

The Legacy of Log4shell

The Future of DevSecOps

Texas Linux Fest
2024-04-13

Outline

- “Learn from log4shell”
 - A lot has changed since then
- State of log4 today?
- Problems with NVD/CVE
- Open source is way bigger now
- Supply chains are now an actual thing
- Open Source is not a vendor, Maintainers are not suppliers
- You are on their turf
- What is the future? CVSS? EPSS? KEV?
- Open Source “insights”
- Infosec info distribution is absolutely in chaos

Paul Novarese, Solutions Engineer, Anchore



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@pvn@mas.to

Paul Novarese, Solutions Engineer, Anchore



anchore



This is not a utopian talk with magic solutions



Agenda

01

Log4Shell Today

02

A Fundamental Shift

03

Software “Supply” Chains

04

Three Big Things

Learn From Log4Shell

Log4Shell Rewind

I posted this in December 2021 right after log4shell dropped

Almost a year later, October 2022 I presented “learn from log4shell” at devopsdays houston, I had basically given up and said this was completely wrong

Now it may end up being correct, but not in the way I thought

<https://twitter.com/CubicleApril/status/1469825942684160004>

https://www.linkedin.com/posts/novarese_log4j-log4shell-activity-6876206319238463488-8bEA



Paul Novarese

SBOMs and Software Supply Chain Management at Anchore

2y · Edited

...

The **#log4j** debacle is going to have ramifications far beyond the vulnerability itself. There has been a lot of inertia in how issues are evaluated and classified, how information about those issues is disseminated, and how organizations respond to them, and **#log4shell** has exposed a lot of these problems. This will be a catalyst for a lot of changes that are way overdue.



April King

@CubicleApril

...

The fact that there are almost 10,000 CVEs with the same CVSS score as the Log4j vulnerability suggests to me that maybe the scale should be logarithmic.

6:26 PM · Dec 11, 2021 · Twitter for iPhone

71 Retweets 6 Quote Tweets 736 Likes

13 · 1 Comment

The State of Log4Shell Today

Log4Shell Today

It's been over two years and log4shell is still the single most exploited CVE

Data from CISA - cybersecurity and infrastructure security agency
<https://www.cisa.gov/news-events/cybersecurity-advisories/aa22-279a>

Table I: Top CVEs most used by Chinese state-sponsored cyber actors since 2020

Vendor	CVE	Vulnerability Type
Apache Log4j	CVE-2021-44228	Remote Code Execution
Pulse Connect Secure	CVE-2019-11510	Arbitrary File Read
GitLab CE/EE	CVE-2021-22205	Remote Code Execution
Atlassian	CVE-2022-26134	Remote Code Execution
Microsoft Exchange	CVE-2021-26855	Remote Code Execution

Fukushima Daiichi

Incident: 2011

Cleanup: at LEAST thirty years





**Chernobyl
Incident: 1986
Cleanup: at LEAST until 2065**

Contain a vulnerability known

2023: 40% of Log4j downloads still vulnerable

ll still be causing problems a decade from now

vulnerable Log4j versions] a



Mark Chmarny (He/Him) • Following

Product, Infra & DevEx at Cruise

4mo •

% of Log4j consumption worldwide STILL uses versions that are known to be
vulnerable (source: [Sonatype](#))

Home / Risk Management

With 40% of Log4j Downloads Still Vulnerable, Security Retrofitting Needs to Be a

Log4j flaw: Why it will still be causing problems a decade from now

Log4Shell ain't over until it's over, warns the US review board tasked with investigating the critical Apache Log4J flaw known as Log4Shell.



Written by Brian Topp, Contributing Writer on July 15, 2022

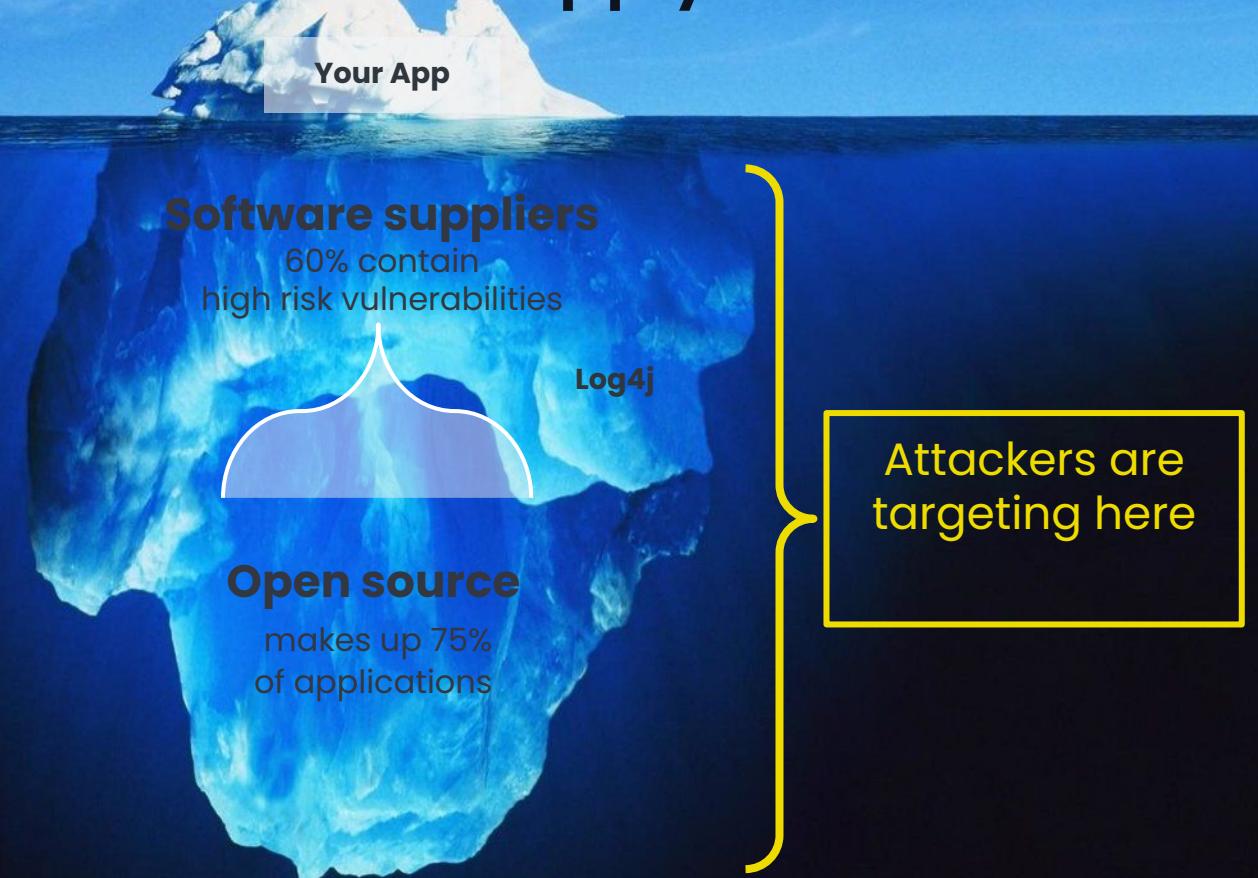
...

years ago, said
association that

Log4Shell Highlighted a Fundamental Shift

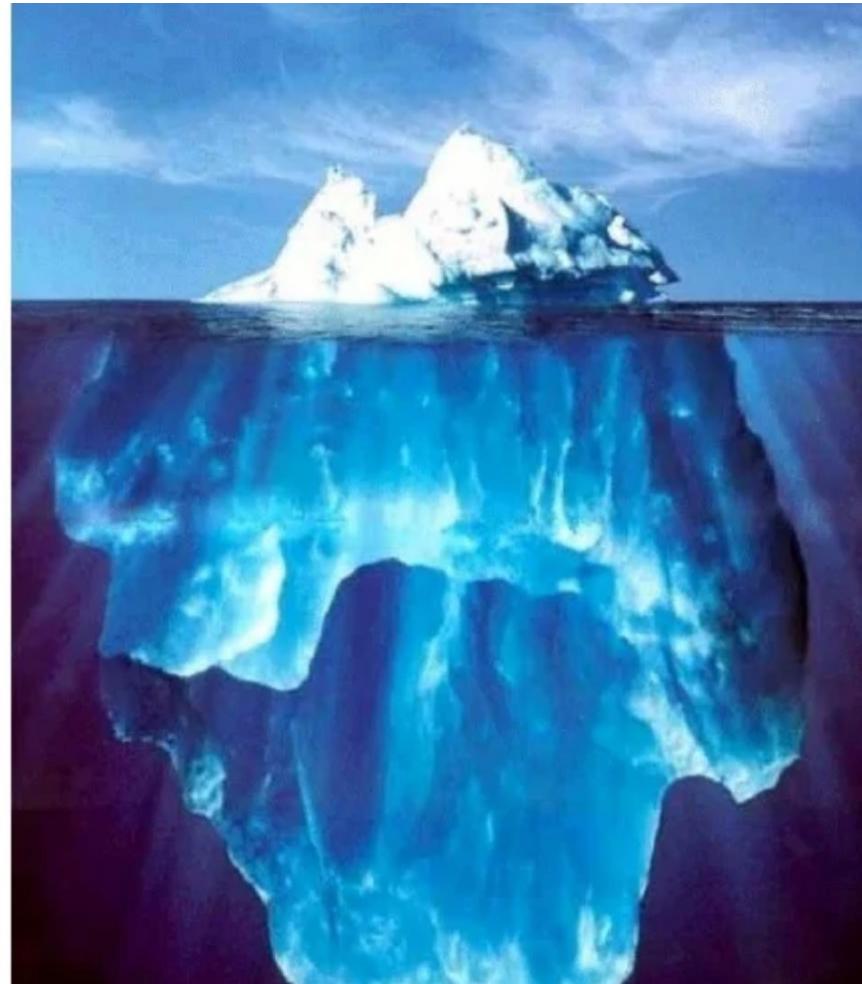
Hidden Risk in the Software Supply Chain

