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EUROPE 2023  
DECEMBER 4-7  
EXCEL LONDON / UK

# AutoSpill

Zero Effort Credential Stealing from Mobile Password Managers

**Ankit Gangwal**, Shubham Singh, Abhijeet Srivastava  
IIIT Hyderabad, IN





## Internet ~~Information~~ Age

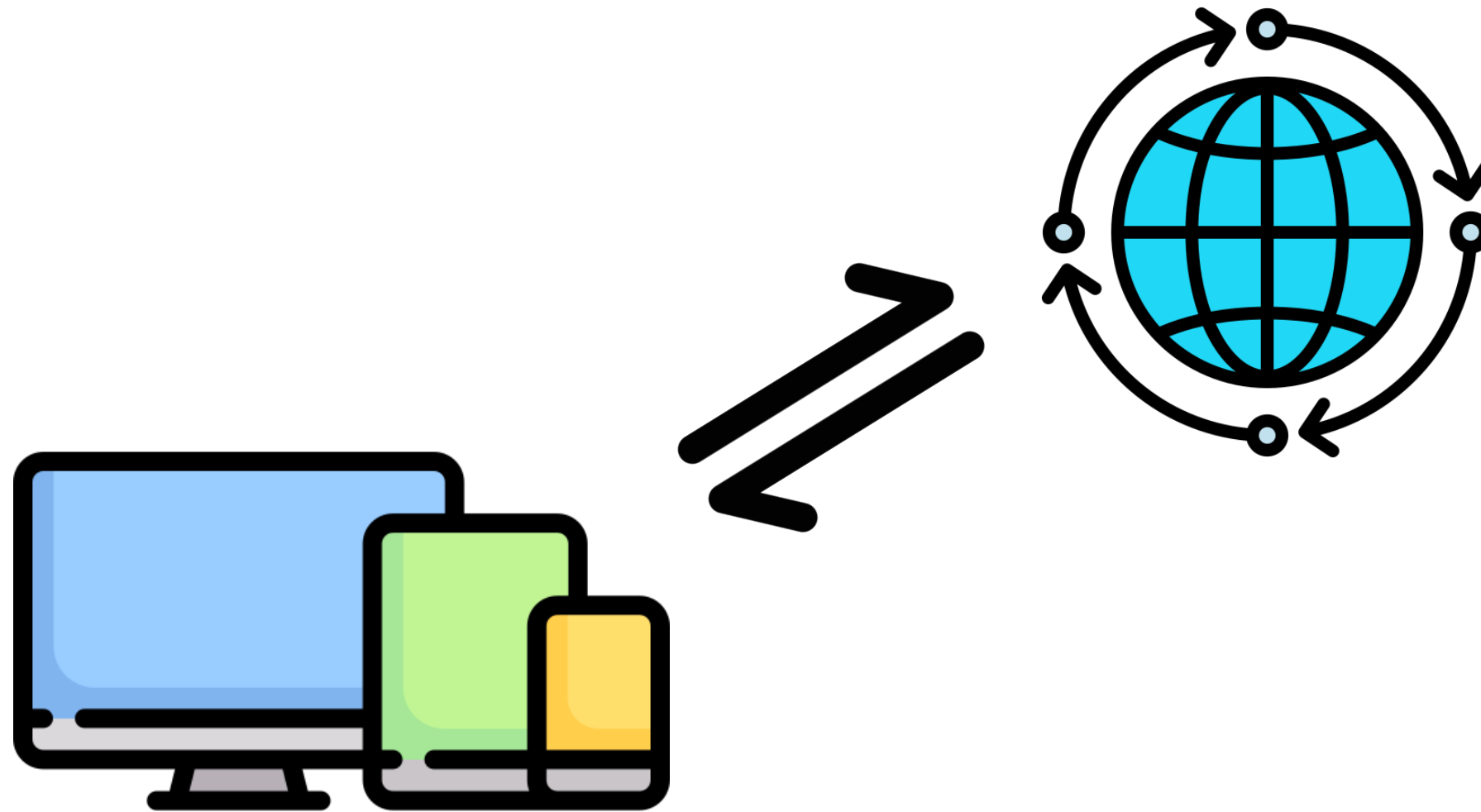
## Connect the world



## Become the world

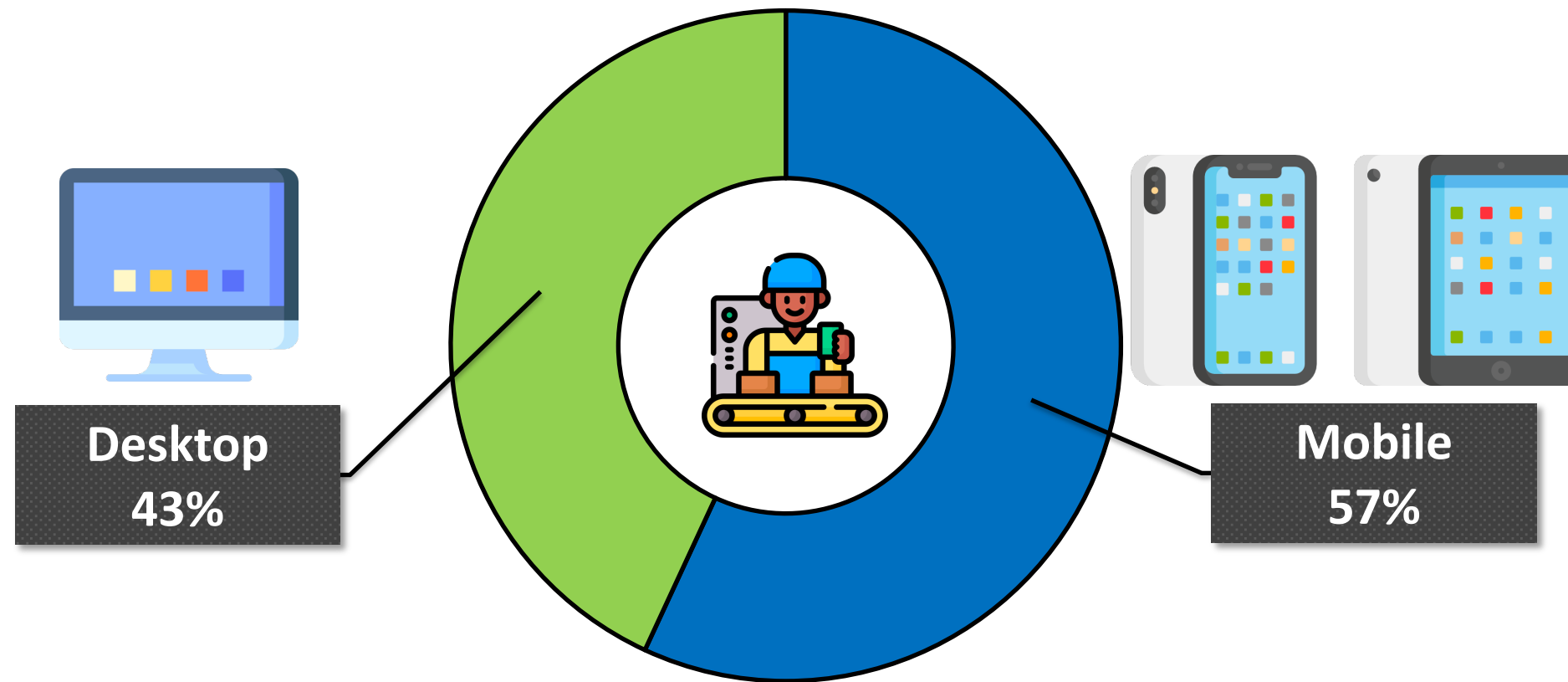


## Connecting to the Internet



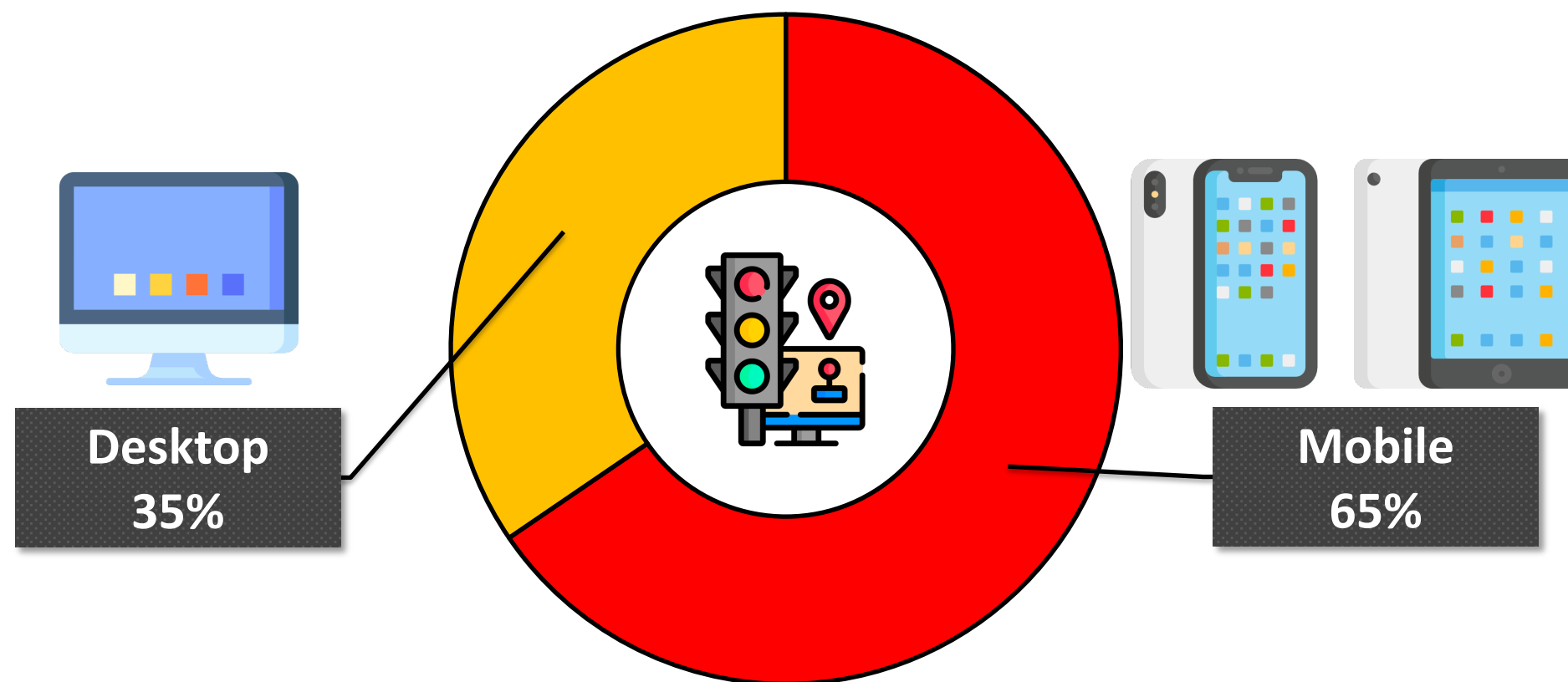
Different devices

## Desktop vs. mobile

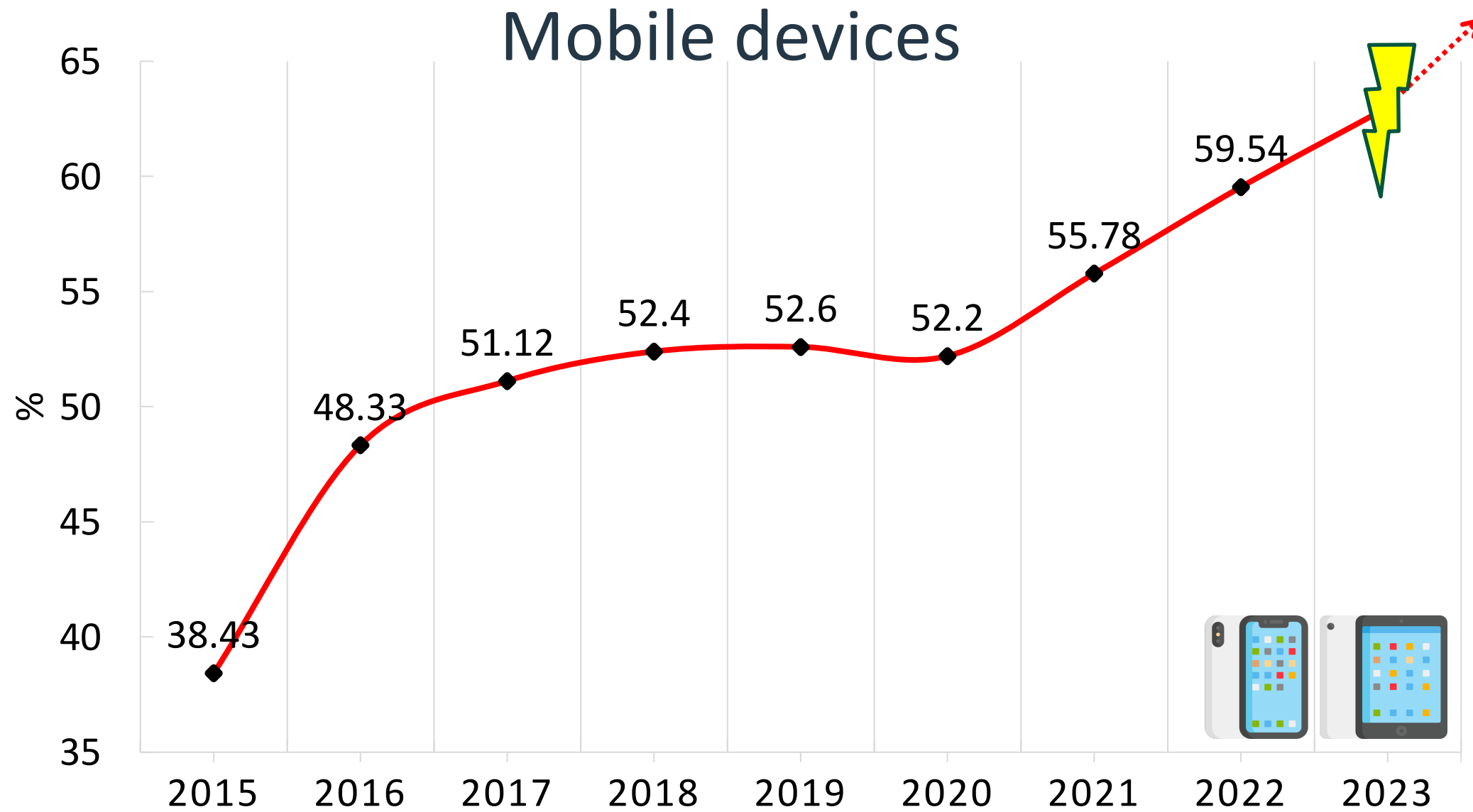


Worldwide device market share - 2023

## Desktop vs. mobile



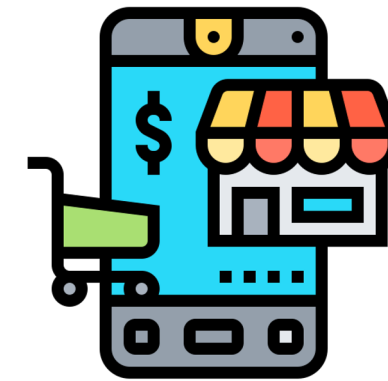
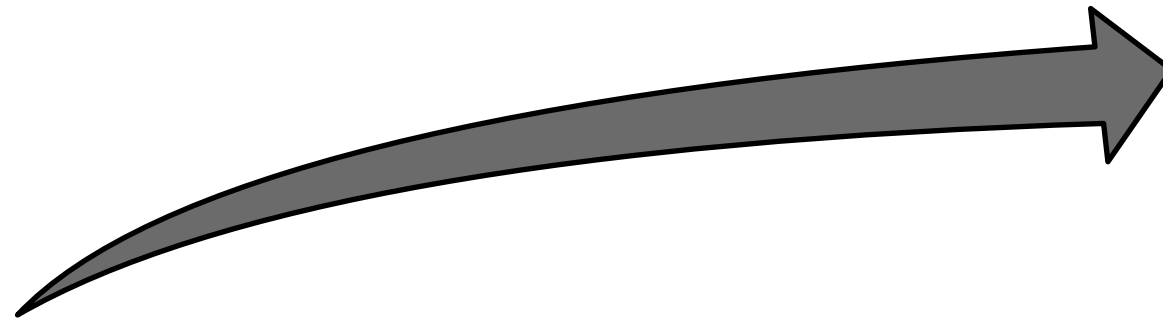
Worldwide Internet traffic share - Q1 2023



