

The background image is a photograph of a grand, multi-story library interior. The ceiling is a large, ornate dome with a grid of decorative panels. The walls are lined with arched windows and bookshelves. The floor is filled with rows of long study tables and chairs. The overall atmosphere is one of a historic, well-maintained library.

# Building Great Libraries with .NET Standard

Chad Green  
Nebraska.Code()  
August 15, 2019



# Who is Chad Green

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ChadwickEGreen





# Agenda

Building Great Libraries with .NET Standard

- 1 Quick History Lesson
- 2 Choosing the Right Version
- 3 Referencing .NET Framework Libraries
- 4 When to Use .NET Standard
- 5 Platform Specific Code
- 6 Guidelines for Great Libraries



The background image is a high-angle, wide shot of a magnificent library interior. The space is characterized by a massive, coffered dome that fills the upper half of the frame. Below the dome, the architecture features multiple levels of arched galleries and balconies, all lined with floor-to-ceiling bookshelves. The ground floor is filled with long, wooden study tables and chairs, arranged in a grid-like pattern. The lighting is warm and ambient, highlighting the intricate details of the architecture and the vastness of the collection. The overall atmosphere is one of intellectual grandeur and historical significance.

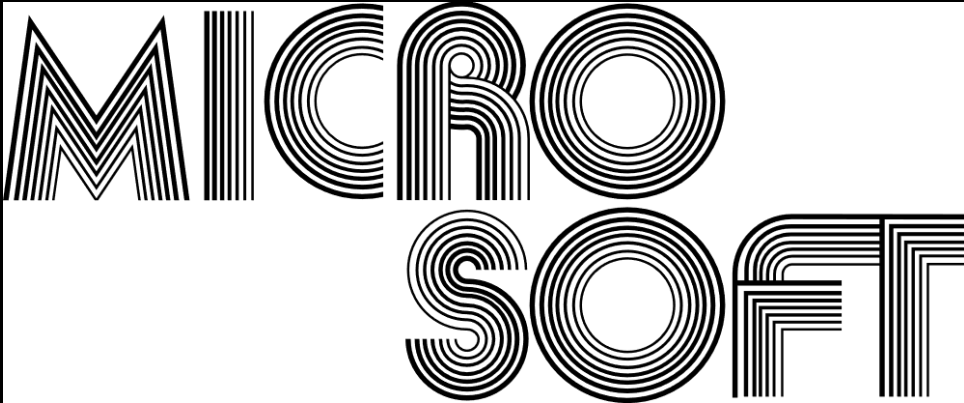
# Quick History Lesson

Building Great Libraries with .NET Standard



# Microsoft Development Tools Up to .NET

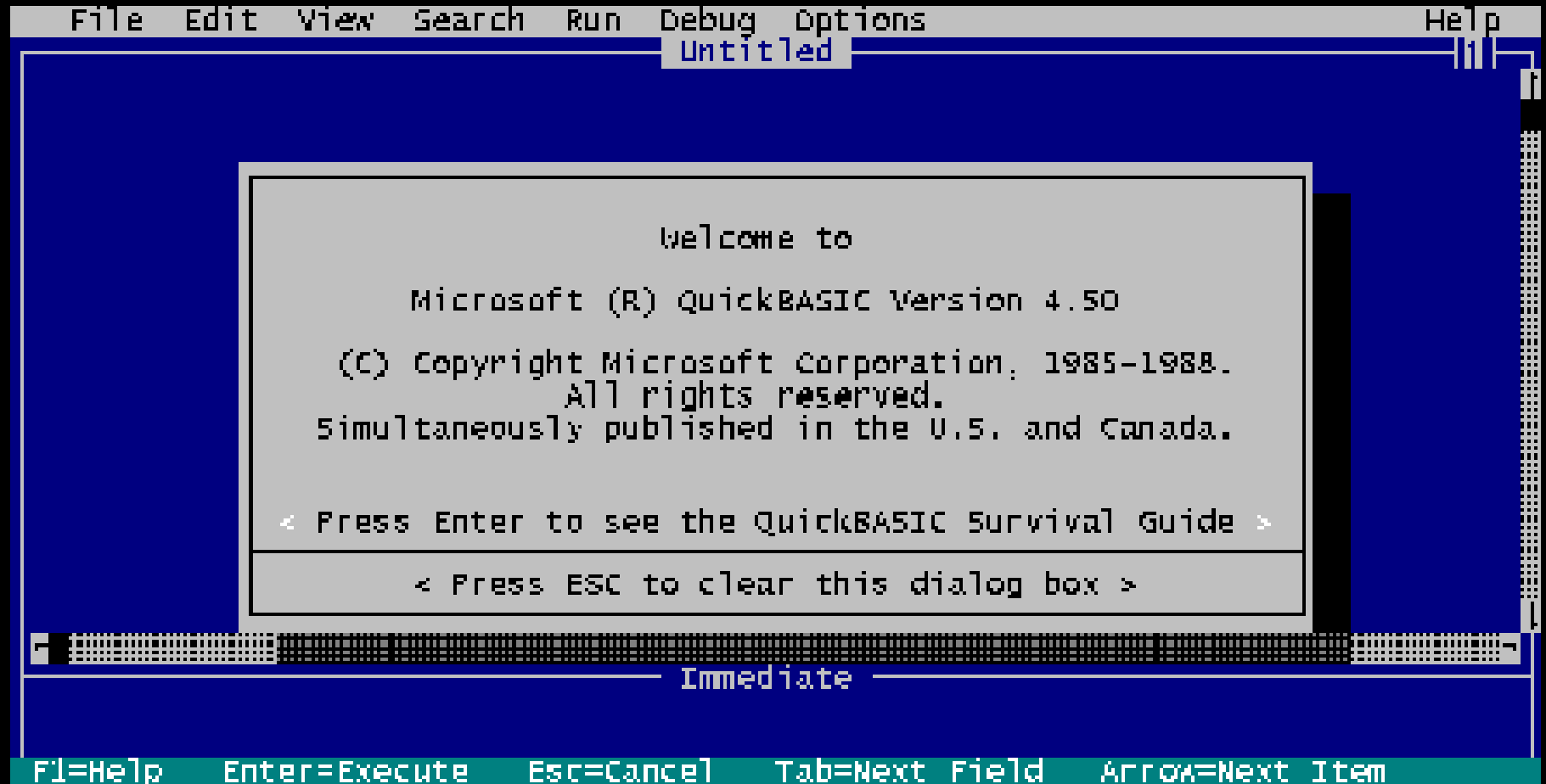
- MicroSoft Basic





# Microsoft Development Tools Up to .NET

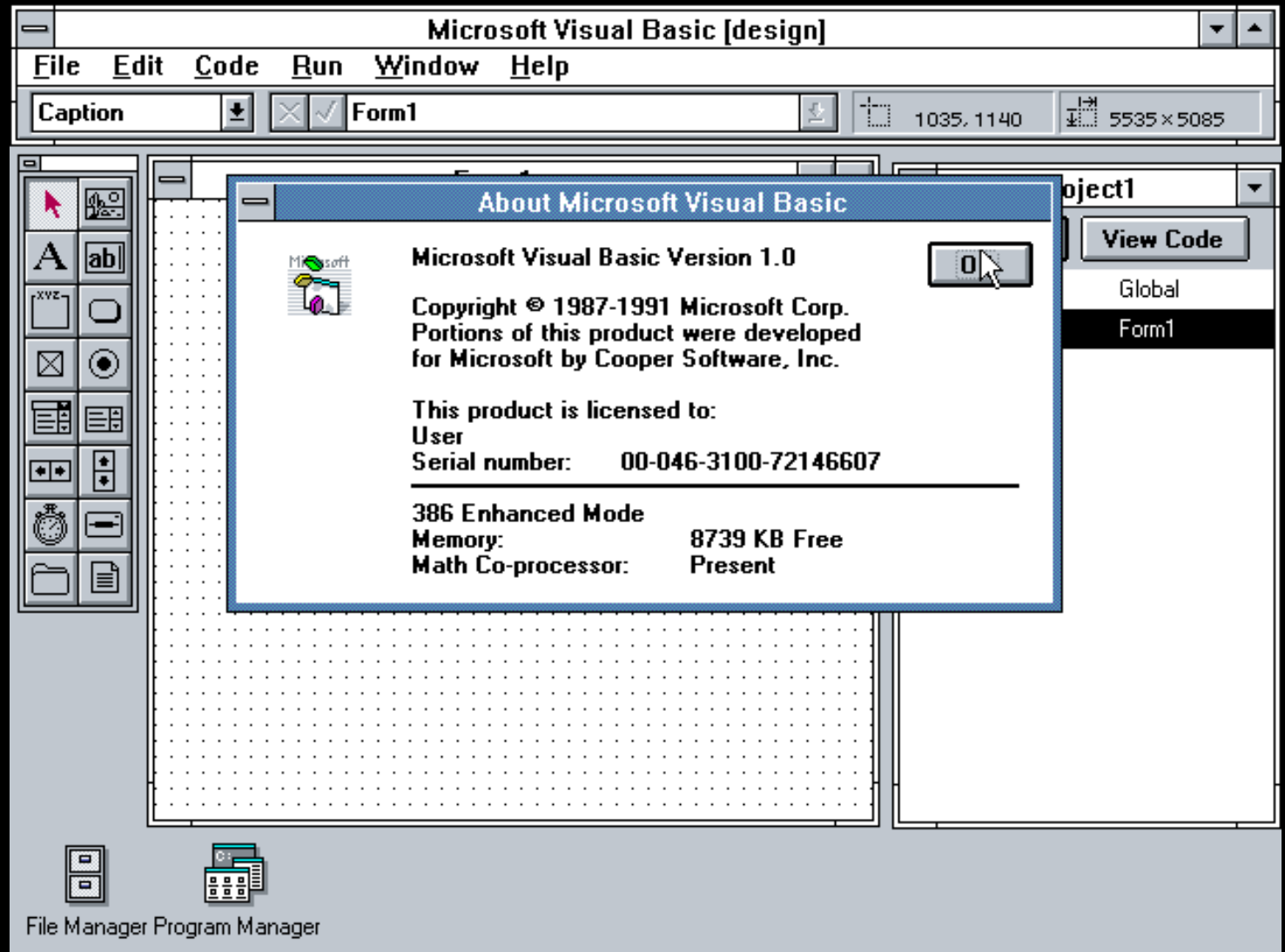
- MicroSoft Basic
- QuickBASIC





# Microsoft Development Tools Up to .NET

- MicroSoft Basic
- QuickBASIC
- Visual Basic



# Introduction of Microsoft .NET

- Java
- Managed Runtime
- Runtime of many names
  - COM+
  - Compound Object Runtime (COR)
  - Universal RunTime (URT)
  - Next-Gen Windows Service (NGWS)
  - .NET

