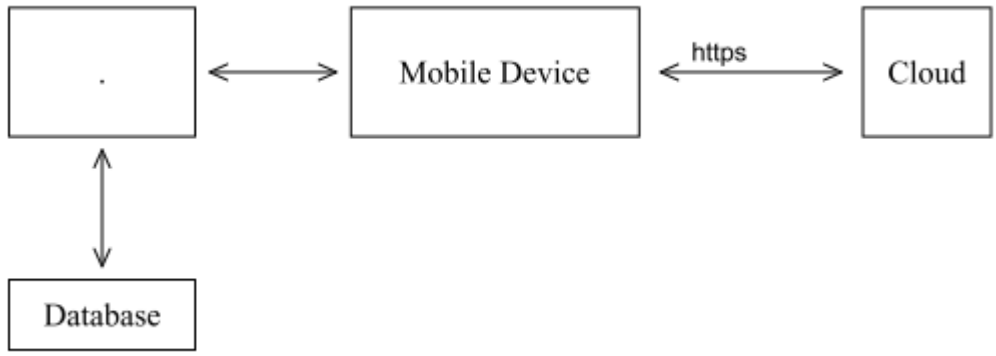
Final Report

Architeture	Hybrid Application
Application domain type	m-Health
Authentication	Username and Password
Has DB	Yes
Type of data storage	SQL
Which DB	MySQL
Type of data stored	Personal Information ; Confidential Data ; Critical Data
User Registration	Yes
Type of Registration	The users will register themselves
Programming Languages	HTML5 ; PHP
Input Forms	Yes
Upload Files	Yes
The system has logs	Yes
The system has regular updates	Yes
The system has third-party	Yes
System Cloud Environments	Public Cloud
Hardware Specification	Yes
HW Authentication	Basic Authentication (user/pass)
HW Wireless Tech	4G / LTE
Data Center Phisical Access	Yes



Input Validation

Input validation is performed to ensure only properly formed data is entering the workflow in an information system, preventing malformed data from persisting in the database and triggering malfunction of various downstream components.

Implementing input validation

- Data type validators available natively in web application frameworks
- Validation against JSON Schema and XML Schema (XSD) for input in these formats.
- Type conversion (e.g. Integer.parseInt() in Java, int() in Python) with strict exception handling
- Minimum and maximum value range check for numerical parameters and dates
- Minimum and maximum length check for strings.
- Array of allowed values for small sets of string parameters (e.g. days of week).
- Regular expressions for any other structured data covering the whole input string (^...$) and not using "any character" wildcard (such as . or \S)

If it's well structured data, like dates, social security numbers, zip codes, e-mail addresses, etc. then the developer should be able to define a very strong validation pattern, usually based on regular expressions, for validating such input. If the input field comes from a fixed set of options, like a drop down list or radio buttons, then the input needs to match exactly one of the values offered to the user in the first place. Free-form text, especially with Unicode characters, is perceived as difficult to validate due to a relatively large space of characters that need to be whitelisted. The primary means of input validation for free-form text input should be:

- Normalization: Ensure canonical encoding is used across all the text and no invalid characters are present.
- Character category whitelisting: Unicode allows whitelisting categories such as "decimal digits" or "letters" which not only covers the Latin alphabet but also various other scripts used globally (e.g. Arabic, Cyryllic, CJK ideographs etc).
- Individual character whitelisting: If you allow letters and ideographs in names and also want to allow apostrophe ' for Irish names, but don't want to allow the whole punctuation category.

Client Side vs Server Side Validation
Be aware that any JavaScript input validation performed on the client can be bypassed by an attacker that disables JavaScript or uses a Web Proxy. Ensure that any input validation performed on the client is also performed on the server.

Email Validation Basics
Many web applications do not treat email addresses correctly due to common misconceptions about what constitutes a valid address. Specifically, it is completely valid to have an mailbox address which:

- Is case sensitive in the local portion of the address (left of the rightmost @ character).
- Has non-alphanumeric characters in the local-part (including + and @).
- Has zero or more labels.

Following RFC 5321, best practice for validating an email address would be to:

- Check for presence of at least one @ symbol in the address.
- Ensure the local-part is no longer than 64 octets.
- Ensure the domain is no longer than 255 octets.
- Ensure the address is deliverable.

https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/Input_Validation_Cheat_Sheet.md

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.

Additionally, web applications will make use of sessions once the user has authenticated. This ensures the ability to identify the user on any subsequent requests as well as being able to apply security access controls, authorized access to the user private data, and to increase the usability of the application. Therefore, current web applications can provide session capabilities both pre and post authentication.

Session ID Properties

In order to keep the authenticated state and track the users progress within the web application, applications provide users with a session identifier (session ID or token) that is assigned at session creation time, and is shared and exchanged by the user and the web application for the duration of the session. The session ID is a name=value pair.

With the goal of implementing secure session IDs, the generation of identifiers (IDs or tokens) must meet the following properties:

Session ID Name Fingerprinting
The name used by the session ID should not be extremely descriptive nor offer unnecessary details about the purpose and meaning of the ID. It is recommended to change the default session ID name of the web development framework to a generic name, such as id.

Session ID Length
The session ID must be long enough to prevent brute force attacks, where an attacker can go through the whole range of ID values and verify the existence of valid sessions. The session ID length must be at least 128 bits (16 bytes).

Session ID Entropy
The session ID must be unpredictable (random enough) to prevent guessing attacks, where an attacker is able to guess or predict the ID of a valid session through statistical analysis techniques. For this purpose, a good PRNG (Pseudo Random Number Generator) must be used. The session ID value must provide at least 64 bits of entropy (if a good PRNG is used, this value is estimated to be half the length of the session ID).

Session ID Content (or Value)
The session ID content (or value) must be meaningless to prevent information disclosure attacks, where an attacker is able to decode the contents of the ID and extract details of the user, the session, or the inner workings of the web application.

The session ID must simply be an identifier on the client side, and its value must never include sensitive information. The meaning and business or application logic associated to the session ID must be stored on the server side, and specifically, in session objects or in a session management database or repository.

The stored information can include the client IP address, User-Agent, e-mail, username, user ID, role, privilege level, access rights, language preferences, account ID, current state, last login, session timeouts, and other internal session details. If the session objects and properties contain sensitive information, such as credit card numbers, it is required to duly encrypt and protect the session management repository. It is recommended to create cryptographically strong session IDs through the usage of cryptographic hash functions such as SHA256.

Inactivity Time Out*
Authenticated sessions should timeout after determined period of inactivity - 15 minutes is recommended.

Login & Logout
New session IDs should be created on login (to prevent session fixation via XSS on sibling domains or subdomains). Upon logout the session ID should be invalidated on the server side and deleted on the client via expiration/overwriting the value.

Cookies

The session ID exchange mechanism based on cookies provides multiple security features in the form of cookie attributes that can be used to protect the exchange of the session ID:

Secure Attribute The Secure cookie attribute instructs web browsers to only send the cookie through an encrypted HTTPS (SSL/TLS) connection. This session protection mechanism is mandatory to prevent the disclosure of the session ID through MitM (Man-in-the-Middle) attacks. It ensures that an attacker cannot simply capture the session ID from web browser traffic.

HttpOnly Attribute The HttpOnly cookie attribute instructs web browsers not to allow scripts an ability to access the cookies via the DOM document.cookie object. This session ID protection is mandatory to prevent session ID stealing through XSS attacks.

SameSite Attribute SameSite allows a server define a cookie attribute making it impossible to the browser send this cookie along with cross-site requests. The main goal is mitigate the risk of cross-origin information leakage, and provides some protection against cross-site request forgery attacks.

