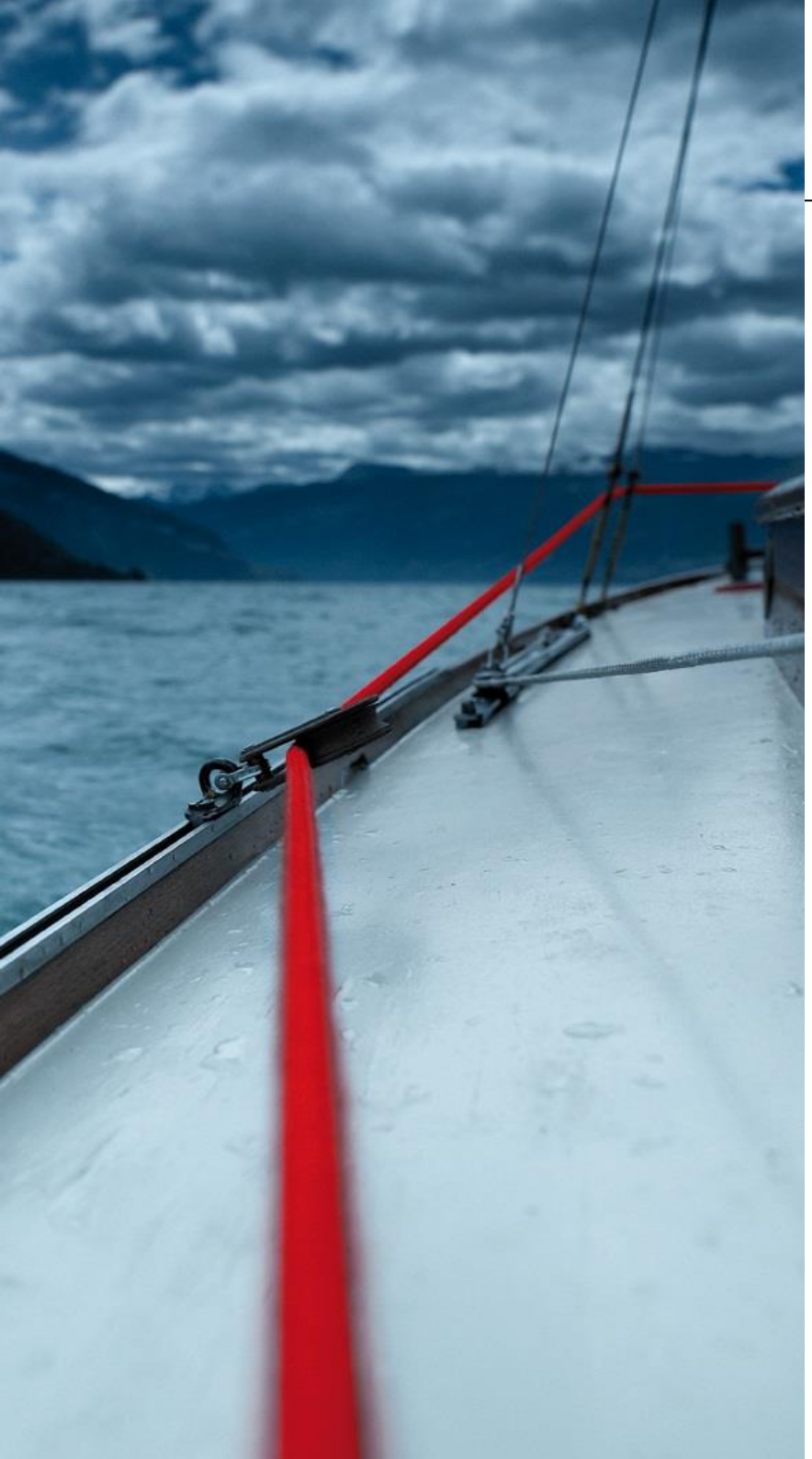
10.01.2022

Web Application Security Architectures

UNITED SECURITY PROVIDERS

Christoph Schulthess

Gastvortrag FHNW



Who’s speaking

Christoph Schulthess
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United Security Providers AG
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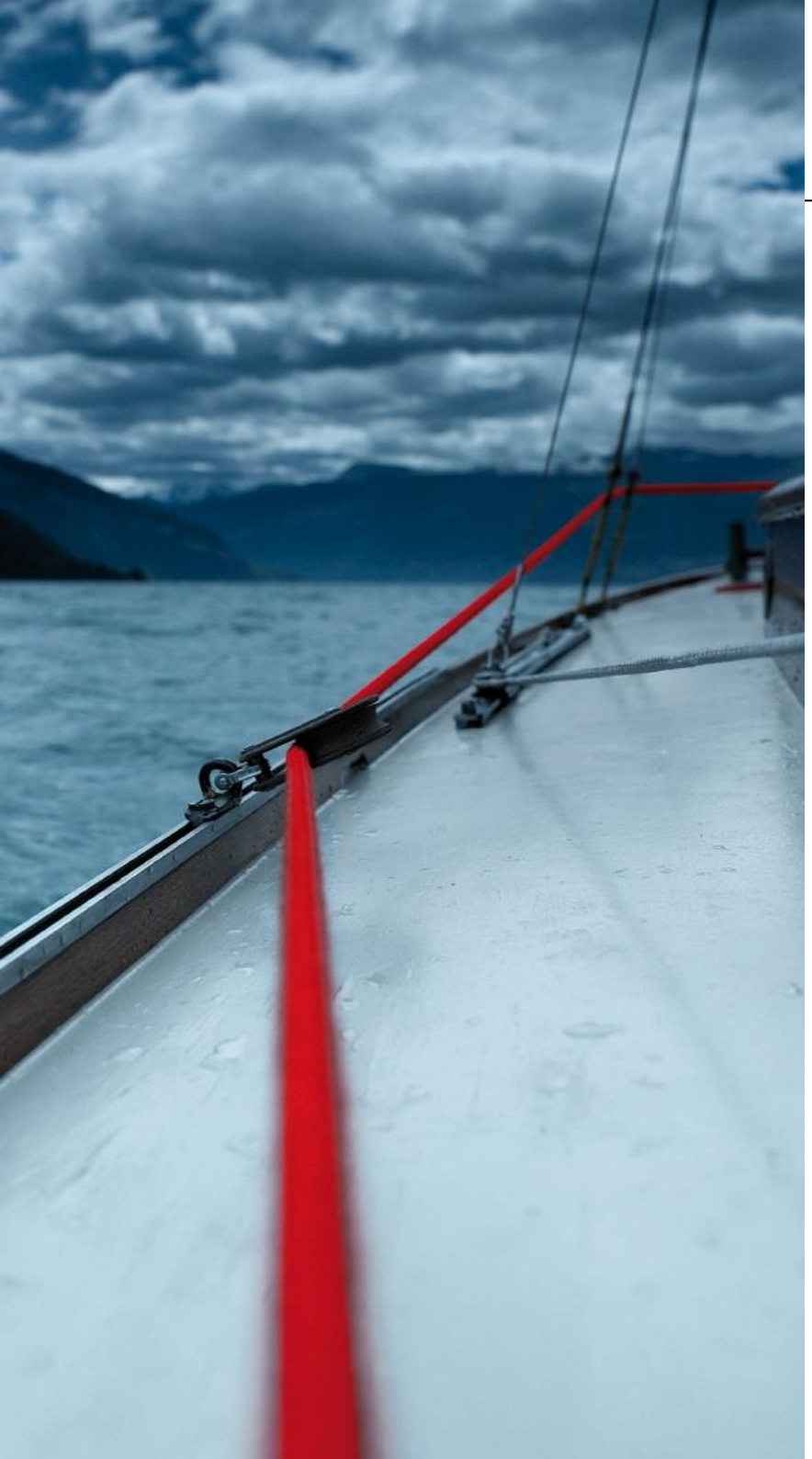
Web: www.united-security-providers.ch

