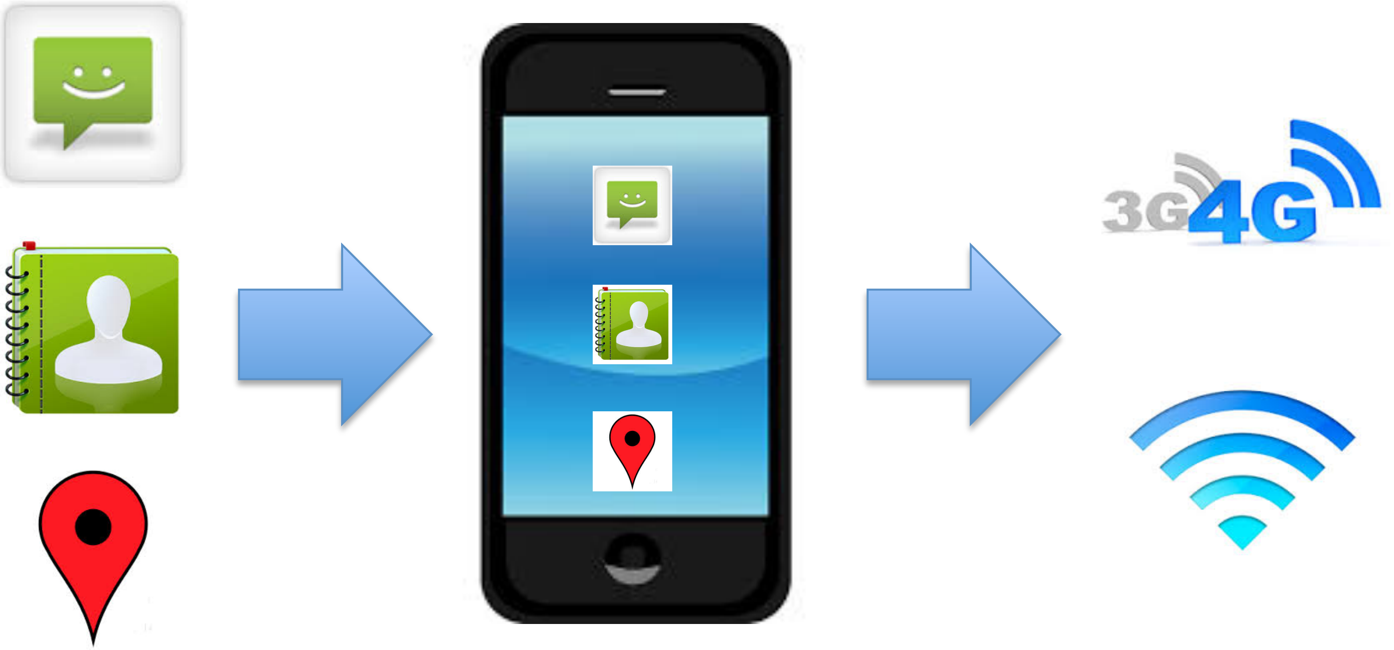
Analyzing ARM Native Code for Tracking Information Flow

Woo-Yeon Lee
Seo-Yoon Choi
Tae-Hun Kim
Byung-Gon Chun

CMS laboratory
Seoul National University

Privacy Leak in Mobile Environment

- Third-party "apps" may leak users' privacy-sensitive data or manifest malicious behavior



Why do we Target ARM Native Code?

- Platform Environmental Reason
  - Android : 49% of the apps packaged with third-party native library (increasing trend)
  - Tizen : Native apps written as ARM native code.

