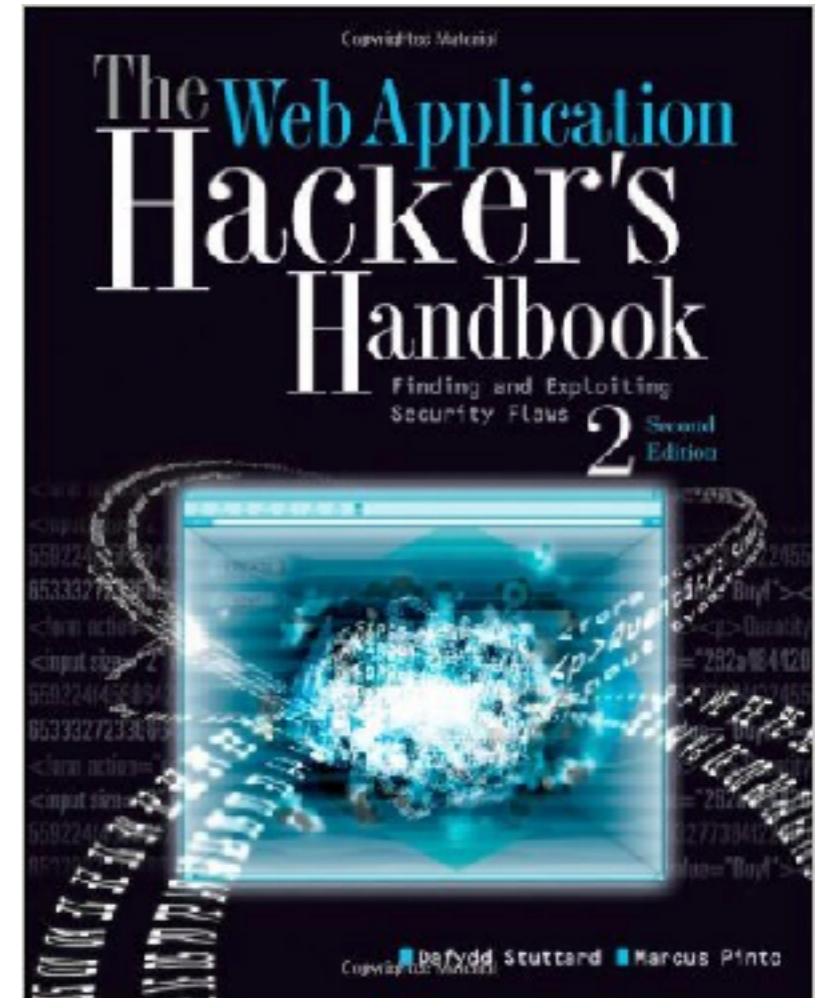


CNIT 129S: Securing Web Applications

Ch 6: Attacking Authentication

Updated 2-23-2022



Authentication Technologies

- HTML forms-based authentication
 - Multifactor mechanisms, such as those combining passwords and physical tokens
 - Client SSL certificates and/or smartcards
 - HTTP basic and digest authentication
 - Windows-integrated authentication using NTLM or Kerberos
 - Authentication services
-
- **Over 90% of apps use name & password**

More Secure Methods

- **Two-factor authentication (or more)**
 - **PIN from a token, SMS message, or mobile app**
 - **In addition to a password**
 - **Submitted through an HTML form**



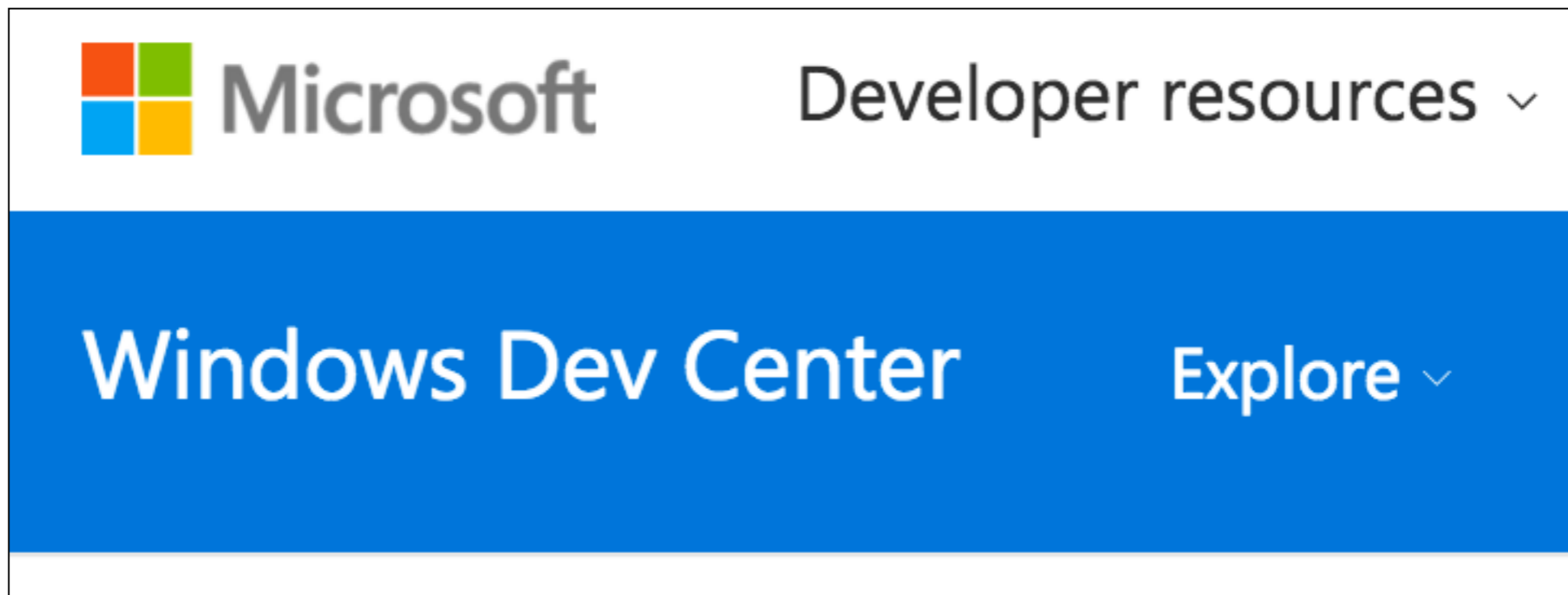
Cryptographic Methods

- **Client-side SSL certificate**
- **Smartcards**
- **More expensive, higher overhead**
- **SAML and JWT (at end of slides)**

HTTP Authentication

- **Basic, Digest, and Windows-integrated**
- **Rarely used on the Internet**
- **More common in intranets, especially Windows domains**
 - **So authenticated employees can easily access secured resources**

