http://tracedroid.few.vu.nl

Introduction

Application Fundamentals

Apps are written in Java, executed by a VM

Building blocks:
- *Activity* — Single screen with a UI
- *Service* — Background components
- *Receiver* — Listener for specific announcements, e.g., *boot completed, sms received*

Distributed as signed jar files (.apk)

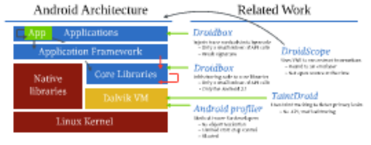
Scope

Limit method tracing to Java code
- Interesting features only accessible via Java
- Existing tools for tracing native code
  - strace
  - ltrace

Use dynamic analysis
- Evade obfuscation
- Existing tools for static analysis
  - *Androguard*
  - *Dexter*

Android Architecture

Related Work



Android Profiler
- Trace app internally
- Trace app to application framework
- Trace app to core libraries

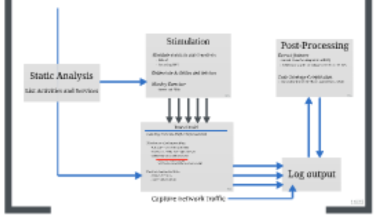
~~Trace application framework to core libraries~~
~~Trace core libraries internally~~

Extend Android Profiler to suit our needs

Implementation

TraceDroid Analysis Platform

Automated analysis



TraceDroid Analysis Platform

Inspection tool

Quickly analyze >100K lines of trace output

Load trace output into Python objects
- Interactive shell
- Call graphs for control flow analysis

TraceDroid: A Fast and Complete Android Method Tracer

Mobile Malware

+614%

Android: 92%

How do we automate analysis?

Contributions

TraceDroid

Android OS with comprehensive method tracing capabilities:
- Parameter resolution
- Return values
- Object representation

TraceDroid Analysis Platform

Framework for automated dynamic analysis

Detect suspicious activity

Ease post analysis

Evaluation

TraceDroid is fast

Benchmark: browse to 8 cached webpages

Visit each page 10 times before computing average load time

Simulation Effectiveness

Simulation Effectiveness

Code coverage of 33% is fairly low

Simulation efforts vary per app

Conclusions

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TraceDroid
- Fast and comprehensive Android method tracer
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TraceDroid Analysis Platform
- Automated analysis of unknown applications
- Quickly identify suspicious applications
- Interactive environment to ease post-analysis

Future work

TraceDroid

Unpack arrays

Run on real hardware

TraceDroid Analysis Platform

Compute code coverage per package

Improve stimulation
- Symbolic execution?

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Submit your .apk for automated analysis

.tar.gz output containing:
- method traces
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- call graph

Contact me if you would like to analyze a batch

No source or inspect tool available yet

Demo

ZitMo: Zeus in the Mobile
- Collaborates with PC-based Zeus
- Steals mobile TAN codes

TraceDroid: A Fast and Complete Android Method Tracer

Hack in the Box 2013, Kuala Lumpur

Victor van der Veen

About me

Currently

- 2.04 m
- Security Consultant at ITQ
- ITQ CTF team member

Past

- HITB CTF {KUL|AMS} 2010, 2011, 2012, 2013
- Memory Errors: The Past, The Present and the Future (RAID 2012)
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March 2012	38,689 samples
March 2013	276,259 samples

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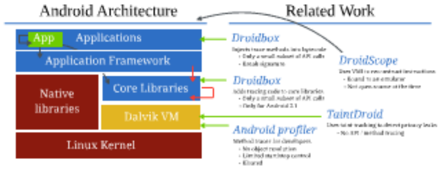
App
Applications
Application Framework
Native libraries
Core Libraries
Dalvik VM
Linux Kernel
Droidbox
Injects trace methods into bytecode
• Only a small subset of API calls
• Break signature
DroidScope
Uses VMI to reconstruct instructions
• Bound to an emulator
• Not open source at the time
Droidbox
Adds tracing code to core libraries
• Only a small subset of API calls
• Only for Android 2.1
TaintDroid
Uses taint tracking to detect privacy leaks
• No API / method tracing
Android profiler
Method tracer for developers
• No object resolution
• Limited start/stop control
• Bloated