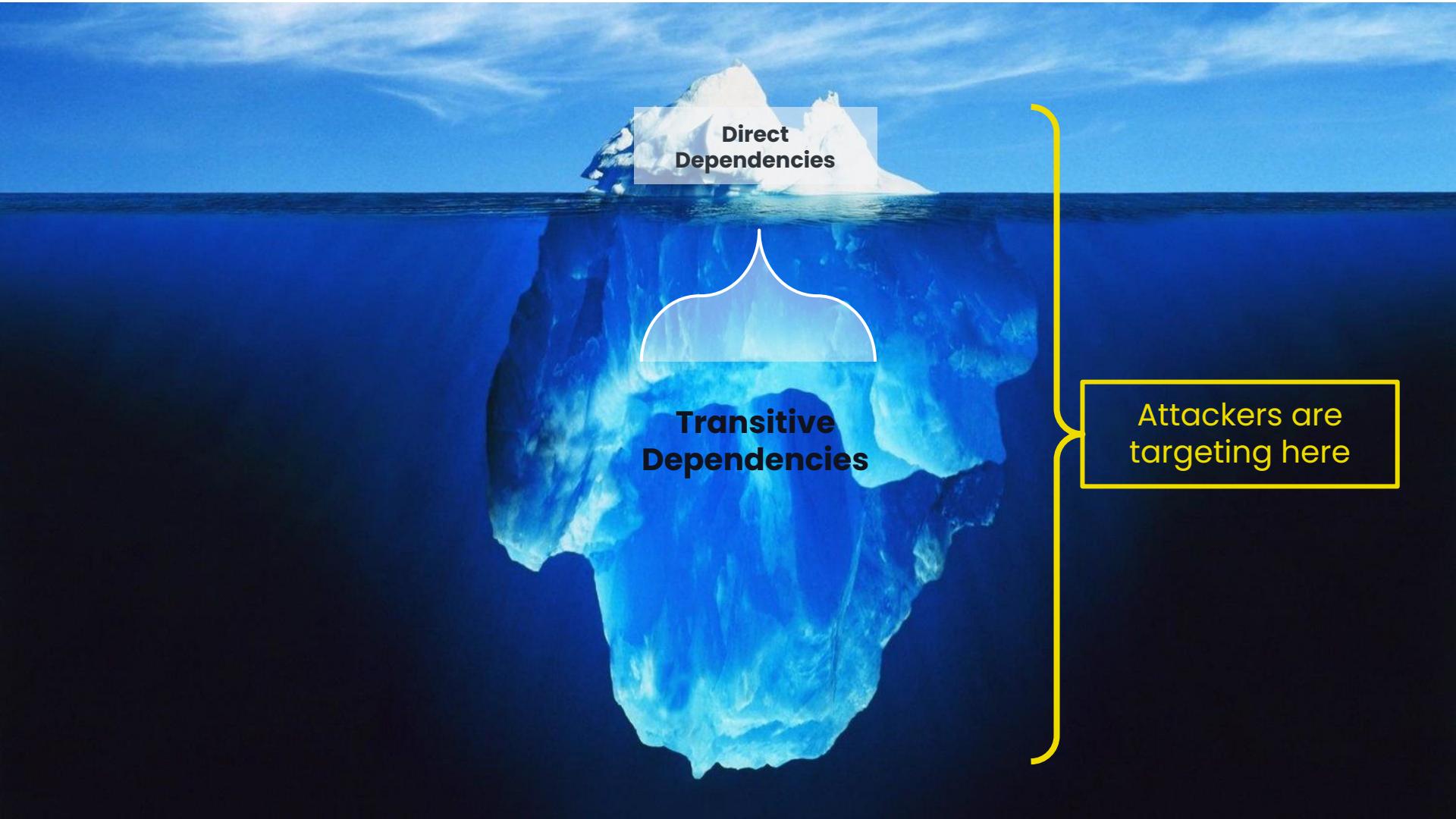
Risk in the Software Supply Chain



Free is Just the Tip of the Iceberg: Open Source Library System Software

Lori Bowen Ayre
lori.ayre@galecia.com
METRO Webinar
October 6, 2009





Direct
Dependencies

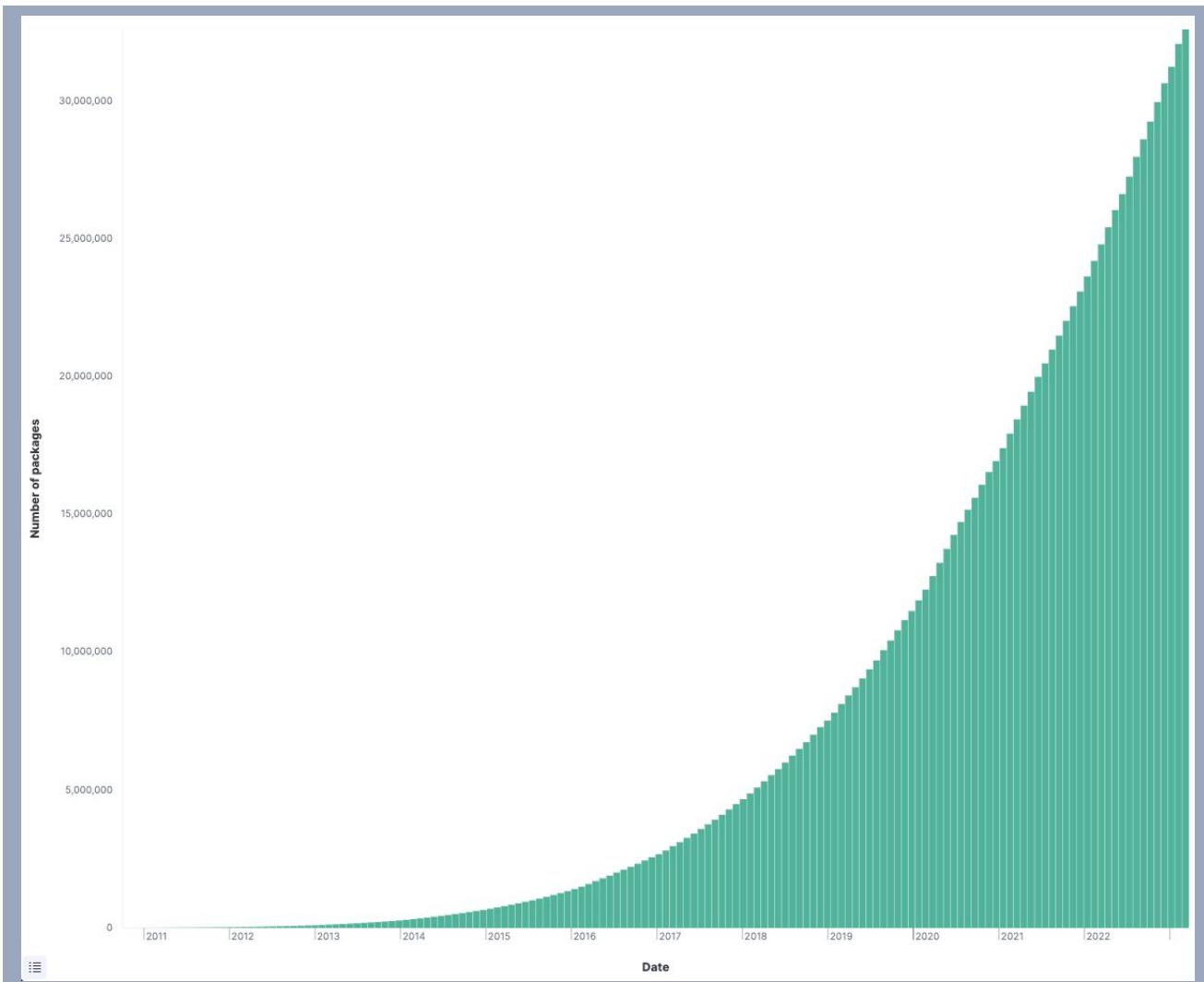
Transitive
Dependencies

Attackers are
targeting here

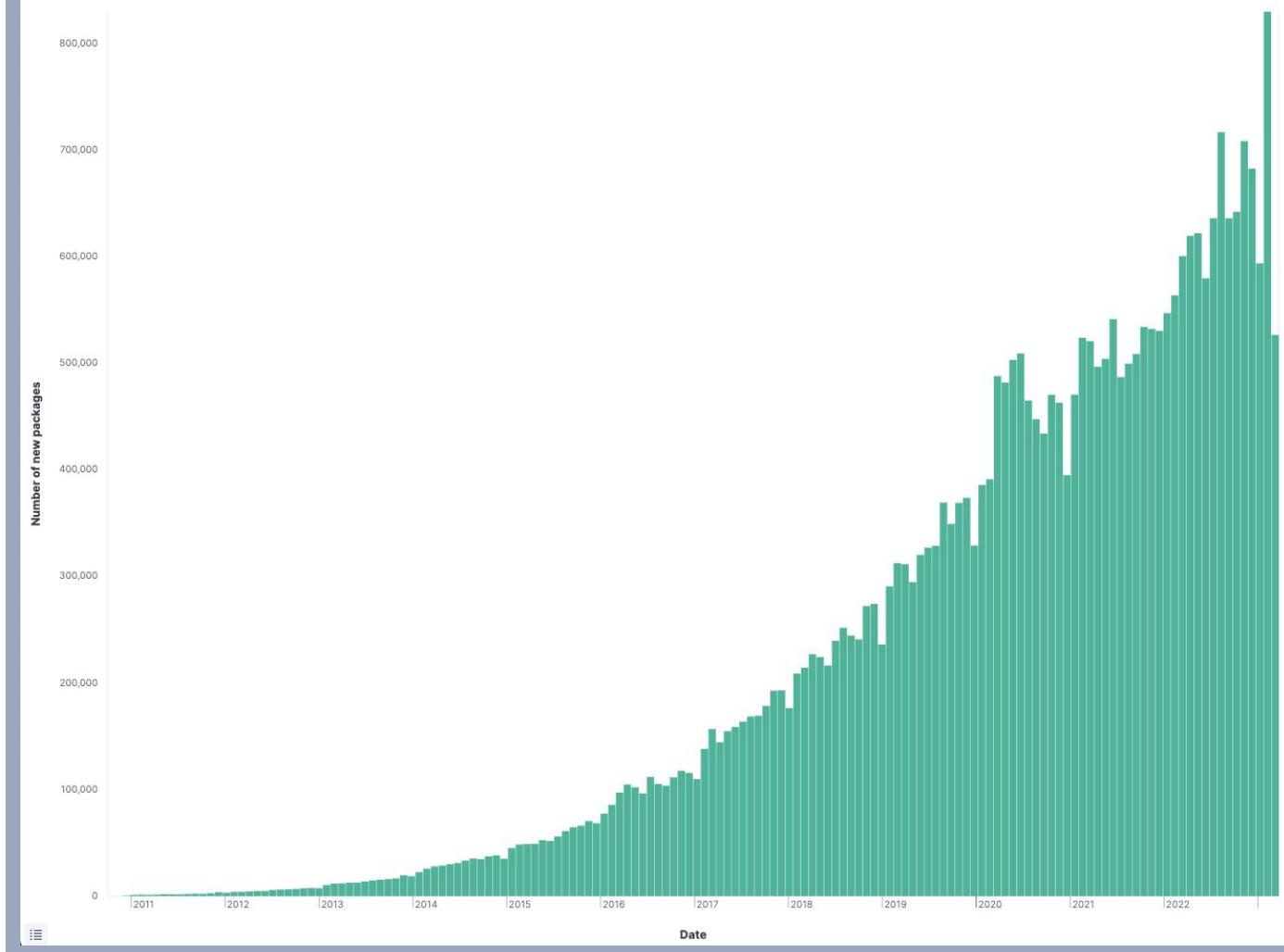
This metaphor...

- You've seen this iceberg metaphor. I've used this metaphor 100 times, I've criticized this metaphor.
- This is an OLD metaphor
- Things have changed a lot but we're still thinking about old systems
- <https://www.slideshare.net/loriayre/open-source-library-system-software-free-is-just-the-tip-of-the-iceberg>
- They're attacking the bottom now - that's a supply chain attack
- But really, the top isn't "your code" - the top is your direct dependencies, bottom is transitive
- You can only directly control what's at the top
- They're attacking the whole iceberg, but you probably only know about the stuff at the top
- The change is largely due to the massive rise in software package managers
- The CVE system predates this change and hasn't really evolved

