Sandboxing .NET Assemblies for fun, profit and, of course Security!

Niels Tanis

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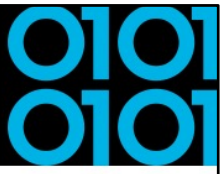
Who am I?

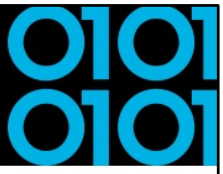
- Niels Tanis
- Principal Security Researcher @ Veracode
  - Background .NET Development, Pentesting/ethical hacking, and software security consultancy
  - ISC² CSSLP
  - Research on static analysis for .NET apps

Agenda



- Introduction
- The security risks of third party libraries
- Sandboxing techniques
- Let's create a sandbox!
- Conclusion
- QA

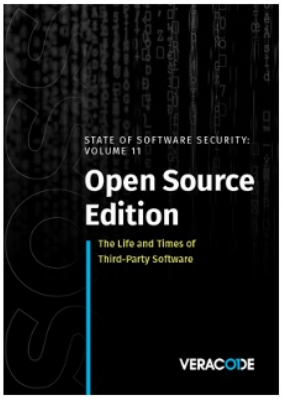
Third Party Libraries



- Big chunk (80%+) of our apps consists of 3rd party libraries
- Efficient in time, why reinvent the wheel?
- How actively is it maintained?
- What do they do for security?

State Of Software Security v11 2021

"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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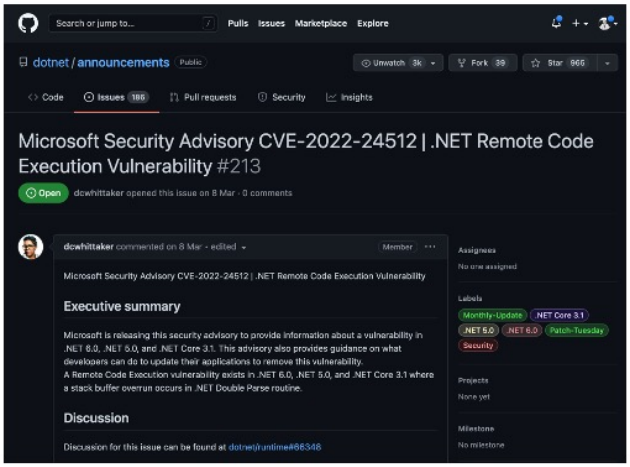
https://info.veracode.com/fy22-state-of-software-security-v11-open-source-edition.html