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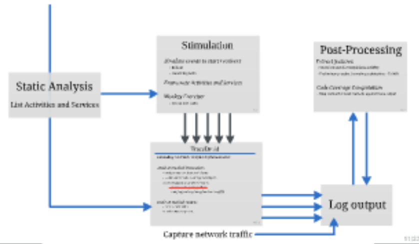

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Speedup of [illegible] compared to original profiler

Simulation Effectiveness

Compare automated analysis against manual input (180 seconds)

	Manual		TraceDroid
- [illegible] benign	[illegible]	-2.45%	[illegible]
- [illegible] malicious	[illegible]	+3.79%	[illegible]

TraceDroid's coverage is about as good as manual analysis

Likely of higher quality due to receiver stimulation

Analysis of ~[illegible] samples	Code Coverage	
- [illegible] benign	[illegible]	~33%
- [illegible] malicious	[illegible]	

Simulation Effectiveness

Code coverage of 33% is fairly low
- (third-party) Libraries
- Unreachable code
- Complex applications

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Monkeys tech is growing

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Unpack arrays
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Run on real hardware
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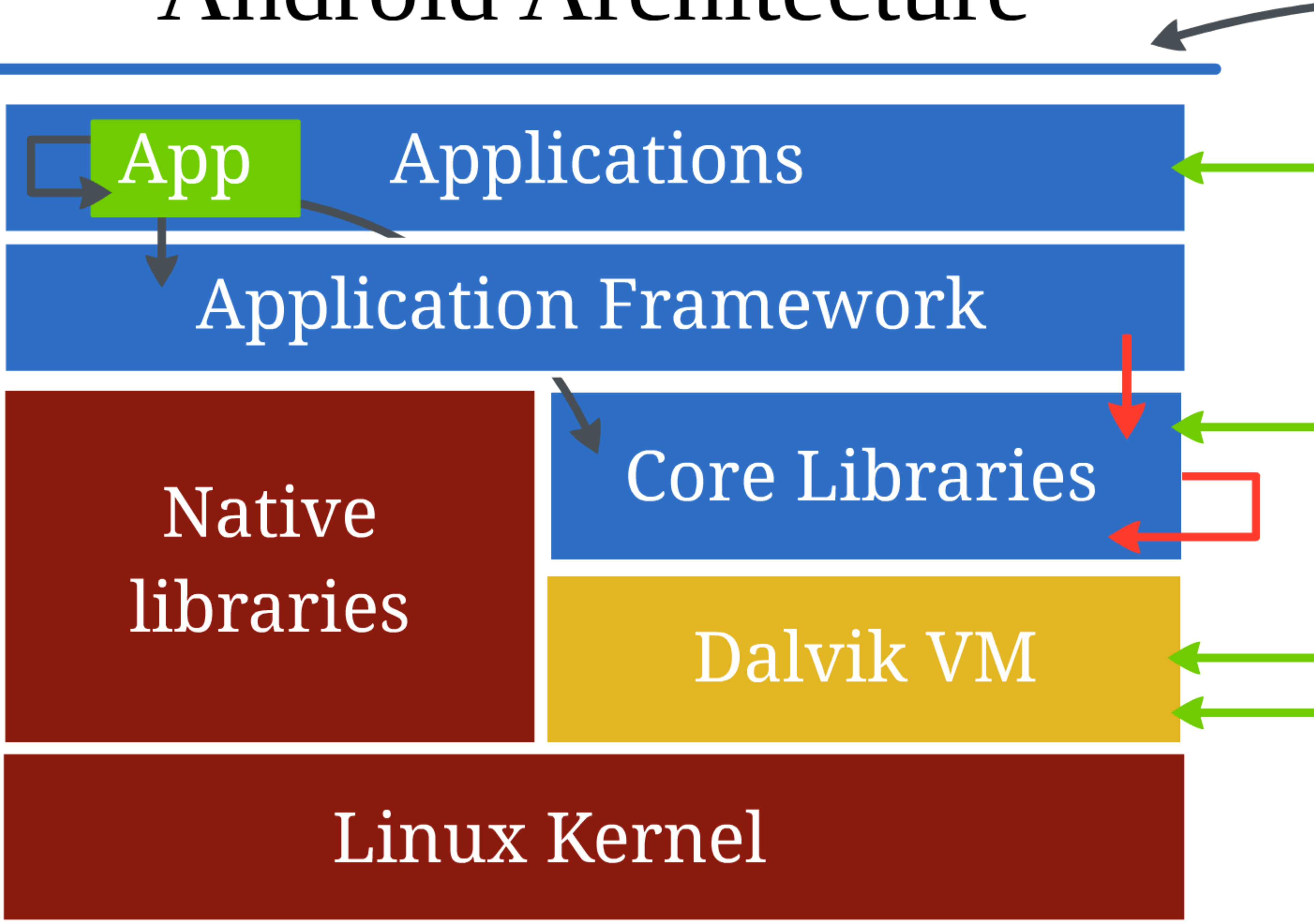

