	Variable	---	---	---	High	Short	---

HTTP

TCP HTTP BASED	**10**	**HTTP Fragmentation**	Non-Spoofed	Yes	Small	Very Low	Small	Valid	High	Very Low	Very Long	Very Low
	11	**Excessive VERB**	Non-Spoofed	Yes	Small	High	---	Valid	---	High	Short	High
	12	**Excessive VERB Single Session**	Non-Spoofed	Yes	Small	Low	---	Valid	---	Low	Moderate	High
	13	**Multiple VERB Single Request**	Non-Spoofed	Yes	Small	Very Low	Large	Valid	---	Low	Long	High
	14	**Recursive GET**	Non-Spoofed	Yes	Small	Low	---	Valid	---	Low	Short	Low
	15	**Random Recursive GET**	Non-Spoofed	Yes	Small	Low	---	Valid	---	Low	Short	Low
	16	**Faulty Application**	Non-Spoofed	Yes	Small	Low	---	Valid	---	Low	Short	Low

NOT a complete list, but examples, see another example
https://en.wikipedia.org/wiki/Slowloris_(computer_security)

UDP

UDP BASED	17	**UDP Flood**	Spoofed	---	Very Large	Very High	Small	Not Valid	---	---	---	---
	18	**Fragmentation**	Spoofed	---	Moderate	Very High	Large	Not Valid	High	---	---	---
	19	**DNS Flood**	Spoofed	---	Very Large	Very High	Small	Valid	---	---	---	---
	20	**VoIP Flood**	Spoofed	---	Very Large	Very High	Small	Valid	---	---	---	---
	21	**Media Data Flood**	Spoofed	---	Very Large	Very High	Moderate	Valid	---	---	---	---
	22	**Non-Spoofed UDP Flood**	Non-Spoofed	---	Small	Very High	---	Valid	---	---	---	---

UDP is not used in most Web applications. My advice is to bandwith limit UDP flow into parts of the network with HTTP/HTTPS servers.

ICMP

ICMP BASED	23 **ICMP Flood**	Spoofed	---	Very Large	Very High	Variable	Not Valid	---	---	---	---
	24 **Fragmentation**	Spoofed	---	Moderate	Very High	Large	Not Valid	High	---	---	---
	25 **Ping Flood**	Spoofed	---	Very Large	Very High	Small	Valid	---	---	---	---

ICMP is a control protocol for sending messages about a problem. It does not carry data for web applications, so could be restricted and bandwidth limited in most network.

If you have a 10Gigabit connection, having 1Gbit UDP and 100Mbit ICMP is often enough.

Stress testing: Apache benchmark and others

```
$ ab -n 100 https://www.kramse.org/
This is ApacheBench, Version 2.3 <$Revision: 1879490 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking www.kramse.org (be patient).....done
...
```

Multiple stress testing tools available

Apache Benchmark is old, but easy to run

Older tool Tsung can simulate 10.000s of users and 10Gbps with a single PC

Tsung can be used to stress HTTP, WebDAV, SOAP, PostgreSQL, MySQL, LDAP, Jabber/XMPP servers, JSON and REST API testing, http://tsung.erlang-projects.org/

Apache Benchmark output - 1

```
Server Software:        nginx
Server Hostname:        www.kramse.org
Server Port:            443
SSL/TLS Protocol:       TLSv1.2,ECDHE-RSA-AES256-GCM-SHA384,4096,256
Server Temp Key:        ECDH P-384 384 bits
TLS Server Name:        www.kramse.org

Document Path:          /
Document Length:        5954 bytes

Concurrency Level:      1
Time taken for tests:   9.596 seconds
Complete requests:      100
Failed requests:        0
Total transferred:      651100 bytes
HTML transferred:       595400 bytes
Requests per second:    10.42 [#/sec] (mean)
Time per request:       95.962 [ms] (mean)
Time per request:       95.962 [ms] (mean, across all concurrent requests)
Transfer rate:          66.26 [Kbytes/sec] received
```

