CSE 484 / CSE M 584: Computer Security and Privacy

Web security: Lab 2 and Context

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Looking Forward

- Today: Introduction to Lab 2 + related concepts
- Wednesday & Monday: More web security
  - **No class or office hours on Friday!**

- Lab #2 out; due **11/20**
- Final Project Deadline #1 due **Friday**

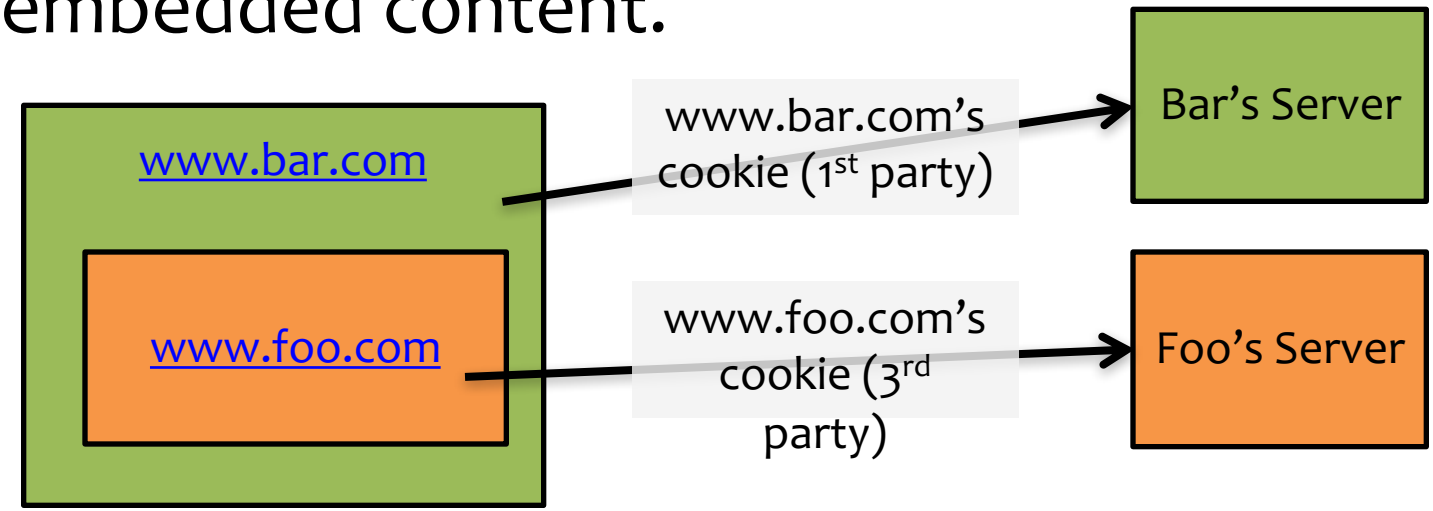
- Section this week: More lab 2 and clickjacking

Same-Origin Policy (Cookies)

- **For cookies:** Only code from same origin can read/write cookies associated with an origin.
  - Can be set via Javascript (`document.cookie=…`) or via `Set-Cookie` header in HTTP response.
  - Can narrow to subdomain/path (e.g., http://example.com can set cookie scoped to http://account.example.com/login.)
  - Secure cookie: send only via HTTPS.
  - HttpOnly cookie: can't access using JavaScript.

Same-Origin Policy (Cookies)

- Browsers automatically include cookies with HTTP requests.
- **First-party cookie:** belongs to top-level domain.
- **Third-party cookie:** belongs to domain of embedded content.



XSS: Cross-Site Scripting

- **Idea:** Place user-provided data in the page.
  - Makes page more interactive and personal.
- **Threat:** Improperly used data can be interpreted as code.
- **Solutions?**
  - Sanitize/validate input. (e.g., `htmlspecialchars()`)
  - Browser detection/prevention.