Vulnerabilities in libraries



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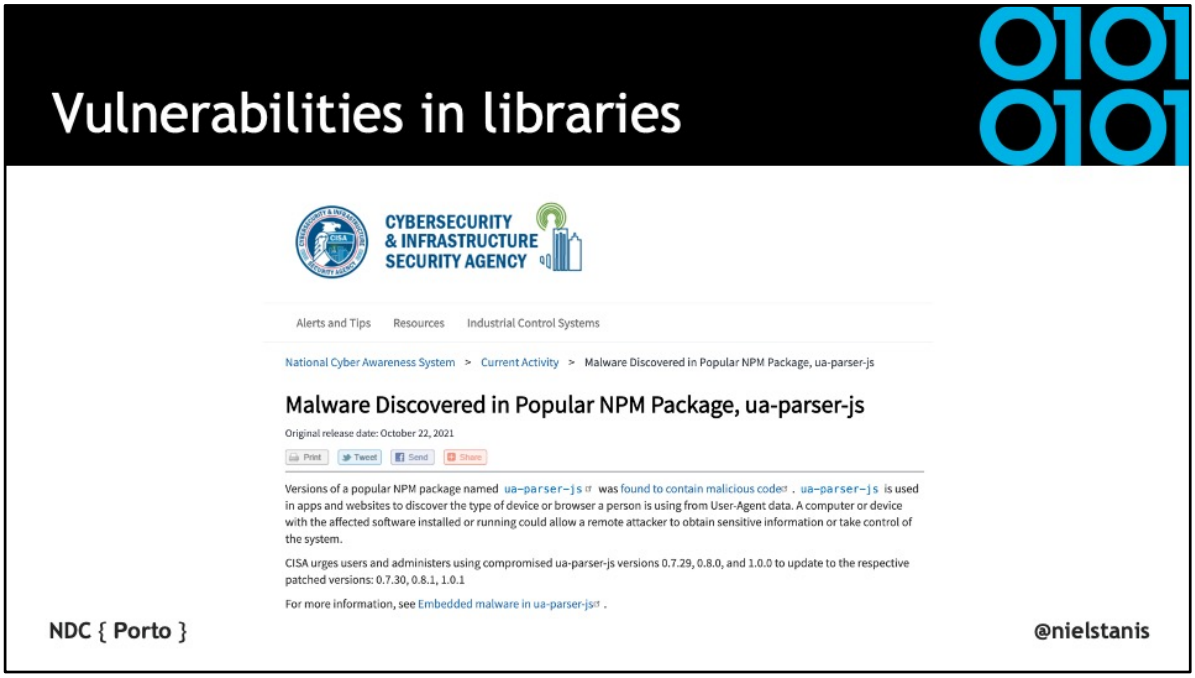
https://github.com/dotnet/announcements/issues/213

Vulnerabilities in libraries



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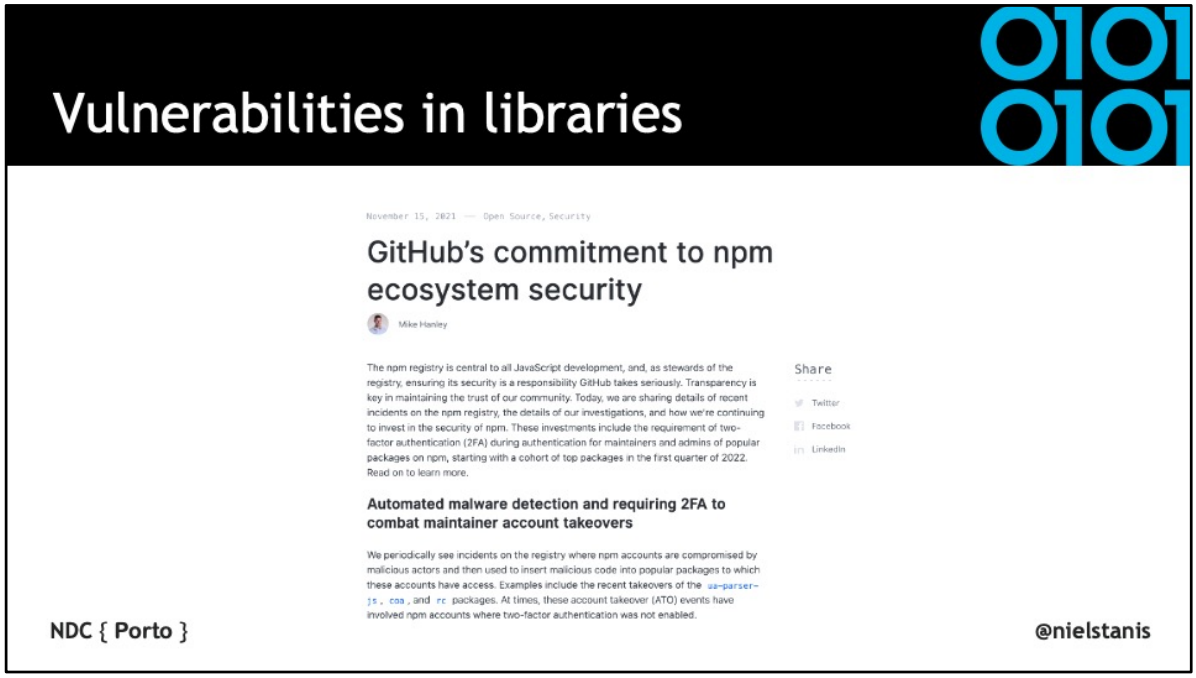
https://us-cert.cisa.gov/ncas/current-activity/2021/10/22/malware-discovered-popular-npm-package-ua-parser-js
https://portswigger.net/daily-swig/popular-npm-package-ua-parser-js-poisoned-with-cryptomining-password-stealing-malware

