

Hack-Proof Your Mobile Apps

Carlos Holguera @ r2con
9 November 2024



How many of you
are experienced
in mobile app sec?

... know about the
OWASP MAS project?

MASTG, MASVS, etc.

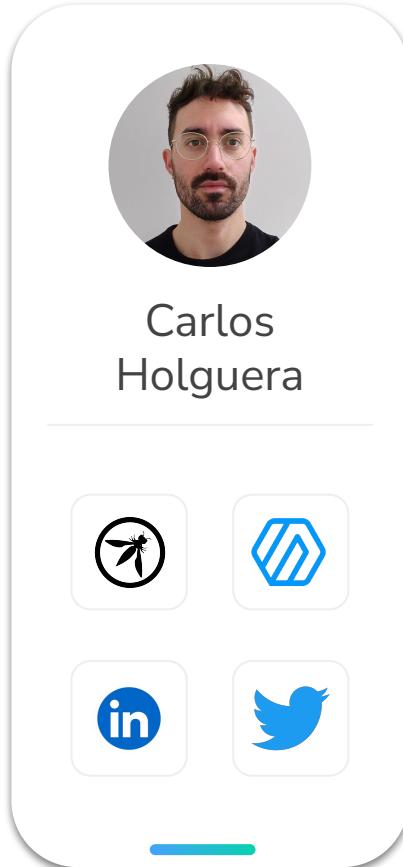
... use it regularly?

... has contributed to
OWASP MAS?



OWASP
Mobile Application Security (MAS)
Flagship Project Co-leader

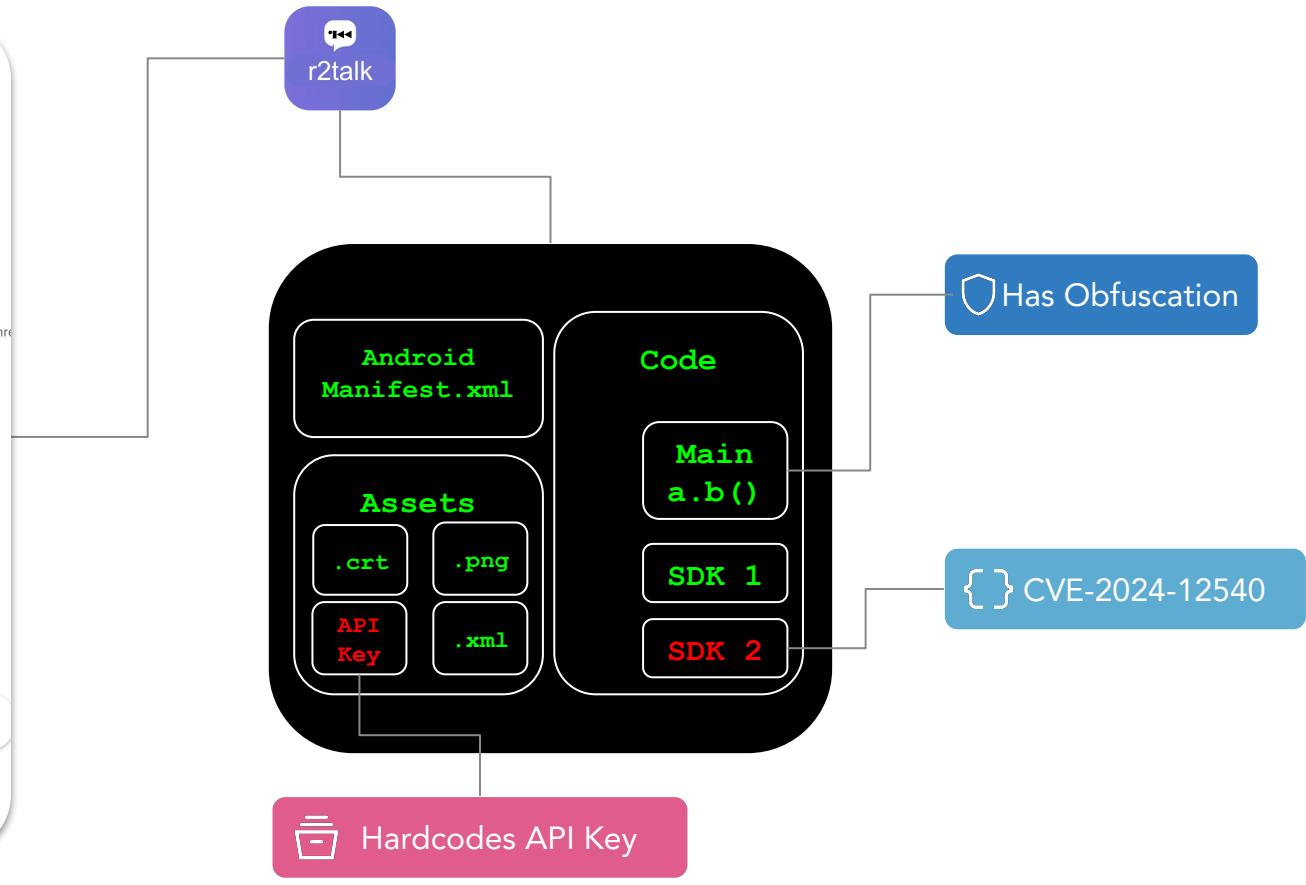
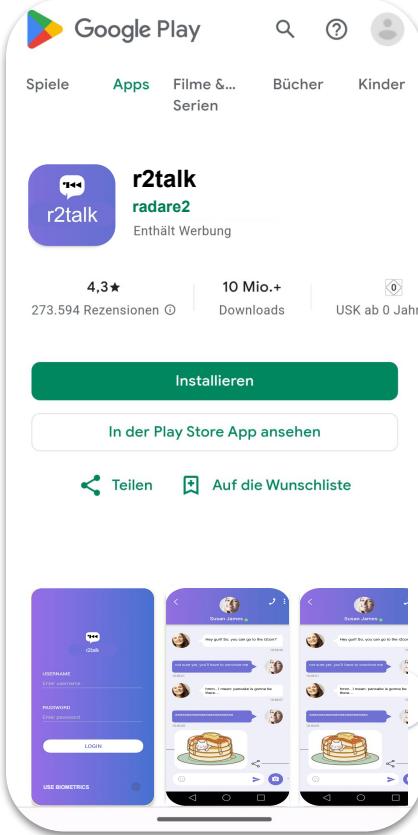
[carlos-holguera](#)