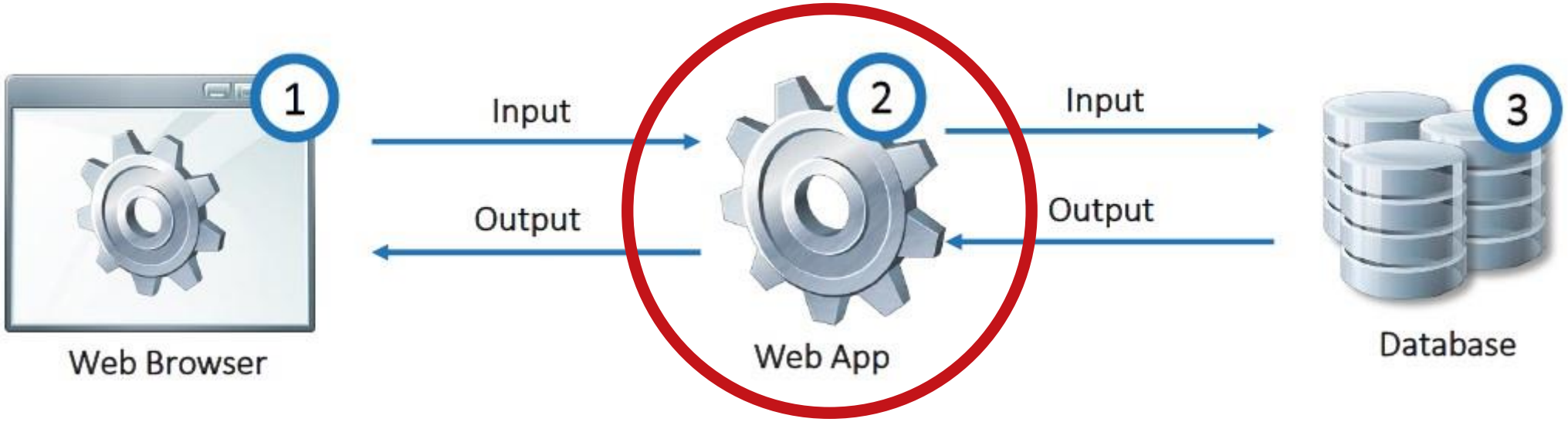


Agenda

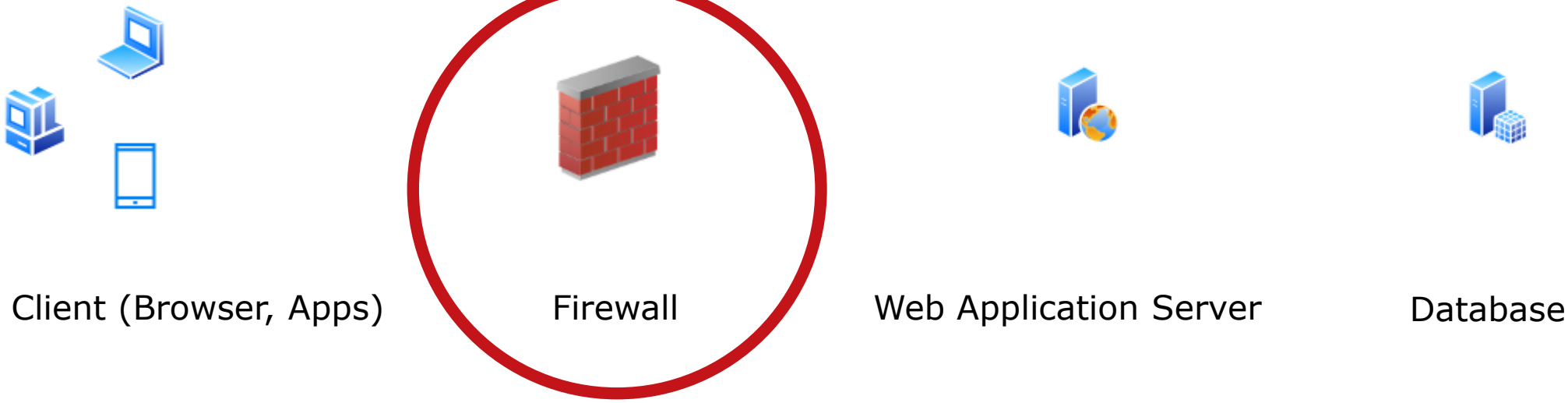
1. What’s a WAF
2. Why enterprises need a WAF
3. Real life example
4. How can you adapt

