CryptoChronicles

LessPM's Quest to a Passwordless Utopian Ecosystem

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Executive Summary

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Abstract

Introduction

Polybius' *The Histories* [5] contains the first documented use of passwords, describing how the Romans employed "*watchwords*" to verify identities within the military. This provided a transparent, simple way to allow or deny entry to restricted areas of authorized personnel only. The story of secret writing (in this context referenced as cryptography) goes back the past 3000 years [2], where the need to protect and preserve privacy between two or more individuals blossomed.

Fernando J. Corbató is widely credited as the all-father of the first computer password when he was responsible for the Compatible Time-Sharing System (CTSS) in 1961 at MIT [4]. The system had a `"LOGIN"` command, which, when the user followed it by typing `"PASSWORD"`, had its printing mechanism turned off to offer the applicant privacy while typing the password [1]. Given the long history of passwords and their importance, one could argue that it was a natural and judicious step in the evolution of computer systems.

In today's digital landscape, utilizing various identifiers (such as usernames, email addresses, or phone numbers) combined with passwords has become a prevalent method for verifying an individual's identity and ensuring their authorization to access restricted materials.

In 2004, a study titled *"The Memorability and Security of Passwords"* [10] was conducted into advising users on the entropy of passwords and ways someone can use to remember a or multiple passwords. A typical standard for larger organizations with a form of password creation system is to emphasize the diversity of smaller characters, capitalized characters, length, and not be commonly referred to in a dictionary [10]. The study analyzed the effectiveness of different password-creation strategies, suggesting that acronym-based passwords offer a delicate balance between memorability and security[10].

However, as technology has advanced, the limitations of password-based authentication have become increasingly apparent, leading to the development of more sophisticated methods like Universal Authentication Framework (UAF) [3] and WebAuthn[9] through the Fast IDentity Online Alliance (FIDO) and The World Wide Web Consortium (W3C).

WebAuthn, short for Web Authentication, is an open standard for web-based authentication that enables users to securely access online web services without relying on a traditional password. Through a collaborative effort between FIDO and W3C, WebAuthn is developed

to leverage asymmetric cryptography [1][2]and biometric or hardware-based authenticators to provide a more secure and robust authentication experience.

This report delves into the implementation of LessPM, a passwordless password manager that leverages WebAuthn to provide a secure authentication experience, free from the constraints of traditional passwords, while placing a strong emphasis on security. By examining recent advancements in authentication mechanisms and the related innovative potential of WebAuthn, we hope to illuminate the prospects of a passwordless future in digital security.

Methodology

Exploring the development and implementation of LessPM, a passwordless password manager, our focus will be on the key components, technologies, and steps that form the system's development process. This section will discuss the WebAuthn standard, its effective integration and role in LessPM, and the various security measures contributing to a robust and reliable solution.

WebAuthn

WebAuthn, short for Web Authentication, is a collaborative project between the FIDO Alliance and W3C that aims to implement a secure, robust key-based authentication system for the web, to strongly authenticate users [9]. The concept relies on the use of a third-party device, called an Authenticator, which leverages asymmetric cryptography. These devices employ biometric or hardware-based mechanisms to provide a secure and reliable means of authenticating a user.

Upon registration, the Authenticator device generates a key pair called a Passkey. This Passkey contains a credential ID uniquely generated for each registered key-pair [7, 8] on the Authenticator. The unique generation of each key pair offers the advantage of making it much more difficult for trackers to follow a user [3]. Further, if an attacker gains access to an individual's Passkey, they might compromise one specific service, whereas a traditional password could potentially compromise multiple services where password reuse occurs[6].

[1] Asymmetric cryptography uses a key pair consisting of public and private keys. The public key encrypts data, while the private key decrypts it. The keys are mathematically related, but deriving one from the other is infeasible, ensuring secure communication and data exchange.

[2] **Note:** According to the library used to implement jsonwebtokens in Rust it is the private key that encrypts and the public key is responsible for decrypting. *Last Accessed: 2023-03-25.*

[3] This is subject to the key-pair alone. A willing party could still track the user through their email or similar.

Registration

In order to register in a WebAuthn authentication system, the user (i.e., client, browser, phone, etc.) issues a registration request to a WebAuthn implemented server, called a Relying Party (RP), asking to be registered. The request contains a body with the relevant user identifier (i.e., username, phone number, email, etc.). The server responds by initiating a registration ceremony and generates a challenge, which is sent to the client.

The client then calls the browser-integrated WebAuthn API, requesting the Authenticator (i.e., phone, hardware Authenticator device, or similar) to create a new public key credential. [4] During this process, the Authenticator generates a new key-pair (public and private keys). The Authenticator then signs the challenge received from the server with the private key.

The newly created public key, signed challenge, and additional metadata are combined into a public key credential object, which the client sends back to the server.

The server verifies the authenticity of the signed challenge and the public key credential object. If successful, the server stores the user's public key and other relevant information (e.g., user identifier, credential ID) for future authentication. The process can be seen in figure 1

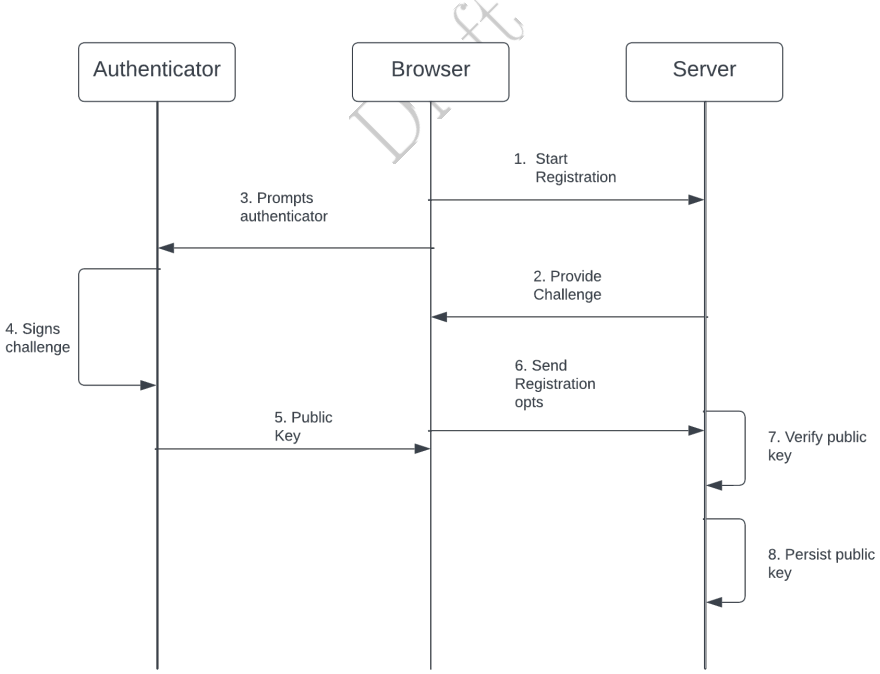

Figure 1: A diagram dipicting the registration process through WebAuthn and Authenticator Device.

[4] The user is prompted to use their Authenticator to prove their presence, which can involve scanning a QR code, providing a fingerprint, or any other modality supported by the device.

Authentication

Conclusion

Future work

Through implementing LessPM, we aimed to create a barebone implementation that could serve as a reliable Minimal Viable Product (MVP). However, we recognize that more work is needed to further enhance and compliment the product. The related topics to further improve LessPM are listed below and briefly discussed as a way to highlight potential drawbacks of the current version.

- **Authorization Headers**
- **AES Key Encryption for Password**
- **Hardcoded AES for JWT**
- **Encrypted Passkey**

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