ĐẠI HỌC BÁCH KHOA HÀ NỘI
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IT4409: Web Technologies and e-Services

Lec 14: Web Security

Outline

1. **What is web security?**
2. HTTPS
3. Session Management
4. Authentication
5. Common Web Attacks

What is web security?

- Website security is the act/practice of protecting websites from unauthorized access, use, modification, destruction, or disruption. (Mozilla)

- Effective website security requires design effort across the whole of the website:
  - Web application
  - Configuration of the web server
  - Policies for creating and renewing passwords
  - Client-side code.

Facts and Stats

- 95% of breached records came from only three industries in 2016
- There is a hacker attack every 39 seconds
- 43% of cyber attacks target small business
- The average cost of a data breach in 2020 will exceed $150 million
- In 2018 hackers stole half a billion personal records
- Over 75% of healthcare industry has been infected with malware over 2018
- Large-scale DDoS attacks increase in size by 500%

Facts and Stats

- Approximately $6 trillion is expected to be spent globally on cybersecurity by 2021
- By 2020 there will be roughly 200 billion connected devices
- Unfilled cybersecurity jobs worldwide will reach 3.5 million by 2021
- 95% of cybersecurity breaches are due to human error
- More than 77% of organizations do not have a Cyber Security Incident Response plan
- Most companies take nearly 6 months to detect a data breach, even major ones
- Share prices fall 7.27% on average after a breach
- Total cost for cybercrime committed globally has added up to over $1 trillion dollars in 2018

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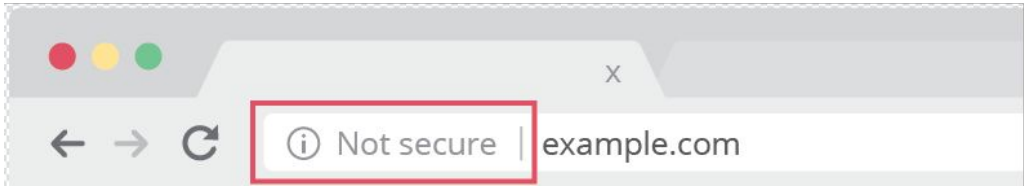
HTTPS

- Hypertext transfer protocol secure (HTTPS) is the secure version of HTTP, which is the primary protocol used to send data between a web browser and a website.

- HTTPS is encrypted in order to increase security of data transfer.



- This is particularly important when users transmit sensitive data, such as by logging into a bank account, email service, or health insurance provider.

HTTPS

- HTTPS uses an encryption protocol to encrypt communications.

- The protocol is called Transport Layer Security (TLS), although formerly it was known as Secure Sockets Layer (SSL).

  - The private key - this key is controlled by the owner of a website and it's kept, as the reader may have speculated, private. This key lives on a web server and is used to decrypt information encrypted by the public key.

  - The public key - this key is available to everyone who wants to interact with the server in a way that's secure. Information that's encrypted by the public key can only be decrypted by the private key.

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Session Management

- A web session is a sequence of network HTTP request and response transactions associated to the same user.
- Modern and complex web applications require the retaining of information or status about each user for the duration of multiple requests.
- Therefore, sessions provide the ability to establish variables – such as access rights and localization settings – which will apply to each and every interaction a user has with the web application for the duration of the session.

Session Management

- Web applications can create sessions to keep track of anonymous users after the very first user request.

Session Management

- The disclosure, capture, prediction, brute force, or fixation of the session ID will lead to session hijacking (or sidejacking) attacks.
- An attacker is able to fully impersonate a victim user in the web application.
- Attackers can perform two types of session hijacking attacks, targeted or generic.

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Major security issues

- Prevent unauthorized users from accessing sensitive data
  - Authentication: identifying users to determine if they are one of the authorized ones
  - Access control: identifying which resources need protection and who should have access to them
- Prevent attackers from stealing data from network during transmission
  - Encryption (usually by Secure Sockets Layer)

Authentication

- Collect user ID information from end users ("logging in")
  - usually by means of browser dialog / interface
  - user ID information normally refers to username and password
- Transport collected user ID information to the web server
  - unsecurely (HTTP) or securely (HTTPS = HTTP over SSL)
- Verify ID and passwd with backend Realms ("security database")
  - Realms maintain username, password, roles, etc., and can be organized by means of LDAP, RDBMS, Flat-file, etc.
  - Validation: the web server checks if the collected user ID & passwd match with these in the realms.
- Keep track of previously authenticated users for further HTTP operations

WWW-Authenticate

- The authentication request received by the browser will look something like:
  - WWW-Authenticate = Basic realm="defaultRealm"
    - Basic indicates the HTTP Basic authentication is requested
    - realm indicates the context of the login
      - realms hold all of the parts of security puzzle
        - Users
        - Groups
        - ACLs (Access Control Lists)
- Basic Authentication
  - userid and password are sent base 64 encoded (might as well be plain text)
  - hacker doesn't even need to unencode all he has to do is "replay" the blob of information he stole over and over (this is called a "replay attack")

WWW-Authenticate

- Digest Authentication
  - attempts to overcome the shortcomings of Basic Authentication
  - WWW-Authenticate = Digest realm="defaultRealm" nonce="Server SpecificString"
  - see RFC 2069 for description of nonce, each nonce is different
  - the nonce is used in the browser in a 1-way function (MD5, SHA-1….) to encode the userid and password for the server, this function essentially makes the password good for only one time
- Common browsers don't use Digest Authentication but an applet could as an applet has access to all of the Java Encryption classes needed to create the creation of a Digest.