## Worldwide mobile Internet traffic trend

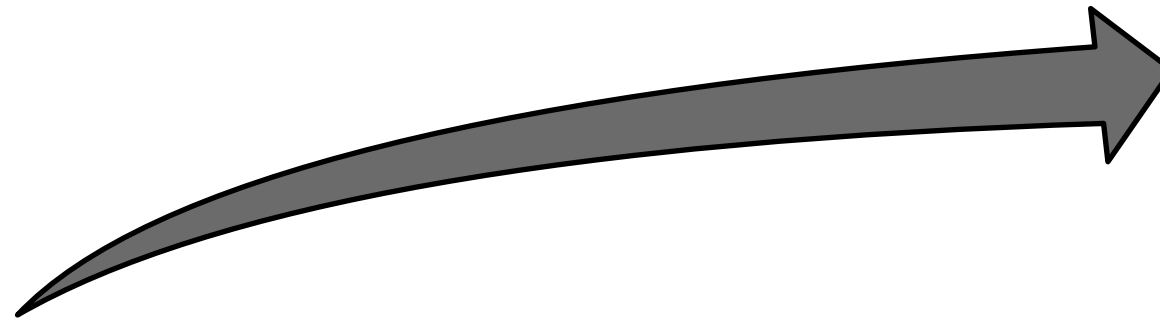
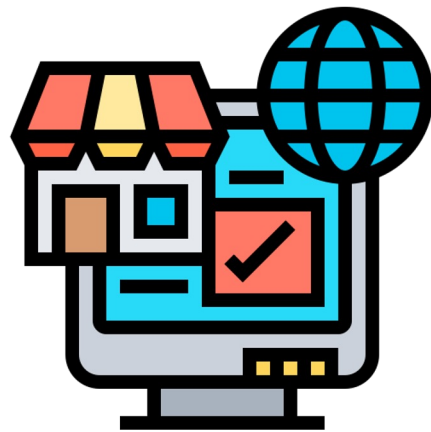


## The big shift - Oh my!





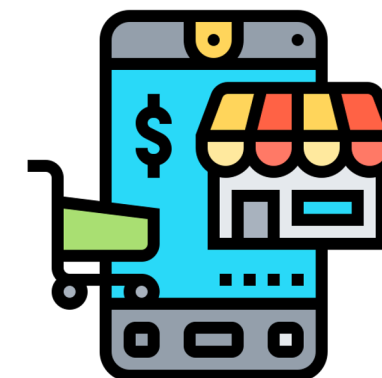
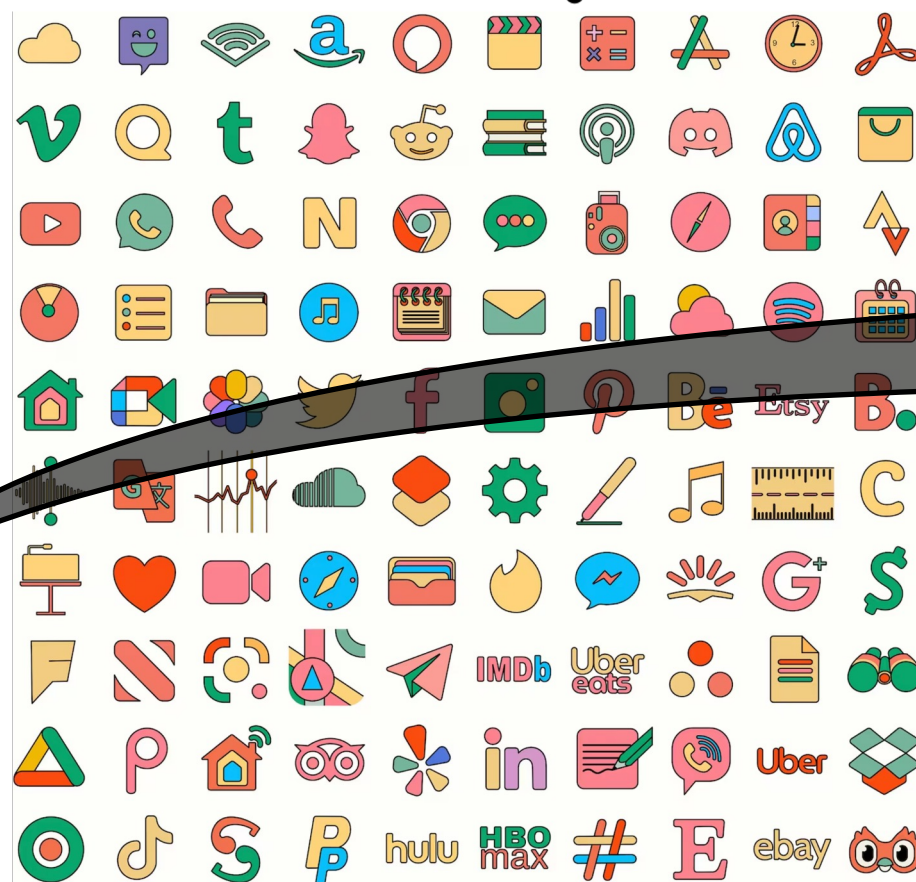
The big shift - Oh my!





The big shift - Oh my!

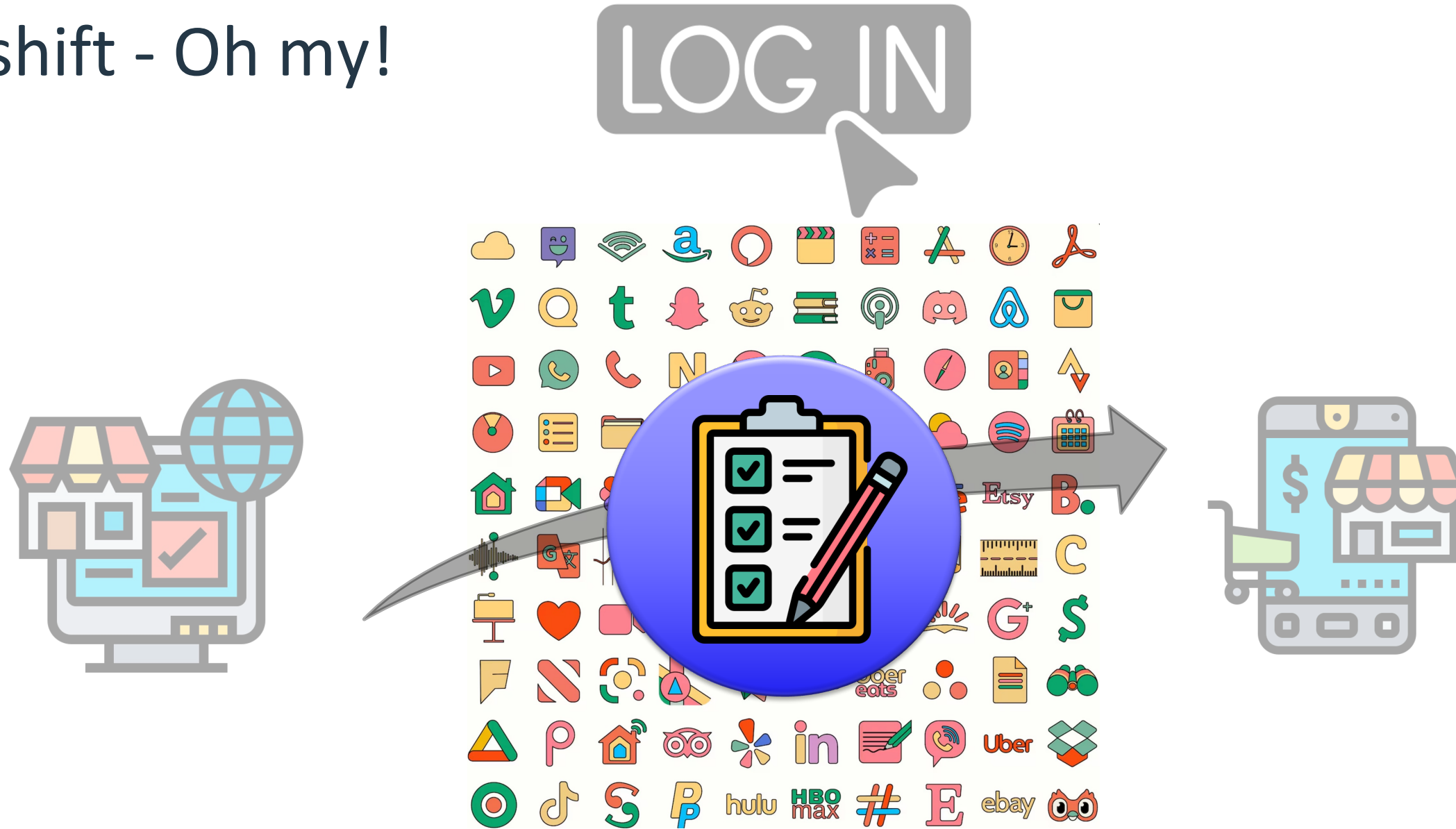
**LOG IN**



# Introduction



The big shift - Oh my!



The big shift - Oh my!





☰ CBS NEWS 🔍

U.S. >

## Common passwords like "123456" and "admin" take less than a second to crack, research shows

BY CAITLIN O'KANE  
NOVEMBER 15, 2023 / 1:28 PM EST / CBS NEWS

f t

☰ The New York Times

## 'Password,' 'Monkey' and the Other Terrible Passwords We Choose

📄 Share full article ↗️ 📖

This year's worst passwords, according to one creator of security applications, include "starwars," "iloveyou," "monkey," "hello," "freedom," "qazwsx" and "trustno1." Damian Dovarganes/Associated Press

By Niraj Chokshi

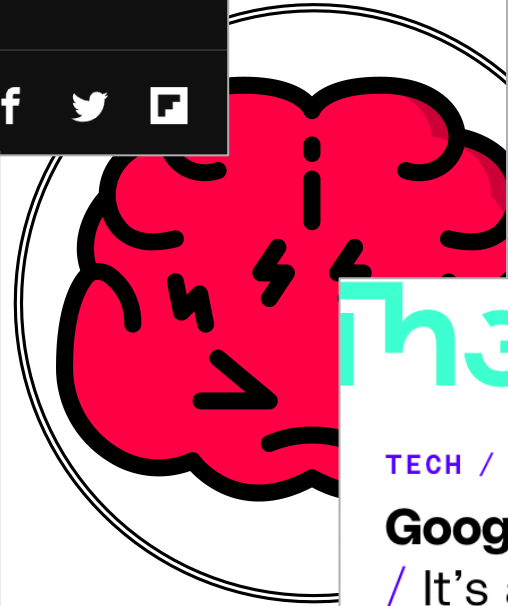
**Forbes**

INNOVATION • CYBERSECURITY

## These Are The World's Most Hacked Passwords -- Is Yours On The List?

Kate O'Flaherty Senior Contributor ©  
*Cybersecurity and privacy journalist*

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**The Verge**

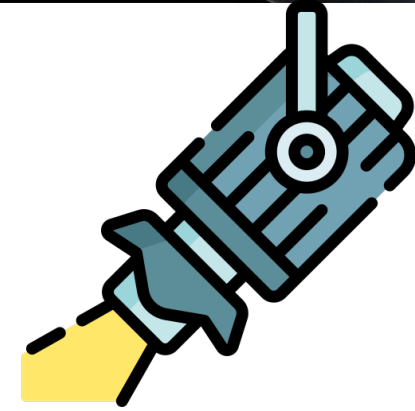
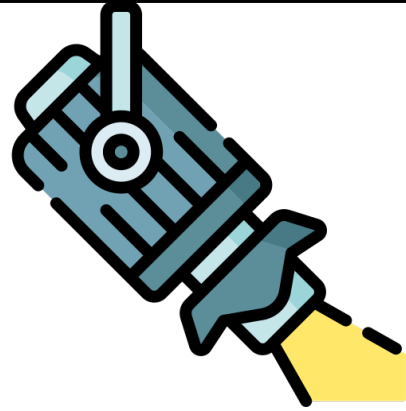
Menu +

