The Emperor's New Autofill Framework: A Security Analysis of Autofill on iOS and Android

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Background

Motivation and information on mobile autofill frameworks

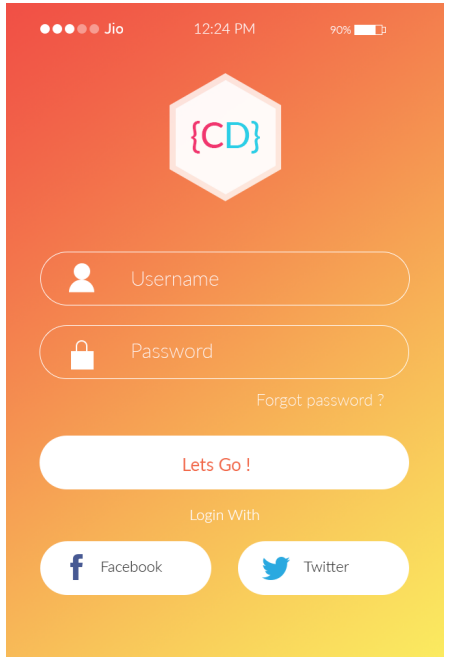
Motivation

- Prior evaluations focused on desktop managers
- Autofill frameworks are unique to mobile and present their own set of security challenges
  - Could be single point of failure
- We set out to understand three different approaches to an autofill framework on mobile

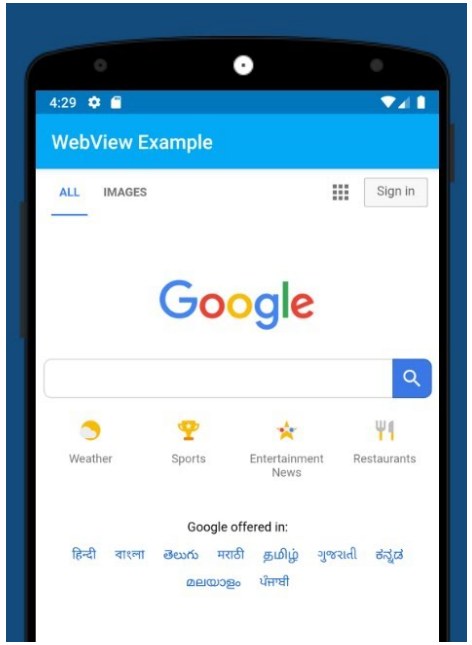
Autofill on Mobile

- Multiple contexts for autofill
  - Browser
  - Apps
- Multiple approaches to autofill