1. **What**’s a WAF

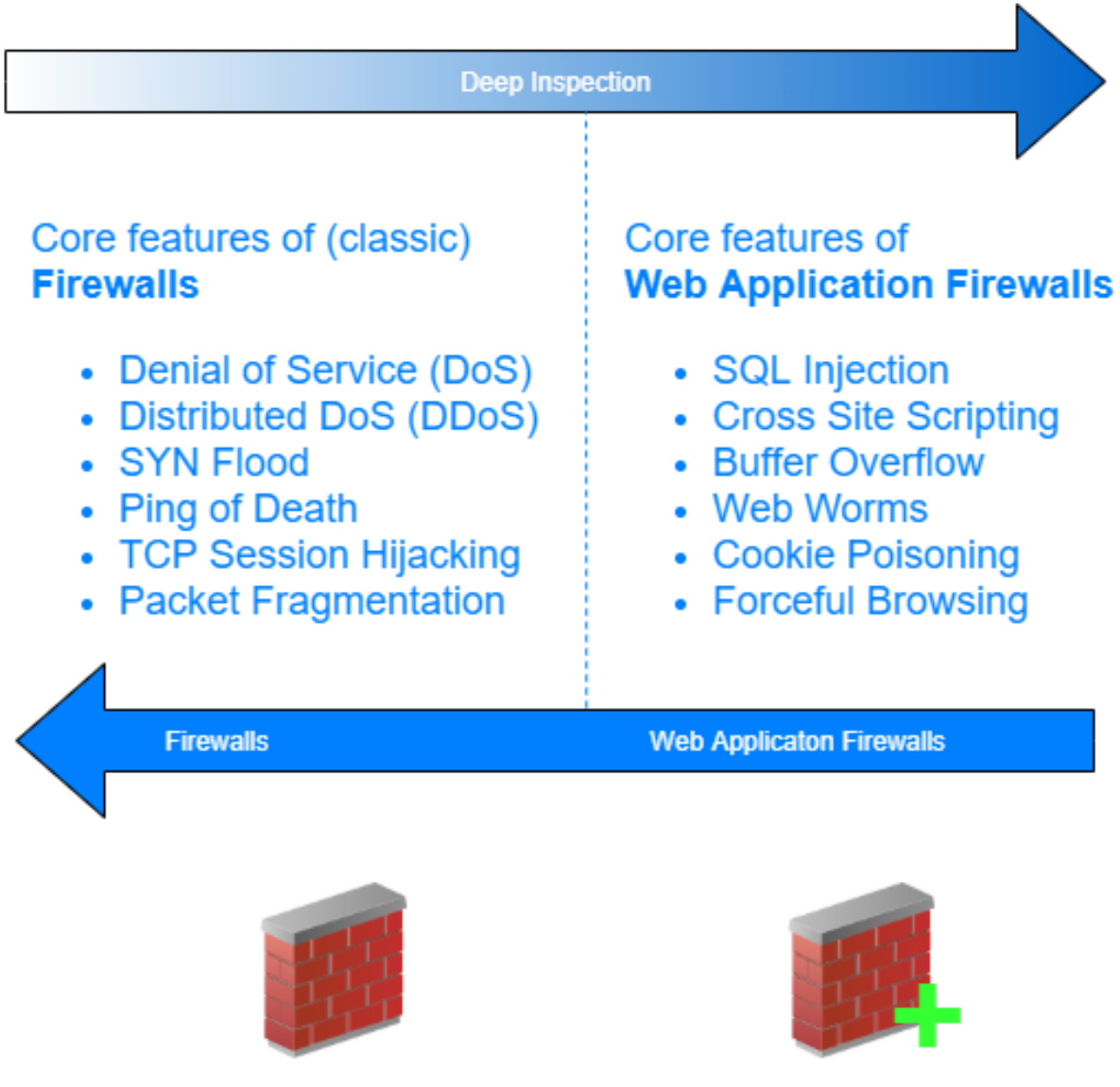
3 tier architecture



(Web Application) Firewall..?



(L3/L4 Firewall vs. WAF)



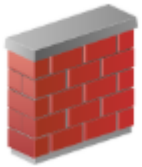
OWASP Top10 Web Application Security Risks

1. Broken Access Control
2. Cryptographic Failures
3. Injection
4. Insecure Design
5. Security Misconfiguration
6. Vulnerable and Outdated Components
7. Identification and Authentication Failures
8. Software and Data Integrity Failures
9. Security Logging and Monitoring Failures
10. Server-Side Request Forgery

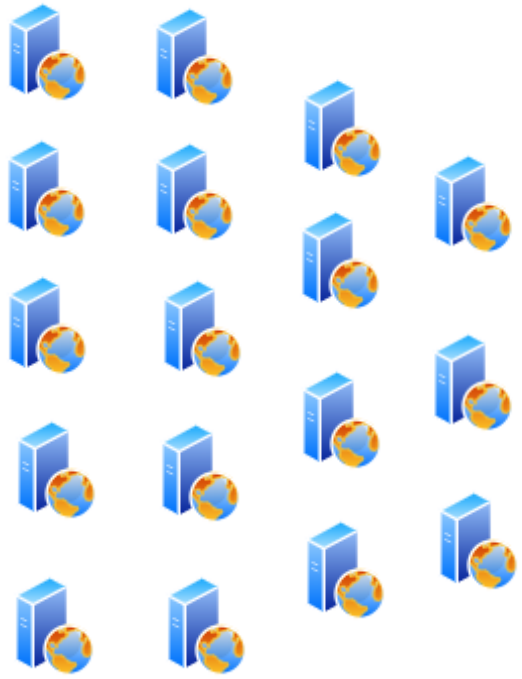
2. Why is this relevant and important

Architecture View

Client (Browser, Apps)



Firewall



√ XSS Protection

Web Application Server

Database

Web Application Firewall

Description according to OWASP (Open Web Application Security Project):

*"A web application firewall (WAF) is an **application firewall** for **HTTP** applications. It applies a set of **rules** to an HTTP conversation. Generally, these rules cover common attacks such as cross-site scripting (XSS) and SQL injection.*

*While proxies generally protect clients, **WAFs protect servers**. A WAF is deployed to protect a specific web application or set of web applications. A WAF can be considered a **reverse proxy**.*

*WAFs may come in the form of an appliance, server plugin, or filter, and may be **customized** to an application. The effort to perform this customization can be significant and needs to be maintained as the application is modified"*

(Source: https://www.owasp.org/index.php/Web_Application_Firewall)

➔ It's **not** a network firewall on layer 3 or 4 but an application **gateway**.

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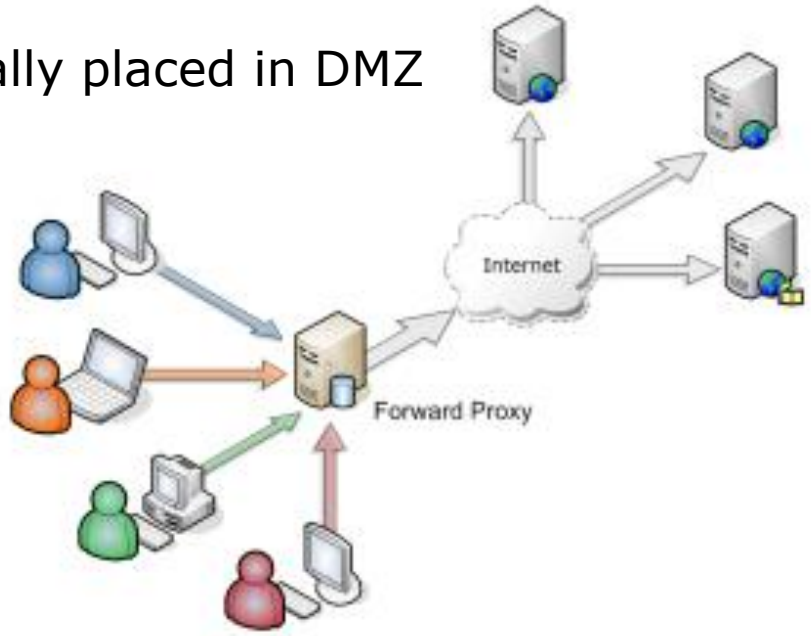
Reverse Proxy