Server Side Scripts Review

- Before a webpage is sent to you, code is executed by the server
- Can be use to set and read cookies for authentication
- You will need a basic script to receive captured cookies
- We will use PHP

Lab 2

Overview

- Pikachu, Meowth, and Cookies
  - XSS; **Today**
- Jailbreak
  - SQL Injection; **Today** if time
- Hack your 4.0!
  - XSRF; **Wednesday** or **Monday**

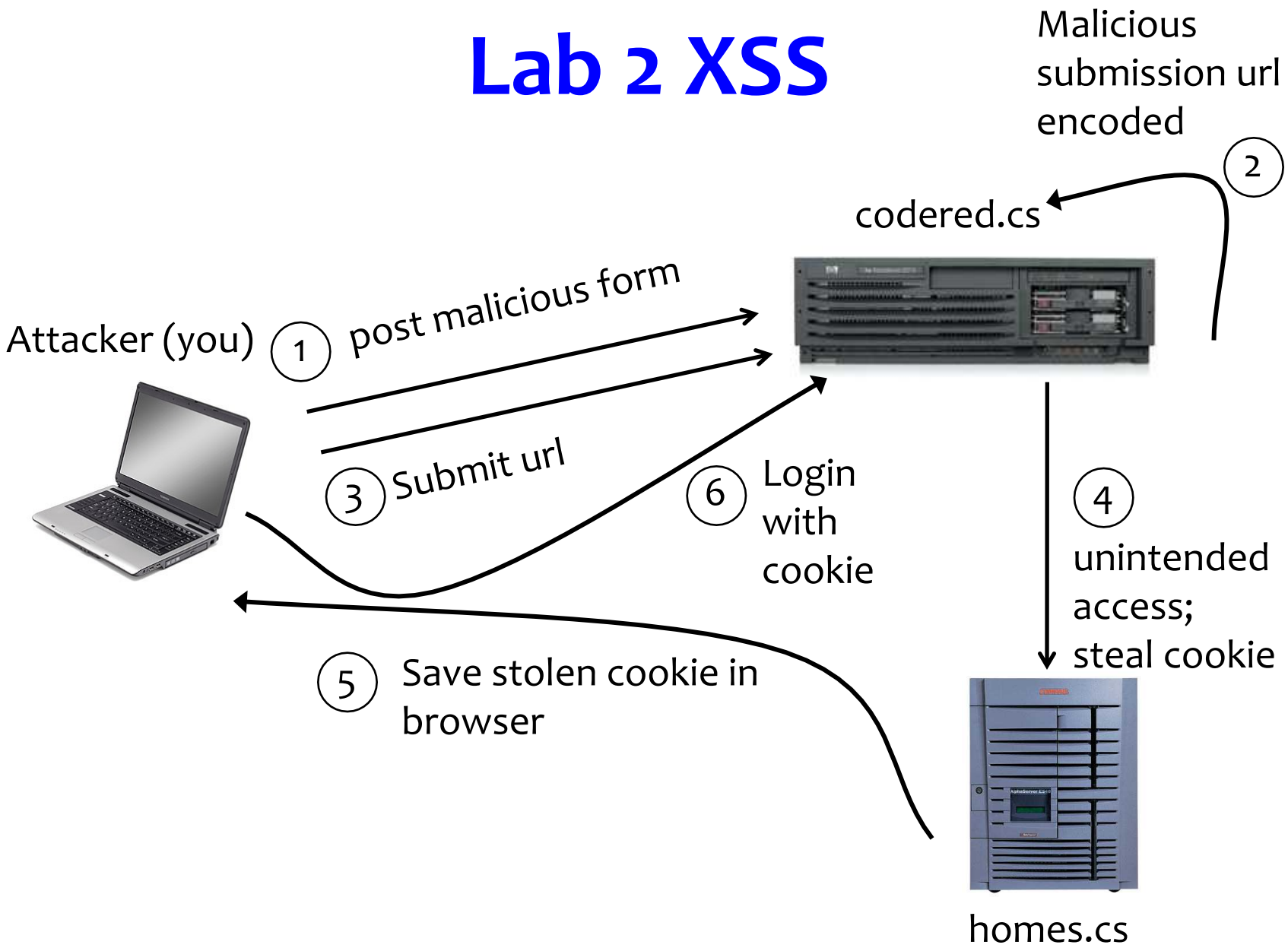
Lab 2 XSS

- Give the TAs (codered.cs) a link with a XSS vulnerability.
- TAs will ‘visit’ this link, and their cookie will be stolen.
- The process of stealing cookie involves sending it to a place you control.
- You’ll save the cookie, read it, and use it to log in