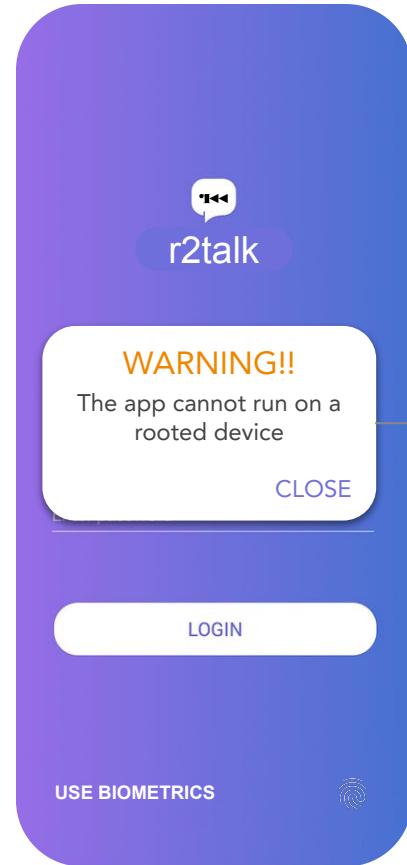


NowSecure
Principal Mobile Security
Research Engineer

[@greharder](#)







Has Root
Detection

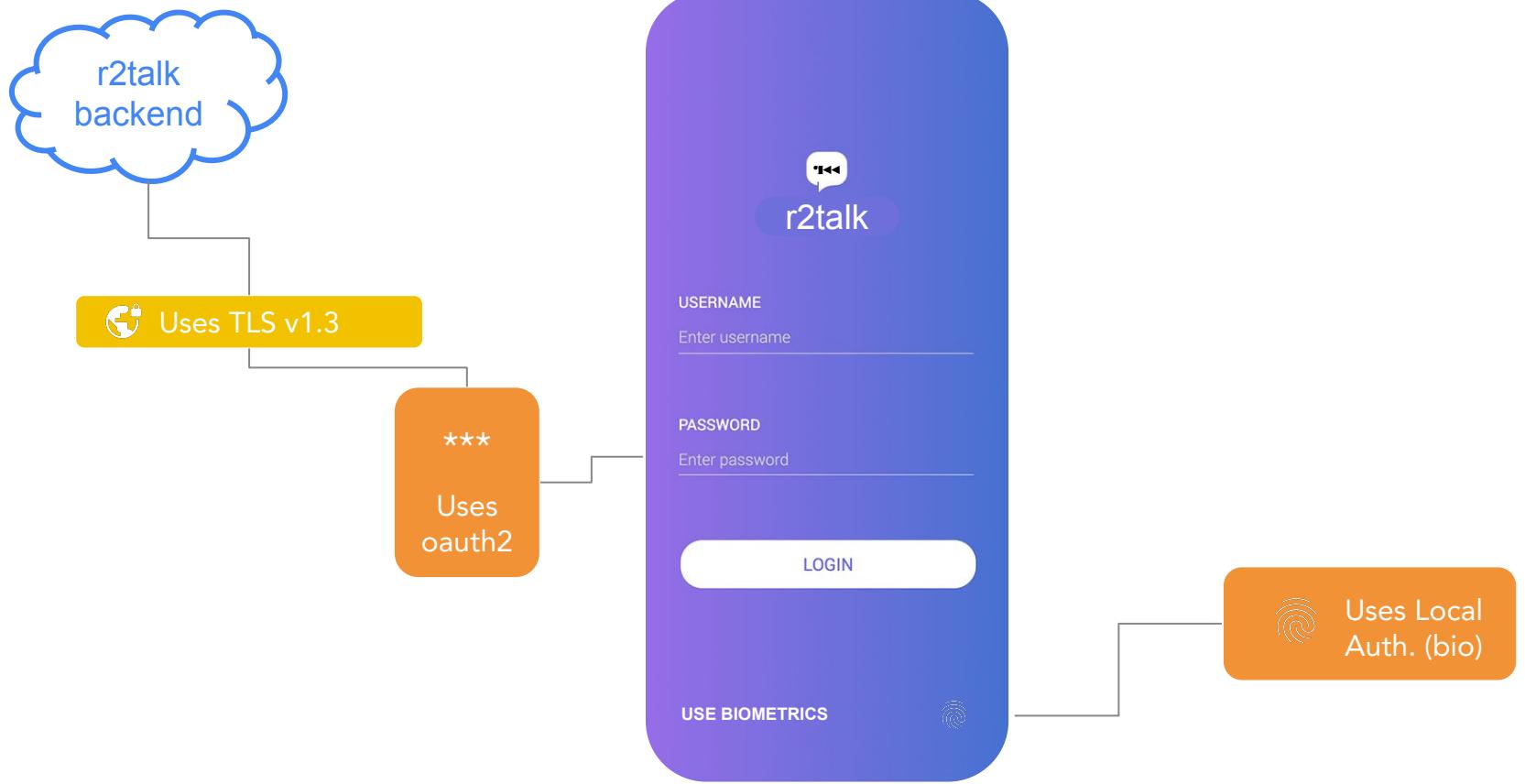
Let's **FRIDA** it away!