TECH / GOOGLE / SECURITY

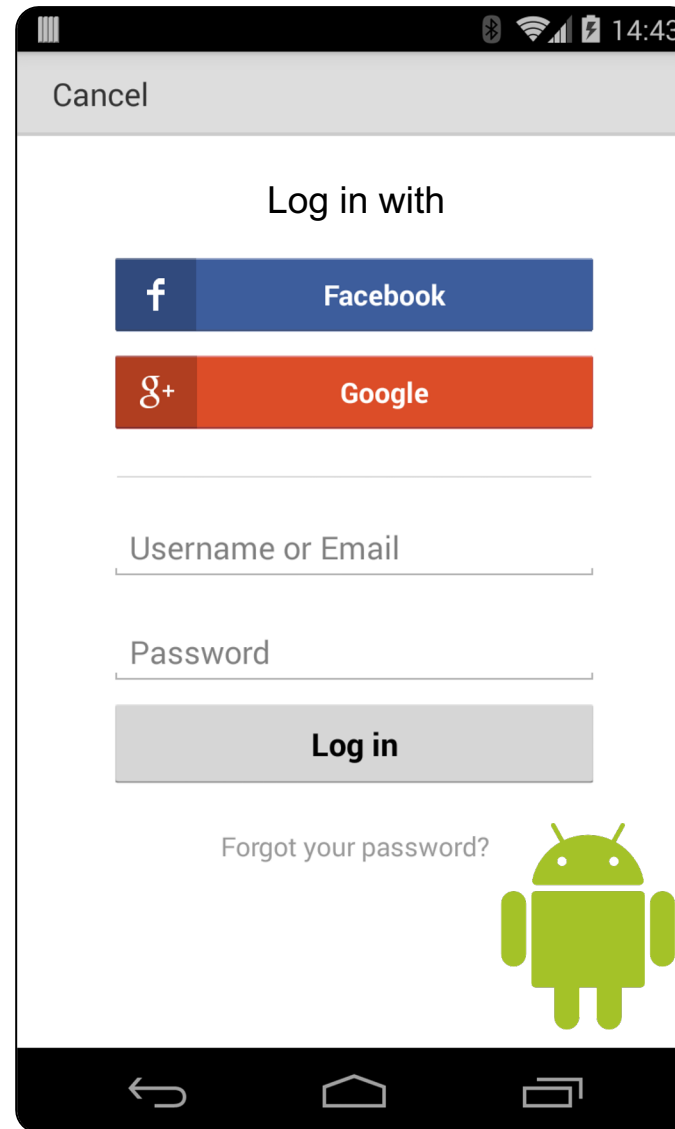
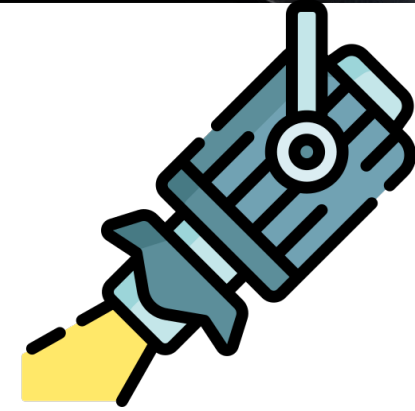
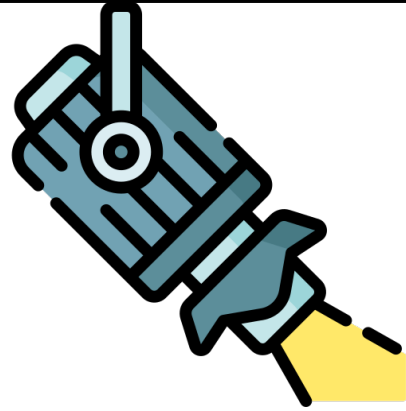
## Google is on a mission to stop you from reusing passwords / It's adding its Password Checkup tool to the Security Checkup dashboard

By Jay Peters, a news editor who writes about technology, video games, and virtual worlds. He's submitted several accepted emoji proposals to the Unicode Consortium.

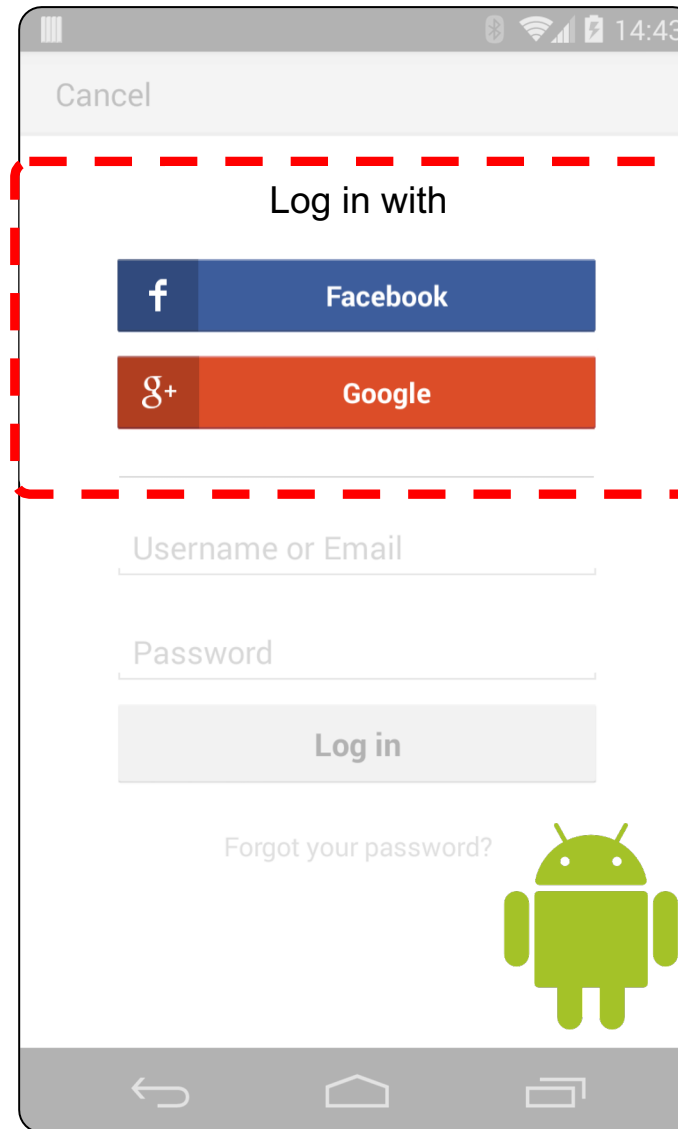
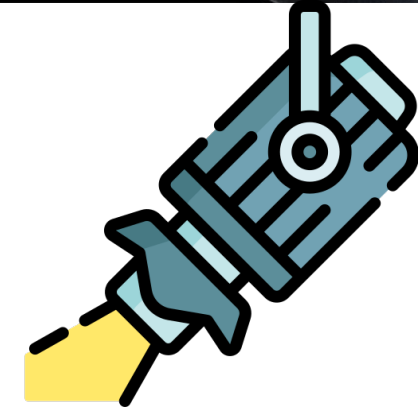
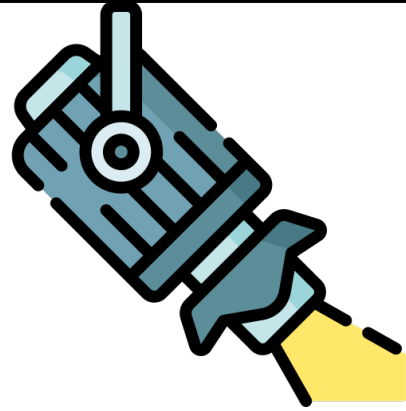
Jun 23, 2020, 5:30 PM GMT+5:30 | 0 Comments / 0 New



# Introduction



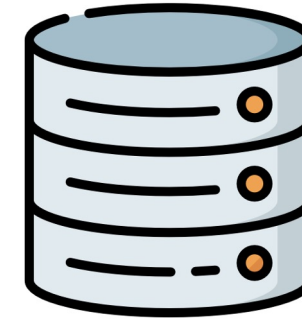
# Introduction



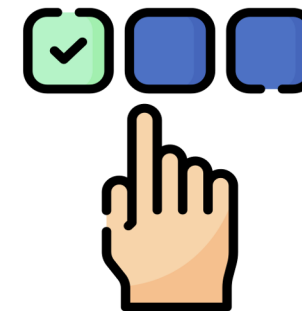


## Password Managers (PMs)

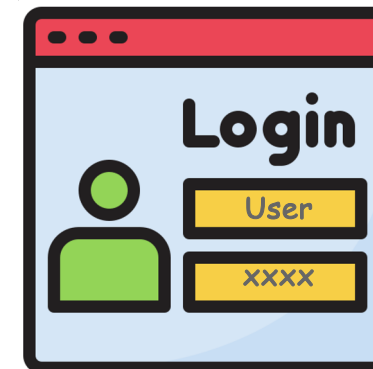
Store & manage



Choose stronger passwords



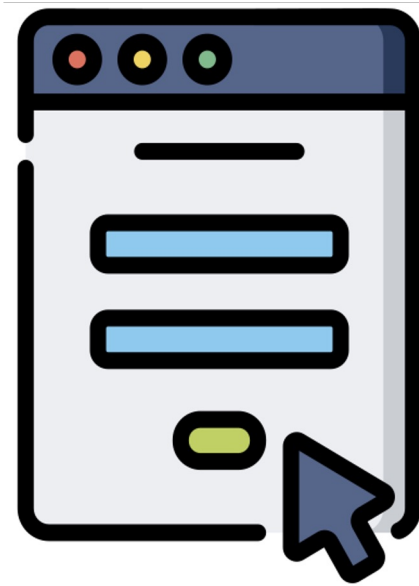
Automatically fill (autofill)





PMs are becoming increasingly common

Computers as well as mobile devices (e.g., smartphones) [1, 2]



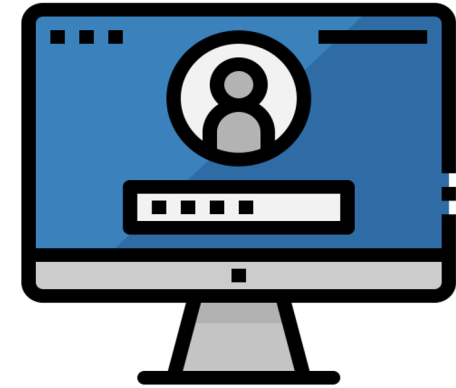
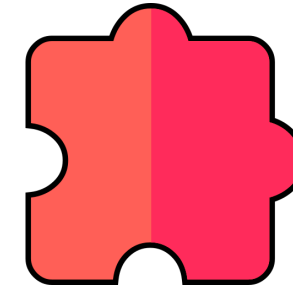
[1] Sean Oesch, Anuj Gautam, and Scott Ruoti, “The Emperor’s New Autofill Framework: A Security Analysis of Autofill on iOS and Android,” In Annual Computer Security Applications Conference. 996-1010, 2021.

[2] Sean Oesch and Scott Ruoti, “That was then, this is Now: A Security Evaluation of Password Generation, Storage, and Autofill in Browser-based Password Managers,” In USENIX Security Symposium. 2165-2182, 2020.



PMs on computers

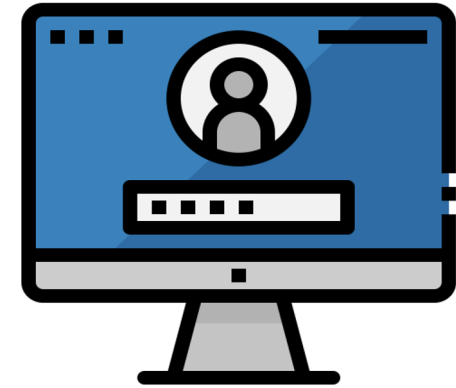
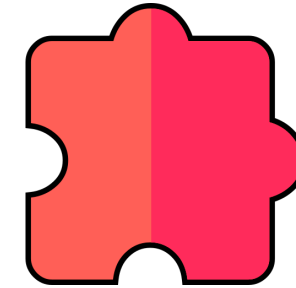
Generally, implemented as browser extension





## PMs on computers

Generally, implemented as browser extension



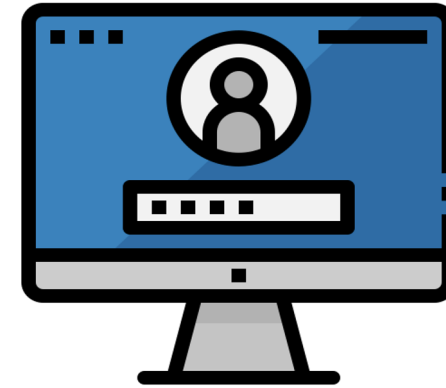
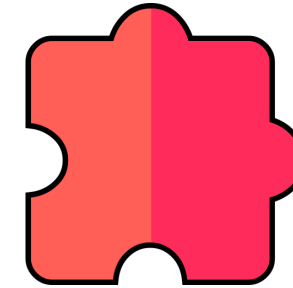
## Handles everything

Storing, rendering, prompting, autofilling



## PMs on computers

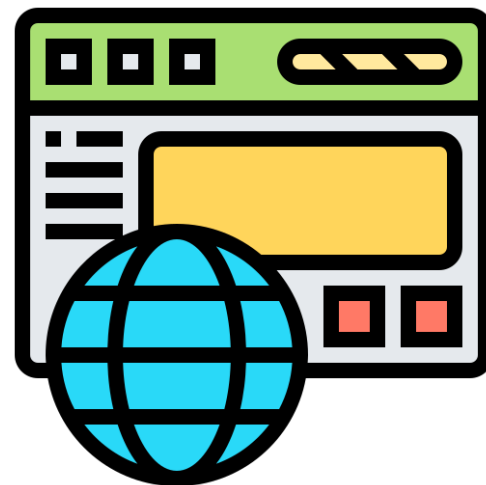
Generally, implemented as browser extension



## Handles everything

Storing, rendering, prompting, autofilling

Autofill ceremony involves only two parties

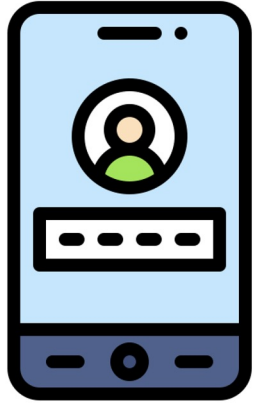
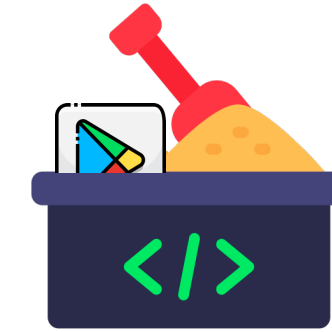


# Background



PMs on mobile OSes (e.g., Android)

System-wide autofill frameworks & sandboxing



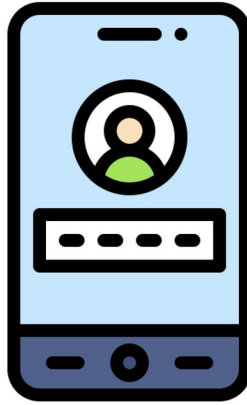
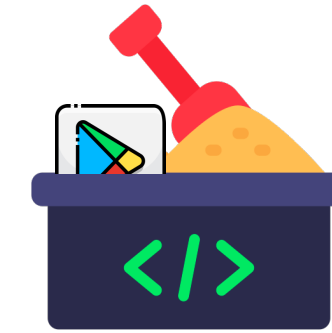
Autofill ceremony involves at least three parties