Vulnerabilities in libraries



November 15, 2021 — Open Source, Security

GitHub's commitment to npm ecosystem security

Mike Hanley

The npm registry is central to all JavaScript development, and, as stewards of the registry, ensuring its security is a responsibility GitHub takes seriously. Transparency is key in maintaining the trust of our community. Today, we are sharing details of recent incidents on the npm registry, the details of our investigations, and how we're continuing to invest in the security of npm. These investments include the requirement of two-factor authentication (2FA) during authentication for maintainers and admins of popular packages on npm, starting with a cohort of top packages in the first quarter of 2022. Read on to learn more.

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Automated malware detection and requiring 2FA to combat maintainer account takeovers

We periodically see incidents on the registry where npm accounts are compromised by malicious actors and then used to insert malicious code into popular packages to which these accounts have access. Examples include the recent takeovers of the `ua-parser-js`, `coa`, and `rc` packages. At times, these account takeover (ATO) events have involved npm accounts where two-factor authentication was not enabled.

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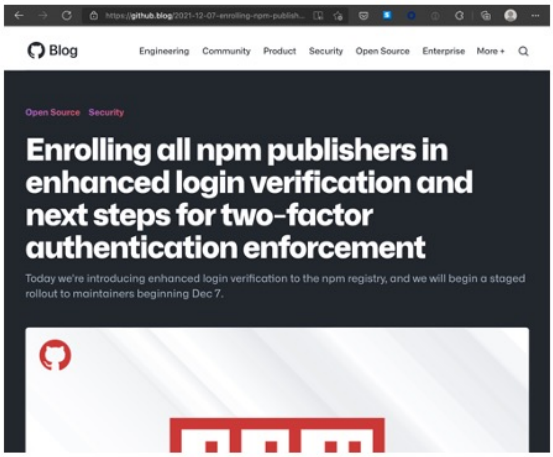
https://github.blog/2021-11-15-githubs-commitment-to-npm-ecosystem-security/

Vulnerabilities in libraries



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https://github.blog/2021-12-07-enrolling-npm-publishers-enhanced-login-verification-two-factor-authentication-enforcement/

Vulnerabilities in libraries

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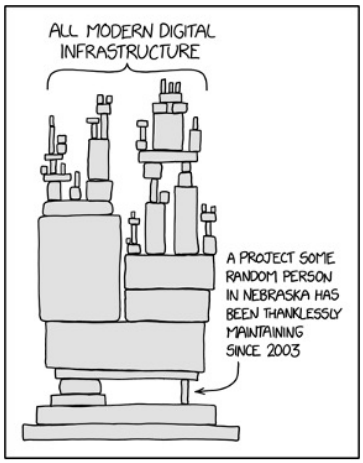
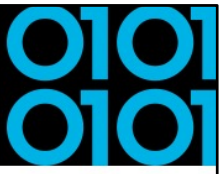
https://blog.secure.software/third-party-code-comes-with-some-baggage

XKDC - Dependency



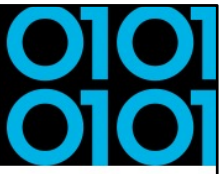
https://xkcd.com/2347/ @nielstanis

Sandboxing .NET Assemblies



- Is there a way we can do a better job?
- A way for us to reduce the security risks?
- Keep in mind it's not a matter of how it's more when!