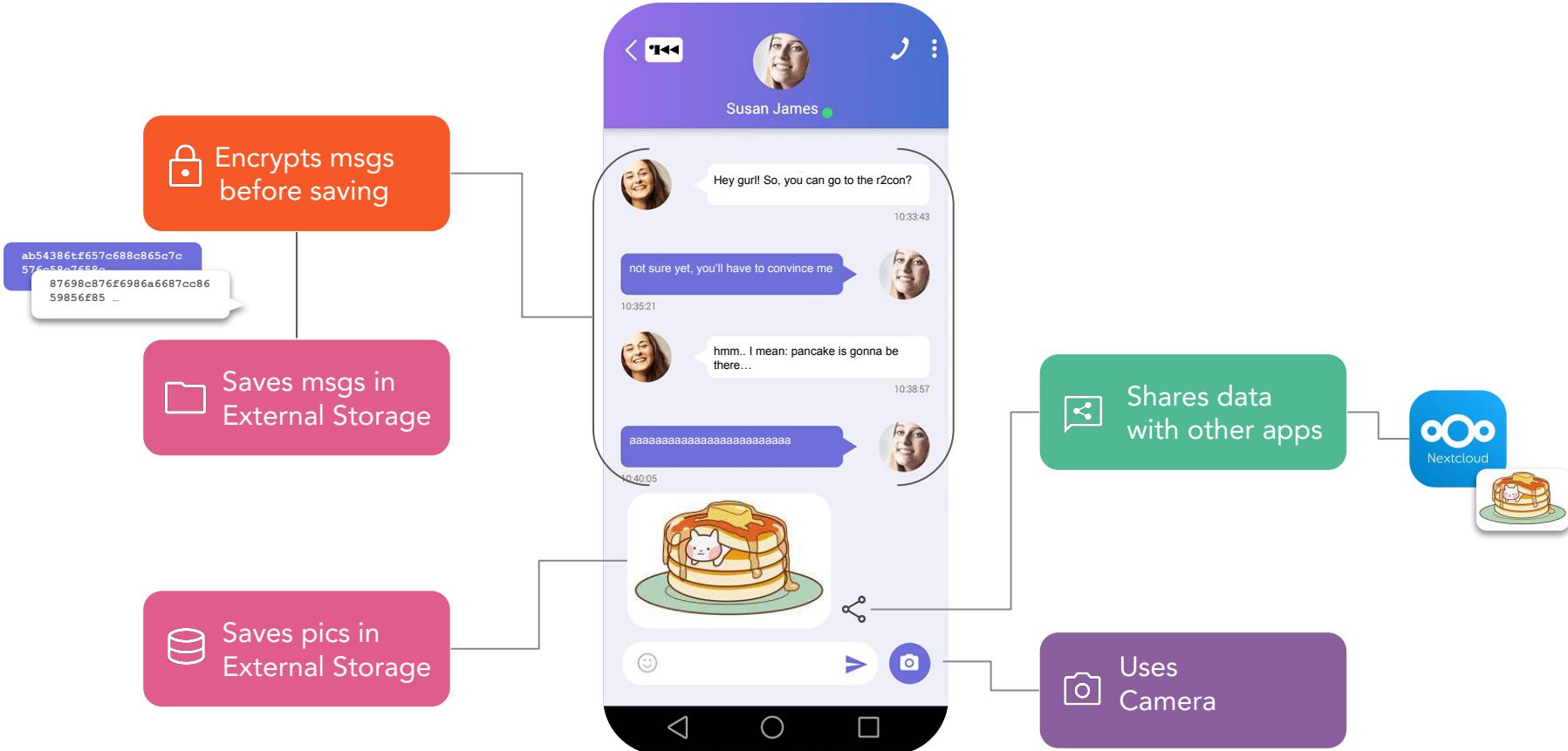
```
| /-|  Frida 16.5.6 - A world-class dynamic instrumentation toolkit
| |(| |
| > |
| /|-| Commands:
| . . . help      -> Displays the help system
| . . . object?   -> Display information about 'object'
| . . . exit/quit -> Exit
| . . . More info at https://frida.re/docs/home/
| . . . Connected to Android Emulator 5554 (id=emulator-5554)
```

LOGIN

USE BIOMETRICS







MASVS

Mobile Application Security
Verification Standard



Sven Schleier
Bernhard Mueller
Jeroen Beckers

Carlos Holguera
Jeroen Willemse



MASVS-STORAGE

MASVS-CRYPTO

MASVS-AUTH

MASVS-NETWORK

MASVS-PLATFORM

MASVS-CODE

MASVS-RESILIENCE

MASVS-PRIVACY

MASVS

Mobile Application Security
Verification Standard



Sven Schleier
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Jeroen Beckers

Carlos Holguera
Jeroen Willemsen



MASWE

Mobile Application Security
Weakness Enumeration



Sven Schleier
Carlos Holguera
Jeroen Beckers



MASTG

Mobile Application Security
Testing Guide



Sven Schleier
Bernhard Mueller

Carlos Holguera
Jeroen Willemsen



<https://mas.owasp.org/news/2024/07/30/new-maswe/>

High-level
Less Specific

MASVS

Example

Insecure Crypto is bad

MASWE

Example

The app uses weak
Encryption Algorithms

MASTG

Example

Test for `Cipher` objects
using DES

Low-level
More specific

MASVS-CRYPTO-1



The app employs current strong cryptography and uses it according to industry best practices.

Weakness: Cryptographically Weak Pseudo-Random Number Generator (PRNG)

