You've Been Hacked

An (Interactive) Course on Web Security

Paul Duplys

@duplys duplys linkedin.com/in/paulduplys/

0x0: Preliminaries

0x1: Web Security 101

0x2: Recon

0x3: Stateful Attacks

0x4: Attacks on Authentication

0x5: Cross-Site-Scripting (XSS)

0x6: SQL Injection

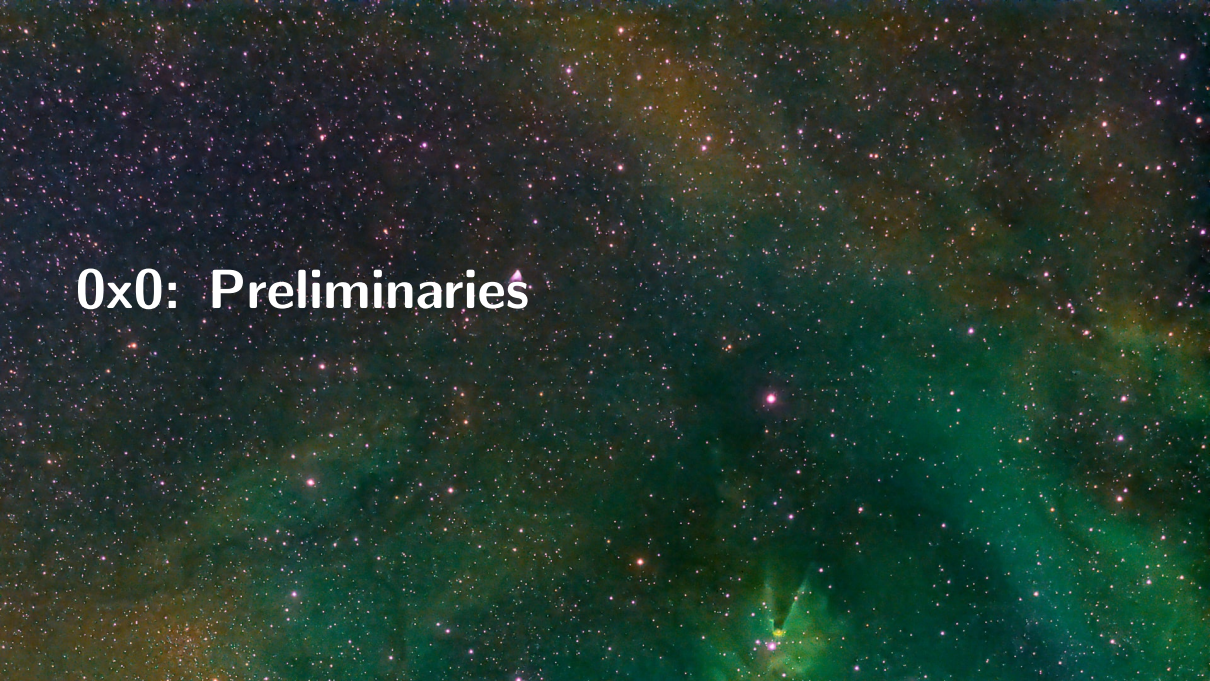
0x7: Other Injection-Based Vulnerabilities

0x8: Attacks on File Operations

0x9: Buffer Overflows, Format Strings and Integer Bugs

0xA: Architectural Attacks

0xB: Attacks on the Web Server


0x0: Preliminaries

whoami

short intro/bio.

man slides

(Interactive) course on web security based on Carsten Eiler's book "You've Been Hacked".
Who is the audience? How can I use the book? How can I explore the app?