Domain and Path Attributes The Domain cookie attribute instructs web browsers to only send the cookie to the specified domain and all subdomains. If the attribute is not set, by default the cookie will only be sent to the origin server. The Path cookie attribute instructs web browsers to only send the cookie to the specified directory or subdirectories (or paths or resources) within the web application. If the attribute is not set, by default the cookie will only be sent for the directory (or path) of the resource requested and setting the cookie.

Expire and Max-Age Attributes Typically, session management capabilities to track users after authentication make use of non-persistent cookies. This forces the session to disappear from the client if the current web browser instance is closed. Therefore, it is highly recommended to use non-persistent cookies for session management purposes, so that the session ID does not remain on the web client cache for long periods of time, from where an attacker can obtain it.

- Ensure that sensitive information is not comprised, by ensuring that sensitive information is not persistent / encrypting /stored on a need basis for the duration of the need
- Ensure that unauthorized activities cannot take place via cookie manipulation Ensure secure flag is set to prevent accidental transmission over "the wire" in a non-secure manner
- Determine if all state transitions in the application code properly check for the cookies and enforce their use
- Ensure entire cookie should be encrypted if sensitive data is persisted in the cookie
- Define all cookies being used by the application, their name and why they are needed

https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/Session_Management_Cheat_Sheet.md

Cross Site Scripting (XSS)

Given the way browsers parse HTML, each of the different types of slots has slightly different security rules. When you put untrusted data into these slots, you need to take certain steps to make sure that the data does not break out of that slot into a context that allows code execution.

HTML entity encoding is okay for untrusted data that you put in the body of the HTML document, such as inside a "div" tag. It even sort of works for untrusted data that goes into attributes, particularly if you're religious about using quotes around your attributes. But HTML entity encoding doesn't work if you're putting untrusted data inside a "script" tag anywhere, or an event handler attribute like onmouseover, or inside CSS, or in a URL.

XSS Prevention Rules

- Never Insert Untrusted Data Except in Allowed Locations - The first rule is to deny all
- HTML Escape Before Inserting Untrusted Data into HTML Element Content
- Attribute Escape Before Inserting Untrusted Data into HTML Common Attributes
- JavaScript Escape Before Inserting Untrusted Data into JavaScript Data Values
- HTML escape JSON values in an HTML context and read the data with JSON.parse
- Ensure returned Content-Type header is application/json and not text/html.
- CSS Escape And Strictly Validate Before Inserting Untrusted Data into HTML Style Property Values
- URL Escape Before Inserting Untrusted Data into HTML URL Parameter Values
- Sanitize HTML Markup with a Library Designed for the Job
- Prevent DOM-based XSS
- Use HTTPOnly cookie flag
- Implement Content Security Policy
- Use an Auto-Escaping Template System
- Use the X-XSS-Protection Response Header
- Properly use modern JS frameworks like Angular (2+) or ReactJS

https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/Cross_Site_Scripting_Prevention_Cheat_Sheet.md

Cryptography

An architectural decision must be made to determine the appropriate method to protect data at rest. There are such wide varieties of products, methods and mechanisms for cryptographic storage.The general practices and required minimum key length depending on the scenario listed below:

Good practices:

- Cryptographic algorithms are up to date and in-line with industry standards. This includes, but is not limited to outdated block ciphers (e.g. DES), stream ciphers (e.g. RC4), as well as hash functions (e.g. MD5) and broken random number generators like Dual_EC_DRBG (even if they are NIST certified). All of these should be marked as insecure and should not be used and removed from the application and server.
- Key lengths are in-line with industry standards and provide protection for sufficient amount of time. A comparison of different key lengths and protection they provide taking into account Moore's law is available online.
- Cryptographic means are not mixed with each other: e.g. you do not sign with a public key, or try to reuse a keypair used for a signature to do encryption.
- Cryptographic parameters are well defined within reasonable range. This includes, but is not limited to: cryptographic salt, which should be at least the same length as hash function output, reasonable choice of password derivation function and iteration count (e.g. PBKDF2, scrypt or bcrypt), IVs being random and unique, fit-for-purpose block encryption modes (e.g. ECB should not be used, except specific cases), key management being done properly (e.g. 3DES should have three independent keys) and so on.

Recommended Algorithms: * Confidentiality algorithms: AES-GCM-256 or ChaCha20-Poly1305; * Integrity algorithms: SHA-256, SHA-384, SHA-512, Blake2; * Digital signature algorithms: RSA (3072 bits and higher), ECDSA with NIST P-384; * Key establishment algorithms: RSA (3072 bits and higher), DH (3072 bits or higher), ECDH with NIST P-384; * Application must be capable of using end-to-end encryption via SSL / TLS in relation to sensitive data in transit and at rest.

Additionally, you should always rely on secure hardware (if available) for storing encryption keys, performing cryptographic operations, etc.

Secure Cryptographic Storage Design:

- All protocols and algorithms for authentication and secure communication should be well vetted by the cryptographic community.
- Ensure certificates are properly validated against the hostnames users whom they are meant for.
- Avoid using wildcard certificates unless there is a business need for it
- Maintain a cryptographic standard to ensure that the developer community knows about the approved ciphersuits for network security protocols, algorithms, permitted use, cryptoperiods and Key Management.
- Only store sensitive data that you need

Use strong approved Authenticated Encryption
CCM or GCM are approved Authenticated Encryption modes based on AES algorithm.

Use strong approved cryptographic algorithms

- Do not implement an existing cryptographic algorithm on your own, no matter how easy it appears. * Instead, use widely accepted algorithms and widely accepted implementations.
- Only use approved public algorithms such as AES, RSA public key cryptography, and SHA-256 or better for hashing.
- Do not use weak algorithms, such as MD5 or SHA1.
- Avoid hashing for password storage,instead use Argon2, PBKDF2, bcrypt or scrypt.
- See NIST approved algorithms or ISO TR 14742 "Recommendations on Cryptographic Algorithms or Algorithms", key size and parameters by European Union Agency for Network and Information Security.
- If a password is being used to protect keys then the password strength should be sufficient for the strength of the keys it is protecting. * When 3DES is used, ensure K1 != K2 != K3, and the minimum key length must be 192 bits .
- Do not use ECB mode for encrypting lots of data (the other modes are better because they chain the blocks of data together to improve the data security).

Use strong random numbers

- Ensure that all random numbers, especially those used for cryptographic parameters (keys, IV's, MAC tags), random file names, random GUIDs, and random strings are generated in a cryptographically strong fashion.
- Ensure that random algorithms are seeded with sufficient entropy.
- Tools like NIST RNG Test tool can be used to comprehensively assess the quality of a Random Number Generator by reading e.g. 128MB of data from the RNG source and then assessing its randomness properties with the tool.

The following libraries are considered weak random numbers generators and should not be used:

C library: random(), rand(), use getrandom(2) instead
Java library: java.util.Random() instead use java.security.SecureRandom instead
For secure random number generation, refer to NIST SP 800-90A. CTR-DRBG, HASH-DRBG, HMAC-DRBG are recommended

https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/Cryptographic_Storage_Cheat_Sheet.md

Authentication and Integrity

Introduction

This cheat sheet provides a simple model to follow when implementing transport layer protection for an application. Although the concept of SSL is known to many, the actual details and security specific decisions of implementation are often poorly understood and frequently result in insecure deployments. This article establishes clear rules which provide guidance on securely designing and configuring transport layer security for an application. This article is focused on the use of SSL/TLS between a web application and a web browser, but we also encourage the use of SSL/TLS or other network encryption technologies, such as VPN, on back end and other non-browser based connections.