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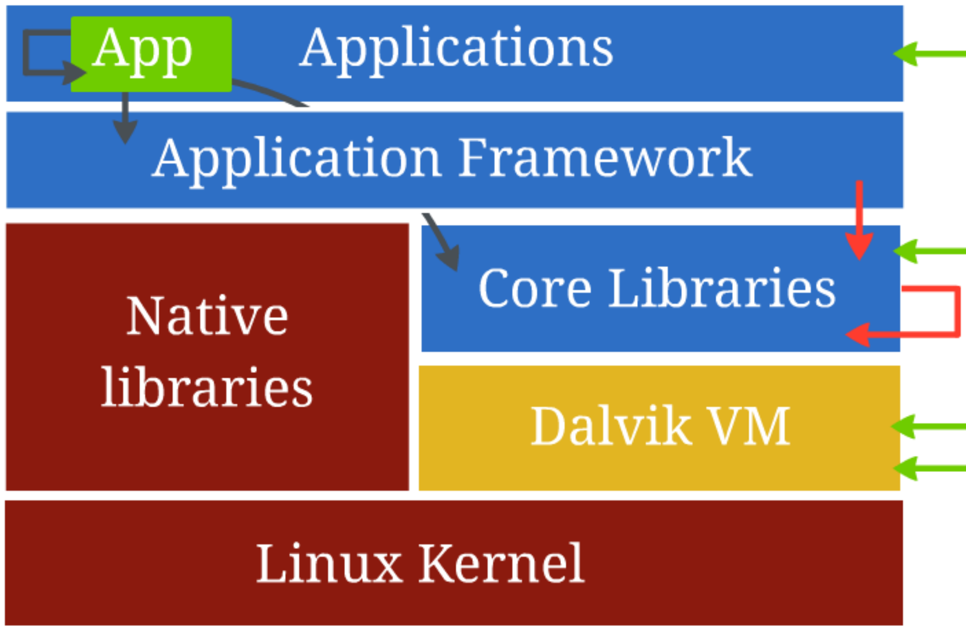

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TraceDroid

Extending Android's Profiler implementation

Hook on method invocations

- Fetch parameters from stack frame
- Lookup and invoke .tostring() for Objects
- Convert signatures and descriptors

  ~~*foo(Ljava/lang/String;Z[[J)V*~~

  void foo(java.lang.String, boolean, long[][])