`docker image ls`

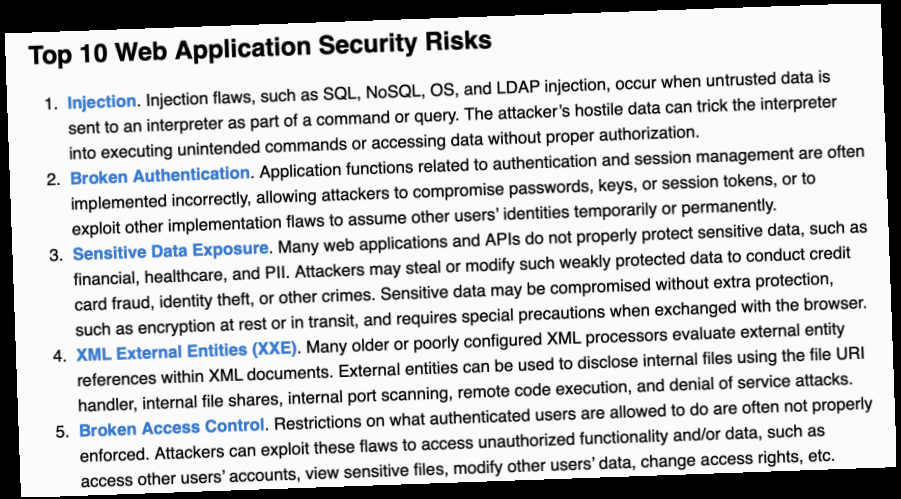
Where are the instruction located for how to build the Docker files and use the repository?

0x1: Web Security 101

In a nutshell, **to find vulnerabilities in your web application**, ...

1. ... test various values for parameters used by the web application and see what happens (conceptually similar to fuzzing)
2. ... check web application code for bugs that may lead to security vulnerabilities (typically missing checks of input values or missing countermeasures against certain types of attacks)

The Open Web Application Security Project (OWASP) maintains a list of Top 10 vulnerabilities in web applications.