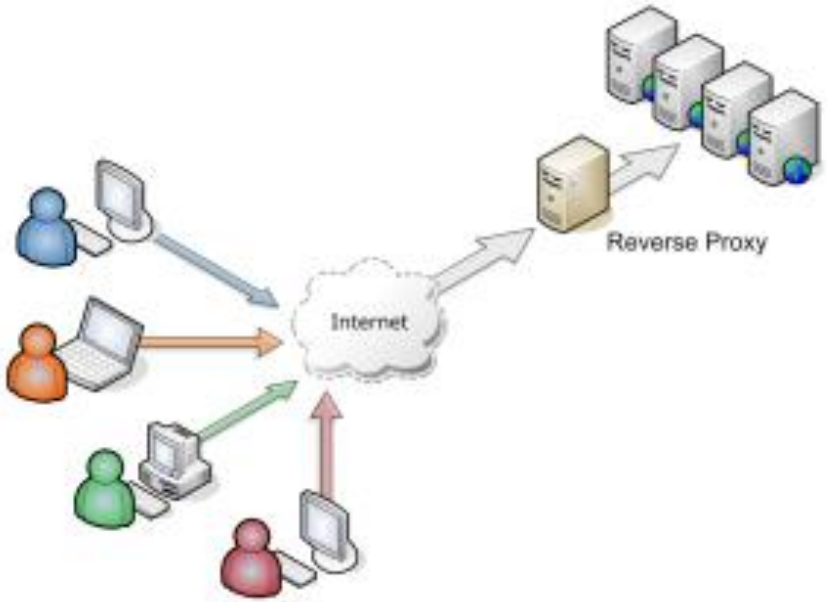
- **Forward proxy** acts on behalf of the client
- **Reverse proxy** acts on behalf of the server

Typical functions of a reverse proxy

- SSL/TLS Termination/Offloading
- Caching/Acceleration
- Load distribution

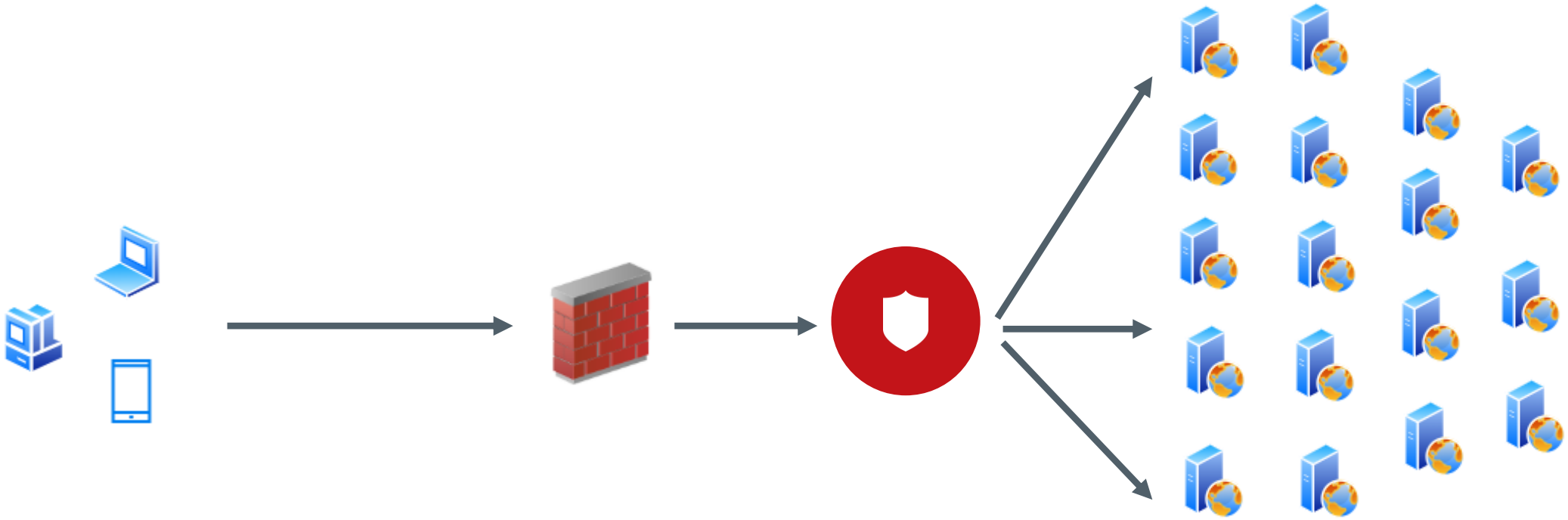
Usually placed in DMZ





(Source: https://i.stack.imgur.com/0qpxZ.png)

Architecture View



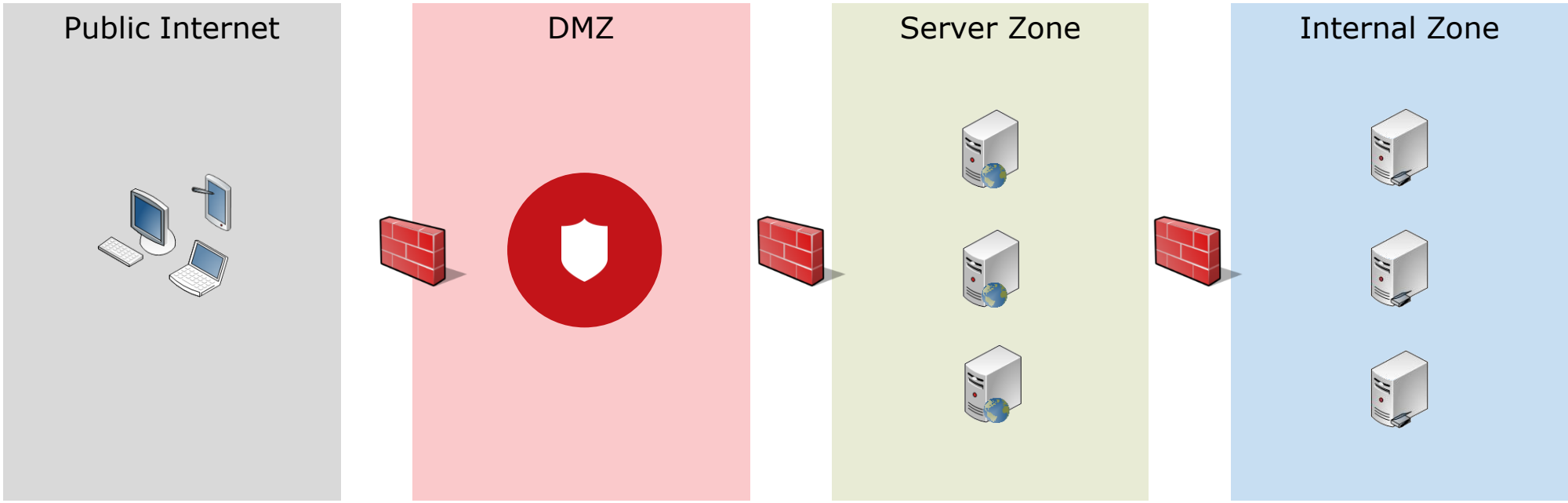
Client (Browser, Apps)

