Secure Copy Protection for Mobile Apps

Nils T. Kannengiesser
Technical University of Munich
Chair for Operating Systems (F13)
Munich, Germany
Nils.Kannengiesser@tum.de

Uwe Baumgarten
Technical University of Munich
Chair for Operating Systems (F13)
Munich, Germany
baumgaru@tum.de

Sejun Song
University of Missouri-Kansas City
Computing and Engineering
Kansas City, USA
sjsong@umkc.edu

Content

Introduction

Foundations

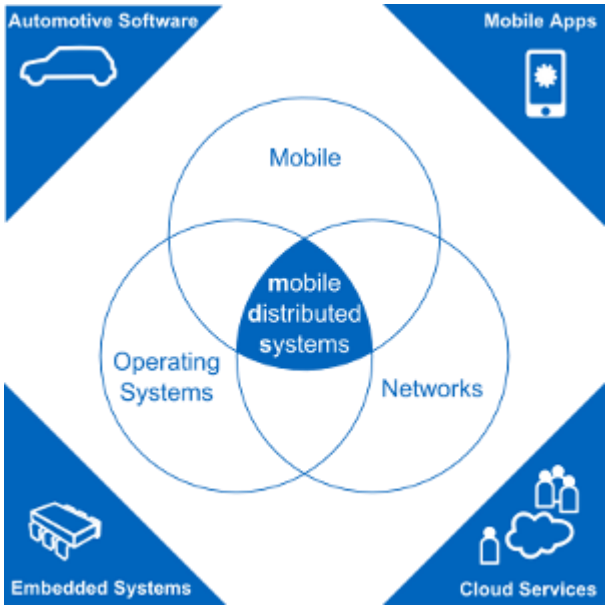
Proposals

Conclusion / Outlook / Problems

Introduction

Nils T. Kannengiesser
http://www.os.in.tum.de/personen/kannengiesser/

- Computer Science
- Research Assistant at TUM/F13
- Research field:
  Android Security / Copy Protection
- Teaching
  - Android Practical Course
  - “Computersysteme 2” training
  - Advisor of various theses



Chair for Operating Systems (F13)

- Cloud Services
- Automotive Software
- Mobile Apps
- Embedded Systems

Foundations

Foundations

Main Research Question:

How can be achieved that an app can only be used on valid devices?

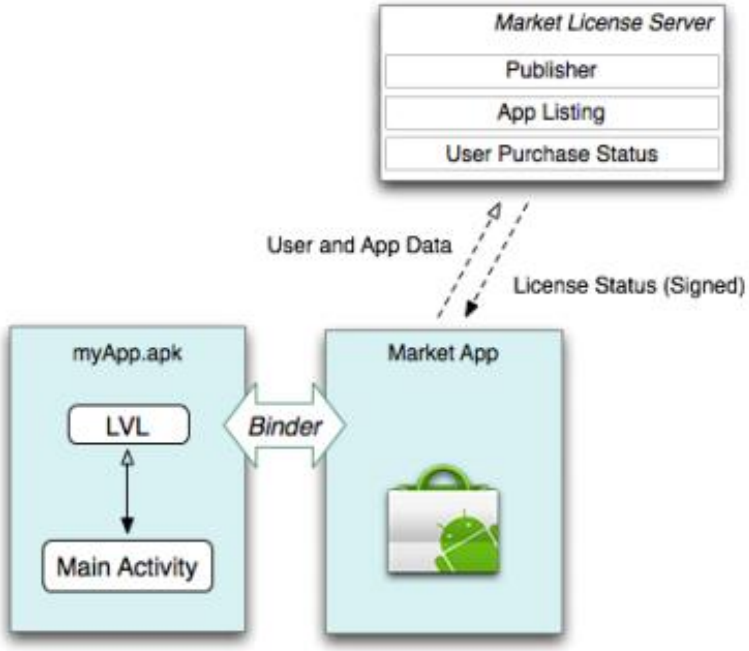
Additional notice:

These are early proposals towards the topic.

There are more assumptions than results available yet.