Contexts for Autofill in Apps



Native UI Elements

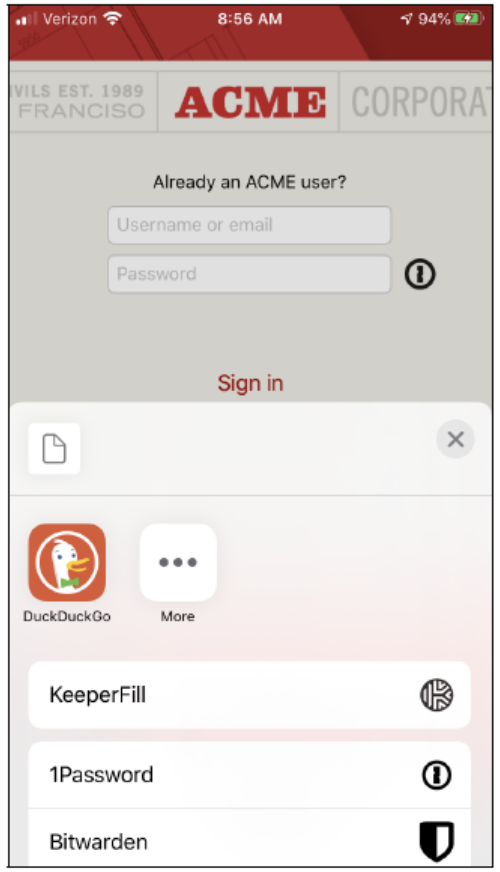


WebView

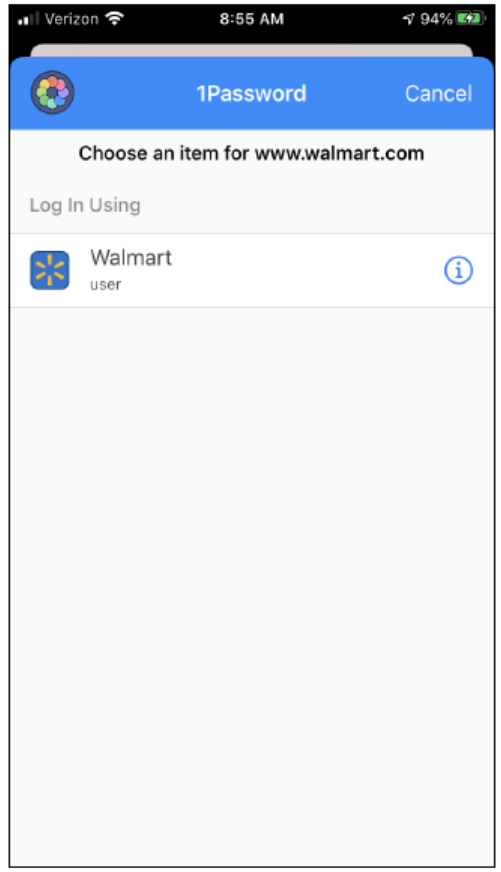
Custom UI Elements

iOS App Extensions

- iOS 8 – 2014
- Popular managers still support – 1Password, Keeper, LastPass
- Older devices – prior iOS 12



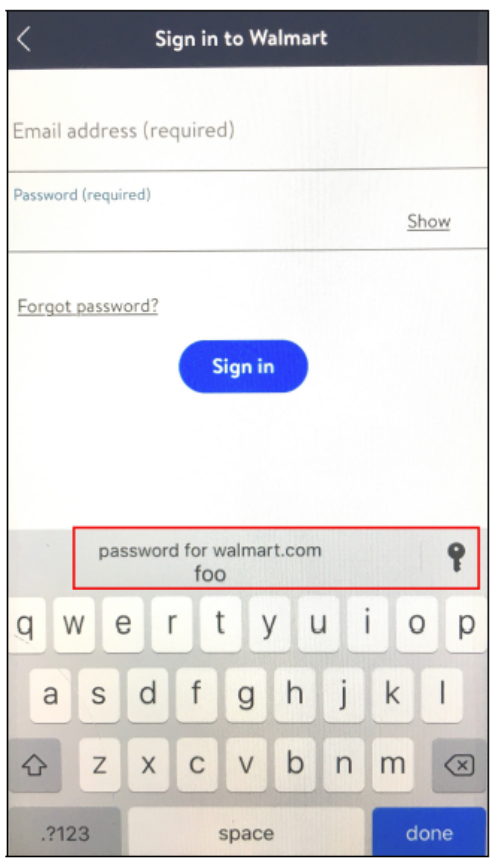
(a) Selecting app extension



(b) Selecting password

iOS AutoFill

- iOS 12 – 2018
- Controls entire autofill process
  - form identification
  - mapping app and domain
  - user interface
  - autofill