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Common Web Attacks

Client side

- XSS
- CSRF

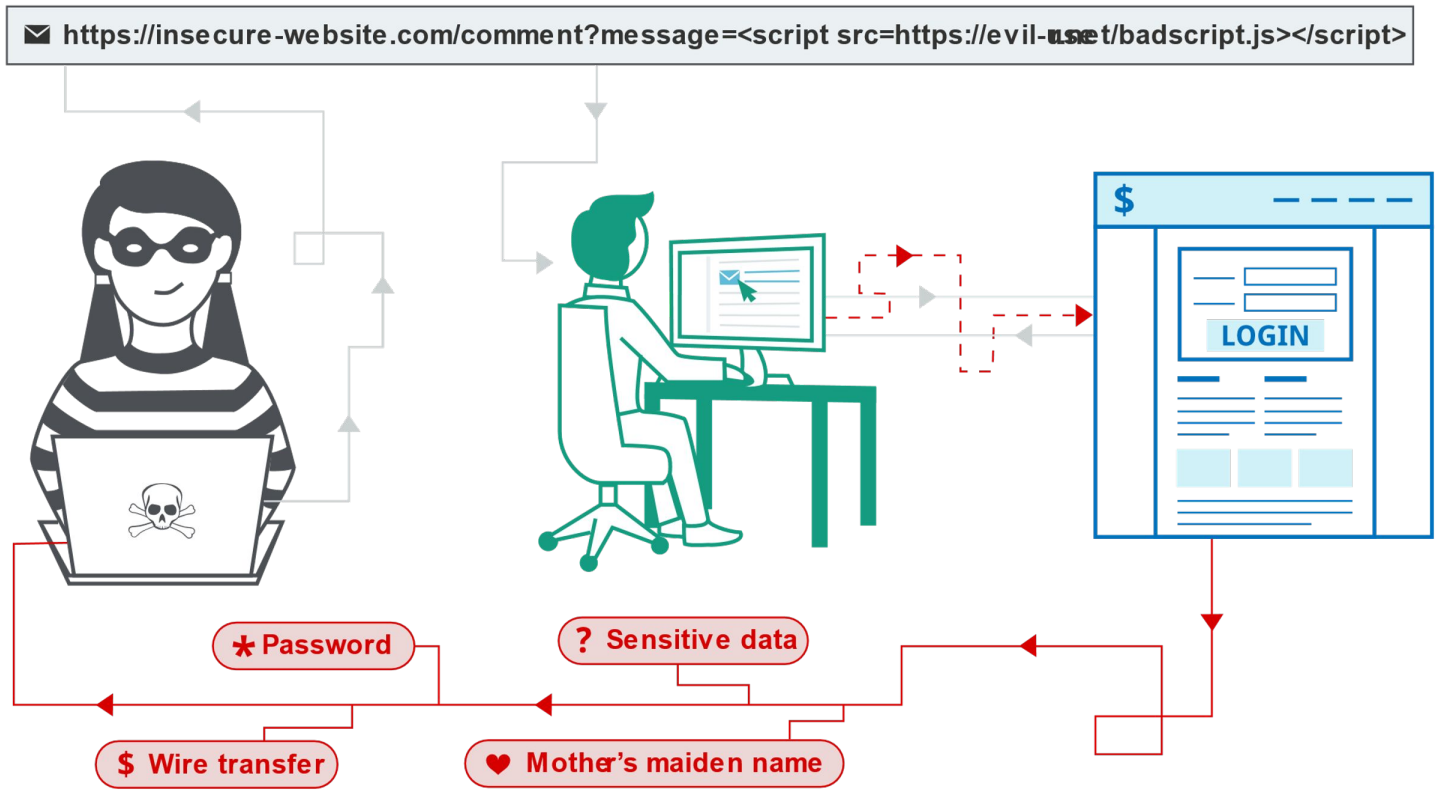
Server side

- SQLi
- Brute-force
- File upload
- Command injection

Cross-Site Scripting - XSS

- Cross-site scripting (XSS) is a security exploit which allows an attacker to inject into a website malicious client-side code.
- This code is executed by the victims and lets the attackers bypass access controls and impersonate users.
- XSS was the seventh most common Web app vulnerability in 2017 - OWASP

Cross-Site Scripting - XSS



Cross-Site Scripting - XSS

- There are three main types of XSS attacks. These are:

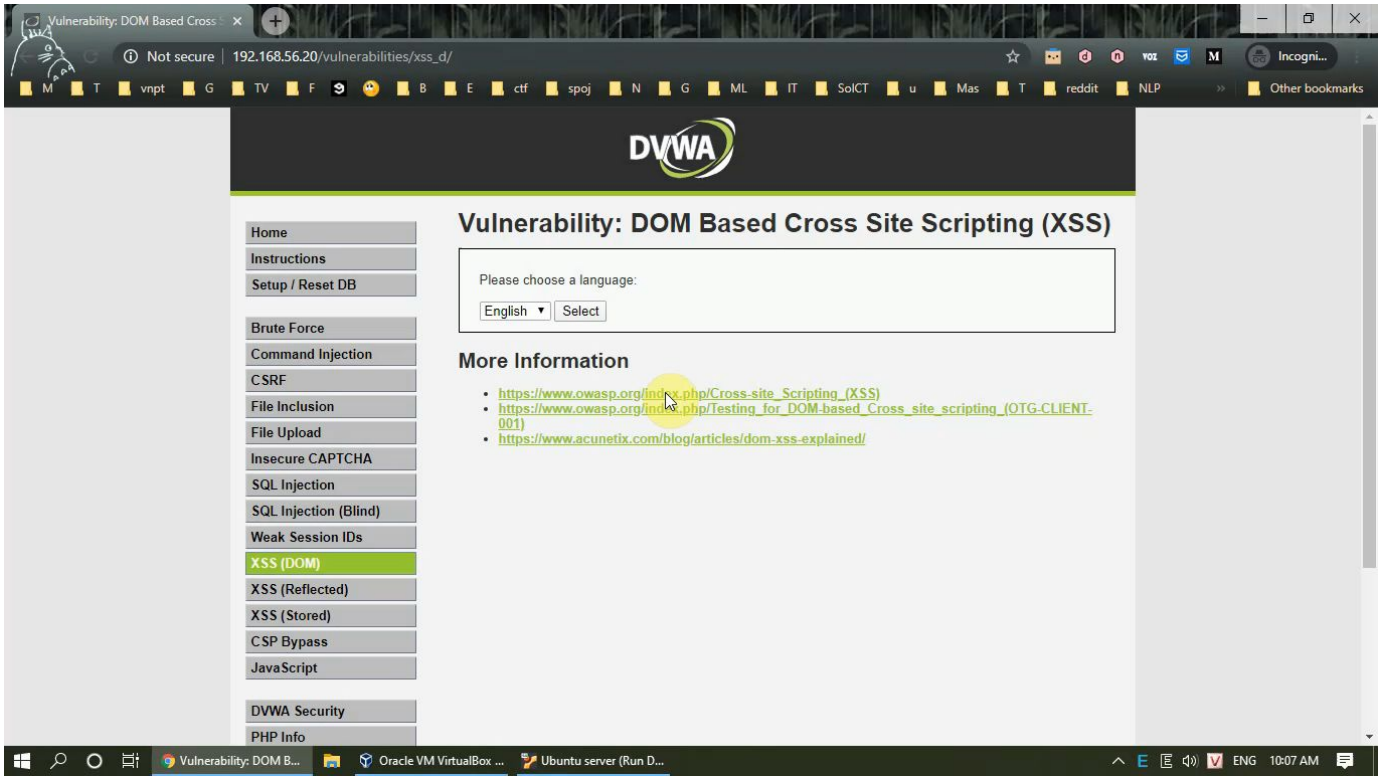
- Reflected XSS, where the malicious script comes from the current HTTP request.
- Stored XSS, where the malicious script comes from the website's database.
- DOM-based XSS, where the vulnerability exists in client-side code rather than server-side code.