Architectural Decision

An architectural decision must be made to determine the appropriate method to protect data when it is being transmitted. The most common options available to corporations are Virtual Private Networks (VPN) or a SSL/TLS model commonly used by web applications. The selected model is determined by the business needs of the particular organization. For example, a VPN connection may be the best design for a partnership between two companies that includes mutual access to a shared server over a variety of protocols. Conversely, an Internet facing enterprise web application would likely be best served by a SSL/TLS model.

TLS is mainly a defence against man-in-the-middle attacks. An TLS Threat Model is one that starts with the question "What is the business impact of an attacker's ability to observe, intercept and manipulate the traffic between the client and the server".

This cheat sheet will focus on security considerations when the SSL/TLS model is selected. This is a frequently used model for publicly accessible web applications.

Providing Transport Layer Protection with SSL/TLS

Benefits *

The primary benefit of transport layer security is the protection of web application data from unauthorized disclosure and modification when it is transmitted between clients (web browsers) and the web application server, and between the web application server and back end and other non-browser based enterprise components.

The server validation component of TLS provides authentication of the server to the client. If configured to require client side certificates, TLS can also play a role in client authentication to the server. However, in practice client side certificates are not often used in lieu of username and password based authentication models for clients.

TLS also provides two additional benefits that are commonly overlooked; integrity guarantees and replay prevention. A TLS stream of communication contains built-in controls to prevent tampering with any portion of the encrypted data. In addition, controls are also built-in to prevent a captured stream of TLS data from being replayed at a later time.

It should be noted that TLS provides the above guarantees to data during transmission. TLS does not offer any of these security benefits to data that is at rest. Therefore appropriate security controls must be added to protect data while at rest within the application or within data stores.

Good Practices *

Use TLS, as SSL is no longer considered usable for security;

- All pages must be served over HTTPS. This includes css, scripts, images, AJAX requests, POST data and third party includes. Failure to do so creates a vector for man-in-the-middle attacks;
- Just protecting authenticated pages with HTTPS, is not enough. Once there is one request in HTTP, man-in-the-middle attacks are possible, with the attackers being able to prevent users from reaching the secured pages.

The HTTP Strict Transport Security Header must be used and pre loaded into browsers. This will instruct compatible browsers to only use HTTPS, even if requested to use HTTP. Cookies must be marked as Secure.

Basic Requirements *

Access to a Public Key Infrastructure (PKI) in order to obtain certificates;

- Access to a directory or an Online Certificate Status Protocol (OCSP) responder in order to check certificate revocation status;
- Agreement/ability to support a minimum configuration of protocol versions and protocol options for each version.

[https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/Transport_Layer_Protection_Cheat_Sheet.md]

Access Control

Authorization is the process where requests to access a particular resource should be granted or denied. It should be noted that authorization is not equivalent to authentication - as these terms and their definitions are frequently confused. Authentication is providing and validating identity. Authorization includes the execution rules that determines what functionality and data the user (or Principal) may access, ensuring the proper allocation of access rights after authentication is successful.

Web applications need access controls to allow users (with varying privileges) to use the application. They also need administrators to manage the applications access control rules and the granting of permissions or entitlements to users and other entities.

Role Based Access Control (RBAC)
Access decisions are based on an individual's roles and responsibilities within the organization or user base. An RBAC access control framework should provide web application security administrators with the ability to determine who can perform what actions, when, from where, in what order, and in some cases under what relational circumstances.

Advantages:

- Roles are assigned based on organizational structure with emphasis on the organizational security policy

- Easy to use
- Easy to administer
- Built into most frameworks
- Aligns with security principles like segregation of duties and least privileges

Problems:

- Documentation of the roles and accesses has to be maintained stringently.
- Multi-tenancy can not be implemented effectively unless there is a way to associate the roles with multi-tenancy capability requirements e.g. OU in Active Directory
- There is a tendency for scope creep to happen e.g. more accesses and privileges can be given than intended for. Or a user might be included in two roles if proper access reviews and subsequent revocation is not performed.
- Does not support data based access control

Areas of caution:

- Roles must be only be transferred or delegated using strict sign-offs and procedures.
- When a user changes his role to another one, the administrator must make sure that the earlier access is revoked such that at any given point of time, a user is assigned to only those roles on a need to know basis.
- Assurance for RBAC must be carried out using strict access control reviews.

Discretionary Access Control (DAC) is a means of restricting access to information based on the identity of users and/or membership in certain groups. Access decisions are typically based on the authorizations granted to a user based on the credentials he presented at the time of authentication. The owner of information or any resource is able to change its permissions at his discretion.

Advantages:

- Easy to use
- Easy to administer
- Aligns to the principle of least privileges.
- Object owner has total control over access granted

Problems:

- Documentation of the roles and accesses has to be maintained stringently.
- Multi-tenancy can not be implemented effectively unless there is a way to associate the roles with multi-tenancy capability requirements
- There is a tendency for scope creep to happen e.g. more accesses and privileges can be given than intended for.

Areas of caution:

- While granting trusts
- Assurance for DAC must be carried out using strict access control reviews.

Mandatory Access Control (MAC) Ensures that the enforcement of organizational security policy does not rely on voluntary web application user compliance. MAC secures information by assigning sensitivity labels on information and comparing this to the level of sensitivity a user is operating at.MAC is usually appropriate for extremely secure systems including multilevel secure military applications or mission critical data applications.

Advantages :

- Access to an object is based on the sensitivity of the object
- Access based on need to know is strictly adhered to and scope creep has minimal possibility
- Only an administrator can grant access

Problems :

- Difficult and expensive to implement
- Not agile

Areas of caution :

- Classification and sensitivity assignment at an appropriate and pragmatic level
- Assurance for MAC must be carried out to ensure that the classification of the objects is at the appropriate level.

Permission Based Access Control Is the abstraction of application actions into a set of permissions. A permission may be represented simply as a string based name, for example "READ". Access decisions are made by checking if the current user has the permission associated with the requested application action.

The has relationship between the user and permission may be satisfied by creating a direct relationship between the user and permission (called a grant), or an indirect one. In the indirect model the permission grant is to an intermediate entity such as user group.

A user is considered a member of a user group if and only if the user inherits permissions from the user group. Systems that provide fine-grained domain object level access control, permissions may be grouped into classes. The system can be associated with a class which determines the permissions applicable to the respective domain object.

> In such a system a "DOCUMENT" class may be defined with the permissions "READ", "WRITE" and "DELETE"; a "SERVER" class may be defined with the permissions "START", "STOP", and "REBOOT".

File Uploading

Into web applications, when we expect upload of working documents from users, we can expose the application to submission of documents that we can categorize as malicious. We use the term "malicious" here to refer to documents that embed malicious code that will be executed when another user (admin, back office operator...) will open the document with the associated application reader.
Usually, when an application expect his user to upload a document, the application expect to receive a document for which the intended use will be for reading/printing/archiving. The document should not alter is content at opening time and should be in a final rendered state.

The most common file types used to transmit malicious code into file upload feature are the following:

- Microsoft Office document: Word/Excel/Powerpoint
- Adobe PDF document: Insert malicious code as attachment.
- Images: Malicious code embedded into the file or use of binary file with image file extension.

For Word/Excel/Powerpoint/Pdf documents:

> Detect when a document contains "code"/OLE package, if it's the case then block the upload process. For Images document: Sanitize incoming image using re-writing approach and then disable/remove any "code" present (this approach also handle case in which the file sent is not an image).

