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Fakebook: Security Design and Evaluation Report

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Introduction

- Brief description of the Fakebook platform.

The integrity of digital conversations is critical in an increasingly connected world. Fakebook has emerged as a fortress of secure social media communication, allowing users to share their thoughts, moments, and messages while remaining confident in their privacy and security. Fakebook's inception was rooted in the commitment to protect user interactions from prying eyes, including those of the cloud provider itself, with the understanding that the digital realm is fraught with potential breaches and privacy concerns. This report outlines the meticulous design and stringent measures that have been woven into the fabric of Fakebook to ensure that the sanctity of communication is preserved and trust remains the cornerstone of every user interaction on the platform.

1)Cyber-security Threat Identification and Ranking

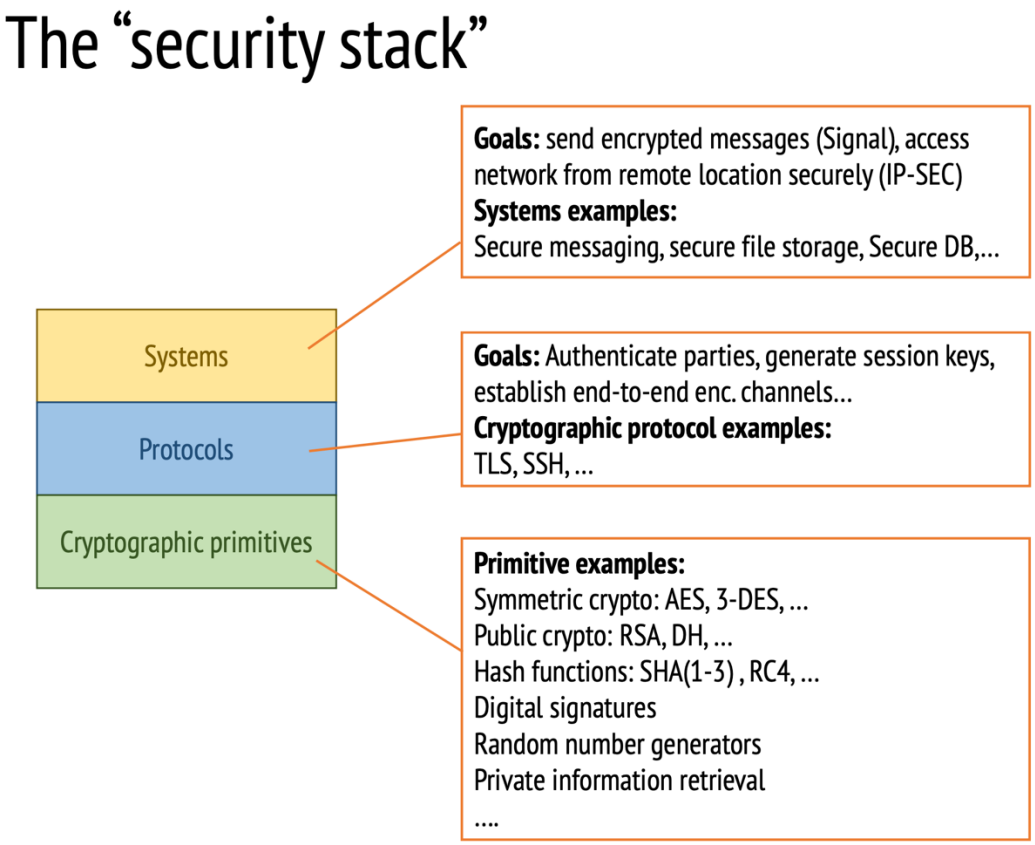
Threat	Impact	Likelihood	Description
Unauthorized Access to Sensitive Data	High	Moderate	Sensitive user data, including financial information, private messages, and personal details, are accessed by attackers without authorization. Blackmail, identity theft, and other nefarious activities may result from this
Data Interception and Eavesdropping	High	Medium	Sensitive communications sent over the network are intercepted and read by attackers. Sensitive personal information may be revealed and message confidentiality may be jeopardised.
Insider Threats	High	Low-Moderate	Cloud provider employees or Fakebook administrators with access to sensitive data intentionally or accidentally leak or misuse that information. This can be motivated by financial gain, personal vendettas, or other factors.
Account Takeover Attacks	Moderate-High	Medium	User accounts are accessed by attackers without authorization. Attackers can use a compromised account to send spam, propagate malware, or view private messages.
Service Disruption Attacks (e.g., DDoS)	Moderate	Medium	Attackers flood the servers of Fakebook with traffic, rendering the platform inaccessible to users. Frustration, missed business opportunities, and reputational harm may result from this.
Message Modification	High	Medium	Attackers may change the content or meaning of messages while they are being transmitted or stored on the cloud. Confusion, mistrust, and possibly even legal consequences could result from this, should the messages be presented as proof in court.
Message Replay	High	Medium	Attackers replay old messages to users, giving the impression that they are being sent in real time. It can be used to impersonate other users or spread false information.
Message Spoofing	High	Medium	Attackers create fake messages that appear to be sent from legitimate users or groups. This can be used to deceive users, spread malware, or damage Fakebook's reputation.
Data Exfiltration	High	Medium	Attackers exfiltrate sensitive user data from Fakebook's servers, including private messages, personal information, and financial data. This can be used for identity theft, blackmail, or other malicious purposes.