Tools

- Web browser (Firefox or Chrome)
- Cookie editing capability
- A php script on homes.cs to capture cookies
  - (see lab details)

Lab 2 XSS


Malicious submission url encoded
2
codered.cs
Attacker (you)
1
post malicious form
3
Submit url
6
Login with cookie
4
unintended access; steal cookie
5
Save stolen cookie in browser
homes.cs

Demo

Preventing Cross-Site Scripting

- Any user input and client-side data <u>must</u> be preprocessed before it is used inside HTML
- Remove / encode HTML special characters
  - Use a good escaping library
    - OWASP ESAPI (Enterprise Security API)
    - Microsoft's AntiXSS
  - In PHP, htmlspecialchars(string) will replace all special characters with their HTML codes
    - ' becomes ' " becomes " & becomes &
  - In ASP.NET, Server.HtmlEncode(string)

Evading XSS Filters

- Preventing injection of scripts into HTML is hard!
  - Blocking “<” and “>” is not enough
  - Event handlers, stylesheets, encoded inputs (%3C), etc.
  - phpBB allowed simple HTML tags like <b>

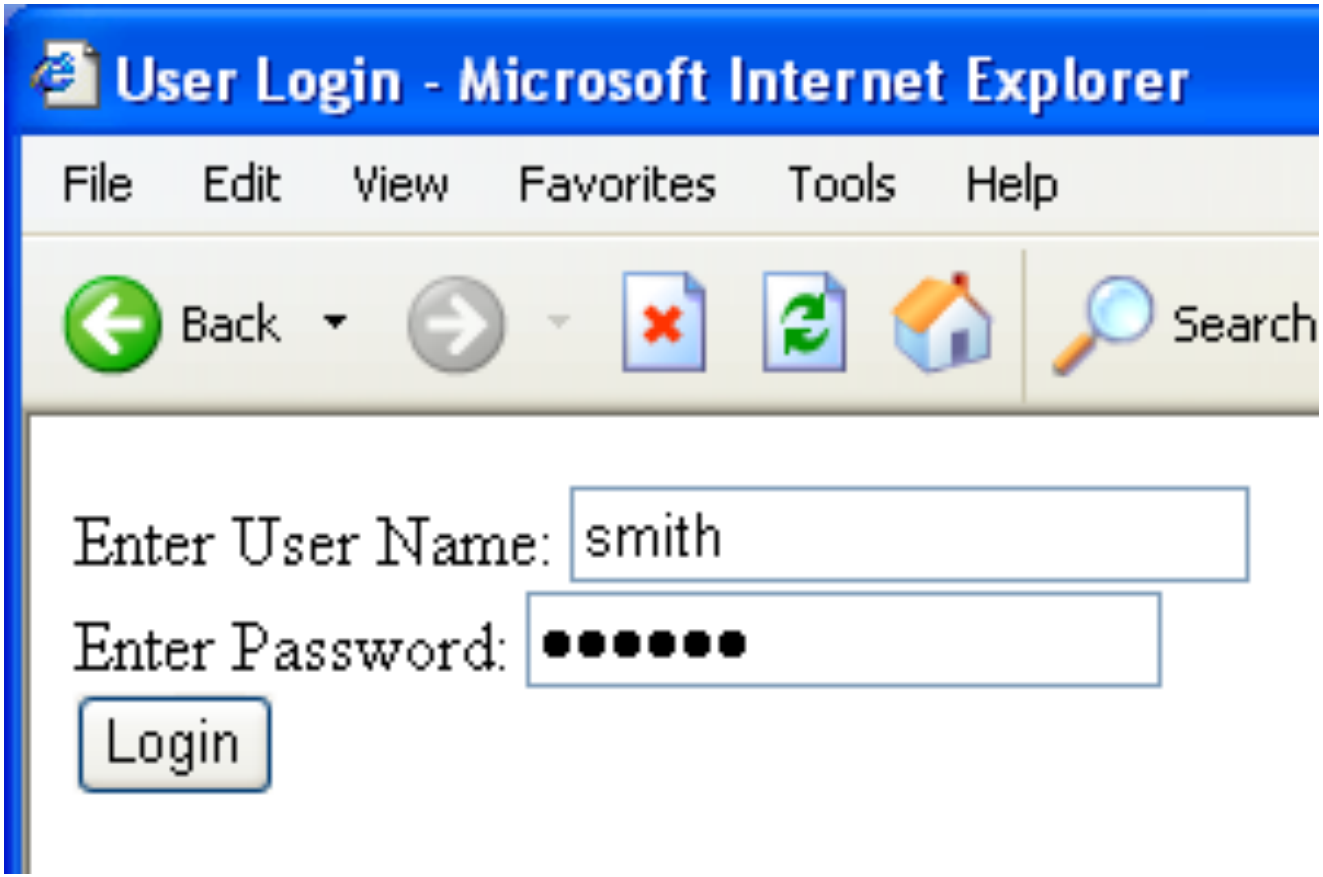
```
<b c=“>” onmouseover=“script” x=“<b ”>Hello<b>
```