Hook on method returns

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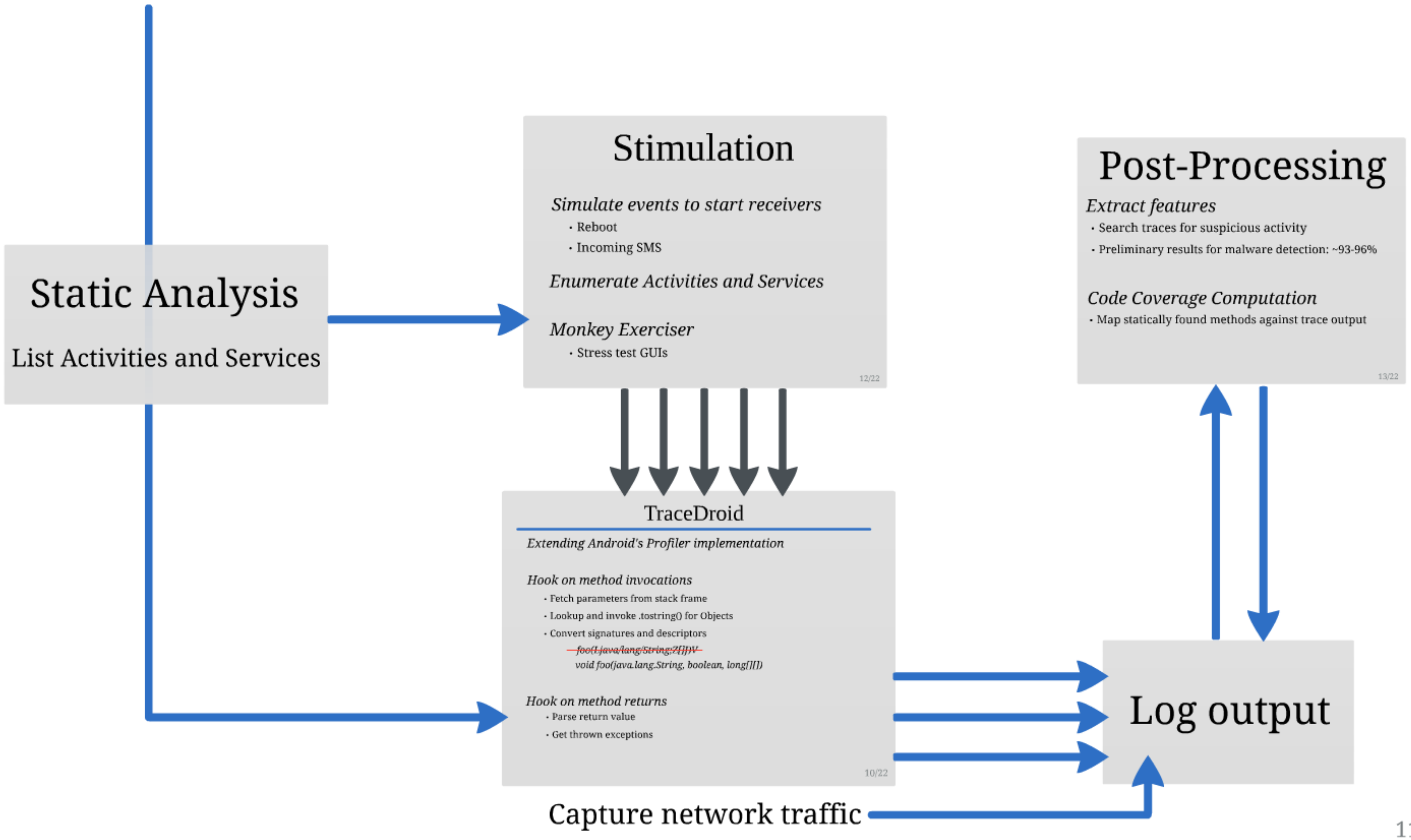
TraceDroid Analysis Platform

Automated analysis



Static Analysis

List Activities and Services

Stimulation

Simulate events to start receivers
- Reboot
- Incoming SMS

Enumerate Activities and Services

Monkey Exerciser
- Stress test GUIs

12/22

Post-Processing

Extract features
- Search traces for suspicious activity
- Preliminary results for malware detection: ~93-96%

