System & Software Security
Software Bills of Materials
Hands-On Project

Davide Baggio	s4426428
João Pereira	s4443322
Nuno Pereira	s4443330

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We confirm that this report was fully produced by the team members **Davide Baggio, João Pereira and Nuno Pereira** and we are jointly responsible for all content presented in this work. All used sources were attributed properly.

Contents

1 Introduction

Software Chain Security is an increasingly important challenge to tackle as early as possible in the Software Development process due to the catastrophic effect that vulnerabilities or security issues in downstream dependencies can cause to any software product, like in the SolarWinds [6] and Log4J [5] cases. It is therefore crucial from a development standpoint to be aware of what components are included in any software project and the potential vulnerabilities that they might introduce. Many solutions have been developed to aid in that process, the prime example being *package-managers* [1], tools that help managing software dependencies and version conflicts between dependencies. Examples of such package managers are NPM (Node Package Manager) and Cargo [20, 21].

Another solution to dependency and vulnerability tracking are *Software Bills of Materials* (SBOMs) [3], detailed listings of dependencies, their relations, licensing information and other metadata pertinent to software products. These provide a standard format to work and process dependency information, allowing easier communication and shareability. Currently, 3 mainstream SBOM standards exist: OWASP's *CycloneDX*, Linux Foundation's *SPDX* and NIST's *SWID* [12, 13, 18].

In previous work [22], the authors performed a critical comparison on 5 articles from the literature [7–11] based on author-defined metrics. The authors provide insights on the state-of-the-art regarding SBOMs and provide guidelines for SBOM adoption and development, as well as future work that can be done in further research. Should add more sentences/explain this further

In an attempt to complement [22], this article reports on a hands-on comparison of the three mainstream SBOM standards by making use of available tools for each standard. SBOM generation tools for each standard were used on a set of N major Open-Source repositories found on GitHub and the resulting SBOM output files were compared, both between standards as well as between the tools of each standard.

2 Methodology

In this section, we detail the methodology used to perform the hands-on comparison between SBOM standards. In 2.1 we discuss the different available standards and the tools chosen to generate SBOMs for each one of them. Based on the tools picked we chose, in 2.2, the repositories on which the SBOMs will be generated.

2.1 Standards and tools

Each one of the three standard formats focuses on a specific part of the software supply chain, which can be reflected in the (meta)data that each standard stores and processes. The tools developed for each each standard also reflect these decisions. I felt that I had to fill this in with something

2.1.1 CycloneDX

CycloneDX [13] is an SBOM standard format developed by the CycloneDX Core Working Group and backed by the OWASP Foundation with a focus on "cyber-risk reduction" [13] and security [7]. The standard supports writing BOMs for several domains of software development, such as Software BOMs (SBOMs), Cryptographic BOMs

(CBOMs), Software-as-a-Service BOMs (SaaSBOMs), among others. Over 200 tools related to CycloneDX's SBOM format are available at CycloneDX's official tool webpage. Should this be a reference instead?

For this hands-on comparison, we limited our search to *Open-Source* tools as these are free to access and use. Out of 172 listed Open-Source tools, 2 were chosen: CycloneDX `cdxgen` [14] and `build-info-go` [17].

Other tools exists but they are either unrelated (SBOM analysis, VEX generation, ...), too specific (official SBOM generators for several existing programming languages and build tools) or too limited on the supported development environments.

cdxgen is an official tool developed and released on GitHub by the CycloneDX team, built around the idea of being a "polyglot SBOM generator that is user friendly, precise and comprehensive" Add more text?

build-info-go is a CLI tool to generate BuildInfo metadata, a custom format designed to encapsulate software components, their versions and their dependencies. The tool supports multiple languages and package managers and has the option to export the produced BuildInfo output into a valid CycloneDX JSON file.

2.1.2 SPDX

2.1.3 SWID

Software Identification (SWID) Tags [12] are a standard format for identifying software components and metadatas, which can be used to generate SBOMs. Nowadays, the current standard of it is ISO/IEC 19770-2:2015 [2] and is maintained by the ISO/IEC JTC 1/SC 7/WG 21 committee [16]. A generated SWID Tag document consists of a well-organized collection of data fields that specify the software product, its version, identify the organizations and people involved in its creation and distribution, list the components that make up the software, define relationships between different software products and include additional metadata for further description. SWID tagging differs from CycloneDX and SPDX in that it is not a full-fledged SBOM format, as it doesn't aggregate information of all softwares so it's rather a standard for identifying software components and their metadata.
The recommended official NIST tools for generating SWID Tags only support Java programs built with Maven, which is too restrictive, and most of them aren't properly documented or don't fit our use case. Out of all the official tools available, we found the following one to be the most suitable and usable:

swid-maven-plugin is a Maven plugin published by NIST [19] that generates SWID Tags for Java projects and is compliant with the above mentioned ISO standard. It needs to be configured in the project's `pom.xml` file and additionally it requires the assembly descriptor in `src/assembly/bin.xml` to be configured aswell.

swid-generator We also looked for unofficial tools on GitHub and found this one by Labs64 [4], which also supports Gradle projects. The downside of it is that it requires implementing a custom portion of code in the project to generate the SWID Tags, which is not as straightforward as the other tool and it might be unsuitable for complex projects.

By the same authors, there is also a Maven plugin which is unfortunately not maintained anymore and uses an outdated version of Java, which results in a lot of errors when trying to build it, as testified by this issue.

2.2 Repositories

To ensure a fair comparison between standards, we chose a representative set of major Open-Source repositories that could be analyzed by most, if not all, of the tools selected.

As such, we have picked N repositories from GitHub:

- Apache Kafka [15]
- N/A

3 Conclusion

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A Appendix A

A.1 Example CycloneDX output for cdxgen

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A.2 Example CycloneDX output for build-info-go

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A.3 Example SPDX output for N/A

bla bla

A.4 Example SWID output for N/A

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B Appendix B