L1 L2

Test 1: Insecure Random API Usage

Demo 1: Common Uses of Insecure Random APIs

Sample Code

Test Script

SAST Rule *

Output

Test 2: Non-random Sources Usage

Weaknesses - Overview

The screenshot shows the MASWE (Beta) section of the OWASP Mobile Application Security website. The left sidebar lists categories: MASVS-STORAGE, MASVS-CRYPTO, MASVS-AUTH, MASVS-NETWORK, MASVS-PLATFORM, MASVS-CODE, MASVS-RESILIENCE, and MASVS-PRIVACY. The main content area is titled "Mobile Application Security Weakness Enumeration (MASWE)". It includes sections for "Content in BETA" and "About the MASWE". Below is a table listing 108 entries, showing columns for ID, Title, Platform (Android and iOS icons), MASVS v2 ID, L1, L2, R, P, and Status (draft). The first few entries are:

| ID | Title | Platform | MASVS v2 ID | L1 | L2 | R | P | Status |
|------------|--|-------------|--------------|----|----|---|---|-----------------------|
| MASWE-0029 | Step-Up Authentication Not Implemented After Login | Android iOS | MASVS-AUTH-3 | ● | ● | | | draft |
| MASWE-0038 | Authentication Tokens Not Validated | Android iOS | MASVS-AUTH-1 | ● | ● | | | draft |
| MASWE-0043 | App Custom PIN Not Bound to Platform KeyStore | Android iOS | MASVS-AUTH-2 | ● | ● | | | draft |
| MASWE-0041 | Authentication Enforced Only Locally Instead of on the Server-side | Android iOS | MASVS-AUTH-2 | ● | ● | | | draft |
| MASWE-0032 | Platform-provided Authentication APIs Not Used | Android iOS | MASVS-AUTH-1 | ● | ● | | | draft |
| MASWE-0039 | Shared Web Credentials and Website-association Not Implemented | Android iOS | MASVS-AUTH-1 | ● | ● | | | draft |

Unique IDs

Titles

Platform

MASVS IDs

Profiles

Status with links to Github Issues

Weaknesses

The screenshot shows the OWASP Mobile Application Security website. The navigation bar includes links for Home, MASWE (Beta), MASIG, MASVS, MAS Checklist, MAS Crackmes, News, Talks, Continue, Donate, and Connect with Us. The main content area displays the MASWE-0007 weakness: "Sensitive Data Stored Unencrypted in Shared Storage Requiring No User Interaction". The page includes sections for Overview, Impact, Modes of Introduction, Mitigations, and Tests. The Overview section discusses the risk of sensitive data being accessed by malicious apps due to lack of user interaction or external storage emulation. The Impact section lists several attack vectors. The Modes of Introduction section highlights specific Android behaviors. The Mitigations section advises encrypting data and protecting keys. The Tests section lists two specific test cases from the MASTG framework.

MASWE-0007: Sensitive Data Stored Unencrypted in Shared Storage Requiring No User Interaction

Content in BETA

Overview

Apps frequently opt to store data in the external storage due to its larger capacity. However, this convenience comes with a potential security drawback. Once a malicious app is granted the relevant permissions, it can access this data without user consent or interaction at any time. Additionally, external storage like SD cards can be physically removed and read by a malicious actor. Even if the external storage is emulated by the system, the risk arises from improper file permissions or the misuse of APIs for saving files. In such cases, the files become vulnerable to unauthorized access, modifications and deletions, posing a security threat to the application.

Developers may consider switching to Private Storage or Shared Storage Requiring User Interaction if they need more privacy and security. However, if the external storage is the most suitable for the app, it's a good practice to encrypt data stored in the external storage. Below you can find potential security impacts and mitigations linked to the use of the external storage.

Impact

- Loss of confidentiality:** An attacker can extract sensitive data stored externally, such as personal information and media like photos, documents, and audio files.
- Loss of secure material:** An attacker can extract passwords, cryptographic keys, and session tokens to facilitate additional attacks, such as identity theft or account takeover.
- Modification of app's behaviour:** An attacker can tamper with data used by the app, altering the app's logic. For example, they could modify a database describing the state of premium features or inject a malicious payload to enable further attacks such as SQL injection and Path Traversal.
- Modification of downloaded code:** An app can download new functionality from the Internet and store the executable code in external storage before loading it into the process. An attacker can modify this code before it is used by the app.

Modes of Introduction

The threat is primarily a concern for Android devices since they permit the use of external storage. Even if a device lacks physical external storage, Android emulates it to provide access to the external storage API.

- Data Stored Unencrypted:** Sensitive data is stored in the external storage unencrypted.
- Hardcoded Encryption Key:** Sensitive data is encrypted and stored in the external storage but the key is hardcoded inside the application.
- Encryption Key Stored on Filesystem:** Sensitive data is encrypted and stored in the external storage but the key is stored alongside it or in another easily accessible location.
- Encryption Used is Insufficient:** Sensitive data is encrypted but the encryption is not considered to be strong.
- Reuse of encryption key:** The encryption key is shared between two devices owned by a single user, enabling the process of data cloning between these devices in the external storage.