Cross-Site Scripting - XSS

How to prevent XSS attacks

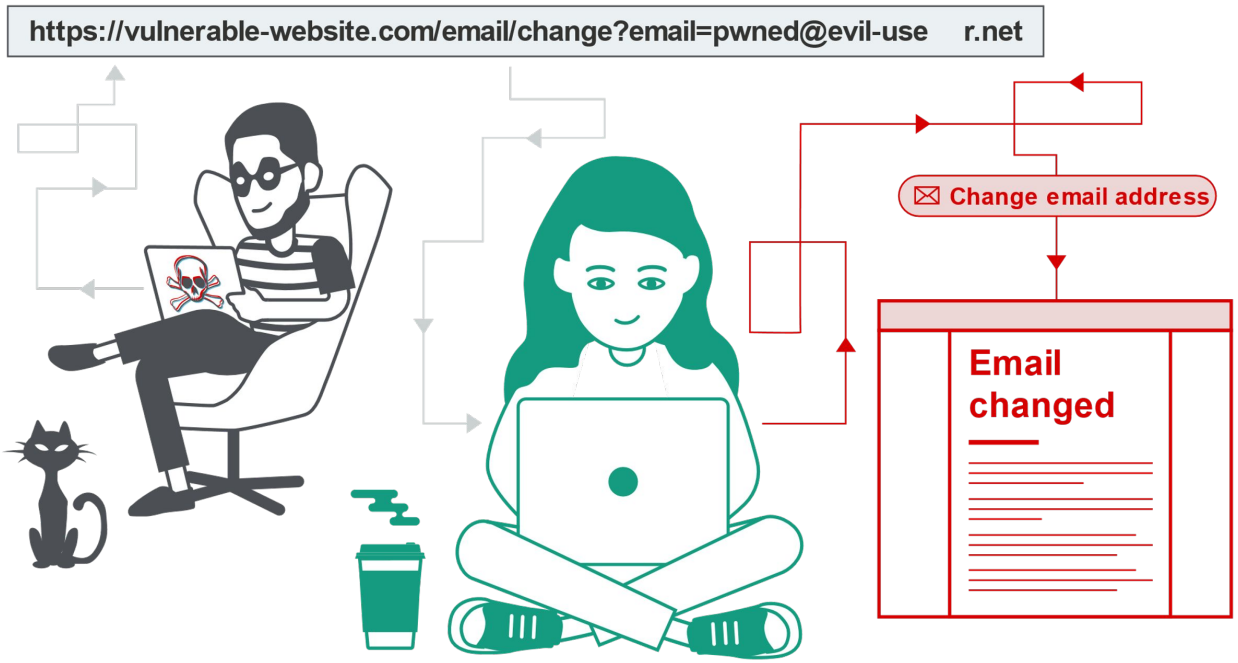
- Filter input on arrival
- Encode data on output
- Use appropriate response headers
- Content Security Policy

Cross-Site Scripting - XSS



Cross-Site Request Forgery - CSRF

- Cross-Site Request Forgery (CSRF) is an attack that forces an end user to execute unwanted actions on a web application in which they're currently authenticated.



Cross-Site Request Forgery - CSRF

- Preventing CSRF attacks:
  - Include a CSRF token within relevant requests

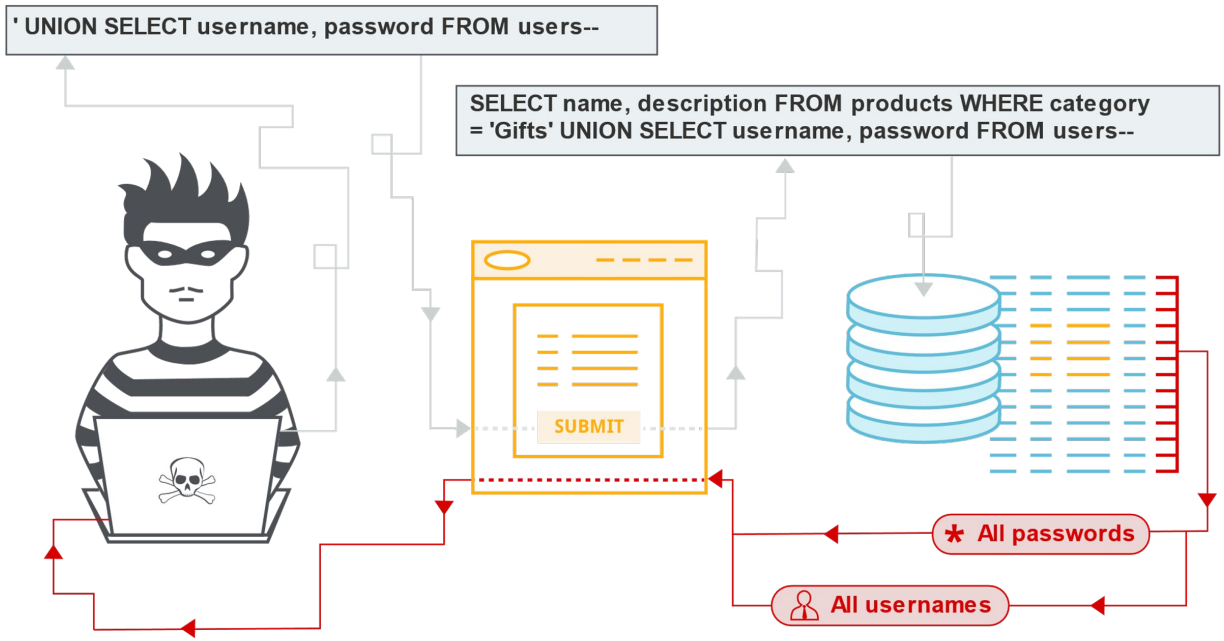
- The token should be:
  - Unpredictable with high entropy, as for session tokens in general.
  - Tied to the user's session.
  - Strictly validated in every case before the relevant action is executed.