- Lots of studies about information flow tracking, but not in ARM-instruction level
  - Tainttrace, Panorama, TaintBochs for x86
  - Taintdroid for byte-code level

Approach

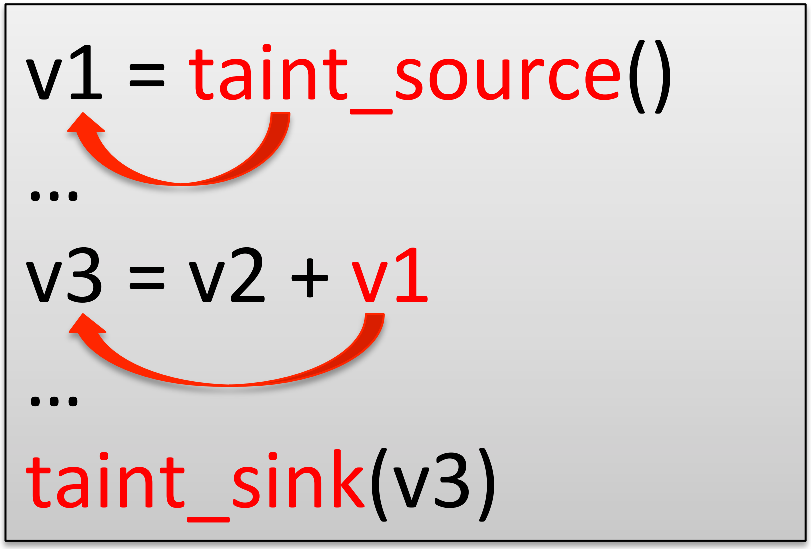
- Dynamically monitor ARM native code's behavior to detect leakage of user's privacy-sensitive data

- Main Challenge
  - Architecture Dependent
    - ARM's limited control feature

Taint Tracking

- Technique used to track information dependencies from an origin

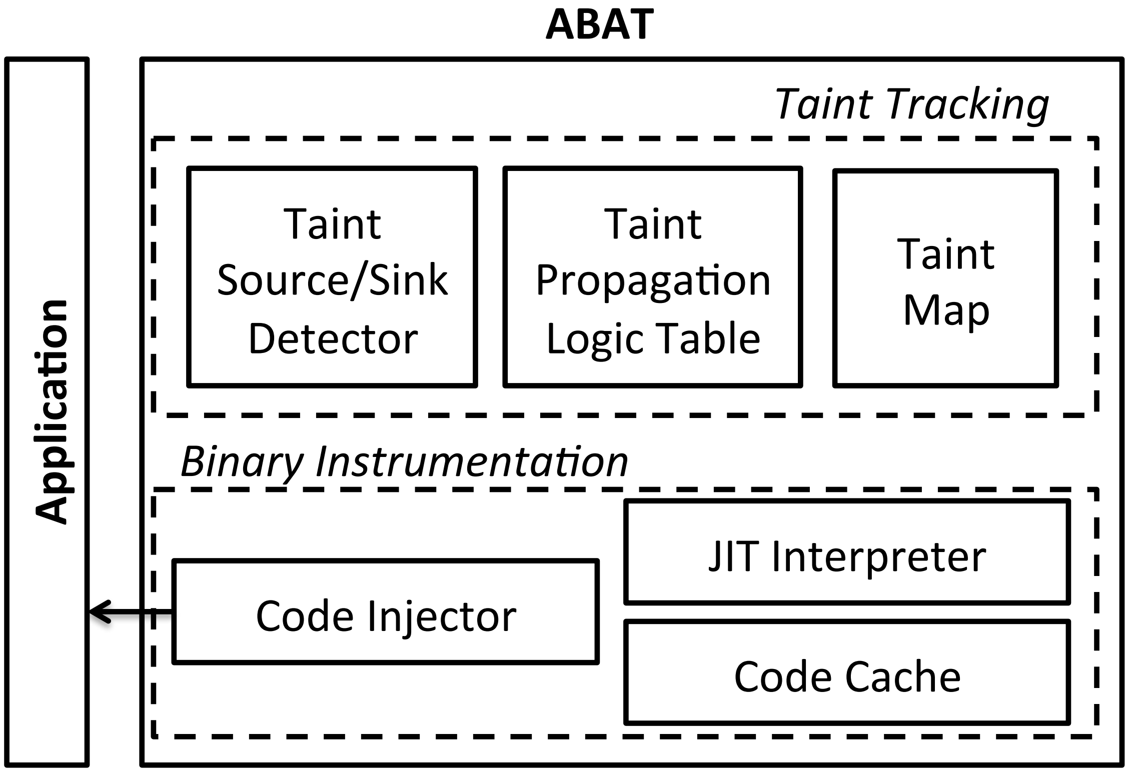
- Three Factors
  - Taint Source
  - Taint Propagation
  - Taint Sink



```
v1 = taint_source()
…
v3 = v2 + v1
…
taint_sink(v3)
```