Firewall

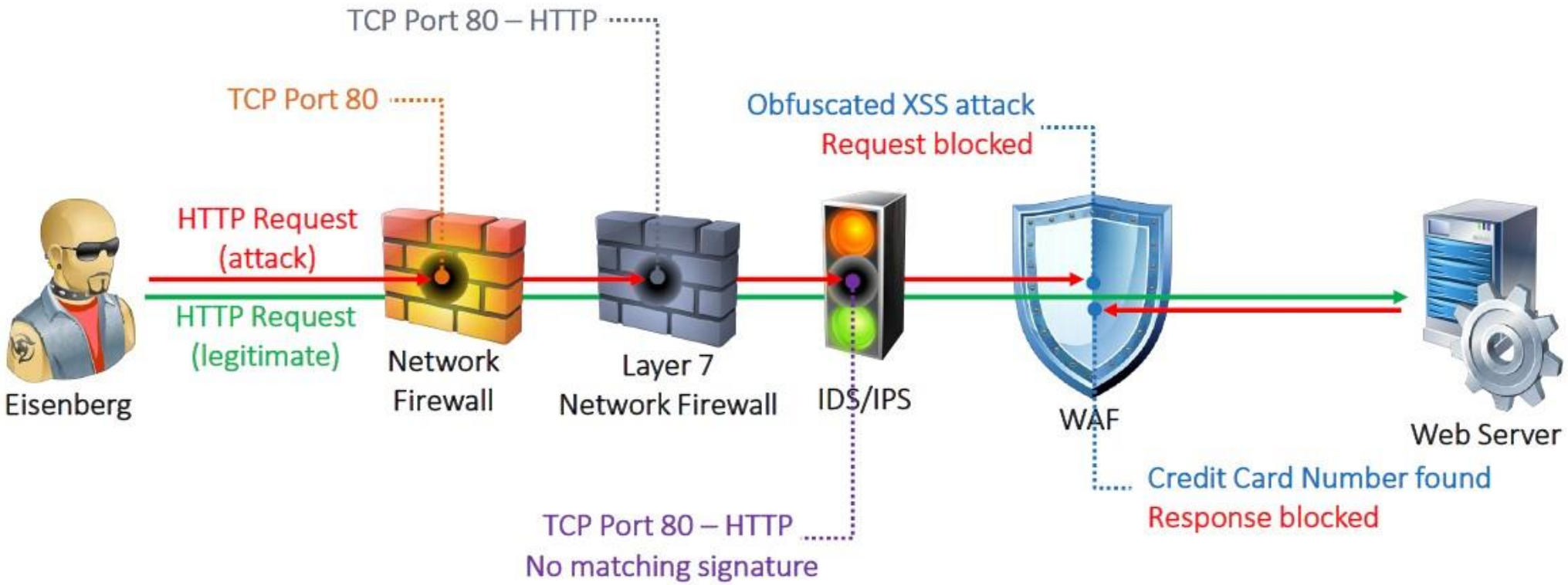
Web Application Firewall
+
Reverse Proxy

Web Application Server

Architecture View – more detailed view



Attack Example



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➔ It's **not** a network firewall on layer 3 or 4 but an application **gateway**.

- The OWASP ModSecurity CRS Project's goal is to provide an easily "pluggable" set of generic attack detection rules that provide a base level of protection for any web application.
- Consider the Web Application Firewall Evaluation Criteria Project (WAFEC) to help evaluate commercial and open source web application firewalls.

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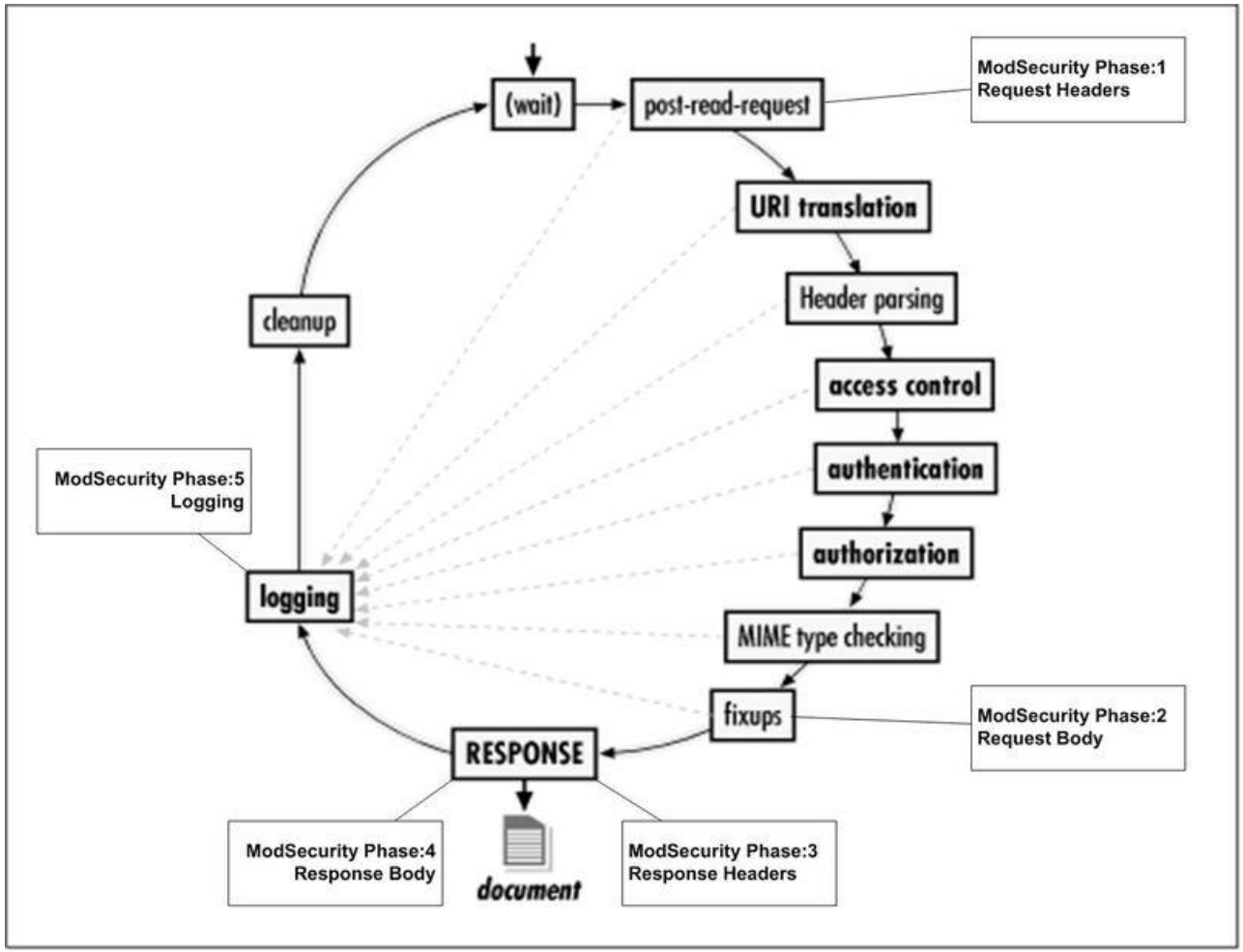
ModSecurity

"Open Source Web Application Firewall"

- Open Source (Apache License 2.0)
- Engine
- Rules/Ruleset
- Traditional vs. Scoring mode
- OWASP Core Rule Set (CRS)



(Source: https://camo.githubusercontent.com/8c6d225b0c7fbb4a8a6ac1a98ead9a1d57d22fbf/687474703a2f2f7777772e6d6f647365637572697479792e6f72672f6772617068696373732f6d6f647365632d726f746174696f6e2e6a7067)