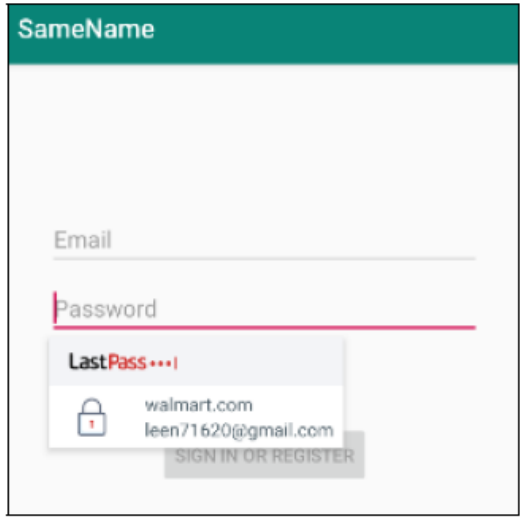


(a) Credential found

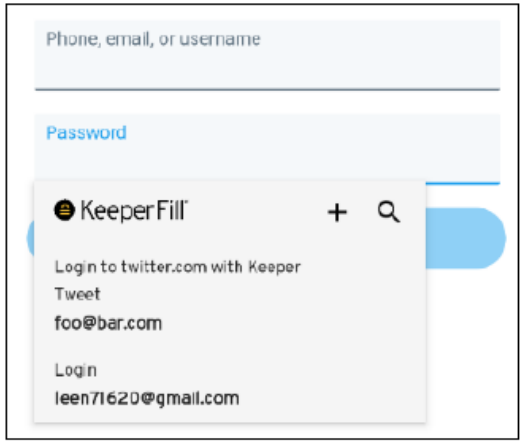
(b) No credential found

Android Autofill Service

- Android 8 (Oreo) 2017 – replaces accessibility service
- Leaves a lot of leeway to individual managers



(a) LastPass



(b) Keeper

Approach

Systematic evaluation of autofill properties and testing methodology

Secure Autofill Properties

- Managers should only fill credentials when:
  - P1: Users explicitly authorize operation
  - P2: Credential is securely mapped to web domain or app
  - P3: Credential is only accessible to mapped domain
- Protects against credential scraping and phishing

Autofill dialogue tells user it is safe to fill credentials

Testing

- Strategy
  - Evaluated 14 managers implemented with the autofill frameworks
  - Considered all three properties in all supported contexts
  - Looking for what the framework enforces, what it fails to enforce, and what it prevents managers from enforcing
- Environment
  - iPhone 7 running iOS 13, using Safari for browser tests
  - Genymotion Android emulator
    - Simulated a Google Pixel 2 running Android 9 (Pie)
    - Chrome for browser

Results

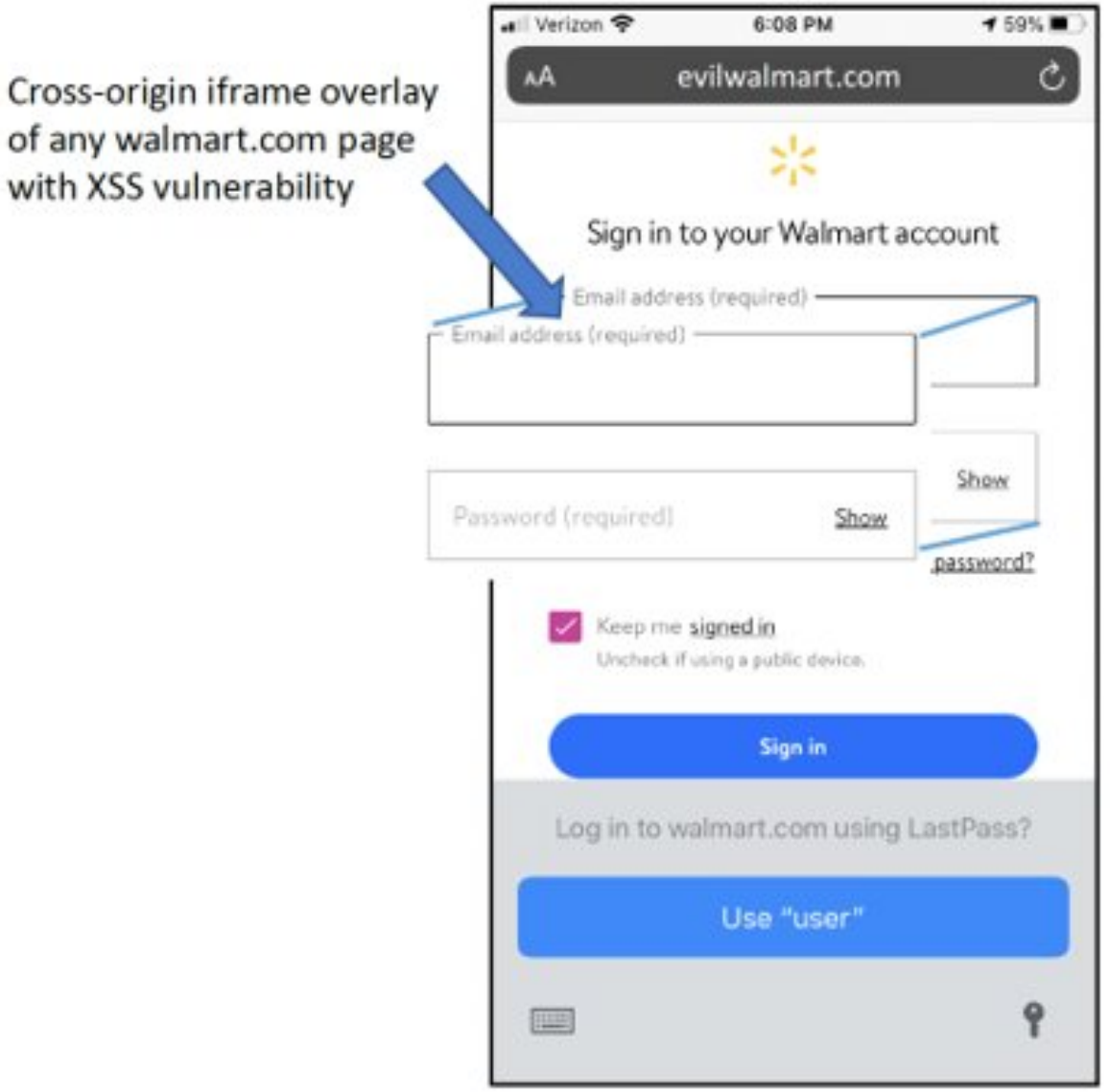
Browser, Native UI Elements, and WebView