Third-Party Authentication



Microsoft Passport and Windows Hello

Third-Party Authentication

The New York Times


Obama's Internet Plan Sounds an Awful Lot Like a National Internet ID


By CURT HOPKINS of  **ReadWriteWeb**


Published: January 10, 2011

Link Ch 6b

Third-Party Authentication

 SlideShare

 | Login with LinkedIn

 | Login with Facebook

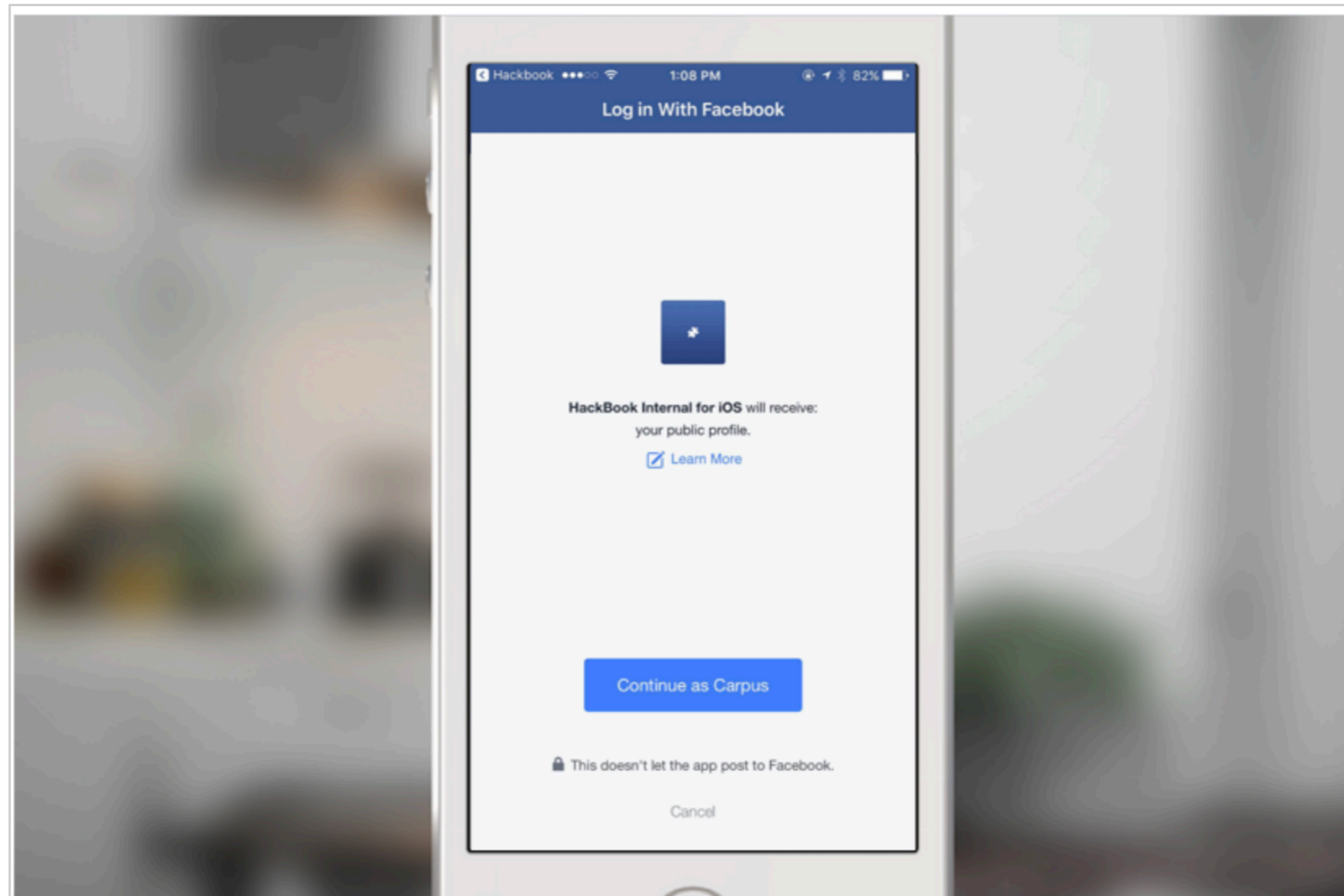
or

Login with your SlideShare account

 Keep me logged in
 [Forgot password?](#)

Facebook Login Overview

Facebook Login is a fast and convenient way for people to create accounts and log into your app across multiple platforms. It's available on [iOS](#), [Android](#), [Web](#), [desktop apps](#) and [devices such as Smart TVs and Internet of Things objects](#). Facebook Login enables two scenarios, [authentication](#) and asking for [permissions to access people's data](#). You can use Facebook Login simply for authentication or for both authentication and data access.



Design Flaws

- **Bad Passwords**
 - Very short or blank
 - Common dictionary words or names
 - The same as the username
 - Still set to a default value

Hack Steps

Attempt to discover any rules regarding password quality:

- 1.** Review the website for any description of the rules.
- 2.** If self-registration is possible, attempt to register several accounts with different kinds of weak passwords to discover what rules are in place.
- 3.** If you control a single account and password change is possible, attempt to change your password to various weak values.

Brute-Force Attacks

- **Attackers use lists of common passwords**
- **Defense: account lockout rules after too many failed login attempts**

- password
- *website name*
- 12345678
- qwerty
- abc123
- 111111
- monkey
- 12345
- letmein

Figure 6.2 A successful password-guessing attack

intruder attack 3

attack save columns

Filter: showing all items

results target positions payloads options

request	payload	status	error	timeo..	length	comment
9306	password2	302	<input type="checkbox"/>	<input type="checkbox"/>	563	
0		200	<input type="checkbox"/>	<input type="checkbox"/>	1610	baseline request
1	Aaaaaa	200	<input type="checkbox"/>	<input type="checkbox"/>	1610	
2	Abcdef	200	<input type="checkbox"/>	<input type="checkbox"/>	1610	
3	Abcdefg	200	<input type="checkbox"/>	<input type="checkbox"/>	1610	
4	Action	200	<input type="checkbox"/>	<input type="checkbox"/>	1610	
5	Adidas	200	<input type="checkbox"/>	<input type="checkbox"/>	1610	
6	Admin	200	<input type="checkbox"/>	<input type="checkbox"/>	1610	
7	Administrative	200	<input type="checkbox"/>	<input type="checkbox"/>	1610	

request response

raw params headers hex

```
POST /auth/16/Default.ashx HTTP/1.1
Host: mdsec.net
Content-Type: application/x-www-form-urlencoded
Content-Length: 34
Connection: close

username=nesahi&password=password2
```

+ < > 0 matches

finished

Poor Attempt Counters

- **Cookie containing failedlogins=1**
- **Failed login counter held within the current session**
 - **Attacker can just withhold the session cookie to defeat this**
- **Sometimes a page continues to provide information about a password's correctness even after account lockout**

Verbose Failure Messages

Username:

Password:


Password is incorrect.

Username:

Password:

User is not recognised.

- **Friendly for legitimate users**
- **But helpful for attackers**

 [Shop](#) [myAT&T](#) [Support](#)

[Overview](#) [Bill & Payments](#) [Wireless](#) [Digital TV](#) [Internet](#) [Home Phone](#) [Messages & Email](#) [Profile](#)

Forgot ID — Enter Contact Email Address

Enter Contact Email Address [What's this?](#)


Please enter the contact email address you provided when you created your User ID to register your account online.

Contact Email Address [?](#)

[Forgot your contact email address?](#)

[Cancel](#) [Next](#)

[AT&T U-verse Offer Details](#) | [U-verse Terms of Service](#) | [Contract \(Wireless\)](#) | [Cell Phone Records Security](#) | [Wireless Legal Site](#)

 [Shop](#) [myAT&T](#) [Support](#)

[Overview](#) [Bill & Payments](#) [Wireless](#) [Digital TV](#) [Internet](#) [Home Phone](#) [Messages & Email](#) [Profile](#)

myAT&T Online Account Management

The wireless number you provided (6782345678) is your User ID.