Apache Benchmark output - 3

```
Connection Times (ms)
              min  mean[+/-sd] median   max
Connect:       48   71 105.5     61    1114
Processing:     6   25 157.8      9    1587
Waiting:        5    9   1.9      9      16
Total:         55   96 189.0     70    1649

Percentage of the requests served within a certain time (ms)
  50%     70
  66%     72
  75%     73
  80%     74
  90%     76
  95%     78
  98%   1124
  99%   1649
 100%   1649 (longest request)
```

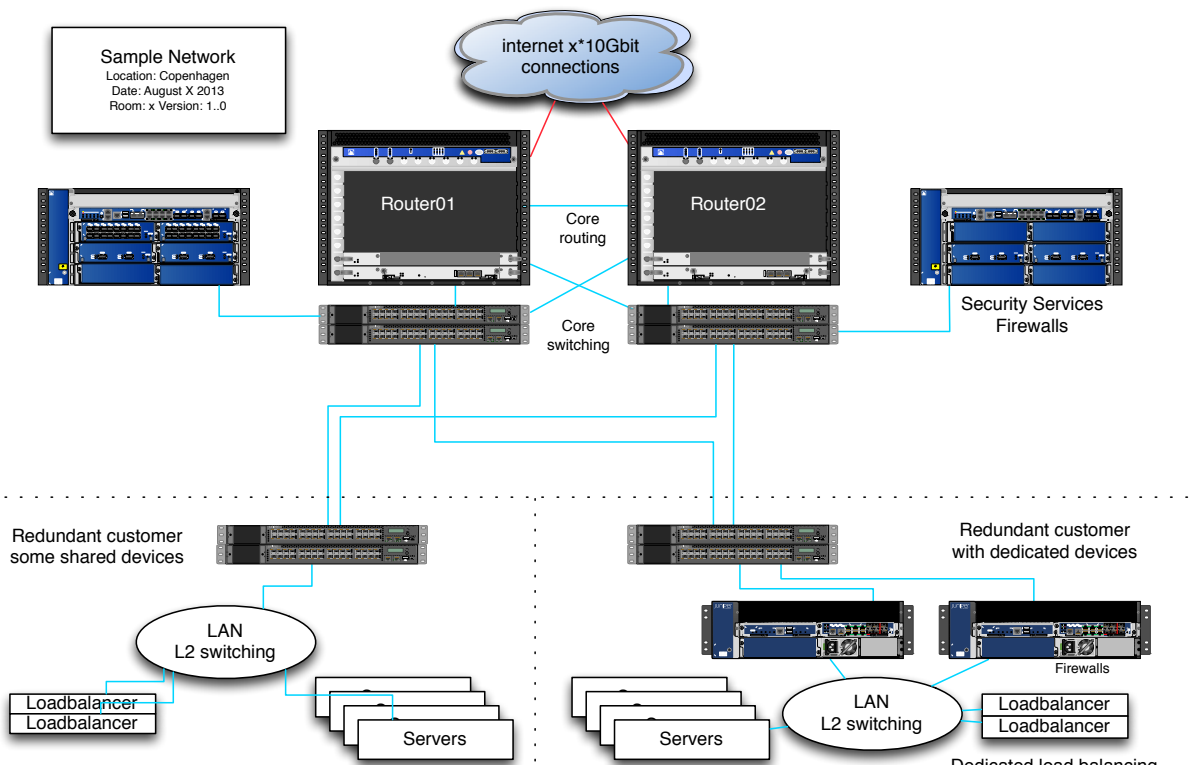
Exercise

Now lets do the exercise

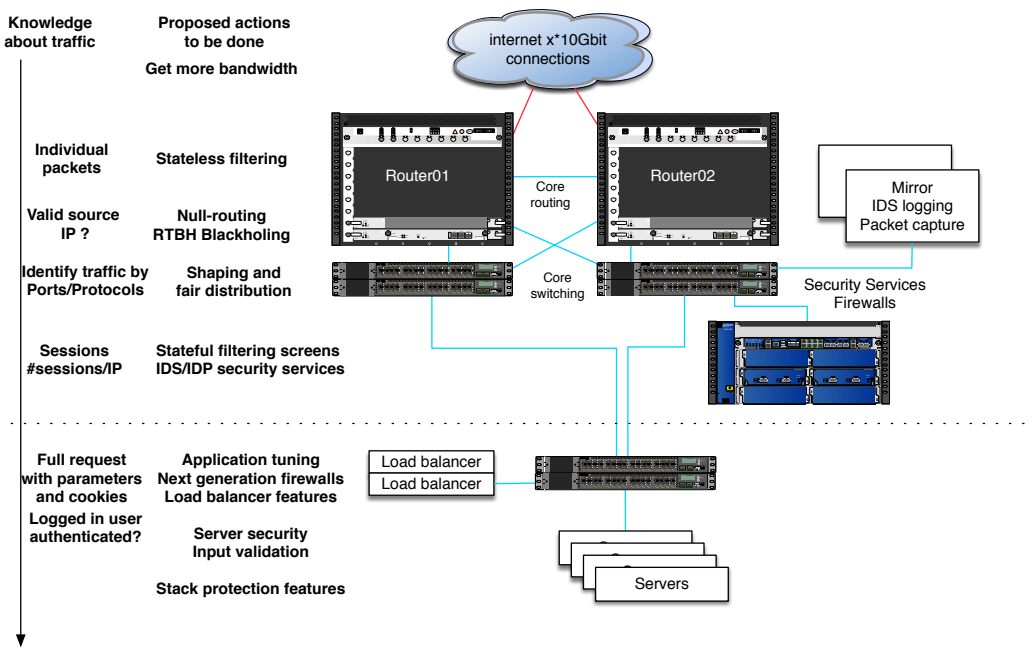
Apache Benchmark 20 min

which is number **30** in the exercise PDF.

Networks today



Defense in depth - multiple layers of security



We will now look at Nginx for Defense

Exercise

Now lets do the exercise

Bonus:TCP SYN flooding 30min

which is number 31 in the exercise PDF.

Nginx for defense

> Nginx (pronounced "engine X"[8] / ˌ ɛ n ˌ ɛ k s/ EN-jin-EKS), stylized as NGI X, is a web server that can also be used as a reverse proxy, load balancer, mail proxy and HTTP cache. The software was created by Igor Sysoev and publicly released in 2004.[9] Nginx is free and open-source software, released under the terms of the 2-clause BSD license. A large fraction of web servers use NGINX,[10] often as a load balancer.[11]

https://en.wikipedia.org/wiki/Nginx

