VERACODE

Reviewing NuGet Packages security easily using OpenSSF Scorecard

Niels Tanis
Sr. Principal Security Researcher

NDC { Oslo }

Who am I?

- Niels Tanis
- Sr. Principal Security Researcher
  - Background .NET Development, Pentesting/ethical hacking, and software security consultancy
  - Research on static analysis for .NET apps
  - Enjoying Rust!
- Microsoft MVP – Developer Technologies

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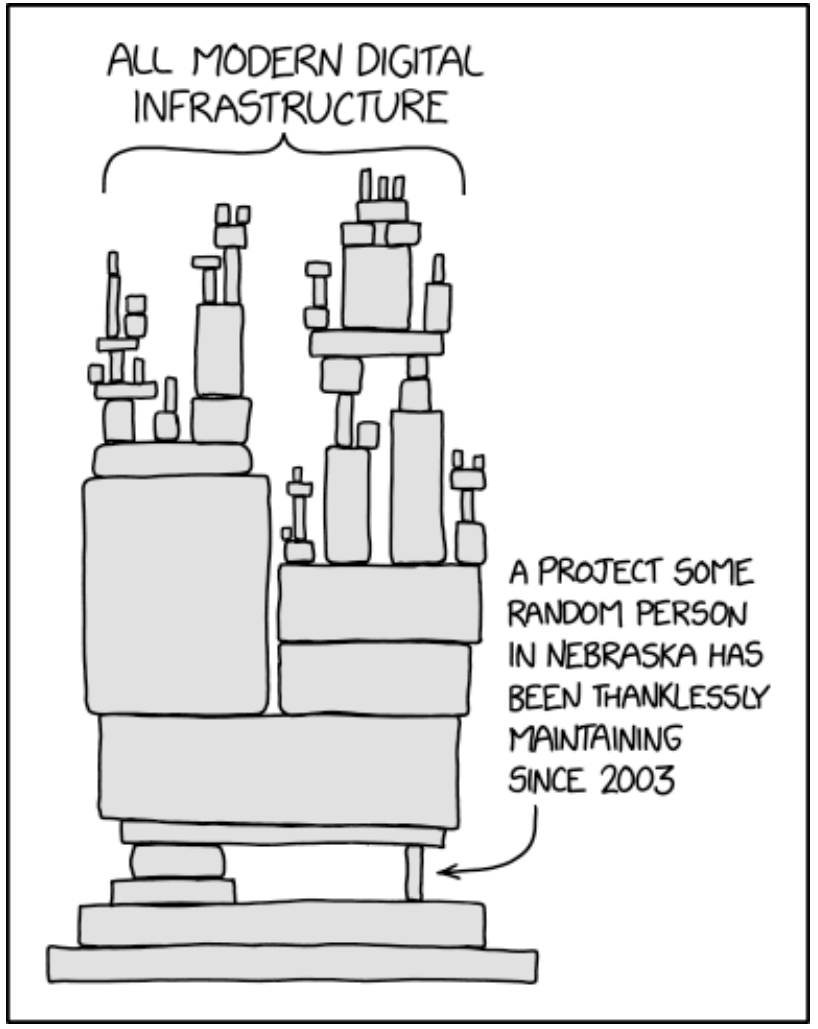
Modern Application Architecture XKCD 2347



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Agenda

- Risks in 3rd party NuGet Packages
- OpenSFF Scorecard
- New & Improved
- Conclusion - Q&A

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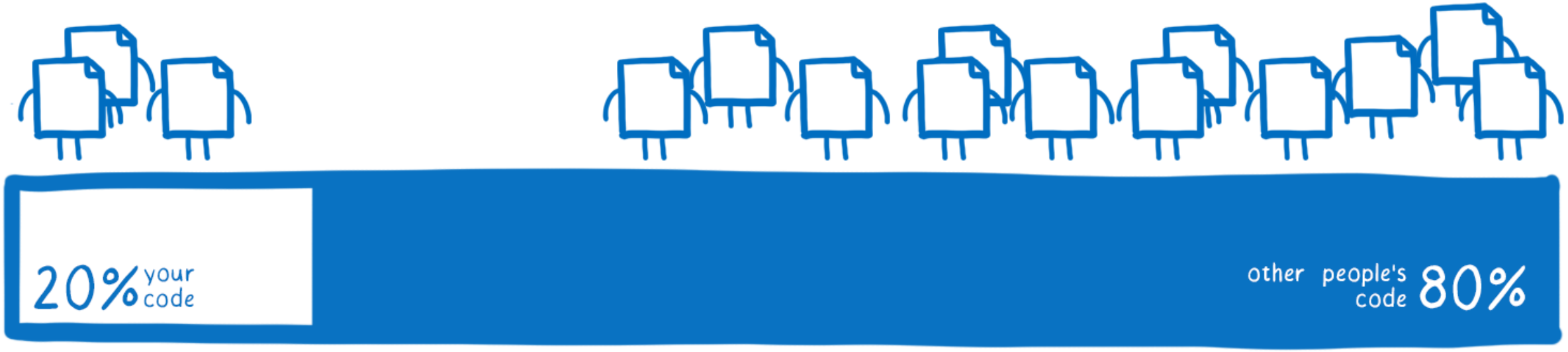
Average codebase composition



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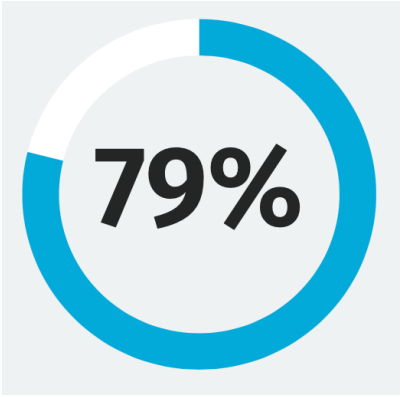
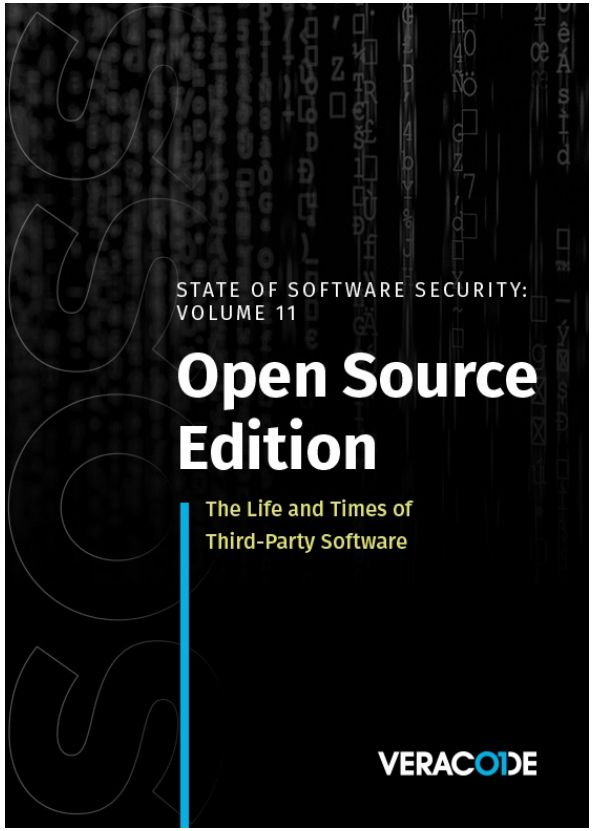
State of Software Security v11

”Despite this dynamic landscape, 79 percent of the time, developers never update third-party libraries after including them in a codebase.”





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State of Log4j – 2 years later

- Analysed our data August-November 2023
  - Total set of almost 39K unique applications scanned
- 2.8% run version vulnerable to Log4Shell
- 3.8% run version patched but vulnerable to other CVE
- 32% rely on a version that's end-of-life and have no support for any patches.

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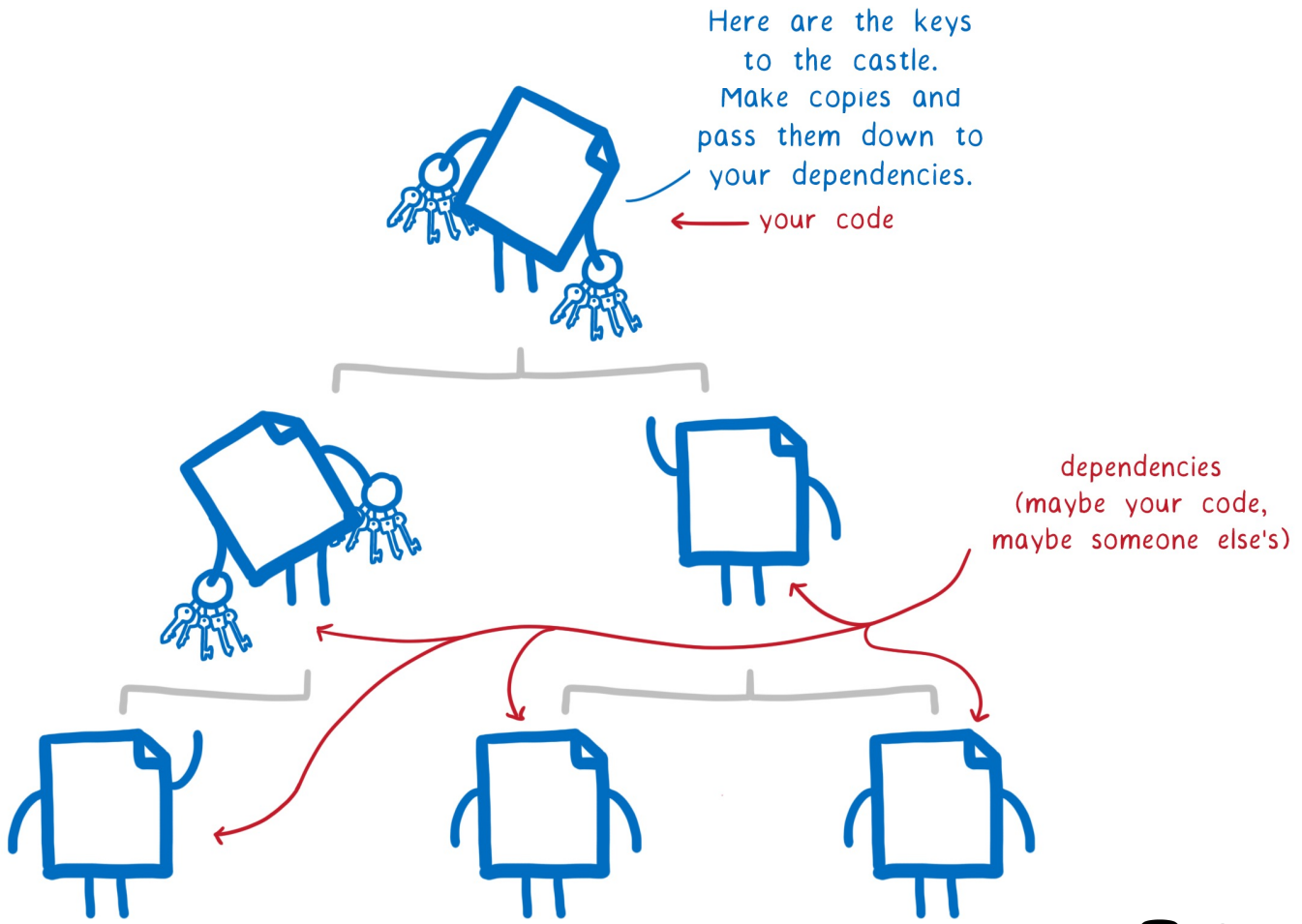
Average codebase composition