NEW! No need to select an account type. Just enter your User ID and password to access your AT&T account.


[?](#)

Remember me [Log In](#)

Online Account Management made easy

Quickly view and manage all of your AT&T accounts with online access.

Don't have a login? [Register today!](#)

[Register now](#) > [Learn more](#) 

Script to Find Phone #s

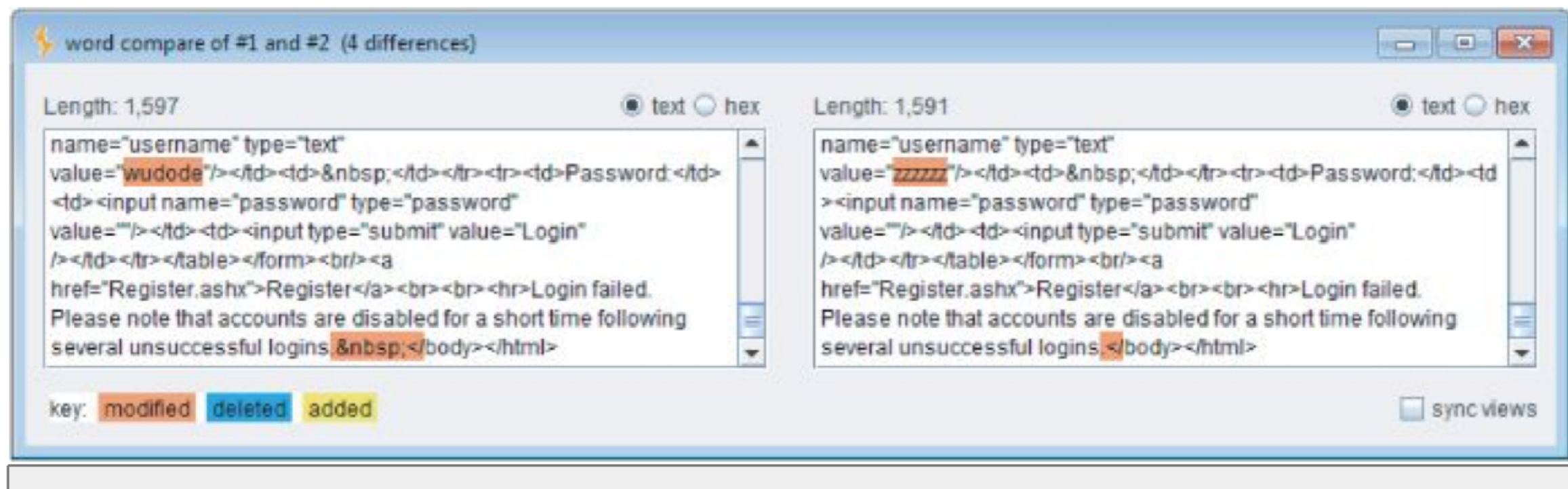
- `echo $1, `curl -d "customerEmailAddress=$1" "https://www.att.com/olam/submitSLIDEmailForgotIdSlid.myworld" -silent | grep -Po '(?<=provided \(\)\d*'``
- When you run `getatt.sh john.smith@example.com` it will output a line of text that looks like:
- `john.smith@example.com,6782345678`
 - Link Ch 6d

Username Importance

- **Attacks that reveal valid usernames are called "username enumeration"**
- **Not as bad as finding a password, but still a privacy intrusion**
- **But could be used for social engineering attacks, such as spearphishing emails**

Similar but Non-Identical Error Messages

Figure 6.4 Identifying subtle differences in application responses using Burp Comparer



- **Any difference can be exploited; even response time**

Kahoot!

A

Vulnerable Transmission of Credentials

- **Eavesdroppers may reside:**

- On the user's local network
- Within the user's IT department
- Within the user's ISP
- On the Internet backbone
- Within the ISP hosting the application
- Within the IT department managing the application

HTTPS Risks

- **If credentials are sent unencrypted, the eavesdropper's task is trivial, but even HTTPS can't prevent these risks:**
 - **Credentials sent in the query string are likely to appear in server logs, browser history, and logs of reverse proxies**
 - **Many sites take credentials from a POST and then redirect it (302) to another page with credentials in the query string**

HTTPS Risks

- **Cookie risks:**
 - **Web apps may store credentials in cookies**
 - **Even if cookies cannot be decrypted, they can be re-used**
- **Many pages open a login page via HTTP and use an HTTPS request in the form**
 - **This can be defeated by a man-in-the-middle attack, like sslstrip**

Password Change Functionality

- **Periodic password change mitigates the threat of password compromise (a dubious claim)**
- **Users need to change their passwords when they believe them to be compromised**

Vulnerable Password Change Systems

- **Reveal whether the requested username is valid**
- **Allow unrestricted guesses of the "existing password" field**
- **Validate the "existing password" field before comparing the "new password" and "confirm new password" fields**
 - **So an attacker can test passwords without making any actual change**

Password Change Decision Tree

- **Identify the user**
- **Validate "existing password"**
- **Integrate with any account lockout features**
- **Compare the new passwords with each other and against password quality rules**
- **Feed back any error conditions to the user**
- **Often there are subtle logic flaws**

Forgotten Password Functionality

- **Often the weakest link**
 - **Uses a secondary challenge, like "mother's maiden name"**
 - **A small set of possible answers, can be brute-forced**
 - **Often can be found from public information**

Forgotten Password Functionality

- **Often users can write their own questions**
 - **Attackers can try a long list of usernames**
 - **Seeking a really weak question, like "Do I own a boat?"**
- **Password "Hints" are often obvious**

Forgotten Password Functionality

- **Often the mechanism used to reset the password after a correct challenge answer is vulnerable**
- **Some apps disclose the forgotten password to the user, so an attacker can use the account without the owner knowing**
- **Some applications immediately let the user in after the challenge--no password needed**

Forgotten Password Functionality

- **Some apps allow the user to specify an email for the password reset link at the time the challenge is completed**
 - **Or use email from a hidden field or cookie**
- **Some apps allow a password reset and don't notify the user with an email**

"Remember Me"

- **Sometimes a simple persistent cookie, like**
 - **`RememberUser=jsmith`**
 - **`Session=728`**
- **No need to actually log in, if username or session ID can be guessed or found**

"Remember Me"