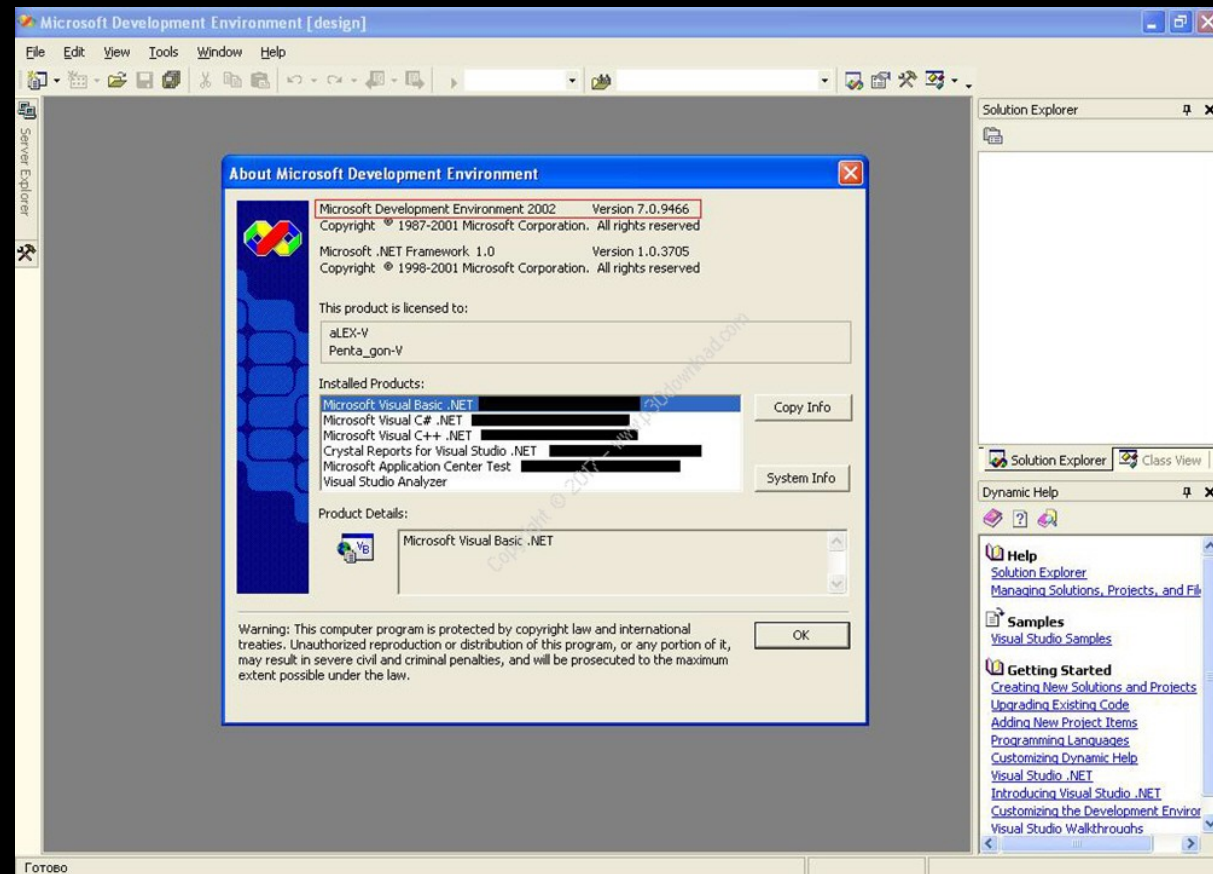


# Introduction of Microsoft .NET

- Microsoft actually wanted industry support
  - Took specifications to ECMA
  - ECMA 334 – C# Language Specification
  - ECMA 335 – Common Language Infrastructure (CLI)
  - Microsoft, HP, Intel were core sponsors

