Building a Commit-level Dataset of Real-World Vulnerabilities

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Biography

whoami

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Problem

Situation

Let's imagine I have a shiny new tool that detect if a patch has been applied to a binary,

how do I test my solution efficiently?

Potential Solutions

- Gather a few couples of binaries from real vulnerabilities
- Create a synthetic project where I add hand-crafted vulnerabilities
- ...

Problem

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- Gather a few couples of binaries from real vulnerabilities
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- ...
- Use the dataset presented today

Contributions

Commit Level Dataset

A dataset of more than 1,900 vulnerabilities:

- Based on real-world issues (CVEs);
- Precise at a Commit Level.

Precompiled Dataset

Binaries for a 600 of these vulnerabilities:

- 4 architectures (`ARM`, `x86`, `x86-64`, `ARM64`);
- With debug symbols.

Available on GitHub at `https://github.com/quarkslab/aosp_dataset`.

Existing Work

- Standard Testing Suites (Juliet [1], CGC [2])
  Synthetic, Small samples

- Generated Dataset (LAVA [3], MAGMA)
  Only one bug type

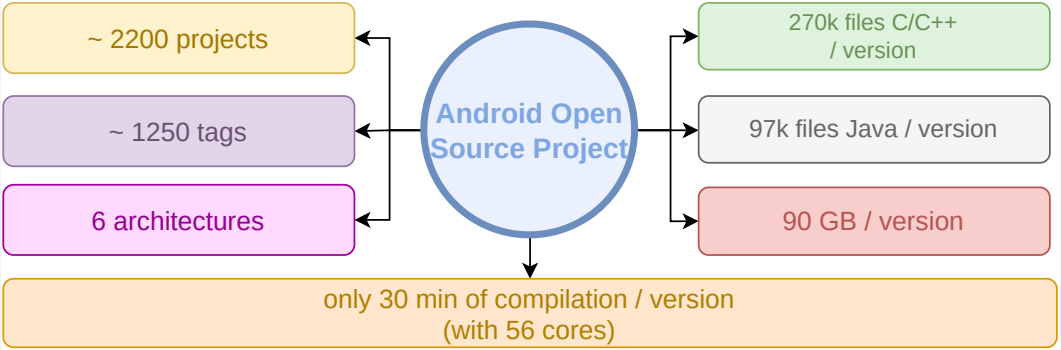
- CVE Datasets (Akram and Ping [4], Li *et al.* [5])
  Discontinued, Small dataset, Imprecise

Potential Applications

- Patch Characterization
  Draw an identity card of Patch
- Silent Fix Detection
  Detect if a commit was a security fix
- Cross Architecture Binary Diffing
  Match the same binary across different architectures
- Patch Detection
  Detect if a patch has been applied
- ...

Android Open Source Project (AOSP)

What is AOSP?



Android's security

Update process

- Multiple stakeholders (*Google*, OEM, carriers...)
- Intricated, complex, and usually not followed in time *2 years of security-update*
- *Project Treble* [6] to solve part of the problem *starting to get enforced*

Android Security Bulletins by Google

- Monthly reports of vulnerability fixes in AOSP
- Contains CVE-ID, severity and **a link to the fixing commit**

Android Security Bulletins

Framework

The most severe vulnerability in this section could lead to local escalation of privilege with no additional execution privileges needed. User interaction is not needed for exploitation.

CVE	References	Type	Severity	Updated AOSP versions
CVE-2021-39619	A-197399948	EoP	High	11, 12
CVE-2021-39663	A-200682135*	EoP	High	10
CVE-2021-39676	A-197228210*	EoP	High	11
CVE-2021-39664	A-203938029	ID	High	12

Extract of March 2022 Bulletin

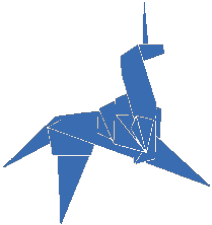
Roy: Tool Overview

Objective

Based on the *Security Patch Level*, find CVEs affecting a device.

How does it work?

1. Crawl Android Security Bulletins
2. Parse results
3. Store them in a database



Towards Binary Artefacts

Motivations

Not every vulnerability is found in Open Source.
There exists a need for binary only solutions.

Why using AOSP?