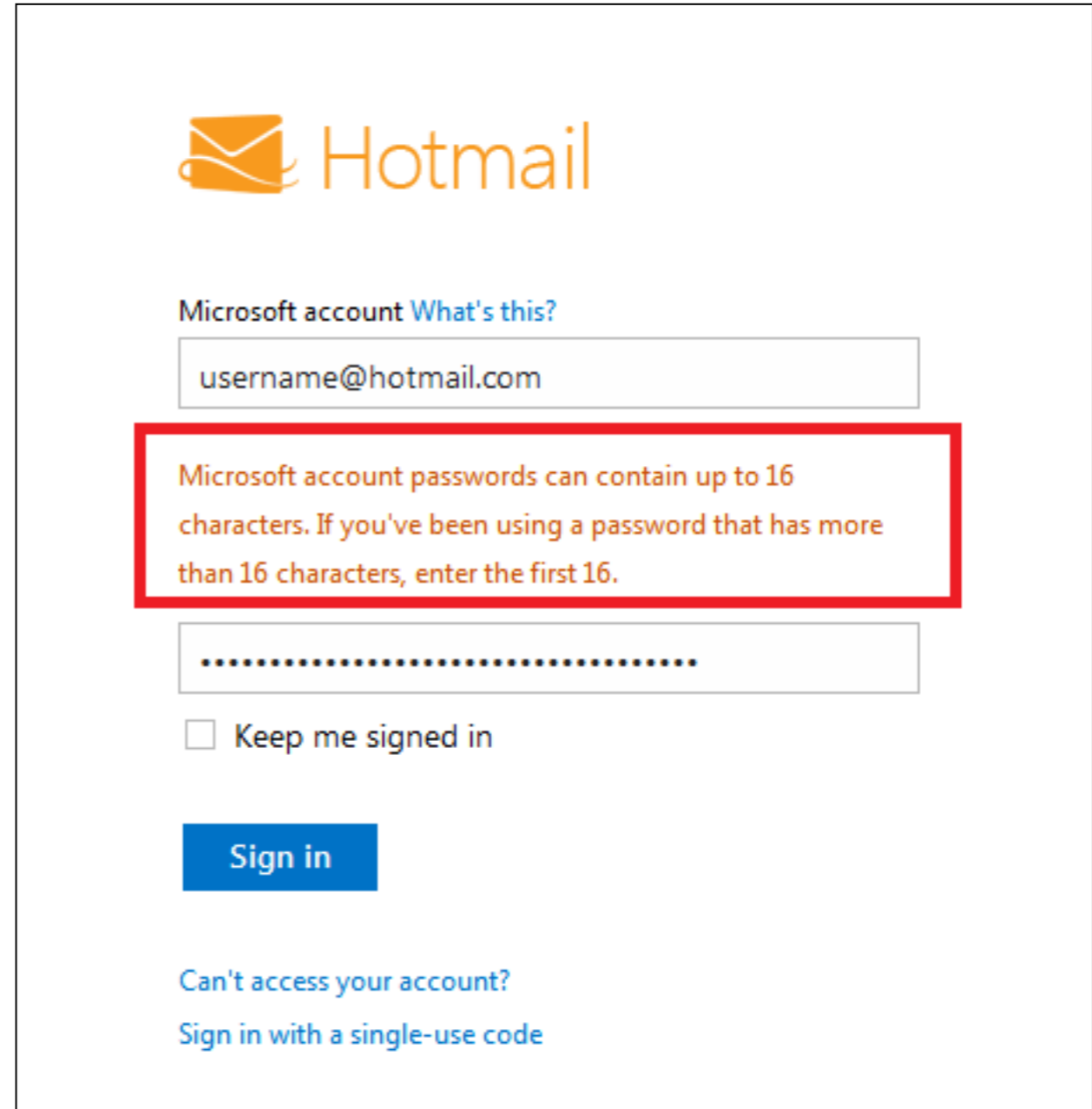
- **Even if the userid or session token is properly encrypted, it can be stolen via XSS or by getting access to a user's phone or PC**

User Impersonation

- **Sometimes help desk personnel or other special accounts can impersonate users**
- **This may have flaws like**
 - **Implemented with a "hidden" function lacking proper access controls, such as**
 - **`/admin/ImpersonateUser.jsp`**
 - **A guessable session number**
 - **A fixed backdoor password**

Incomplete Validation

- **Some applications truncate passwords without telling users**
- **Also strip unusual characters**
- **Link Ch 6e**



The screenshot shows the Hotmail login interface. At the top is the Hotmail logo. Below it is a link for "Microsoft account What's this?". A text input field contains the email address "username@hotmail.com". A red rectangular box highlights an error message: "Microsoft account passwords can contain up to 16 characters. If you've been using a password that has more than 16 characters, enter the first 16." Below the error message is a password input field filled with dots. There is a checkbox labeled "Keep me signed in" and a blue "Sign in" button. At the bottom, there are two links: "Can't access your account?" and "Sign in with a single-use code".

Nonunique Usernames

- **Rare but it happens**
- **You may be able to create a new account with the same username as an existing account**
- **During registration or a password change**
- **If the password also matches, you can detect that from a different error message**

Predictable Usernames

- **Automatically generated names like**
 - **User101, User102, ...**

Predictable Initial Passwords

- **User accounts are create in large batches**
- **All have the same initial password**

Insecure Distribution of Credentials

- **Passwords sent by email, SMS, etc.**
- **Users may never change those credentials**
- **Activation URLs may be predictable**
- **Some apps email the new password to the user after each password change**

Kahoot!

B

Implementation Flaws

Fail-Open Login

- **Blank or invalid username may cause an exception in the login routine**
 - **Or very long or short values**
 - **Or letters where numbers are expected...**
- **And allow the user in**

Multistage Login

- **Enter username and password**
- **Enter specific digits from a PIN (a CAPTCHA)**
- **Enter value displayed on a token**

Multistage Login Defects

- **May allow user to skip steps**
- **May trust data that passes step one, but let user change it, so invalid or locked-out accounts remain available**
- **May assume that the same username applies to all three stages but not verify this**

Multistage Login Defects

- **May use a randomly-chosen question to verify the user**
- **But let the attacker alter that question in a hidden HTML field or cookie**
- **Or allow many requests, so attacker can choose an easy question**

Insecure Credential Storage

- **Plaintext passwords in database**
- **Hashed with MD5 or SHA-1, easily cracked**

Securing Authentication

- **Considerations**
 - **How critical is security?**
 - **Will users tolerate inconvenient controls?**
 - **Cost of supporting a user-unfriendly system**
 - **Cost of alternatives, compare to revenue generated or value of assets**

Strong Credentials

- **Minimum password length, requiring alphabetical, numeric, and typographic characters**
- **Avoiding dictionary words, password same as username, re-use of old passwords**
- **Usernames should be unique**
- **Automatically generated usernames or passwords should be long and random, so they cannot be guessed or predicted**
- **Allow users to set strong passwords**

Handle Credentials Secretively

- **Protect them when created, stored, and transmitted**
- **Use well-established cryptography like SSL, not custom methods**
- **Whole login page should be HTTPS, not just the login button**
- **Use POST rather than GET**
- **Don't put credentials in URL parameters or cookies**

Handle Credentials Secretively

- **Don't transmit credentials back to the client, even in parameters to a redirect**
- **Securely hash credentials on the server**

Hashing

- **Password hashes must be salted and stretched**
- **Salt: add random bytes to the password before hashing it**
- **Stretched: many rounds of hashing (Kali Linux 2 uses 5000 rounds of SHA-512)**

GNU nano 2.2.6

File: login.defs

```
# Note: It is recommended to use a value consistent with
# the PAM modules configuration.
#
ENCRYPT_METHOD SHA512

#
# Only used if ENCRYPT_METHOD is set to SHA256 or SHA512.
#
# Define the number of SHA rounds.
# With a lot of rounds, it is more difficult to brute forcing the password.
# But note also that it more CPU resources will be needed to authenticate
# users.
#
# If not specified, the libc will choose the default number of rounds (5000).
# The values must be inside the 1000-999999999 range.
# If only one of the MIN or MAX values is set, then this value will be used.
# If MIN > MAX, the highest value will be used.
#
# SHA_CRYPT_MIN_ROUNDS 5000
# SHA_CRYPT_MAX_ROUNDS 5000
```