# Microsoft .NET

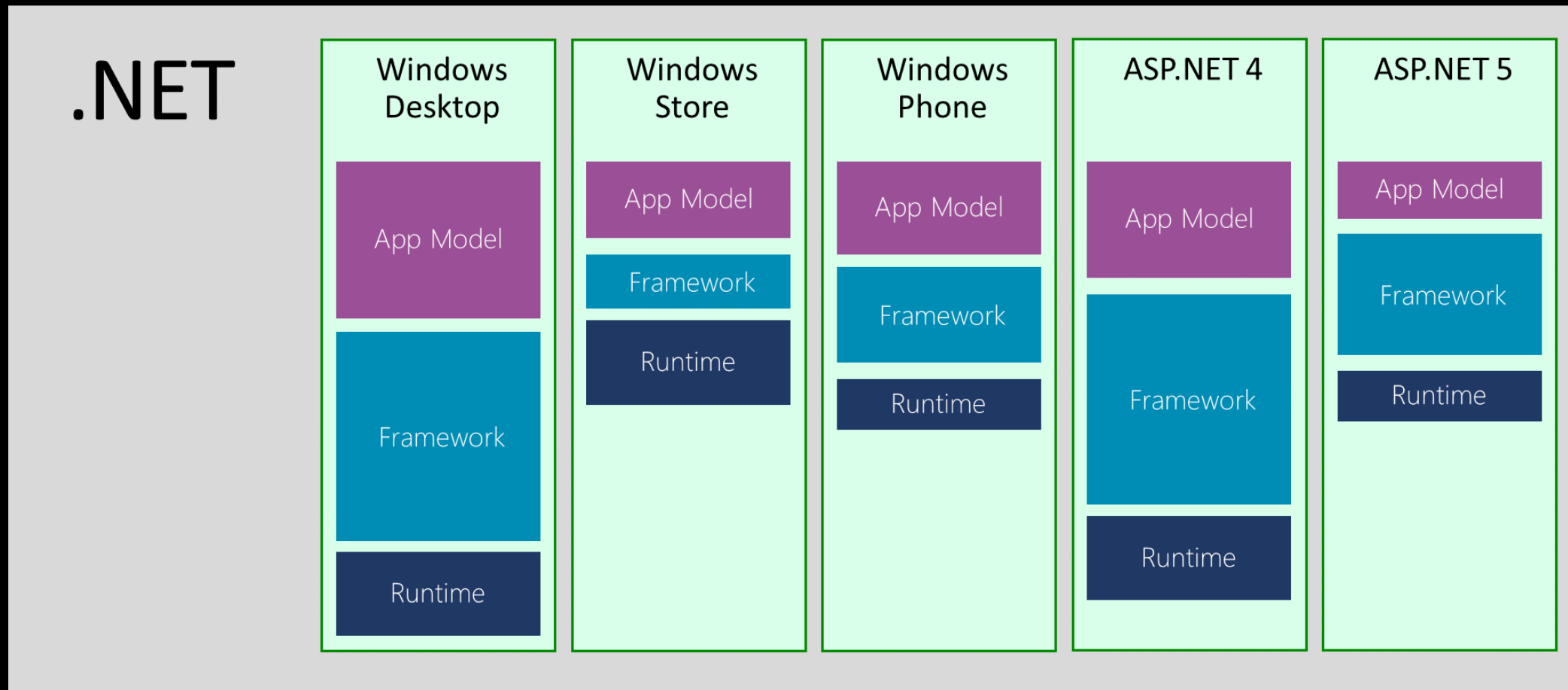
- Introduction of CLR
- Support for object-oriented Web application development
- Use of DLL class libraries





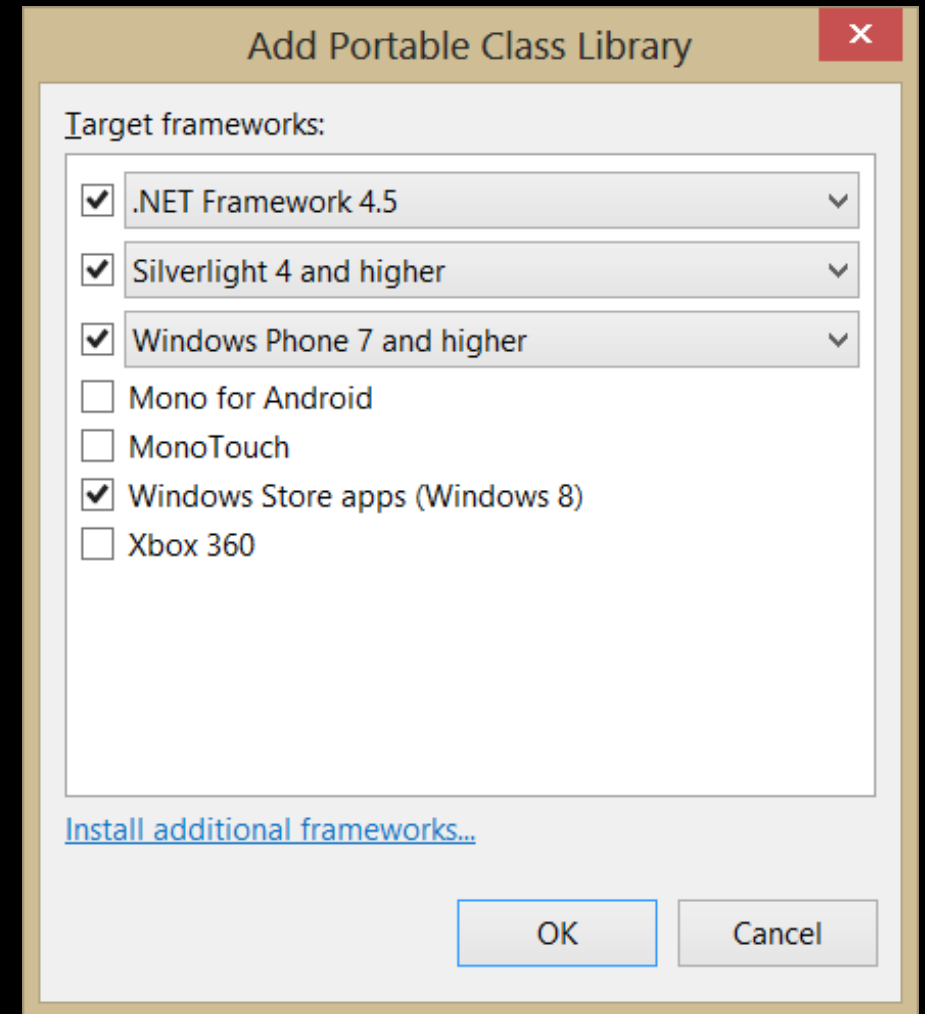
# So why something different?