- Beware of filter evasion tricks (XSS Cheat Sheet)
  - If filter allows quoting (of <script>, etc.), beware of malformed quoting: `<IMG """><SCRIPT>alert("XSS")</SCRIPT>">`
  - Long UTF-8 encoding
  - Scripts are not only in <script>:

```
<iframe src=‘https://bank.com/login’ onload=‘steal()’>
```

SQL Injection

Typical Login Prompt

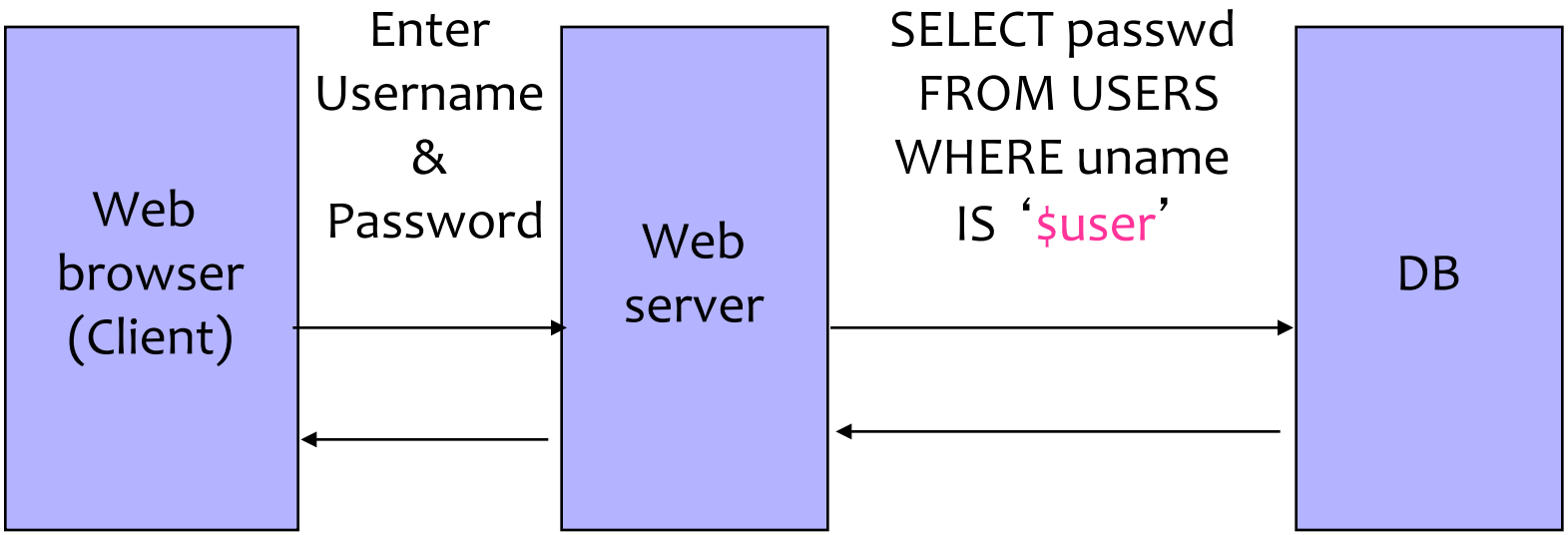


Typical Query Generation Code

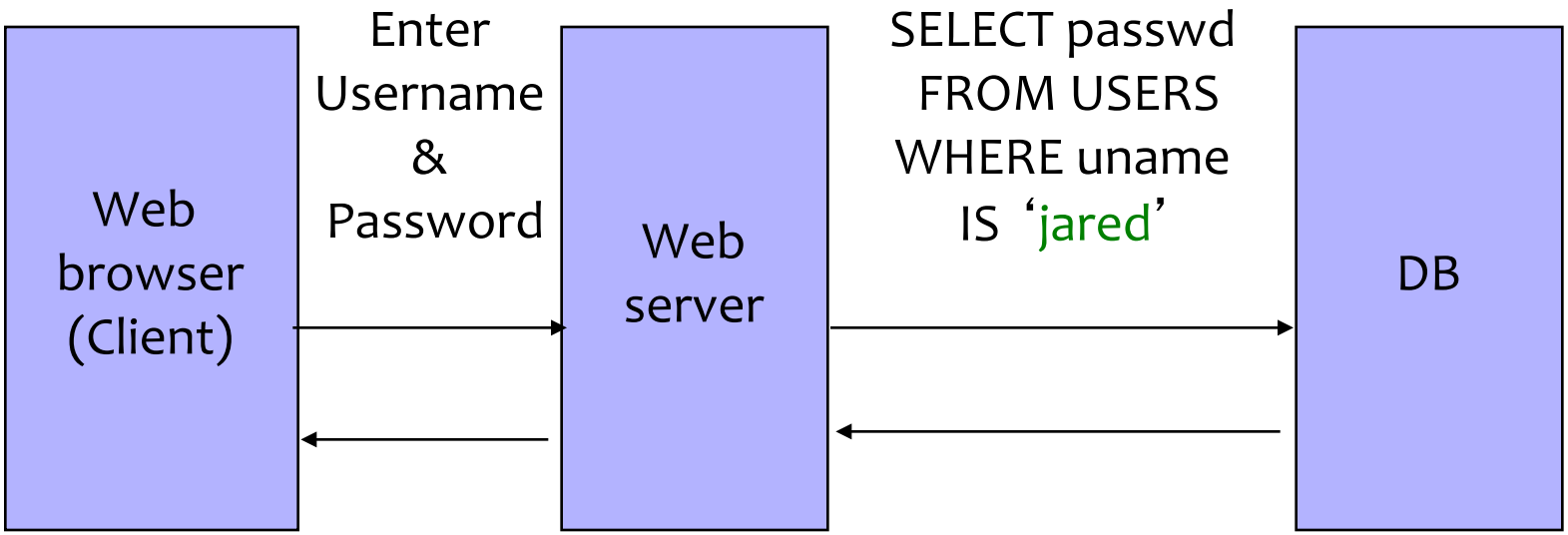
```
$selecteduser = $_GET['user'];
$sql = "SELECT Username, Key FROM Key " .
        "WHERE Username='$selecteduser'";
$rs = $db->executeQuery($sql);
```

What if **'user'** is a malicious string that changes the meaning of the query?