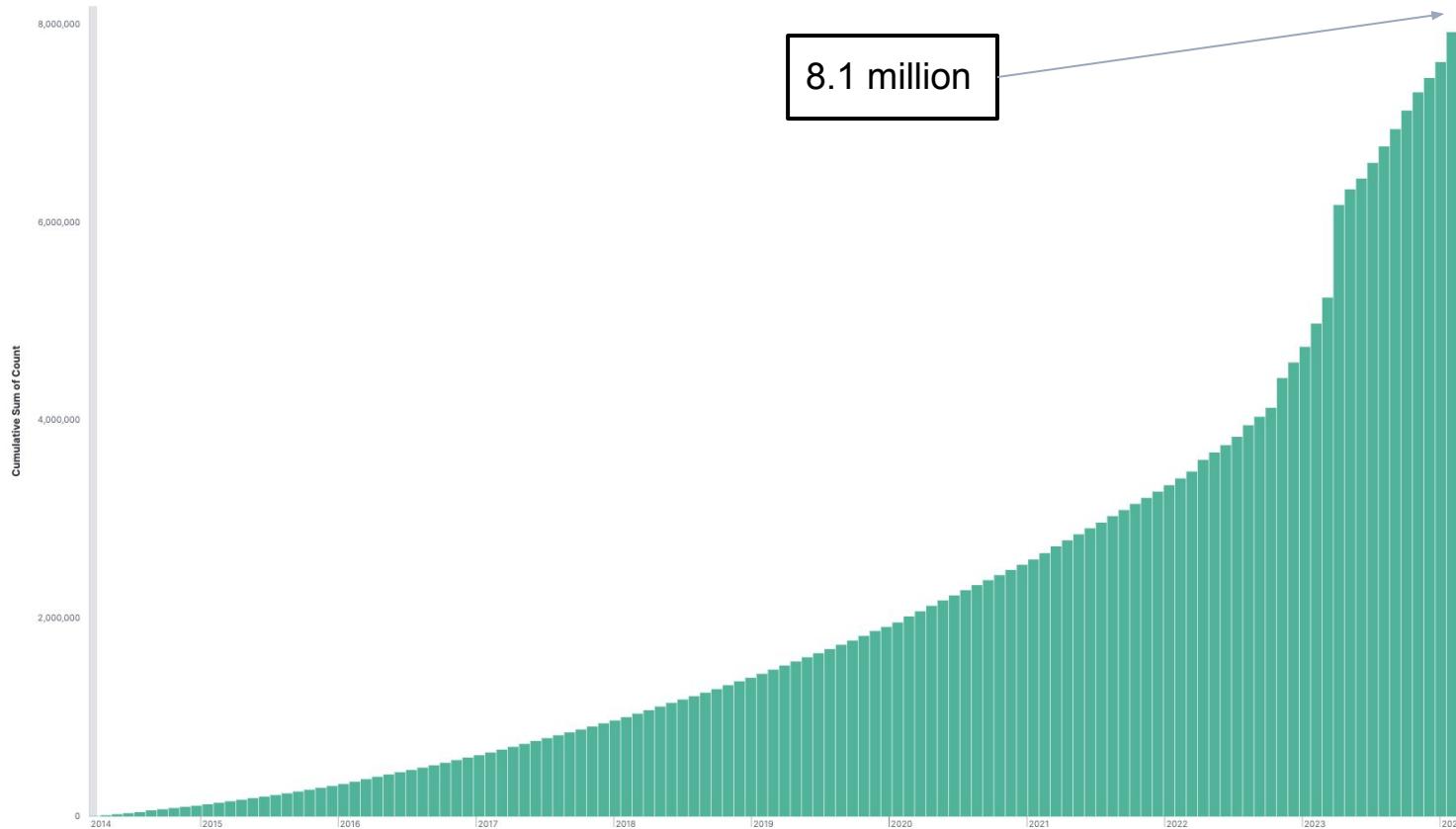
Number of NPM packages



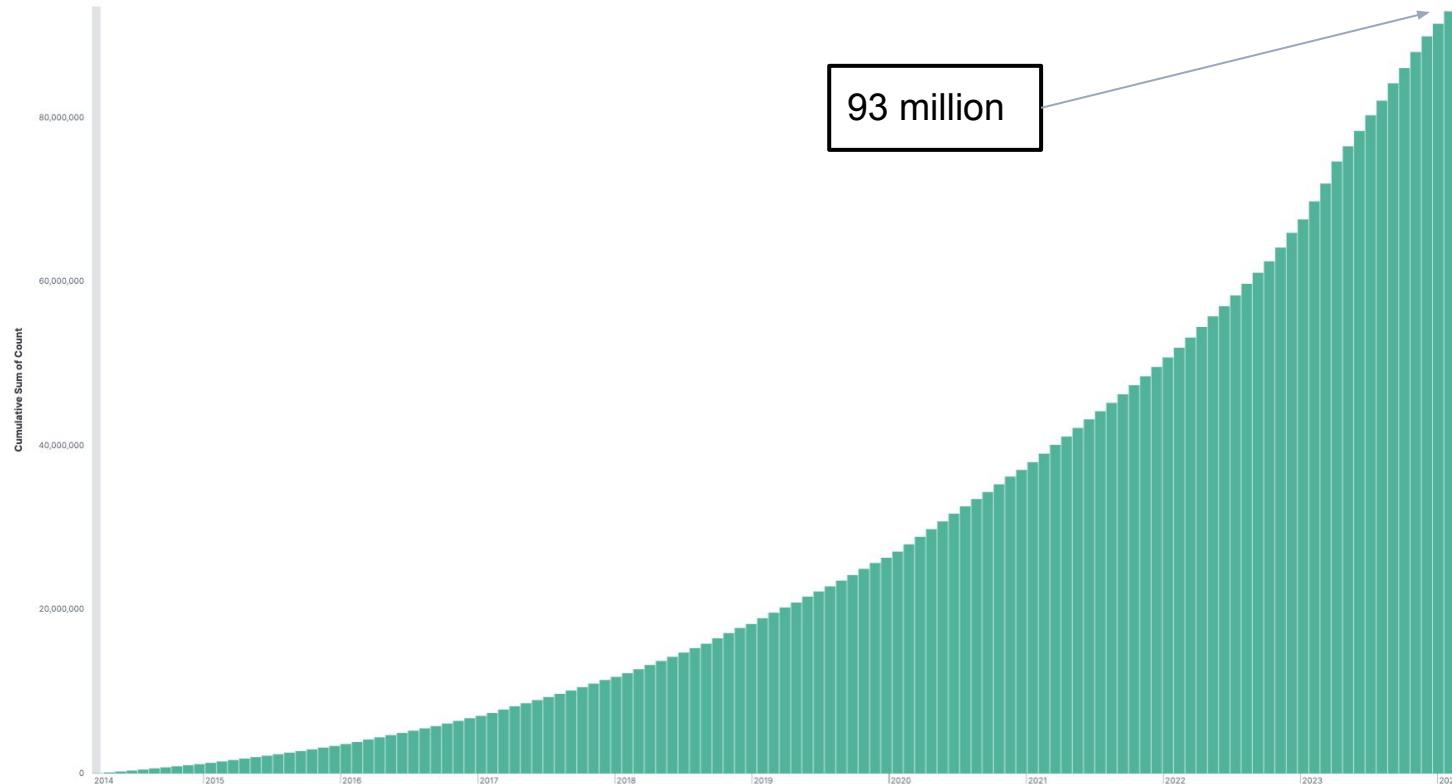
Number of NEW packages



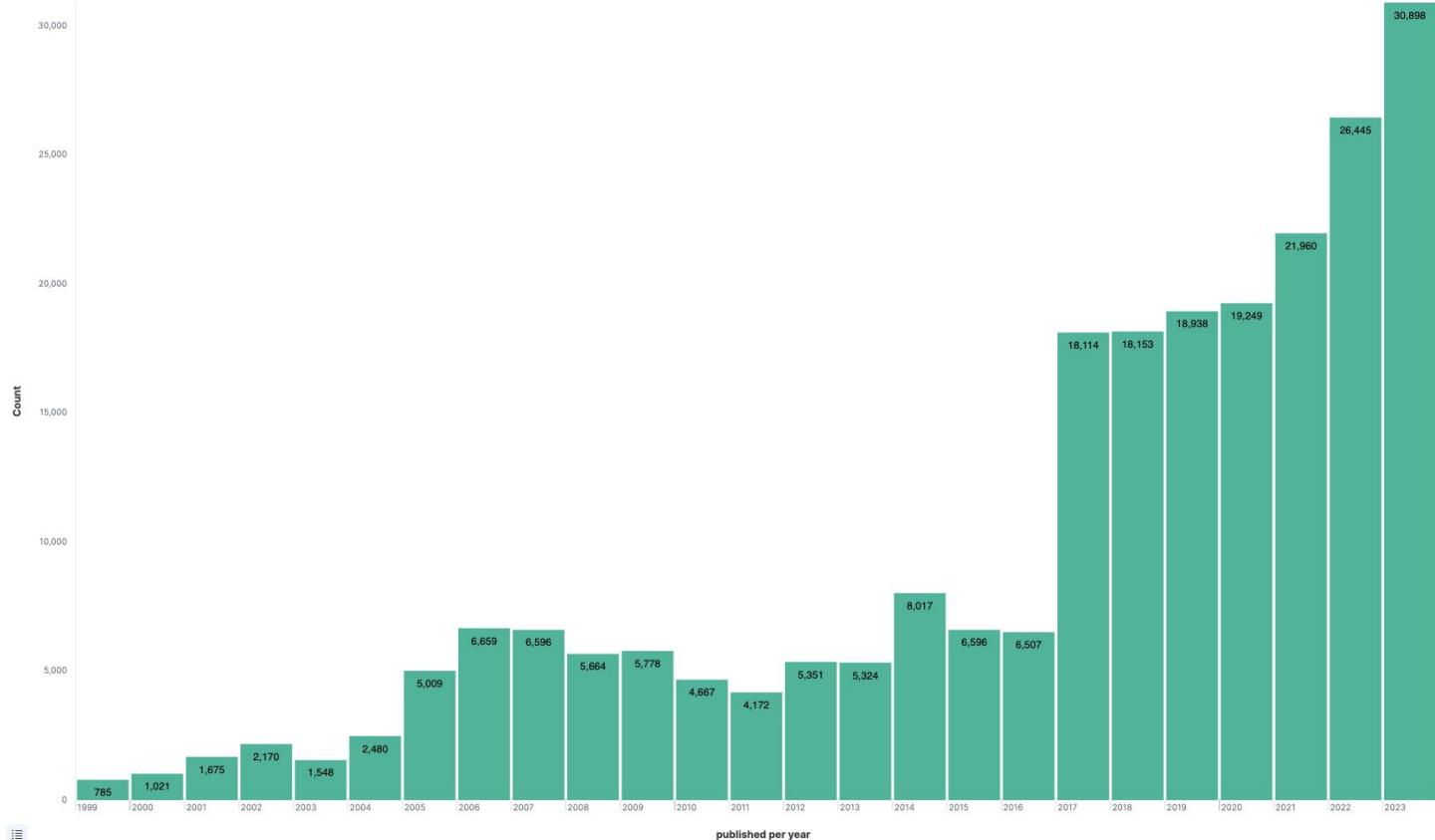
How big is big? (all packages over time)



How big is big? (all versions of all packages)



Also CVE growth



Open source is huge

- NPM introduced 2010
- 43 million packages (as of April)
- Approx 1,000,000 new packages **per month**
- That's just NPM!

npmjs.org

3,732,919 packages

42,958,444 versions

850,084 maintainers

231,488 namespaces

752,313 keywords

256,314,168,001 downloads



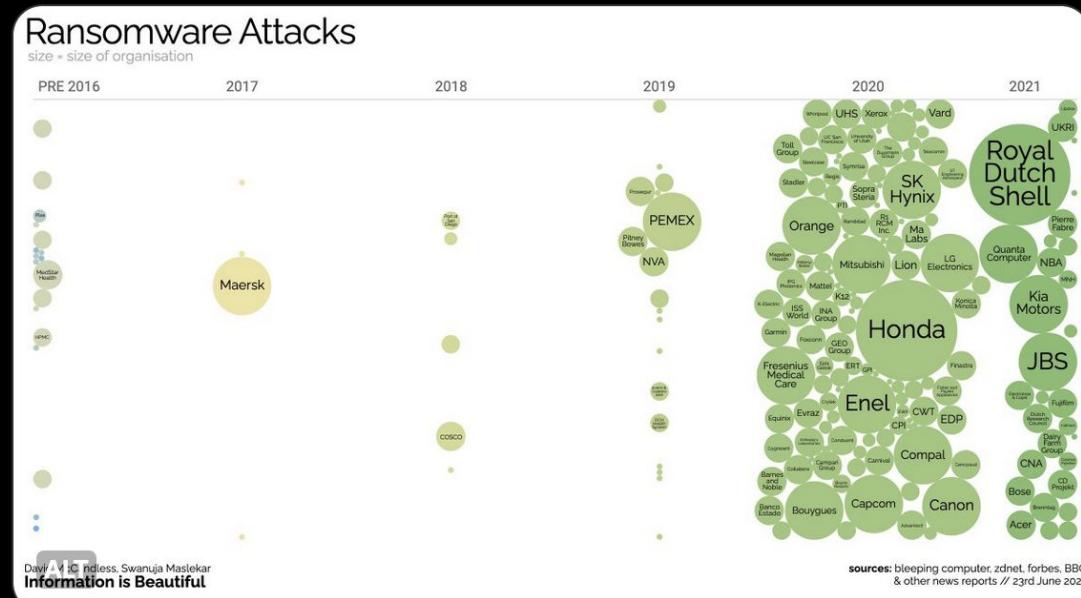


Information is Beautiful
@infobeautiful

2

Are #Ransomware attacks increasing? I think #Ransomware attacks are increasing...