- .NET – a set of verticals



# So why something different?

- .NET – a set of verticals
- Birth of portable class libraries



The background image is a high-angle, wide shot of a magnificent library interior. The space is characterized by a massive, coffered dome that fills the upper half of the frame. Below the dome, the architecture features multiple levels of arched loggias with classical columns and decorative balustrades. The ground floor is filled with rows of long, wooden study tables, each equipped with a small lamp. In the background, tall bookshelves line the walls, and a central staircase leads to an upper level. The overall atmosphere is one of grandeur and intellectual pursuit.

# It's a Whole New World

Building Great Libraries with .NET Standard



A romantic scene from Disney's 'The Little Mermaid' featuring Ariel and Prince Eric. Ariel, with her dark hair and blue seashell top, is looking up at Prince Eric, who is smiling back at her. They are positioned in front of a large, glowing full moon against a dark blue night sky filled with stars. The scene is framed by the silhouettes of other characters in the background.

**A whole new world**

# It's a whole new world

**.NET Framework**

Windows Only

**.NET Core**

Windows, Linux,  
Mac OS

**Xamarin**

iOS, Android

It's a whole new world

**.NET Framework**

**.NET Core**

**Xamarin**

**.NET Standard**



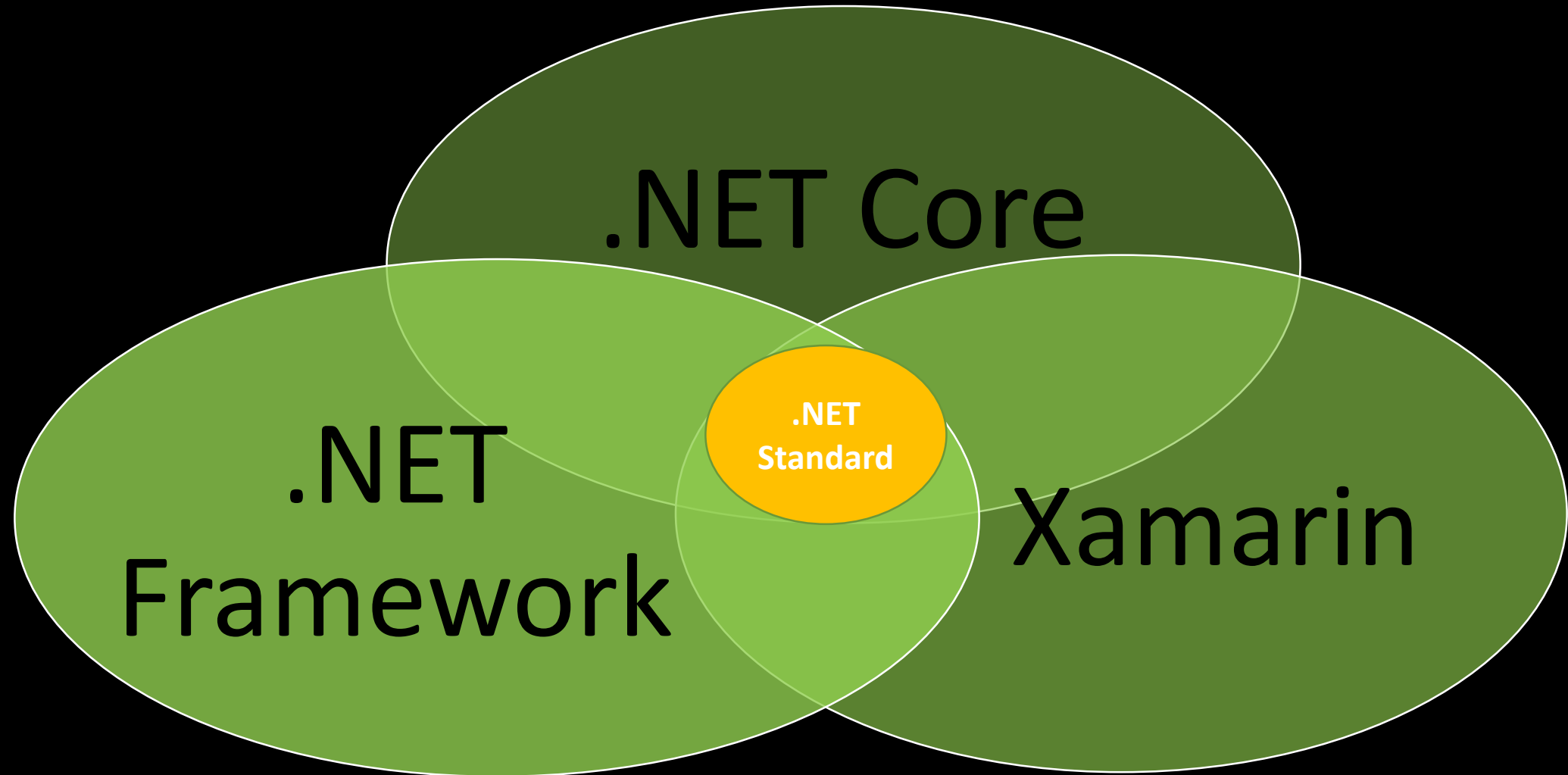
# What is .NET Standard?