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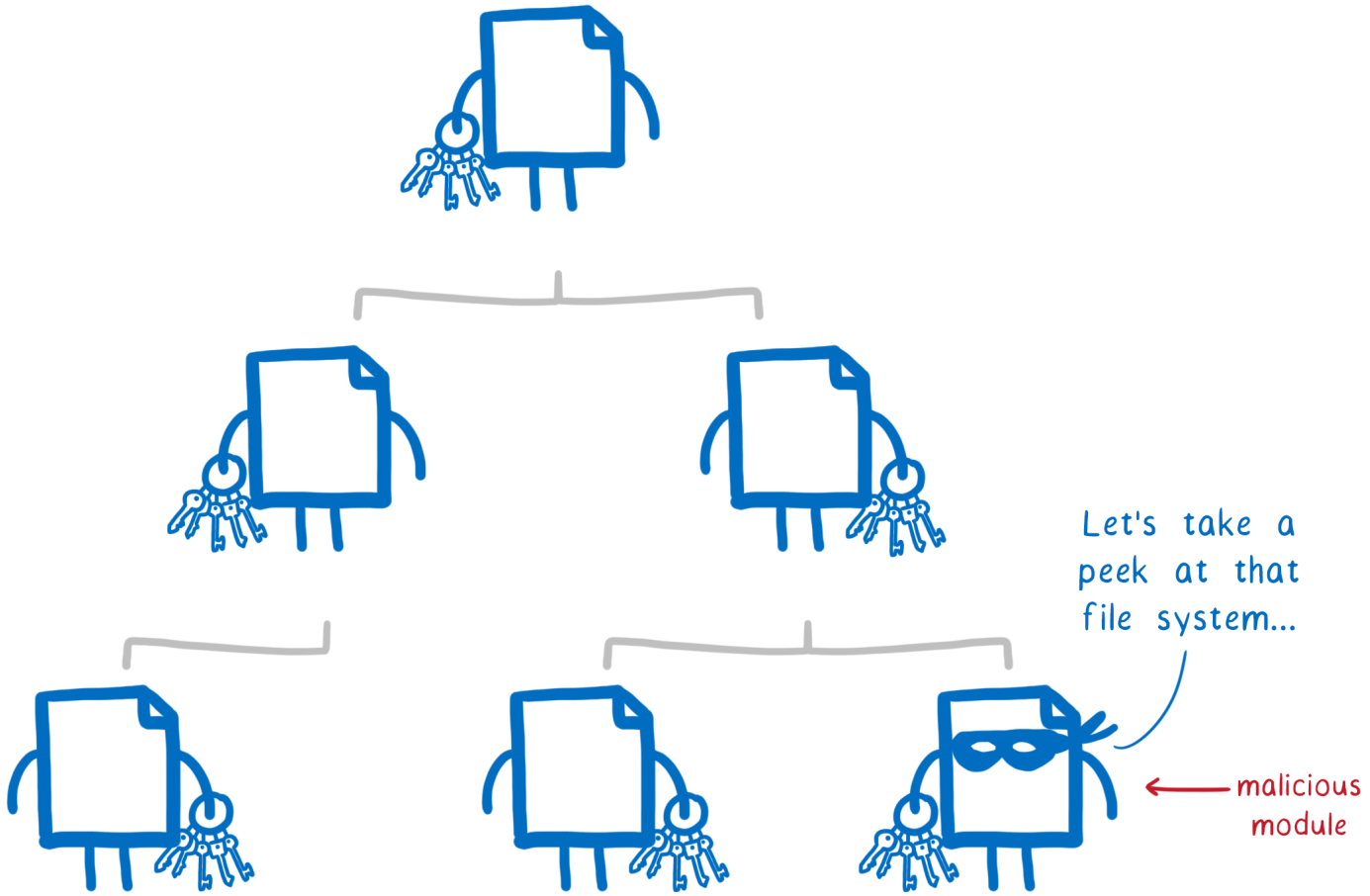
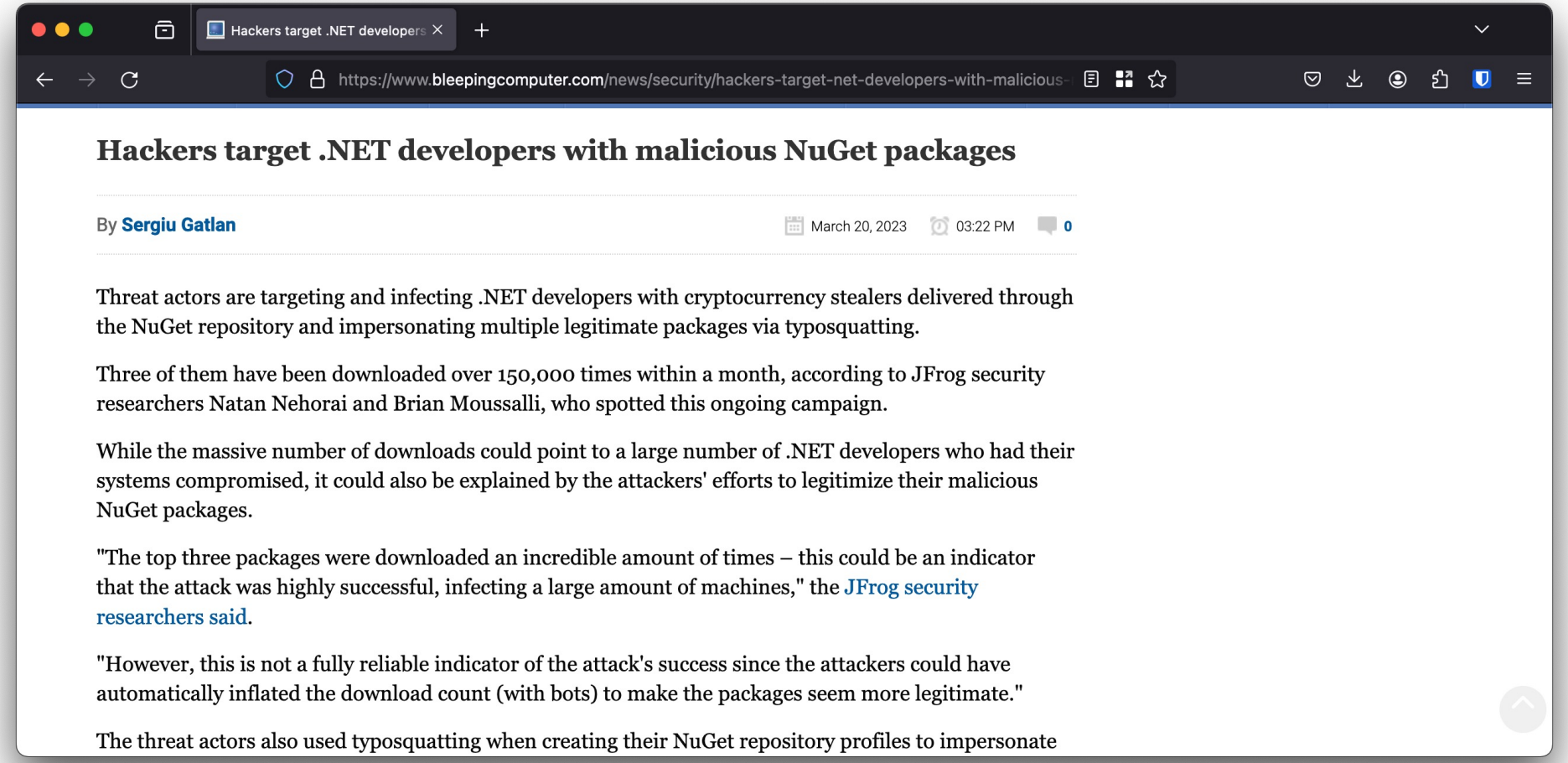
Malicious Assembly



Malicious Package



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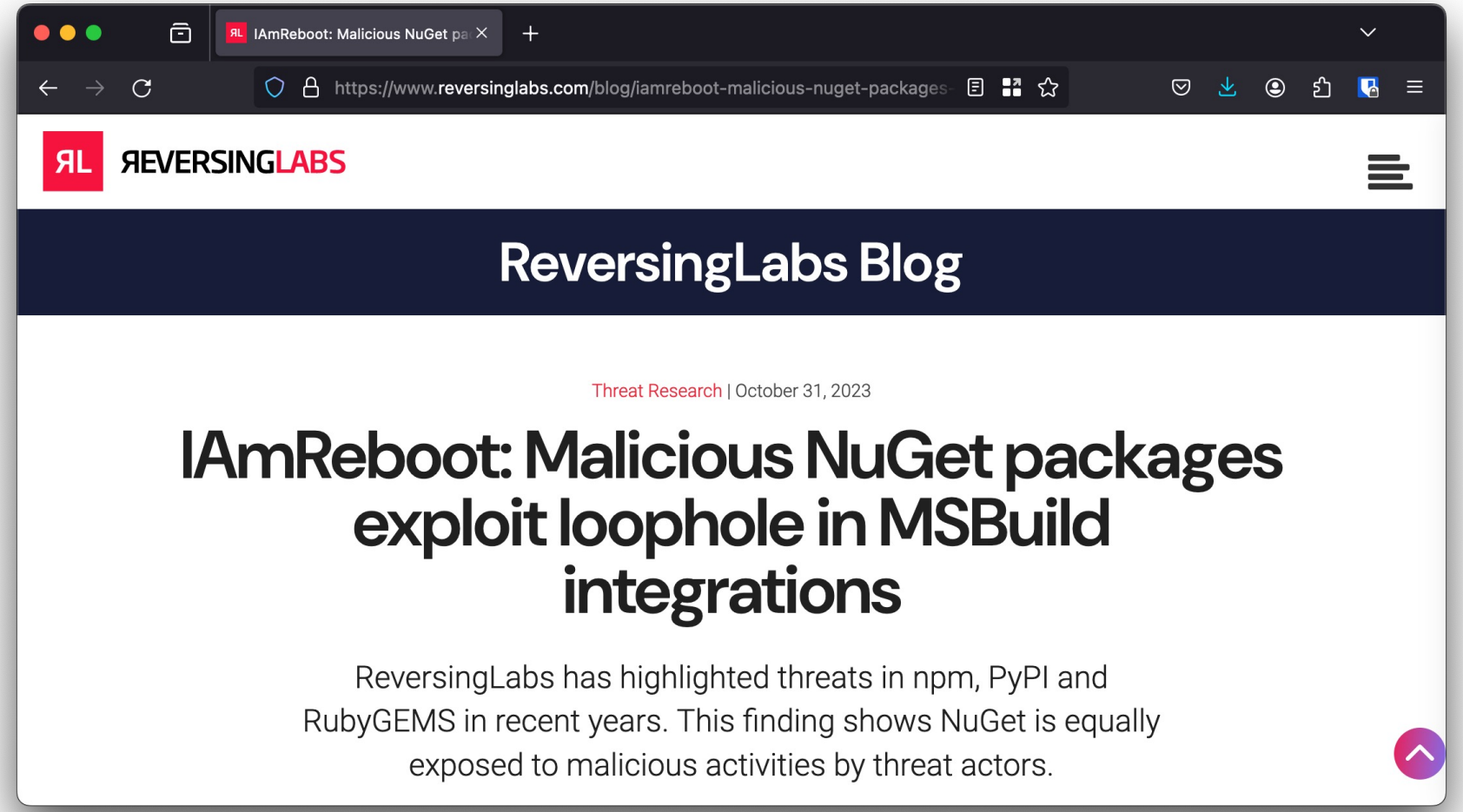
Malicious Package