On iOS, apps cannot directly write to or read from the arbitrary locations, as compared to desktop operating system or Android. iOS maintains strict sandboxing rules, meaning apps can only access their own sandboxed file directories.

Mitigations

Sensitive data stored in the external storage should be encrypted, and any keys used for data encryption should be protected by the device's hardware-backed keystore, where available. It is highly discouraged to include cryptographic keys hardcoded inside the application. You can also consider storing your files in the private app sandbox or internal storage and using Android's EncryptedFile API wrapper for file encryption.

Tests

- MASTG-TEST-0202: References to APIs and Permissions for Accessing External Storage
- MASTG-TEST-0200: Files Written to External Storage

What's bad?

What can happen?

How can this happen?

How to fix it?

Links to tests

mas.owasp.org

Tests

The screenshot shows the OWASP Mobile Application Security (MAS) website. The main navigation bar includes links for Home, MASWE (Beta), MASTG, MASVS, MAS Checklist, MAS Checkmes, News, Talks, Contribute, Donate, and Connect with Us. The MASTG section is currently active, displaying a detailed test page for 'MASTG-TEST-0202: References to APIs and Permissions for Accessing External Storage'. The page includes sections for Overview, Steps, Observation, Evaluation, References, and Demos. The 'Observation' section notes that the output should contain a list of APIs and storage-related permissions used to write to shared storage and their code locations. The 'Evaluation' section states that the test case fails if the app has the proper permissions declared in the Android manifest (e.g., WRITE_EXTERNAL_STORAGE, MANAGE_EXTERNAL_STORAGE, etc.) and the data being written to shared storage is sensitive and not encrypted. The 'References' section lists 'Manage all files on a storage device' and 'Access media files from shared storage'. The 'Demos' section lists three items: 'MASTG-DEMO-0003: App Writing to External Storage without Scoped Storage Restrictions', 'MASTG-DEMO-0005: App Writing to External Storage via the MediaStore API', and 'MASTG-DEMO-0004: App Writing to External Storage with Scoped Storage Restrictions'. A sidebar on the left provides navigation for MASTG, MASVS, MAS-CRYPTO, and MAS-PRIVACY.

What are we testing and why?

Steps to test

Output of test

How to evaluate?

Links to demos

mas.owasp.org



MAS Test Apps



MASTestApps

The screenshot shows two GitHub repository pages for 'cpholguera / MASTestApp-iOS' and 'cpholguera / MASTestApp-Android'. Both repositories are public and have a single commit from 'cpholguera' updating the 'android.gradle' file for Java 17.

MASTestApp-iOS

- Code: 1 file, 1 branch, 0 tags
- Issues: 0
- Pull requests: 0
- Actions: 0
- Projects: 0
- Wiki: 0
- Security: 0
- Insights: 0
- Settings: 0

MASTestApp-Android

- Code: 1 file, 1 branch, 0 tags
- Issues: 0
- Pull requests: 0
- Actions: 0
- Projects: 0
- Wiki: 0
- Security: 0
- Insights: 0
- Settings: 0

About

No description, website, or topics provided.

Activity

- 0 stars
- 1 watching
- 0 forks

Releases

No releases published

[Create a new release](#)

Packages

No packages published

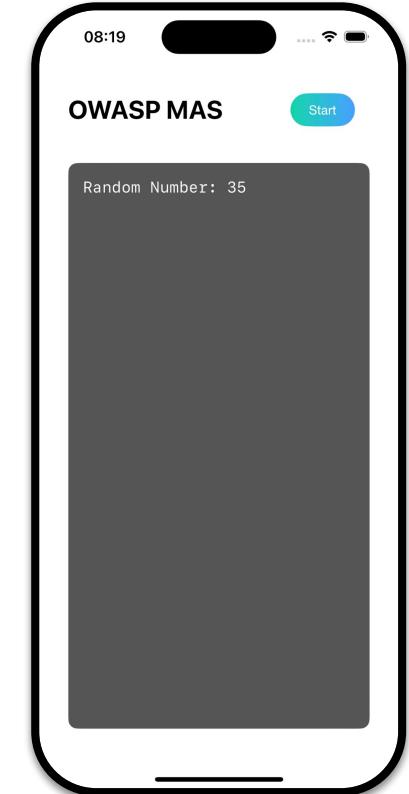
[Publish your first package](#)

Languages

Swift 100.0%

MASTestApp-Android

[MASTestApp-iOS](#)



MASTestApps

The screenshot shows the MASTG (Mobile Application Security Testing Guide) application running on a Windows desktop. The main window has several tabs at the top: Home, MASWE (Beta), MASTG, MASVS, MAS Checklist, MAS Crackmes, News, Talk, Contribute, Donate, and Connect with Us. The title bar indicates the current project is "MASTG-DEMO-0005: App Writing to External Storage via the MediaStore API".

