VulnerableCode

Because a vulnerability database should not be about Vulnerabilities

Hritik Vijay

- ▷ Passionate about opensource, Linux and infosec
- ▷ Co-maintainer at VulnerableCode and univers
- ▷ Application Security engineer at CRED
- ▷ Google summer of code mentor and a participant
- ▷ Supporter of suckless philosophy
- ▷ hritik.elf@gmail.com, @MrHritik

Tushar Goel

- Co-maintainer at VulnerableCode, FetchCode, univers and PackageURL
- Software Engineer at NexB
- Google summer of code mentor and a participant
- tgoel@nexb.com

Agenda

- ▷ The state of vulnerability databases (open or not)
- ▷ How do we search? By package first!
- ▷ A better approach: package first
- ▷ Why VulnerableCode?
- ▷ VulnerableCode Solution
- ▷ How to create a package vulnerability database
    - ○ Aggregate and correlate many data sources
    - ○ Multi level data refinement
- ▷ Issues with vulnerability data
- ▷ Future plans
- ▷ Next steps: we need your help!

State of vulnerability databases (1)

- Databases with ghost **packages**
  - DBs reference packages that do not exist anywhere
- Databases ghost **vulnerable versions**
  - Even though these are not vulnerable or the opposite
- Databases "Crying wolf", **improbable** vulnerabilities
  - DBs report a package as vulnerable if anything in the dependency tree may be vulnerable (Log4j)
- Impossible, self-contradictory version ranges
  - Resolved to nothing or everything
- Redundant and noisy duplicated vulnerabilities
- Vulnerabilities mapped to hard-to-find CPEs

State of vulnerability databases (2)
The Telephone Game problem

- Everyone is making something up a little by trying to improve data
- Each of them makes something up slightly differently
  - Too much reliance on automated tools on top of bad data
- Many DBs base their content on another DB content
  - At each step the data is transformed (and damaged) in subtle ways
- You can have as many vulnerable ranges as there are DB interpretations.
  - None of them is entirely faithful to the upstream data
    - Over time this turns into The Telephone game
- **Upstream has better data**

The true-true vulnerabilities are **UPSTREAM!**

Credit https://live.staticflickr.com/3798/10142017736_7f69d9f472_h.jpg
"Brown Bears at Brooks Camp, Katmai National Park"
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https://www.youtube.com/watch?v=V4kWQSpCbvo

State of vulnerability databases (3)

- Databases of known FOSS software vulnerabilities are mostly **proprietary** and/or **privately** maintained using proprietary tools, processes and data.
- Why not open data? FOSS code likes open data about FOSS!
  - Some new entrants are now using open licenses: 🎉
  - GHSA (GitHub), OSV (Google), GitLab (one month delay)
- Emerging support for **Package URL** promotes interoperability
  - OSSF OSV, Sonatype OSSINDEX
- Emerging common format promotes interoperability
  - **OSSF OSV**
- But open formats does not mean common data identifiers

How do we search? By package first!

Questions to answer:

- ▷ Is package foo@1.0 known to be vulnerable?
  - ○ What are the vulnerabilities?
  - ○ What is the severity of the vulnerability?
  - ○ Which version has a fix?
- ▷ More rarely: do I have any package vulnerable to this vulnerability?

A better approach: package first

~~Lookup **vulnerabilities**, find packages~~

Find **packages**, lookup vulnerabilities

Why VulnerableCode? accuracy and correctness

- Vulnerabilities are important!
- Code is more important! **Package first**!
- There is no Free Software Vulnerability Database that is
  - Open!!
  - Comprehensive, most ecosystems (system + package)
  - Curated by expert humans
  - Validated: Trusted but correlated and verified data
  - **Working towards correctness**

VulnerableCode Solution

- Find packages with scanning, matching and tracing
  - Leverage all tools that report package-url (we support CPE too)
  - ScanCode.io and Toolkit, ORT, Tern, OWASP Dependency Track and many more .... or an SBOM (SPDX, CycloneDX)
- Lookup package vulnerabilities in an open database that aggregates them all
- Query by purl!
- Open data and open source tools are better.
- Eventually expert review and curate all the data.

How to create a package vulnerability database?