Upload Verification

- Use input validation to ensure the uploaded filename uses an expected extension type
- Ensure the uploaded file is not larger than a defined maximum file size

Upload Storage

- Use a new filename to store the file on the OS. Do not use any user controlled text for this filename or for the temporary filename.
- Store all user uploaded files on a separate domain. Archives should be analyzed for malicious content (anti-malware, static analysis, etc).

Public Serving of Uploaded Content

- Ensure the image is served with the correct content-type (e.g. image/jpeg, application/x-xpinstall)

Beware of "special" files

> The upload feature should be using a whitelist approach to only allow specific file types and extensions. However, it is important to be aware of the following file types that, if allowed, could result in security vulnerabilities.
>
> "crossdomain.xml" allows cross-domain data loading in Flash, Java and Silverlight. If permitted on sites with authentication this can permit cross-domain data theft and CSRF attacks. Note this can get pretty complicated depending on the specific plugin version in question, so its best to just prohibit files named "crossdomain.xml" or "clientaccesspolicy.xml".
>
> ".htaccess" and ".htpasswd" provides server configuration options on a per-directory basis, and should not be permitted.

Logging and Error Handling

Purpose of logging Application logging should be always be included for security events. Application logs are invaluable data for:

Identifying security incidents
Monitoring policy violations
Establishing baselines
Assisting non-repudiation controls
Providing information about problems and unusual conditions Contributing additional application-specific data for incident investigation which is lacking in other log sources
Helping defend against vulnerability identification and exploitation through attack detection

> Each log entry needs to include sufficient information for the intended subsequent monitoring and analysis. It could be full content data, but is more likely to be an extract or just summary properties.
>
> The application logs must record "when, where, who and what" for each event.

Where to record event data

- When using the file system, it is preferable to use a separate partition than those used by the operating system, other application files and user generated content

    For file-based logs, apply strict permissions concerning which users can access the directories, and the permissions of files within the directories In web applications, the logs should not be exposed in web-accessible locations, and if done so, should have restricted access and be configured with a plain text MIME type (not HTML)

- When using a database, it is preferable to utilize a separate database account that is only used for writing log data and which has very restrictive database , table, function and command permissions
- Use standard formats over secure protocols to record and send event data, or log files, to other systems e.g. Common Log File System (CLFS) or Common Event Format (CEF) over syslog; standard formats facilitate integration with centralised logging services.

Which events to log

- Input validation failures e.g. protocol violations, unacceptable encodings, invalid parameter names and values
- Output validation failures e.g. database record set mismatch, invalid data encoding
- Authentication successes and failures
- Authorization (access control) failures
- Session management failures e.g. cookie session identification value modification
- Application errors and system events e.g. syntax and runtime errors, connectivity problems, performance issues, third party service error messages, file system errors, file upload virus detection, configuration changes
- Application and related systems start-ups and shut-downs, and logging initialization (starting, stopping or pausing)
- Use of higher-risk functionality e.g. network connections, addition or deletion of users, changes to privileges, assigning users to tokens, adding or deleting tokens, use of systems administrative privileges, access by application administrators,all actions by users with administrative privileges, access to payment cardholder data, use of data encrypting keys, key changes, creation and deletion of system-level objects, data import and export including screen-based reports, submission of user-generated content - especially file uploads.

Data to exclude

- Application source code
- Session identification values (consider replacing with a hashed value if needed to track session specific events)
- Access tokens
- Sensitive personal data and some forms of personally identifiable information (PII) e.g. health, government identifiers, vulnerable people
- Authentication passwords
- Database connection strings
- Encryption keys and other master secrets
- Bank account or payment card holder data
- Data of a higher security classification than the logging system is allowed to store
- Commercially-sensitive information
- Information it is illegal to collect in the relevant jurisdictions
- Information a user has opted out of collection, or not consented to e.g. use of do not track, or where consent to collect has expired

Error Handling

User Facing Error Messages
Error messages displayed to the user should not contain system, diagnostic or debug information.

Formatting Error Messages

Error messages are often logged to text files or files viewed within a web browser.

- text based log files: Ensure any newline characters (%0A%0C) are appropriately handled to prevent log forging
- web based log files: Ensure any logged html characters are appropriately encoded to prevent XSS when viewing logs

Recommended Error Handling Design

- Log necessary error data to a system log file
- Display a generic error message to the user
- If necessary provide an error code to the user which maps to the error data in the logfile. A user reporting an error can provide this code to help diagnose issue

https://github.com/OWASP/CheatSheetSeries/blob/master/cheatsheets/Logging_Cheat_Sheet.md

Application Regular Updates

Mobile devices and platforms, such as, for example, smartphones, typically provide the capability for operating system (OS), firmware (FW) and applications updates or re-installations with reduced user involvement. The user involvement may often be limited to clicking an icon or accepting an agreement. While this

reduced level of involvement may provide convenience and an improved user experience, it fails to address the issue of secure user authentication.

Mobile devices and platforms, such as smartphones, typically provide features for operating system (OS), firmware (FW) upgrades, and applications or reinstallations with reduced user engagement. User engagement may be limited to clicking an icon or accepting a contract. While this reduced level of engagement can provide convenience and enhance the user experience, it does not address the issue of secure user authentication. Thus, it is necessary to create a secure channel that provides confidentiality, integrity, authentication and data updating.

Requirements for a secure software update:

Data Confidentiality: the contents of transmitted data should be kept confidential. This also includes software updates. Thus, secure channels between the mobile device and the network manager must be set up. The standard approach to keep sensitive data secret is to encrypt the data with a key that is shared only between the intended receivers;

Data integrity: it must be possible to ensure that data packets have not been modified in transit. For mobile devices, control requests, and software updates it is critically important to verify that the contents in the packets have not been tampered with;

Data Authentication: To prevent an attacker from injecting packets it is important to make sure that the receiver can verify the sender of the packets. Data authentication ensures this property such that the re- ceiver can verify that the received packets really are from the claimed sender. For example, for software updates, data authentication is needed such that the device can verify that the received software comes from a trusted source. Data authentication can be achieved using a MAC or Digital Signature;

Data Freshness: to protect against replay attacks, e.g., during the key establishment phase, the proto- col must ensure that the messages are fresh. Data freshness ensures the security property that the data is recent and that an attacker is not replaying old data.

Third-Party Applications

Many social networks also offer the possibility to create additional applications that extend the functionality of the network. The two major platforms for such applications are the Facebook Platform and Open Social. While applications designed for the Facebook Platform can only be executed in Facebook, Open Social is a combined effort to allow developers to run their applications on any social network that supports the Open Social platform (e.g., MySpace and Orkut).

Requirements for a secure third-party applications:

Data Privacy;

Data Authentication;

Data Authorization.

Apps that process or query sensitive information should run in a trusted and secure environment. To create this environment, the app can check the device for the following:

- PIN - or password-protected device locking;
- Recent Mobile Plataform or OS version;
- USB Debugging activation;
- Device encryption;
- Device rooting (see also "Testing Root Detection").

Man-in-the-Middle Attack

In this type of attack an active Man listening and changing communications between Mobile Device and Cloud. In other hand, in this attack an intruder enters in the ongoing conversation between sender and the receiver and makes them believe that conversation is taking place between them only.

Definition

This type of attack occurs whenever an attacker intends to intercept communications in order to interpret or alter the original data in transit between the sender and the receiver establishing a conversation.

Attacker Powers

The attacker generally and depending on whether the communication situation is encrypted or not, is able to modify the cryptographically unprotected communication or modify the cryptographically protected communication. More specifically, it will have the following powers:

- Steal encryption key;
- Discover cryptographic key using cryptanalysis;
- Exploit vulnerabilities in cryptographic algorithm;
- Exploit vulnerabilities in cryptographic protocol.