The left sidebar lists several test cases under the "MASTG" category:

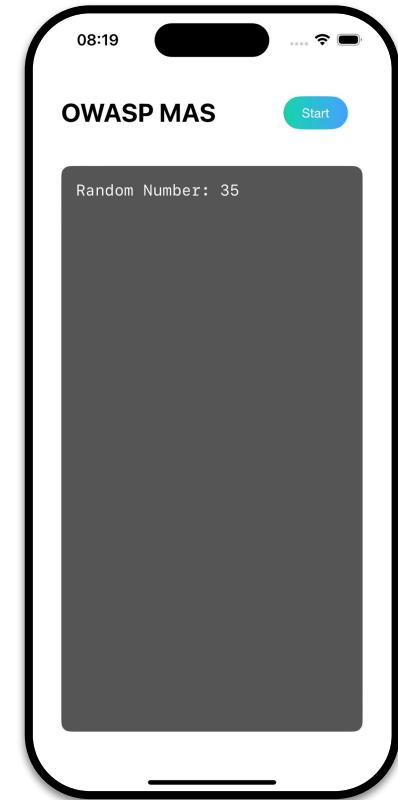
- MASTG-DEMO-0001: File System Snapshots from External Storage
- MASTG-DEMO-0002: External Storage APIs That Work with Context
- MASTG-DEMO-0003: App Writing to External Storage without Scoped Storage Requests
- MASTG-DEMO-0004: App Writing to External Storage with Scoped Storage Requests
- MASTG-DEMO-0005: App Writing to External Storage via the MediaStore API
- MASTG-DEMO-0006: Tracing Common Logging APIs Looking for Secrets
- MASTG-DEMO-0010: File System Snapshots from Internal Storage

Below the sidebar, there are two buttons: "MASVS-CRYPTO" and "MASVS-PRIVACY".