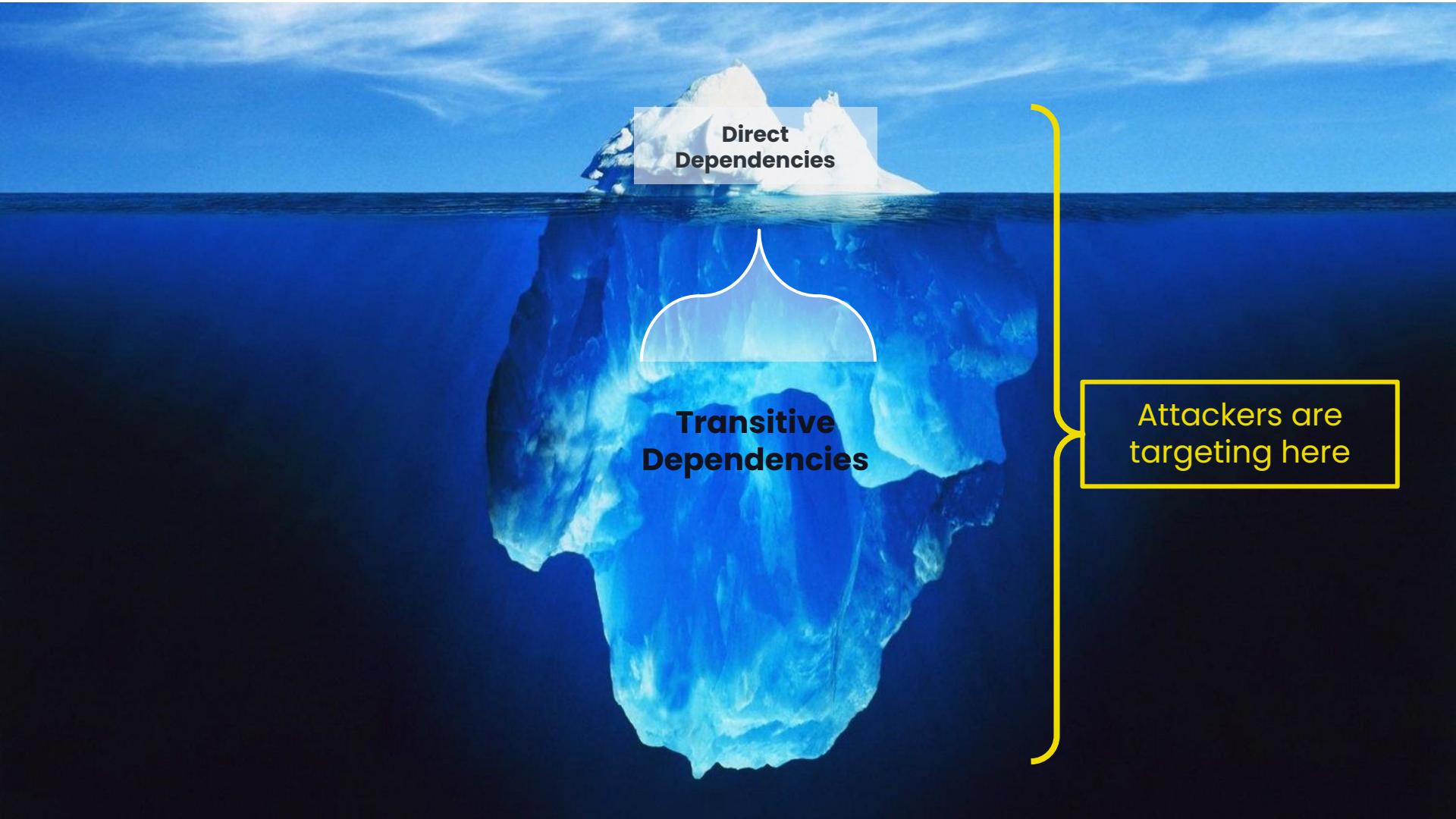
interactive: bit.ly/3h1lYPs



The predictable consequence

- Ransomware has exploded along with transitive dependencies and open source in general
- I don't believe in coincidences





Direct
Dependencies

Transitive
Dependencies

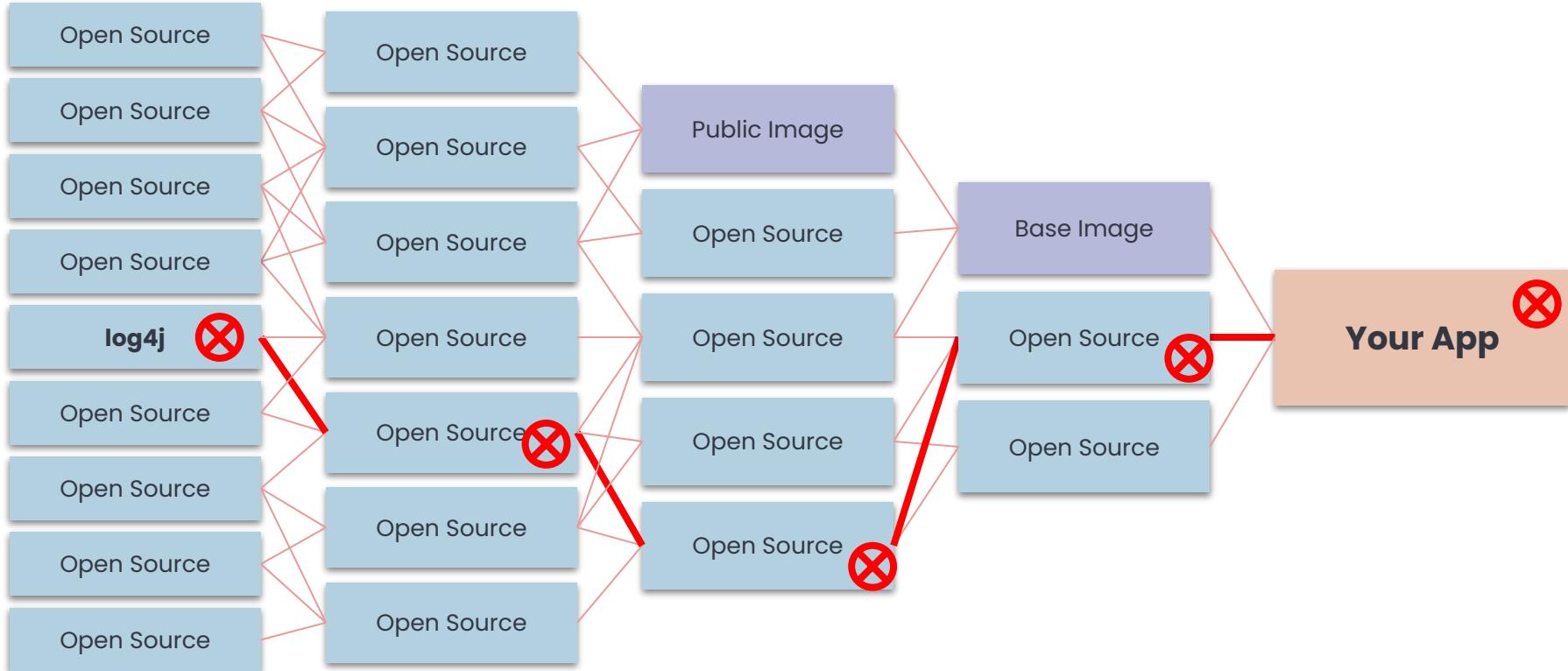
Attackers are
targeting here

If We Knew What We are Consuming

- People spent insane amounts of time just finding log4j, because nobody knew where (or even if) it was hiding
- Knowing = Faster Remediation
- SBOMs help, a LOT, but... “a phone book is not illuminating”
 - They aren’t a silver bullet
 - Scanners aren’t perfect (e.g. can’t penetrate binary blobs, cf. OpenSSL3.)
 - Not all SBOMs are equal
 - SBOMs aren’t ubiquitous (yet) (producers aren’t reliably supplying them)
 - SBOMs are more accurate and useful when producers/maintainers generate them
BUT something is better than nothing
 - SBOM management is hard
 - Any SBOM generated before an actual build is suspect (transitive deps)
 - SBOM Everywhere: <https://github.com/ossf/sbom-everywhere>
 - I don’t know what the end game is but generating them is better than nothing, figure out the details later

Software “Supply” Chains

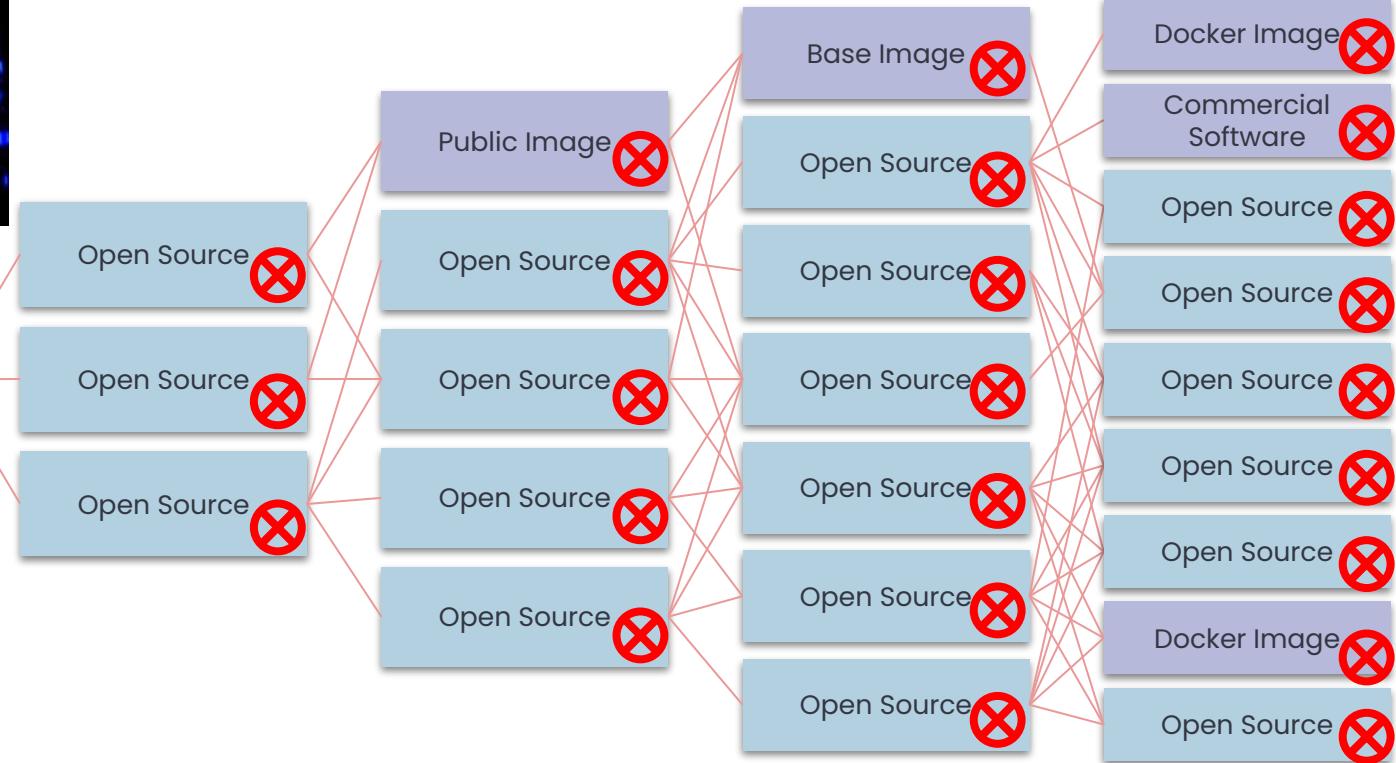
Software “Supply” Chain: The ~~Iceberg~~ Funnel