ModSecurity

Example of a ModSecurity Rule from CRS 3.2 (SQL Injection)

```
SecRule REQUEST_COOKIES|!REQUEST_COOKIES:/__utm/|REQUEST_COOKIES_NAMES|ARGS_NAMES|ARGS|XML:/* "@rx (?i)union.*?select.*?from" \
    "id:942270,\
    phase:2,\
    block,\
    capture,\
    t:none,t:urlDecodeUni,\
    msg:'Looking for basic sql injection. Common attack string for mysql, oracle and others.',\
    logdata:'Matched Data: %{TX.0} found within %{MATCHED_VAR_NAME}: %{MATCHED_VAR}',\
    tag:'application-multi',\
    tag:'language-multi',\
    tag:'platform-multi',\
    tag:'attack-sqli',\
    tag:'paranoia-level/1',\
    tag:'OWASP_CRS',\
    tag:'OWASP_CRS/WEB_ATTACK/SQL_INJECTION',\
    tag:'WASCTC/WASC-19',\
    tag:'OWASP_TOP_10/A1',\
    tag:'OWASP_AppSensor/CIE1',\
    tag:'PCI/6.5.2',\
    ver:'OWASP_CRS/3.2.0',\
    severity:'CRITICAL',\
    setvar:'tx.sql_injection_score=+%{tx.critical_anomaly_score}',\
    setvar:'tx.anomaly_score_pl1=+%{tx.critical_anomaly_score}'"
```

Web Application Firewall

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WAFEC

Joined project between the Web Application Security Consortium (WASC) and OWASP.

Detailed guideline with categories

- Deployment Architecture
- HTTP Support
- Detection Techniques
- Protection Techniques
- Logging
- Reporting
- Management
- Performance
- XML

(Source: http://projects.webappsec.org/w/page/13246983/WAFEC%201%20HTML%20Version)

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"fully fledged"

(Source: https://www.owasp.org/index.php/Web_Application_Firewall)

* Apache/ModSecurity Tutorials https://www.netnea.com/cms/apache-tutorials/

Added Value of a “fully fledged” WAF

Fine-grained WAF functions
- allow, deny
- Header & Content Manipulation

Central Security Baseline
- E.g. allowed SSL/TLS versions & ciphers

High Availability
- active/active, active/passive etc.

Requirements for Operations
- Interfaces to monitoring solutions
- Log forwarding to central log collectors an SIEM systems
- Config change history (traceability of config changes)
- Useful tools for troubleshooting and log analysis

Upfront Authentication
- With 2FA if required
- Support of federated authentication setups via SAML, OpenID Connect or OAuth

Session Management / Session Store
- Clients only have **1** session, the one with the WAF
- Session of the application servers are stored in a session store on the WAF component

Identity Propagation
- Flexible options for identity propagation in direction of the apps

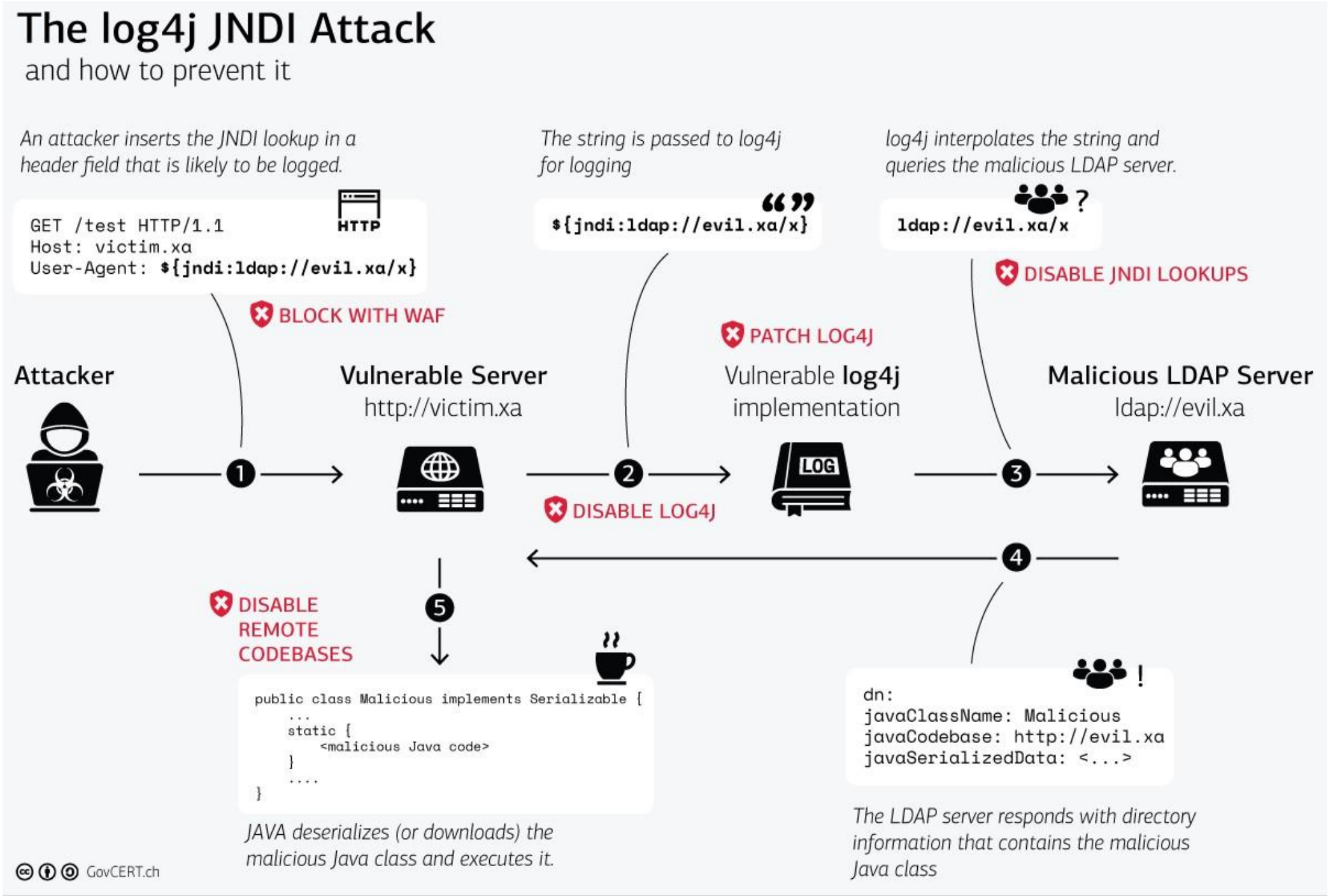
Policy-based Authorization
- Access control e.g. based on group memberships