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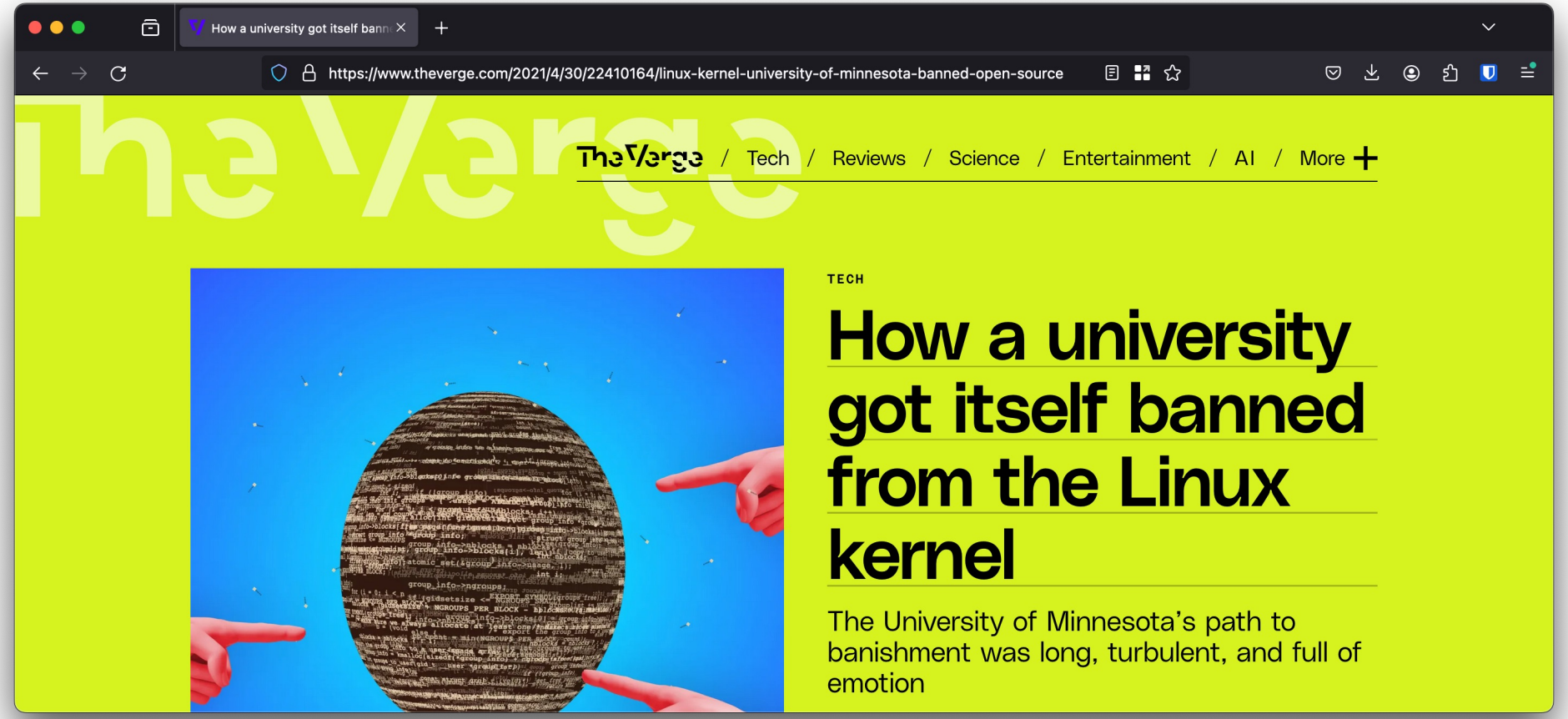
Hypocrite Commits



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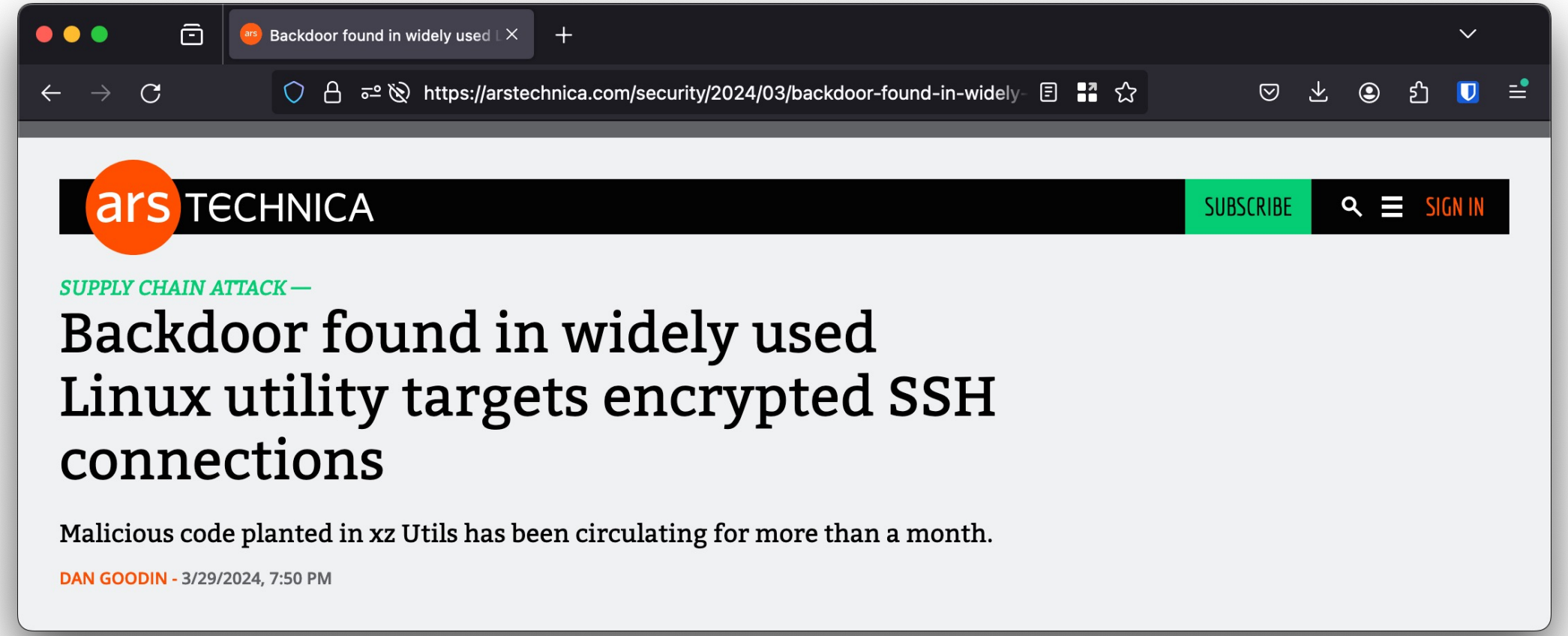
XZ Backdoor



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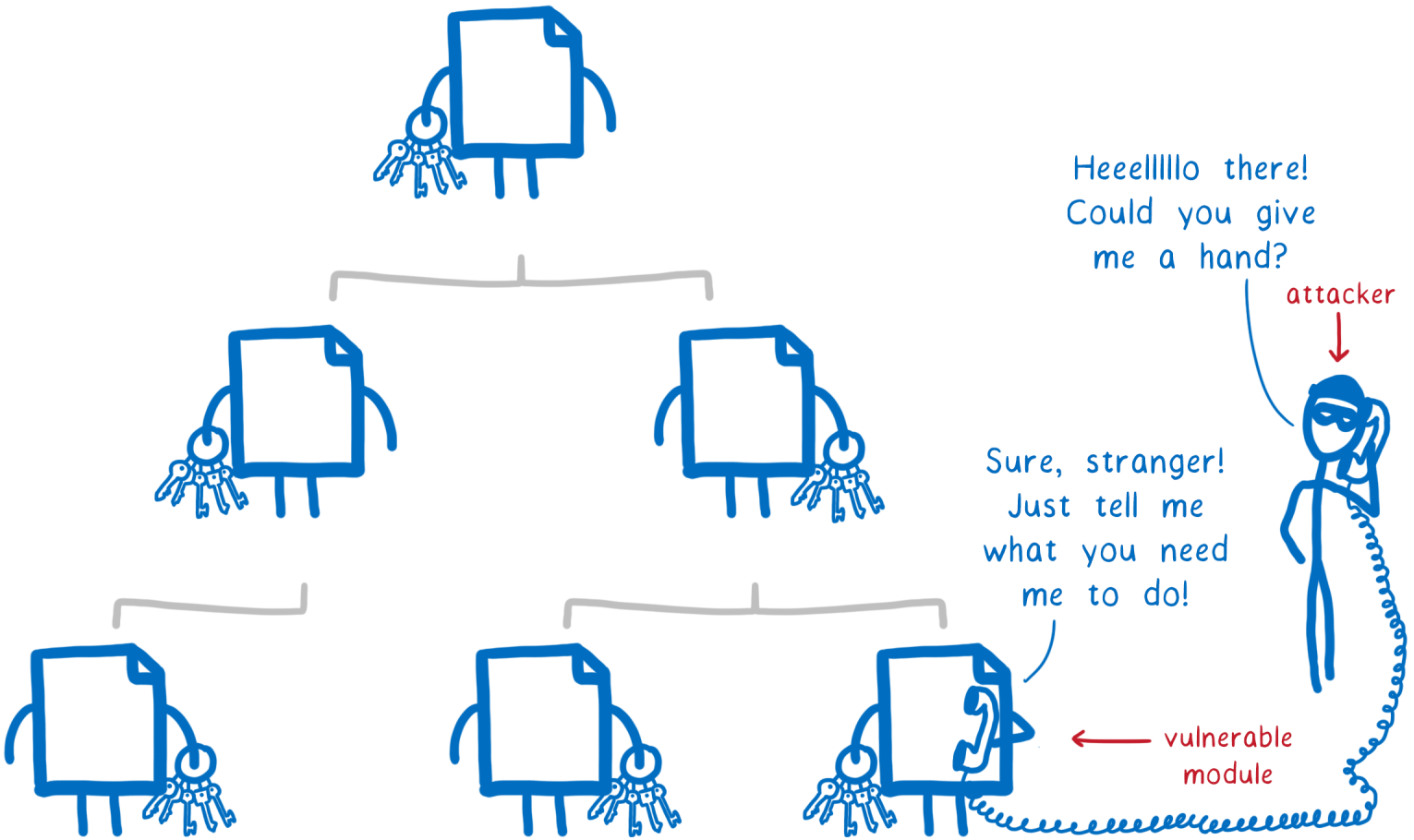
Vulnerable Assembly



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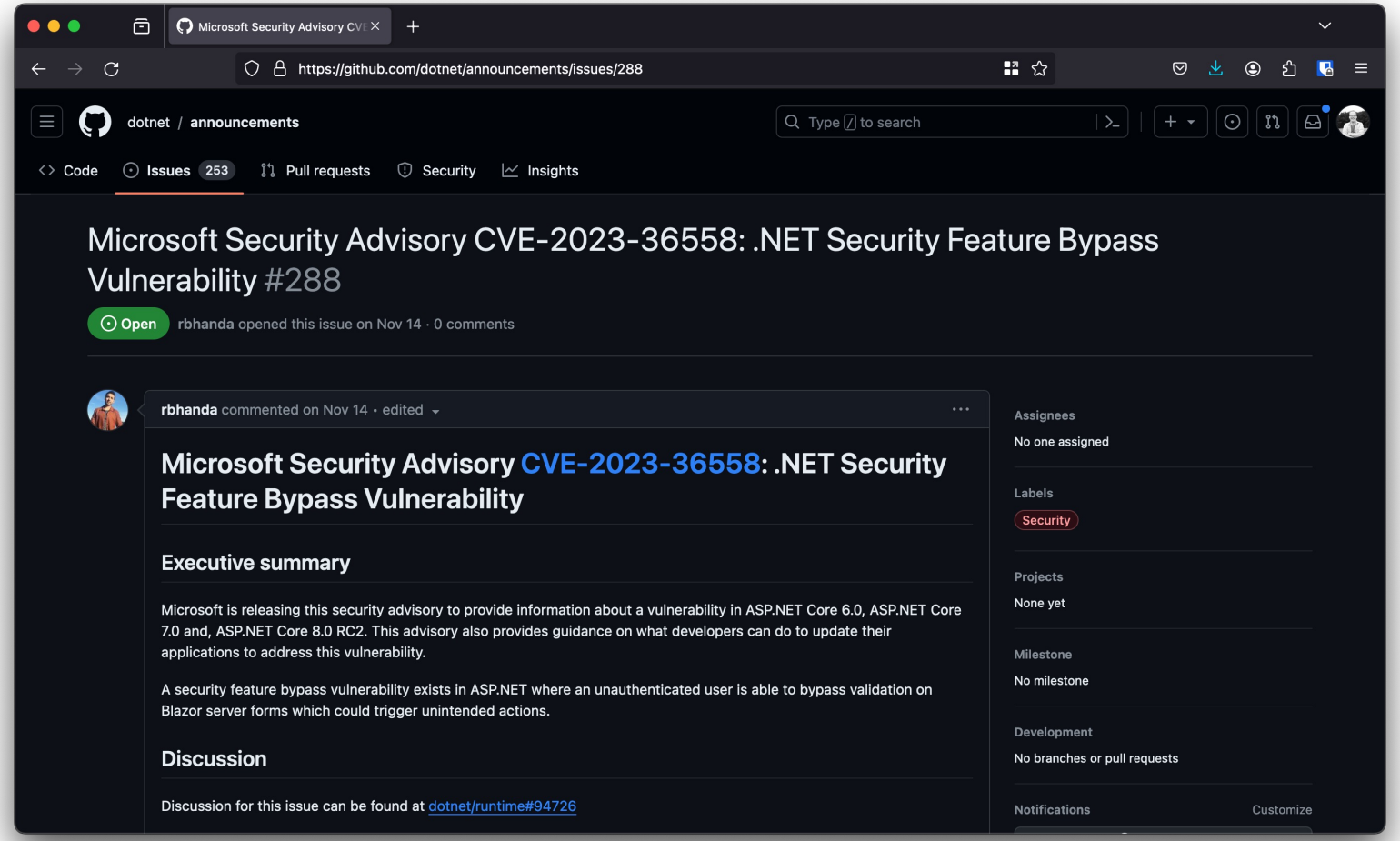
Vulnerabilities in Libraries