Data Manipulation	High	Medium	Attackers create fake messages that appear to be sent by legitimate users or groups. It can be used to defraud users, spread malware or damage Fakebook and its reputation.
Data Loss	High	Medium	Attackers exfiltrate sensitive user information from Fakebook's servers, including private messages, personal information, and financial information. It can be used for identity theft, blackmail or other malicious purposes
Phishing Scams	Moderate-High	Medium	Attackers manipulate sensitive user data stored on Fakebook's servers, for example by changing timestamps or content. It can be used to deceive users, spread false information or damage the reputation of Fakebook.
Social Engineering Attacks	Moderate-High	Medium	Attackers manipulate people into taking actions or revealing confidential information. Attackers can use different tactics, such as impersonating trusted individuals or creating fake scenarios.
Malicious Apps	Moderate	Medium	Attackers develop and distribute malicious applications that can steal user data, spy on user activities, or even take control of devices.
Supply Chain Attacks	High	Low-Moderate	Attackers target Fakebook and the vendors and service providers to access Fakebook's systems and data.
Zero-Day Attacks	High	Low	Attackers exploit software security holes that the vendor is not aware of. These attacks can be very difficult to defend against because no patch is available.

[References : added at the last]

2)Security Protocols and Frameworks Integration

There are several appropriate security protocols, tools, frameworks, and technological layers of security which can be integrated into the platform, having a conducive effect in building a secure & impenetrable system. The below diagram depicts an abstract, broad structure of technological tools at our disposal.

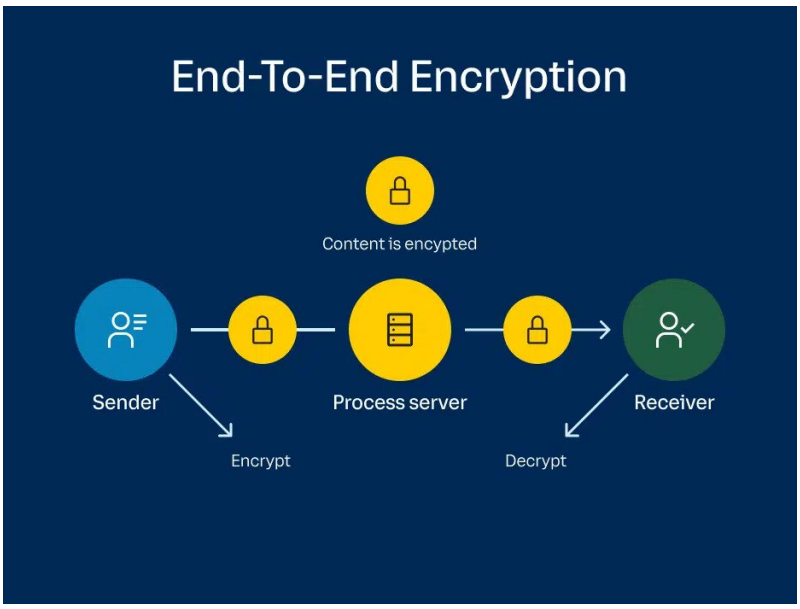


(fig:Security Stack)