Code Coverage Computation
- Map statically found methods against trace output

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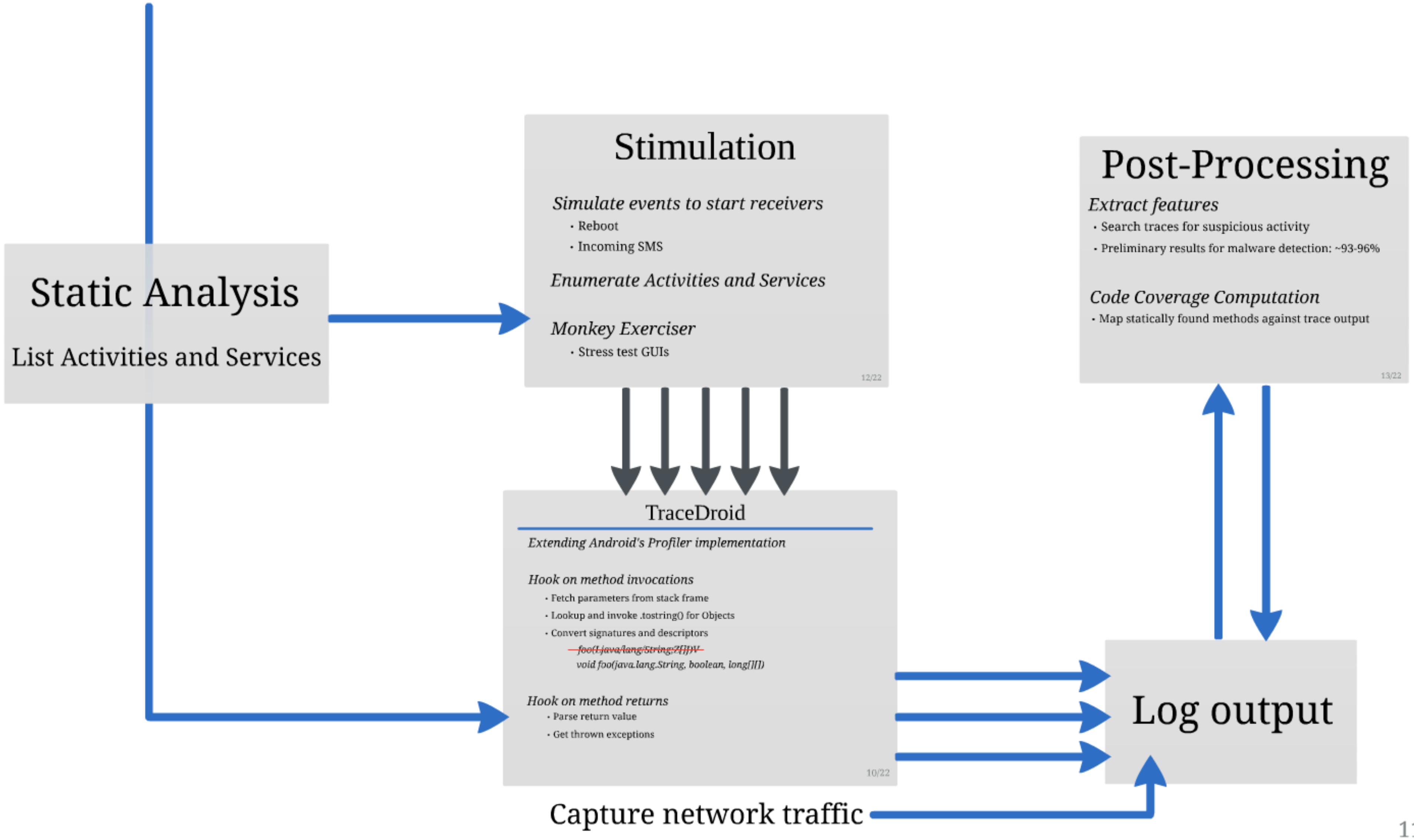

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Analysis of ~500 samples	*Code Coverage*	
• 250x benign	35.02%	~33%
• 242x malicious	31.10%	

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Monkeys suck at gaming

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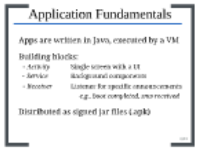
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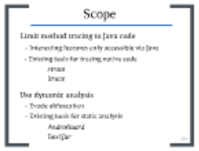
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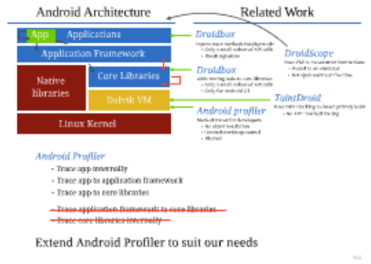
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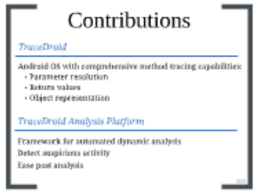
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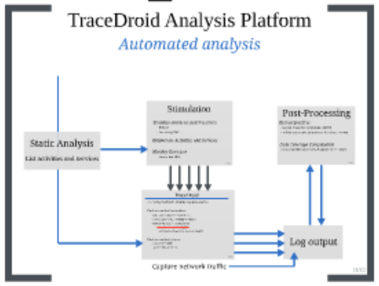
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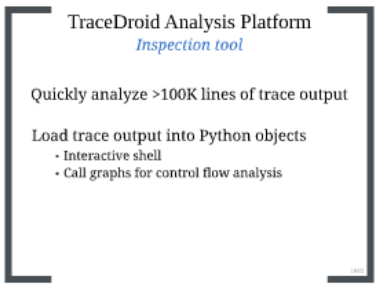
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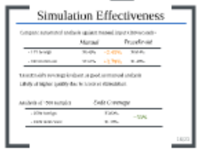
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