Handle Credentials Secretively

- **Client-side "remember me" functionality should remember only nonsecret items such as usernames**
- **If you allow users to store passwords locally, they should be reversibly encrypted with a key known only to the server**
 - **And make sure there are no XSS vulnerabilities**

Handle Credentials Secretively

- **Force users to change passwords periodically**
 - *No longer recommended*
- **Credentials for new users should be sent as securely as possible and time-limited; force password change on first login**
- **Capture some login information with drop-down lists instead of text fields, to defeat keyloggers**

Validate Credentials Properly

- **Validate entire credential, with case sensitivity**
- **Terminate the session on any exception**
- **Review authentication logic and code**
- **Strictly control user impersonation**

Multistage Login

- **All data about progress and the results of previous validation tasks should be held in the server-side session object and never available to the client**
- **No item of information should be submitted more than once by the user**
- **No means for the user to modify data after submission**

Multistage Login

- **The first task at every stage should be to verify that all prior stages have been correctly completed**
- **Always proceed through all stages, even if the first stage fails--don't give attacker any information about which stage failed**

Prevent Information Leakage

- **All authentication failures should use the same code to produce the same error message**
 - **To avoid subtle differences that leak information**
- **Account lockout can be used for username enumeration**
 - **Login attempts with invalid usernames should lead to the same error messages as valid ones**

Self-Registration

- **Allowing users to choose usernames permits username enumeration. Better methods:**
 - **Generate unique, unpredictable usernames**
 - **Use e-mail addresses as usernames and require the user to receive and use an email message**

Prevent Brute-Force Attacks

- **At login, password change, recover lost password, etc.**
- **Using unpredictable usernames and preventing their enumeration makes brute-force attacks more difficult**
- **High-security apps like banks disable an account after several failed logins**
 - **Account holder must do something out-of-band to re-activate account, like phone customer support and answer security questions**
 - **A 30-minute delay is friendlier and cheaper**

Prevent Brute-Force Attacks

- **Password Spray attack**
 - **Use many different usernames with the same password, such as "password"**
 - **Avoids account lockouts**
- **Defenses: strong password rules, CAPTCHA**



Password Change

- **No way to change username**
- **Require user to enter the old password**
- **Require new password twice (to prevent mistakes)**
- **Same error message for all failures**
- **Users should be notified out-of-band (such as via email) that the password has been changed**

Account Recovery

- **For security-critical apps, require account recovery out-of-band**
- **Don't use "password hints"**
- **Email a unique, time-limited, unguessable, single-use recovery URL**

Account Recovery

- **Challenge questions**
 - **Don't let users write their own questions**
 - **Don't use questions with low-entropy answers, such as "your favorite color"**

Log, Monitor, and Notify

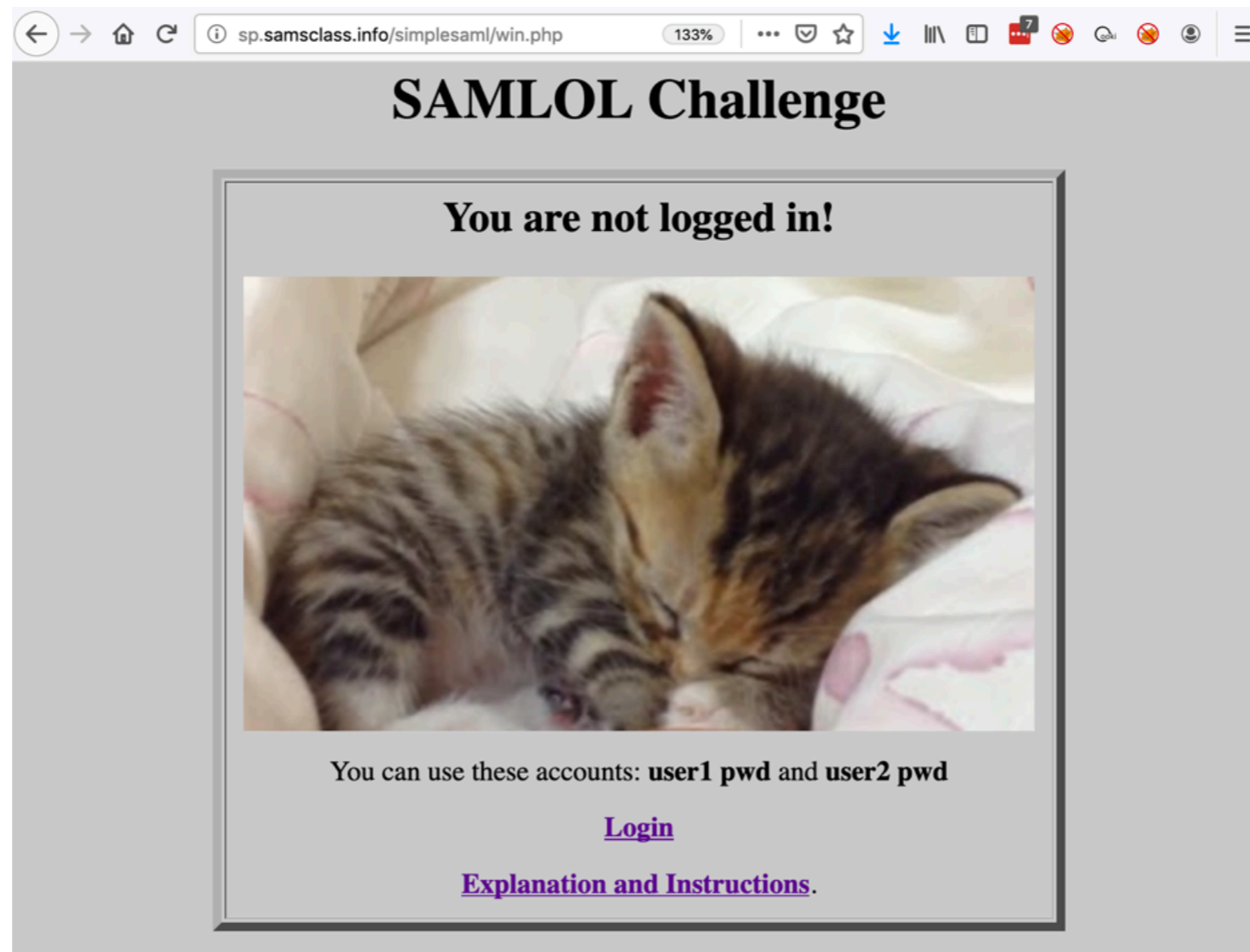
- **Log all authentication-related events**
 - **Protect logs from unauthorized access**
- **Anomalies such as brute-force attacks should trigger IDS alerts**
- **Notify users out-of-band of any critical security events, such as password changes**
- **Notify users in-band of frequent security events, such as time and source IP of the last login**

Kahoot!

