Improving Web Vulnerability Scanning

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Introduction

Hey!

- Hi there!
- I’m Dan. This is my first year at DEFCON.
- I do programming and security start-ups.
- I do some penetration testing as well

More Introduction

- Today I'm going to talk about vulnerability scanning
- Primary on the web
- "The cloud" is involved as well
- Network security too
- I'll show some things, so there is plenty of demo time
- Have fun, thanks for being here!

Some Facts

- There are a lot of web vulnerability scanners, fuzzers and penetration testing tools out there already
- Some of them work, some of them do not
- But basically all of them have one thing in common:
  They actually don't attack web applications on the application layer
- They mostly fuzz HTTP and sometimes perform injection attacks

Some more facts

- The fundamental design of web scanners has not changed in over a decade
- But: The web has changed.
- So there seems to be a problem.

Software Architecture

What web vulnerability scanners and fuzzers look like

A pentesters point of view

- Javascript/Ajax rich applications are still not supported
- Authenticated scanning is still incredibly challenging / not reliable
- Exploitation techniques are mostly poor
- “I don’t know which scanner will work for foo.com and which one for bar.com, so I use toolchains”

A developers point of view

- Javascript/Ajax rich applications are still not supported
- Authenticated scanning is still incredibly challenging / not reliable
- Exploitation techniques are mostly poor
- “I don’t know which scanner will work for foo.com and which one for bar.com, so I use toolchains”

- HTTP Libraries don’t support JS - Scanners are based on an HTTP Libraries
- Web Logins are not standarized - So how should they be detected
- No time for exploits
  (Already spent 100000 lines [and nights] of code making the crawler immune to encoding issues, malformed HTML, redirects and binary content!)
- A false positive is better than a false negative

How I see it

- Both of them are right.
- The web is a mess. Nobody cares about RFCs anymore. (Especially these SEO guys!)
- 10 years ago, you would have expected a Query String at the end of a URL like https://foo.com/xxx/yyy?foo=bar
- Nowadays, https://foo.com/something.ext/foo/bar is good practice
- The result: It's incredibly hard for scanner developers to figure out the dynamic components of an HTTP request. Because of that, we feel overhelmed and fuzz nearly everything.
- Header Keys, Header Values, VHost, Cookie, Method, Path, Version, ...