Here are the some of the ways in which the security of system can be better equiped with:

2.1: End-to-End Encryption (E2EE)

When messages are sent using E2EE, only the sender and the receiver can read them. E2EE stands for end-to-end encryption, which means that the message is encrypted at one end (the sender) and decrypted at the other end (the receiver). No one else, not even the service that delivers the message, can see the message in plain text. E2EE protects the privacy of messages from everyone, including the cloud provider. This applies to messages sent to one person, a group of people, or the public. E2EE uses protocols like Signal's protocol or the Double Ratchet Algorithm to make sure that only the intended recipients can access the messages.

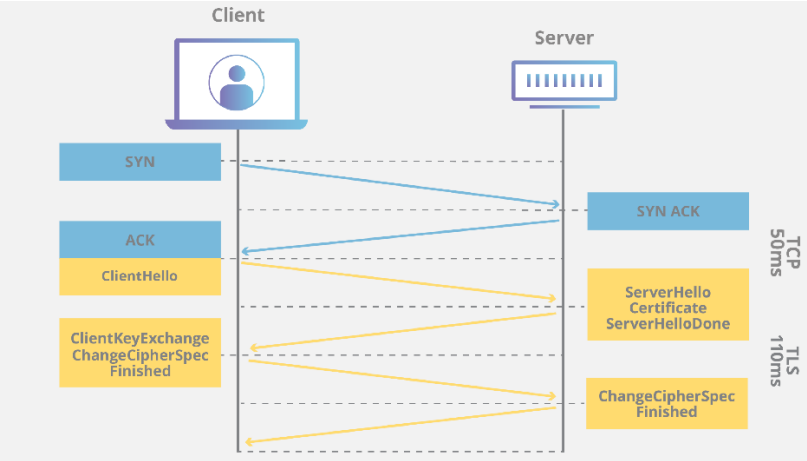


(fig: End-to-End Encryption)

2.2: Secure Socket Layer (SSL)/Transport Layer Security (TLS)

SSL and TLS are cryptographic protocols that encrypt data when it is sent over the internet between a client and a server. SSL was created by Netscape in the 1990s and TLS is its successor. They both use public key encryption, which means that each endpoint has a pair of keys: one public and one private. The public key is used to encrypt the data and the private key is used to decrypt it. This way, only the sender and the receiver can read the data, and no one else can intercept or modify it. TLS is used between a user and a server, not between two users. For example, when a user visits a website, TLS encrypts the data between the user's browser and the web server. However, the data is briefly decrypted at the server before being encrypted again. This means that the server can see the data, but not anyone else. TLS also requires certificates, which are digital documents that prove the identity of the endpoints. Certificates are issued by Certificate

Authorities (CAs), which are trusted entities that verify the identity of the endpoints. Some cloud providers offer CA services to their customers, so that they can get certificates from a public CA that is controlled by the cloud provider. Encryption is an additional layer of security that protects the confidentiality and integrity of data, on top of the network layer protections.



(fig: 2.2: Secure Socket Layer)

2.3: Multi-Factor Authentication (MFA)

MFA stands for Multi-Factor Authentication, which means that you need to provide more than one way to authenticate yourself. When you want to access a resource, you need to prove your identity with MFA. The most common way to authenticate yourself is with a username and password, but this is not very secure, because usernames can be easily found out, and passwords can be easily forgotten or guessed. MFA makes your accounts more secure by asking for a second way to authenticate yourself. This second way is called a factor, and it can be different things. For example, you may use the Microsoft Authenticator app as your second factor. Some factors can be something you know, like a PIN or a password, something you have, like a phone or a USB key, or something you are, like a fingerprint or a face scan.