# Background

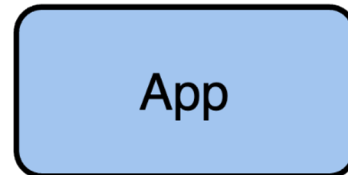


PMs on mobile OSes (e.g., Android)

System-wide autofill frameworks & sandboxing



Autofill ceremony involves at least three parties

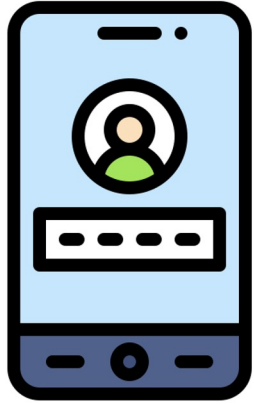
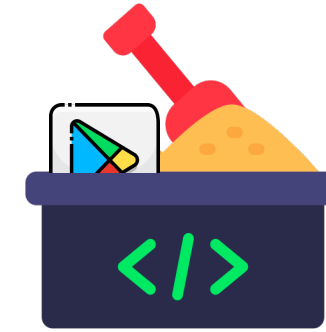


# Background

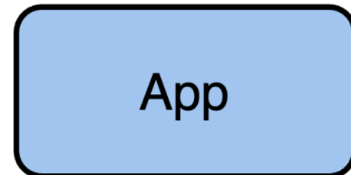


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Autofill ceremony involves at least three parties

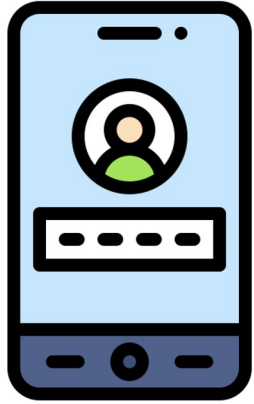
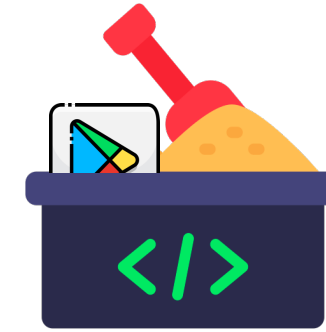


# Background

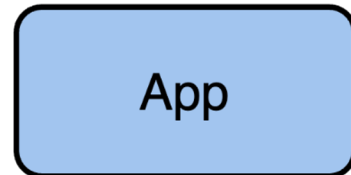


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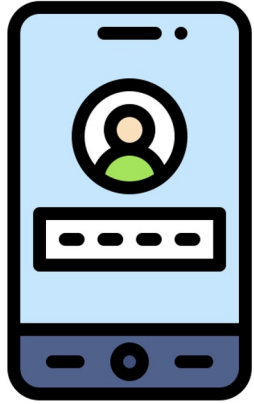
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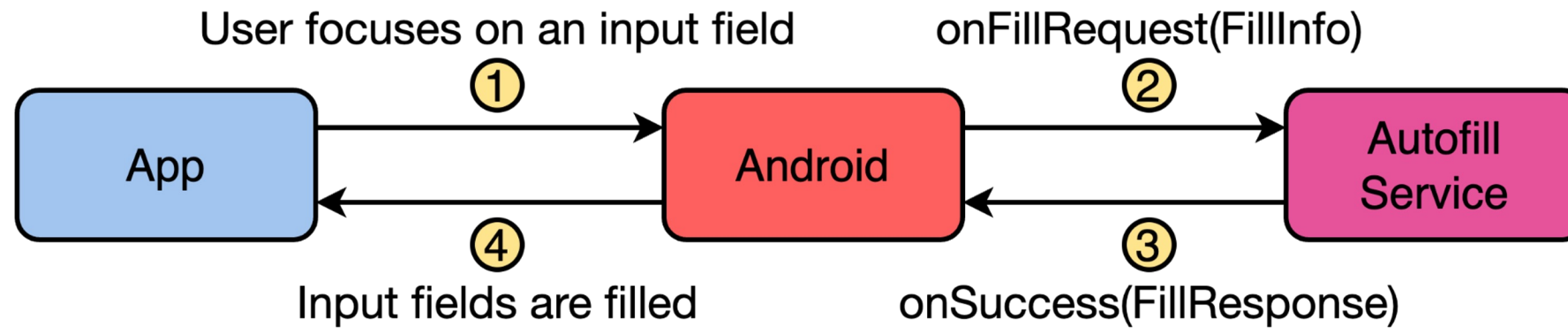
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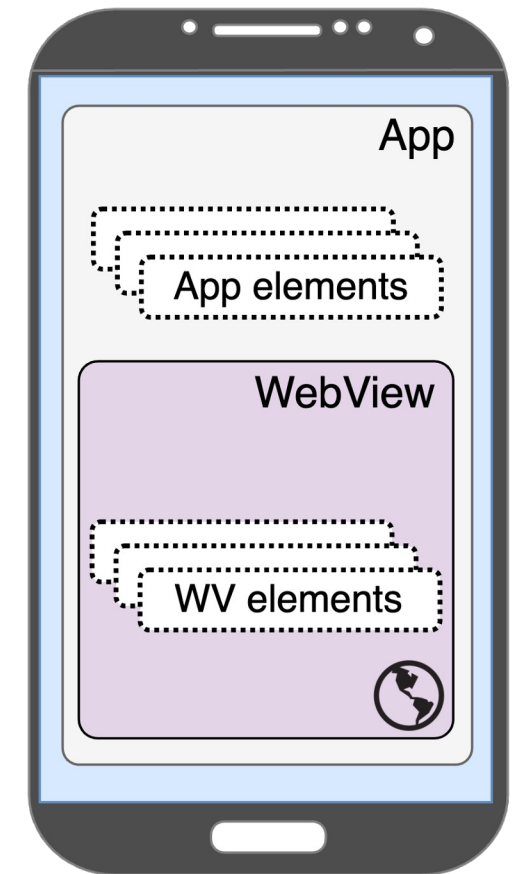


Mobile OSes have developed WebView controls

Act as a minimalistic browser

Empower an app to render web content within itself

Prevents redirection to main browser app



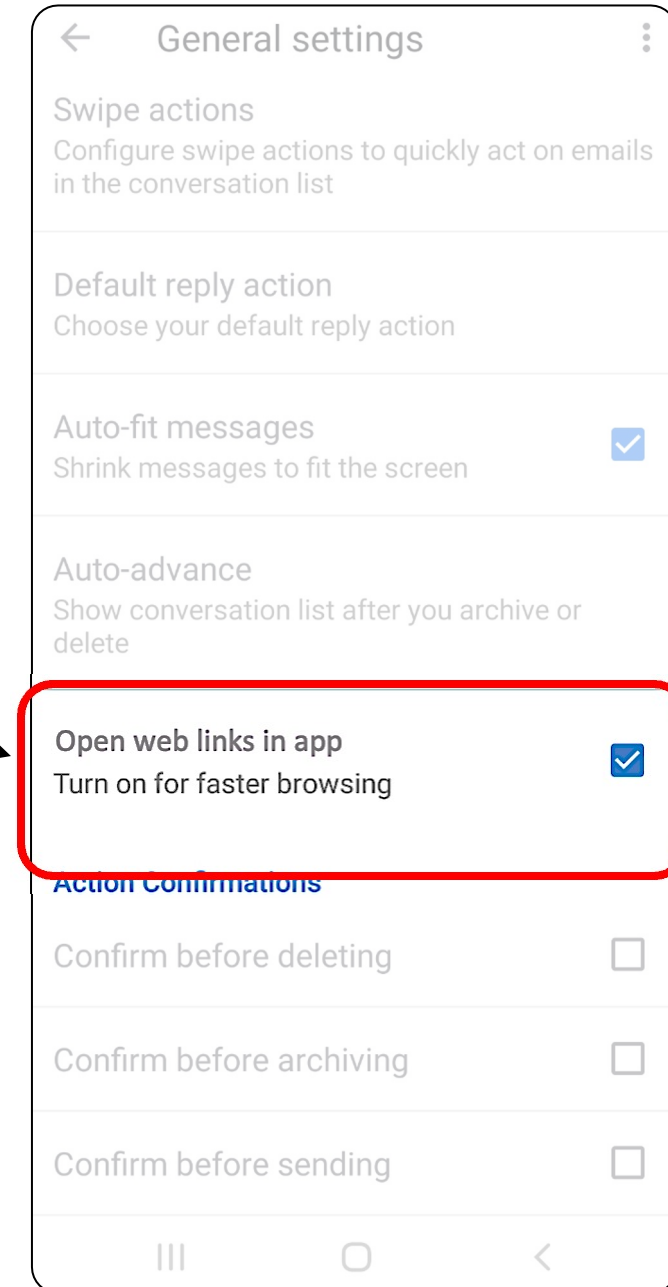


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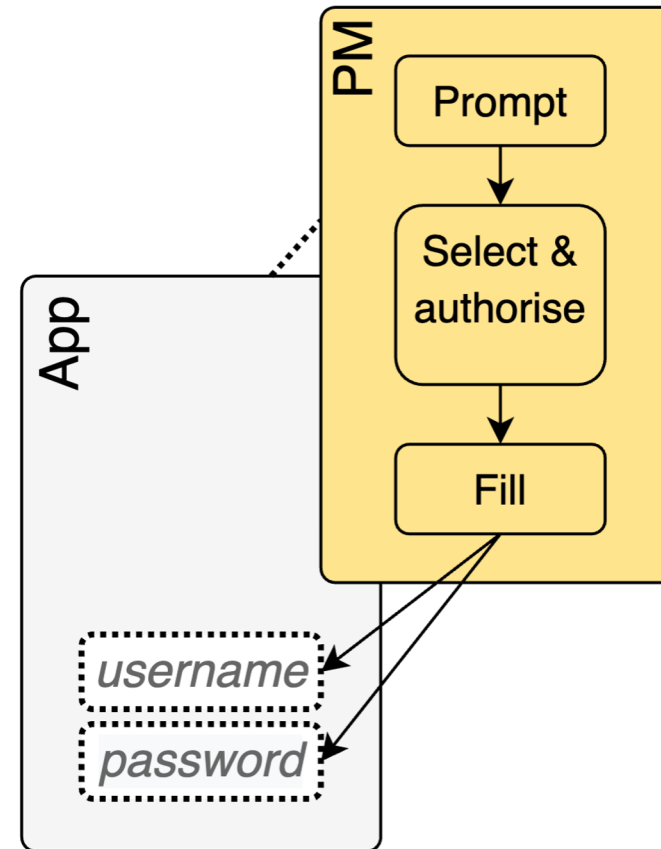