Autofill in the Browser

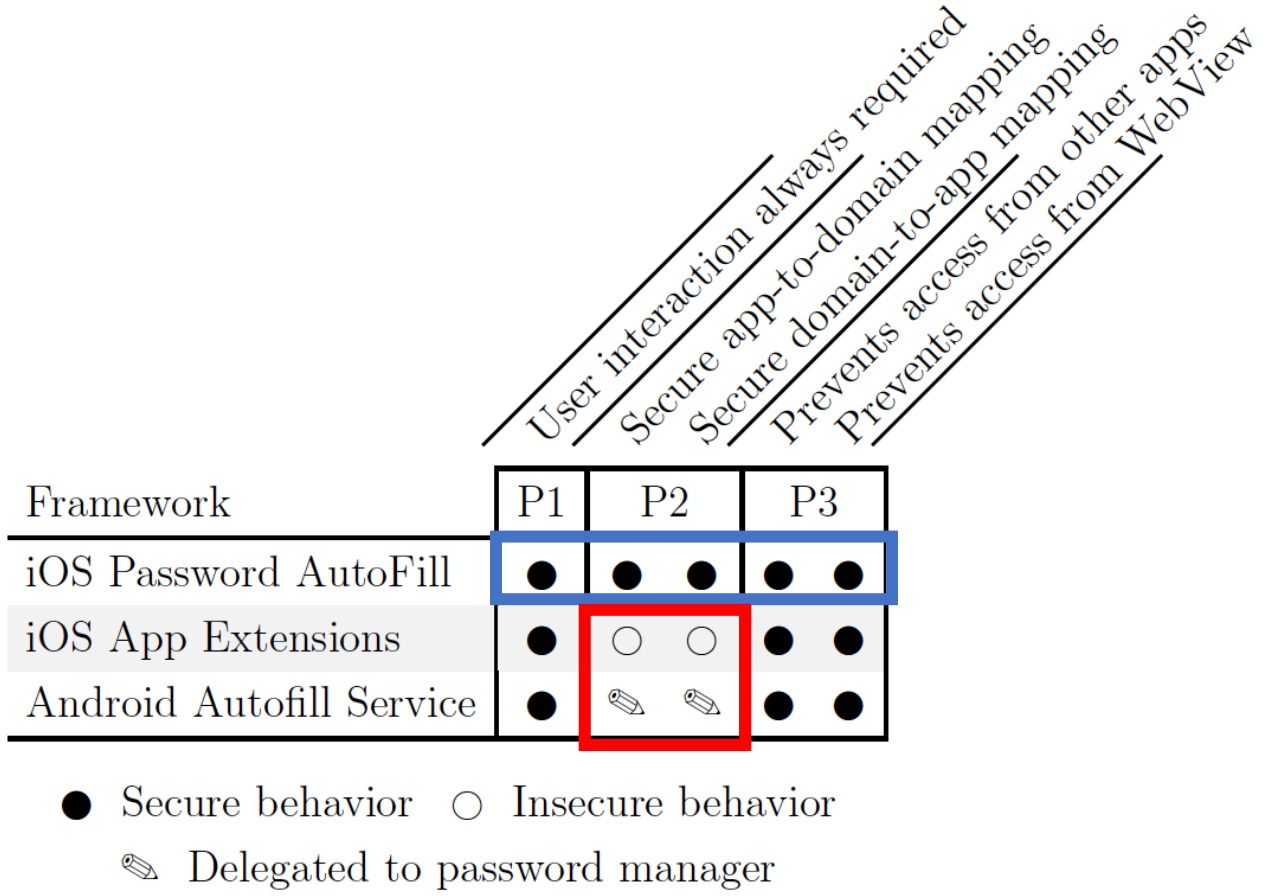
Framework	P1	P2			P3				
	User interaction always required	Maps credentials to domains	Won't fill HTTPS→HTTP	Won't fill HTTPS→bad cert	Fills password only on transmission	Won't fill different `action` (static)	Won't fill different `action` (dynamic)	Won't fill different `method`	Won't fill cross-origin iframe
iOS Password AutoFill	●	●	○	○	○	○	○	○	○
iOS App Extensions	●	●	○	○	○	○	○	○	●
Android Autofill Service	●	●	○	○	○	○	○	○	✎
Most secure desktop manager [48]	●	●	◐	●	○	◐	◐	◐	●
Least secure desktop manager [48]	○	●	●	○	○	●	●	○	○