Foundations

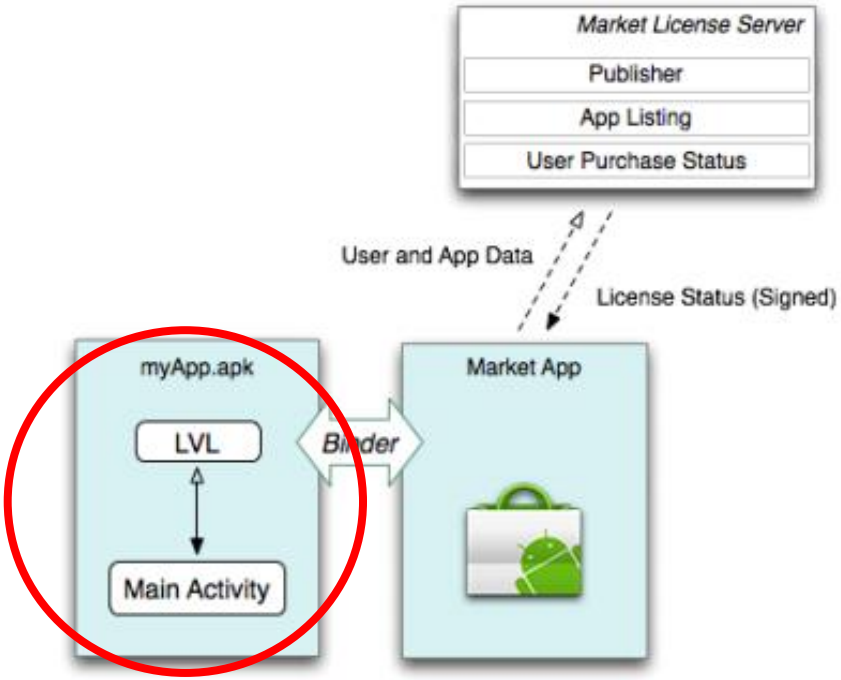
- For monetization of apps it is reasonable to use some kind of copy protection (= less piracy)
- Google released the **License Verification Library** in 2010



Ref. http://developer.android.com/google/play/licensing/overview.html

Foundations

- It got cracked the same year by changing a condition within any application



Ref. http://www.androidpolice.com/2010/08/23/exclusive-report-googles-android-market-license-verification-easily-circumvented-will-not-stop-pirates/

Foundations

- The problem: Reengineering (usual) Android Apps is quite readily
  - Tools: APKtool (baksmali/smali), dex2jar & JD-GUI

- The resulting code is an assembly dialect (smali) or even Java code containing **all class and variable names**

Example: LicenseValidator.smali

```
[…] .field private static final LICENSED:I = 0x0
.field private static final LICENSED_OLD_KEY:I = 0x2
.field private static final NOT_LICENSED:I = 0x1
[…]
.sparse-switch
0x0 -> :sswitch_d3
0x1 -> :sswitch_de
[…]
```

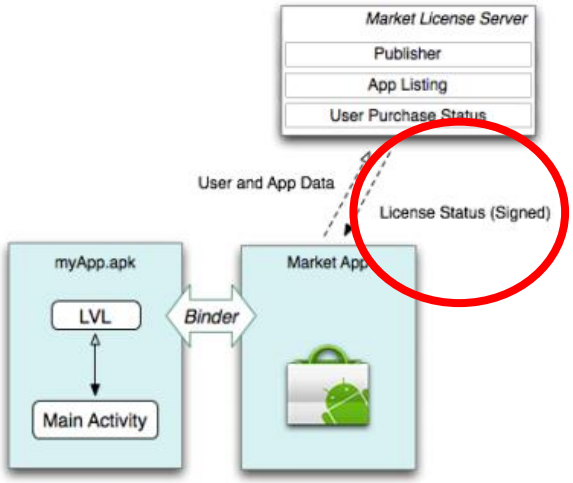
Ref. Example Source Code - http://www.androidpolice.com/2010/08/23/exclusive-report-googles-android-market-license-verification-easily-circumvented-will-not-stop-pirates/

Foundations

- Later they included another tool in their IDE:
  ProGuard (Obfuscator* ; disabled by default)
  ➔ main reason that lots of apps are still easy to reengineer

- Since then Google updated the LVL, of course. In their latest release they added e.g. signed replies.