SQL Injection

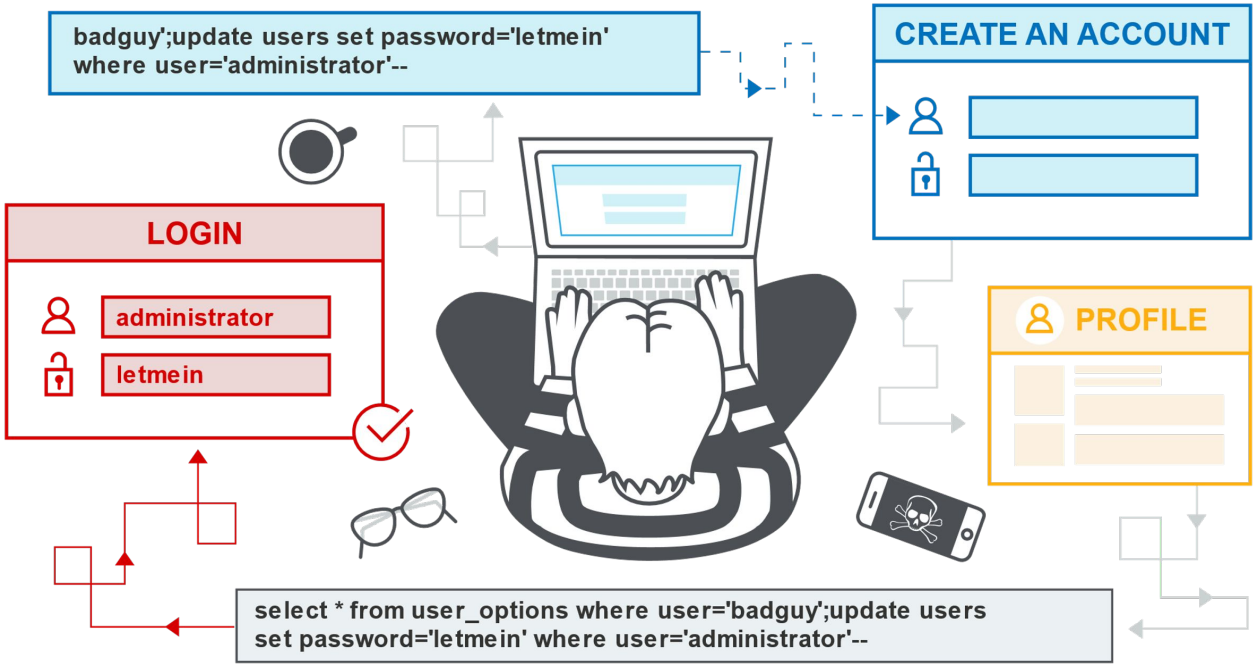
- A SQL injection attack consists of insertion or “injection” of a SQL query via the input data from the client to the application.

- SQL injection vulnerabilities enable malicious users to execute arbitrary SQL code on a database, allowing data to be accessed, modified, or deleted irrespective of the user's permissions.