# AutoSpill



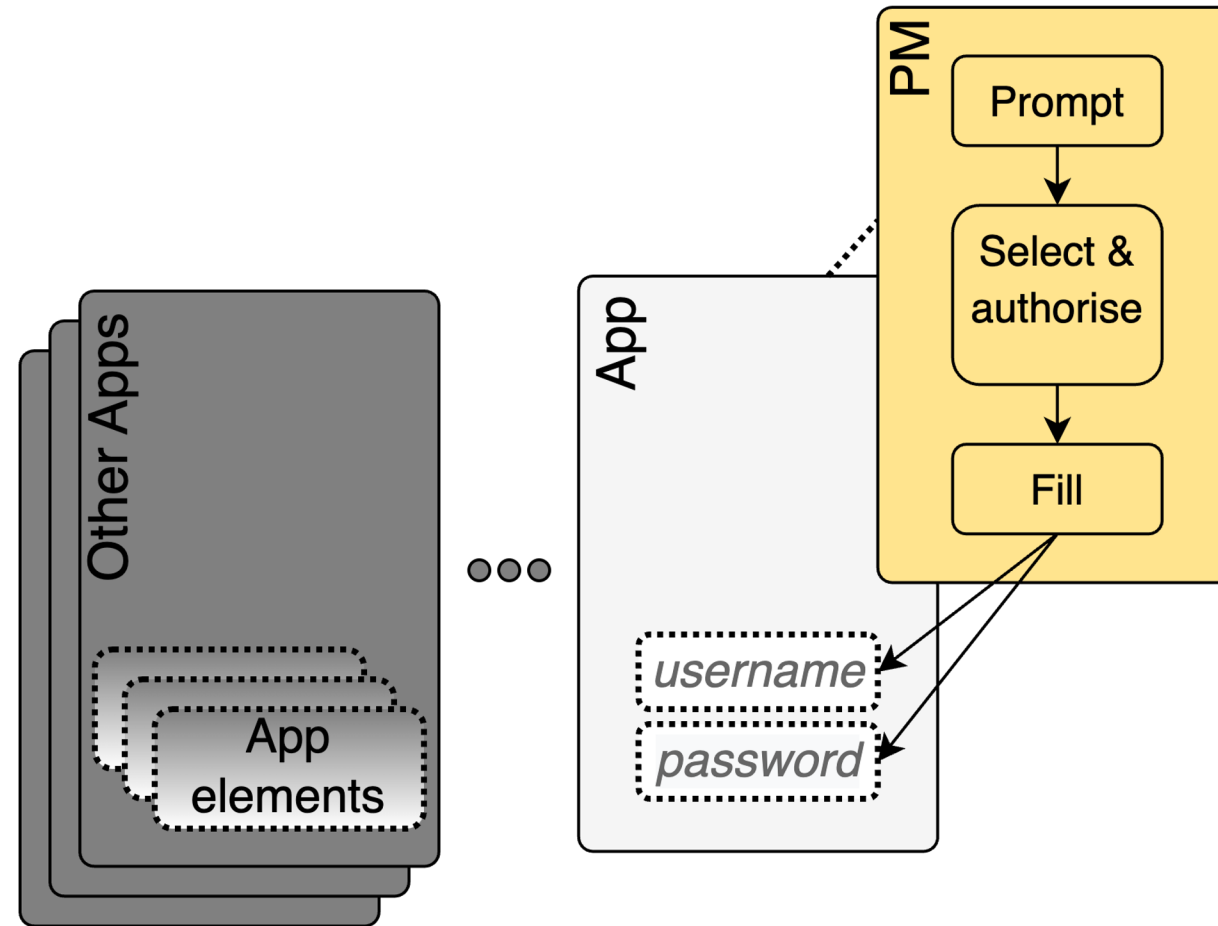


PM is invoked to fill fields in an app



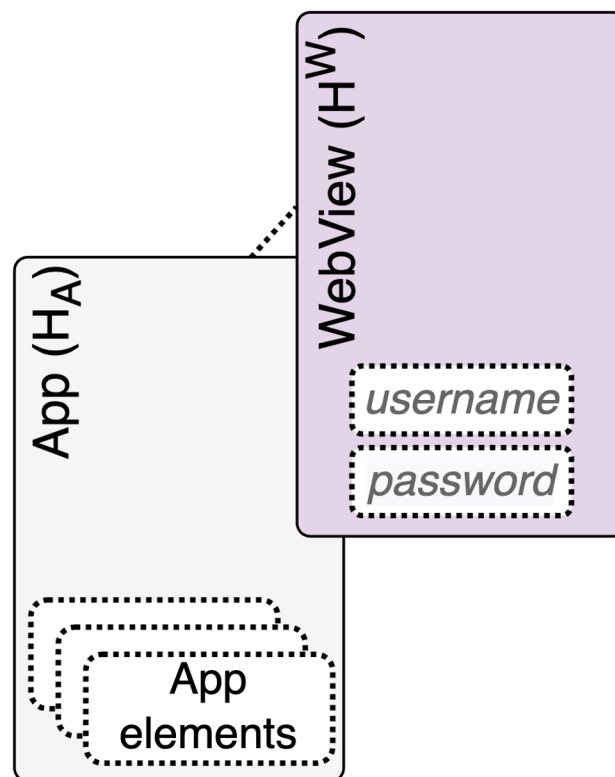


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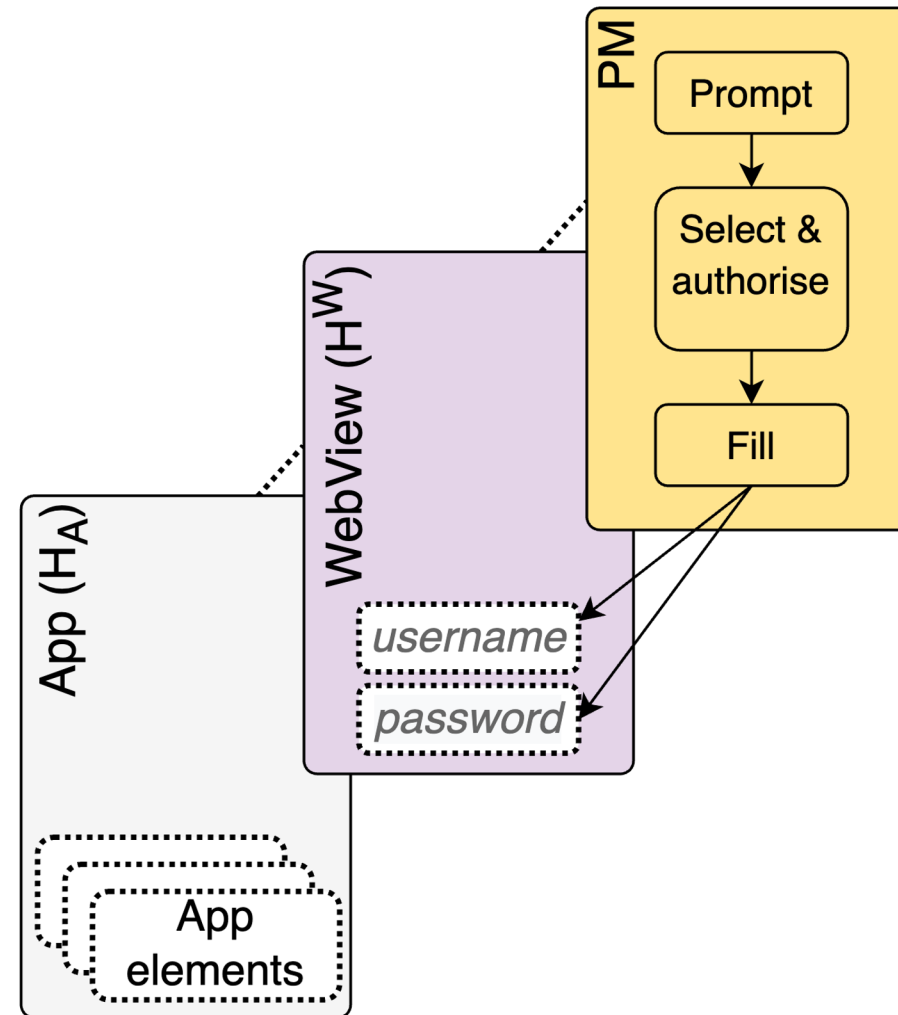


PM is invoked to fill fields in a WebView





## PM is invoked to fill fields in a WebView





## PM is invoked to fill fields in a WebView

### Example 1

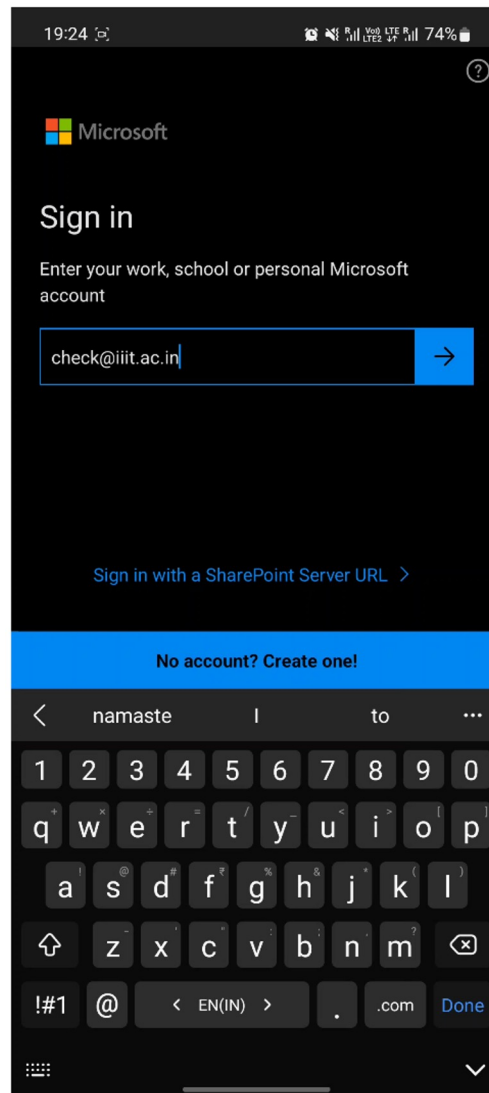


“Login with Apple/Facebook/Google/etc.” buttons



## PM is invoked to fill fields in a WebView

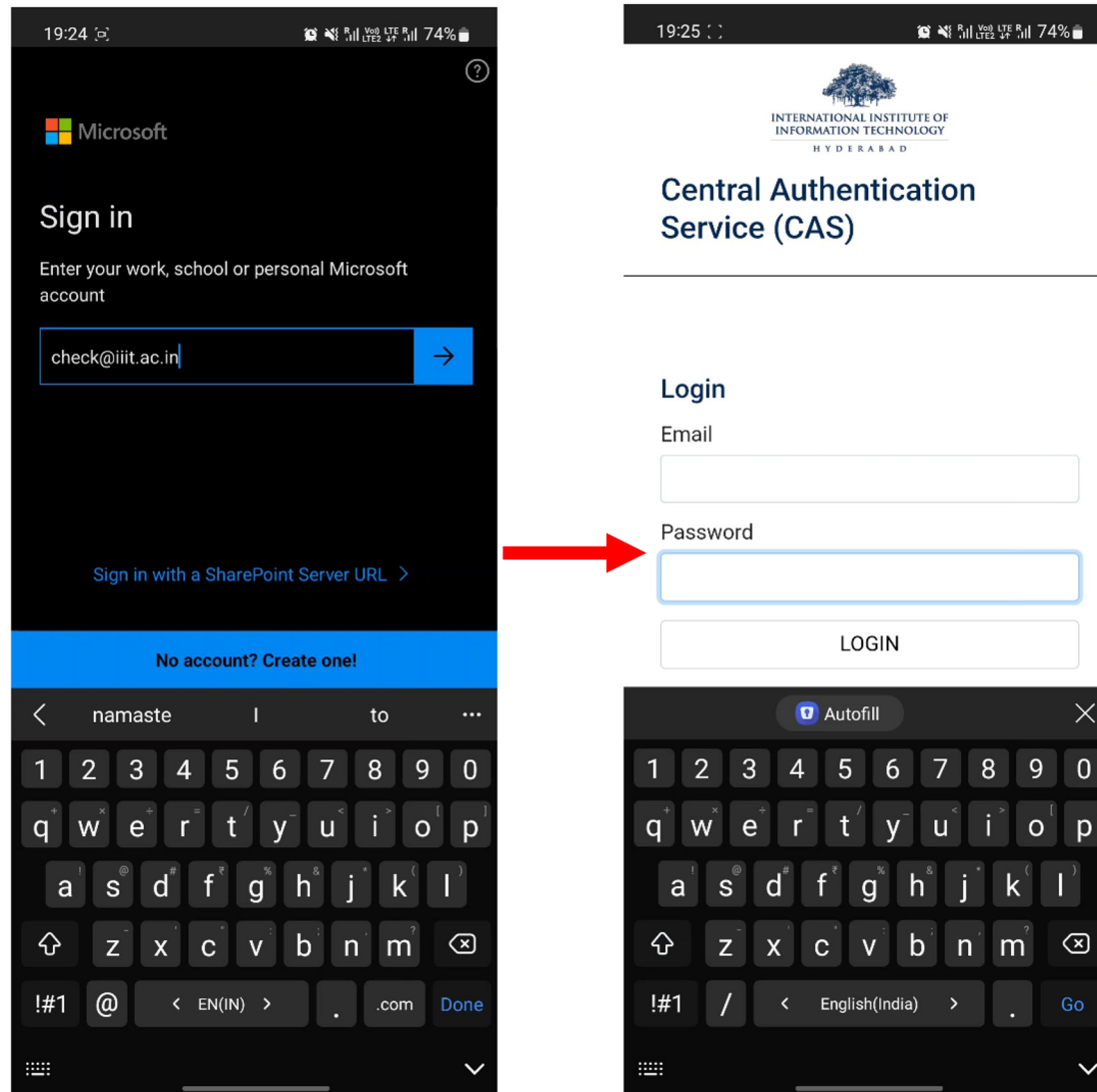
### Example 2



Logging in OneDrive app, which supports 3rd party authentication



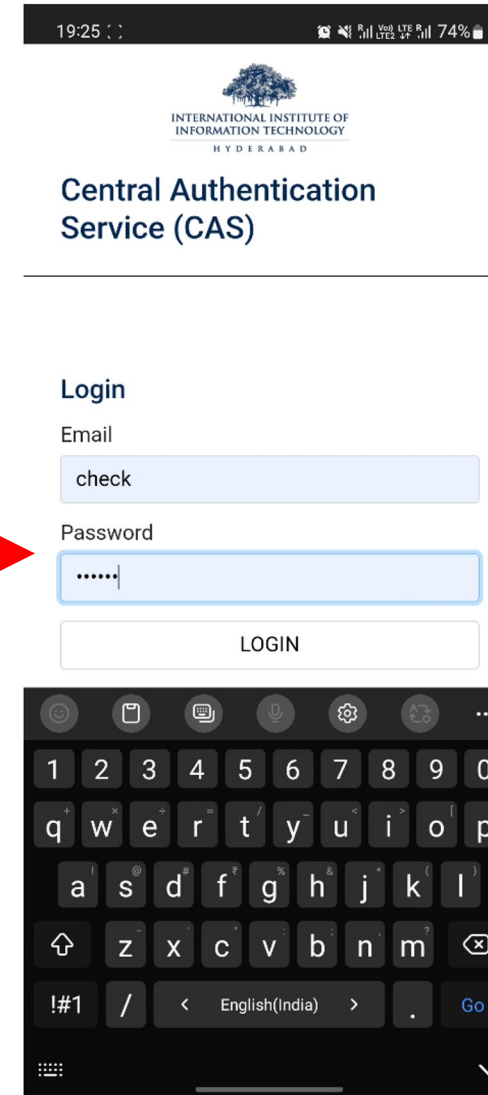
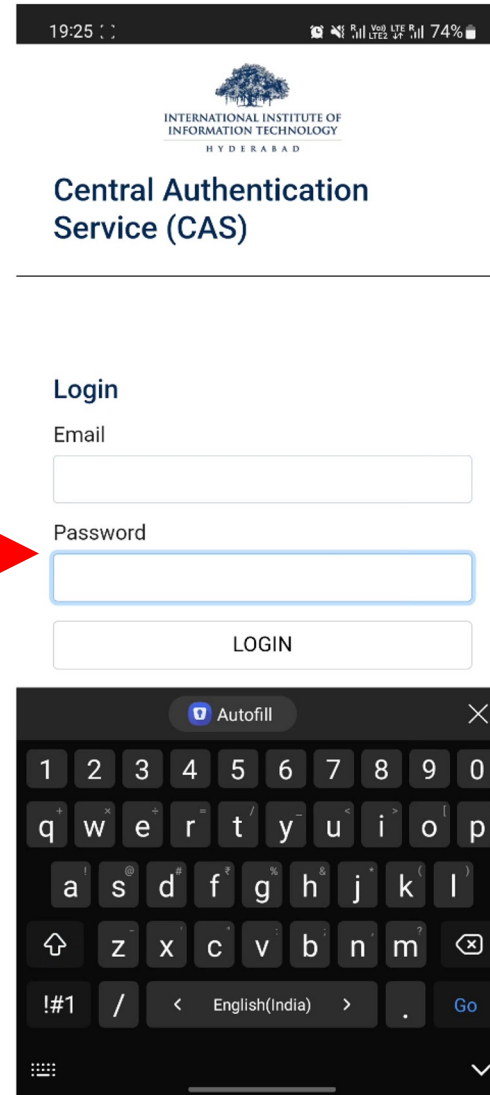
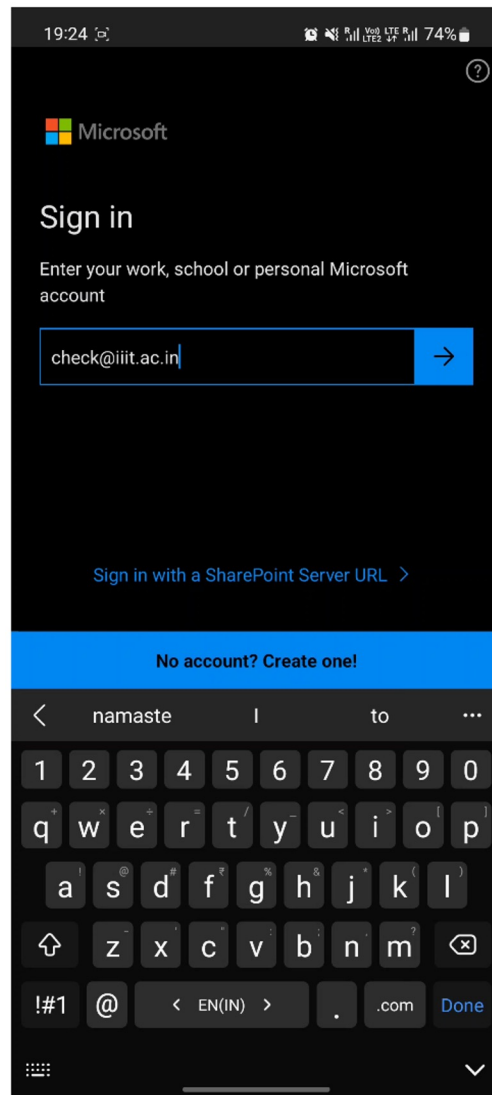
## PM is invoked to fill fields in a WebView Example 2