**A Specification**

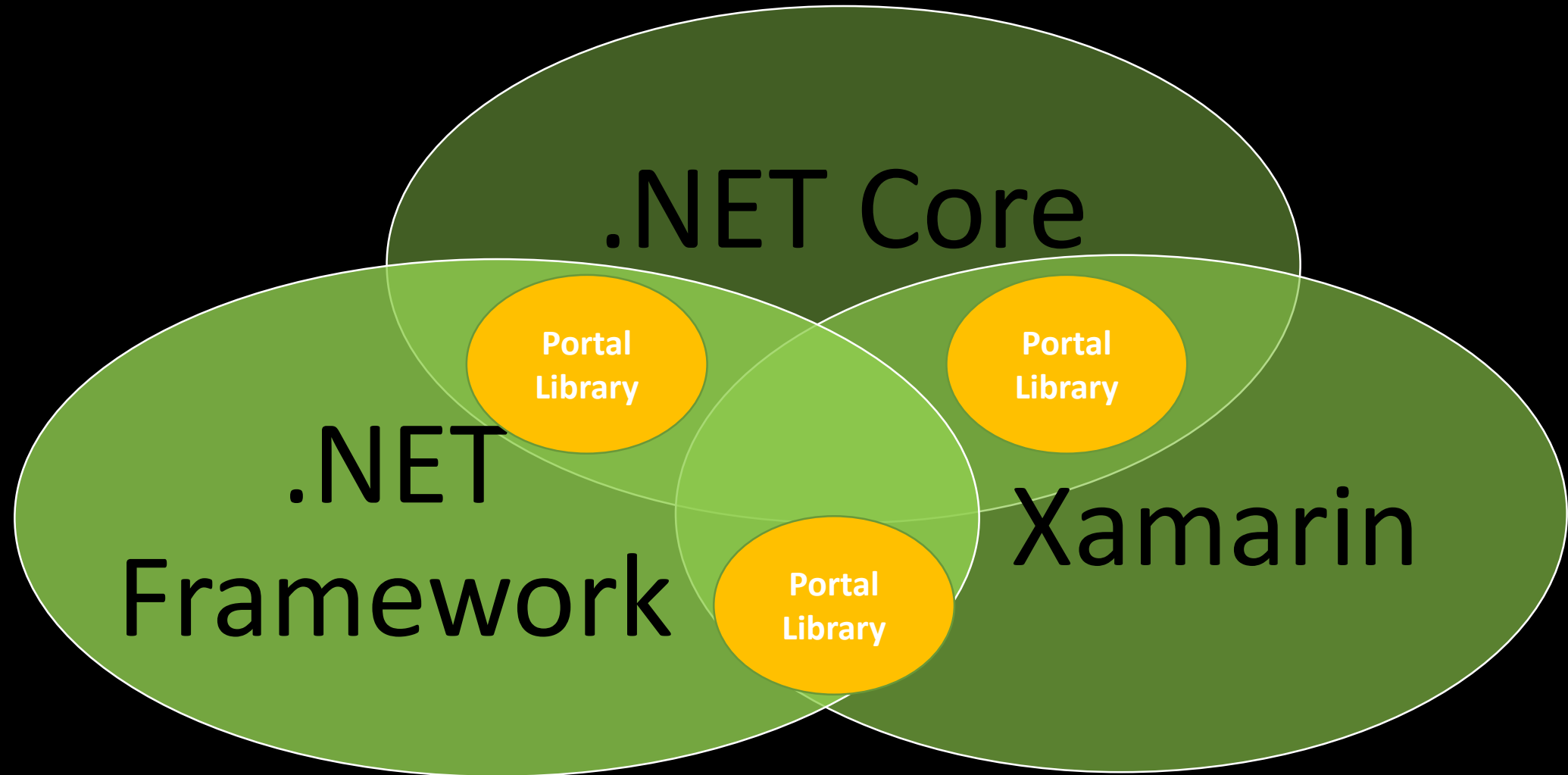
**Defines a set of  
APIs that all  
.NET platforms  
have to  
implement**