*** Example:**
aa.smali
[…]
.field private static final c:I = 0x1
[…]
.sparse-switch
0x0 -> :sswitch_d3
0x1 -> :sswitch_de
[…]



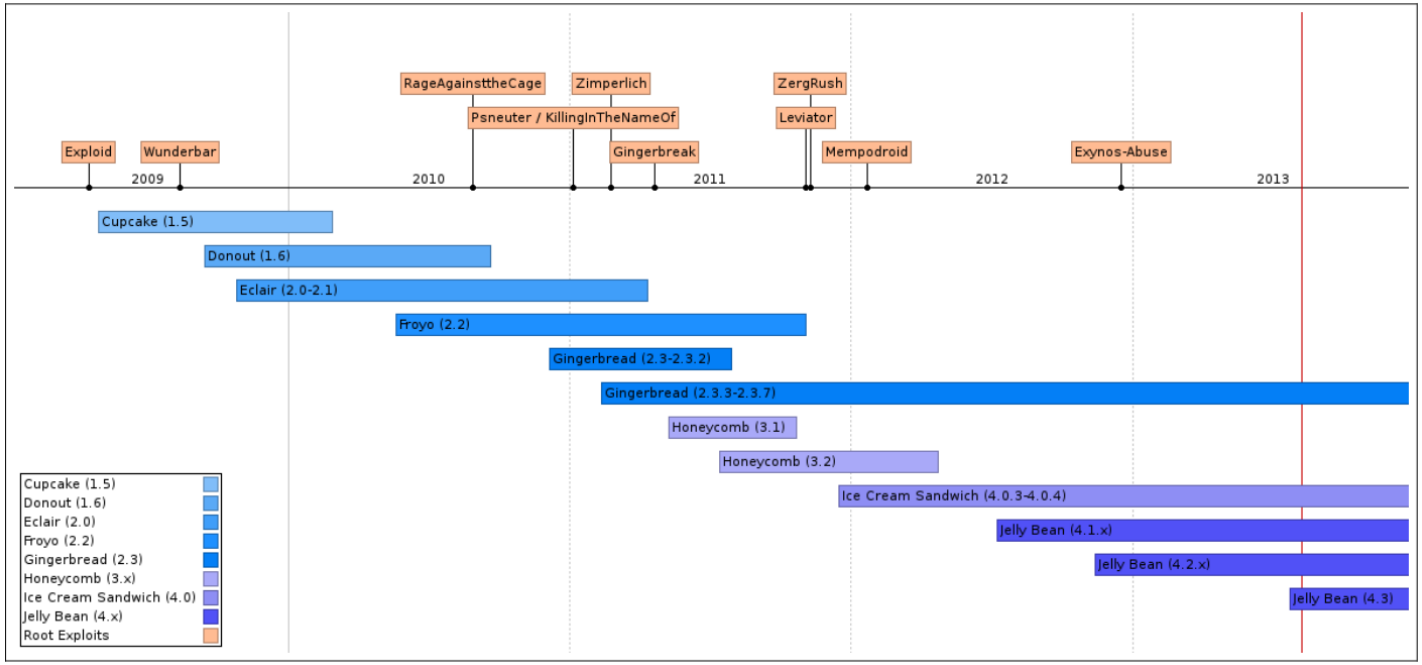
Ref. Graphic http://developer.android.com/google/play/licensing/overview.html

Foundations

Why is reengineering actually a problem? My phone can't be rooted.
There are lots of exploits and it can be assumed that every Android version is insecure and it's going to be insecure. It's possible to access APKs* and private files (as root user).

*

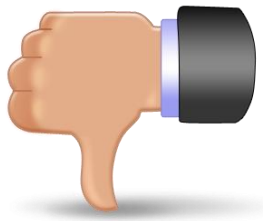
Android
Application
Pack**k**age
File



Ref. Graph. Janosch Maier, Bachelor's thesis

Foundations

Current LVL summary:



- Our current assumption is that the LVL is still insecure, since an app can be decompiled and changed to work properly – with certain time effort maybe (cf. obfuscation tools).
- “actual enforcement and handling of the license [...] are up to you“ by Google
- There are even deobfuscation tools in current development (by hackers), which might cause problems soon.
- **Their newest LVL release is under current investigation by us.**

Ref. Quote http://developer.android.com/google/play/licensing/overview.html

Foundations

- Possible solutions (for instance) and related work:

Trusted Execution Environments	Secure Elements	Enhanced Operating Systems
ARM's TrustZone	Giesecke & Devrient's MSC	NSA's SEAndroid
	Any SIM card	Fraunhofer's TrustDroid
	Embedded (phone's NFC chip)	

Advantages

Highly secure	Secure ; HW attached easily	No additional HW required

Disadvantages

New hardware New OS/drivers	Limited security (cf. root access)	Less secure (exploits?)