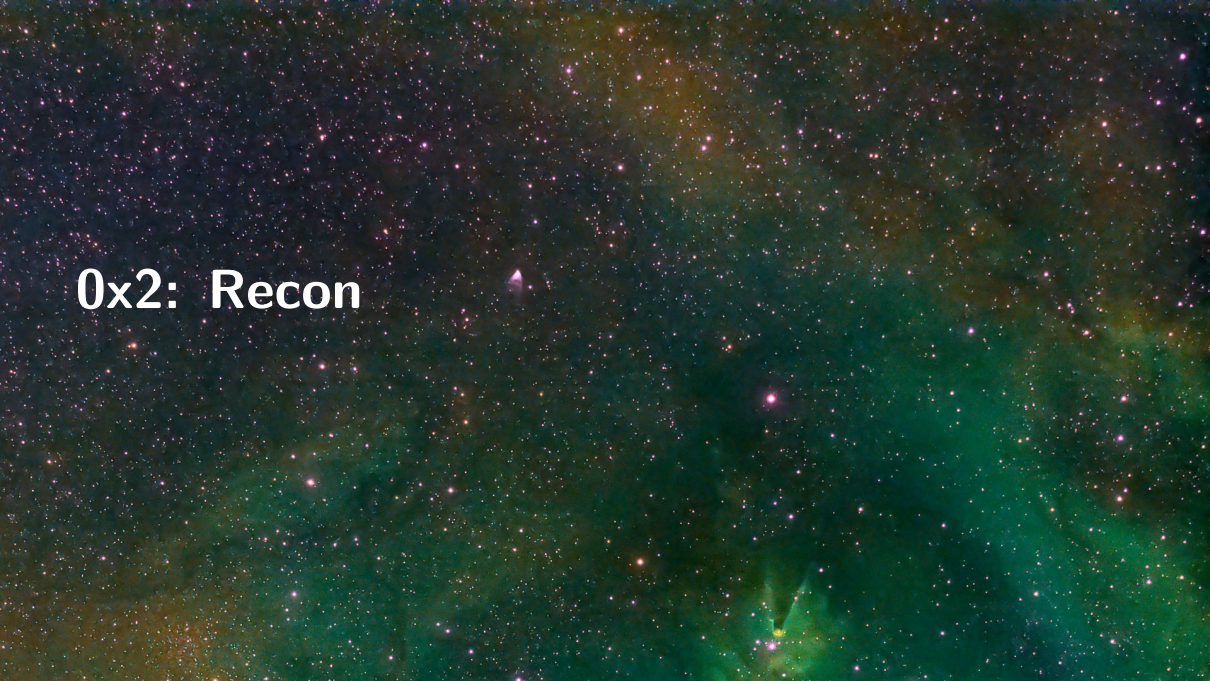


Top 10 Web Application Security Risks

1. **Injection**. Injection flaws, such as SQL, NoSQL, OS, and LDAP injection, occur when untrusted data is sent to an interpreter as part of a command or query. The attacker's hostile data can trick the interpreter into executing unintended commands or accessing data without proper authorization.
2. **Broken Authentication**. Application functions related to authentication and session management are often implemented incorrectly, allowing attackers to compromise passwords, keys, or session tokens, or to exploit other implementation flaws to assume other users' identities temporarily or permanently.
3. **Sensitive Data Exposure**. Many web applications and APIs do not properly protect sensitive data, such as financial, healthcare, and PII. Attackers may steal or modify such weakly protected data to conduct credit card fraud, identity theft, or other crimes. Sensitive data may be compromised without extra protection, such as encryption at rest or in transit, and requires special precautions when exchanged with the browser.
4. **XML External Entities (XXE)**. Many older or poorly configured XML processors evaluate external entity references within XML documents. External entities can be used to disclose internal files using the file URI handler, internal file shares, internal port scanning, remote code execution, and denial of service attacks.
5. **Broken Access Control**. Restrictions on what authenticated users are allowed to do are often not properly enforced. Attackers can exploit these flaws to access unauthorized functionality and/or data, such as access other users' accounts, view sensitive files, modify other users' data, change access rights, etc.

Fahrplan

- Get to know your target
- Test for stateful attacks
- Test for attacks on authentication
- Test for cross-site-scripting (XSS)
- Test for SQL injection
- Test for other injection-based vulnerabilities
- Test for attacks on file operations
- Test for buffer overflows, format strings and integer bugs
- Test for architectural attacks
- Test for attacks on the web server


0x2: Recon

reconnaissance: *n*. 1. Military observation of a region to locate an enemy or ascertain strategic features. 2. Preliminary surveying or research.

Why Reconnaissance?

Hint: consider the anatomy of a typical cybersecurity attack.

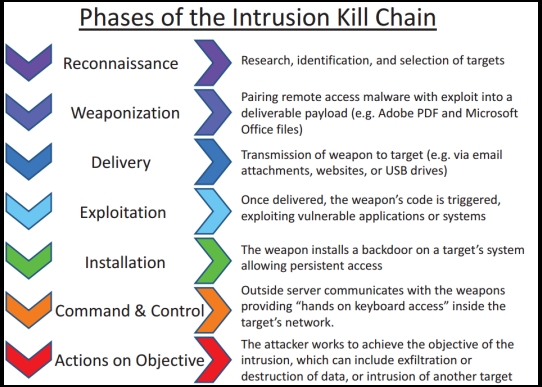
Kill Chain

The term kill chain was originally coined by the military to describe the structure of an attack: finding adversary targets suitable for engagement; fixing their location; tracking and observing; targeting with a suitable weapon or asset to create desired effects; engaging the adversary; assessing the effects;

In 2011, Hutchins et al [1] from Lockheed-Martin expanded this concept to an **intrusion kill chain** for (network) security. They defined intrusion kill chain as reconnaissance, weaponization, delivery, exploitation, installation, command and control (C2), and actions on objectives.

Later on, security organizations have adopted this concept under the name "cyber kill chain".

Intrusion Kill Chain



Source: Wikimedia Commons.

Mimicking the Attacker

Every attack starts by collecting information about the target, e.g., a web application ($\rightarrow$ cyber kill chain).

Likewise, to test a web application for security vulnerabilities, you must first get to know it. You must understand what functions it uses and what parameters these functions have. You have to test every parameter whether it can be exploited (e.g., using illegitimate values). You need to check whether the web application code contains known vulnerabilities.