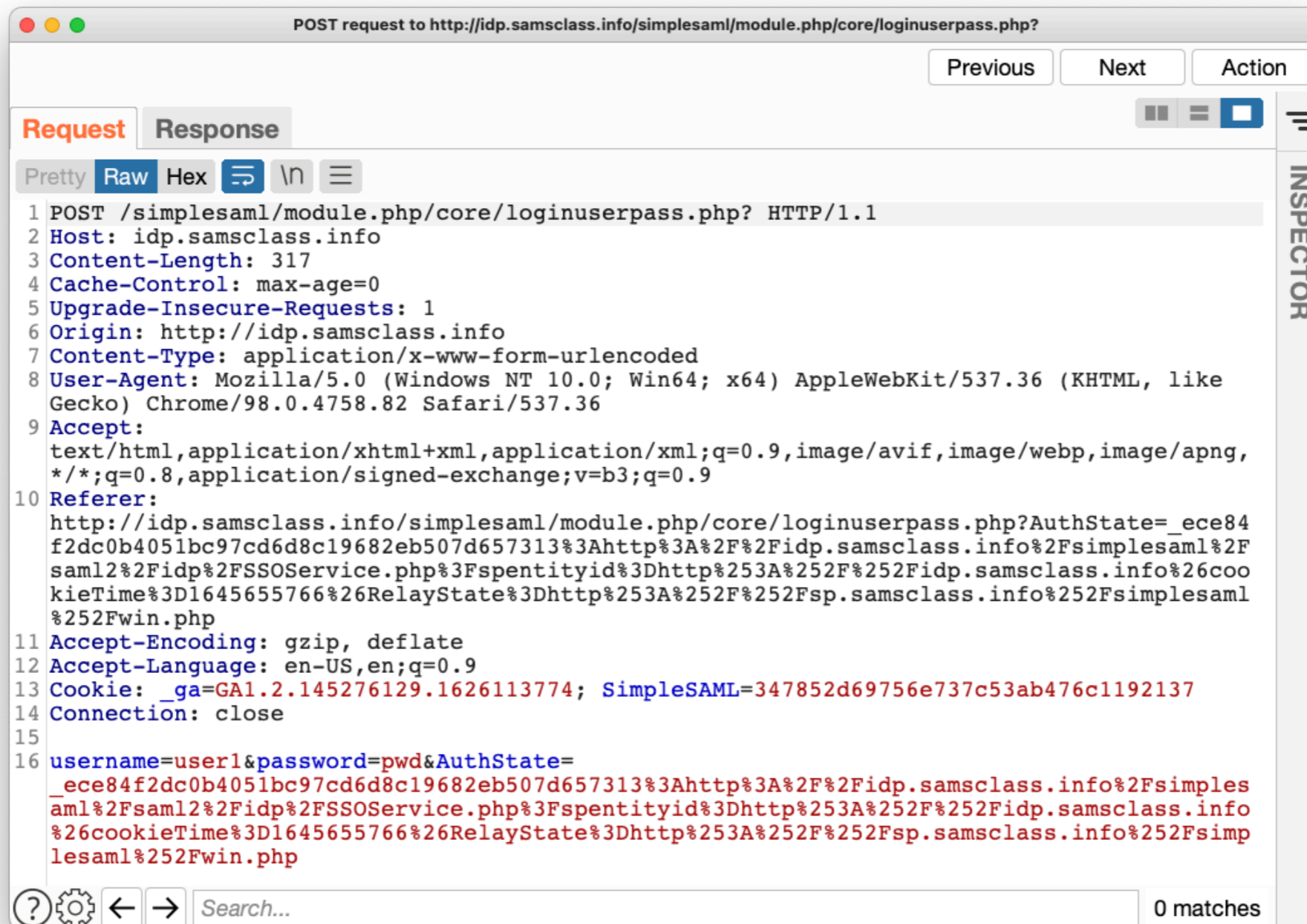
c

SAML (Security Assertion Markup Language)

- <http://samlol.samsclass.info>



Send password to identity provider



The screenshot shows a network inspector window with the following details:

- Title:** POST request to http://idp.samsclass.info/simplesaml/module.php/core/loginuserpass.php?
- Request/Response:** The 'Request' tab is active, showing the raw request data.
- Raw View:** The request is displayed in a raw format, showing the following fields:
 - 1 POST /simplesaml/module.php/core/loginuserpass.php? HTTP/1.1
 - 2 Host: idp.samsclass.info
 - 3 Content-Length: 317
 - 4 Cache-Control: max-age=0
 - 5 Upgrade-Insecure-Requests: 1
 - 6 Origin: http://idp.samsclass.info
 - 7 Content-Type: application/x-www-form-urlencoded
 - 8 User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/98.0.4758.82 Safari/537.36
 - 9 Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9
 - 10 Referer: http://idp.samsclass.info/simplesaml/module.php/core/loginuserpass.php?AuthState=_ece84f2dc0b4051bc97cd6d8c19682eb507d657313%3Ahttp%3A%2F%2Fidp.samsclass.info%2Fsimplesaml%2Fsaml2%2Fidp%2FSSOService.php%3Fspentityid%3Dhttp%253A%252F%252Fidp.samsclass.info%26cookieTime%3D1645655766%26RelayState%3Dhttp%253A%252F%252Fsp.samsclass.info%252Fsimplesaml%252Fwin.php
 - 11 Accept-Encoding: gzip, deflate
 - 12 Accept-Language: en-US,en;q=0.9
 - 13 Cookie: _ga=GA1.2.145276129.1626113774; SimpleSAML=347852d69756e737c53ab476c1192137
 - 14 Connection: close
 - 15
 - 16 username=user1&password=pwd&AuthState=_ece84f2dc0b4051bc97cd6d8c19682eb507d657313%3Ahttp%3A%2F%2Fidp.samsclass.info%2Fsimplesaml%2Fsaml2%2Fidp%2FSSOService.php%3Fspentityid%3Dhttp%253A%252F%252Fidp.samsclass.info%26cookieTime%3D1645655766%26RelayState%3Dhttp%253A%252F%252Fsp.samsclass.info%252Fsimplesaml%252Fwin.php