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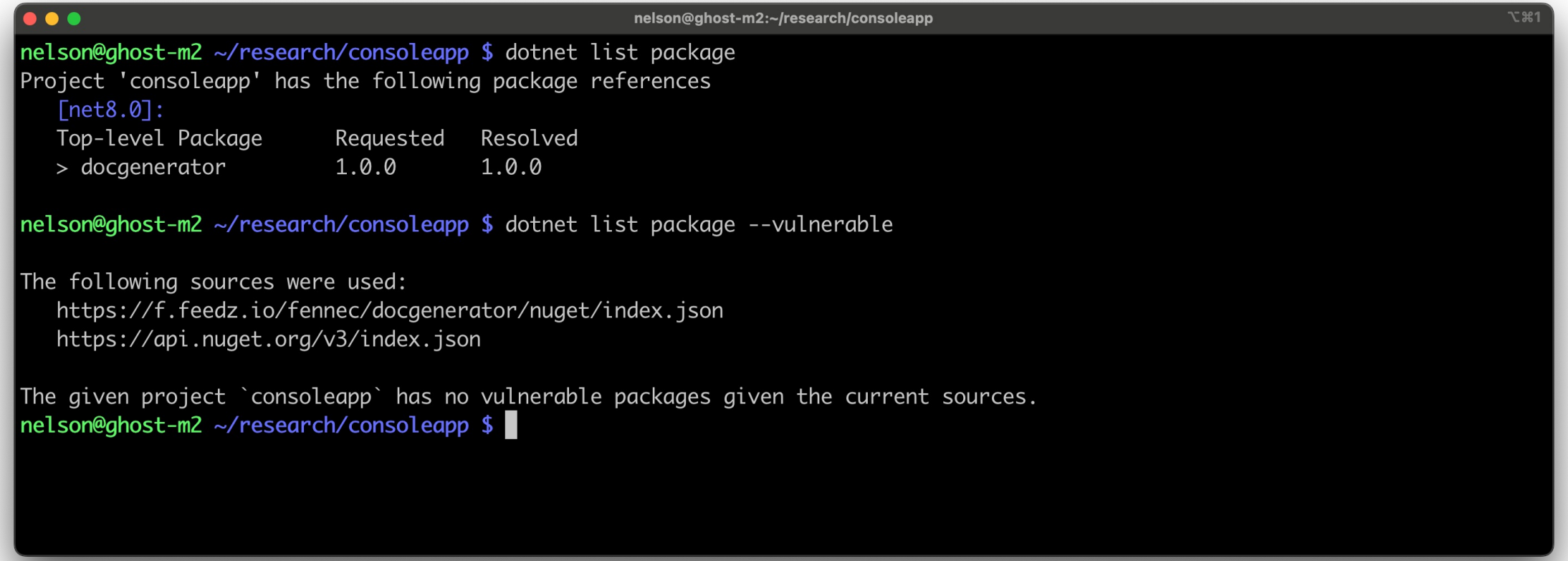
DotNet CLI



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DotNet CLI

```
nelson@ghost-m2:~/research/consoleapp                                    ⌥⌘1
nelson@ghost-m2 ~/research/consoleapp $ dotnet list package --include-transitive
Project 'consoleapp' has the following package references
   [net8.0]:
   Top-level Package      Requested   Resolved
   > docgenerator         1.0.0       1.0.0

   Transitive Package                                                Resolved
   > itext7                                                          7.2.2
   > itext7.commons                                                  7.2.2
   > Microsoft.CSharp                                                4.0.1
   > Microsoft.DotNet.PlatformAbstractions                           1.1.0
   > Microsoft.Extensions.DependencyInjection                        5.0.0
   > Microsoft.Extensions.DependencyInjection.Abstractions           5.0.0
   > Microsoft.Extensions.DependencyModel                            1.1.0
   > Microsoft.Extensions.Logging                                    5.0.0
   > Microsoft.Extensions.Logging.Abstractions                       5.0.0
   > Microsoft.Extensions.Options                                    5.0.0
   > Microsoft.Extensions.Primitives                                 5.0.0
```


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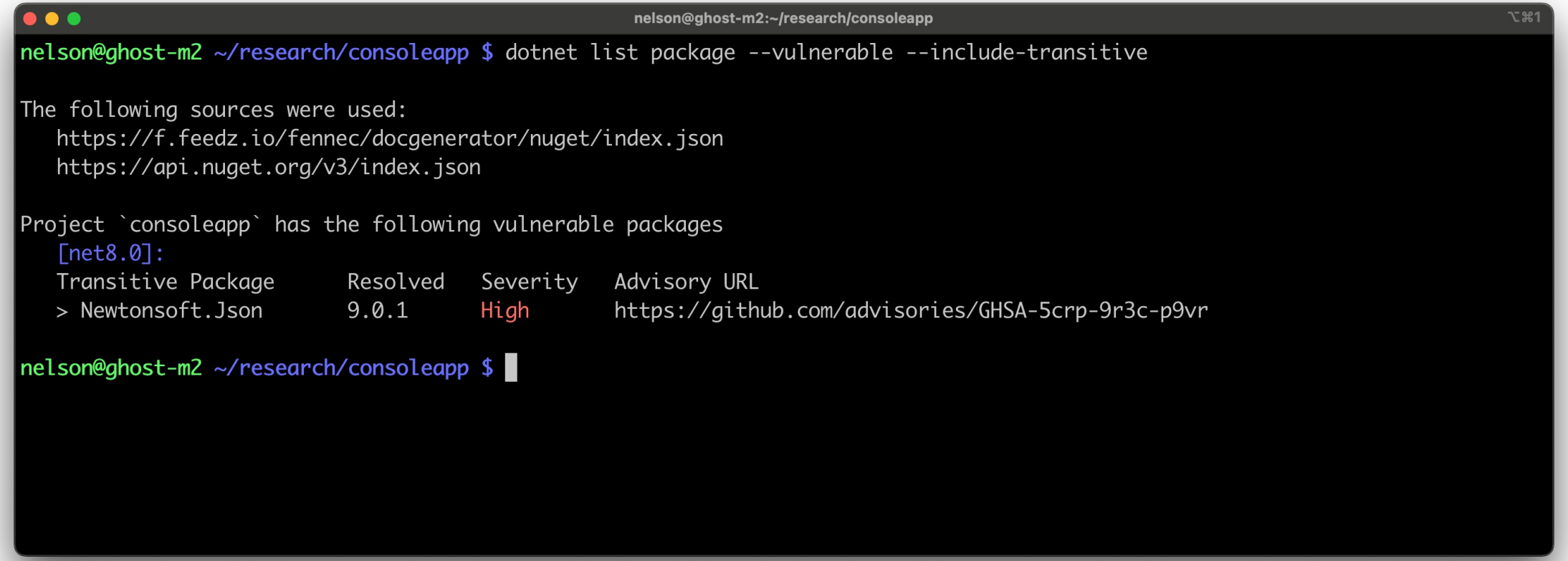
DotNet CLI



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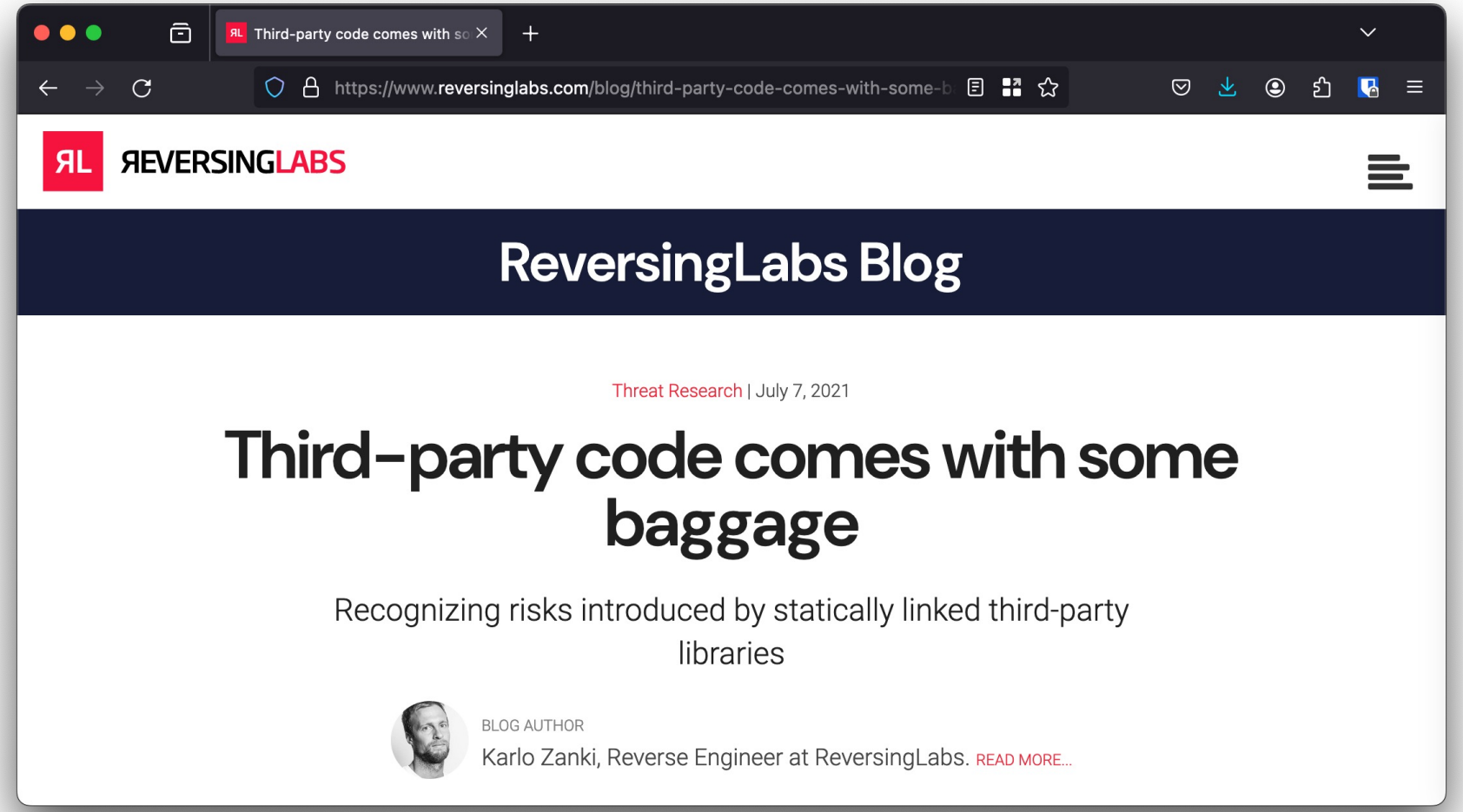
Do you know what's inside?



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Nutrion Label for Software?