Systematic collection and documentation allows you to understand what a real attacker would learn and where she could break your application's security.

Collecting Rudimentary Information

Document any **easy-to-spot hints** to security vulnerabilities:

- Suspicious comments in the HTML code (`<!-- default password:...`)
- Sensitive information embedded in the HTML code
- Error messages from the web application
- Error messages from the webserver and http responses

Learning the Web Application Structure

Catalogue **all pages, resources and parameters** that belong to or are used by the web application:

- using a general-purpose tool like `wget`
- using a special-purpose tool like the OWASP Zed Attack Proxy (ZAP) crawler
- by manually visiting all web pages of the application (works well for small web applications)

While `GET` parameters are displayed in the URL, you'll need a web proxy like OWASP ZAP to access `POST` parameters and cookies.

If your web application has different roles (guest, admin, ...), you'll have to test it for all these roles (i.e., first as a guest, then logged in as admin, etc.)

Investigating Individual Web Pages

Visit all pages and **inspect their source code**. Look for things like:

- **Leaky HTML comments** (comments containing e.g., code fragements, configuration parameters, server names, SQL table descriptions, etc.)
- **Hidden input fields** (`<input type='hidden' ...>`)
- **SQL queries** printed in the page source due to programming or configuration errors (reveal the structure of the database and the queries used)
- **IP addresses of internal servers**
- **Web or email addresses**, e.g., email addresses of the developers (might reveal who wrote the application. Maybe it's just an optical tweak of a well-known application?)

Investigating Parameters

Investigate **all parameters** passed to the application:

- What happens when you change their values or use invalid values, e.g., a string instead of an integer?
- Do invalid parameters return error message that leak information about the application like database table names?

Collecting More Information

- Are there unlinked resources likes directories or files?
- E.g., if there are links to files financial-report18.pdf and financial-report19.pdf, is there an unpublished file financial-report20.pdf?
- Are there any hints to the structure of file names or subdirectories?
- E.g., if the web application contains user profiles, is it possible to access an arbitrary profile using `user-[number].html` or `user.php?id=[number]`?
- Are there unlinked subdirectories like `test/` or `admin/`?
- Does the webserver contain unused libraries or example application code that contains hints to known vulnerabilities or the internals of the web application?
- What else is running on the server? SSH?

Investigating Client-Side Code

What input parameters are sanitized in the client-side code (JavaScript or plain HTML)?

Investigating Client-Side Code: Static Pages

If user input is checked, i.e., sanitized, at client side (either in JavaScript or in HTML), chances are that no sanitization is implemented on the server.
Because an attacker can easily manipulate the client-side code, she can manipulate the user inputs sent to the server.

Investigating Client-Side Code: Static Pages

Check **all input fields** like text input, drop-down menus, radio buttons and select tags for **constraints for their values**. E.g., is there a maximum text length for a text field? Are numeric input values scoped? If yes, change these values and check how the web application is behaving.

Investigating Client-Side Code: Static Pages

There are 3 ways to change the client-side values:

- Parameters transmitted via `GET` requests can be manipulated directly in the URL
- Parameters transmitted via `POST` requests can be manipulated directly in a local copy of the website code
- On the fly, using a proxy like the OWASP ZAP or web developer tools in the web browser

Investigating Client-Side Code: Static Pages

Hidden forms (`type="hidden"`) are sometimes used to store values used by the web application. A classic mistake is to store the price of the items in a webshop application (since you can easily manipulate them before sending them to the server).

A Trivial Example

Say there is a drop-down menu to select the number of items to be added to a shopping cart. The drop-down menu allows numbers in the range 0 to 100. What happens when you set this parameter to a negative value and transmit it to the server? Maybe there is no sanitization on the server side because only values greater or equal to zero can be selected from the drop-down menu? In this case, the final price is calculated by multiplying the price of the item with a negative number.