Response contains SAMLResponse

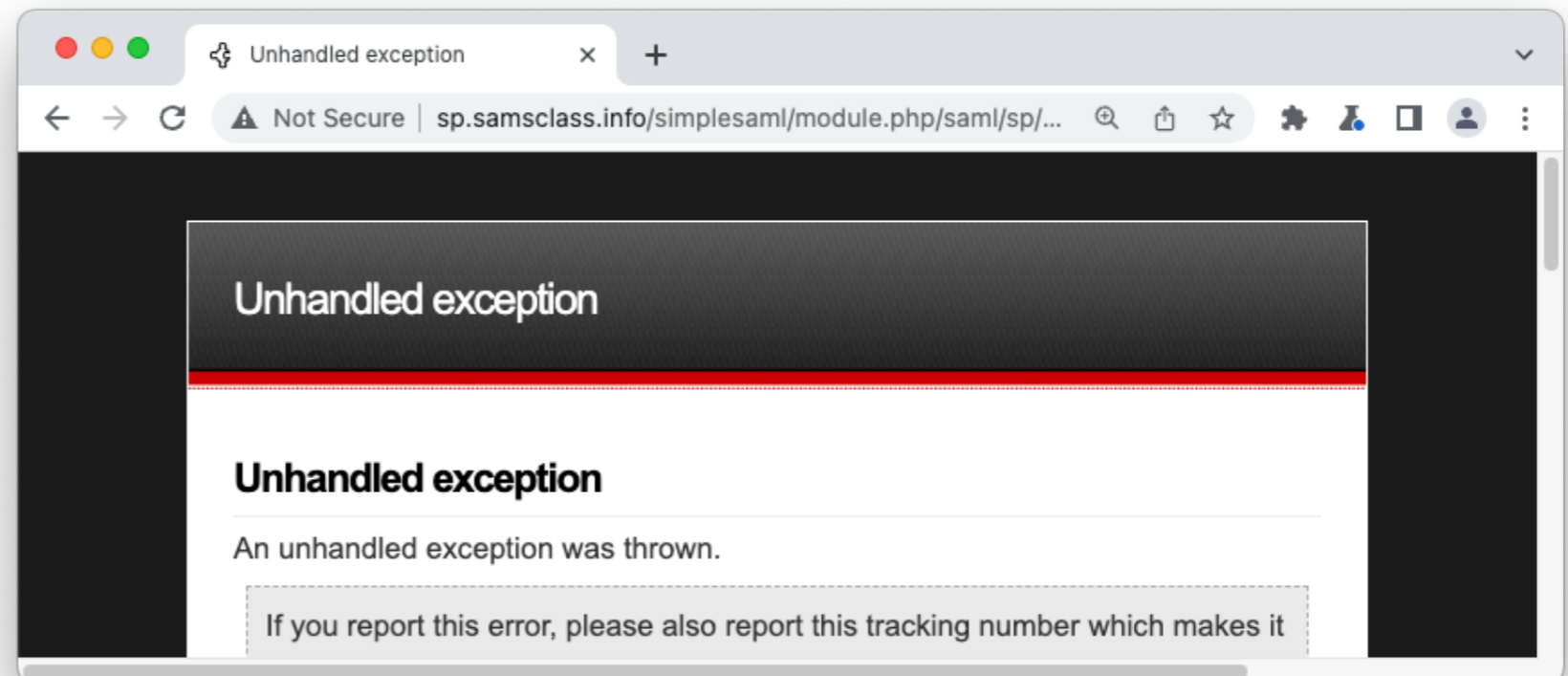
```
<input type="hidden" name="SAMLResponse" value="
PHNhbWxwO1Jlc3BvbNlIHhtbG5zOnNhbWxwPSJ1cm46b2FzaXM6bmFtZXM6dGM6U0FNTDoy
LjA6cHJvdG9jb2wiIHhtbG5zOnNhbWw9InVybJpvYXNpczpuYW1lc3p0YzptQU1MOjIuMDph
c3N1cnRpb24iIElEPSJfODc5NzQ1N2NlMDk0OWVhMTRhNWl5NmZknWFmODk0ZGVhOWUxyY2I1
YmY3IiBWZXJzaW9uPSIyLjA6cHJvdG9jb2wiIHhtbG5zOnNhbWw9InVybJpvYXNpczpuYW1lc3p0
IERlc3RpbmF0aW9uPSJodHRwOi8vc3Auc2Ftc2NsYXNzLmluZm8vc2ltcGxlc2FtbC9tb2Rl
bGUucGhwL3NhbWwvc3Auc2FtbDIyYWNzLnBocC9kZWZhdWx0LXNwIiBjb1Jlc3BvbNlVG89
I182OTY0MGVkmTEeXmjk5NzBhYWI1ZTg5ODAlZDhlYjE5MWRkOVRhZjVlMGEiPjxzYW1sOk1z
c3Vlcj5odHRwOi8vaWRwLnNhbXNjbGFzcy5pbmZvL3NpbXBsZXNhbWwvc2FtbDIvaWRwL21l
dGFkYXRhLnBocDwvc2FtbDpJc3N1ZXI+PGRzO1NpZ25hdHVyZSB4bWxuczpkcz0iaHR0cDov
L3d3dy53My5vcmcvMjAwMC8wOS94bWxkc2lnIyI+CiAgPGRzO1NpZ25lZEluZm8+PGRzOkNh
bm9uaWNhbG16YXRpb25NZXRob2QgQWxnb3JpdGhtPSJodHRwOi8vd3d3LnczLm9yZy8yMDAx
LzEwL3htbC1leGMtYzE0biMiLz4KICAgIDxkc3pTaWduYXR1cmVNZXRob2QgQWxnb3JpdGht
PSJodHRwOi8vd3d3LnczLm9yZy8yMDAwLzA5L3htbGRzaWcjc2NhbXNhbWwvc2FtbDIvaWRwL21l
UmVmZXJlbmNlIFVSST0iI184Nzk3NDU3Y2UwOTQ5ZWExNGE1Yjk2ZmQ1YWY4OTRkZWE5ZTFj
YjViZjciPjxkc3pUcmFuc2ZvcmlzPjxkc3pUcmFuc2ZvcmlzPjxkc3pUcmFuc2ZvcmlzPjxkc3pU
d3d3LnczLm9yZy8yMDAwLzA5L3htbGRzaWcjc2NhbWwvc2FtbDIvaWRwL21lZGFkYXRhLnBocDwvc2
cmFuc2ZvcmlzPjxkc3pUcmFuc2ZvcmlzPjxkc3pUcmFuc2ZvcmlzPjxkc3pUcmFuc2ZvcmlzPjxkc3pU
YzE0biMiLz48L2RzO1RyYW5zZm9ybXM+PGRzOkRzO1NpZ25lZEluZm8+PGRzOkRzO1NpZ25lZEluZm8+
```