Man-in-the-Middle Attack Diagram

Cross Site Scripting Attacks

In short, Cross Site Scripting (XSS) allows an attacker to execute a browser script bypassing access control mechanisms such as the same origin policy. During this attack a malicious script is injected into web content and user considering it to be authentic executes it over its own machine, thus giving either control of the machine or exposure of confidential information to the attacker.

Definition

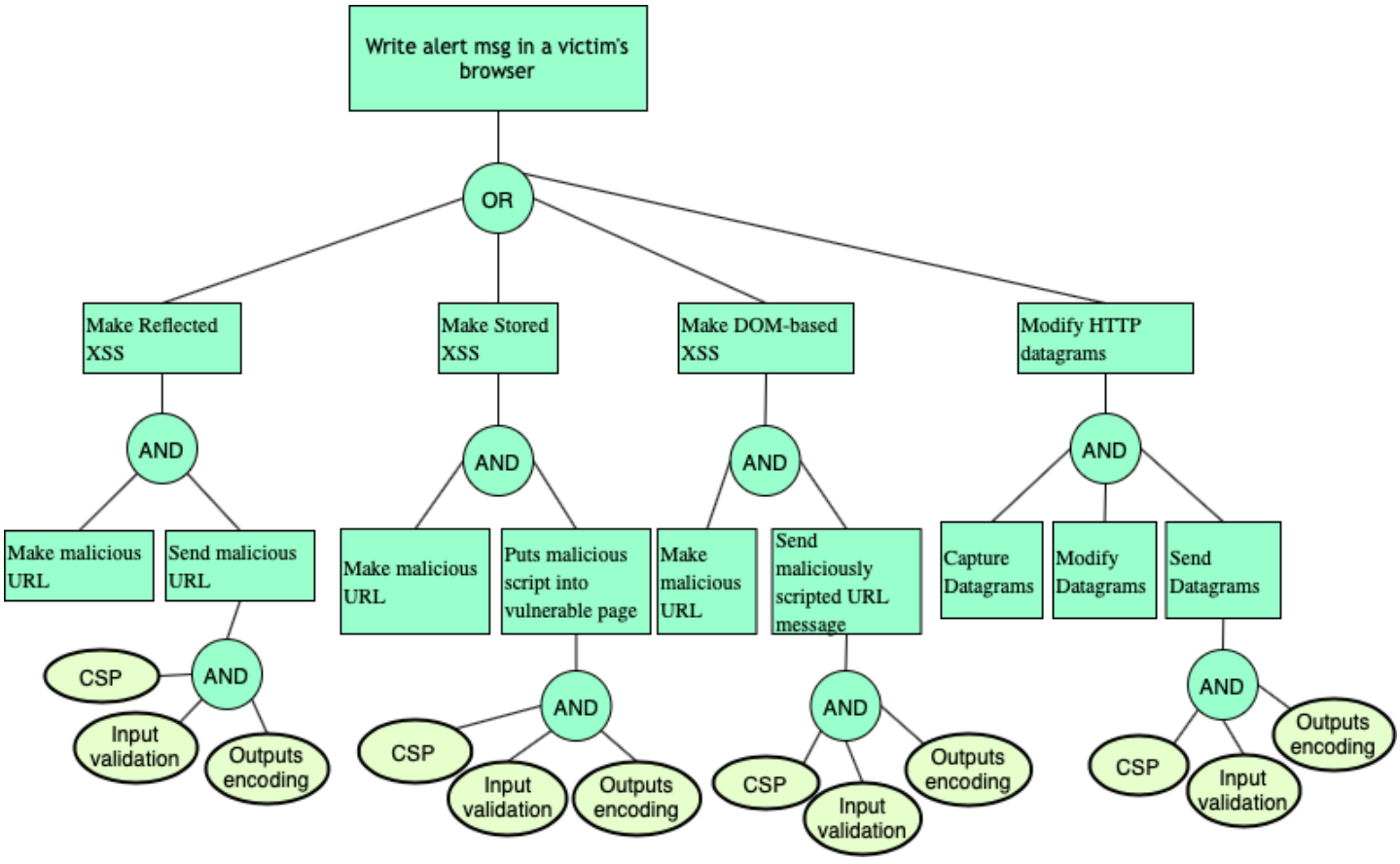
Being an attack that exploits vulnerabilities in web applications, the attacker in this type of attack executes malicious database claims, exploiting improper validation of data flowing from the user to the database. The attacker's goal is to access the intended party's confidential data by inserting malicious code into the user's web page in order to redirect them to their site. There are two ways to forge this type of attack:

- Stored XSS (uninterruptedly stores malicious code in a resource managed by the web application);
- Reflective XSS (promptly reflects malicious code against the user and therefore does not store it permanently;
- XSS based on DOM (Document Object Model).

Attacker Powers

- Circumvent the policy of same origin;
- Impersonate you to websites and/or web applications you regularly use by obtaining/altering/destroying various types of content.

Cross Site Scripting Attacks Diagram



Google Hacking Attacks

Google hacking attacks refers to using Google search engine to find sensitive information that a hacker can use to his benefit while hacking a user's account. Generally, hackers try to find out the security loopholes by probing out on Google about the system they wish to hack. After having gathered the necessary information, they carry out the hacking of the concerned system.

Definition

Google Hacking Attacks, also known as Google Dorking is a hacking method that uses Google Search Engine to find security loopholes in the configuration. With the help of search queries, hackers can locate security vulnerabilities and are able to gather information about the target they wish to hack.

Attacker Powers

- Theft of login credentials from authorized users or entities;
- Access and theft of confidential information from legitimate users;
- Account hijacking;
- Impersonation of accounts fraudulently.

Google Hacking Attacksg Attacks Diagram

Cookie Poisoning Attacks

Cookie Poisoning attacks are basically manipulation and forging of the cookies in order to achieve an unauthorized access to web application.

Definition

In this type of attack, an attacker can change or modify the contents of cookie to have an unauthorized access to an application or to a web page. Cookies basically contain the user's identity related credentials and once these cookies are accessible, the content of these cookies can be forged to impersonate an authorized user.

Attacker Powers

- Theft of login credentials from authorized users or entities;
- Access and theft of confidential information from legitimate users;
- Account hijacking;
- Impersonation of accounts fraudulently.

Cookie Poisoning Attacks Diagram

Malicious QR Code Attacks

Typically, a user scanning a malicious QR code is directed to an exploit or to a phishing site.

Definition

QR code-based attack is defined as an attack that attempts to lure victims into scanning a QR code that directs them to malicious websites. The key idea behind QR code attacks is that victims might trust the web page or the printed material on which the QR code is displayed, and assume that the associated code is harmless.

Attacker Powers

- Direct the user to an exploit or phishing site;
- Perform other attacks such as phishing and botnet; * Distribute malware; * Extraction of personal and confidential data from smartphones and tablets;

Malicious QR Code Attacks Diagram

CAPTCHA Breaking Attacks

CAPTCHAs were developed in order to prevent the usage of internet resources by bots or computers. They are used to prevent spam and overexploitation of network resources by bots. But recently, it has been found that the spammers (attackers) are able to break the CAPTCHA. In this case, we will be in the presence of an attack of this nature, Captcha Breaking.

Definition

In this type of attacks, the attacker can break the CAPTCHAs by using an audio system, can read the CAPTCHAs by using speech to text conversion software and can also break image-based scheme and video-based scheme.

Attacker Powers

- Spamming;
- Conducting DoS and DDoS attacks;
- Excessive exploitation of network resources by bots.