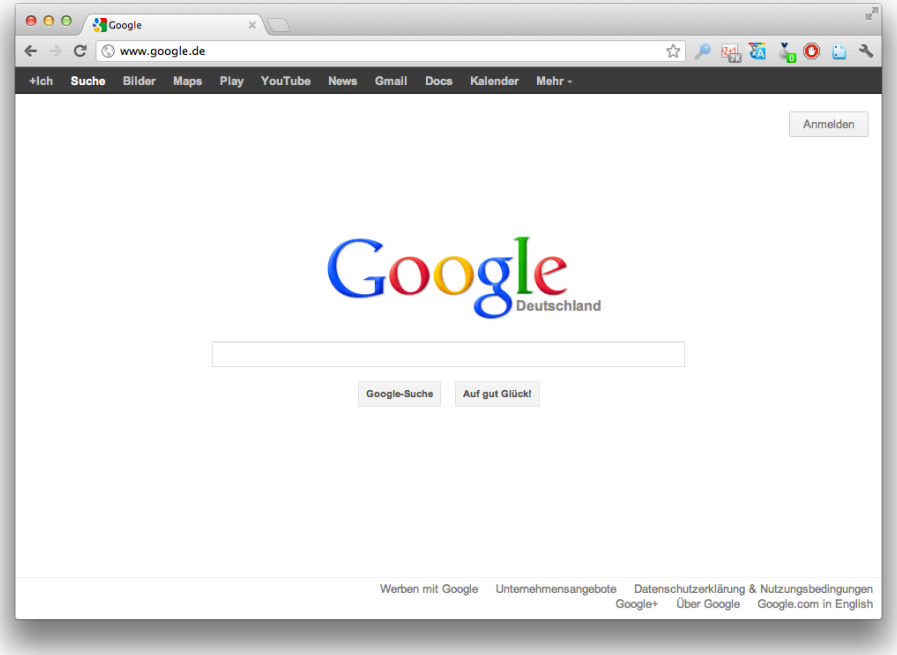
How I see it

- Fuzzing HTTP is incredibly important. You never know if you are talking to an apache2, nginx or some hidden application server upstream
- But it has nothing to-do with web vulnerability scanning
- So - developers are struggling with websites because they use HTTP to crawl and attack them. Things like flash, images, javascript seems to be an unsolveable problem
- Redirects are hard to handle sometimes (wait there is more)
- Javascript redirects (after 10 seconds!) and of course: onmouseover, onclick, onfocus, ...
- Flash isn't helpful either

Web 2.0

- But - WE DO SECURITY
- Is it really *our* job to make sure that our software executed all the JS and grabbed all the links?
- When we spend 100 hours on the crawler, and 5 hours on the actual payloads (that's how it looks right now) something, somewhere, went terribly wrong
- So - Is there a (open source?) piece of software that we could use instead of the HTTP library? Something that has prooven its mastery in handling unpredictably broken web content already? There is.

Webkit!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Auf gut Glück!
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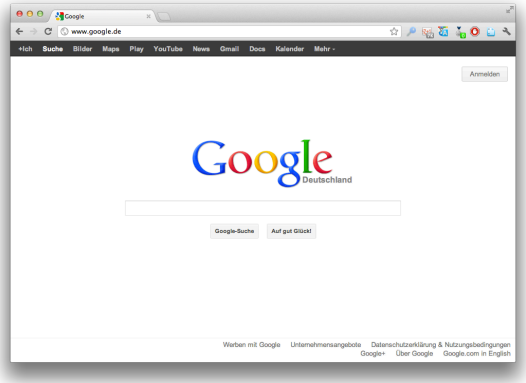
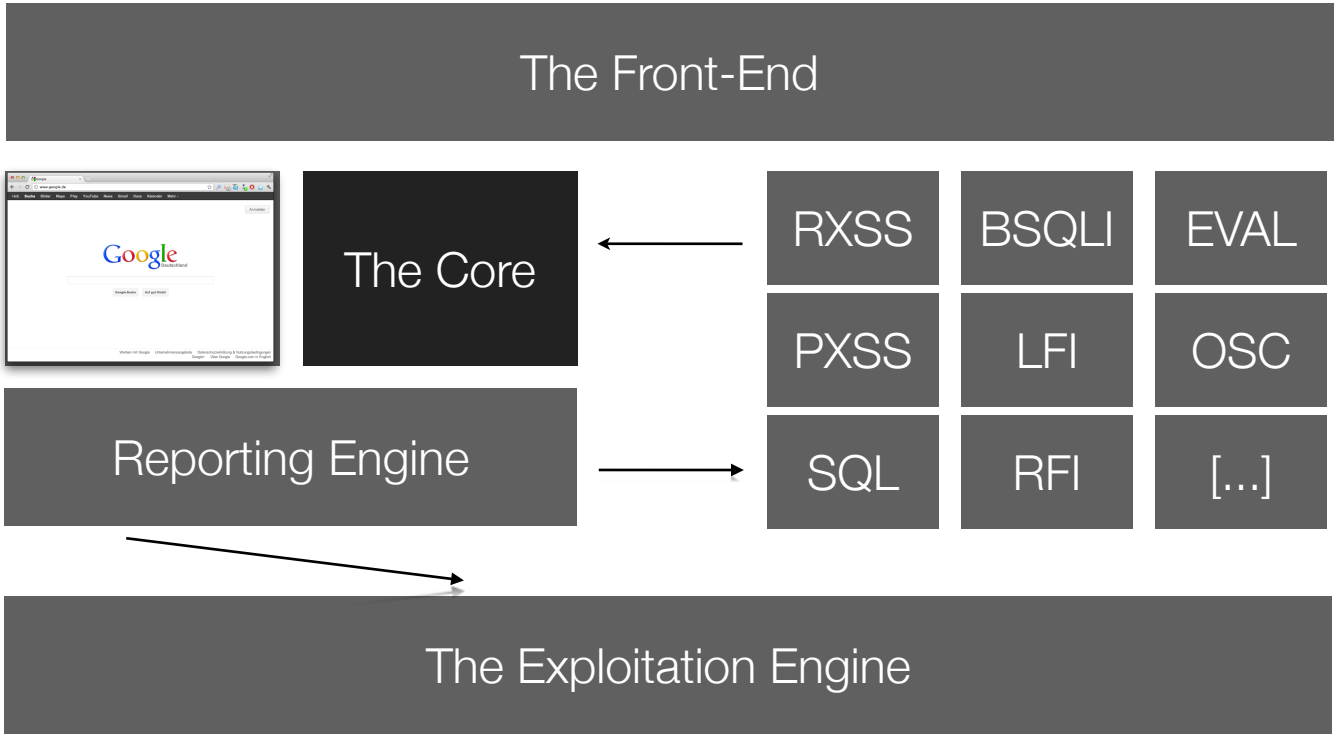
Webkit knows