Proposals

Proposals: Hardware

- We decided to go with ***Secure Elements***, since our solution should be available for a huge variety of phones
- Due to available partnerships the **M**obile **S**ecurity **C**ard (MSC) by Giesecke & Devrient was picked for our research purposes

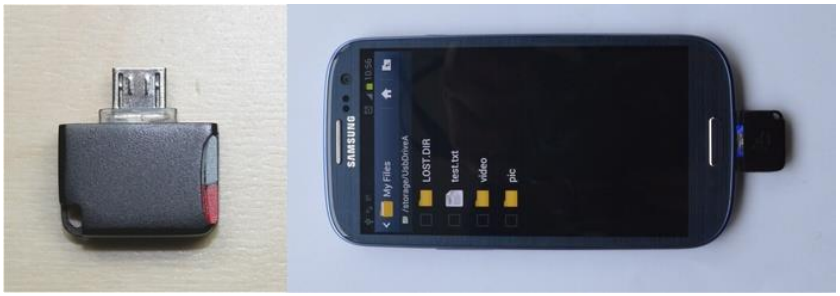
Ref. Graphic http://www.gi-de.com/de/about_g_d/press/press_releases/global_press_release_7234.jsp

Proposals: Hardware

- Since we want to be able to offer it for current smartphones as well, we plan to make use of a MicroSD adapter.

- Function tests using the MSC are still open due to unavailability of the adapter

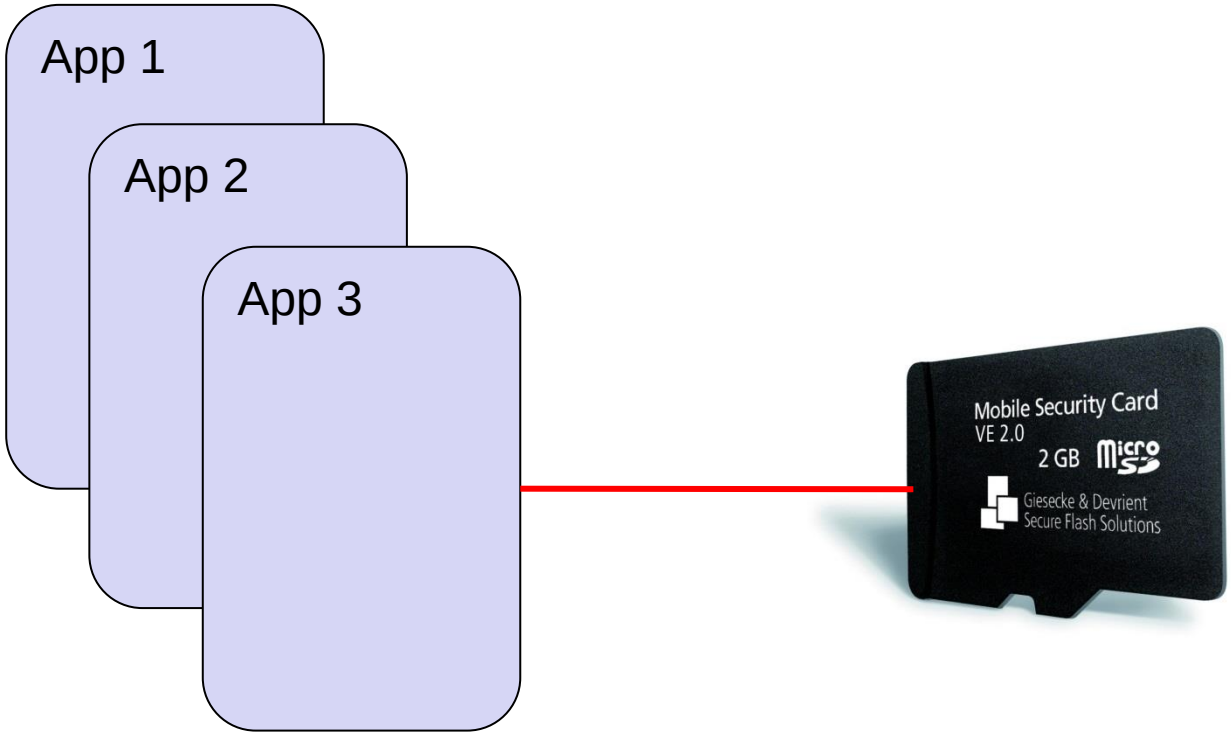
“Mini MicroSD Reader for Android Smartphones & Tablets“, Kickstarter project



Ref. Graphic http://www.kickstarter.com/projects/andyfei/mini-microsd-reader-for-android-smartphones-and-ta

Proposals: Idea

- The basic idea is to ***bind apps to their owners*** (Apps <> MSC).
- We assume that the source code is available to be able to modify it.