Logging in OneDrive app, which supports 3rd party authentication



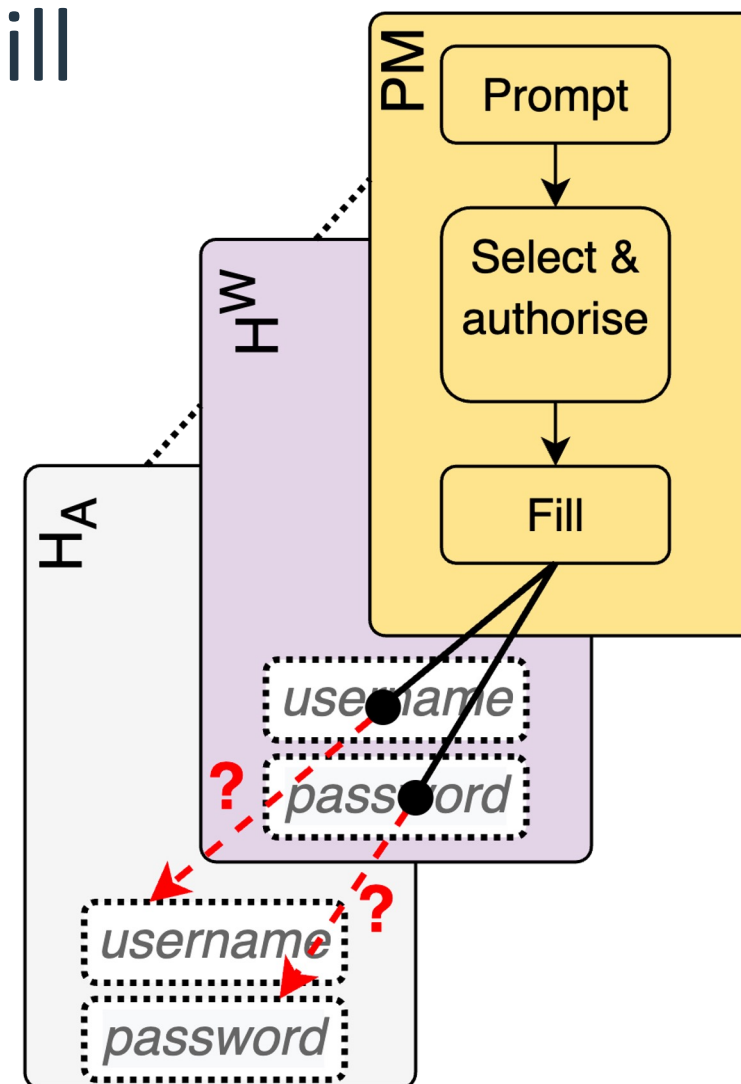
## PM is invoked to fill fields in a WebView Example 2



Logging in OneDrive app, which supports 3rd party authentication



## Credential leakage from $H^W$ to $H_A = \text{AutoSpill}$



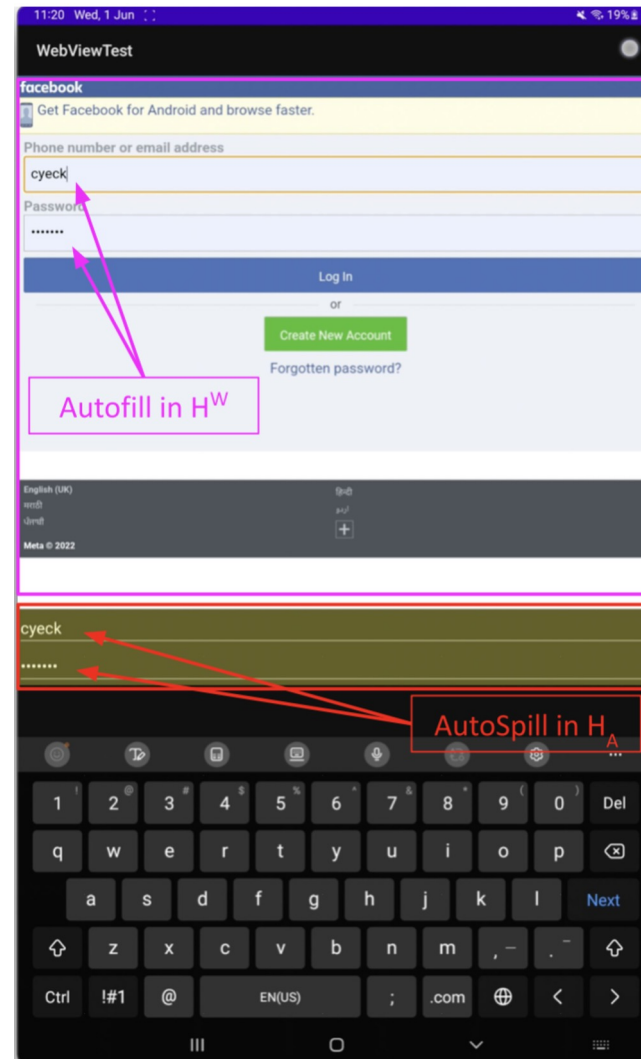
**Violation** of secure autofill process

Responsibility for leakage is stranded between PM and Android

# AutoSpill



Credential leakage from  $H^W$  to  $H_A = \text{AutoSpill}$



A real-world credential AutoSpill from Facebook page



Biggest **benefit** (rather **risk!**) of AutoSpill

+ **Phishing is not required**

1. Benign app with input fields
2. Invokes H<sup>W</sup>
3. Code for processing

+ **No malicious code in app**

Reside on official app store





Created a custom autofill service

Information exchanged during autofill ceremony

App

Android

Autofill  
Service





Created a custom autofill service

Information exchanged during autofill ceremony

*1. Autofill request from Android to autofill service*



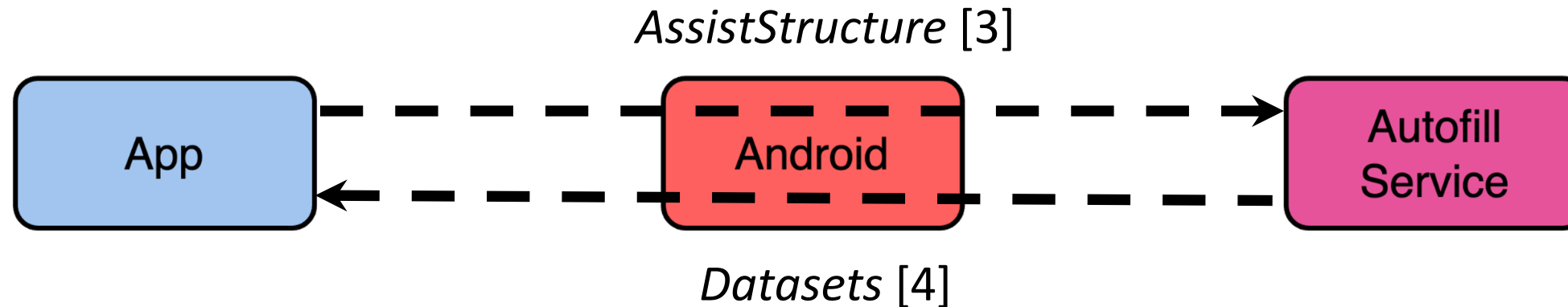
[3] AssistStructure, <https://developer.android.com/reference/android/app/assist/AssistStructure>  
<https://t.me/learningnets>



## Created a custom autofill service

Information exchanged during autofill ceremony

1. *Autofill request from Android to autofill service*
2. *Processing and response from autofill service*

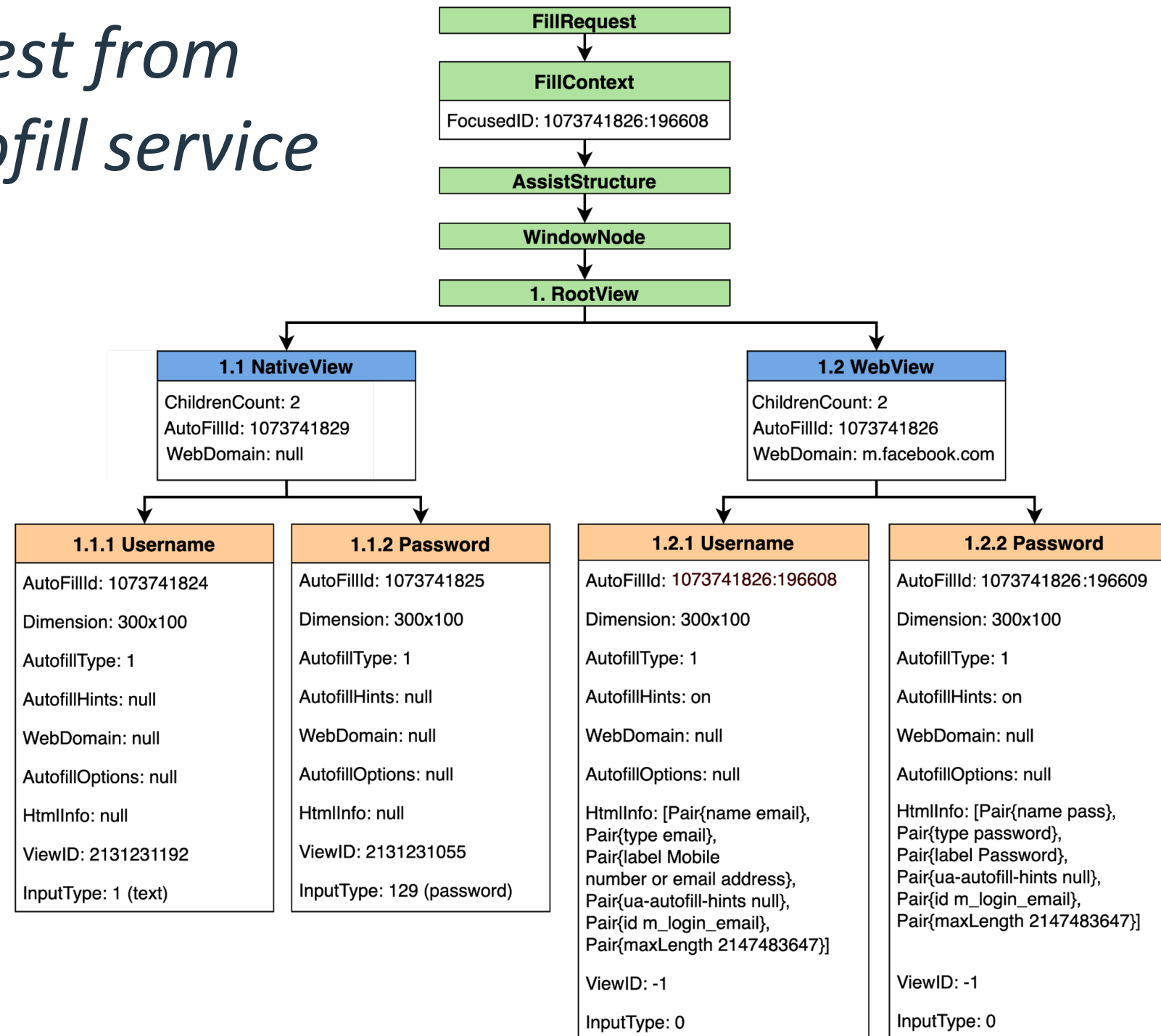


[3] AssistStructure, <https://developer.android.com/reference/android/app/assist/AssistStructure>  
[4] Datasets, <https://developer.android.com/reference/android/service/autofill/Dataset>