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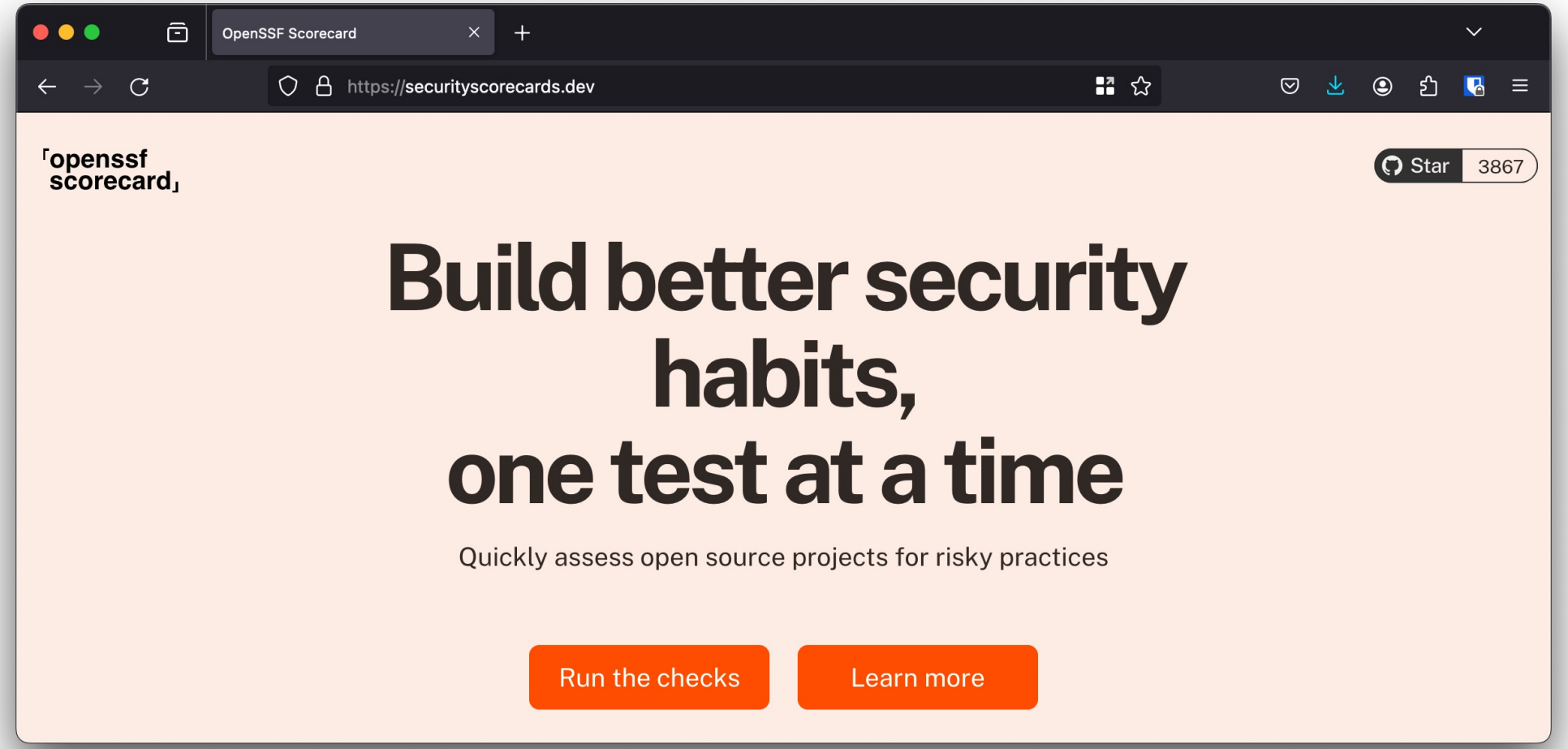
OpenSSF Scorecards



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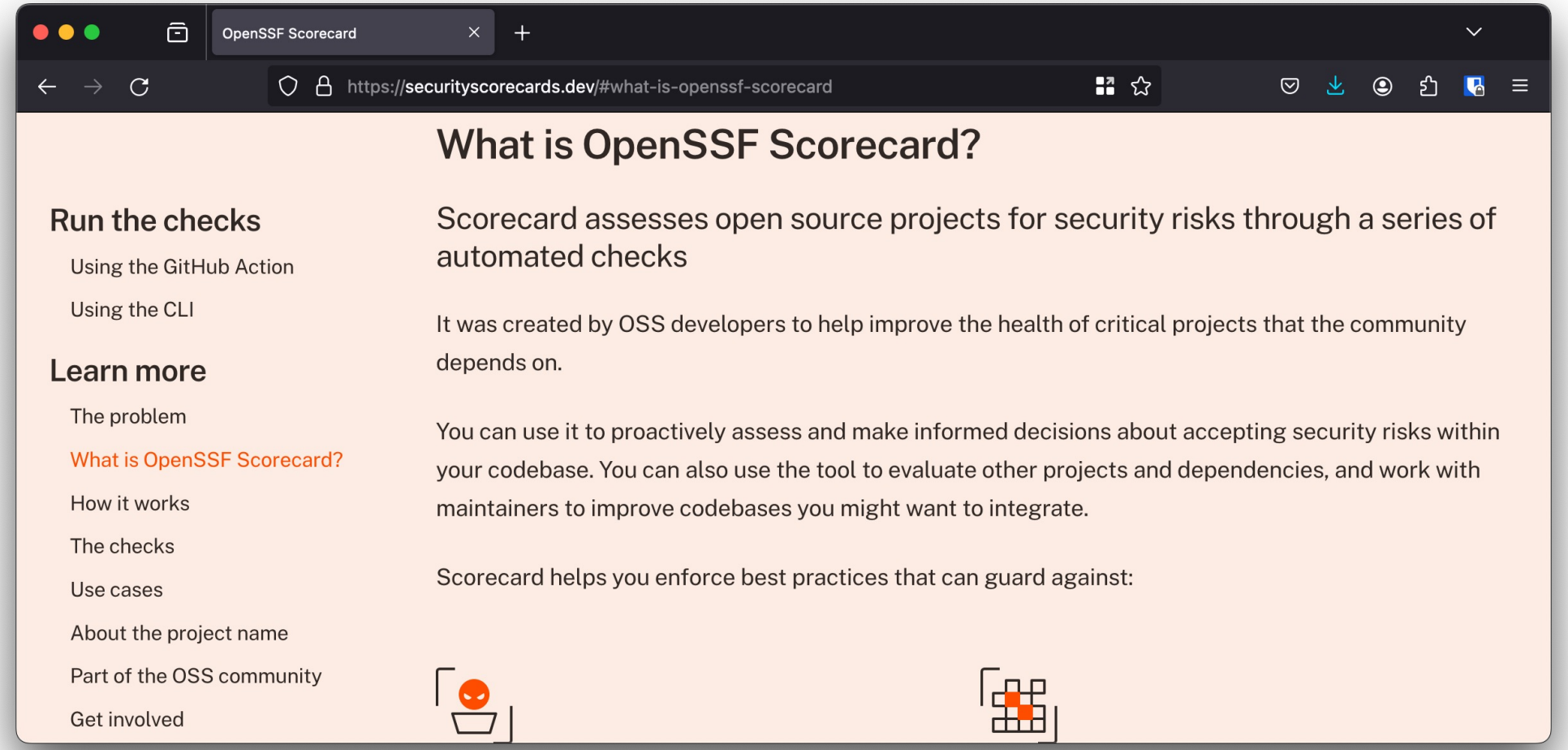
OpenSSF Security Scorecards



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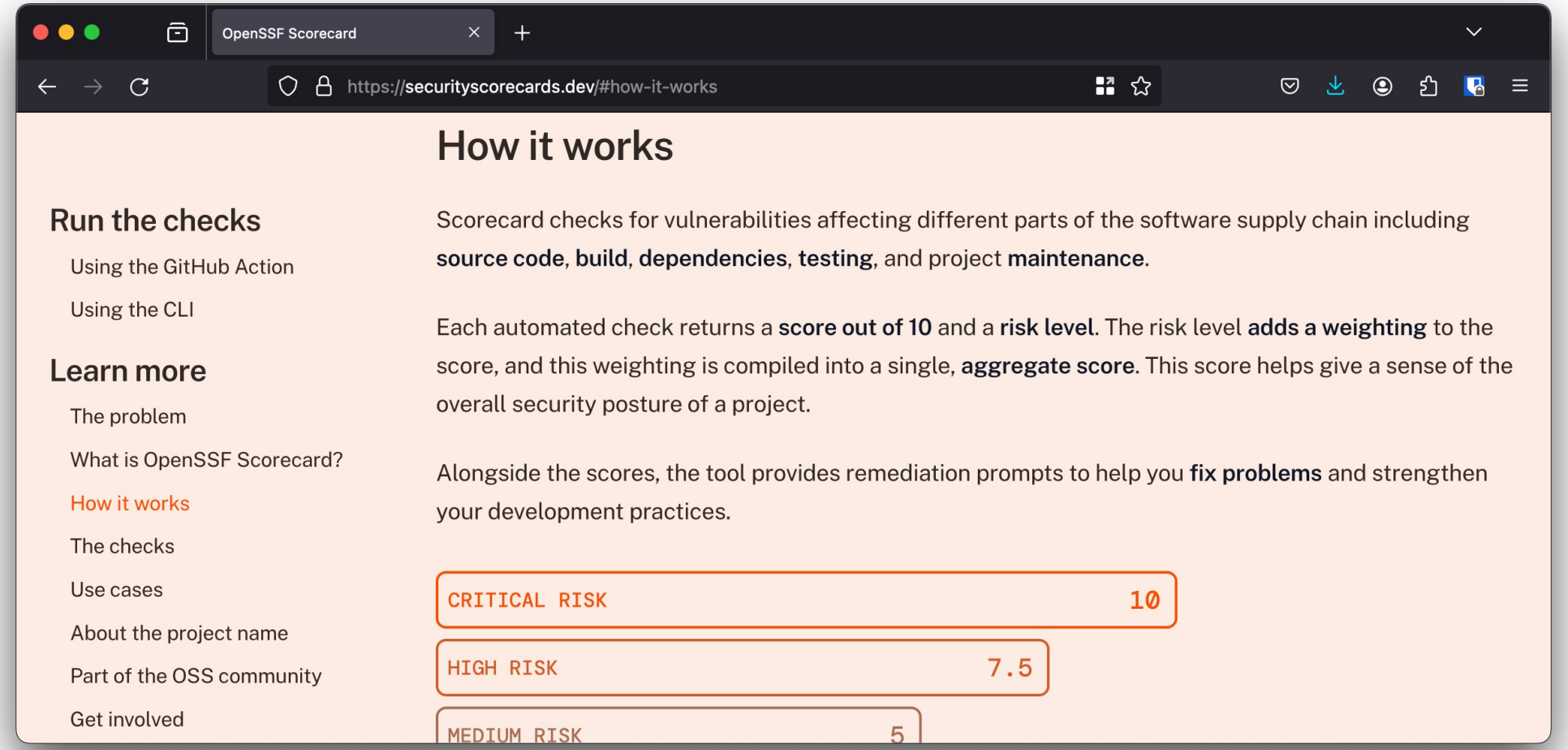
OpenSSF Security Scorecards