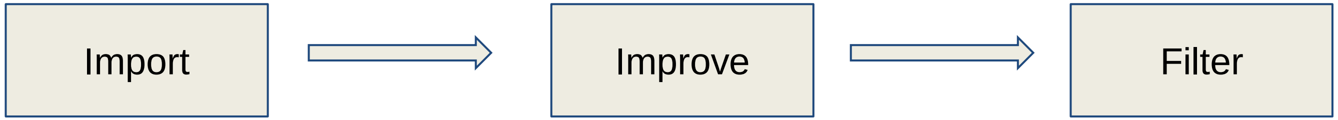
- Use data from upstream, at the source of the source!
    - From the package maintainers and authors themselves
- Employ a confidence based system: not all data are equally trusted
- Aggregate and correlate many data sources to enrich and validate
- Discover of new relations between vulnerabilities and packages from mining the graph
- Eventually curate and review for correctness with experts

Aggregate and correlate many data sources

- Collect and parse **many sources**
  - Store in a common data model
  - Cross-reference to create a graph
- **Project-specific trackers**
  - Apache, OpenSSL, nginx...
  - Bug trackers, CHANGELOGs.
- **Linux distro trackers** (Debian, Ubuntu, RedHat, SUSE, Gentoo, ...)
  - Custom or standard formats (CVRF, OVAL)
- **Application package trackers**
  - NuGet, Rust, RubyGems, Pysec, RustSec, npm, ...
- **NVD**, and other aggregators: **OSV, GHSA, GitLab, GSD and more**.

Multi level data refinement

- The data is always imported in an “Advisory” staging area
- "Advisory" data are converted to "Vulnerability" and "Package" data and their relationships using "Improvers"
- "Advisory" data that cannot be converted are kept with a log to investigate and resolve issue
- Specific improvers can mine the graph, cross check with other data sources, resolve updated version ranges



Issue: Ghost packages

- **Some packages do not exist anywhere**
    - Including versions that may not exist

- **Solution: Lookup upstream in the package registries and repositories**
    - We can lookup in the registries and repositories to validate that the Package URLs and versions are correct and really exist upstream

Issue: Lesser data quality

- **Some vulnerability sources cannot be trusted**
  - Known to make incorrect or inaccurate assertions about packages and versions
- **Solution: store confidence level**
  - Confidence level ensure we keep all inferred data, even lesser quality data
  - We do not trust others: We can discount the data source we trust less
  - And we do not trust ourselves: we can discount the automated inferences we do if we are not 100% sure about their correctness

Issue: Incorrect or missing versions

- **Some package versions are missing or incorrect**
  - Affected version statements are often ambiguous
  - ***"All the versions of package foo are vulnerable to CVE XZY"*** really means all the versions of foo known at the time this advisory was published were vulnerable.
- **Solution: store version range, resolve range and "time travel"**
  - We store version ranges as a compact string (using new purl "vers" spec)
  - We expand and resolve ranges with "univers" version handling library
  - Package version can be re/checked for being in a vulnerable range as needed
    - In the past and in the future
  - Improvers can do "**time travel**" based on version publication dates and determine if a package version was vulnerable **in the past when published**.

Issue: Duplicated data

- **Some vulnerabilities are duplicates**
  - Leads to many noisy relationships and lesser correlation abilities
- **Solution: Introduce a new set of vulnerabilities id aliases**
  - Before, we tracked by CVE id; only if there was none we created a VULCOID id. (VulnerableCode ID for a vulnerability)
  - We now always use a VULCOID id and track many aliases (including a CVE id when available) for each vulnerability
  - Aliases are used for data reconciliation during the second step of "Improvers" meaning that we avoid a large number of duplicates
  - Improver jobs will further merge additional duplicates

Other issues

- **Many data sources - redundant, unstructured, messy, incomplete**
  - We grew to appreciate the complexity of the task and why commercial vendors currently dominate the space
  - **Solution**: integrate them all (all the data sources) to cross-check them
- **Old, obsolete, or less useful data**
  - More is not always better - e.g. old vulnerabilities on Windows 95
  - Commercial-only software (Windows, etc.) or hardware is less interesting
  - **Solution**: let go of some of the past! and ignore the legacy

Future plans

- More primary data sources, going upstream
- Actual commits fixing and introducing vulnerabilities
- YARA Rules: enable finer grain detection of actual vulnerable code
- Community peer curation system including curation UI
- AI/ML for data quality improvements
- .... and good ole heuristics
- VulnTotal: Tool to compare all the Vulnerabilities DB
    - Think Virustotal for vulnerabilities