The Reverse Funnel

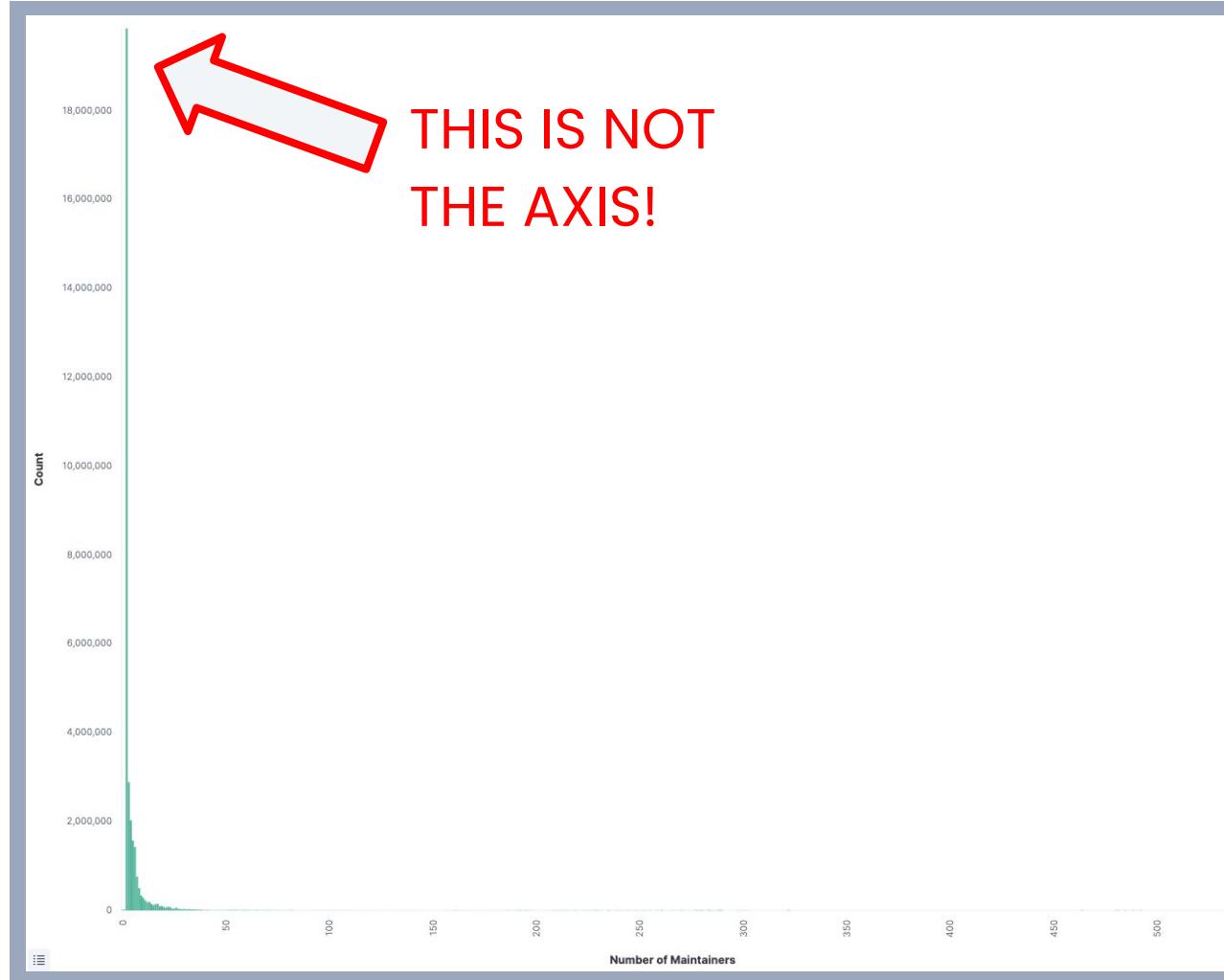


Compromised Package



An Example Project Health Metric:

Number of
Maintainers



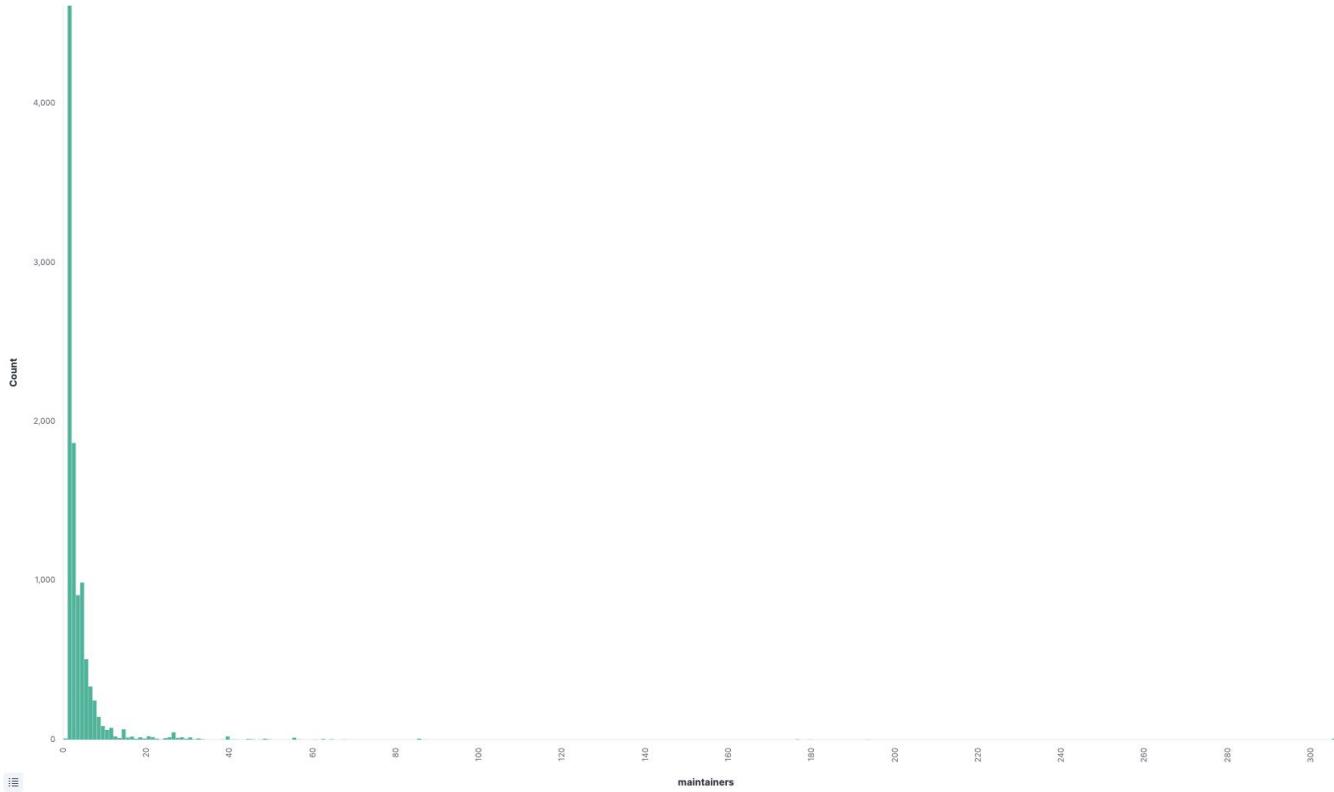
How many people are maintaining these things?



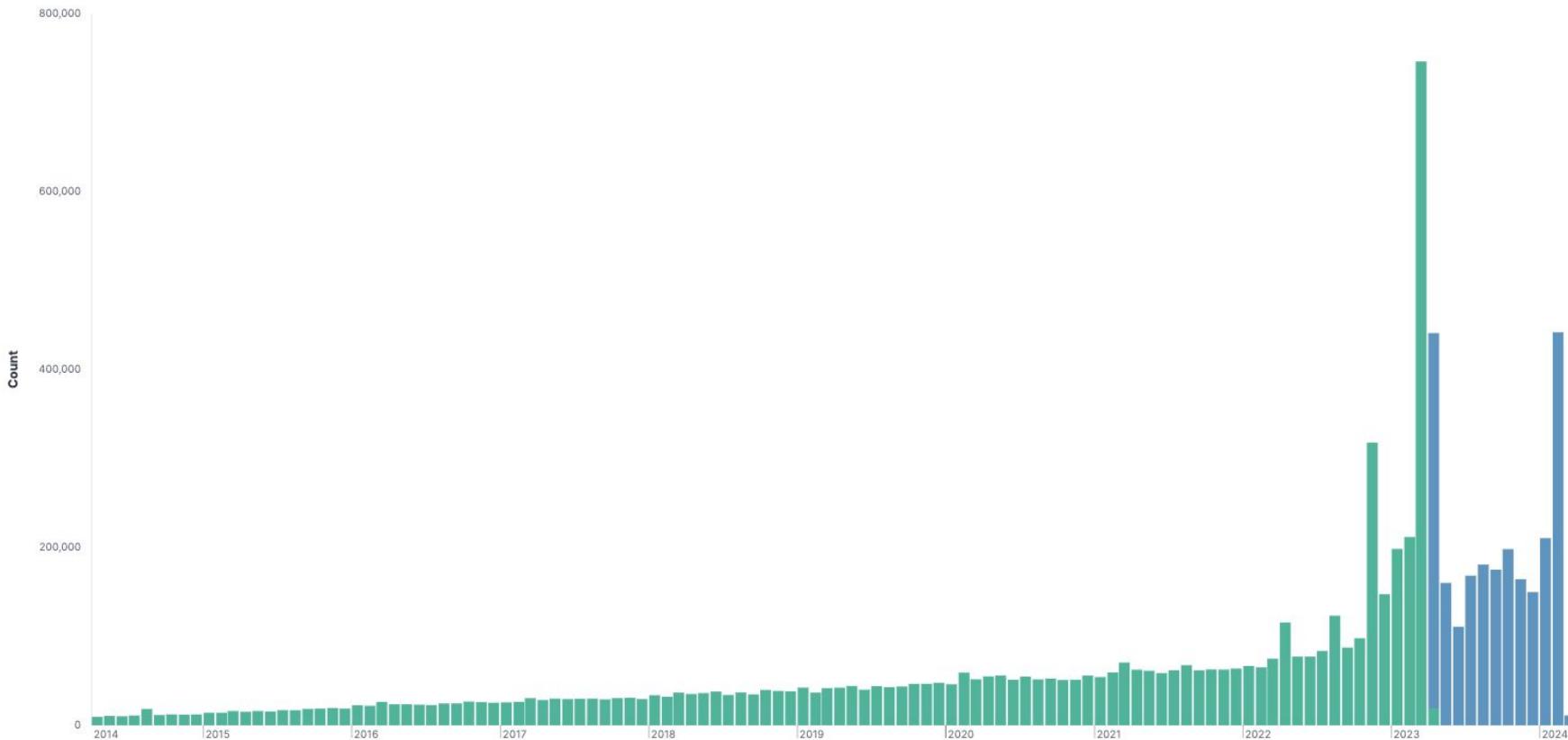
› 100,000 downloads



> 1,000,000 downloads



How many packages are more than a year old?





daniel:// stenberg://

@bagder

...

If you are a multi billion dollar company and are concerned about log4j, why not just email OSS authors you never paid anything and demand a response for free within 24 hours with lots of info? (company name redacted for *my* peace of mind)

Dear Haxx Team Partner,

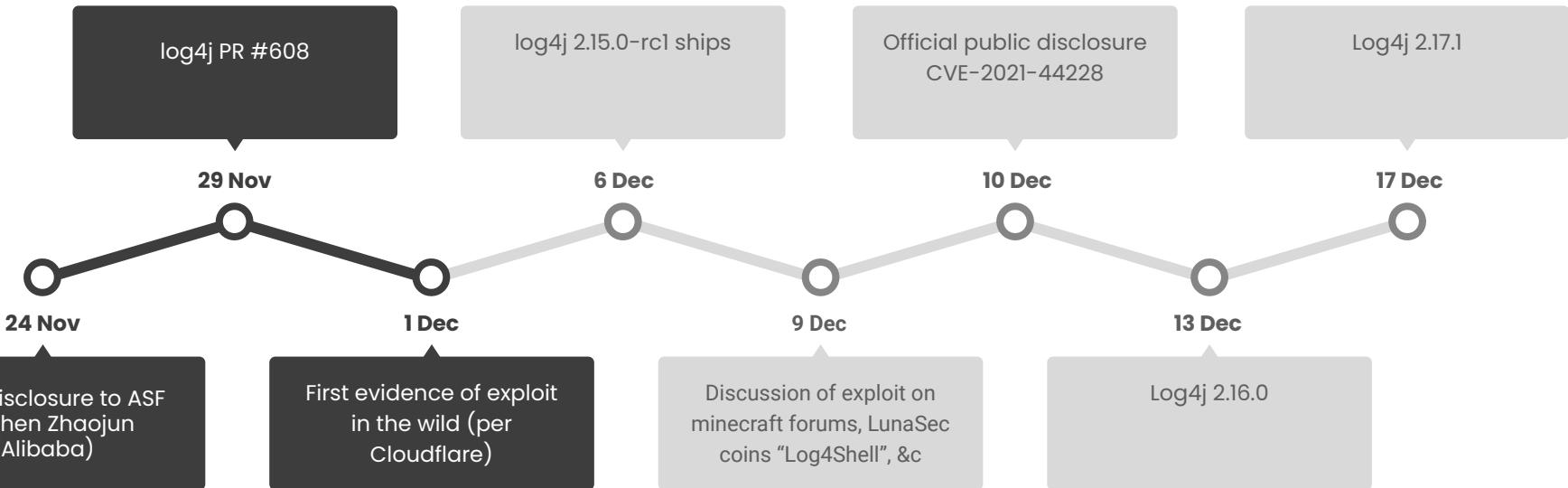
You are receiving this message because [REDACTED] uses a product you developed. We request you review and respond within 24 hours of receiving this email. If you are not the right person, please forward this message to the appropriate contact.

As you may already be aware, a newly discovered zero-day vulnerability is currently impacting Java logging library Apache Log4j globally, potentially allowing attackers to gain full control of affected servers.