CAPTCHA Breaking Attacks Diagram

SQL Injection Attacks

In this type of attack, an attacker could provide malicious input with a clever mix of characters and meta characters from a form (e.g., login form) to alter the logic of the SQL command.

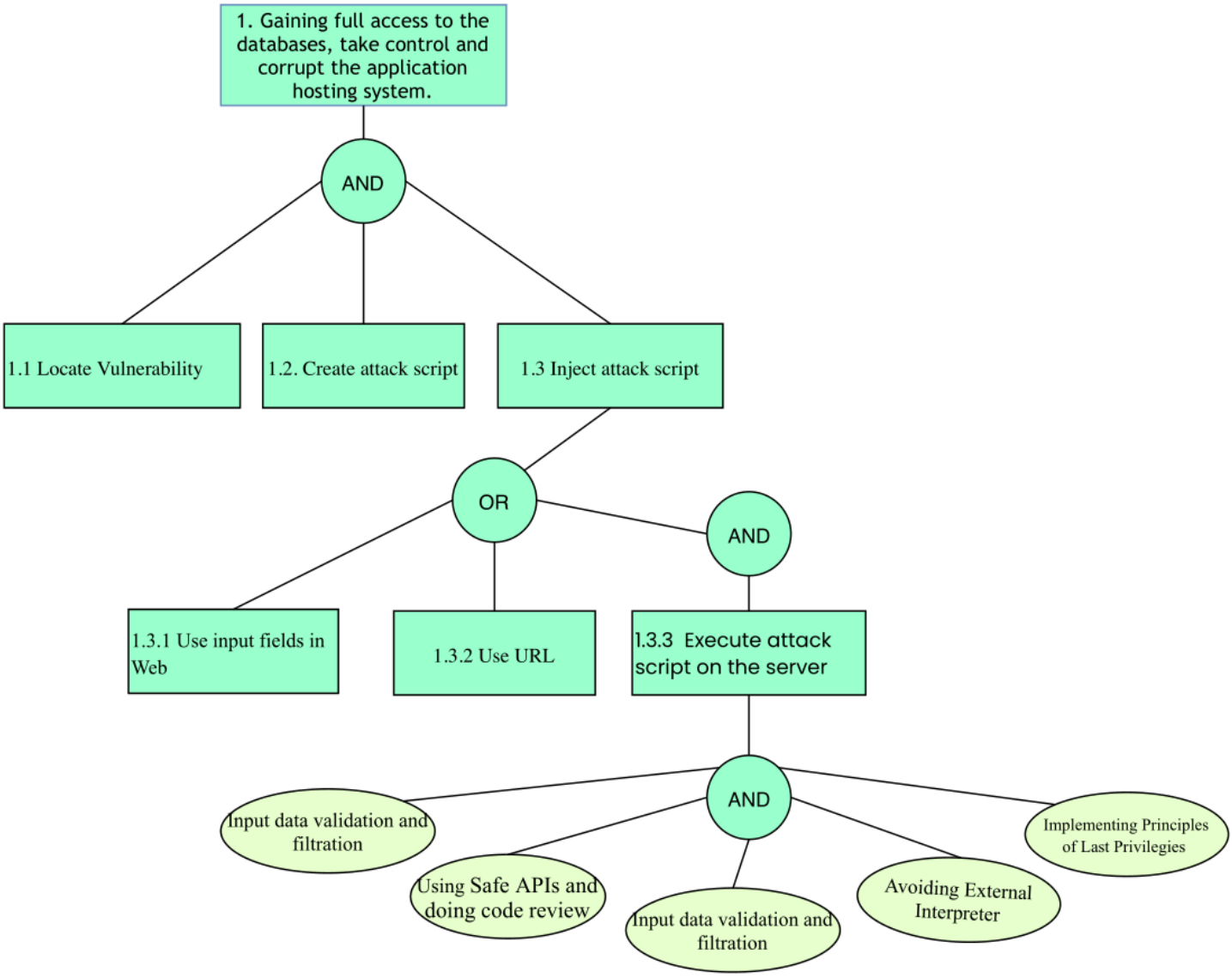
Definition

Structured Query Language (SQL) Injection Attack is a code injection technique commonly used to attack web applications where an attacker enters SQL characters or keywords into an SQL statement through superuser input parameters for the purpose. to change the logic of the desired query.

Attacker Powers

- Identify parameters vulnerable to injection; * Discover DBMS and version; * Discover relational scheme; * Extract data; * Add / modify data; * Cause denial of service; * Evade detection; * Bypass authentication; * Execute commands; * Elevate privileges.

SQL Injection Attacks Diagram



Denial of Services

In a DoS attack scenario, the attacker attempts to disrupt the network or disable services provisioned by a server by sending uninterrupted data packets to the target server and without changing nodes, data packets, or decrypting encrypted data. Typically, these data packets take up bandwidth and consume server resources.

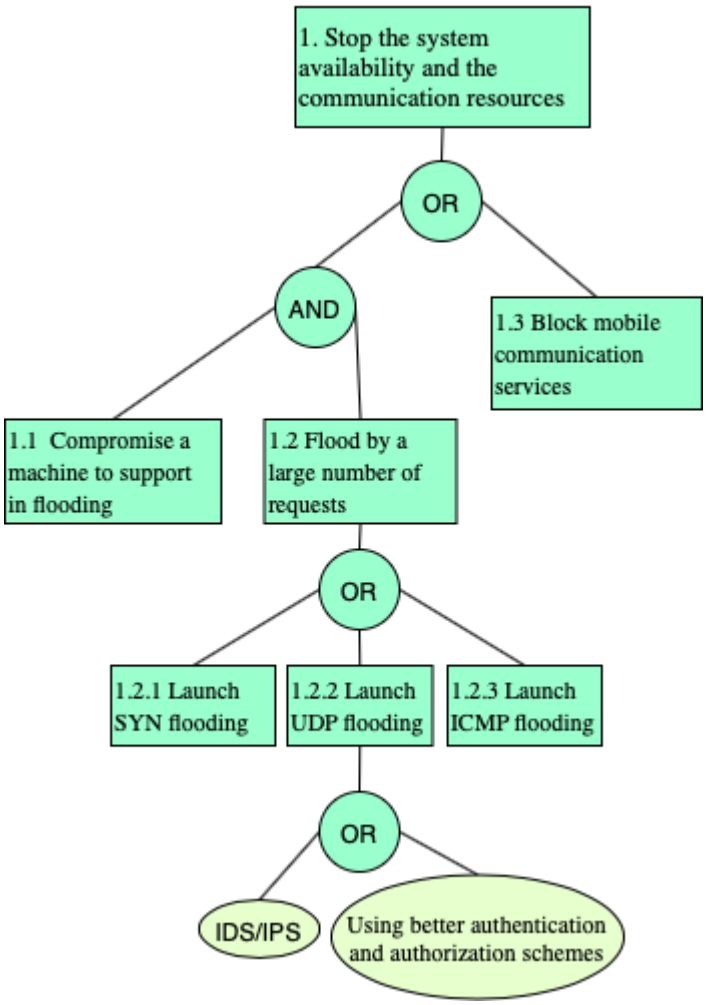
Definition

In such attacks, the attacker attempts to prevent a service or feature that is signed by authorized users from being released by launching various types of floods - SYN flooding, User Datagram Protocol (UDP) flooding, Internet Control Message Protocol (ICMP) attacks) flooding, etc - on the server.

Attacker Powers

- Prevent the availability of a service or resource to authorized users;
- Perpetrating other types of attacks while services or features are unavailable, such as Spoofing.