- Javascript
- Javascript events
- Redirects
- Flash
- Images
- Websockets
- WebGL
- CSS Rendering
- Binary Downloads
- Broken HTML
- Broken CSS
- Performance
- Forking / Multiprocessing
- [...]



Software Architecture

What it should look like



Changes? Improvments?

- Replacing the HTTP library by a Webkit Engine
- Less code (A **lot** less code)
- 100% support for JS/Ajax/Broken HTML/JS Events/Crazy Redirects and all kinds of things
- The ability to simulate human user behaviour
- CSS Renderings (Two text fields beside each other: 10px - one of them is a input[type=password]) - May be a login!

Making it scale (heavily)

- Webkit is **slow** (Website rendering, Executing JS, ... - compared to - Speaking Plaintext HTTP)
- Downloading Images is slow
- Waiting for delayed JS events is slow
- Flash is even slower

Making it scale (heavily)

Bad news: Qt / PyQt / PySide

- QtWebkit does not support multithreading
- It tends to SEGFAULT from time to time :(
- Multiple QApplication instances are almost impossible to handle in one Python namespace

Making it scale (heavily)

Good news: Building a preforking TCP Server

- Spawning a pool of processes works quite well (one QApplication +one Browser instance per Process)
- Simultaneous downloads
- Better accessibility inside the scanner (multiprocessing insides loops to increase performance)

Missing pieces

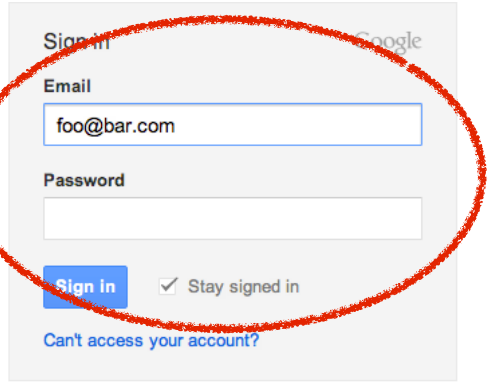
- Mastering Authentication
- Exploitation & Privilege Escalation
- Geographically distributed scanning: Using the cloud
- Reporting

Mastering Authentication

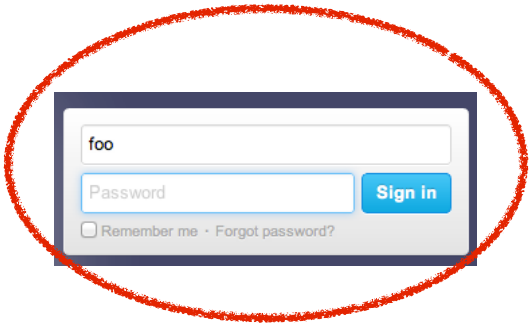
- There is no such thing as a standarized web login
- Basically, everybody develops access control on the web slightly differently
- You can try to detect them by the name/id of the attributes, but that is not reliable
- But in the end, Web logins generally have a few things in common that makes them easily detectable. At least, for our browser engine