The security and protection of our customers' confidential information is our top priority. As a key partner in serving our customers, we need to understand your risk and mitigation plans for this vulnerability.

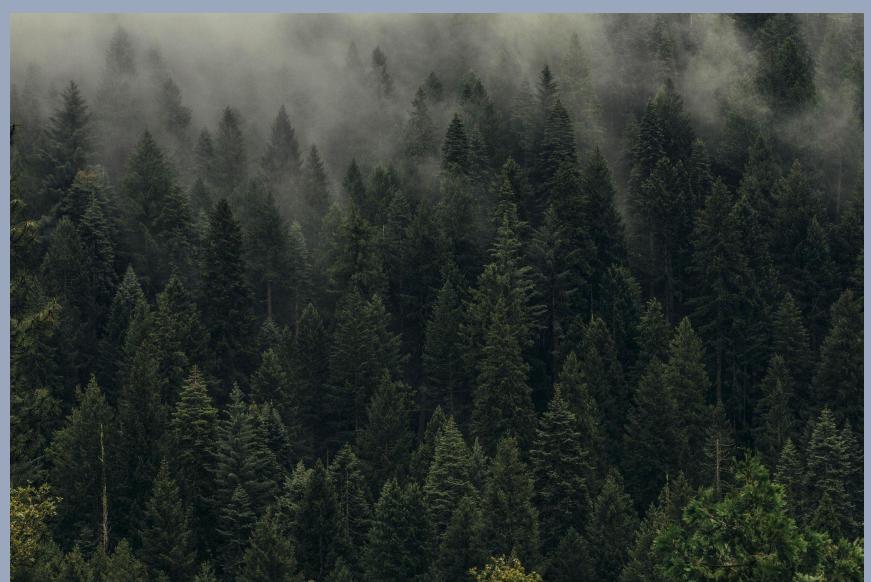
Please respond to the following questions using the template provided below.

log4shell Timeline



Stop thinking about open source like a vendor

This



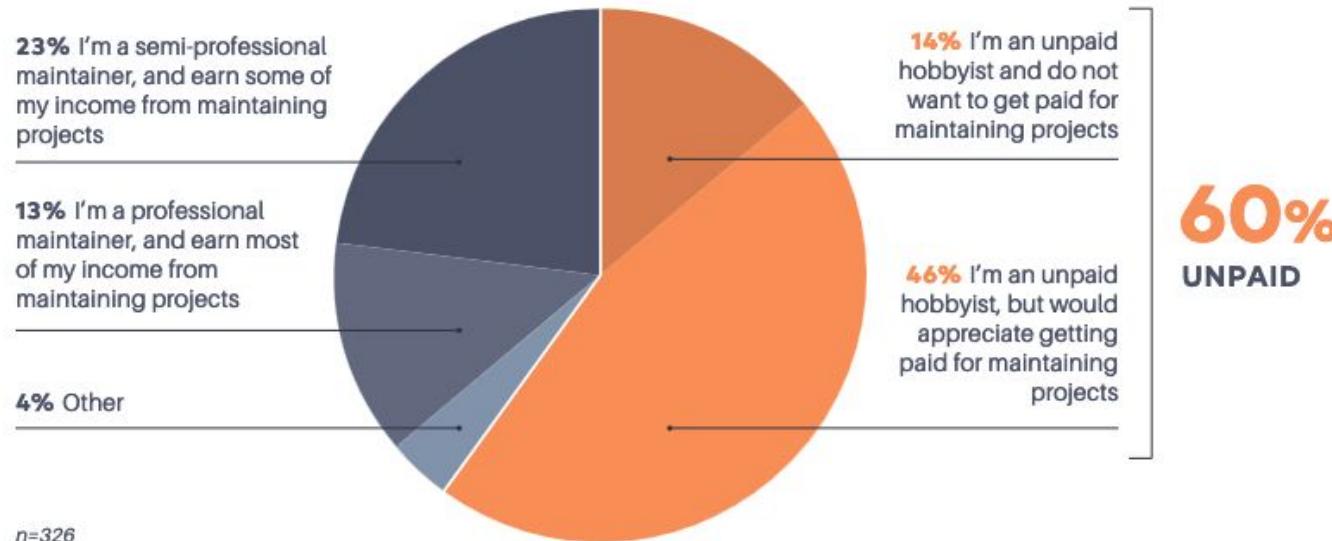
Not this



Who is doing this?

60% of maintainers describe themselves as unpaid hobbyists

Which of the following phrases best describes how you approach your role as an open source maintainer?



Credit: Tidelift 2023 Open Source Maintainer Survey

Summary of Software Supply Chains

- Red Hat is a supplier - they assume responsibility in exchange for money
- npm is NOT a supplier
- A lot of critical plumbing is maintained by unpaid guys who have day jobs, take vacations, etc.

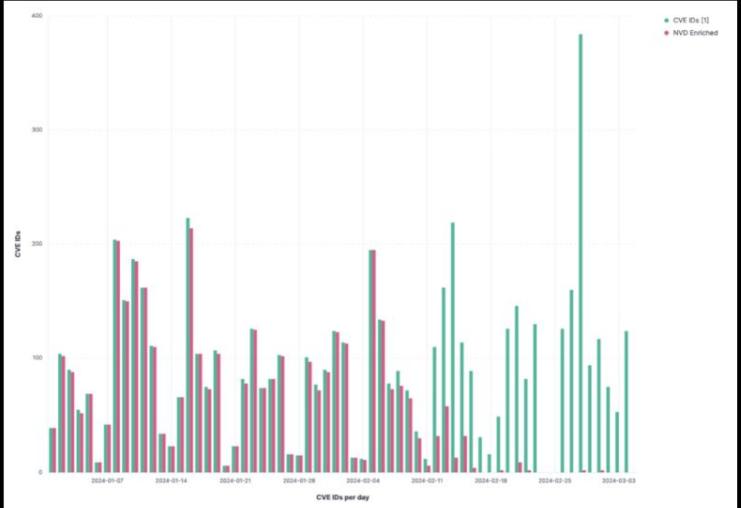
New Developments

NATIONAL VULNERABILITY DATABASE



NOTICE

NIST is currently working to establish a consortium to address challenges in the NVD program and develop improved tools and methods. You will temporarily see delays in analysis efforts during this transition. We apologize for the inconvenience and ask for your patience as we work to improve the NVD program.



BLEEPINGCOMPUTER

NEWS

Top.gg supply chain attack highlights subtle risks

> Hacke

Threat actors used fake Python infrastructure and cookie stealing to poison multiple GitHub code repositories, putting another spotlight on supply chain risks.

By Alexander Culafi, Senior News Writer | Beth Pariseau, Senior News Writer

Published: 26 Mar 2024

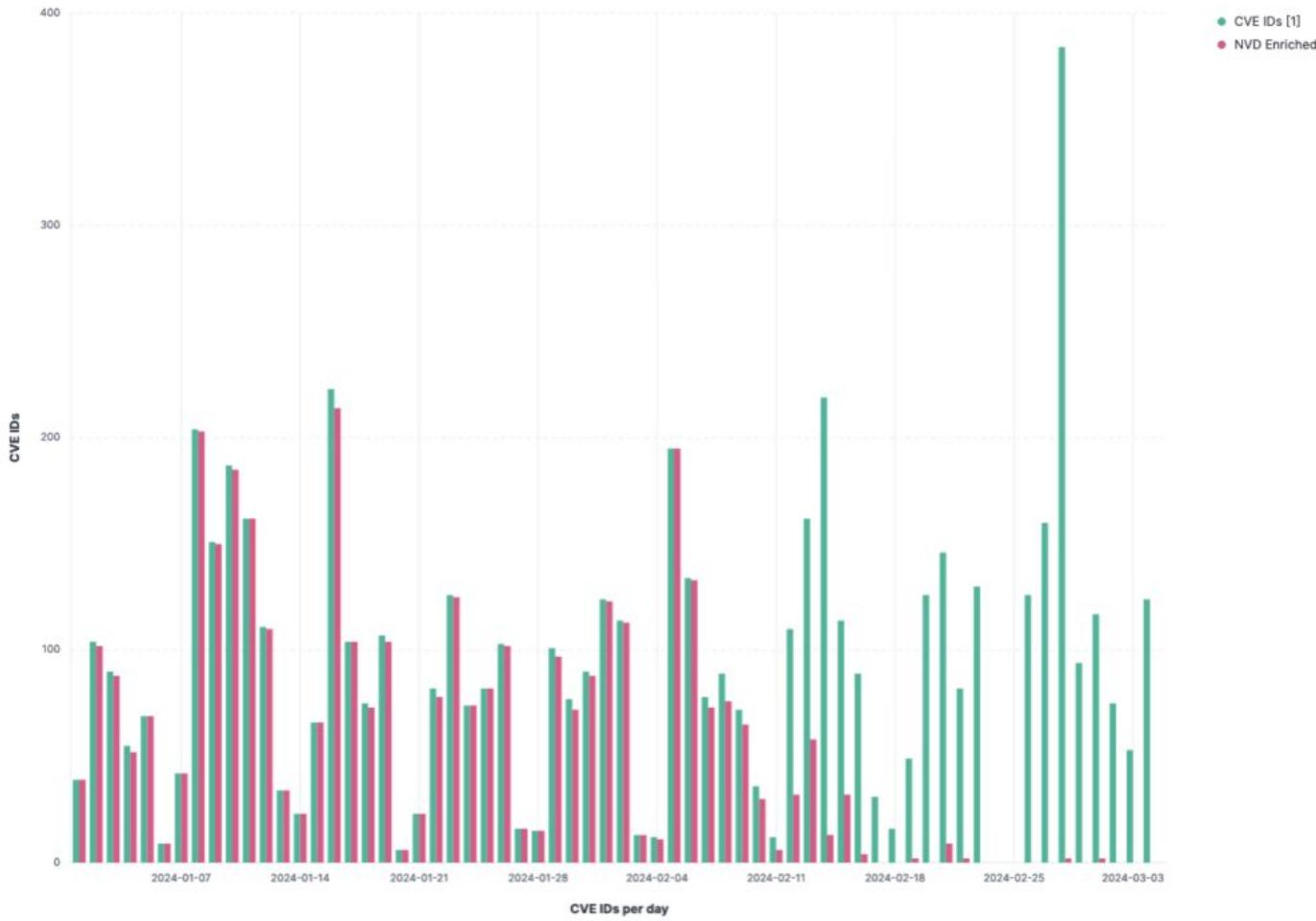
Hackers poison source code from largest Discord bot platform

By Bill Toulas



March 2024 was wild

- NVD Chaos (started mid-Feb, noticed early March)
- top.gg python-sdk poisoned (discovered mid March)
- xz backdoor (discovered late March)



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NEWS

[Home](#)[Hack](#)

Top.gg supply chain attack highlights subtle risks

Threat actors used fake Python infrastructure and cookie stealing to poison multiple GitHub code repositories, putting another spotlight on supply chain risks.