Denial of Services Attacks Diagram



Distributed Denial of Services Attacks

Distributed Denial of Services (DDoS) is an enhanced DoS attack type, originating from multiple network attack surfaces that were previously compromised to disrupt the services or resources provided by the target server. It differs from DoS in that it generates more traffic, so that the targeted server cannot handle requests.

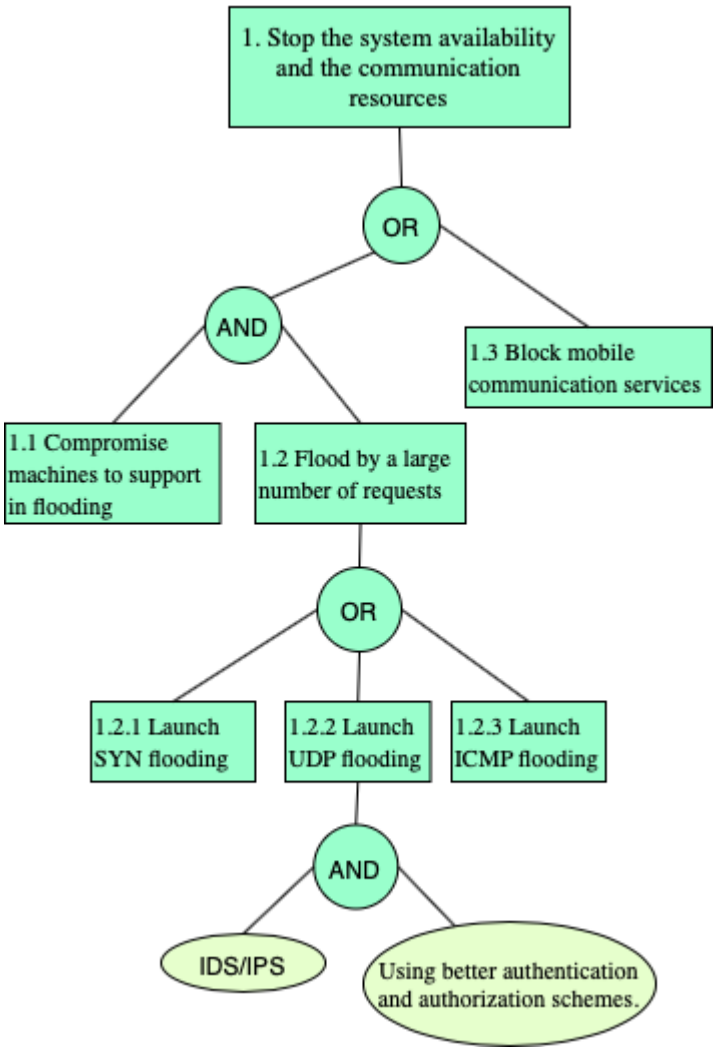
Definition

The DDoS attack attempts to make a service unavailable to intended users by draining the system or network resource. Attackers can now launch various DDoS attacks, including resource-focused attacks (eg, network bandwidth, memory, and CPU) and app-focused attacks (eg, mobile applications, database service) from almost every attack. places.

Attacker Powers

- Make features and services unavailable to authorized users; * Perpetrate other types of attacks and even extract sensitive and critical data.

Distributed Denial of Services Attacks Diagram



Eavesdropping or Sniffing Attacks

This type of attack is carried out by attackers who use applications that can capture data packets in transit over a network, and if they are not heavily encrypted, can be read or interpreted. The goal of the attacker is to spy on all kinds of conversations and recordings and to listen to communication channels.

Definition

This type of attack consists of implant eavesdropping tools in specific network for spying on communication channels, capturing the network traffic behavior and getting the network map. Eavesdropping is dangerous threat that leads to break down the integrity and confidentiality which causes financial and personal failures. There are several ways to get a sniffing attack on a smartphone, as there is a vulnerability in GSM's encryption function for call and SMS privacy, A5 / 1 (it can be stopped second). This vulnerability puts all GSM subscribers at risk of sniffing attacks.

Attacker Powers

- Tracking, capture and theft of confidential information;

Sniffing Attacks Diagram

Botnet Attacks

In short, Cross Site Scripting (XSS) allows an attacker to execute a browser script bypassing access control mechanisms such as the same origin policy.

Definition

A botnet is a set of zombie devices that are infected by malware so that hackers can remotely control them. When a number of smartphones are compromised and remotely controlled, a mobile botnet is formed. Botnets impose serious security threats to the Internet, and most of them are used in organized crime, launching attacks to gain money.

Attacker Powers

- Sending spam;
- Perform attacks like DoS;
- Collecting information that can be used for illegal purposes;

Botnet Attacks Diagram

Domain Name Server Attacks

In this type of attack the attacker uses DNS to convert the domain name to an IP address for the purpose of accessing the user's confidential data. On the other hand, sender and a receiver get rerouted through some evil connection.

Definition

In DNS reflection attacks, attackers send DNS requests toward multiple open DNS servers with spoofed source address of the target, which results in a large number of DNS responses to the target from DNS servers. Since the cloud has its own DNS servers to answer DNS queries from hosted tenants, there should not be any DNS responses from the Internet to the cloud. Therefore, any activity of inbound DNS responses may signify a potential DNS reflection at- tack. Inbound DNS reflection attacks often come from up to 6K distinct sources (with 1500 byte full-size packets). We only observed outbound DNS responses from a single VIP hosting a DNS server at 5666 packets per second for a couple of days repeatedly.

Attacker Powers

- Access confidential information from legitimate/authorized users; * Perpetrate other types of attacks like DDoS and Main-in-the-Middle.

Distributed Denial of Services Attacks Diagram

Reused IP Address Attacks

IP address is reassigned and reused by other customer. The address still exists in the DNS cache, it violating the privacy of the original user.

Definition

Each node of a network has an IP address which is allocated to a particular user when that user leaves the network, the IP address associated with him is assigned to a new user. The chances of accessing previous user data by the new user exist as the address still exist in DNS cache and hence the data belonging to one person can be accessed by another.

Attacker Powers

- Access confidential information from legitimate/authorized users;

Reused IP Address Attacks Diagram

Pharming Attacks

Voice pharming aims to trick the victims into giving out their confidential information (e.g., SSN, credit card number, PIN) to the adversary. Similar to voice phishing, voice pharming exploits people’s trust in voice communication.

Definition

In pharming attacks, attackers can redirect web traffic in a mobile device to a malicious or bogus website. By collecting the subscriber’s mobile device information, specific attacks may follow after pharming attacks. For example, when a user browses a web site in a smartphone, the HTTP header usually includes the smartphone’s operating system, browser information, and version number. With this information, an attacker may learn the security leaks of the smartphone and is then able to start specific attacks on the smartphone.

Attacker Powers

- To Collect the subscriber’s smartphone information;
- Learn and exploit the security leaks of the smartphone and is then able to start specific attacks on the smartphone.

Pharming Attacks Diagram

Watering Hole Attack

An attacker infects the pages frequently visited by target users with malicious software, and the attack is eventually delivered when they view the infected pages.

Definition

In this type of attack, unlike botnet or phishing, instead of actively sending malicious emails, the attacker can identify third party websites that are frequently visited by the target people and try to infect one or more of these websites with malware. Eventually, delivery occurs when the attacked user visits or views these infected pages.

Attacker Powers

- Access confidential information from legitimate users by collecting data through malware; * Perpetrate other types of attacks like Spear-Phishing.

Watering Hole Attack Diagram

XML Injection Attacks

It is an attacking technique used against XML-based applications to modify or compromise their normal operation.