2.4: Regular Security Audits and Logging

An organization's security policies, procedures, and controls are checked by security audits. They are done to find out the weaknesses and dangers in the system and to make sure that the organization follows the rules and standards that apply to them. Logging is when a system keeps track of what happens and what is done on it. Logging can help organizations watch their systems for strange activity, find out if there are any security problems, and investigate what happened. It can also help organizations see how their systems are used, which can help them make their systems work better and be more secure.

2.5: Access Control Lists (ACLs) and Role-Based Access Control (RBAC)

To make sure that only the right employees can use the resources they need, access control lists (ACLs) are a type of access control that depends on the user or group identity. They are used to specify which users or groups can access certain resources or objects. Role-based access control (RBAC) is a more advanced access control model that relies on the roles and duties of the users. In RBAC, access is given based on the user's role in the organization. Each role has a set of permissions that determine what actions the user can do.

2.2.1: Technical Implementation of Workflows with Security Considerations

A: Public Messages

Users can post messages intended for all users. These messages are encrypted with the server's public key for secure transmission and then stored in an encrypted format, using symmetric encryption where the key is also encrypted with the server's public key.

B: Messages for Friends

For these, E2EE is implemented so that the server facilitates the exchange of messages without being able to decrypt them. Friends are determined by mutual consent, and keys are exchanged using a secure key exchange protocol.

C: Messages for Subgroups of Friends

Like messages for friends, but with an added layer of ACLs (Access Control Lists) to manage subgroup memberships and overlapping members. Subgroup members will each have their own set of encryption keys, managed, and distributed securely by the platform.

[References : added at the last]

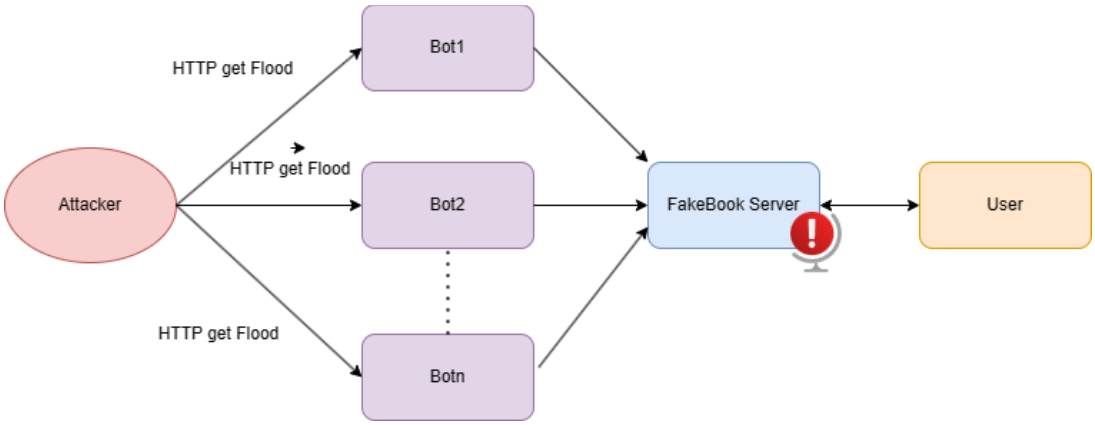
3)Security-Enhanced Workflows

3.1 Attacker Model

The attacker model defines the capabilities and limitations of potential adversaries that could target the Fakebook platform. This model helps in anticipating potential attack vectors and in developing adequate defenses.