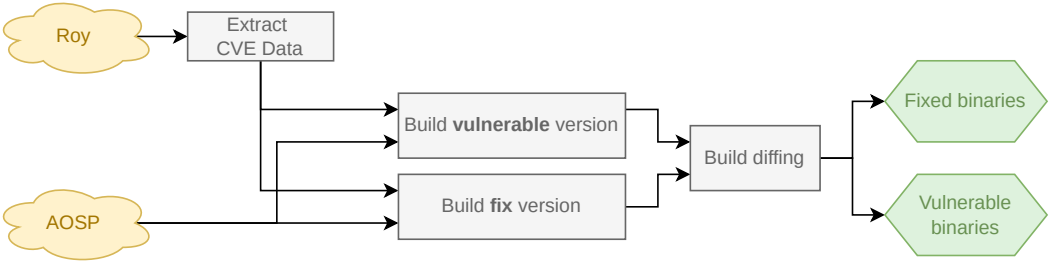
AOSP is a perfect target for building binary artefacts:

- Cross architecture Operating System
- Documented and working build system
- Information precise at a commit level (Roy)

AOSPBuilder: Overview

Process

1. Reuse Roy results for vulnerabilities
2. Prepare a build environment for AOSP
3. (Build-magic)



Dataset Overview: At Source Level

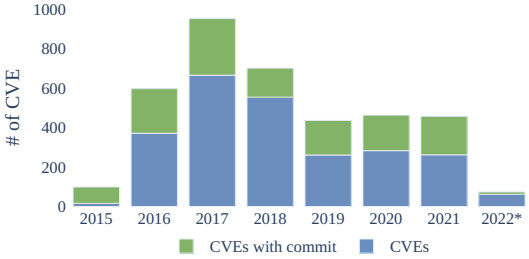
Results

- Huge set of vulnerabilities (3400+ and more than 1900 with commits)
- Ever increasing *but parser often needs to be updated*

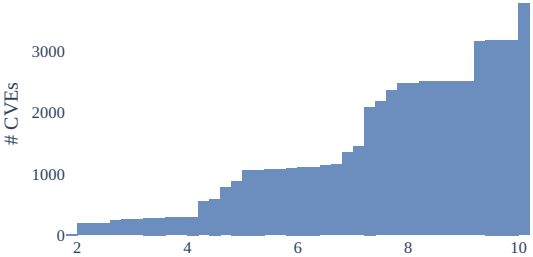
Limitations

- Only Open Source components
- Rely on Google's commitment to publish bulletins

Dataset Overview: At Source Level



CVE Evolution over time



CVSS scores

Dataset Overview: At Binary Level

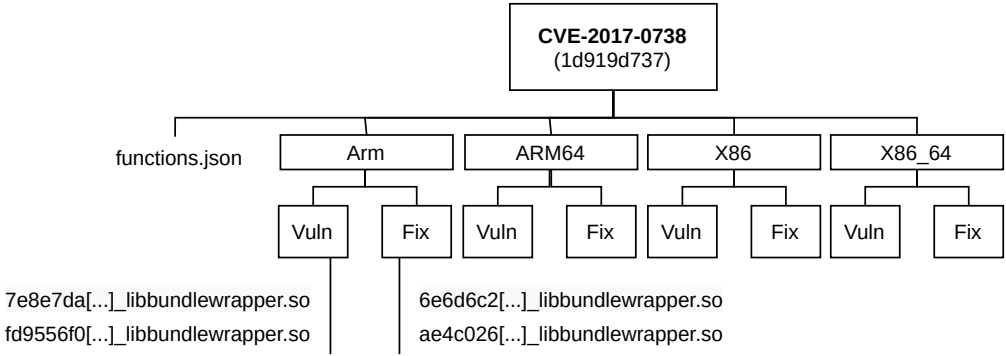
Results

- 600 vulnerabilities compiled
- 120 GB *links to download on GitHub*
- 4 architectures *the same binaries in various architectures*

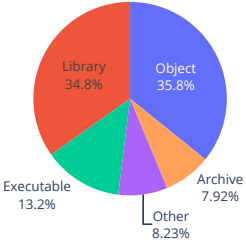
Limitations

- Only vulnerabilities on C/C++
- Build automation is hard: lots of failures
- Only vulnerabilities after Android 6

Dataset Overview: At Binary Level



Dataset Overview: At Binary Level



Binary Files Types

Name	Count
libbluetooth.so	953
bluetooth.default.so	748
libnfc-nci.so	650
libstagefright.so	421
net_test_btif	417

Most Common Binaries

Usage

- Information is stored in JSON Files
- A helper module in Python provided to ease usage

```
aosp-dataset/
├── cves
│   ├── CVE-2012-6701.json
│   ├── CVE-2012-6702.json
│   ├── ....
├── LICENSE
├── precompiled
│   └── links.json
├── pyproject.toml
├── README.md
├── schemas
│   ├── AospCve.schema.json
│   ├── precompiled.schema.json
└── src
    └── aosp_dataset
```

CVE Details

Links towards precompiled vulnerabilities

Schemas definitions

Python module

Conclusion

Dataset

- +1,900 Commit-precise real-world vulnerabilities
- +600 Precompiled artefacts for four architectures

Useful for: Patch characterization, Silent fix detection, Cross architecture diffing ...

`https://github.com/quarkslab/aosp_dataset`

Thank you

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Quarkslab

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