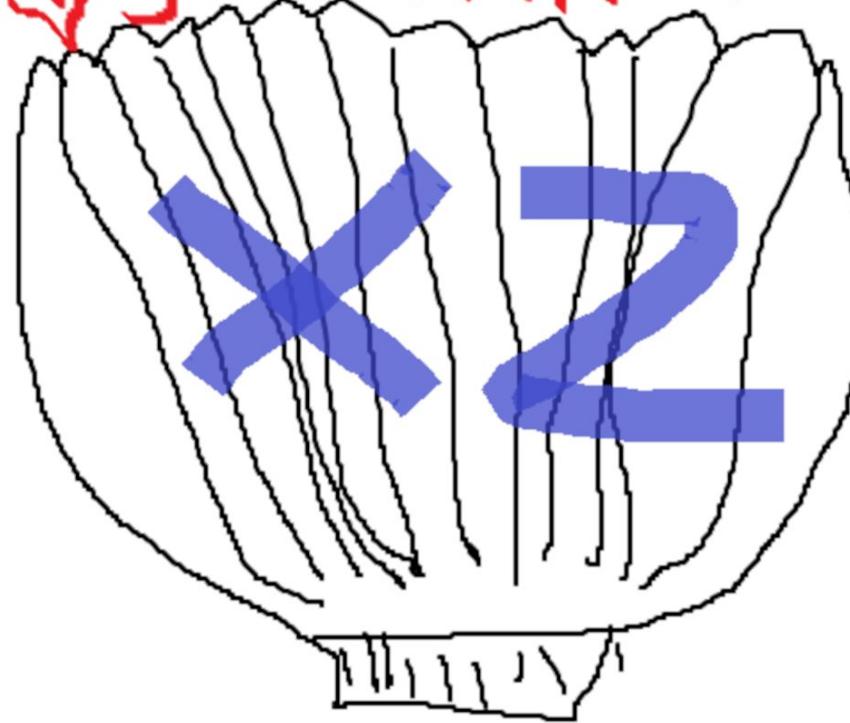
By [Alexander Culafi](#), Senior News Writer | [Beth Pariseau](#), Senior News Writer

Published: 26 Mar 2024

Hackers poison source code from largest Discord bot platform

By [Bill Toulas](#)

QJIA TAN ❤



Three Big Things

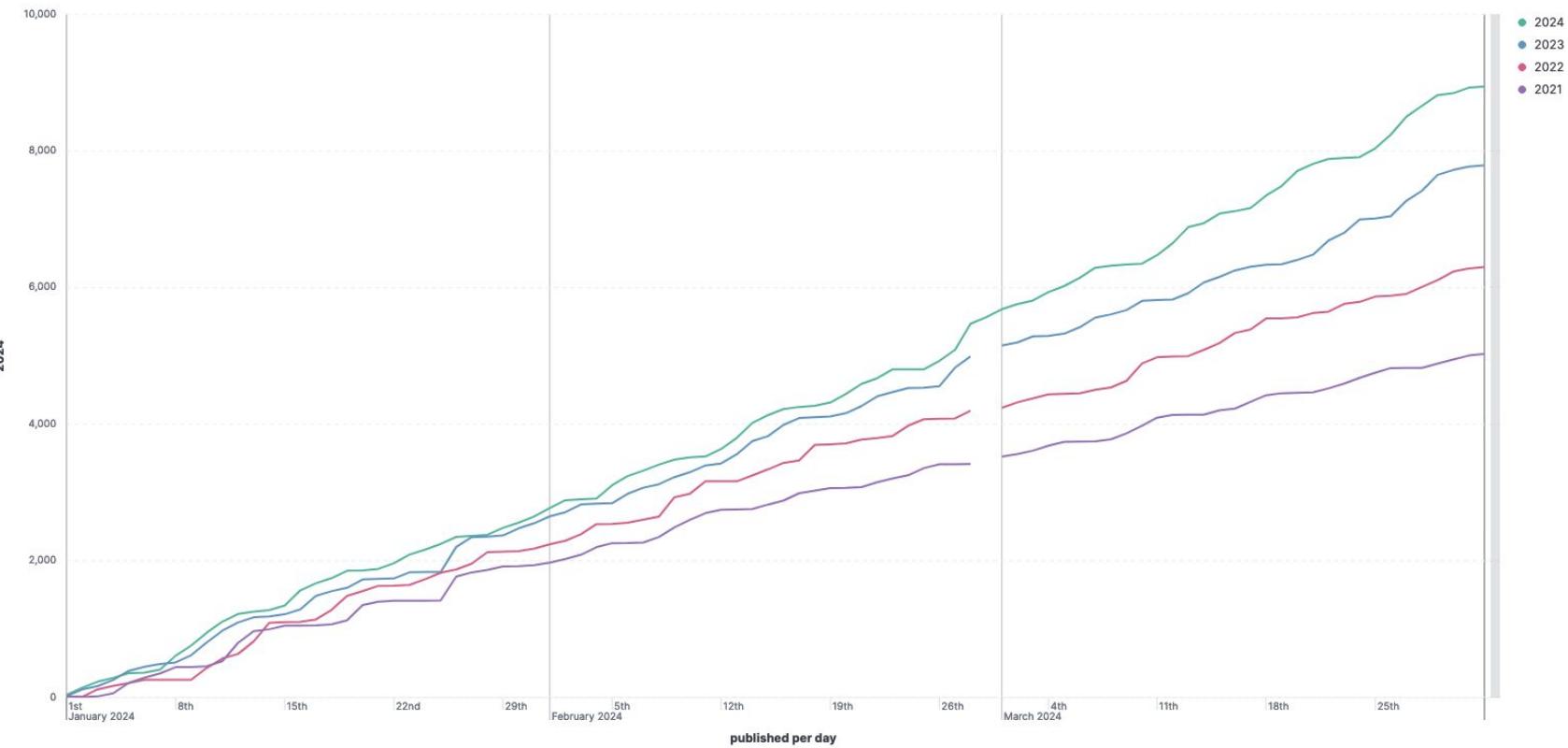
CVE-2020-19909

On August 25 2023, we got [an email to the curl-library mailing list](#) from Samuel Henrique that informed us that “someone” had recently created a CVE, a security vulnerability identification number and report really, for a curl problem.

I wanted to let you know that there's a recent curl CVE published and it doesn't look like it was acknowledged by the curl authors since it's not mentioned in the curl website: CVE-2020-19909

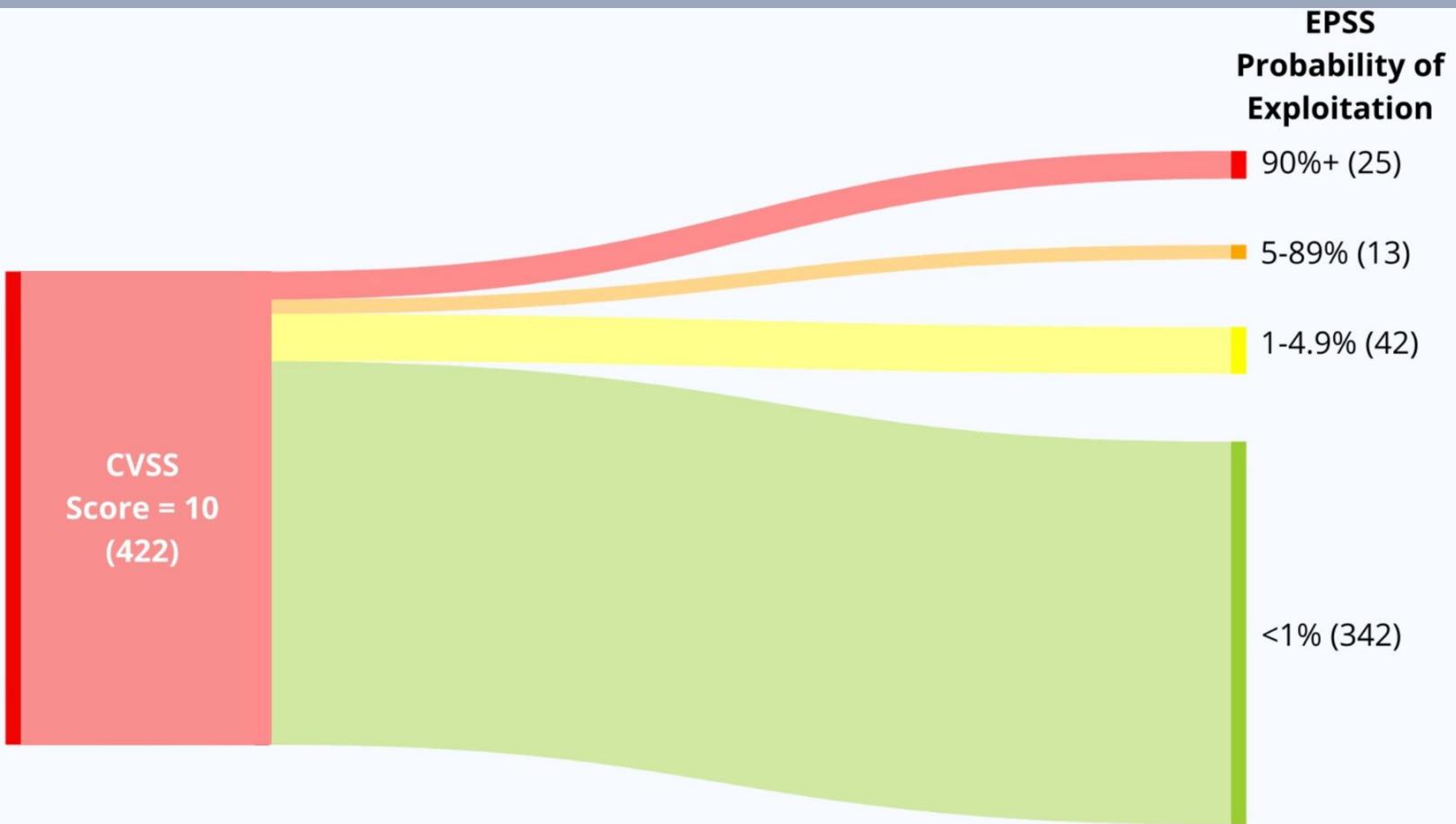
We can't tell who filed it. We just know that it is now there.

CVE by year



Big Thing #1: If Not CVE/cvss, Then What?

- GHSAs (more transparent than CVEs)
- CISA KEV, EPSS, VEX, CSAF, &c
- OpenSSF Malicious Packages Repository
- GitHub Insights and other project health metrics
 - This is (currently) a very manual process
 - But it's getting a lot easier



Big Thing #2: Project Health/Insights

- This is PROACTIVE (the better advisory data, scoring etc is about reactive improvements)
- This is (currently) a manual process (getting easier)
- Evaluating project health isn't directly about safety, it's about tracking all of those deps in the iceberg,
- Are the projects you're depending on healthy, will you be able to work with them?



- Pulse
- Contributors
- Community Standards
- Commits
- Code frequency
- Dependency graph
- Network
- Forks

September 4, 2023 – September 11, 2023

Period: 1 week ▾

Overview

20 Active pull requests**13 Active issues**

↳ 16

Merged pull requests

↳ 4

Open pull requests

↳ 6

Closed issues

↳ 7

New issues

Excluding merges, **9 authors** have pushed **16 commits** to main and **21 commits** to all branches. On main, **20 files** have changed and there have been **240 additions** and **124 deletions**.



↳ 1 Release published by 1 person

↳ v0.90.0

published 3 hours ago

↳ 16 Pull requests merged by 7 people

↳ fix the help output of power-user

#2113 merged 8 hours ago

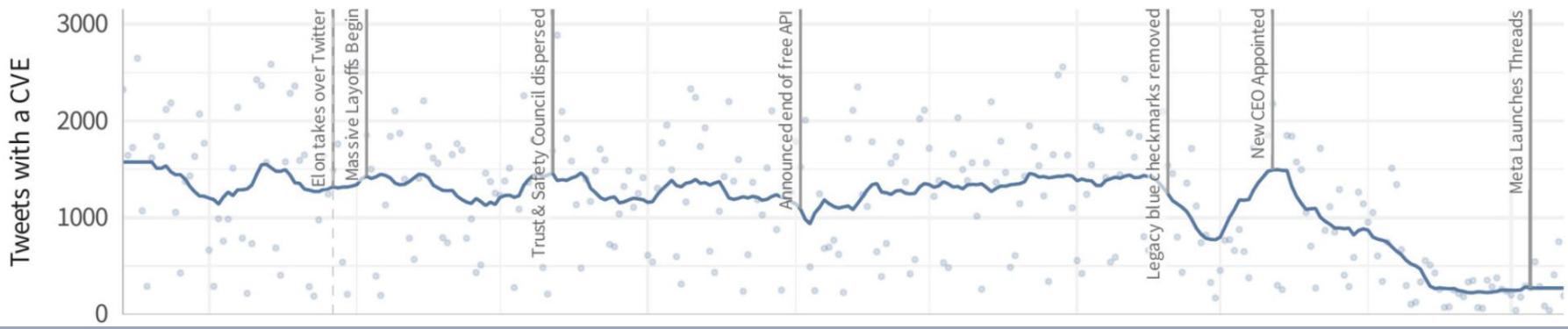
Big Thing #3: Supply Chain Attacks Ascendant

- Open Source has gotten so big that opportunistic, financially-motivated attackers are extremely incentivized to focus on it
- Supply chain attacks are reusable
- Even state-sponsored attackers can't ignore it
- Scale means that it's often useful even to get to particular targets

Bonus Thing: Infosec Twitter is Dead

- Twitter was incredibly central to Log4Shell reaction, forming consensus, and generally just figuring out what was happening
- If log4shell dropped today, this reaction/recovery would be notably worse because of infosec splintering to (e.g.) mastodon, linkedin, bsky, threads
- None of these networks have the critical mass that Twitter had and it doesn't seem to be improving

Infosec Twitter activity: Sep 13, 2022 to July 12, 2023



This seems really bad

1. Well it's not great
2. But things are mostly working OK
3. Open source adapts

Open source is different

There's nothing wrong with open source, this is how it works

There's something wrong with what we expect from open source

Big Changes

1. Better metrics and data sources are coming
2. Tracking dependencies is more proactive
3. Supply chain attacks are here to stay
4. Twitter is Over

Call to Action

SBOM Everywhere: <https://github.com/ossf/sbom-everywhere>

I don't know what the end game is but generating them is better than nothing, figure out the details later

The (first two) "big things" are still very embryonic and probably not ready for prime time but tools are starting to adopt a lot of this

SBOMs: <https://github.com/anchore/syft>

Vulnerabilities: <https://github.com/anchore/grype>

Webinars: <https://anchore.com/webinars/>

Recap

- Log4Shell is radioactive and immortal
- How software gets made has changed
- We don't know what's in our software
- We don't know who is supplying it
- We have to change how we evaluate it
- GitHub is uniquely positioned
- Try to be proactive

Q&A

Our open source projects:

<https://github.com/anchore/syft>

<https://github.com/anchore/grype>

<https://github.com/anchore/grant>

Get an invite to our open source community Slack:

<https://anchore.com/slack/>

These slides are archived:

<https://github.com/pnovarese/2024-04-legacy-of-log4shell>

Notes, &c.