User Input Becomes Part of Query

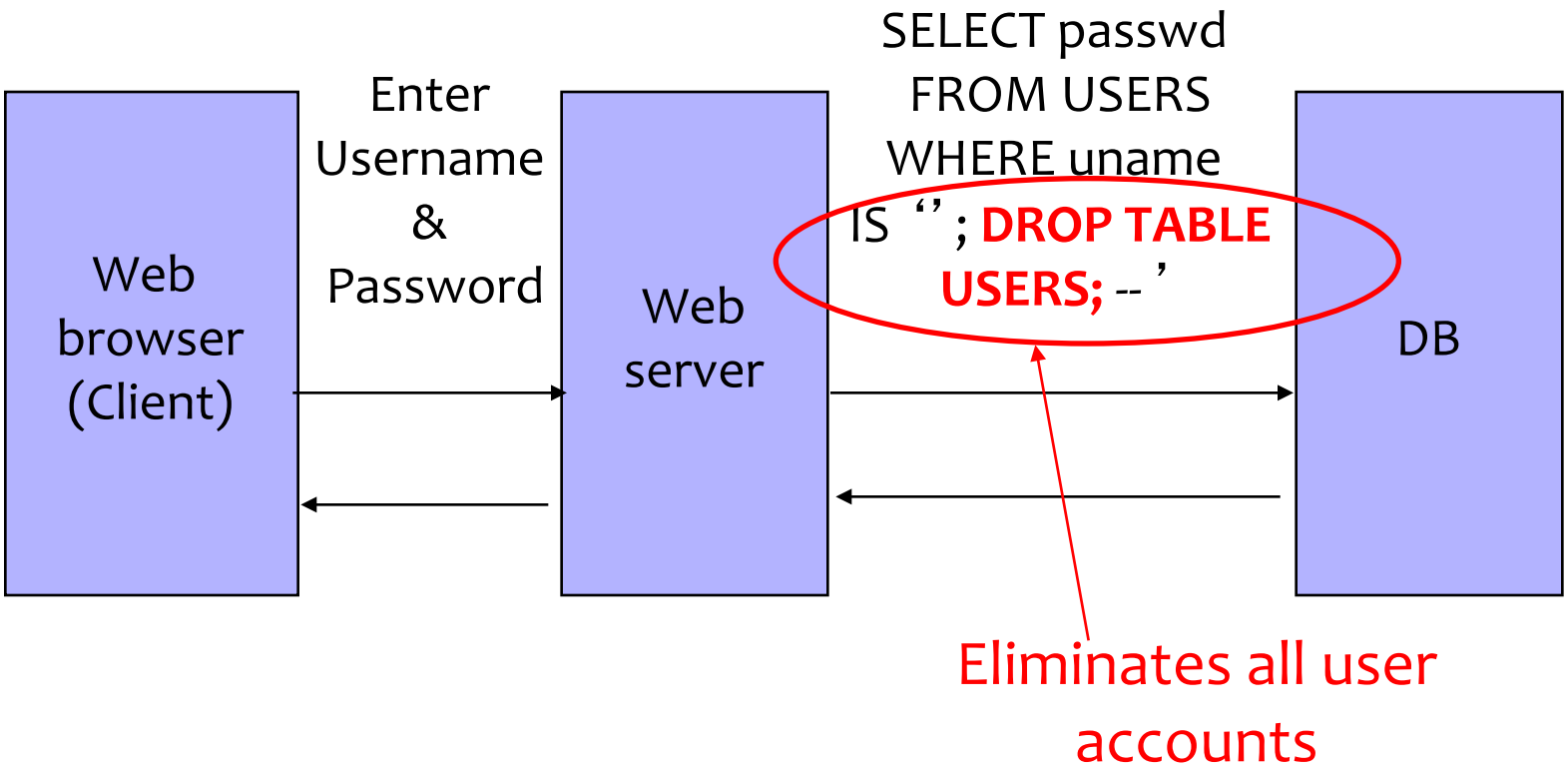


Normal Login

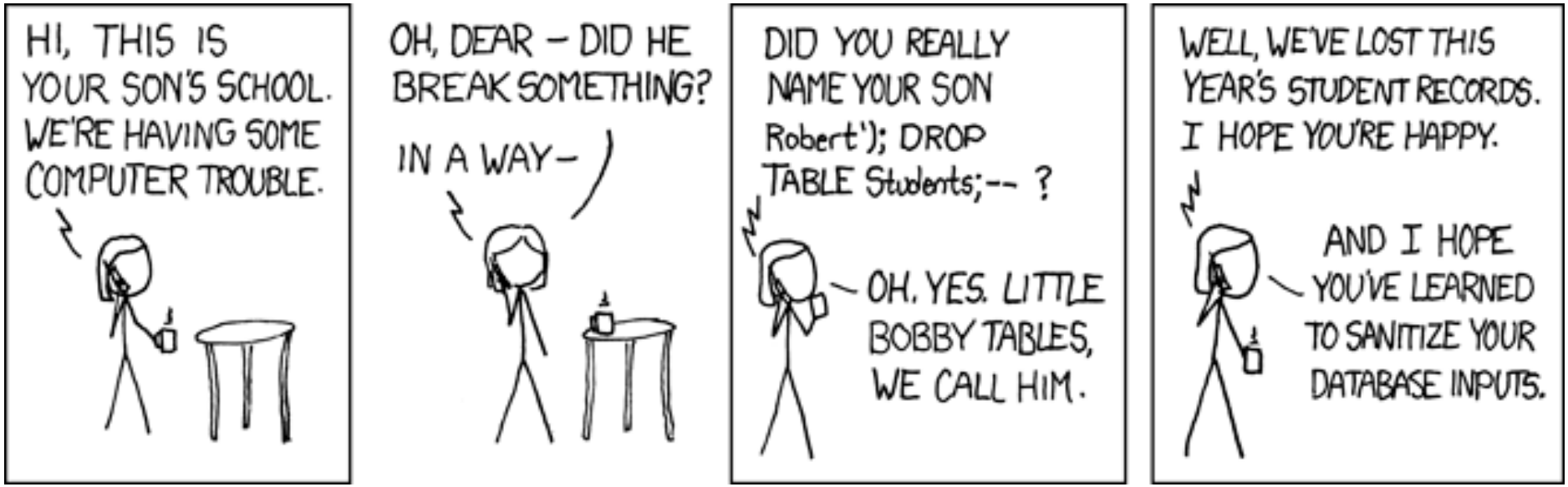


Malicious User Input

SQL Injection Attack

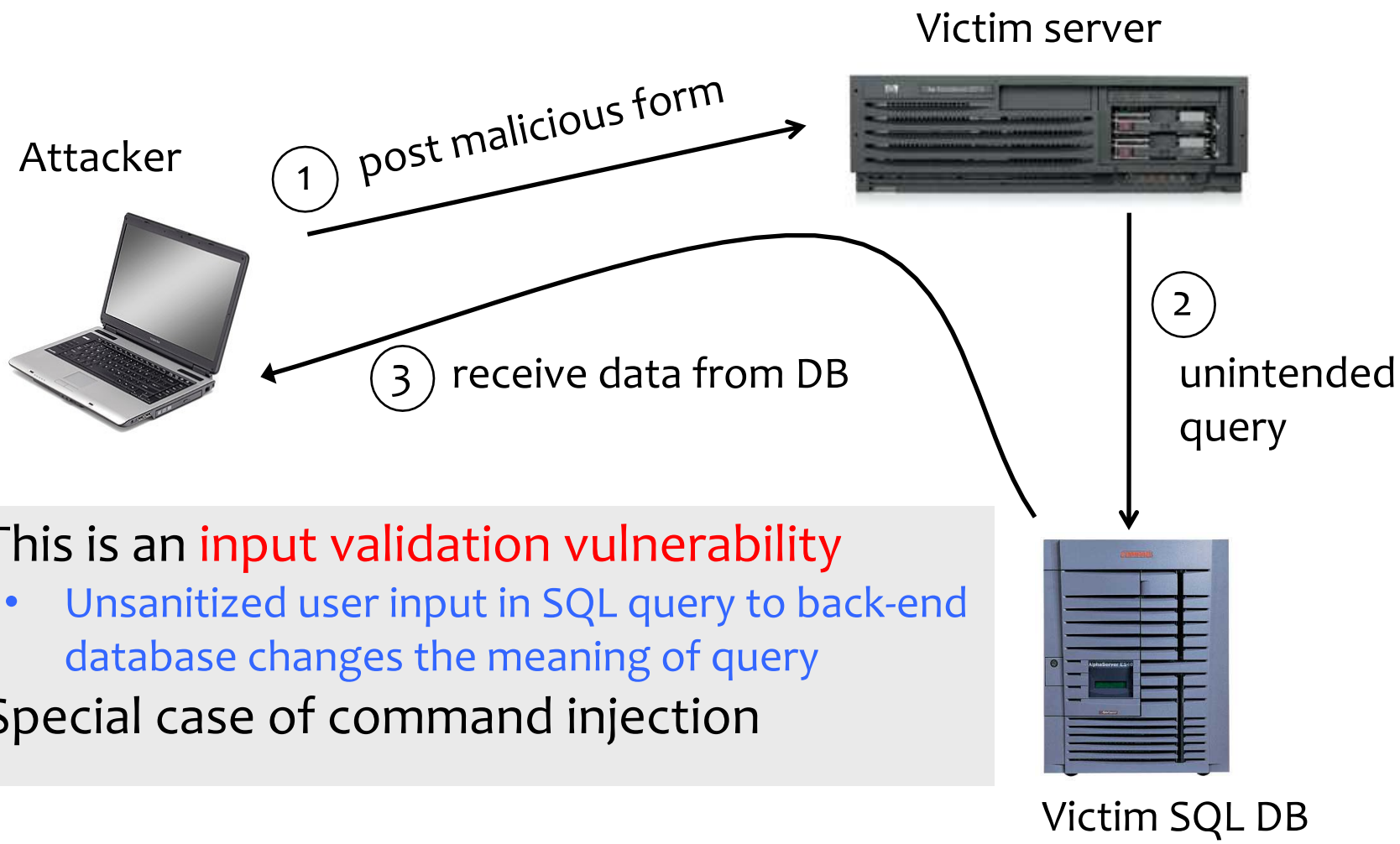


Exploits of a Mom



http://xkcd.com/327/

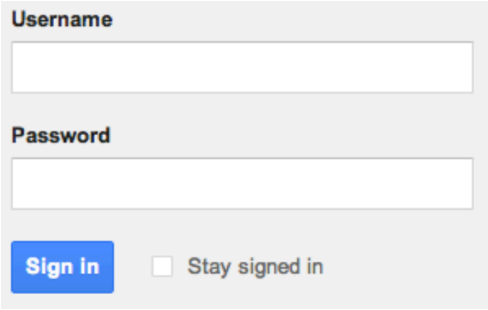
SQL Injection: Basic Idea



- This is an input validation vulnerability
  - Unsanitized user input in SQL query to back-end database changes the meaning of query
- Special case of command injection

Authentication with Backend DB

```
set UserFound = execute(
    "SELECT * FROM UserTable WHERE
    username= ' " & form("user") & " ' AND
    password= ' " & form("pwd") & " ' " );
```