**Not another  
.NET platform**

# What is .NET Standard?



# What is .NET Standard?



# What is .NET Standard?

## Portable Class Libraries

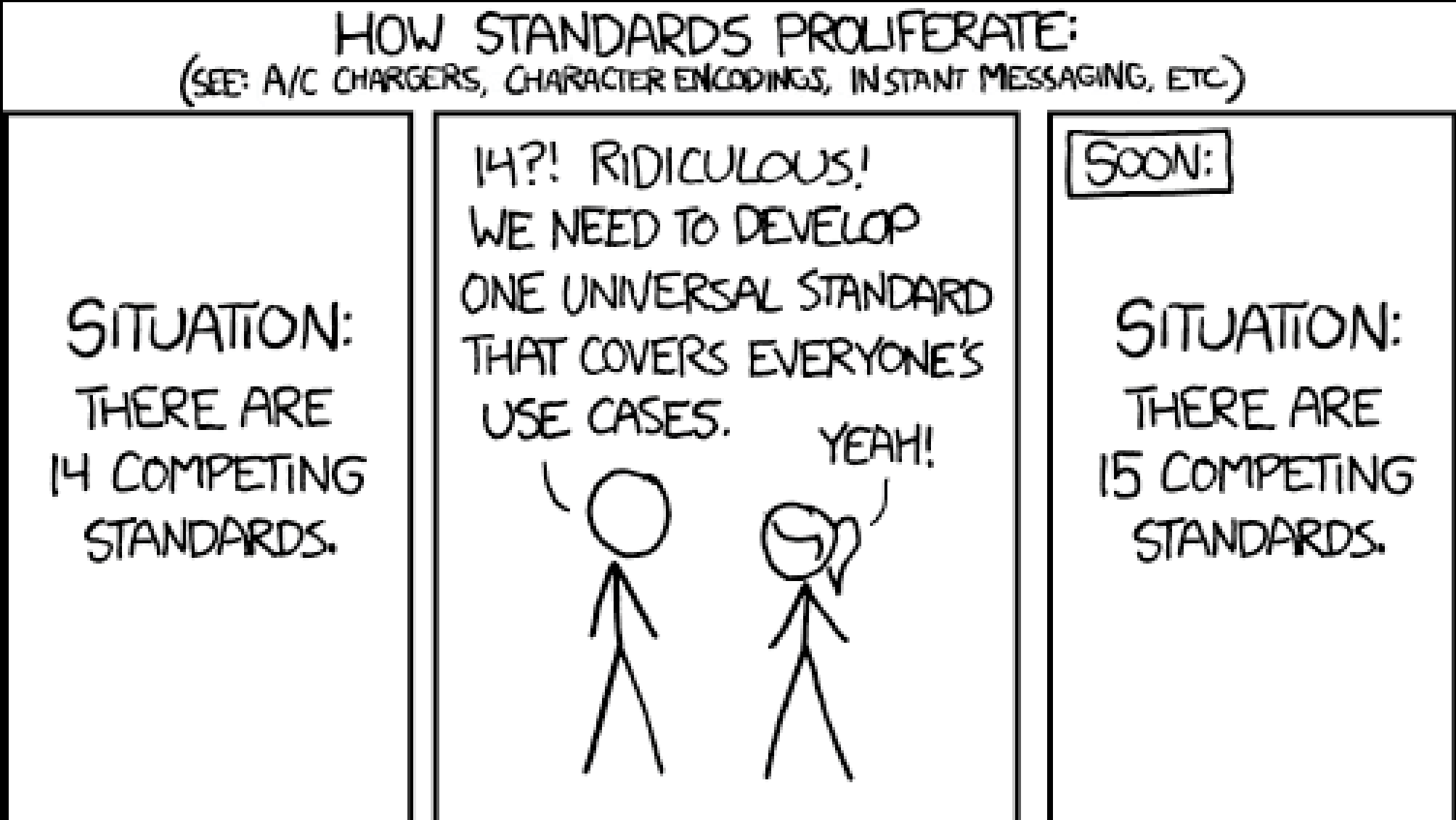
- Intersection profiles are computed
- Depend on the targeted platform
- No systematic versioning approach

## .NET Standard

- Set of APIs that are selected by humans
- Independent from any .NET Platform
- Versioned linearly and backward compatible



# What is .NET Standard?



OK, so which framework am I supposed to use?

IT Depends

.NET Framework

.NET Core

.NET Standard

Windows Only

Windows, Linux,  
Mac OS

Cross .NET  
Platform

The background image is a high-angle, wide shot of a magnificent library interior. The space is characterized by a massive, coffered dome that fills the upper half of the frame. Below the dome, the architecture features multiple levels of arched loggias with classical columns and statues. The lower levels are filled with rows of bookshelves and study tables, creating a sense of depth and grandeur. The lighting is soft and even, highlighting the intricate details of the architecture.