Mastering Authentication

Not more than 2 visible (!) text fields

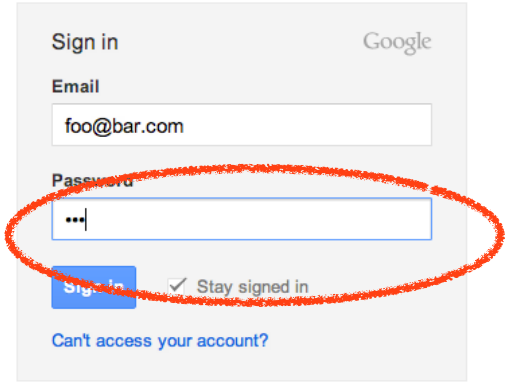


has_login_texts()

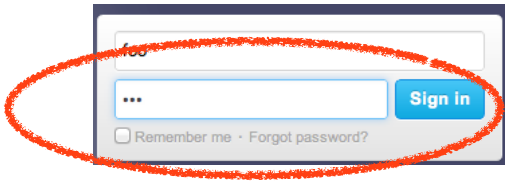


Mastering Authentication

Man-Behind-You Protection



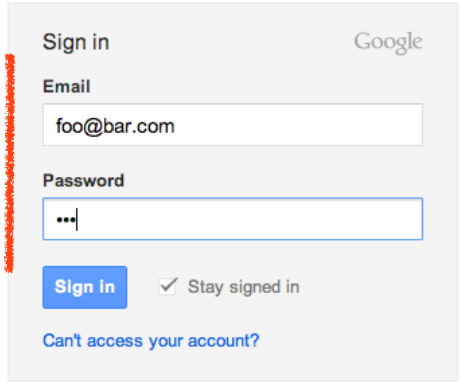
is_input_hidden()



Mastering Authentication

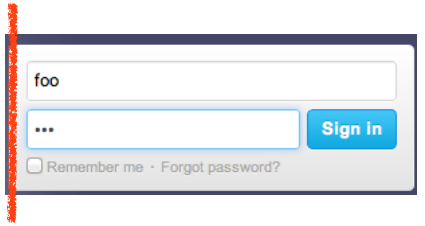
Geometry! Usually, the two visible text fields are under(), next_to() or at least near(radius=10px) each other

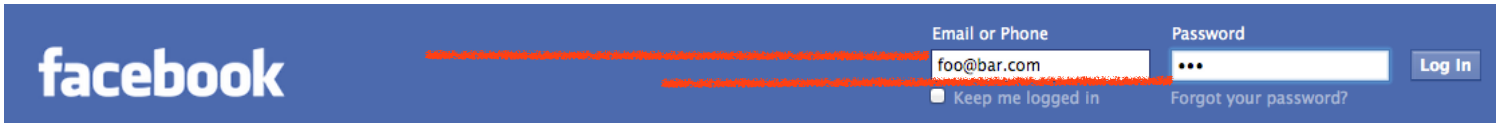
X1 = X2



!

X1 = X2





Y1 = Y2

Mastering Authentication

- That was easy!
- The common way to solve that problem, is to iterate through a wordlist (login, auth, signin, [...]) while checking the input[id], input[name] attributes
- That's not necessarily wrong or bad practice
- After putting the pieces together:
- .login("username", "password")

Mastering Authentication
Demo Time

- Proof Of Concept 1: Twitter (Some Javascript)
- Proof Of Concept 2: Facebook (More Javascript)
- Proof Of Concept 3: Google Plus (Most Javascript + Browser Hacks)

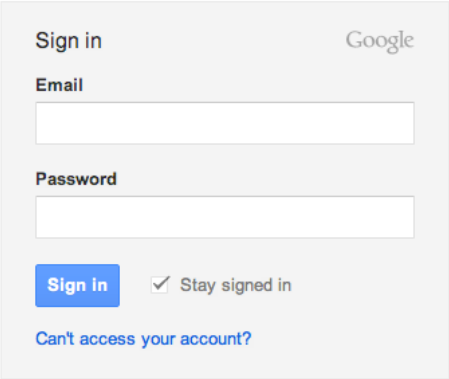
Mastering Authentication

When we are signed in

- New problems occur: How can we let the scanner check if we are indeed signed in?
- Common practive: Looking for a /logout/i String
- The problem: Inefficient. Likely to cause false positives
- There has to be a better way:
- Introduction “Strategies”