Definition **

XML Injection (XMLi) attacks are carried out by injecting pieces of XML code along with malicious content into user inputs in order to produce harmful XML messages. The aim of this type of attacks is to compromise the sys- tem or system component that receives user inputs, mak- ing it malfunction (e.g. crash), or to attack other systems or subsequent components that process those injected XML messages. This type of attack can be classified into 4 categories:

- Deforming: Attack input values of Type 1 are XML meta-characters, such as <, >,]] >, that are intro- duced to compromise the structure of generated XML messages;
- Random closing tags: Attack input values of Type 2 are random XML closing tags (e.g., < /test>), aiming at deforming the generated XML messages to reveal their structure;
- Replicating: Attack input values of Type 3 are strings of characters consisting of XML tag names and malicious content;
- Replacing: Attack input values of Type 4 are similar to those of Type 3 but they involve multiple input fields in order to comment out some existing XML elements and inject new ones with malicious content.

Attacker Powers

- Obtain confidential information;
- Change the underlying business logic of the destination.

XML Injection Attacks Diagram

Session Hijacking Attack

An attacker impersonates a legitimate user through stealing or predicting a valid session ID.

Definition

The Session Hijacking can be facilitated by the architectural weakness of “not securing the storage of session identifiers”. As reported in the CVE-2002-0121, the PHP project vesions 4.0 through 4.1.1 suffered from this architectural flaw because its original design stored each data session in plain textual files in a temporary directory without using a security tactic to store these session files in a secure way (such as encryption).

Attacker Powers

- Steal Session ID;
- Impersonation of a legitimate user and confidential information from a legitimate user.

Session Hijacking Attack Diagram

Spoofing Attacks

In a nutshell, spoofing attacks consist of spoofing the caller ID in order to impersonate a trusted entity and thus obtain confidential information in a disguised manner.

Definition

In this type of attack, the attacker can spoof the "Caller ID" and impersonate him as a legitimate user, i.e., an attacker could spoof the "Caller ID" and impersonate a trusted party. Recent studies have also shown how to spoof MMS messages that appeared to be messages from a number that operators use to send alerts or update notifications. In addition, base stations can also be counterfeited. On the other hand, there is also the mobile application spoofing attack, which consists of an attack where a malicious mobile application mimics the visual appearance of another one. The goal of the adversary is to trick the user into believing that she is interacting with a genuine application while she interacts with one controlled by the adversary. If such an attack is successful, the integrity of what the user sees as well as the confidentiality of what she inputs into the system can be violated by the adversary.

Attacker Powers

- Falsificar a ID do chamador;
- Monitorização de chamadas e acesso à informação confidencial dos utilizadores legítimos a partir das mensagens de voz ou de texto.

Spoofing Attacks Diagram

VM Migration Attacks

A malicious user can start or redirect the migration process to a different network in which he has access or untrusted host, or it can just be copied and used elsewhere, which compromise the VM with the passwords, credentials on it and in case of coping it makes it difficult to trace the attacker.

Definition

VMs roll back to their previous state if an error occurs. Unfortunately, this factor can re-expose them to security vulnerabilities, and attackers can gain benefit to attack on this compromised hypervisor. It is important to protect the data during migration. In fact, this is the defending of data privacy and integrity from various network attacks during migration. Live migration might be susceptible to many attacks like ”man-in-the-middle”, ”denial-of-service” and ”replay. The data during the migration can be sniffed or tampered easily as it is not encrypted.

Attacker Powers

- Launch attacks such as man-in-the-middle, DoS and replay;
- Detect or tamper with data during migration as it is not encrypted.

VM Migration Attacks Diagram

Malicious Insiders Attacks

When there is a malicious entity (client, employee, Hypervisor, Cloud Provider/Broker, etc.) that takes advantage of its privileges to covertly carry out any malicious activity such as information theft and data destruction or physical infrastructures.

Definition

Malicious Hypervisor, Malicious Clients, Malicious Cloud Provider/Broker, etc. are all the other terms which can also be used as an alternative to malicious insiders. This kind of attack occurs from client to server when the person, employee or staffs who know how the system runs, can implant malicious codes to destroy everything in the cloud system.

Attacker Powers

- Implants malicious codes to destroy everything in the cloud system; * Steals confidential data.

Malicious Insiders Attacks Diagram

VM Escape Attacks

This type of attack occurs when an application escapes from the VM and gains control of VMM, as it escapes the VM privilege and obtains the root privilege.

Definition

VM escape is where an application running on a VM can directly have access to the host machine by bypassing the hypervisor, being the root of the system it makes this application escape the VM privilege and gain the root privilege. In this type of attack the attackers attempt to break down the guest OS in order to access the hypervisor or to penetrate the functionalities of other guest OS and underlying host OS. This breaking of the guest OS is called as escape. If the attackers escapes the guest OS it may compromise the hypervisor and as a result it may control over the entire guest OS. In this way the security breach in single point in hypervisor may break down all the hypervisor. If the attacker controls the hypervisor, it can do anything to the VM on the host system.

Attacker Powers

- Desligar e eliminar VMs alvos ou vítimas, o que resulta na perda e destruição de dados ou informação;
- Compromise the hypervisor and other resources.

VM Escape Attacks Diagram

Cross VM Attacks (Side channel attacks)

Side-channel attacks are used to extract cryptographic keys from a victim device or process in a virtualized layer of the cloud ecosystem where a Cross-VM attack exploits the nature of multi-tenancy, which enables that VMs belonging to different customers may co-reside on the same physical machine.

Definition

Side-channel attack, which leverages low-bandwidth message channels (e.g., timing, power, cache misses) in a system to derive or leak security - sensitive information, has been proven to be realistic threats to modern computer systems. Among them, cache-based side-channel attacks have been shown practical to steal cryptographic information within a single operating system. The main idea is that cryptographic algorithms usually have data-dependent memory access patterns, which can be revealed by observing and analyzing the associated cache hit/miss statistics. Cache-based attacks then can rely on certain statistics during the encryption or decryption operations to extract the cryptographic key. Recent research has shown attackers can build up cross-VM side channels to obtain sensitive information. However, currently these channels are mostly based on shared CPU cache, networks, CPU loads and so on. These attacks are generally categorized into one of three classes:

- Time-driven side-channel attack;
- Trace-driven side-channel attacks;
- Access-driven side-channel attacks.

Attacker Powers

- Steal cryptographic information;
- Extract cryptographic key; * Obtains confidential data or sensitive information.

Cross VM Attacks Diagram

Malware Injection Attacks

This type of attack occurs whenever a user can install malware on a mobile device. In addition, this type of attack can be carried out remotely or locally.

Definition

Attacks on the cloud and mobile application-level ecosystem can affect the integrity and confidentiality of data and applications through different strategies. E.g., by injecting malware. Malware can be virus, worm, trojan, rootkit and botnet.

Attacker Powers

- Access and steal users confidential data;
- Obtain root permissions on mobile devices and control the mobile device;
- Directly affect the computational integrity of mobile platforms along with the application.

Malware Injection Attacks Diagram

Tampering Attacks

In this type of attack an attacker preforms physical modifications on the hardware where the software is implemented.

Definition

This type of attack occurs whenever an unauthorized user has physical access to the device. When this access is realized, it is possible to loss, leakage, access or unintentionally disclose of the data or applications to unauthorized users, if the mobile devices are misplaced, lost or theft.

Attacker Powers

- Sending high malicious traffic stream;
- Huge messages to targeting mobile devices to make unused or reducing the capability;
- Access and steal users confidential data.

Tampering Attacks Diagram