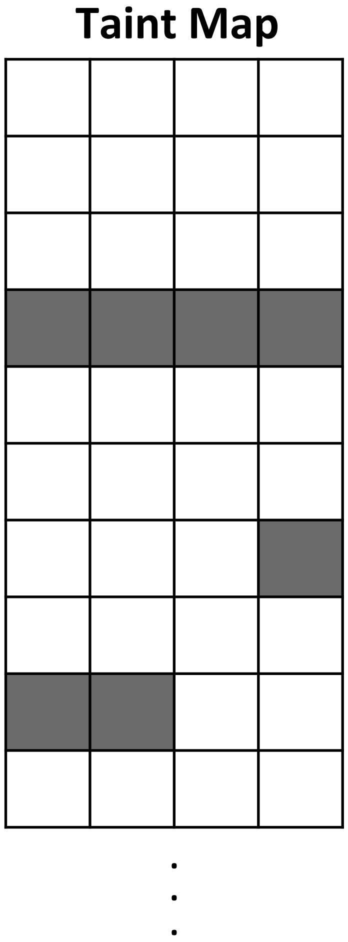
System Overview

- ARM Binary Analysis Tool (ABAT)



System Architecture of ABAT

Dynamic Taint Tracking



- Taint Map

Require fast search

=>Hash table-based taint tag storage
(Key : address, value : taint tag)

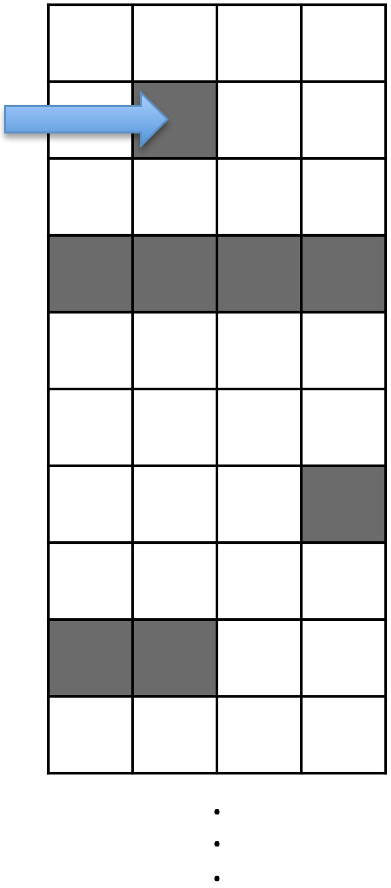
No data type at the instruction level
=>Taint tags per each byte address