Ref. Graphic http://www.gi-de.com/de/about_g_d/press/press_releases/global_press_release_7234.jsp

Proposals

The initial goal of every copy protection mechanism is to identify a valid user/device.

- **Device identification**

Current API functions for the device ID might be spoofed.

Therefore we propose to implement our **own identification algorithms** based on “Short Term”- and “Long Term”-information.

MAC 09-11-22-02-24-20
Googleaccount, Contact details, …

Usual phone locations,
available WiFi networks, …

Proposals

Beside the identification we need *to add new security features* to bind an app and MSC together. Some are based on initial ideas by Google.

- **Content protection (1)**

APK files are usually not encrypted. After reengineering it's possible to extract resources (audio etc.).

We propose to encrypt all files, while the keys are received from the MSC during runtime.

The same applies to received files in future.

Benefit:
Basic protection of files.

Proposals

Beside the identification we need to add new security features:

- **Content protection (2)**

Strings will be replaced by MSC calls, while the MSC returns the string on (validated) requests.

e.g.
MSCauth(…)
[… other code …]
Print: MSC(“msg1”)

Benefit:
Attackers are no longer able to look for strings in reengineered code nor is it possible to deobfuscate it easily.

Proposals

Beside the identification we need to add new security features:

- **Content protection (3)**

Most URLs should be removed from the original source code and replaced by MSC calls. The MSC will provide a temporary URL later on, while keeping the original URL secret.

e.g.
www.os.in.tum.de/scripts.php?p1=222
www.os.in.tum.de/MSC?appid=1&l=1d2e2&p1=222
www.os.in.tum.de/MSC?appid=1&l=1d2e3&p1=222

Benefit:
Real URLs hidden. It's not possible to use the app without the MSC.

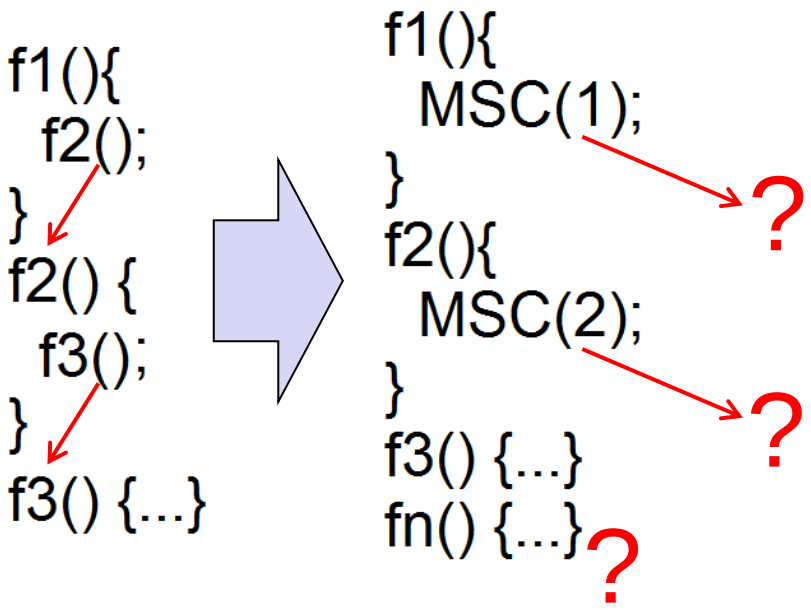
Proposals

Beside the identification we need to add new security features:

- **Obfuscate execution**

Add nonsense functions based on available functions to the code, while replacing function calls with MSC calls. The MSC replies with the required method name.