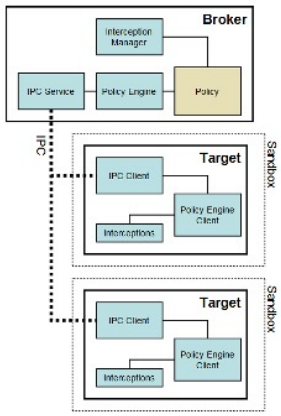
Sandboxing .NET Assemblies



- We want to use the library without modification
- Can we maybe create a controlled (restricted) sandbox?
- A sandbox with limited capabilities?

Browser Sandbox

- Chromium Sandbox
- No direct system access
- Each OS related call is done via IPC
- FireFox Sandbox
  - Containers & Site Isolation



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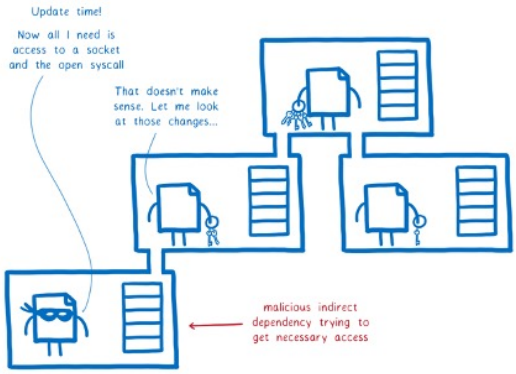
https://chromium.googlesource.com/chromium/src/+/refs/heads/main/docs/design/sandbox.md
https://hacks.mozilla.org/2021/05/introducing-firefox-new-site-isolation-security-architecture/

WebAssembly Nanoprocess

- Lineair memory model
- WASM module isolation

- Declaritive permissions
- Interface types
- WASI for BCL calls



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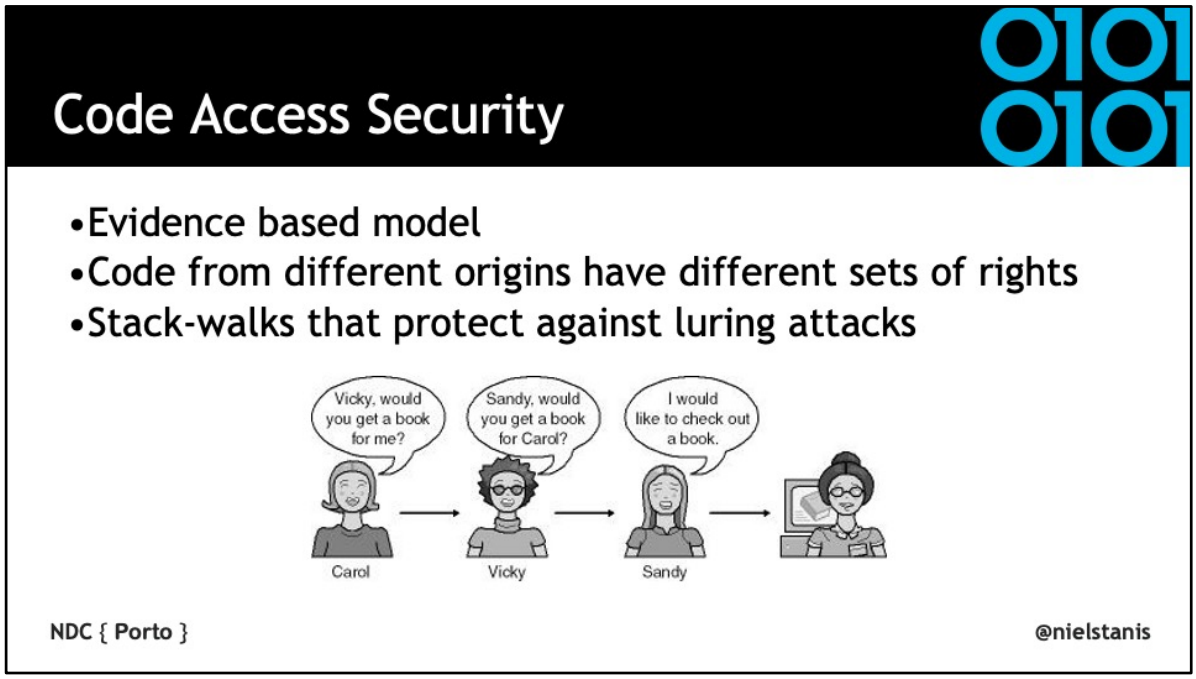
https://hacks.mozilla.org/2019/11/announcing-the-bytecode-alliance/