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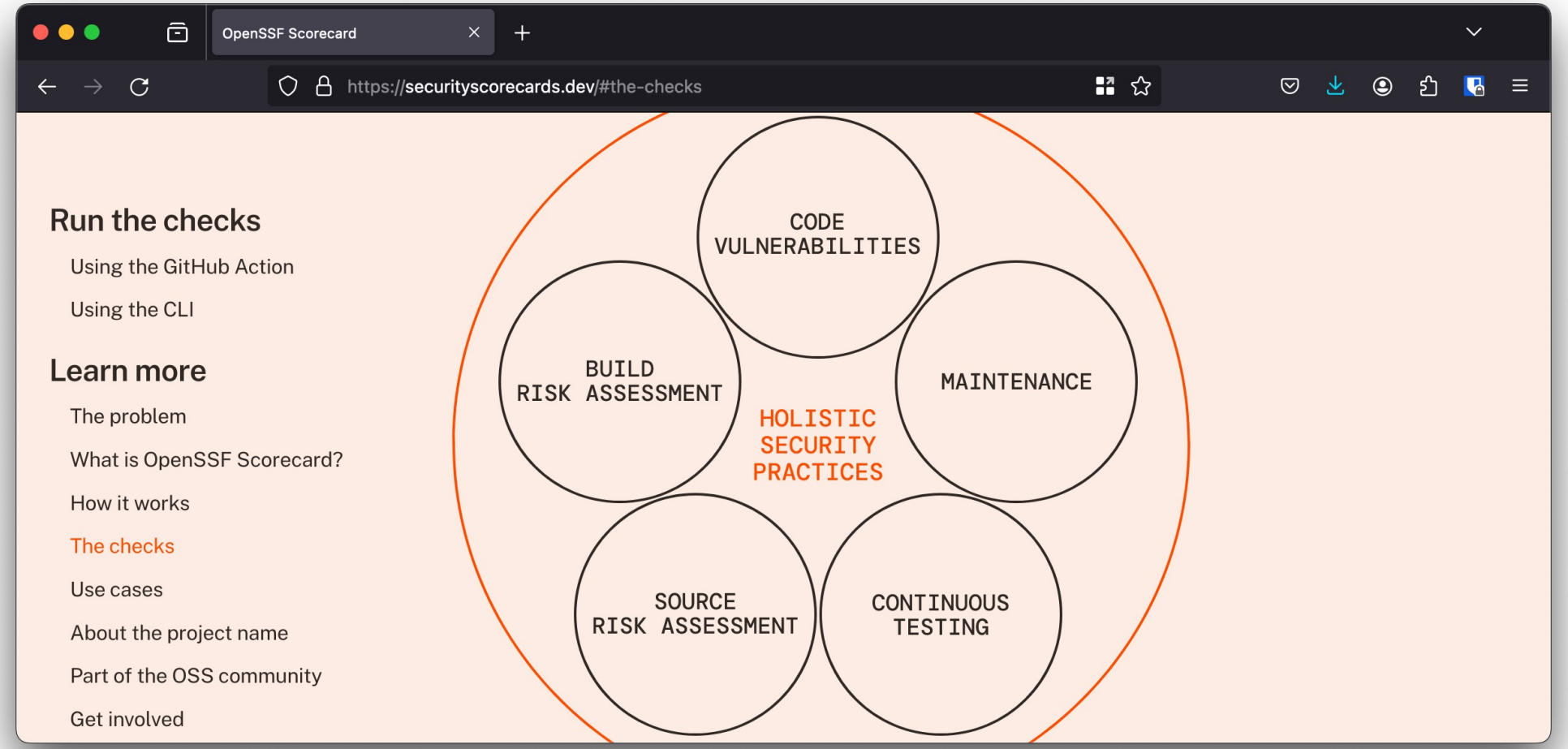
OpenSSF Security Scorecards



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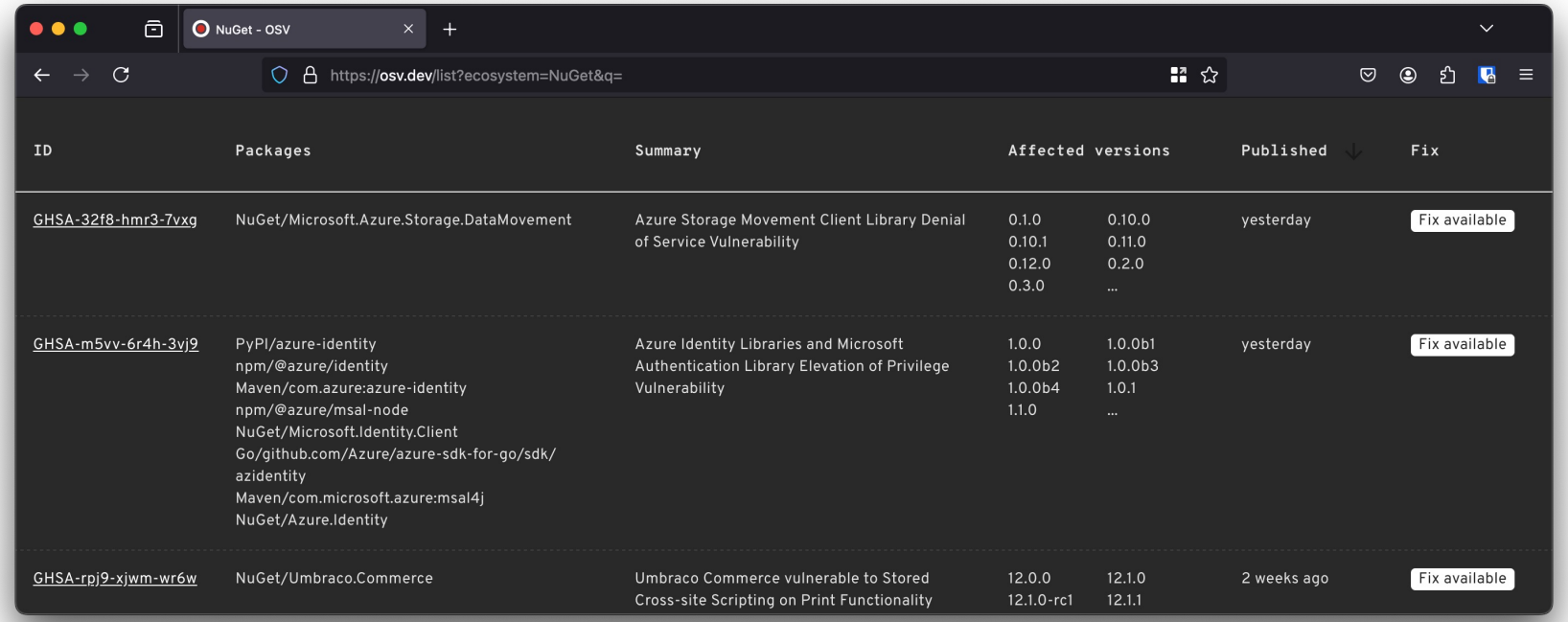
Code Vulnerabilities (High)

- Does the project have unfixed vulnerabilities? Uses the OSV service.



ID	Packages	Summary	Affected versions		Published	Fix
GHSA-32f8-hmr3-7vxg	NuGet/Microsoft.Azure.Storage.DataMovement	Azure Storage Movement Client Library Denial of Service Vulnerability	0.1.0 0.10.1 0.12.0 0.3.0	0.10.0 0.11.0 0.2.0 ...	yesterday	Fix available
GHSA-m5vv-6r4h-3vj9	PyPI/azure-identity npm/@azure/identity Maven/com.azure:azure-identity npm/@azure/msal-node NuGet/Microsoft.Identity.Client Go/github.com/Azure/azure-sdk-for-go/sdk/azidentity Maven/com.microsoft.azure:msal4j NuGet/Azure.Identity	Azure Identity Libraries and Microsoft Authentication Library Elevation of Privilege Vulnerability	1.0.0 1.0.0b2 1.0.0b4 1.1.0	1.0.0b1 1.0.0b3 1.0.1 ...	yesterday	Fix available
GHSA-rpj9-xjwm-wr6w	NuGet/Umbraco.Commerce	Umbraco Commerce vulnerable to Stored Cross-site Scripting on Print Functionality	12.0.0 12.1.0-rc1	12.1.0 12.1.1	2 weeks ago	Fix available

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Maintenance
Dependency-Update-Tool (High)

- Does the project use a dependency update tool? For example Dependabot or Renovate bot?
- Out-of-date dependencies make a project vulnerable to known flaws and prone to attacks.

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Maintenance
Security Policy (Medium)

- Does project have published security policy?
- E.g. a file named **`SECURITY.md`** (case-insensitive) in a few well-known directories.
- A security policy can give users information about what constitutes a vulnerability and how to report one securely so that information about a bug is not publicly visible.

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Maintenance License (Low)

- Does project have license published?
- A license can give users information about how the source code may or may not be used.
- The lack of a license will impede any kind of security review or audit and creates a legal risk for potential users.

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Maintenance
CII Best Practices (Low)

- OpenSSF Best Practices Badge Program
- Way for Open Source Software projects to show that they follow best practices.
- Projects can voluntarily self-certify, at no cost, by using this web application to explain how they follow each best practice.

openssf best practices | passing

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Continuous testing
CI Tests (Low)

- Does the project run tests before pull requests are merged?
- The check works by looking for a set of CI-system names in GitHub CheckRuns and Statuses among the recent commits (~30).

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Continuous testing
Fuzzing (Medium)

- This check tries to determine if the project uses fuzzing by checking:
  - Added to OSS-Fuzz project.
  - If ClusterFuzzLite is deployed in the repository;
- Does it make sense to do fuzzing on .NET projects?

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Continuous testing
Static Code Analysis (Medium)

- This check tries to determine if the project uses Static Application Security Testing (SAST), also known as static code analysis. It is currently limited to repositories hosted on GitHub.
  - CodeQL
  - SonarCloud
- Definitely room for improvement!

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Source Risk Assesement
Binary Artifacts (High)

- This check determines whether the project has generated executable (binary) artifacts in the source repository.
- Binary artifacts cannot be reviewed, allowing possible obsolete or maliciously subverted executables.
- There is need for **reproducible** builds!

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Source Risk Assesement
Branch Protection (High)

- This check determines whether a project's default and release branches are protected with GitHub's branch protection or repository rules settings.
  - Requiring code review
  - Prevent force push, in case of public branch all is lost!

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Source Risk Assesement Dangerous Workflow (Critical)

- This check determines whether the project's GitHub Action workflows has dangerous code patterns.
  - Untrusted Code Checkout with certain triggers
  - Script Injection with Untrusted Context Variables
- https://securitylab.github.com/research/github-actions-preventing-pwn-requests/

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Source Risk Assesement
Code Review (Low)

- This check determines whether the project requires human code review before pull requests are merged.
- The check determines whether the most recent changes (over the last ~30 commits) have an approval on GitHub and merger!=committer (implicit review)

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Source Risk Assesement Contributors (Low)

- This check tries to determine if the project has recent contributors from multiple organizations (e.g., companies).
- Relying on single contributor is a risk for sure!
- But is a large list of contributors good?

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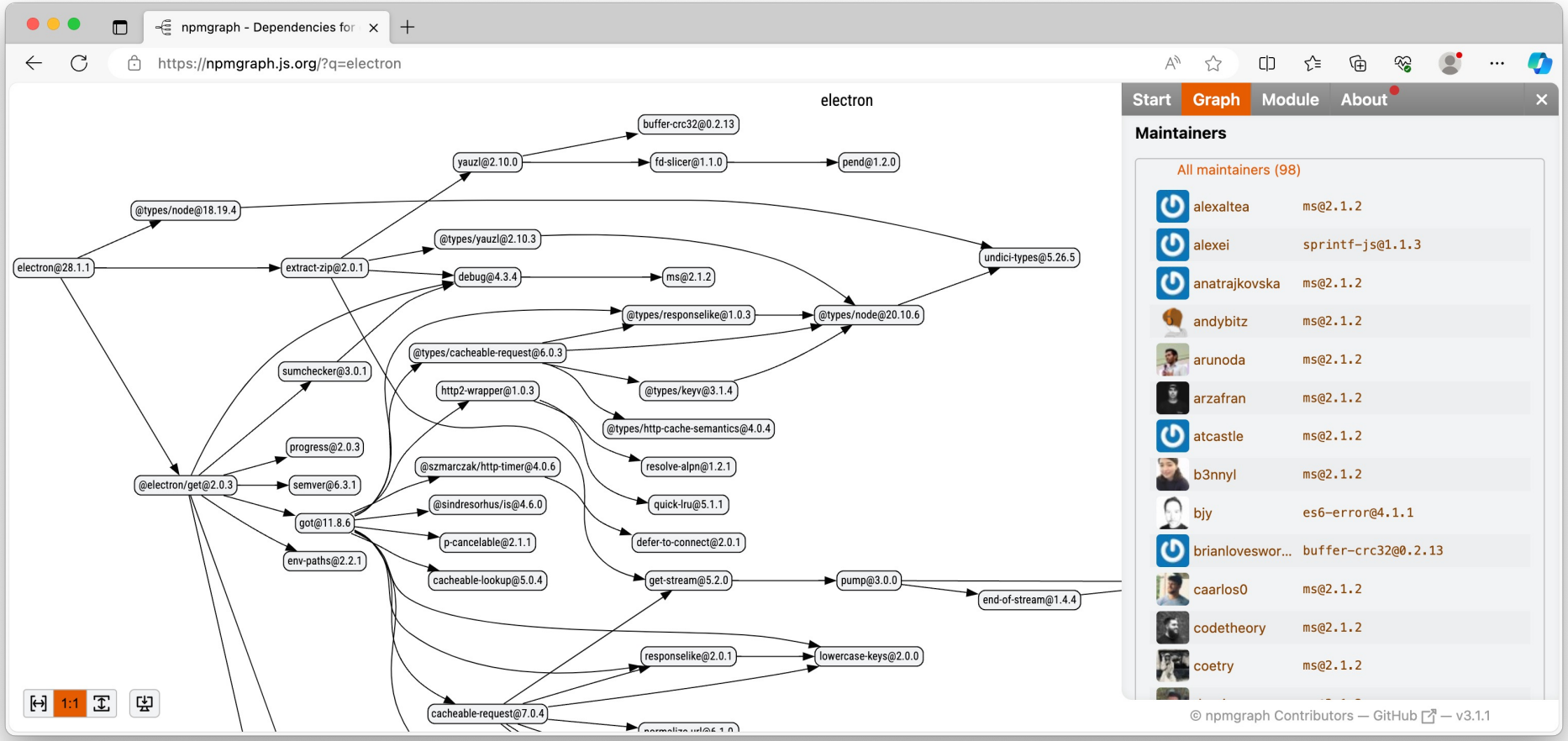
Source Risk Assesement Contributors (Low)