User Self Services
- Password reset
- Change password
- Self registration

Single Sign On (SSO)
- **The added value** for end users

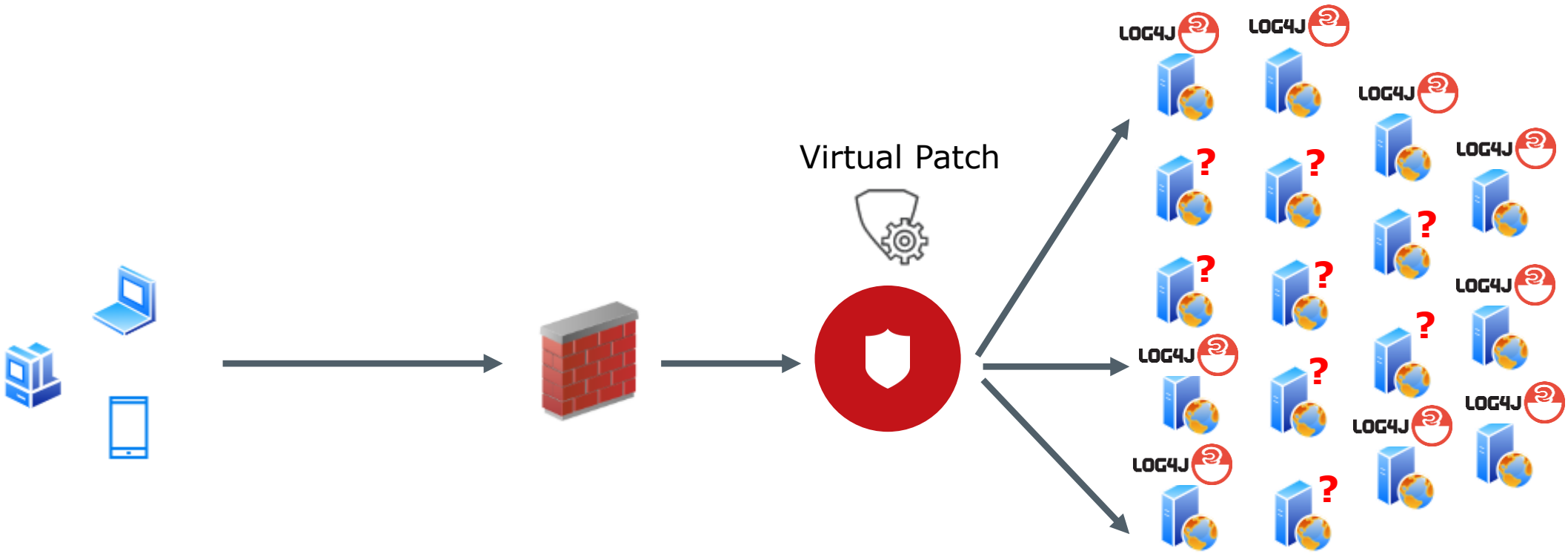
Added Value of a “fully fledged” WAF

3. Real life example



Source: https://www.govcert.ch/blog/zero-day-exploit-targeting-popular-java-library-log4j/

Log4Shell



Client (Browser, Apps)

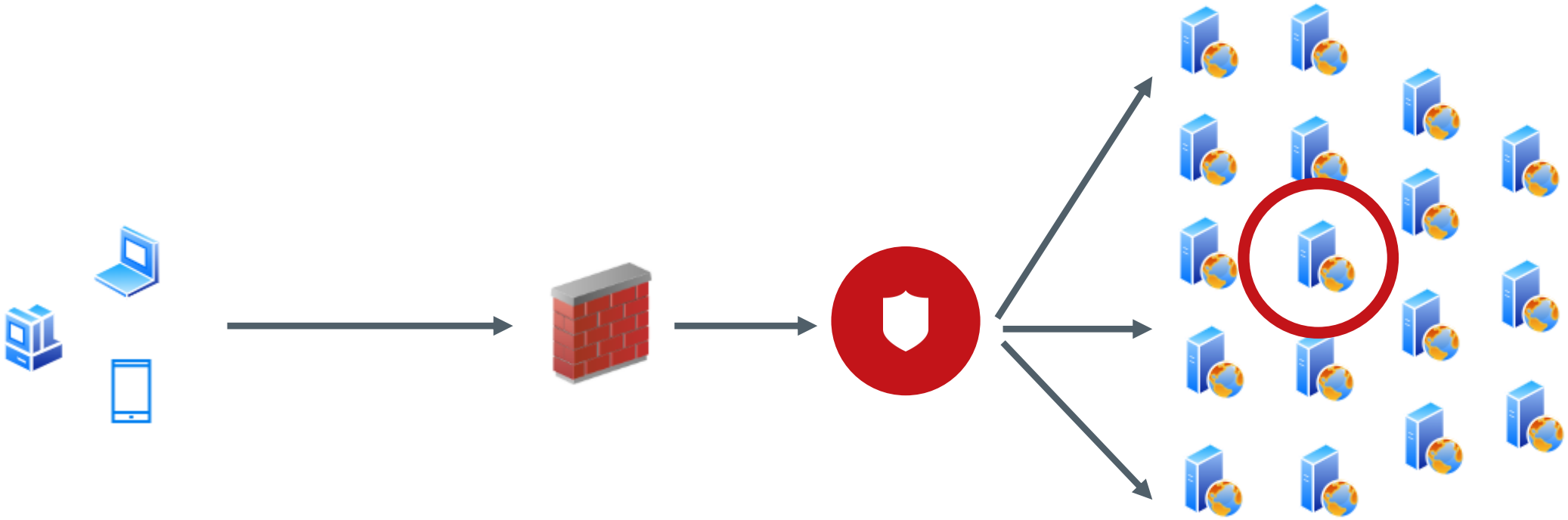
Firewall

Web Application Firewall
+
Reverse Proxy

Web Application Server

4. How can you adapt

Dos and Don’ts



Client (Browser, Apps)

Firewall

Web Application Firewall
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9 Dos and Don’ts

```
POST /webapp/start?action=login HTTP/1.1
Host: www.myapp.ch
User-Agent: Mozilla/1.42
Content-Type: application/x-www-form-urlencoded
…
Cookie: Secure_WAF_Cookie: kd4iib5d6d…
EvilHeader: <script>attack</script>

userid=alice&password=12345&evilparam=evilvalue
```

HTTP Request

```
POST /webapp/start?action=login HTTP/1.1
Host: srv99.localdomain
User-Agent: Mozilla/1.42
Content-Type: application/x-www-form-
urlencoded
…
Cookie: PHPSESSID=2k3kd8f7gkv7y

userid=alice&password=12345
```

HTTP Request

1 Follow standard HTTP specs (RFC)

Client

WAF

Webserver

HTTP Response

```
HTTP/1.1 200 OK
Date: Mon, 1 Jan 2020 06:30:32 GMT
Server: dummy
Content-Type: text/html;charsest=UTF-8
…


<html>
<head</head>
  <body>
    <a href=https://www.myapp.ch/link>click me</a>
  </body>
</html>
```

HTTP Response

```
HTTP/1.1 200 OK
Date: Mon, 1 Jan 2020 06:30:32 GMT
Server: Apache/2.0.55 (Debian) PHP/5.1.2-1
mod_ssl/2.0.55 OpenSSL/0.9.8b
Content-Type: text/html;charsest=UTF-8
…

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User-Agent: Mozilla/1.42
Content-Type: application/x-www-form-
urlencoded
…
Cookie: PHPSESSID=2k3kd8f7gkv7y

userid=alice&password=12345
```