Code Access Security



- Evidence based model
- Code from different origins have different sets of rights
- Stack-walks that protect against luring attacks

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Figure 18-1; Writing Secure Code 2nd Edition

Code Access Security

- Evidence library card
- Policy → Librarian only allows members

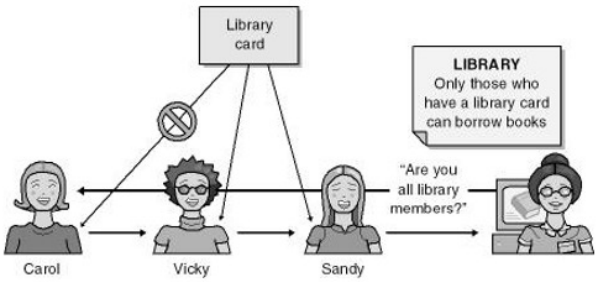

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Figure 18-2; Writing Secure Code 2nd Edition

Code Access Security

- Stack walk

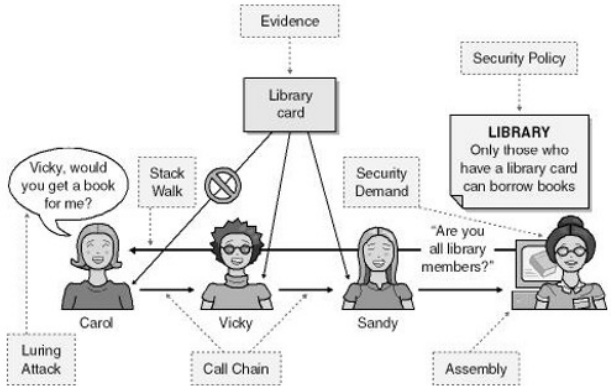

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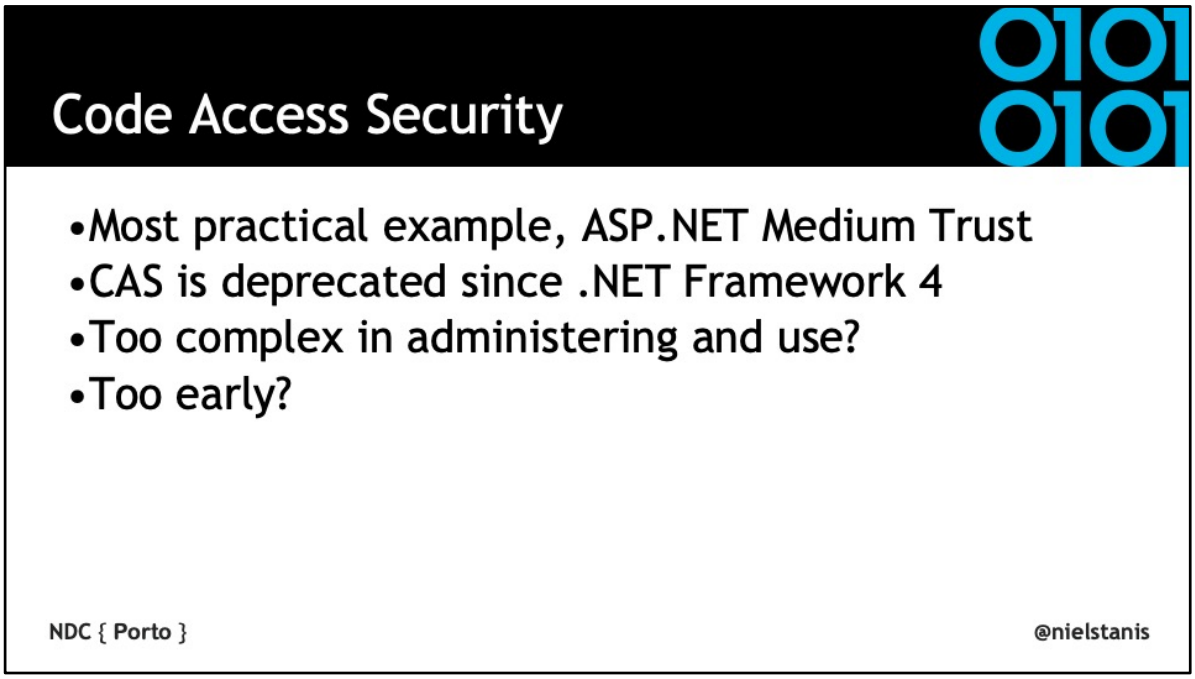
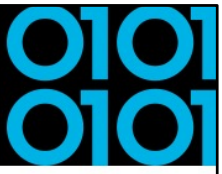
Figure 18-2; Writing Secure Code 2nd Edition