The main content area displays the Java code for "MastTest.kt" and "MastTest_reversed.java". Both files contain nearly identical code for writing a file to external storage using the MediaStore:

```
1 package org.wiapp.mastestapp
2
3 import android.content.ContentValues
4 import android.util.Log
5 import android.content.Context
6 import android.os.Environment
7 import android.provider.MediaStore
8 import java.io.OutputStream
9
10 class MastTest (private val context: Context){
11
12     fun mastTest(): String {
13         try {
14             val resolver = context.contentResolver
15             val contentValues = ContentValues().apply {
16                 put(MediaStore.MediaColumns.DISPLAY_NAME, "secretfile.txt")
17                 put(MediaStore.MediaColumns.MIME_TYPE, "text/plain")
18                 put(MediaStore.MediaColumns.RELATIVE_PATH, Environment.DIRECTORY_DOWNLOADS)
19             }
20
21             val textUri = resolver.insert(MediaStore.Downloads.EXTERNAL_CONTENT_URI, contentValues)
22
23             textUri?.let { uri ->
24
25                 val fileOutputStream: OutputStream? = resolver.openOutputStream(uri)
26                 fileOutputStream?.use {
27                     it.write("Hello, World!".toByteArray())
28                     it.flush()
29                 }
30             }
31         } catch (e: Exception) {
32             Log.e("MASTG", "Error inserting URI to MediaStore", e)
33         }
34     }
35 }
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Demos:
MASWE vulnerable
code samples as
downloadable apps

MASVS-CRYPTO



MASTG-DEMO-0013

Use of Hardcoded RSA Private Key in **SecKeyCreateWithData** with r2

[TEST](#) | [DEMO](#)

OWASP MAS

Start

Original: This is a sample text

Public Key (Hex):
30818902818100bdf6898fb-d0ce64f9a97ec301a48934d2abfdf
f708154cdb87e5dfb1cf8-da25e2a7d92a8bd30b910cf96-da1025d467af9226-
fa43b78683a268d47a56ce4141ed-c0100c89a54e5fc459cc55091-fa11f1f-
b7971d531b73384c3ee8281d-c1686a8d3eb0f20ab37426d2dcc-
fa4acf35b2635d12dee9141a693ed
91fad743838553e50203010001

Signature (Hex):
18a05b4a8d9c8b-fab9e09ac9023d087dcd48905d6e-f5091623216116bc298f2a3939535
c893b708d1f7ac1d-f5f829874b26a4be7748cec10b78e
a88c48047366a4d748383122fc372
f32773708ee28784f99c141eda09a