SQL Injection



SQL Injection



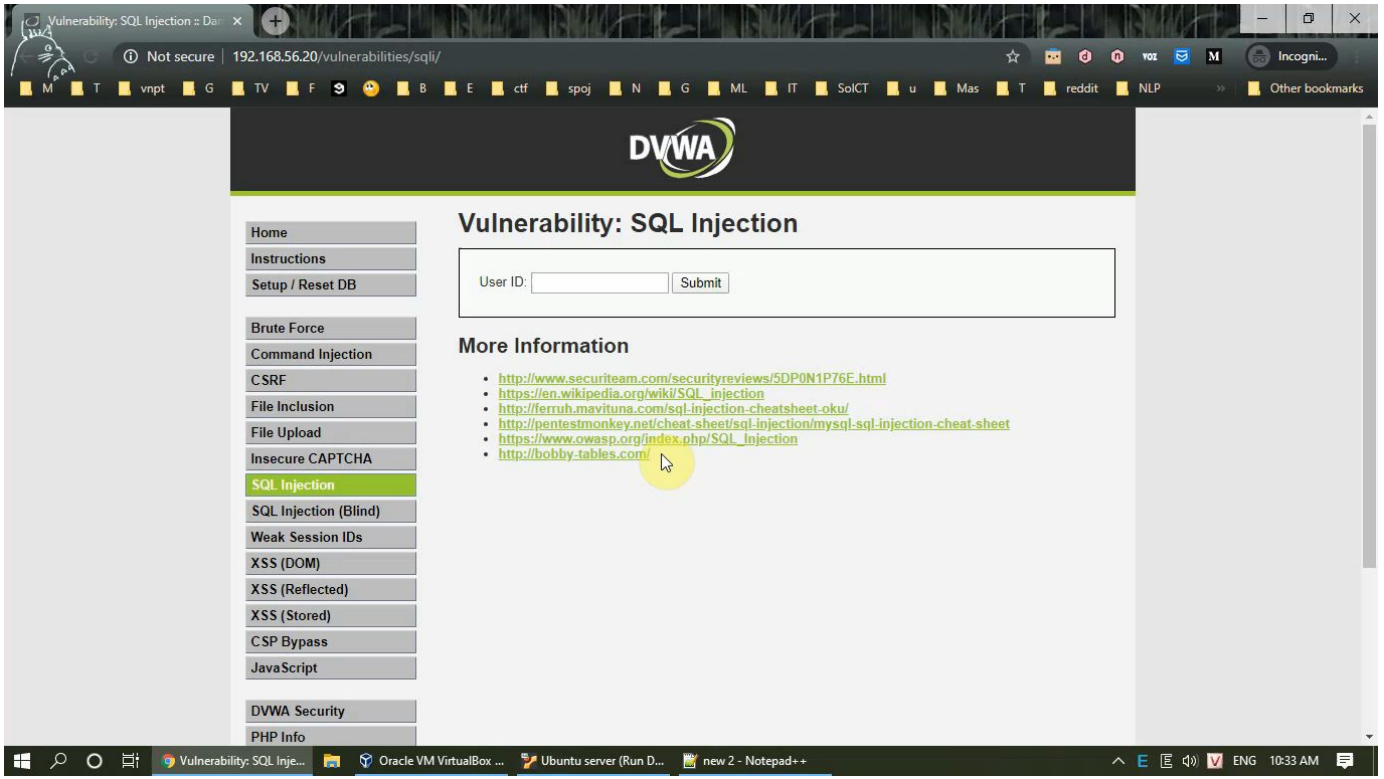
SQL Injection

- How to prevent: Using parameterized queries (also known as prepared statements) instead of string concatenation within the query.

- Before:
  - String query = "SELECT * FROM products WHERE category = '"+ input + "'";
  - Statement statement = connection.createStatement();
  - ResultSet resultSet = statement.executeQuery(query);

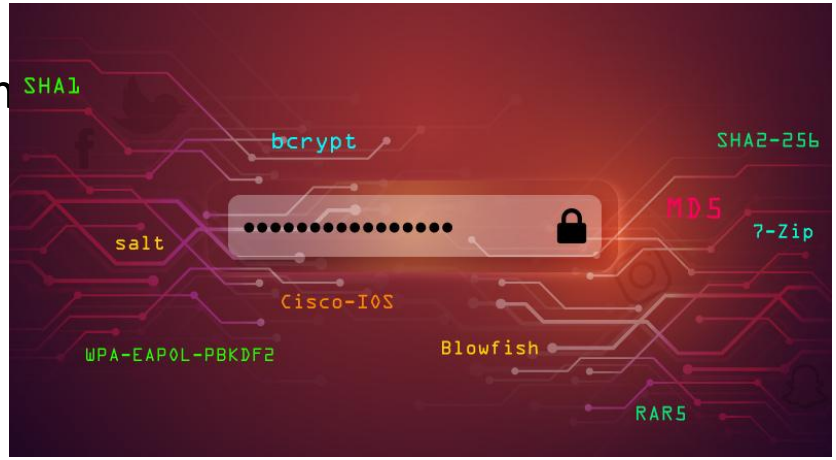
- After:
  - PreparedStatement statement = connection.prepareStatement("SELECT * FROM products WHERE category = ?");
  - statement.setString(1, input);
  - ResultSet resultSet = statement.executeQuery();

SQL Injection



Brute force

- A brute force attack, also known as an exhaustive search, is a cryptographic hack that relies on guessing possible combinations of a targeted password until the correct password is discovered.
  - Combination of letters and num
  - Use a dictionary