# AutoSpill - Investigation

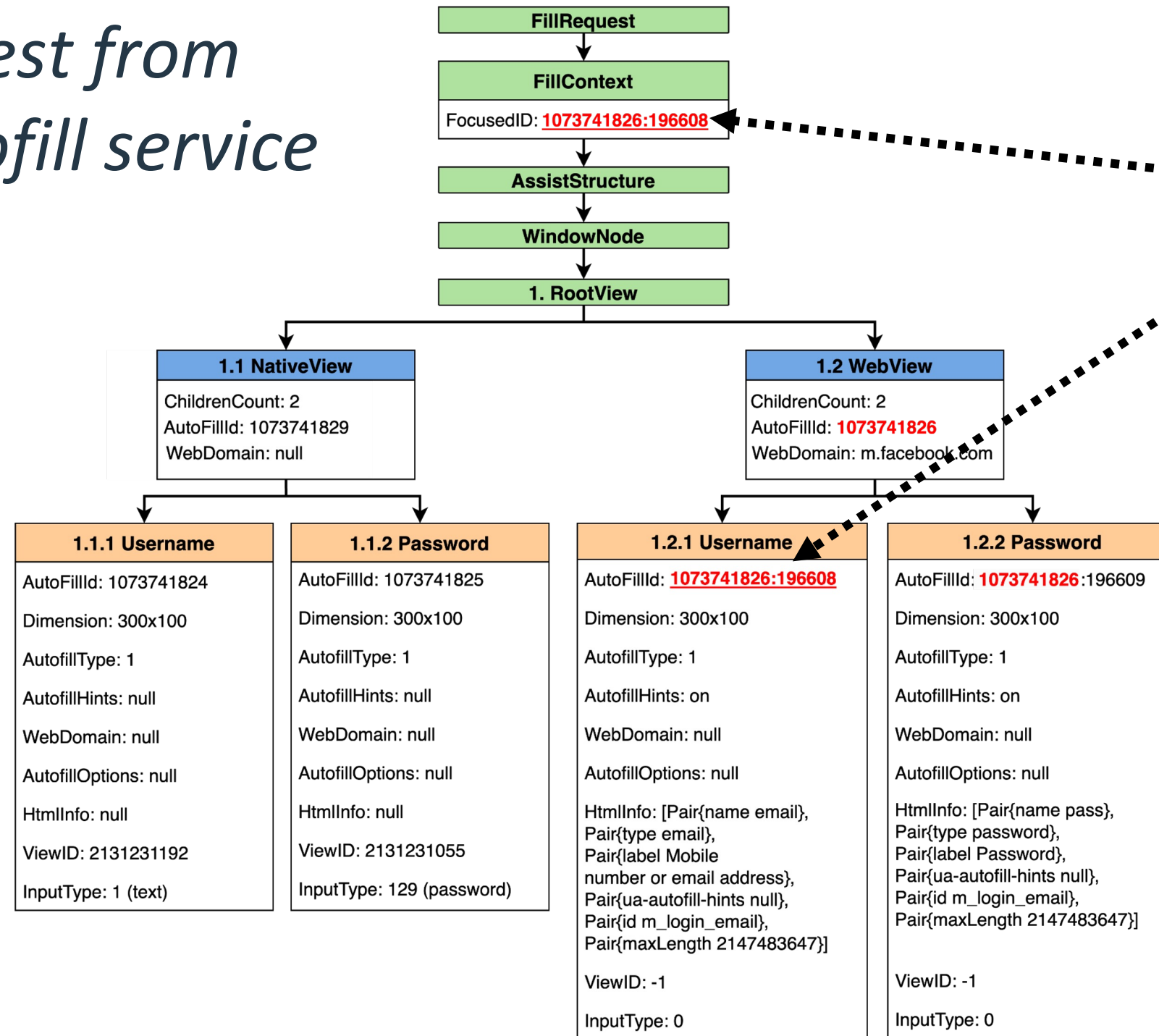


## 1. Autofill request from Android to autofill service



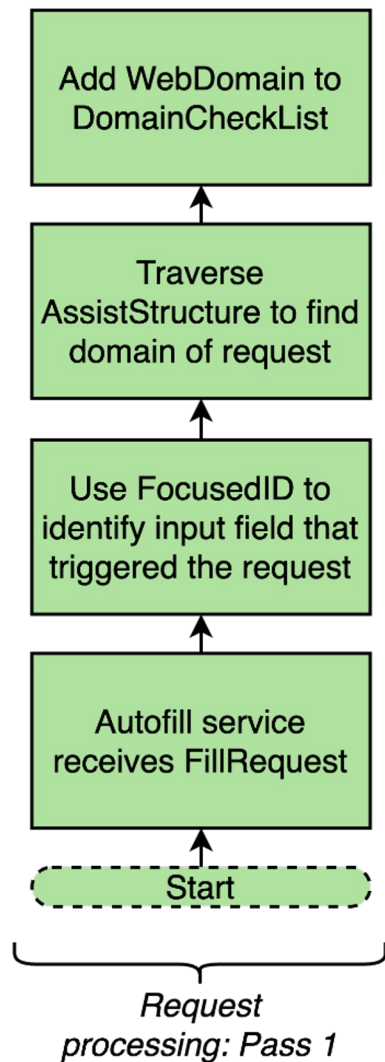
# AutoSpill - Investigation

## 1. Autofill request from Android to autofill service



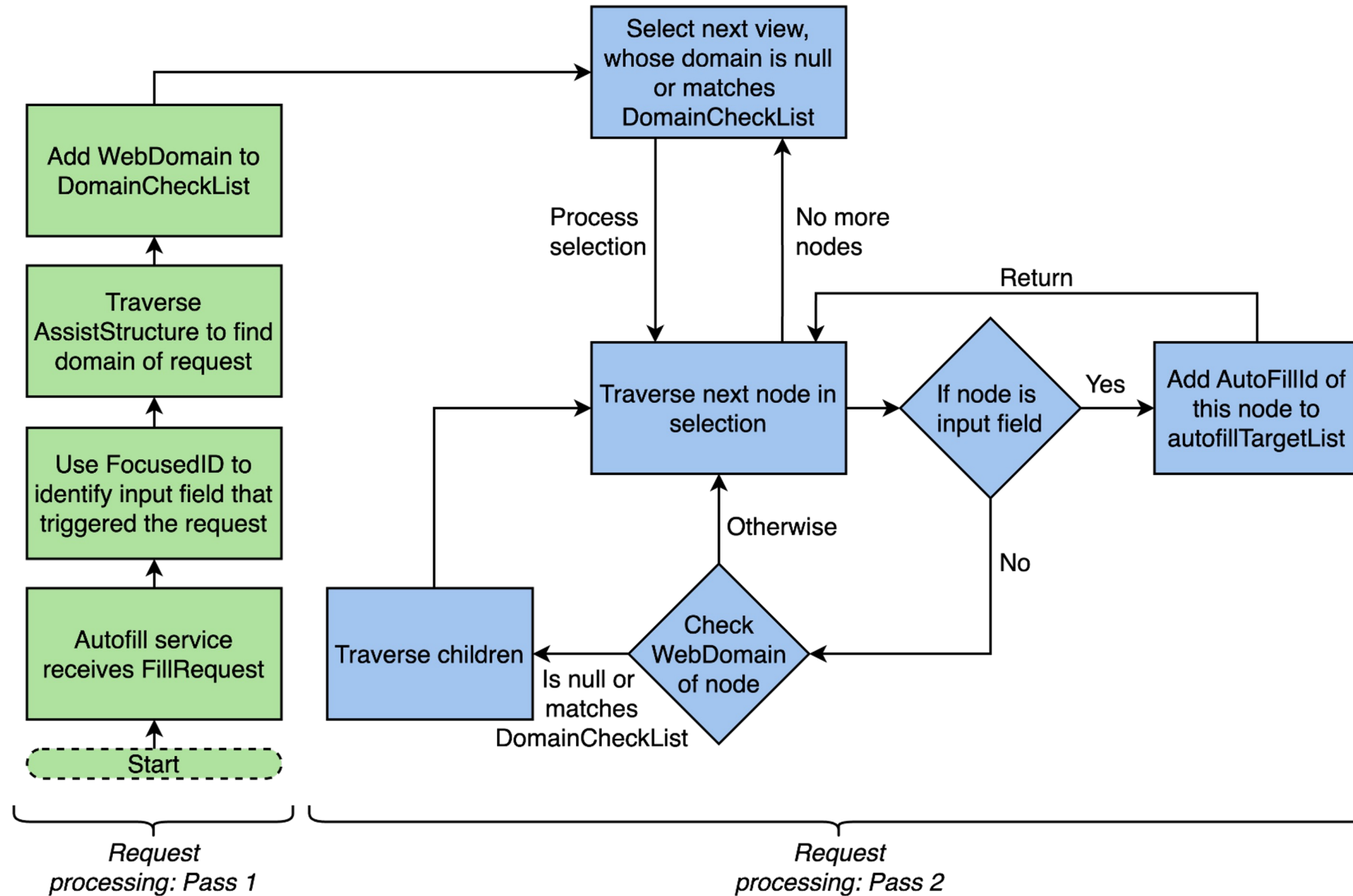


## 2. Request processing and response from autofill service

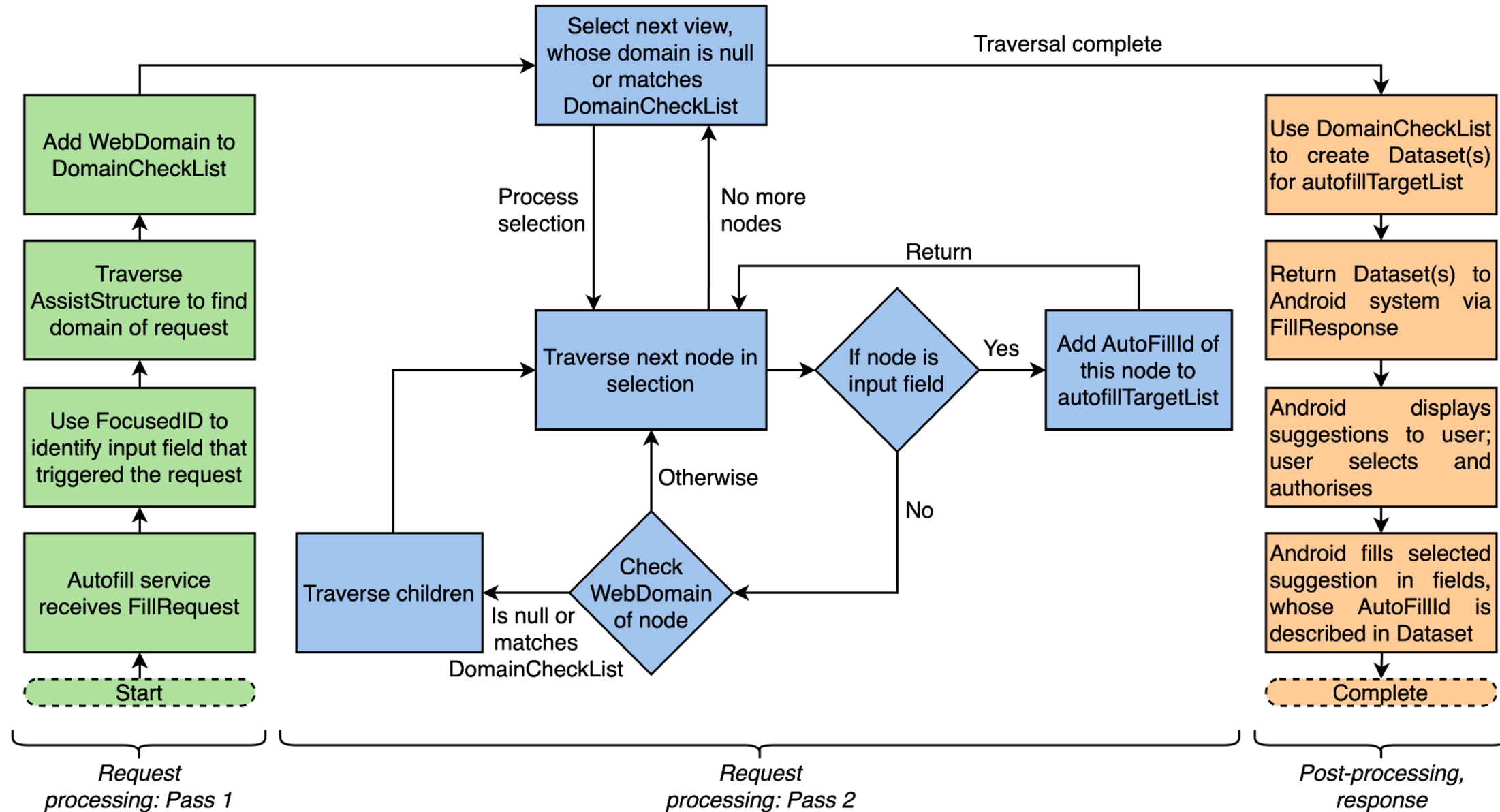




## 2. Request processing and response from autofill service



## 2. Request processing and response from autofill service



# AutoSpill - Investigation





+ Always renders NativeView data

- Even for requests from a WebView
- Creates confusion for autofill service





+ Always renders NativeView data

- Even for requests from a WebView
- Creates confusion for autofill service



+ Parses entire *AssistStructure*

- No track of parent view's *WebDomain*
- Identifies incorrect target input fields

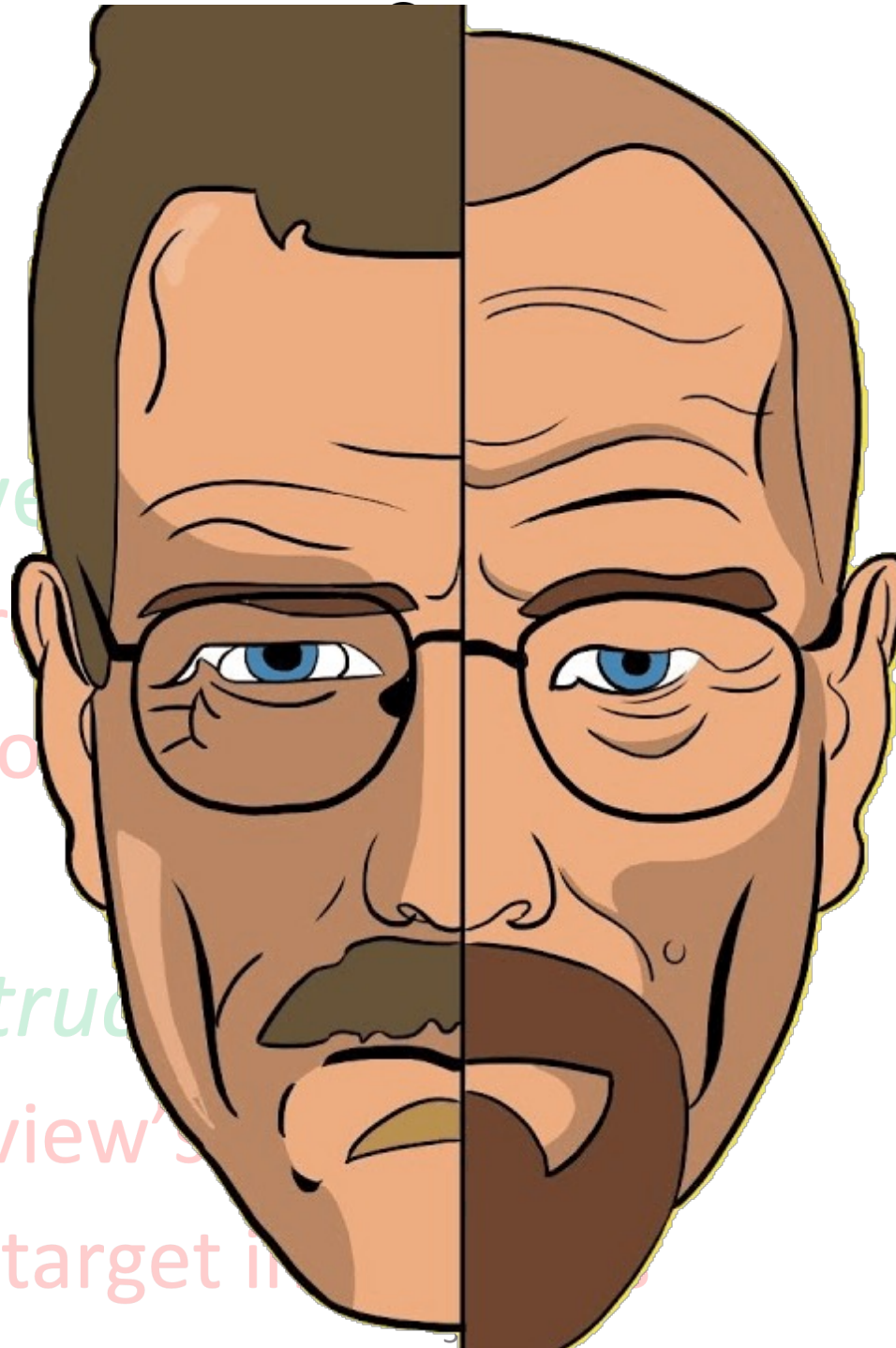


+ Always renders Native

- Even for requests from
- Creates confusion for

+ Parses entire *AssistStructure*

- No track of parent view's
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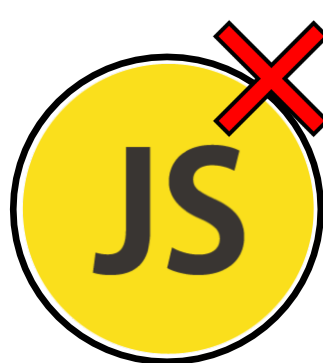
## PMs considered