Footnotes

Log4Shell's immortality:

<https://www.zdnet.com/article/log4j-flaw-why-it-will-still-be-causing-problems-a-decade-from-now/>

<https://securityintelligence.com/articles/log4j-downloads-vulnerable/>

possible origin of the iceberg - <https://www.slideshare.net/loriayre/open-source-library-system-software-free-is-just-the-tip-of-the-iceberg>

Open Source is Bigger Than You Can Imagine - <https://anchore.com/blog/open-source-is-bigger-than-you-imagine/>

log4j survey etc - <https://anchore.com/log4j/>

Half Day Vulnerabilities - <https://github.com/Aqua-Nautilus/CVE-Half-Day-Watcher>

The Death of Infosec Twitter - <https://www.cyentia.com/the-death-of-infosec-twitter/>

Patrick Garrity discussing EPSS and Improved Metrics:

https://www.linkedin.com/posts/patrickmgarrity_the-evolution-of-patrick-s-sankey-matics-activity-7118334146728357888-zxxn/

Various tweets &c:

<https://twitter.com/CubicleApril/status/1469825942684160004>

https://www.linkedin.com/posts/novarese_log4j-log4shell-activity-6876206319238463488-8bEA

<https://twitter.com/bagder/status/1484672924036616195>

<https://lists.haxx.se/pipermail/daniel/2023-September/000032.html>

Projects and Data Sources

OpenSSF Malicious Packages Repository:

<https://openSSF.org/blog/2023/10/12/introducing-openssf-malicious-packages-repository/>

Common Security Advisory Framework:

<https://oasis-open.github.io/csaf-documentation/>

Exploit Prediction Scoring System:

<https://www.first.org/epss/>

CISA Known Exploited Vulnerability Catalog:

<https://www.cisa.gov/known-exploited-vulnerabilities-catalog>

Vulnerability Exploitability Exchange:

<https://cyclonedx.org/capabilities/vex/>

GitHub Advisory Database:

<https://github.com/advisories>

GitHub Insights:

<https://docs.github.com/en/issues/planning-and-tracking-with-projects/viewing-insights-from-your-project/about-insights-for-projects>

Open Source Insights:

<https://deps.dev/>

Reading List

Filling the NVD data gap

<https://github.com/anchore/nvd-data-overrides>

NVD Chaos Podcast

<https://resiliencycyber.substack.com/p/s6ell-josh-bressers-and-dan-loren>

Identifying Software

<https://guix.gnu.org/en/blog/2024/identifying-software/>

CVEs CWEs CVSS and It's Discontents:

<https://www.linkedin.com/pulse/cves-cwes-cvss-its-discontents-sherif-mansour>

Open Source Security Podcast Episode 392 – Curl and the calamity of CVE:

<https://openourcesecurity.io/2023/09/10/episode-392-curl-and-the-calamity-of-cve/>

I am not a Supplier::

<https://www.softwaremaxims.com/blog/not-a-supplier>

<https://openourcesecuritypodcast.libsyn.com/episode-365-i-am-not-your-supplier-with-thomas-depierre>

Shedding Light on CVSS Scoring Inconsistencies:

<https://arxiv.org/abs/2308.15259>

My previous DevOpsDays 2022 talk (Learn From Log4Shell):

https://www.youtube.com/watch?v=PlNtIL_oN0k

<https://github.com/pnovarese/2022-devopsdays>

Probably Don't Rely on EPSS Yet:

<https://insights.sei.cmu.edu/blog/probably-dont-rely-on-epss-yet/>

CVE-2020-19909 is everything that is wrong with CVEs:

<https://daniel.haxx.se/blog/2023/08/26/cve-2020-19909-is-everything-that-is-wrong-with-cves/>

Do SBOMS Need VEX?:

https://www.linkedin.com/posts/aph10_sbom-softwaresupplychainsecurity-vex-activity-7108017924384137216-VARV/

A Study on Navigating Open-Source Dependency Abandonment:

<https://courtney-e-miller.github.io/static/media/WeFeelLikeWereWingingIt.dc3c76d3b3c2d12f4fee.pdf>

xz Reading List

Technologist vs spy: the xz backdoor debate

<https://lcamtuf.substack.com/p/technologist-vs-spy-the-xz-backdoor>

General xz roundups

<https://boehs.org/node/everything-i-know-about-the-xz-backdoor>

<https://arstechnica.com/security/2024/04/what-we-know-about-the-xz-utils-backdoor-hat-almost-infected-the-world/>

faq on the xz compromise/backdoor CVE-2024-3094

<https://gist.github.com/thesamesam/223949d5a074ebc3dce9ee78baad9e27>

examination of claims of technical solutions to xz and why they're wrong

<https://federated.saagarjha.com/notice/AgPahhBPr9HXMAPWi>

OSS backdoors: the folly of the easy fix

<https://lcamtuf.substack.com/p/oss-backdoors-the-allure-of-the-easy>

deep inspection of the backdoor injection

<https://research.swtch.com/xz-script>

<https://gynvael.coldwind.pl/?lang=en&id=782>

interactions in open source projects (examination of xz infiltration)

<https://robmensching.com/blog/posts/2024/03/30/a-microcosm-of-the-interactions-in-open-source-projects/>

thread from november 2023 theorizing about a long con threat actor assuming control of a major project

<https://infosec.exchange/@mariuxdeangelo/111348817163534252>

thread exploring pressure on xz maintainer to hand off control of the project

<https://twitter.com/robmen/status/1774067844785086775>

bullying as a vulnerability in open source

<https://www.404media.co/xz-backdoor-bullying-in-open-source-software-is-a-massive-security-vulnerability/>

tracking jai tan's commit timestamps

<https://twitter.com/birchb0y/status/1773871381890924872>

examining Jia Tan's complete github commit history

<https://huntedlabs.com/where-the-wild-things-are-a-complete-analysis-of-jiat95-github-history>

looking into the "Jia Tan" persona

<https://www.wired.com/story/jia-tan-xz-backdoor/>

Sloppy OpenSSF statement (later redacted) implying Scorecard indicated xz issues

<https://web.archive.org/web/2024031024907/https://openssf.org/blog/2024/03/30/xz-backdoor-cve-2024-3094/>

Lessons from XZ Utils: Achieving a More Sustainable Open Source Ecosystem

<https://www.cisa.gov/news-events/news/lessons-xz-utils-achieving-more-sustainable-open-source-ecosystem>

Supply Chains Reading List

Hackers poison source code from largest Discord bot platform

<https://www.bleepingcomputer.com/news/security/hackers-poison-source-code-from-largest-discord-bot-platform/>

Overcoming Software Supply Chain Attacks

<https://blog.karambit.ai/overcoming-software-supply-chain-attacks-c8746a0236ab>

iconburst NPM supply chain attack

<https://www.scmagazine.com/news/iconburst-supply-chain-attack-uses-typo-squatting-to-spread-malicious-javascript-packages-via-npm>

Deceptive Deprecation: The Truth About npm Deprecated Packages

<https://blog.aquasec.com/deceptive-deprecation-the-truth-about-npm-deprecated-packages>

aquasec/CIS supply chain security guide

<https://www.aquasec.com/news/software-supply-chain-security-guide-cis-aqua-security/>

OWASP kube top ten risks #2: supply chain vulnerabilities

<https://github.com/OWASP/www-project-kubernetes-top-ten/blob/main/2022/en/src/k02-supply-chain-vulnerabilities.md>

Git Checkout Authentication to the Rescue of Supply Chain Security

https://archive.fosdem.org/2023/schedule/event/security_where_does_that_code_come_from/

Software supply chain security practices are maturing — but it's a work in progress

<https://www.reversinglabs.com/blog.openssf-survey-supply-chain-security-practices>

Open Source Supply Chain Security at Google

<https://research.swtch.com/acmscored>

CVE Half-Day Watcher

<https://github.com/Aqua-Nautilus/CVE-Half-Day-Watcher>

State of the Software Supply Chain:

<https://www.sonatype.com/hubfs/9th-Annual-SSSC-Report.pdf>

Few Open Source Projects are Actively Maintained:

<https://www.infoworld.com/article/3708630/report-finds-few-open-source-projects-actively-maintained.html>

The Massive Bug at the Heart of NPM:

<https://blog.vlt.sh/blog/the-massive-hole-in-the-npm-ecosystem>

Log4Shell Reading List

Dealing with log4shell (detection, mitigation, workarounds):

<https://cloudsecurityalliance.org/blog/2021/12/14/dealing-with-log4shell-aka-cve-2021-44228-aka-the-log4j-version-2/>

Keeping up with log4shell (post mortem)

<https://cloudsecurityalliance.org/blog/2021/12/16/keeping-up-with-log4shell-aka-cve-2021-44228-aka-the-log4j-version-2/>

Mysterious tweet hinting at the exploit:

<https://twitter.com/sirifu4k1/status/1468951859381485573>

Another mysterious tweet:

<https://twitter.com/CattusGlavo/status/1469010118163374089>

“THE” pull request:

<https://github.com/apache/logging-log4j2/pull/608>

Cloudflare digs for evidence of pre-disclosure exploits in the wild:

<https://twitter.com/eastdakota/status/1469800951351427073>

Glossary

CVE - Common Vulnerabilities and Exposures - <https://cve.mitre.org/>

CVSS - Common Vulnerability Scoring System - <https://nvd.nist.gov/vuln-metrics/cvss>

CISA - cybersecurity and infrastructure security agency - <https://cisa.gov>

KEV - Known Exploited Vulnerabilities - <https://www.cisa.gov/known-exploited-vulnerabilities-catalog>

EPSS - Exploit Prediction Scoring System - <https://www.first.org/epss/>

SBOM - Software Bill of Materials - <https://www.cisa.gov/sbom>

VEX - Vulnerability Exploitability eXchange - <https://github.com/openvex/spec>

CSAF - Common Security Advisory Framework - <https://oasis-open.github.io/csaf-documentation/>

GHSA - GitHub Security Advisory - <https://github.com/advisories>

OpenSSF - Open Source Security Foundation - <https://openssf.org/>

SBOM Takeaways

00

SBOMs enable continuous, automated security/compliance checks, reduce time spent identifying and remediating issues

01

SBOMs improve a lot of things but do not solve every problem you have

02

Log4j is extremely easy to find, OpenSSL 3 is often obscured

03

SBOMs are more effective when created by maintainers rather than consumers, but something is better than nothing

SBOM Reading List

Making Better SBOMs: <https://kccncna2022.sched.com/event/182GT/> – <https://www.youtube.com/watch?v=earq775L4fc>

Reflections on Trusting Trust: https://www.cs.cmu.edu/~rdriley/487/papers/Thompson_1984_ReflectionsOnTrustingTrust.pdf
<https://web.mit.edu/6.033/2002/wwwdocs/handouts/h25-review2slides2.pdf>

Generate sboms with synt and jenkins: https://www.youtube.com/watch?v=nMlveJ_TxAs

Profound Podcast - Episode 10 (John Willis and Josh Corman):
<https://www.buzzsprout.com/1758599/8761108-profound-dr-deming-episode-10-josh-corman-captain-america>

GitHub Self-Service SBOMs: <https://github.blog/2023-03-28-introducing-self-service-sboms/>