Intercept & Decode

- Change user name from **user1** to **admin**
- Turn off Intercept

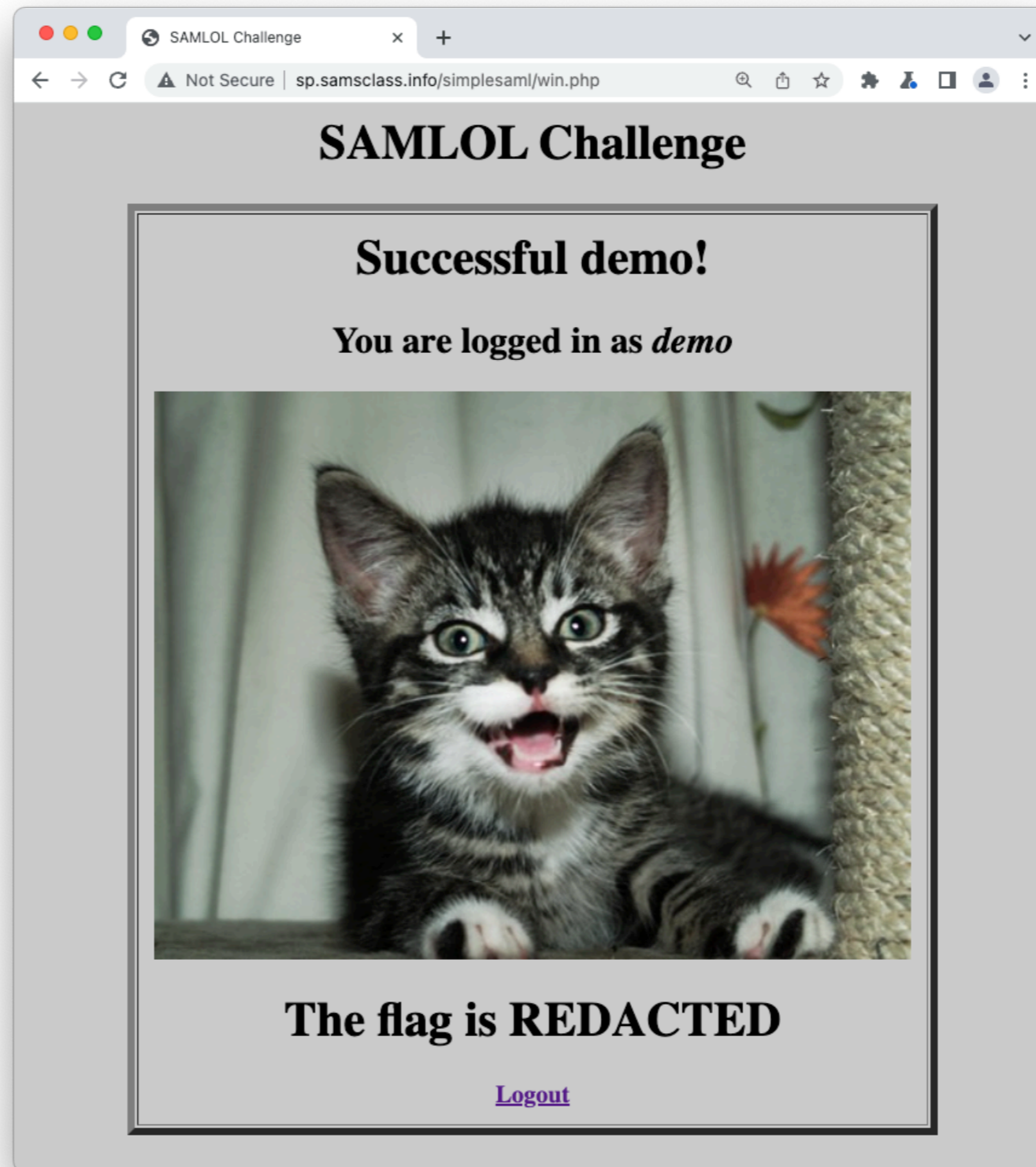
```
9 3CgKCAQEAwfSJJxxWvJ2Xok+Qx1OwQa+LA6mTSomOrgcJkRhFjeA9LMBmQlZKmdHiwKCaJBm711G13CNN2XhBZBqLFEX/4pPO5WBakAEa8h1i1ODmgelNKntcr3jPC
PA8cdnxgWHYXniebXpPNMfoMBPpMao20uv9dkKHH2AzuT7TWAICiSj29ZuHEVJaKlmfwErr+R8etKnGT0tA53/509+gWG0eCQSh+AF/VPWQ4JRoPMSzKdLz14surr
ML:2.0:nameid-format:transient">_658fb0c6d3d3fd05a83371ed78c78c05d5955c702c</saml:NameID><saml:SubjectConfirmation Method="urn
i0:47Z"><saml:AudienceRestriction><saml:Audience>http://idp.samsclass.info</saml:Audience></saml:AudienceRestriction></saml:Cc
ne="uid" NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:basic"><saml:AttributeValue xsi:type="xs:string">user1</saml:
iteValue></saml:Attribute><saml:Attribute Name="last name" NameFormat="urn:oasis:names:tc:SAML:2.0:attrname-format:basic"><san
```

- Attack fails



Remove Signatures

- Change user name from **user1** to **demo**
- Turn off Intercept



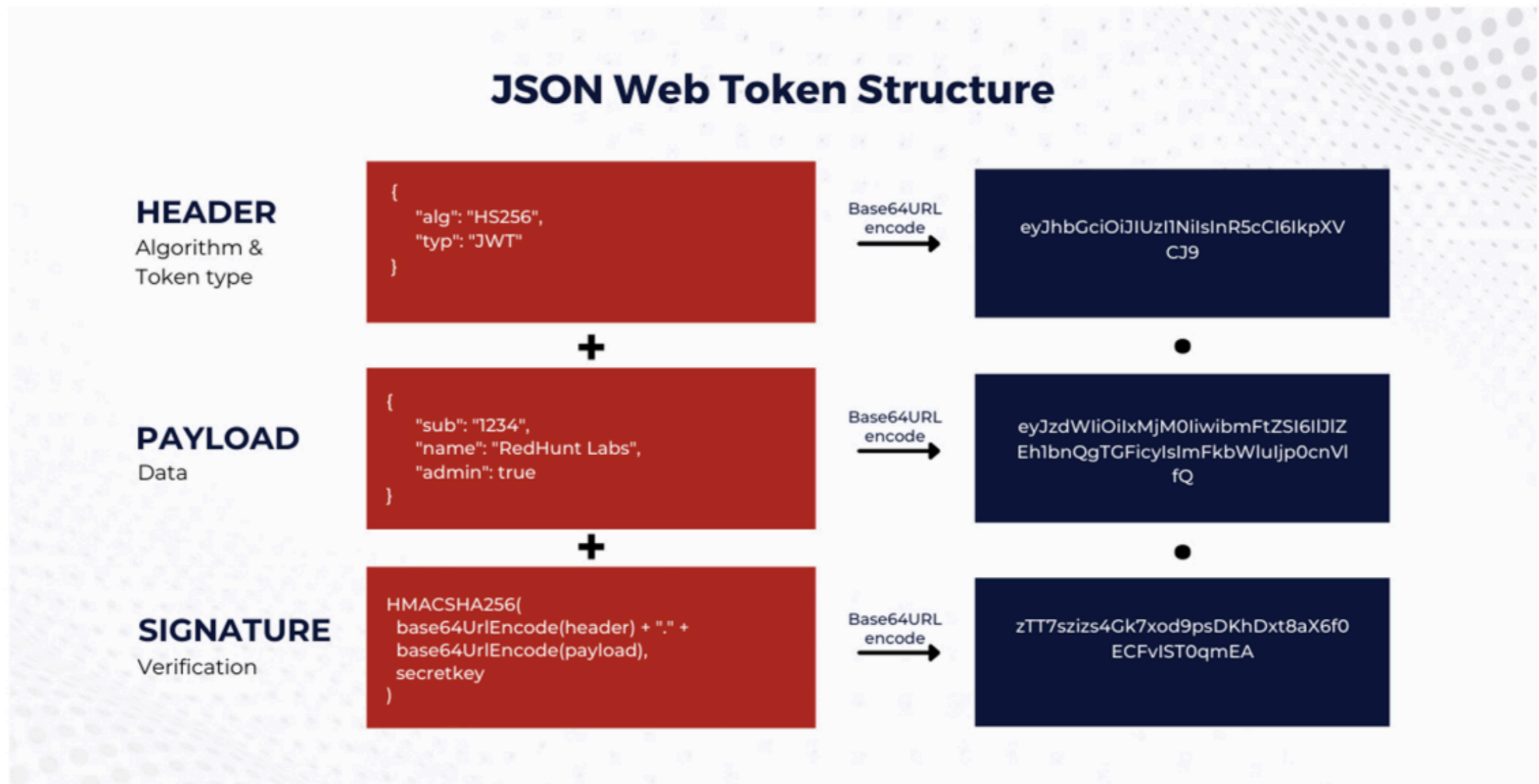
JSON Web Tokens

- <https://redhuntlabs.com/wp-content/uploads/2022/02/A-Practical-Guide-to-Attacking-JWT-JSON-Web-Tokens.pdf>



Structure of JWT tokens

A JWT consists of 3 Base64-URL encoded sections concatenated by a period(.); namely:- **the Header**, **the payload**, and **the Signature**.
Let's go through each one of them:



JWT Attacks

- Failing to verify signature
- "NONE" algorithm (no signature required)
- Weak HMAC Keys
- Command injection
- Path traversal
- SQL injection
- More...