Strategy.Authentication
Step 1: Identification

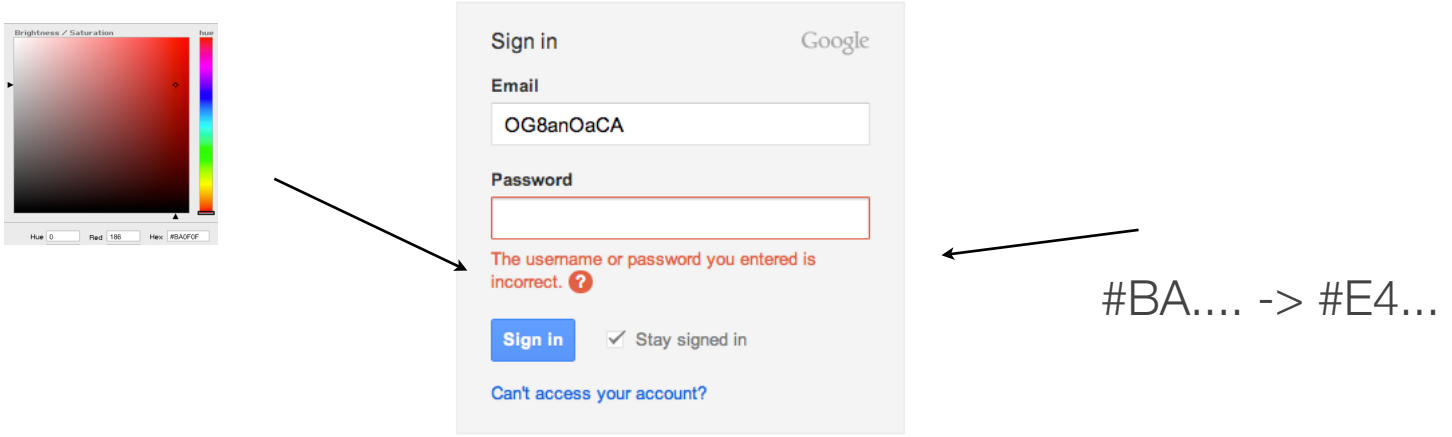
- Identifying a login form (3-way approach, input[type=password], geometry, [...])



Strategy.Authentication

Step 2: Error messages (Why a browser engines rocks)

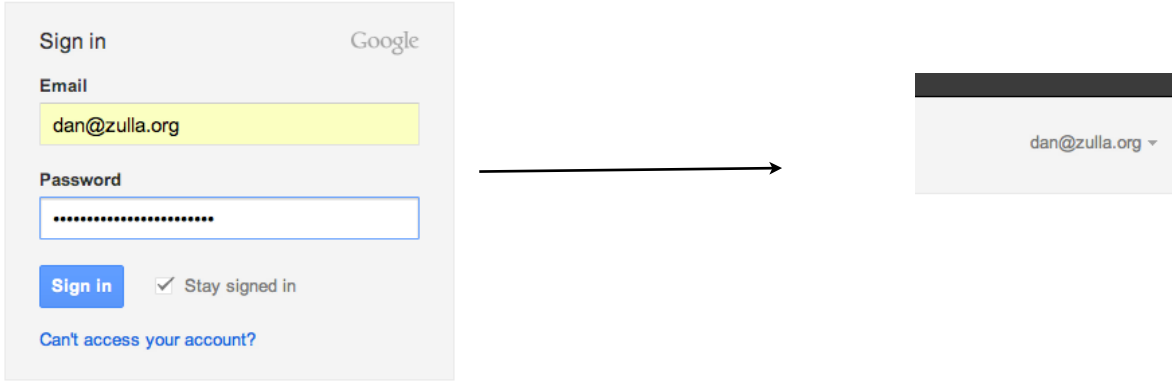
- Verifying **wrong** credentials - Random strings - Failed login



Strategy.Authentication

Step 3: Going in: .login(“..”, “..”)

