Detecting (Absent) App-to-app Authentication on Cross-device Short-distance Channels

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Outline

Introduction

Context

- Cross-device communications allow nearby devices to directly communicate bypassing cellular base stations (BSs) or access points (APs) (e.g. **spectral efficiency improvement, energy saving, and delay reduction**, etc.)
- Without the need for infrastructure, **such a technology enables mobile users (e.g., Android) to instantly share information (e.g., pictures and videos)**
- Such technology is also predominat in **IoT environment** where a mobile device is direct connected to the embedded system.

Current Solutions

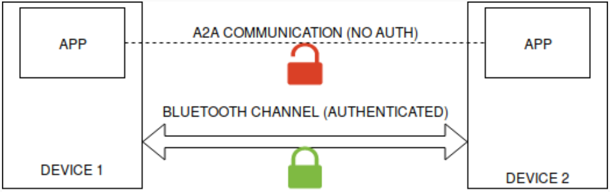
- Several solutions exist for securing cross-device communication. In the Android environment, they allow **authentication of devices and communication channels**.
- Others solutions **restricts apps access to external resources, such as Bluetooth, SMS and NFC**, by defining new SEAndroid types to represent the resources.
- Moroever such **solutions are not able to address several communication channels such as: SMS, Audio, Wi-Fi and NFC** due to of missing important information for the detection purpose.

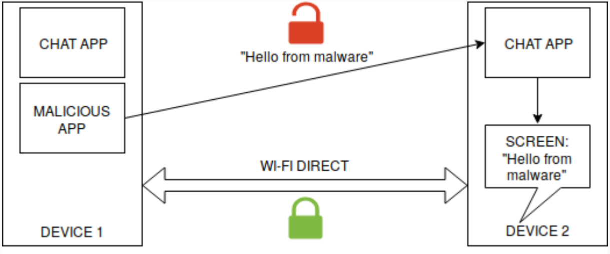
Contributions

- We identify a security problem called **cross-device app-to-app communication hijacking (CATCH)**, which commonly exists in Android apps that use short-distance channels, and afflicts all the tested Android version.
- We provide a solution to the CATCH problem by **designing and developing an authentication scheme detector** that analyzes Android apps to discover potential vulnerabilities
- **Validate the results of our system on Android apps** with manual analysis, and test its resilience in detecting the authentication scheme.

Cross Device Authentication Scheme

Cross-device Authentication Scheme





Threat Model & Attack

- The attacker is able to install a malicious app on the mobile's victim phone.
- The malicious app can therefore craft custom messages to send to the other device, which are displayed as if they were sent from the original app.
- Depending on the particular context, there are some scenarios in which the attack can become very dangerous: **Phishing, Malware delivery, Exploitation**.

Approach Overview

Challenges

- We need to define a **generic scheme that captures the essential logic of app-to-app authentication**.
- We need to define a strategy for differentiating between an if-statement that does not operate on security critical data and an **if-statement that is a part of the authentication scheme**.
- Additionally, the authentication scheme **can be implemented in several ways according to the developer experience**. This adds an additional layer of difficulty for our analysis.

Authentication Scheme Definitions

- We define a **communication** in our model as some exchange of data from A1 to A2, beginning when A2 reads the data from the communication channel.
- We define a **use** of the data as any operation whose result depends on the data itself.
- We define an **authenticated use of the data** as any instruction that needs to be authenticated before access to the data.

Detection Strategy

We define two main check points for our algorithm:

- An **entry point** is an instruction in the code that indicates the start of the communication over the analyzed channel (e.g., data receiving)
- An **exit point** is represented by the first authenticated use of the data coming from the monitored channel.

Detection Algorithm

Algorithm 3.1: Authentication detection

```
input: APK app
output: NO AUTH NEEDED |
        NO AUTH FOUND |
        POSSIBLE AUTH FOUND

  entry_points ← []
  cfg ← computeCFG(app)
  ddg ← computeDDG(app)
 foreach node in cfg
    if isEP(node) then entry_points .add(node)
 end
 if entry_points == [] then return NO AUTH NEEDED

 foreach node in ddg
    if isCondition (node) then
      foreach ep in entry_points
        path ← findPath(ep, node, ddg)
        if path != null
        then
          if isCheckConstant(node, ddg) == false
          then return POSSIBLE AUTH FOUND
        endif
      end
    endif
 end

 return NO AUTH FOUND
```

Technical Details

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- Our system is composed of three main components: (1) **Graphs Builder**, (2) **Path Finder** and (3) **App-to-app Authentication Finder**.
- (1) builds an inter-component control flow graph **(ICFG)** and intercomponent data flow graph of the whole app. Finally, the framework builds a data dependency graph (DDG) on top the **IDFG**.
- (2) The Path Finder component traverses the CFG received from Graphs Builder, and **marks entry points for the analyzed channel** based on a predefined list of method signatures.
- (3) App-to-app Authentication Finder applies **further checks** to the paths received from Path Finder, in order **to exclude false positive** results by recognizing checks against constant values.

Experimental Evaluation

Experimental Evaluation

text..... Here we put the experiments that we did

Dataset Composition

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Results

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Case Studies

Data injection on BluetoothChat

text.....

Data injection on Wi-Fi Direct +

text.....

Discussion

Impact & Limitations

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Conclusion & Future works

Conclusion

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Thank you for attention

Questions?