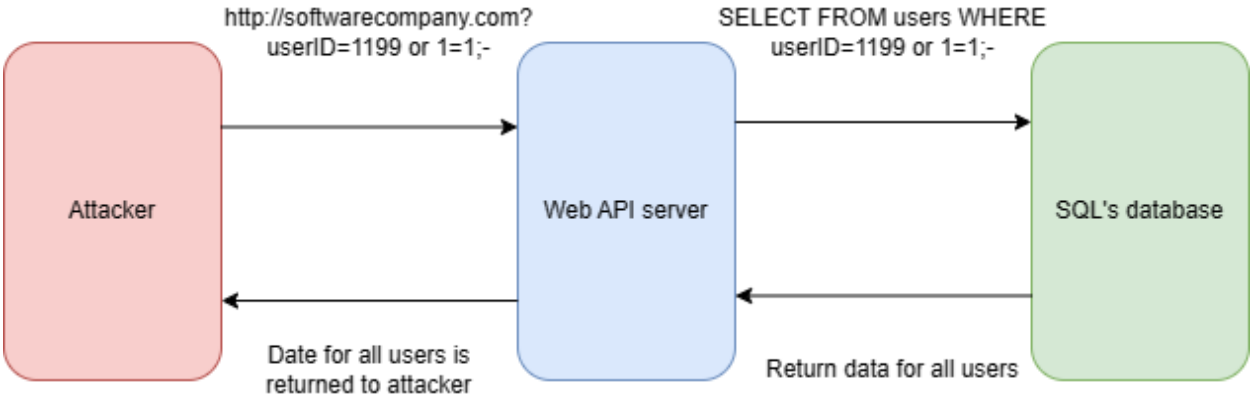
A:Capabilities of an Adversary:

1. **Intercept Communications:** Data transfers between clients and servers may be intercepted in potential security breaches.(Ref Deborah Russell)
2. **Account Compromise:** Unauthorized account control may result from compromised credentials. Reference: Hadnagy, C. (2018). Social Engineering
3. **Exploit Software Vulnerabilities:** Unauthorized access or system disturbances may result from taking advantage of current system vulnerabilities. (Ref: Koblitz, N)
4. **Bypass Access Controls:** The attacker could try to get around rules that guard user access to data.
5. **Data Exfiltration:** If a system is successfully accessed, sensitive data may be stolen or leaked.
6. **Slowloris Attack:**
    - **Detail:** One kind of Denial of Service (DoS) attack that the attacker can launch is a Slowloris assault. It functions by establishing and maintaining many connections to the web server. It sends incomplete requests, which are never fulfilled, until the server's connection pool is eventually depleted, preventing genuine users from accessing the service. (Ref: Zalewski, 2011).



Fig(A.6: SlowLoris Attack workflow)

7. **SQL Injection:**
    - **Detail:** Through the injection of malicious SQL queries, the attacker could take advantage of weaknesses in the platform's database interaction. This may result in data being seen without authorization, database corruption, or even full database takeover. (Ref: Patel, 2013).



Fig(A.6: SQL Injection Attack workflow)

B: Limitations of an Adversary:

1. **Strong Cryptographic Practices:** Modern cryptographic algorithms and protocols, when implemented correctly, are impractical for an adversary to breach.

2. **Effective Access Control Mechanisms:** Access control methods that are properly developed and put into place can stop an attacker from gaining unauthorized access to data.
3. **Anomaly Detection Systems:** These technologies can restrict the amount of time an attacker might go unnoticed by identifying and alerting users to unexpected actions that may be signs of an attack.
4. **Auditing and Logging:** Logs can be used to track an attacker's movements, making it risky to try to penetrate the system without being caught.
5. **Server Hardening and Timeout Management:**
    - **Detail:** Slowloris attacks can be mitigated by adding timeout management for half-open connections on servers.
1. **Input Validation and Parameterized Queries:**
    - **Detail:** SQL injection attacks can be considerably reduced by using robust input validation and parameterized queries or prepared statements.

3.2: Security Mitigations

A: Confidentiality of Messages from the Cloud Provider

1. **End-to-End Encryption (E2EE):** We ensure that the cloud provider and potential eavesdroppers cannot read the content of the messages by encrypting them at the client level and only decrypting them at the recipient's end. (Ref: Bruce Schneier)
2. **Client-Side Encryption:** Data is encrypted on the user's device before being uploaded to the cloud, preventing the cloud provider from accessing the plain text of the messages.