- Prevent password cracking:
  - Long and complex password
  - Account lock out

Brute force

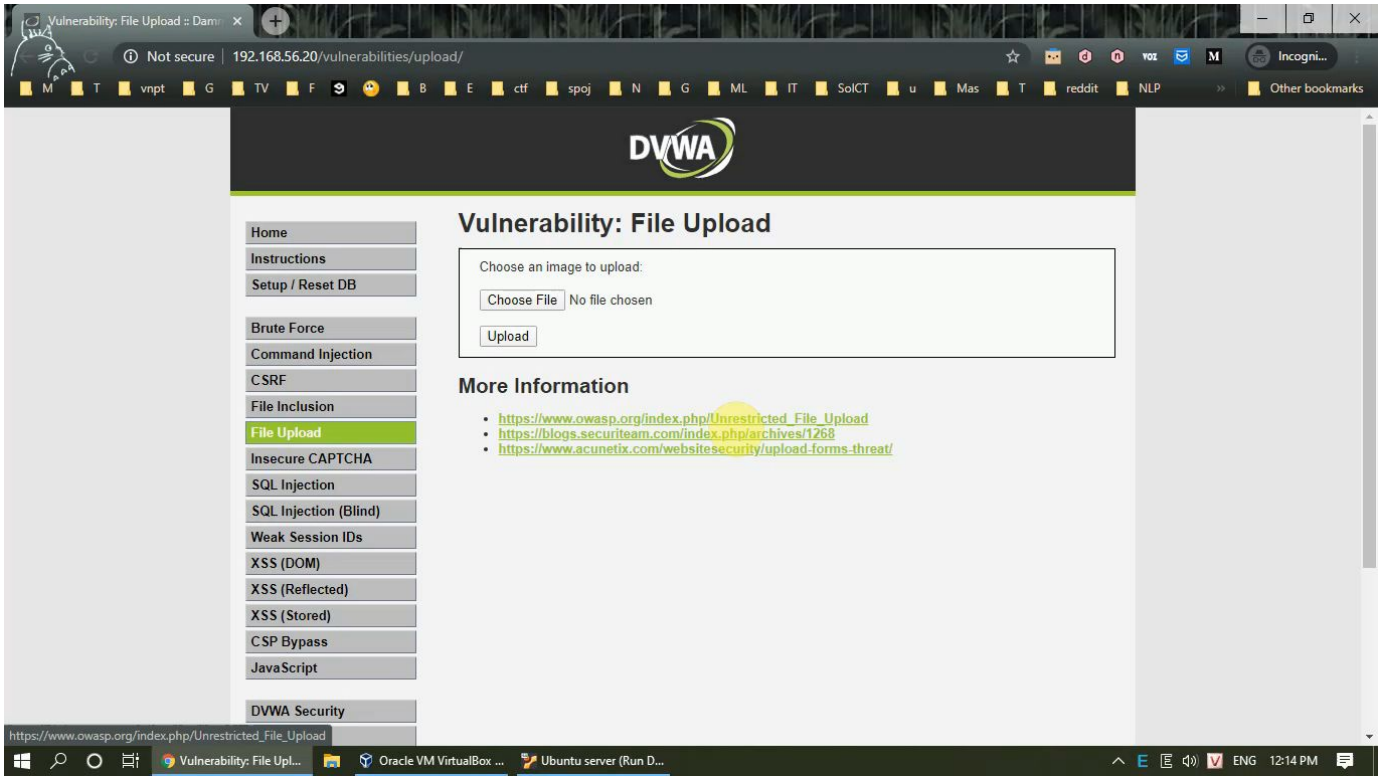
File upload

- Uploaded files represent a significant risk to applications.
- The first step in many attacks is to get some code to the system to be attacked.
- Then the attack only needs to find a way to get the code executed.

File upload

- Prevention Methods:
  - The file types allowed to be uploaded should be restricted to only those that are necessary for business functionality.
  - Never accept a filename and its extension directly without having a whitelist filter.
  - The application should perform filtering and content checking on any files which are uploaded to the server.
  - It is necessary to have a list of only permitted extensions on the web application.
  - All the control characters and Unicode ones should be removed from the filenames and their extensions without any exception.
  - Limit the filename length.
  - Uploaded directory should not have any “execute” permission and all the script handlers should be removed from these directories.
  - Limit the file size to a maximum value in order to prevent denial of service attacks.
  - The minimum size of files should be considered.
  - Use Cross Site Request Forgery protection methods.

File upload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Instructions
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CSRF
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SQL Injection (Blind)
Weak Session IDs
XSS (DOM)
XSS (Reflected)
XSS (Stored)
CSP Bypass
JavaScript
DVWA Security
Vulnerability: File Upload
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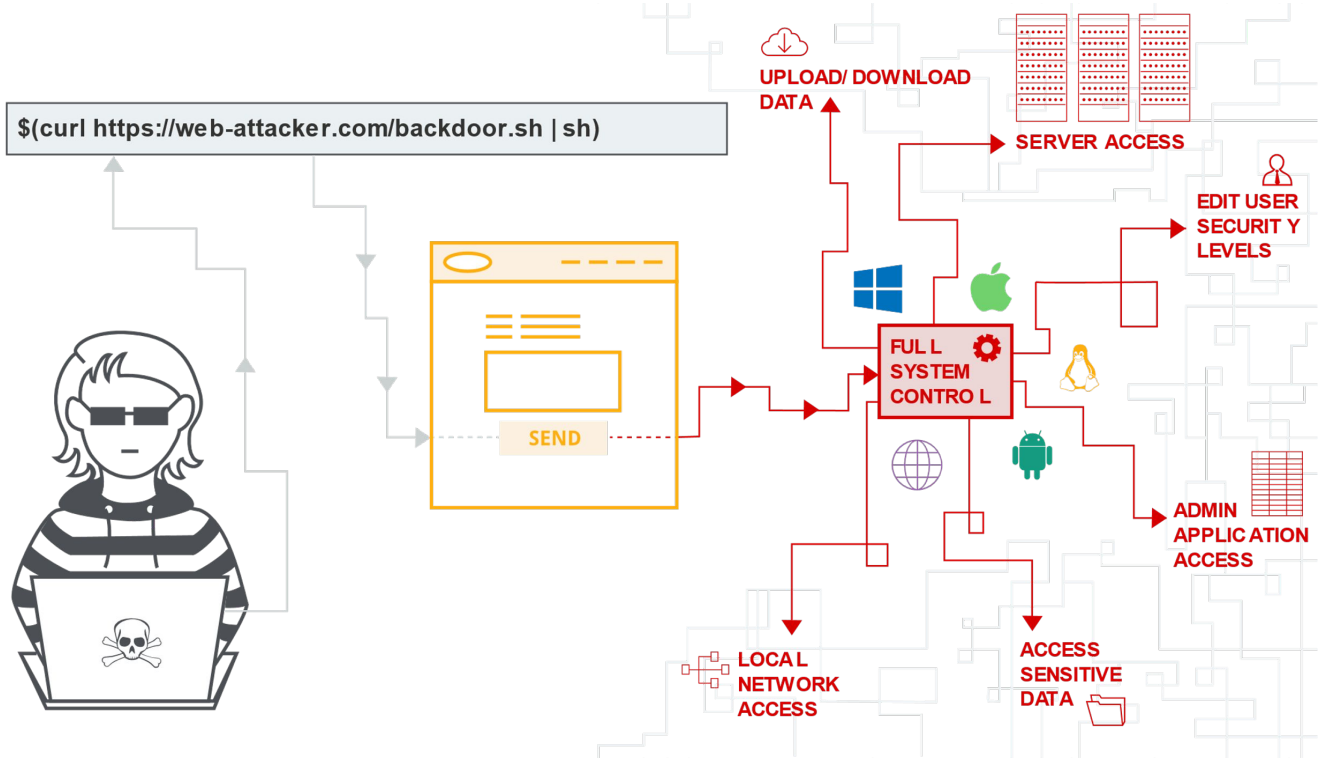
Command Injection