● Secure behavior ◐ Partially secure behavior
○ Insecure behavior ✎ Delegated to password manager

Cross-origin phishing attack



Autofill in Native UI Elements



WebView Overview

Framework	P1	P2		P3					
	User interaction always required	**Maps credentials to domains**	Won't fill HTTPS→HTTP	Won't fill HTTPS→bad cert	**Prevents access from hosting app**	Fills password only on transmission	Won't fill different `action` (static)	Won't fill different `action` (dynamic)	Won't fill different `method`	Won't fill cross-origin iframe
iOS Password AutoFill	●	●	○	○	○	○	○	○	○	○
iOS App Extensions	●	✎	○	○	○	○	○	○	○	●
Android Autofill Service	●	✎	○	○	○	○	○	○	○	✎

● Secure behavior ○ Insecure behavior ✎ Delegated to password manager

Violation P2

- Credential should be mapped to website hosted in WebView
- Some managers/frameworks fill the app credentials into any website hosted in WebView
- Users are conditioned to trust autofill dialogues

WebView Overview

Framework	P1	P2		P3					
	User interaction always required	**Maps credentials to domains**	Won't fill HTTPS→HTTP	Won't fill HTTPS→bad cert	**Prevents access from hosting app**	Fills password only on transmission	Won't fill different `action` (static)	Won't fill different `action` (dynamic)	Won't fill different `method`	Won't fill cross-origin iframe
iOS Password AutoFill	●	●	○	○	○	○	○	○	○	○
iOS App Extensions	●	✎	○	○	○	○	○	○	○	●
Android Autofill Service	●	✎	○	○	○	○	○	○	○	✎

● Secure behavior ○ Insecure behavior ✎ Delegated to password manager

Violation P3

- A host app should not be able to access credentials filled into a WebView
- Both iOS and Android allow JS callbacks

Summary & Recommendations

- P1: Users explicitly authorize operation
  - Obeyed by all mobile autofill frameworks in all contexts
- P2: Credential is securely mapped to web domain or app
  - Need a secure bi-directional app-to-domain mapping
  - Should disable autofill in cross-origin iframes
- P3: Credential is only accessible to mapped domain
  - Need secure autofill in WebView and Browser

Questions?

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