93d4b9cc7a0a33bd75ecd21d-cb7329833d1885729d4f00d-
fe66ec6e58dc58c30fd90e-

23:09



MASVS-CRYPTO



MASTG-DEMO-0018

Uses of Insecure Encryption
Algorithms in **CommonCrypto**
with r2

[TEST](#) | [DEMO](#)

OWASP MAS

Start

Original:

This is a sample text

Encrypted (Hex):

02ecd8fae35a5ae0b9a74045c9ee-
bca2e904772eed8e3338

MASVS-STORAGE



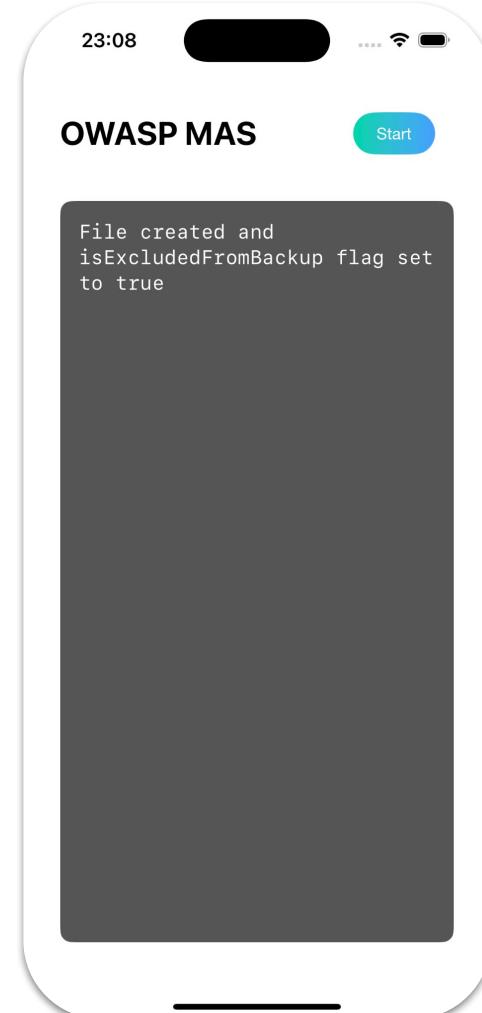
MASTG-DEMO-0019

Uses of

isExcludedFromBackupKey

with r2

[TEST](#) | [DEMO](#)



Contribute: Edit from the website

The diagram illustrates the workflow for contributing to the OWASP Mobile Application Security website. It consists of two main parts:

- Left Side (Completed Weakness):** A screenshot of a web browser displaying the page mas.owasp.org/MASWE/MASVS-STORAGE/MASWE-0005/. The page title is "OWASP Mobile Application Security". The URL bar shows the full URL. The page content includes a navigation bar with filters for maswe, android, ios, L1, L2, and MASVS-STORAGE-1. Below this is a section titled "MASWE-0005: Sensitive Data Hardcoded in the App Package" with a "Content in BETA" button. The main text discusses sensitive data risks. At the bottom is an "Edit this page" button.
- Right Side (Draft Weakness):** A screenshot of a web browser displaying the GitHub edit screen for the file github.com/OWASP/owasp-mastg/edit/master/weaknesses/MASVS-STORAGE/MASWE-0005.md. The GitHub interface shows the code for the weakness, including its title, ID, alias, platforms, profiles, mappings, and status. The code also includes a summary of the risk and an "Impact" section.

A large blue arrow points from the completed weakness page on the left to the GitHub edit screen on the right, indicating the transition from reading to editing.

**Click to edit any page:
completed or draft**

[Guidelines: Writing MAS Weaknesses & Tests](#)



 @OWASP_MAS

 @greharder

 carlos-holguera

mas.owasp.org/contact



References

<https://mas.owasp.org/MASTG/>

<https://mas.owasp.org/MASWE/>

<https://mas.owasp.org/contributing/>

<https://mas.owasp.org/contact/>

<https://mas.owasp.org/news/>

<https://github.com/OWASP/owasp-mastg/>

<https://github.com/cpholquera/MASTestApp-Android/>

<https://github.com/cpholquera/MASTestApp-iOS/>