- Verifying **valid** credentials - Behaviour should not be similiar to the behaviour of a **invalid** login



Strategy.Authentication

Step 4: Going out. .logout()

- Doing similiar work again for .logout() function seems obsolote
- But it really isn't.
- It is the basis to a .is_still_loggedin() function
- Which is really important to **stay** logged in during crawling
- And if the scanner logged itself out, it can simply .login() again
- That's cool. :-)

Exploitation and Privilege Escalation

- There is a whole universe besides injection vulnerabilities
- Usually, scanners don't detect them
- But they should
- And now they can: .login("user1", "..."); .logout(); .login("user2", "...")
- => Demo Time: Privilege Escalation, Multi-User Systems

Geographically distributed scanning: Using the cloud

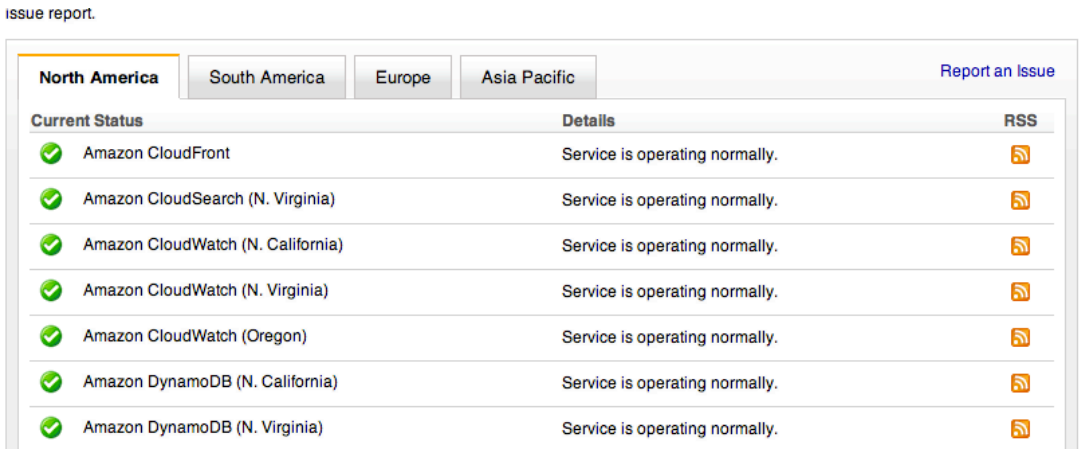
- When (injection) vulnerabilities are getting complicated:
- Scenario 1: The backend of a website creates a log entry for every new IP address. It logs the USERAGENT. The log entries are kept in a SQL database. The function that creates the log entries, is vulnerable. The User-Agent is injectable. The problem is:
- It only works once. As soon as the IP is in the database, the function won't be executed anymore :-(
- ==> SQLMap (and every other tool) will fail.

Geographically distributed scanning: Using the cloud

- But they shouldn't!
- The limitation is totally detectable
- And a new IP is just as far away as a single EC2 API call

Geographically distributed scanning: Using the cloud

- Indeed! The cloud is a good thing for security :)
- Demo Time: Introducing:
  sqlmap and w3af (on steroids)



Combining “Strategies” and the distributed scanning

- Introducing next generation vulnerability scanning
- Exploiting a really amazingly hard SQL Injection
- Demo Time

Further Research & Additional Ideas

- Country specific restrictions can be by-passed in a fully automatic manner
- (Error) messages can be parsed and interpreted: Wolfram Alpha
- Bloomfilters should be integrated
- Other “Strategies” should be implemented (the limitations are gone)

More Live Demos

- Demonstrating a logical layer beyond Authentication:
  .pay(“0000111122223333”, CVV=121, type=VISA)
  .search(“search query”)
  .sort(“DESC UNION SELECT [...]”)
- Interpreting error messages
- Pivoting on penetrated hosts - Spawning another scanner instance
- And finally: Reporting!

Thanks!