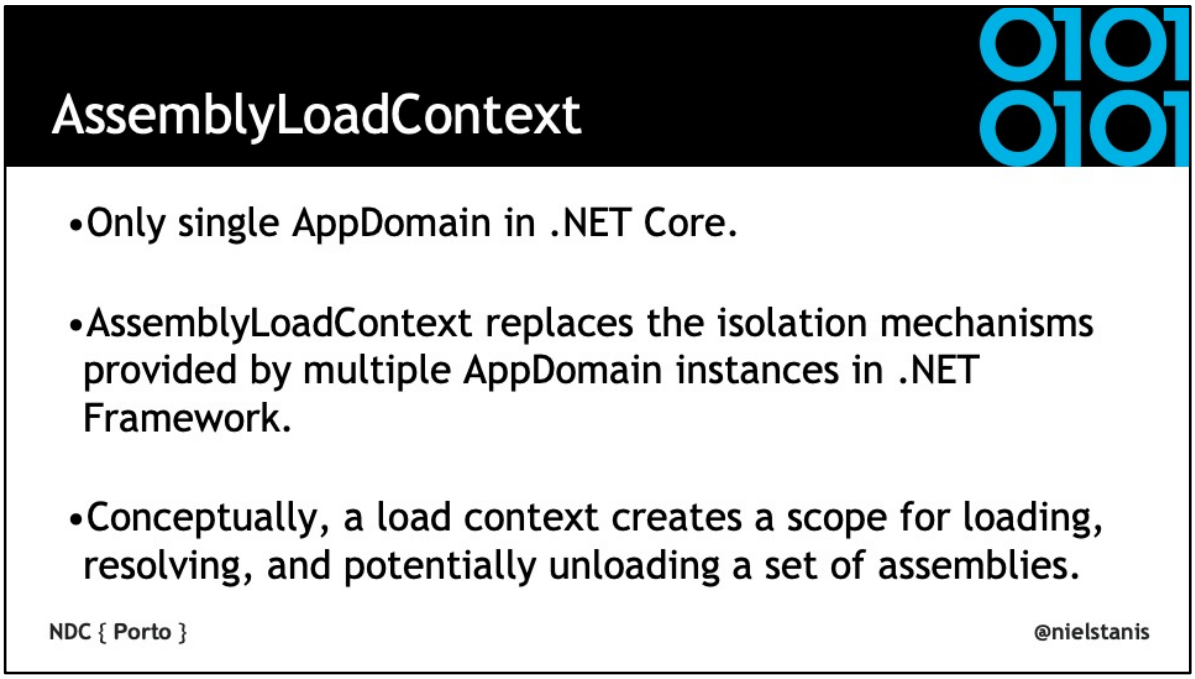
https://docs.microsoft.com/en-us/previous-versions/dotnet/framework/code-access-security/code-access-security-basics
https://docs.microsoft.com/en-us/previous-versions/dotnet/framework/code-access-security/code-access-security-policy-compatibility-and-migration