User supplies username and password, this SQL query checks if user/password combination is in the database

```
If not UserFound.EOF
    Authentication correct
  else Fail
```

Only true if the result of SQL query is not empty, i.e., user/pwd is in the database

Using SQL Injection to Log In

- User gives username **’ OR 1=1 --**
- Web server executes query

```
set UserFound=execute(
    SELECT * FROM UserTable WHERE
    username= ‘ ’ OR 1=1 -- … );
```

Always true!

Everything after -- is ignored!

- Now <u>all</u> records match the query, so the result is not empty ⇒ correct “authentication”!

Preventing SQL Injection

- Validate all inputs
  - Filter out any character that has special meaning
    - Apostrophes, semicolons, percent, hyphens, underscores, …
    - Use escape characters to prevent special characters form becoming part of the query code
      - E.g.: escape(O'Connor) = O\'Connor
  - Check the data type (e.g., input must be an integer)

Prepared Statements

```
PreparedStatement ps =
    db.prepareStatement("SELECT pizza, toppings, quantity, order_day "
                + "FROM orders WHERE userid=? AND order_month=?");
ps.setInt(1, session.getCurrentUserId());
ps.setInt(2, Integer.parseInt(request.getParamenter("month")));
ResultSet res = ps.executeQuery();
```

Bind variable (data placeholder)

- Bind variables: placeholders guaranteed to be data (not code)
- Query is parsed without data parameters
- Bind variables are typed (int, string, …)

http://java.sun.com/docs/books/tutorial/jdbc/basics/prepared.html