Dynamic Taint Tracking

1. Detect Taint Source

=> Insert new taint into Taint Map

Taint Map



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Dynamic Taint Tracking

1. Detect Taint Source

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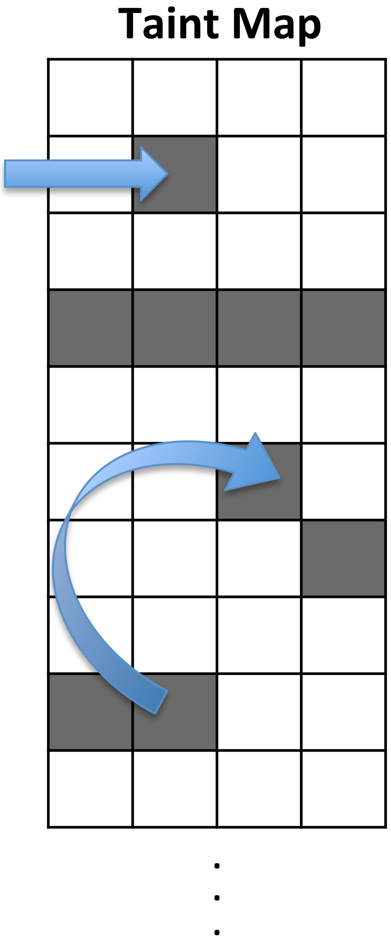
2. Detect Taint Propagation

=> Propagate taint tag in Taint Map



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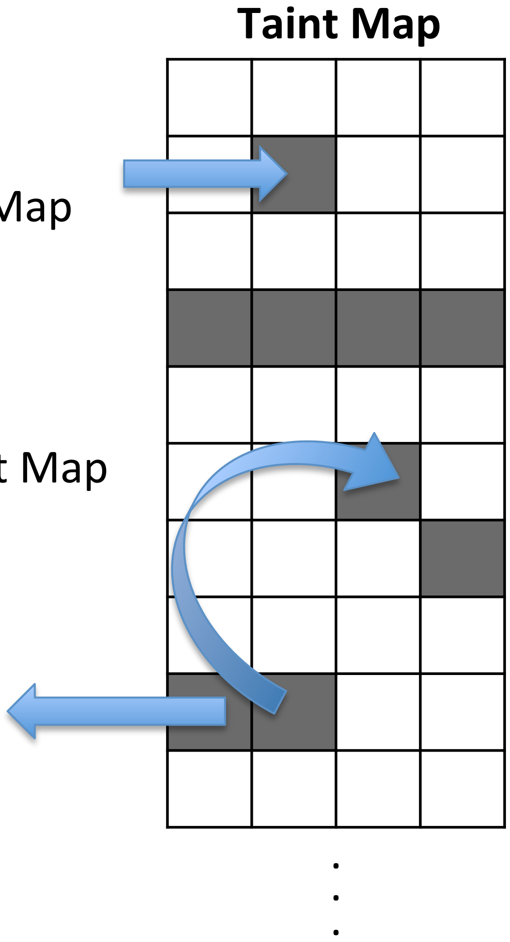
Dynamic Taint Tracking

1. Detect Taint Source
=> Insert new taint into Taint Map

2. Detect Taint Propagation
 => Propagate taint tag in Taint Map

3. Detect Taint Sink
 => Access to tainted data
 alerts the data leak



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ARM Architecture

- Advanced RISC architecture
  - 32bit-fixed instruction length
  - PC is a general register
  - Single execution cycle
  - Conditional execution
- Extension
  - Thumb / Thumb-2 mode (16bit)
- Challenges
  - Implicit branch
  - Restricted features to control program flow

Taint Tracking with DBI

- Inserts additional codes into original application to trace and maintain information about the propagation.
- Handle over 800 ARM instructions:

Before Instrumentation	After Instrumentation
ADD Rd, Rn, <immediate>	ADD Rd, Rn, <immediate> MOV τ(Rd),τ(Rn)
ADD Rd, Rn, Rm	ADD Rd, Rn, Rm OR τ(Rd), τ(Rn), τ(Rm)
MOV Rd, <immediate>	MOV Rd, <immediate> MOV τ(Rd), 0
MOV Rd, Rn	MOV Rd, Rn MOV τ(Rd), τ(Rn)

Current status & Future work

- Current status & Future work
  – Finish Basic Implementation
  – Taint tracking module is on implementation and verification stage
  – Reduce overhead with optimized DBI

- Details on poster session