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Build Risk Assesement
Pinned Dependencies (High)

- Does the project pin dependencies used during its build and release process.
- **RestorePackagesWithLockFile** in MSBuild results in **packages.lock.json** file containing versioned dependency tree with hashes
- If Workflow is present what about the Actions used?

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Build Risk Assesement
Token Permission (High)

- This check determines whether the project's automated workflows tokens follow the principle of least privilege.
- This is important because attackers may use a compromised token with write access to, for example, push malicious code into the project.

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Build Risk Assesement Packaging (Medium)

- This check tries to determine if the project is published as a package.
- Packages give users of a project an easy way to download, install, update, and uninstall the software by a package manager.

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Build Risk Assessment
Signed Releases (High)

- This check tries to determine if the project cryptographically signs release artifacts.
  - Signed release packages
  - Signed build provenance

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Demo OpenSSF Scorecard
Fennec CLI

```
Running checks
```

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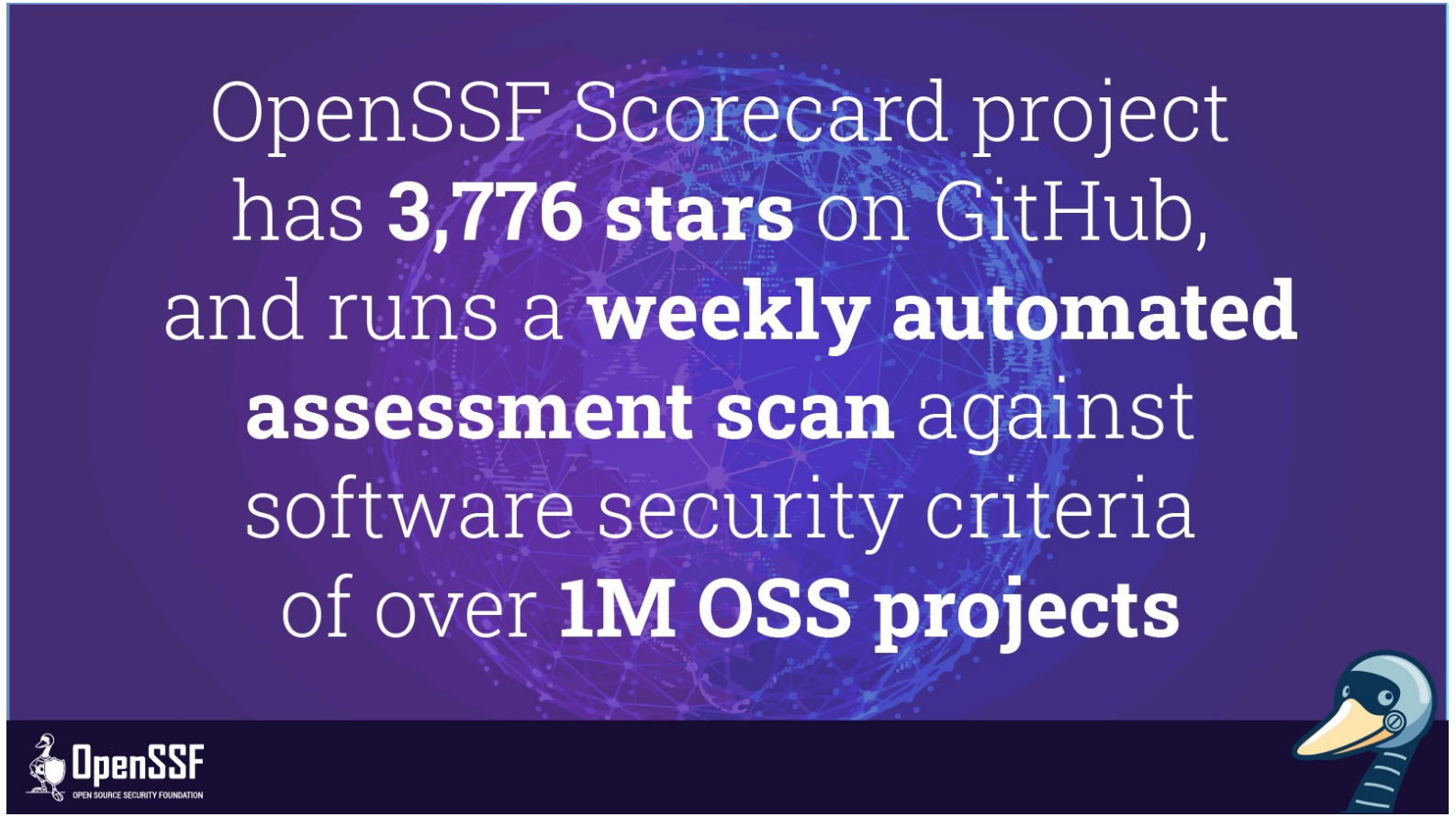
OpenSSF Annual Report 2023



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What can we improve?

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Fuzzing .NET

- Fuzzing, or fuzz testing
  - Automated software testing method that uses a wide range of ***invalid*** and unexpected data as input to find flaws
- Definitely good for finding C/C++ memory issues
- Can it be of any value with managed languages like .NET?

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Fuzzing .NET & SharpFuzz

New & Improved!

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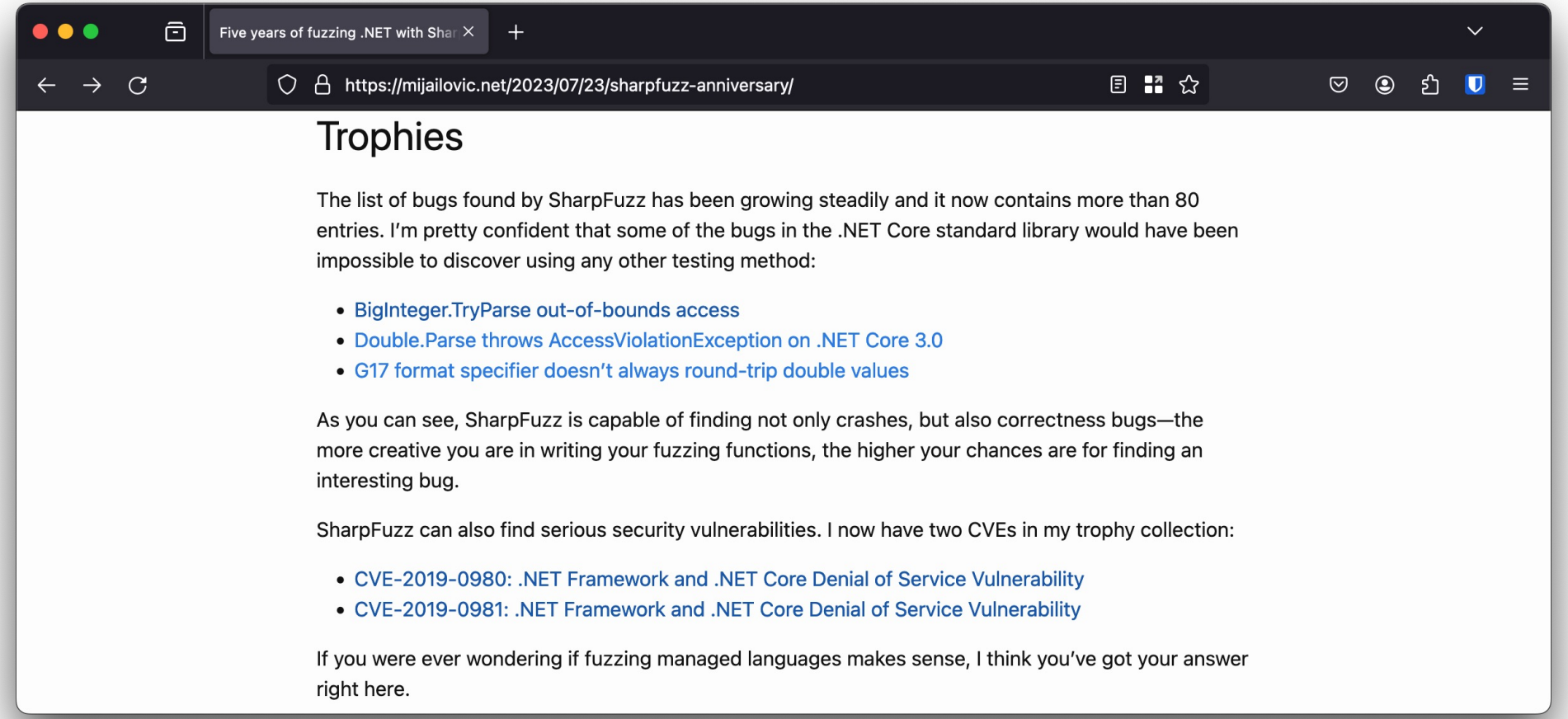
Fuzzing .NET & SharpFuzz



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Fuzzing .NET – Jil JSON Serializer


```
public static void Main(string[] args)
{
        SharpFuzz.Fuzzer.OutOfProcess.Run(stream => {
        try
        {
                using (var reader = new System.IO.StreamReader(stream))
                JSON.DeserializeDynamic(reader);
        }
        catch (DeserializationException) { }
        });
}
```