Nginx is a popular web server, but can also be used for other things. These are enabled when used as a Proxy, reverse proxy in front of services.

Nginx Use-Cases

We will now look at a few use-cases, and discuss

- Nginx as a Transport Layer Security (TLS) endpoint – collect ALL your TLS related configuration in one place
- Nginx as a Load Balancer
- Nginx logging – look into what is logged normal access and error logging – run Nikto to produce bad logs
- Nginx filtering – prevent people from accessing a path like `/administration`

Feel free to do the exercises in any order, depending on your own interests.

Exercise

Now lets do the exercise

Nginx as a Transport Layer Security (TLS) endpoint 20 min

which is number 32 in the exercise PDF.

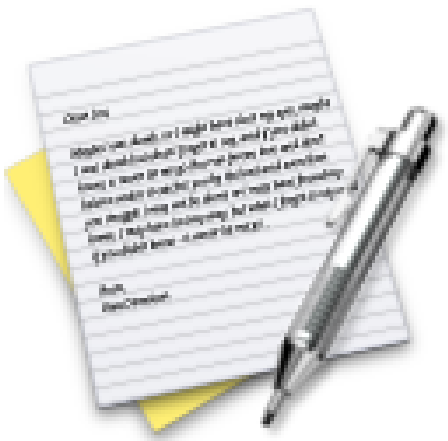
Exercise

Now lets do the exercise

Run Nginx as a load balancer – 20 min

which is number 33 in the exercise PDF.

Exercise



Now lets do the exercise

Nginx logging 20 min

which is number **34** in the exercise PDF.

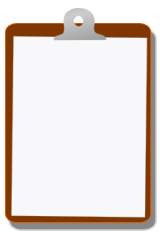
Exercise

Now lets do the exercise

Nginx filtering 40 min

which is number **35** in the exercise PDF.

For Next Time



Think about the subjects from this time, write down questions

Check the plan for chapters to read in the books

Visit web sites and download papers if needed

Retry the exercises to get more confident using the tools