Collecting JavaScript-related Information

Sample frame title

In this slide, some important text will be highlighted because it's important. Please, don't abuse it.

Remark
Sample text

Important theorem

Sample text in red box

Examples

Sample text in green box. The title of the block is "Examples".

Tools

- ZAProxy
- ...

Example

- one

Example

- one
- two

Example

- one
- two
- theorem

Example 1

One

Example 1

One Two

Example 1

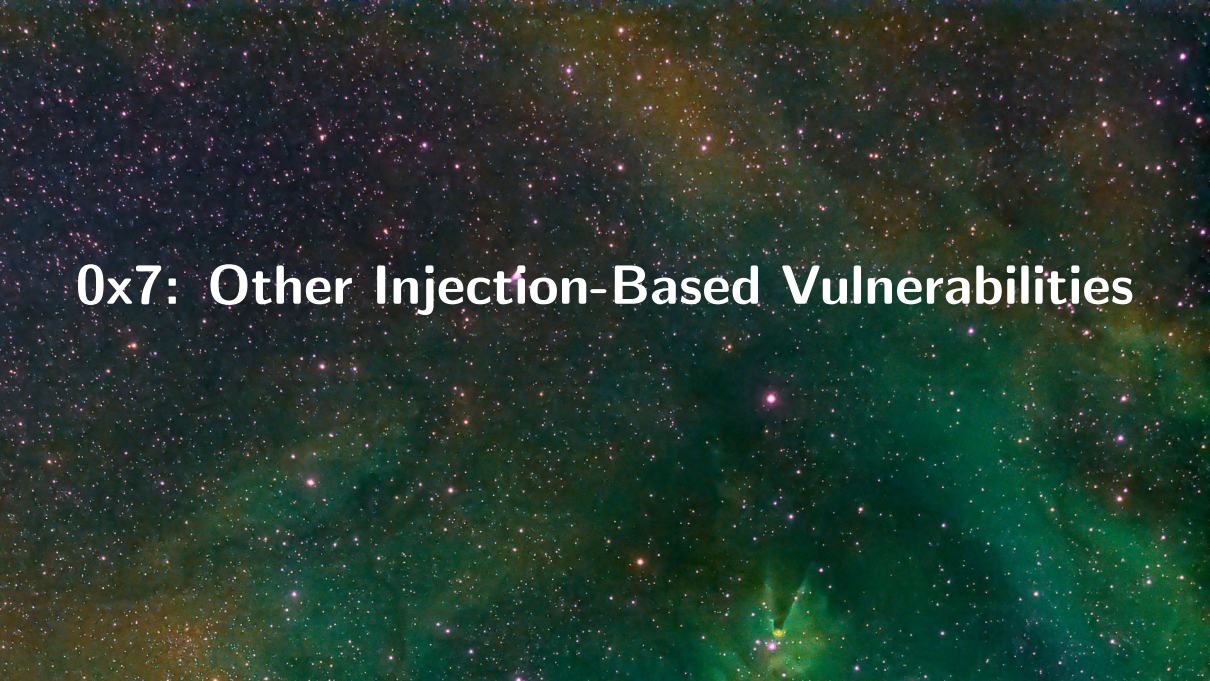
One Two Three


0x3: Stateful Attacks

0x4: Attacks on Authentication

0x5: Cross-Site-Scripting (XSS)

0x6: SQL Injection


0x7: Other Injection-Based Vulnerabilities

0x8: Attacks on File Operations

0x9: Buffer Overflows, Format Strings and Integer Bugs

0xA: Architectural Attacks

0xB: Attacks on the Web Server


0xC: Misc

More Things to Consider

One

More Things to Consider

One Two

More Things to Consider

One Two Three

Bibliography


Eric M Hutchins, Michael J Cloppert, Rohan M Amin, et al.
Intelligence-Driven Computer Network Defense Informed by Analysis of Adversary Campaigns and Intrusion Kill Chains.
Leading Issues in Information Warfare & Security Research, 1(1):80, 2011.