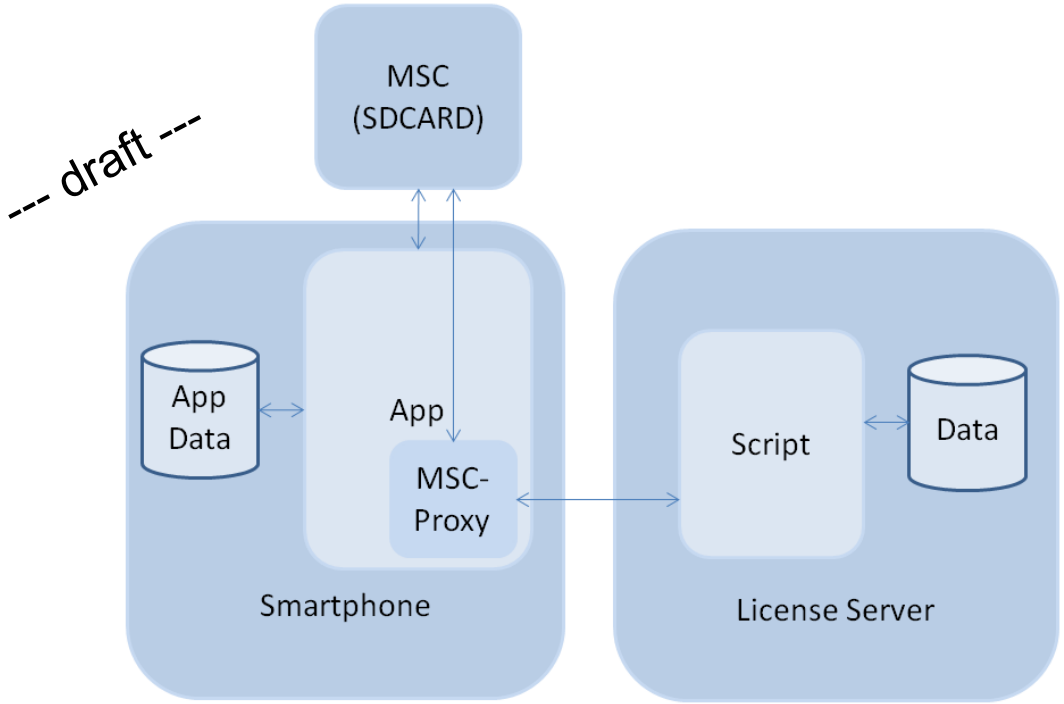
Attacker's view after reengineering:



Benefit:
Attackers will be confused by lots of nonsense code.
Reengineering level increased to difficult (live debugging tools?)

Proposals:

- Also there is the requirement to update the stored information in the MSC according to the used app by using a MSC proxy and a special License server. The connection will be encrypted.



Proposals

Beside these methods, we can try to integrated known methods:

- Integrity checks
- Use methods to break disassemblers (e.g. wrong OPcode)

Ref. Google and http://stackoverflow.com/questions/6481668/protecting-executable-from-reverse-engineering

Conclusion

Conclusion / Problems / Outlook

The goal is to create additional developer tools.

We **are assuming** that the proposed methods will **increase the security** and make piracy much more difficult. The next step is to verify open questions (Performance/MSC, MicroSD Adapter/MSC, MSC & devices, […]), start developing, testing and in the end a hacking contest to prove its security benefit.

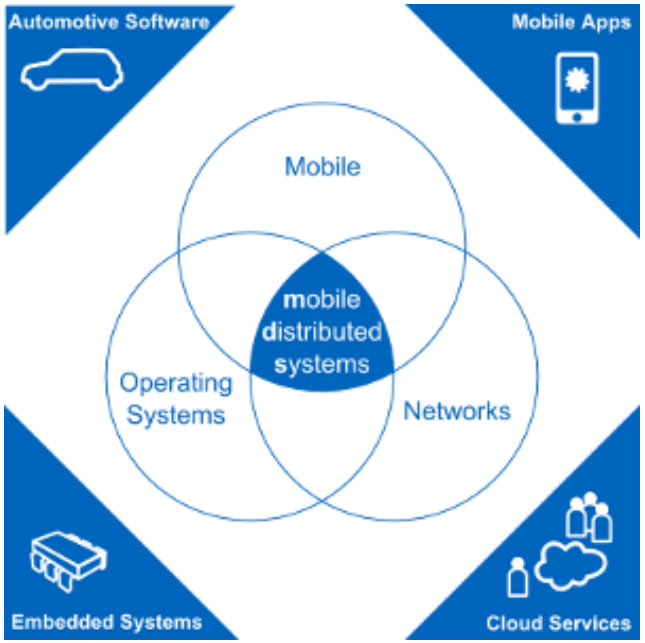
There **might be issues on the performance** of such secure elements, which are unknown currently, too. We want to define methods requiring as less performance as possible to decrease the impact on the runtime performance of apps.

In general Secure Elements might be the key element to provide security in a non-secure environment.

Last but not least …

We are always looking for new partners and cooperations – for research projects as well as for teaching purposes.

Research Topics



Android Practical Course

KISIBOX

Texas A&M UNIVERSITY

TU fast ECO TEAM

Ravensburger Digital

Fraunhofer AISEC

Giesecke & Devrient Secure Flash Solutions

BMW

Deutsches Herzzentrum München

Thank you for your attention

Nils.Kannengiesser@TUM.de