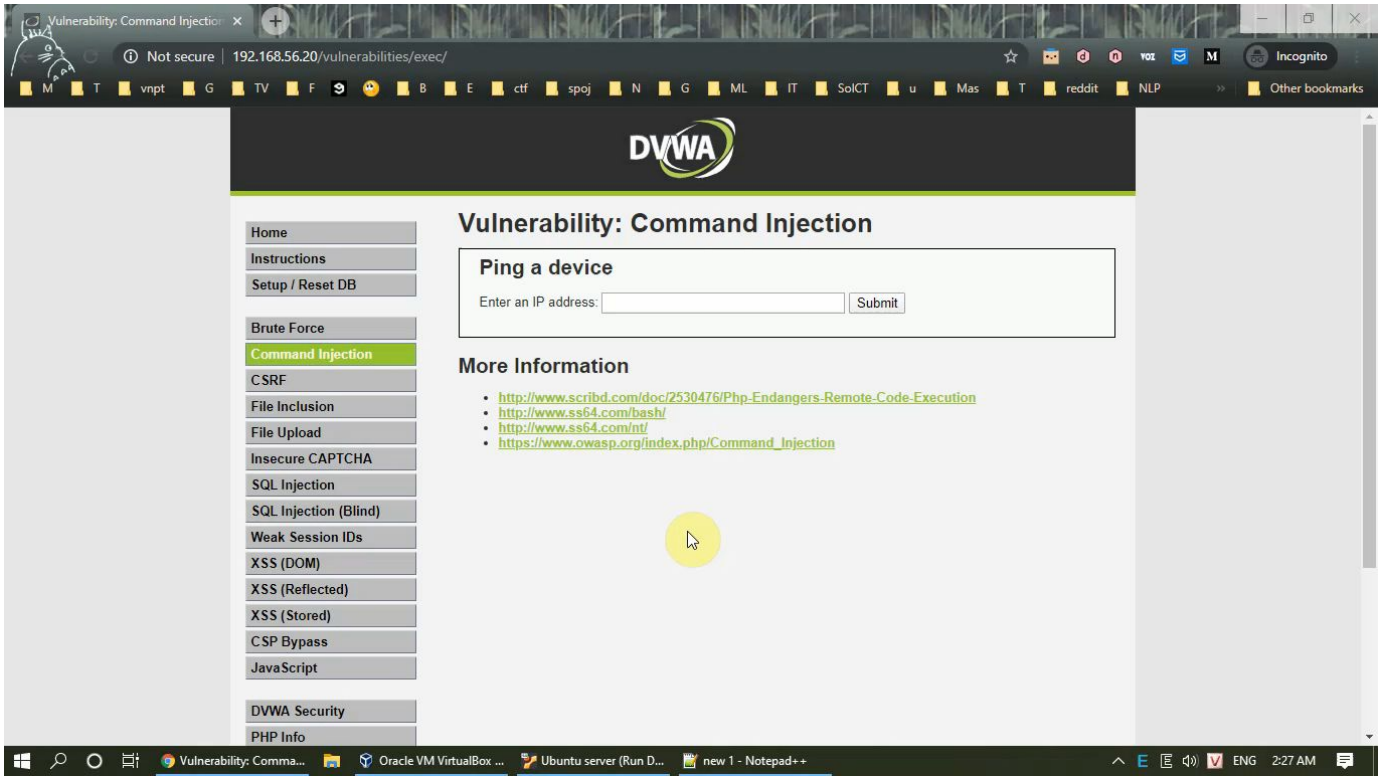
- Command injection is an attack in which the goal is execution of arbitrary commands on the host operating system via a vulnerable application.



Command Injection

- How to prevent:
  - Validating against a whitelist of permitted values.
  - Validating that the input is a number.
  - Validating that the input contains only alphanumeric characters, no other syntax or whitespace.

Command Injection



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