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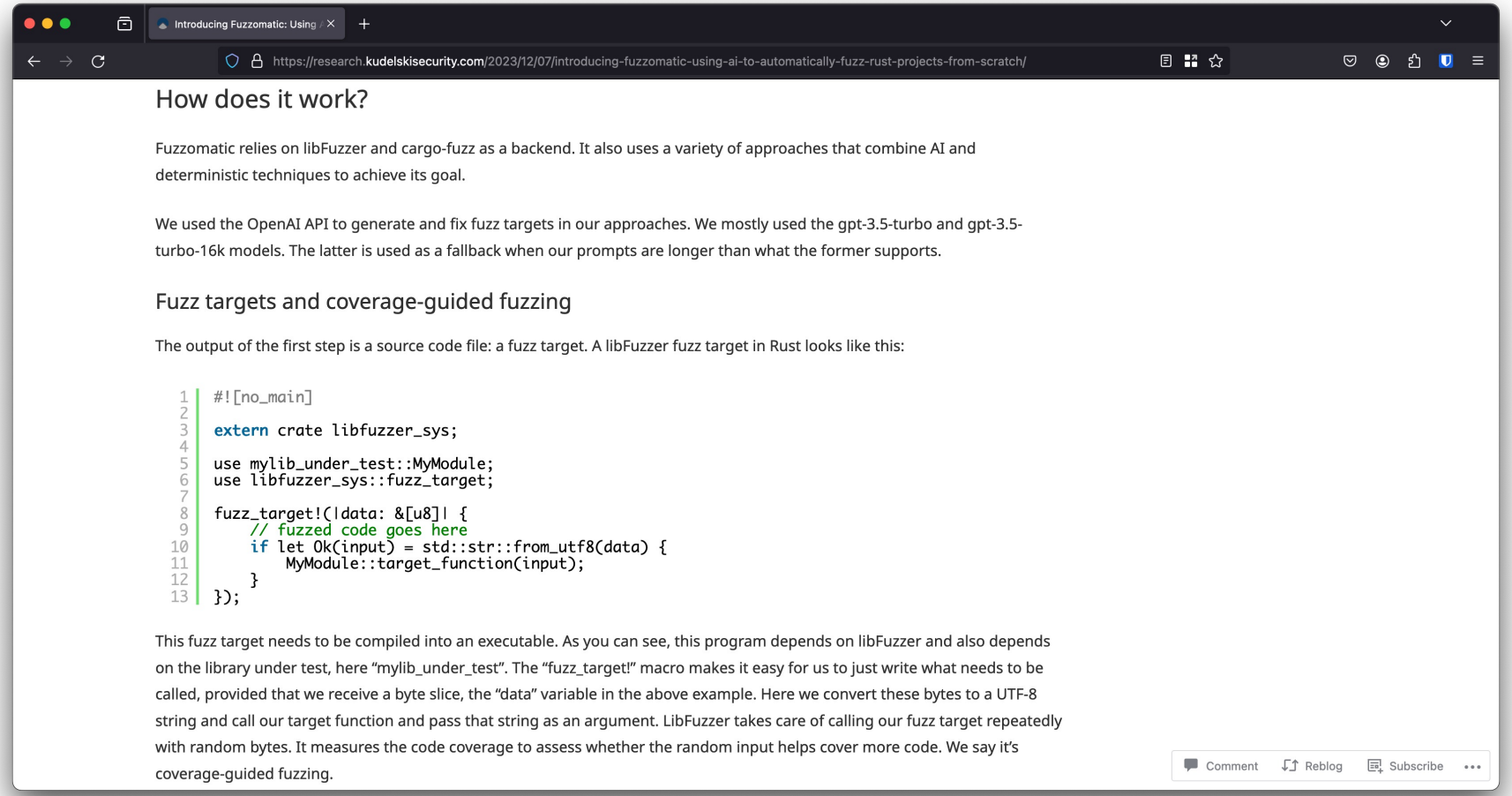
Fuzzomatic: Using AI to Fuzz Rust



New & Improved!

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Static Code Analysis (SAST)


```
public byte[] CreateHash(string password)
{
    var b = Encoding.UTF8.GetBytes(password);
    return SHA1.HashData(b);
}
```


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Static Code Analysis (SAST)


```
public class CustomerController : Controller
{
    public IActionResult GenerateCustomerReport(string customerID)
    {
        var data = Reporting.GenerateCustomerReportOverview(customerID)
        return View(data);
    }
}
```

```
public static class Reporting
{
    public static byte[] GenerateCustomerReportOverview(string ID)
    {
        return System.IO.File.ReadAllBytes($"./data/{ID}.pdf");
    }
}
```


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.NET Reproducibility

- Reproducible builds → independently-verifiable path from source to binary code.
- .NET Roslyn Deterministic Inputs
- How reproducible is a simple console app?
- Fennec Diff (work-in-progress)

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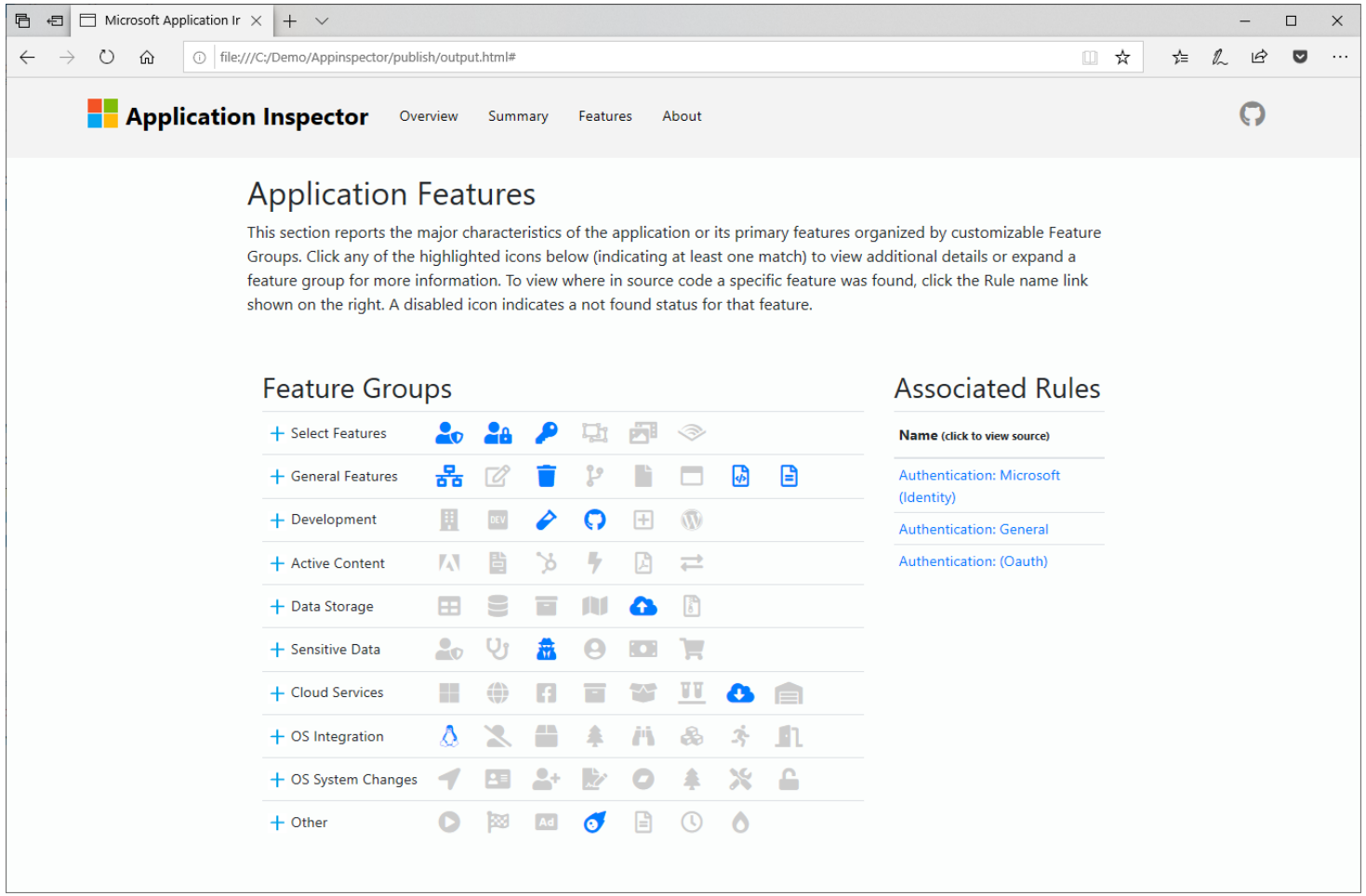
Application Inspector

New & Improved!



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Application Inspector

Select Features

	Feature	Confidence	Details
	Authentication		View
	Authorization		View
	Cryptography		View
	Object Deserialization		N/A
	AV Media Parsing		N/A
	Dynamic Command Execution		N/A

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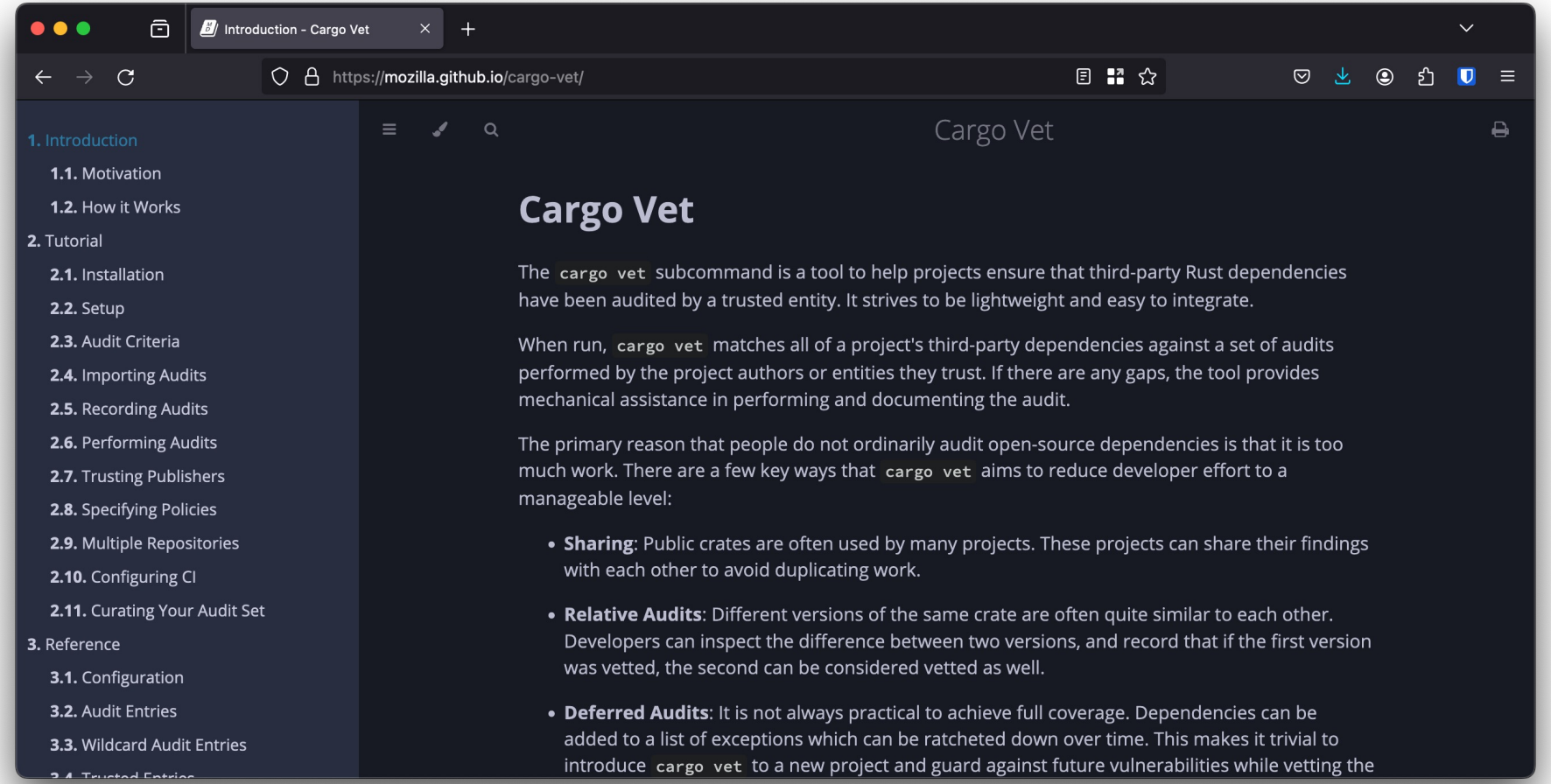
Community Review

New & Improved!



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Conclusion

- Scorecard helps security reviewing a NuGet Package
- Better understand what's inside, how it’s build/maintained and what are the risks!
- Scorecard should not be a goal on it’s own!

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Conclusion

- NuGet Package Scoring (NET Score)
- Room for .NET specific improvements with Fennec CLI
  - Tools (diff, insights)
  - Reporting
  - Trust Graph
  - Contribute back to OpenSSF Scorecard

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Questions?

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Links

- https://github.com/nielstanis/ndcoslo2024/
- ntanis at Veracode.com
- @nielstanis@infosec.exchange
- https://www.fennec.dev & https://blog.fennec.dev