PM	Version	PM's autofill approach
Google Smart Lock	13.30.8.26.arm64	OpenYOLO
DashLane	6.2221.3-arm64-v8a	OpenYOLO
1Password	7.9.4	Autofill Framework
LastPass	5.11.0.9519	Autofill Framework
Enpass	6.8.2.666	Autofill Framework
Keepass2Android	1.09c-r0	Autofill Framework
Keeper	16.4.3.1048	Autofill Framework


## Configurations of devices used

Model	Type	Android version	Android security patch
Poco F1	Smartphone	Android 10	December 2020
Samsung Galaxy Tab S6 Lite	Tablet	Android 11	January 2022
Samsung Galaxy A52	Smartphone	Android 12	April 2022

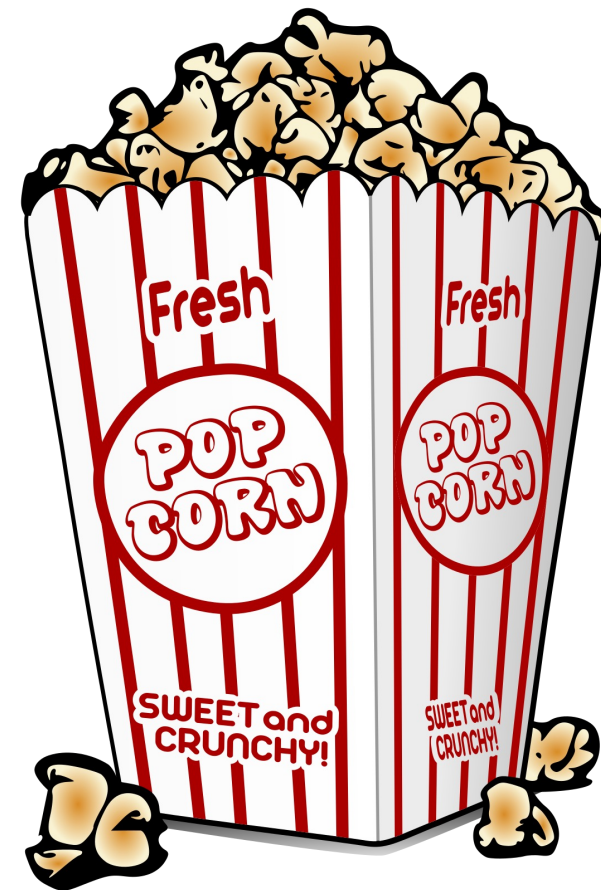
## Without JavaScript support

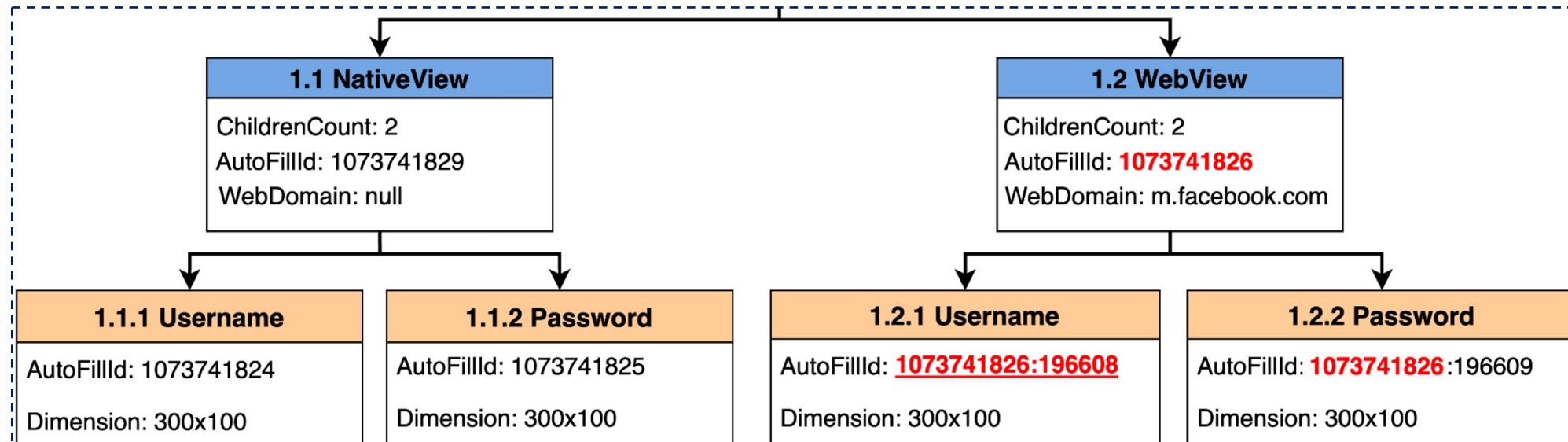
PM	Native fields present in H <sub>A</sub>				JavaScript injection
	2 Both username, password	1 Only username	1 Only password	1 Only <i>none</i>	
Google Smart Lock	✓	✓	✓	✓	
Dashlane	✓	✓	✓	✓	
1Password	X	X	P	U	
LastPass	U+P	U	P	U	
Enpass	U+P	U	P	U	
Keepass2Android	U+P	U	P	U	
Keeper	U+P	U	P	U	
<p>✓: No AutoSpill, safe  X: Autofilling not working at all  U: AutoSpills username  P: AutoSpills password  U+P: AutoSpills both username and password</p>					

## With JavaScript support

PM	Native fields present in H <sub>A</sub>				JavaScript injection
	2 Both username, password	1 Only username	1 Only password	1 Only <i>none</i>	
Google Smart Lock	U+P	U/P	U/P	U/P	
Dashlane	U+P	U/P	U/P	U/P	
1Password	X	X	U/P	U/P	
LastPass	U+P	U/P	U/P	U/P	
Enpass	U+P	U/P	U/P	U/P	
Keepass2Android	U+P	U/P	U/P	U/P	
Keeper	U+P	U/P	U/P	U/P	
<p>X: Autofilling not working at all.</p> <p>U+P: H<sub>A</sub> accessed and stole both username and password</p> <p>U/P: H<sub>A</sub> accessed both username and password, stole credential of choice.</p>					

# Video time!



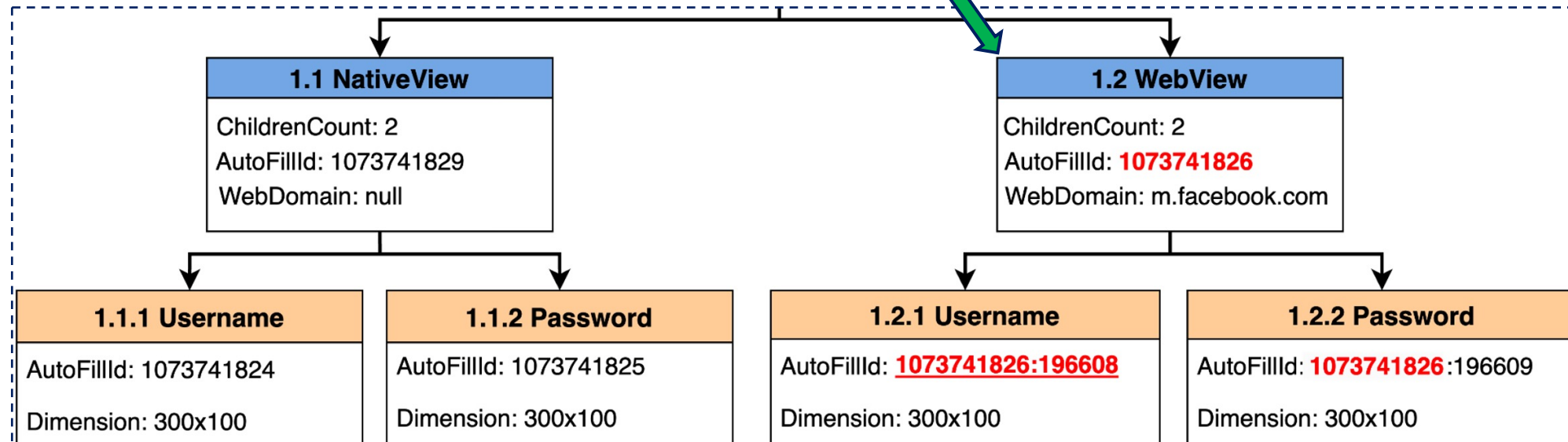




No excess information!



## AssistStructure data for request-triggering view only



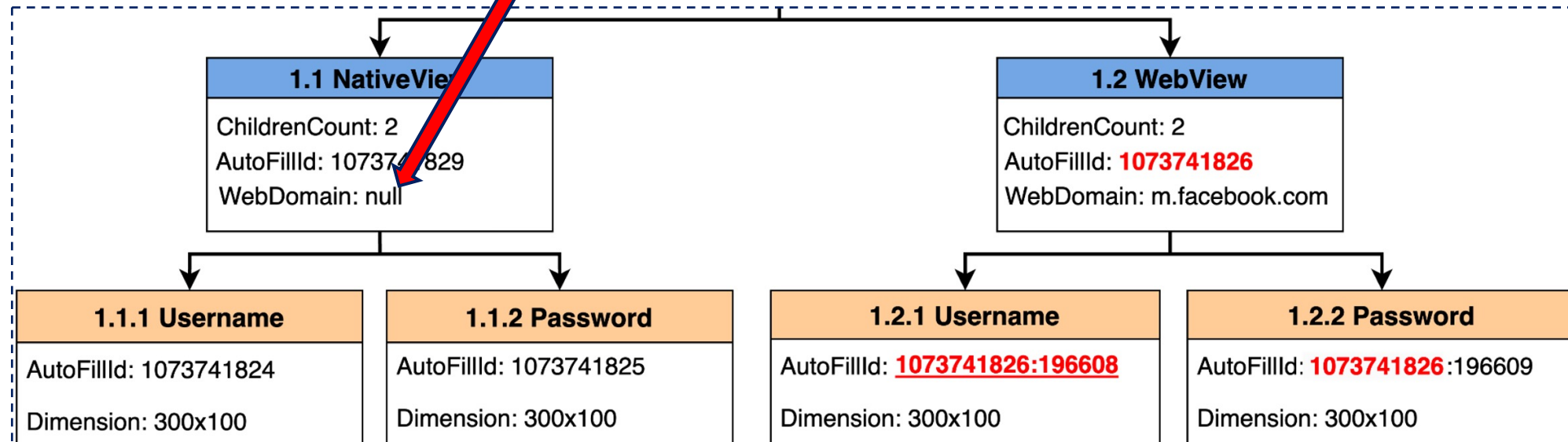
# Countermeasures



No excess information!



*AssistStructure* data for request-triggering view only  
Non-null WebDomain into HTML elements





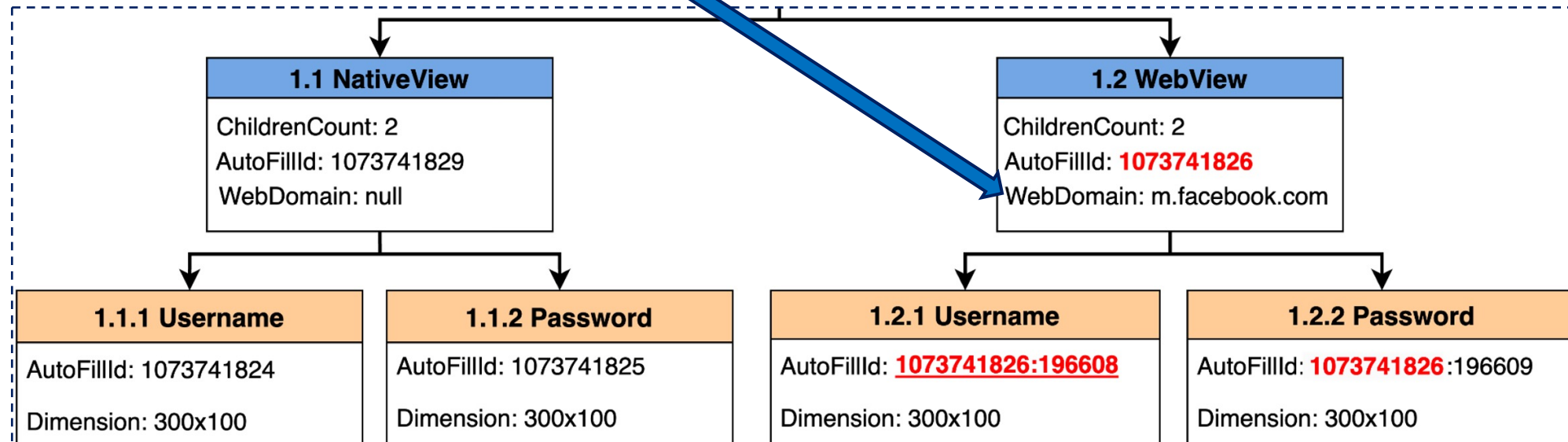
No excess information!



No excess processing!

*AssistStructure* data for request-triggering view only  
Non-null WebDomain into HTML elements

Keep a track of parent view's WebDomain





**No excess  
information!**



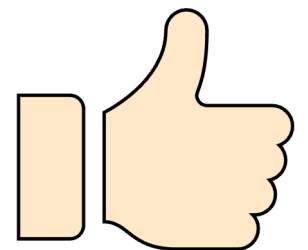
**No excess  
processing!**



*AssistStructure* data for request-triggering view only  
Non-null WebDomain into HTML elements

Keep a track of parent view's WebDomain

Run-time AutoFillId from *AssistStructure* to  
Identify & process request-triggering field  
Supply values back only for request-triggering view



- PMs work under the constraints of Android's app sandboxing
- Excess information (from Android) and excess processing (by PMs) lead to credential AutoSpill
- Android and PM developers must work together to fix AutoSpill





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