Image: C# logo https://docs.microsoft.com/en-us/dotnet/csharp/

DocumentProcessor Package

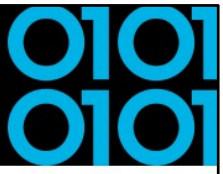


- Use package as is!
  - Disclaimer: always comply with library license!
  - Not allowed to reverse engineer/decompile
- We do want to change behaviour:
  - Opening documents directly from URL – SSRF
  - Writing files to any arbitrary directory – Path Traversal
- There are *several* ways to *fix* this!



https://docs.microsoft.com/en-us/dotnet/api/system.runtime.loader.assemblyloadcontext?view=net-5.0
https://docs.microsoft.com/en-us/dotnet/core/dependency-loading/understanding-assemblyloadcontext

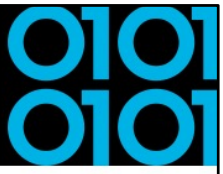
AssemblyLoadContext



- It allows multiple versions of the same assembly to be loaded within a single process.
- It does not provide any security features. All code has full permissions of the process.
- But it does allow us to control what gets loaded!

https://docs.microsoft.com/en-us/dotnet/api/system.runtime.loader.assemblyloadcontext?view=net-5.0
https://docs.microsoft.com/en-us/dotnet/core/dependency-loading/understanding-assemblyloadcontext

AssemblyLoadContext

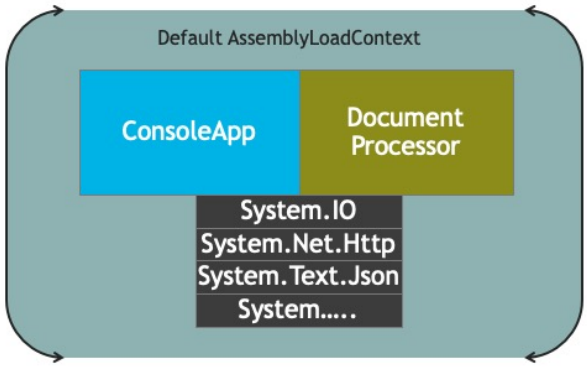


- Interface project used as shared contract
- Remove DocumentProcessor package from ConsoleApp
  - Add reference to interface project
- Create Library that implements interface
  - Reference interface project and DocumentProcessor Package
  - Self-contained deployment to folder that has all to be loaded by our sandboxed loadcontext

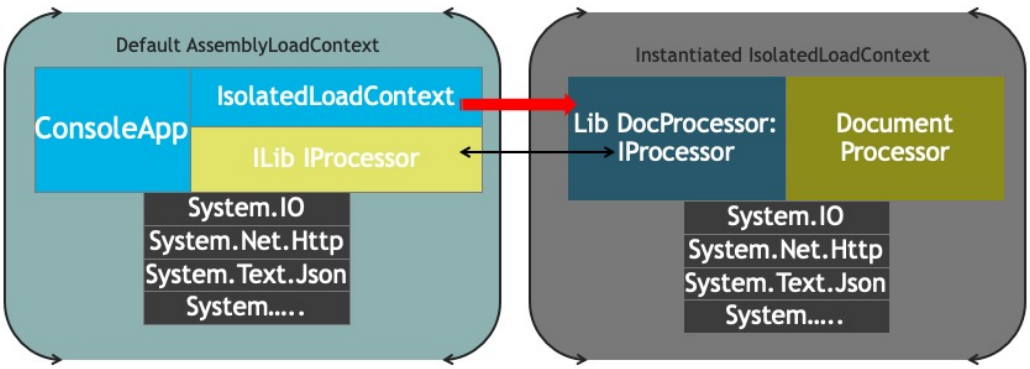
https://docs.microsoft.com/en-us/dotnet/api/system.runtime.loader.assemblyloadcontext?view=net-5.0
https://docs.microsoft.com/en-us/dotnet/core/dependency-loading/understanding-assemblyloadcontext