B: Confidentiality from Non-Intended Recipients

1. **Access Control Lists (ACLs):** They specify which users have read access to which messages. ACLs are especially important for messages intended for specific groups of friends. (Ref: Sandhu)
2. **Multi-Factor Authentication (MFA):** It prevents unauthorized account access by ensuring that even if login credentials are compromised, attackers are unable to gain access without a second form of authentication. (Ref: O'Gorman, 2003)
3. **Data Minimization and Segmentation:** This reduces the risk of user data exposure. It reduces the possibility of mass data leaks by only storing and processing what is absolutely necessary and effectively segregating data.

C: Mitigation Strategies for Slowloris Attack

1. **Connection Timeout Policies:**
    - Implementing shorter connection timeout periods can help to reduce the risk of Slowloris attacks. This narrows the window in which an attacker can exhaust server resources. (Ref: Zalewski, 2011).
2. **Limiting Connection Per IP:**

- The platform can protect itself from being overwhelmed by connections from a single source by limiting the number of simultaneous connections a single IP can establish with the server. (Ref: Douligeris, Mitrokotsa, 2004).

3. **Use of Load Balancers and Reverse Proxies:**
    - Load balancers can distribute traffic evenly across multiple servers, whereas reverse proxies can hide the server's internals from direct external access, providing a safeguard against Slowloris attacks. (Ref: Patel, 2013).

D: Mitigation Strategies for SQL Injection Attack

1. **Input Validation:**
    - Enabling comprehensive input validation ensures that only properly formed data is allowed to pass through to processing and database interaction. (Ref: OWASP, 2013)

2. **Use of Prepared Statements and Parameterized Queries:**
    - By employing these database interaction techniques, the server code can distinguish between code and data regardless of the user's input. (Ref: Halfond, Viegas, Orso, 2006).

3. **Regular Security Audits:**
    - Conducting regular security audits, including SQL injection vulnerability testing, can assist in identifying potential weak points for an attacker to exploit.

3.3:Evaluation Against Adversarial Actions

1. **Against Intercepting Communications:** E2EE makes intercepted data encrypted and unreadable to the attacker. The use of Transport Layer Security (TLS) increases the security of data in transit.

2. **Against Account Compromise:** MFA and regular reminders to users to review their login activity help to reduce the risk of account takeovers.

3. **Against Exploiting Software Vulnerabilities:** Regular security audits and a bug bounty program encourage the discovery and patching of vulnerabilities before they can be exploited.

4. **Against Bypassing Access Controls:** The use of ACLs in conjunction with role-based access control (RBAC) ensures that only authorized individuals have access to sensitive information. (Ref: Sandhu)

5. **Against Data Exfiltration:** Data loss prevention (DLP) tools, in conjunction with network monitoring, can detect and prevent unauthorized data transfers from the platform(Ref:Andreson.R 2008)

6. **Against Slowloris Attack:** Implementing effective timeout management and connection limits per IP, as well as a robust infrastructure that includes load balancers and reverse proxies, can significantly reduce the risk and impact of Slowloris attacks. (Ref: Zalewski, 2011).

7. **Against SQL Injection:** SQL injection attempts are mitigated by the strong input validation process and the use of parameterized queries. Regular security audits strengthen the system's defenses by identifying and correcting vulnerabilities before they are exploited by attackers. (Ref: Patel, 2013).

Conclusion:

This report has identified and evaluated security measures that Fakebook can implement to protect user messages from confidentiality breaches. The proposed security measures, including E2EE, SSL/TLS, regular security audits, logging, ACLs, and RBAC, would mitigate the attacker models of slow loris and SQL injection attacks.

By implementing these security measures, Fakebook can significantly reduce the risk of confidentiality breaches and provide its users with a secure and private platform to communicate.

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