HTTP Request

2

Don’t create links or cookies in the browser

Client

WAF

Webserver

HTTP Response

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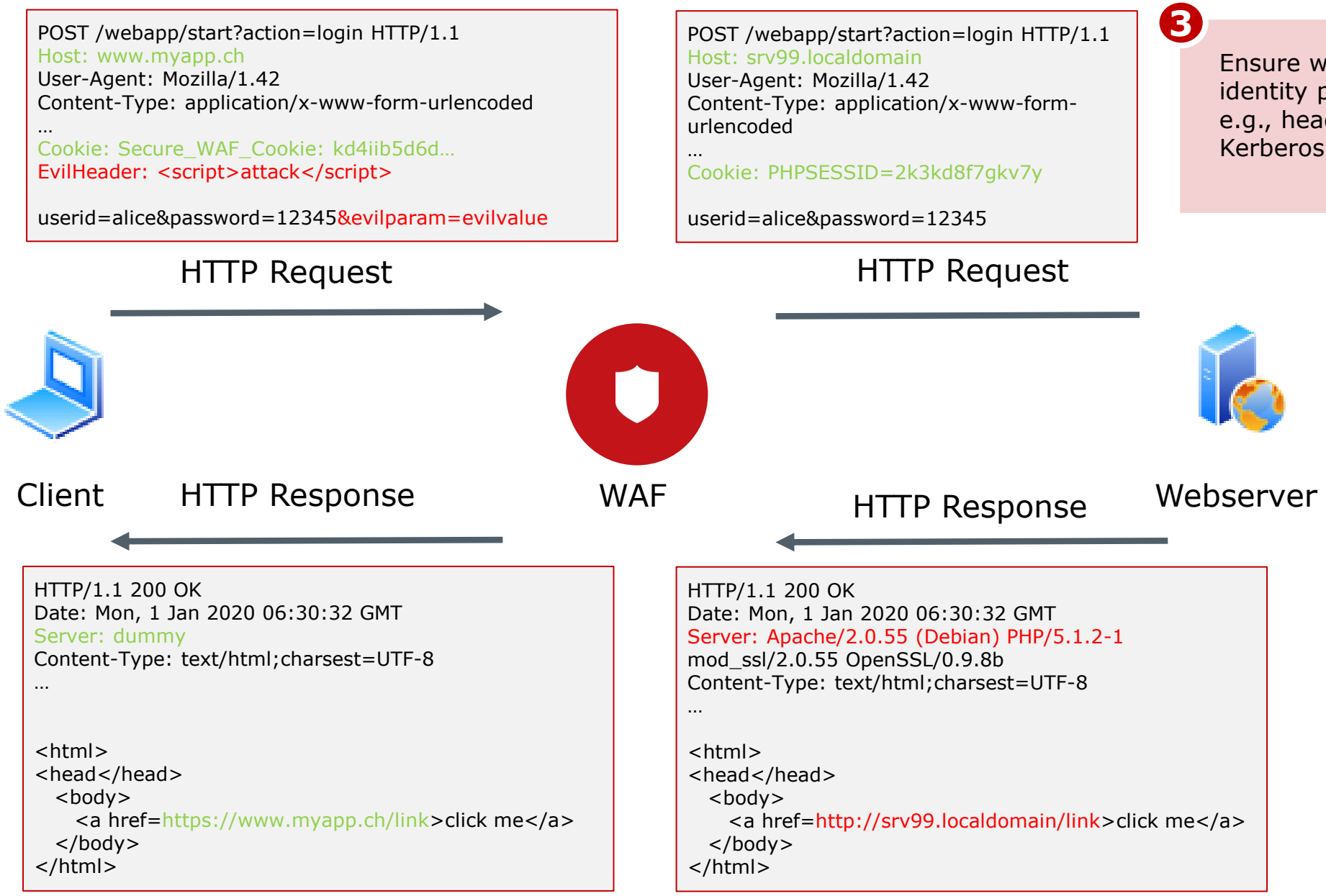

3

Ensure ways for identity propagation: e.g., header, NTLM, Kerberos

9 Dos and Don’ts

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HTTP Request

Client

HTTP Response

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Date: Mon, 1 Jan 2020 06:30:32 GMT
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WAF

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HTTP Request

Webserver

HTTP Response

HTTP/1.1 200 OK
Date: Mon, 1 Jan 2020 06:30:32 GMT
Server: Apache/2.0.55 (Debian) PHP/5.1.2-1
mod_ssl/2.0.55 OpenSSL/0.9.8b
Content-Type: text/html;charset=UTF-8
…

<html>
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4

Separate sensitive from public data

9 Dos and Don’ts

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userid=alice&password=12345
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HTTP Request

5 Use correct MIME type headers

Client

WAF

Webserver

HTTP Response

```
HTTP/1.1 200 OK
Date: Mon, 1 Jan 2020 06:30:32 GMT
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Content-Type: text/html;charsest=UTF-8
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Cookie: PHPSESSID=2k3kd8f7gkv7y

userid=alice&password=12345
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HTTP Request

6 Use relative paths

7 Don’t use <base href= …> tags

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Webserver

HTTP Response

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Server: dummy
Content-Type: text/html;charset=UTF-8
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…

<html>
<head</head>
  <body>
    <a href=http://srv99.localdomain/link>click
me</a>
  </body>
</html>
```

9 Dos and Don’ts

```
POST /webapp/start?action=login HTTP/1.1
Host: www.myapp.ch
User-Agent: Mozilla/1.42
Content-Type: application/x-www-form-urlencoded
…
Cookie: Secure_WAF_Cookie: kd4iib5d6d…
EvilHeader: <script>attack</script>

userid=alice&password=12345&evilparam=evilvalue
```

HTTP Request

Client

WAF

```
POST /webapp/start?action=login HTTP/1.1
Host: srv99.localdomain
User-Agent: Mozilla/1.42
Content-Type: application/x-www-form-
urlencoded
…
Cookie: PHPSESSID=2k3kd8f7gkv7y

userid=alice&password=12345
```

HTTP Request

Webserver

8 Return proper HTTP error codes

9 Trigger proper relogin for asynchronous requests

HTTP Response

```
HTTP/1.1 200 OK
Date: Mon, 1 Jan 2020 06:30:32 GMT
Server: dummy
Content-Type: text/html;charsest=UTF-8
…


<html>
<head</head>
  <body>
    <a href=https://www.myapp.ch/link>click me</a>
  </body>
</html>
```

HTTP Response

```
HTTP/1.1 200 OK
Date: Mon, 1 Jan 2020 06:30:32 GMT
Server: Apache/2.0.55 (Debian) PHP/5.1.2-1
mod_ssl/2.0.55 OpenSSL/0.9.8b
Content-Type: text/html;charsest=UTF-8
…

<html>
<head</head>
  <body>
    <a href=http://srv99.localdomain/link>click me</a>
  </body>
</html>
```

9 Dos and Don’ts

1. Follow standard HTTP specs (RFC)
2. Don’t create links or cookies in the browser
3. Ensure ways for identity propagation: e.g. header, NTLM, Kerberos
4. Separate sensitive from public data
5. Use current MIME type headers
6. Use relative paths
7. Don’t use <base href=…> tags
8. Return proper HTTP error codes
9. Trigger proper relogin for asynchronous requests

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