Image: C# logo https://docs.microsoft.com/en-us/dotnet/csharp/

ConsoleApp Start



ConsoleApp & Sandboxed Library



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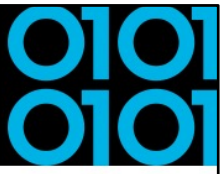
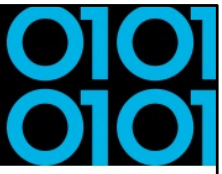
Removing Types?



- Self contained set of assemblies, could we not remove types?
- What about trimming that got introduced with .NET 5?
- Maybe we need something more rigorous?

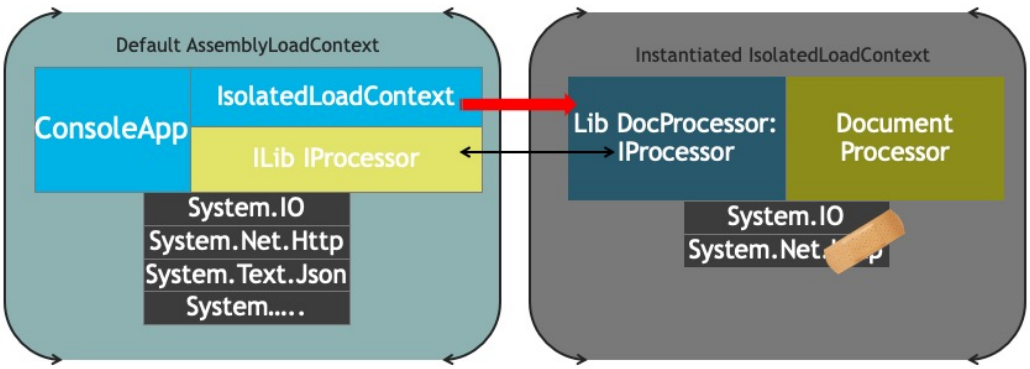
Patching with Harmony2



- A library for patching, replacing and decorating .NET and Mono methods during runtime.
  - Patch at runtime (pre- and postfix)
  - Transpile at compile time (rewrite IL)
- Harmony v2
  - Lib.Harmony on NuGet
  - https://github.com/pardeike/Harmony

Image: C# logo https://docs.microsoft.com/en-us/dotnet/csharp/

ConsoleApp & Sandboxed Library



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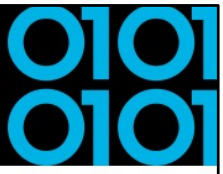
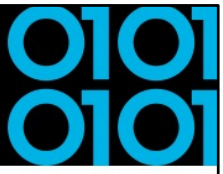
Conclusion



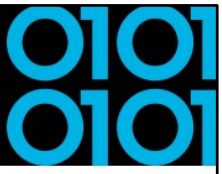
- Update libraries; security problems get fixed
- Integrate security into your development lifecycle
- Know what libraries are used, where and what's inside and most important what you'd expect from it.

Conclusion



- Futures of this Sandbox Concept
  - Easier developer integration (e.g. source generator)
  - Package + good guidance on how this can be used in different application contexts like ASP.NET Core.
  - Basic patches/policy that can be applied on libraries

Questions?



- https://github.com/nielstanis/ndcporto2022
- ntanis at Veracode.com
- @NielsTanis on Twitter
- https://blog.fennec.dev
- Obrigado! Thanks!