If you want to learn more about our projects

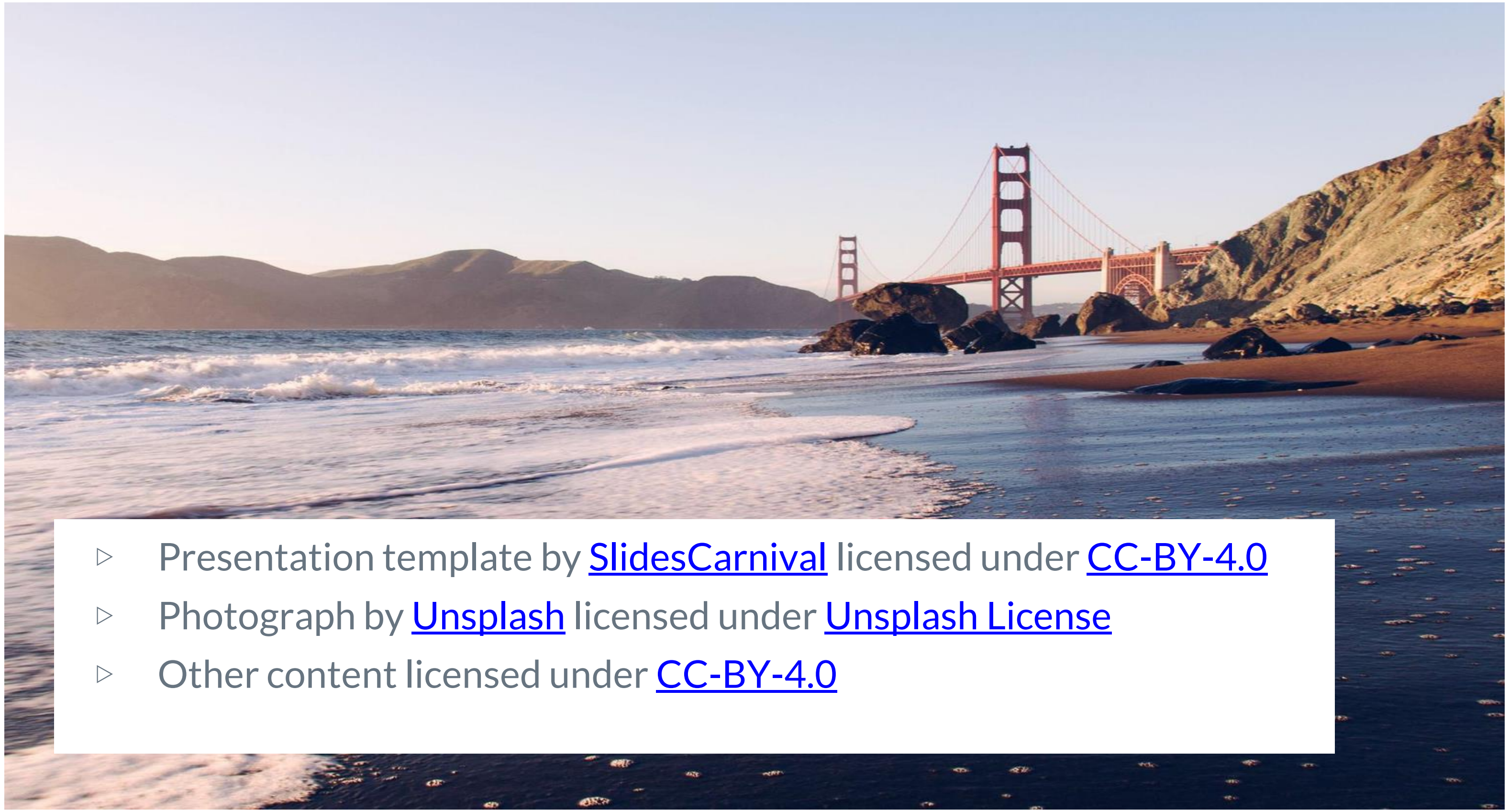
- Register for our upcoming webinar on July 21 at https://nexb.com/0721-vulnerablecode
- Read our latest blog post at https://nexb.com/vulnerablecode-public-release
- Download VulnerableCode at https://github.com/nexB/vulnerablecode/releases/latest
- Visit https://nexb.com/vulnerablecode for more information

If you want to help

You can contribute code, time, docs (or cash?)

- ▷ Use these fine FOSS tools and specs
  - https://github.com/nexb/vulnerablecode
  - https://www.aboutcode.org/
  - https://github.com/nexB/
  - https://github.com/package-url
- ▷ Join the conversation at
  - https://gitter.im/aboutcode-org
- ▷ Donate at
  - https://opencollective.com/aboutcode

Credits



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Summary

- Why Is There No Free Software Vulnerability Database?
- This was the provocative question we were asking two years ago when introducing the VulnerableCode FOSS project. The situation has evolved positively since then -- in particular thanks to the creation of the Open Source Security Foundation and the Open Source Vulnerability (OSV) project and schema.
- Yet the question is still relevant as there is still no comprehensive and open aggregated vulnerabilities database that would cover most system and application package ecosystems. There are also continuous looming concerns about the licensing of vulnerability feeds and how to best share and curate vulnerability data.
- Hritik and Tushar will present the state of the open vulnerability databases and how new designs and models that are not centered on vulnerabilities can help software and security professionals determine if their FOSS software packages are subject to vulnerabilities more quickly, more efficiently and with less noise
- They will also review some new and innovative techniques deployed in VulnerableCode to mine more effectively open source vulnerabilities including "time travel", "log mining" or "range expansion" to produce better focused vulnerability information.