# Demo

Building Great Libraries with .NET Standard



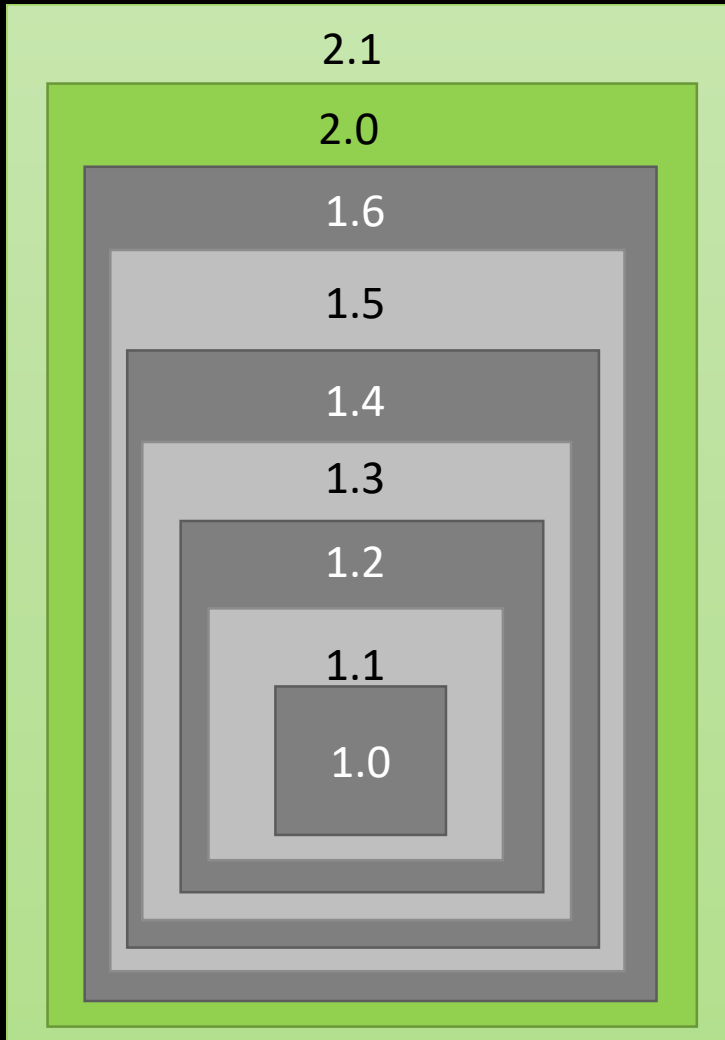


# Choosing the Right Version

Building Great Libraries with .NET Standard



# Choosing the Right Version



- A .NET Standard version contains all APIs from the previous versions
- A .NET platform implements a specific .NET Standard version
- Every .NET Standard version is immutable

# Choosing the Right Version

**A higher version  
means more  
APIs, but less  
platforms**

**A lower version  
means less APIs,  
but more  
platforms**

**Target the  
lowest possible  
version**

# Choosing the Right Version

| Version: .NET Standard 1.0 ▼ | Available APIs: 7,949 of 32,638                                         |
|------------------------------|-------------------------------------------------------------------------|
|                              | <div></div>                                                             |
| .NET Implementation          | Version Support                                                         |
| .NET Core                    | ✓ 1.0 ✓ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |
| .NET Framework               | ✓ 4.5 ✓ 4.5.1 ✓ 4.5.2 ✓ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |
| Mono                         | ✓ 4.6 ✓ 5.4                                                             |
| Xamarin.iOS                  | ✓ 10.0 ✓ 10.14                                                          |
| Xamarin.Android              | ✓ 7.0 ✓ 8.0                                                             |
| Universal Windows Platform   | ✓ 8.0 ✓ 8.1 ✓ 10.0 ✓ 10.0.16299                                         |
| Unity                        | ✓ 2018.1                                                                |

# Choosing the Right Version

Version: .NET Standard 1.1 ▾

Available APIs: 10,239 of 32,638

| .NET Implementation        | Version Support                                                         |
|----------------------------|-------------------------------------------------------------------------|
| .NET Core                  | ✓ 1.0 ✓ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |
| .NET Framework             | ✓ 4.5 ✓ 4.5.1 ✓ 4.5.2 ✓ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |
| Mono                       | ✓ 4.6 ✓ 5.4                                                             |
| Xamarin.iOS                | ✓ 10.0 ✓ 10.14                                                          |
| Xamarin.Android            | ✓ 7.0 ✓ 8.0                                                             |
| Universal Windows Platform | ✓ 8.0 ✓ 8.1 ✓ 10.0 ✓ 10.0.16299                                         |
| Unity                      | ✓ 2018.1                                                                |



# Choosing the Right Version

| Version: <span>.NET Standard 1.2 ▾</span> | Available APIs: 10,285 of 32,638                                        |
|-------------------------------------------|-------------------------------------------------------------------------|
|                                           | <div></div>                                                             |
| .NET Implementation                       | Version Support                                                         |
| .NET Core                                 | ✓ 1.0 ✓ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |
| .NET Framework                            | ✗ 4.5 ✓ 4.5.1 ✓ 4.5.2 ✓ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |
| Mono                                      | ✓ 4.6 ✓ 5.4                                                             |
| Xamarin.iOS                               | ✓ 10.0 ✓ 10.14                                                          |
| Xamarin.Android                           | ✓ 7.0 ✓ 8.0                                                             |
| Universal Windows Platform                | ✗ 8.0 ✓ 8.1 ✓ 10.0 ✓ 10.0.16299                                         |
| Unity                                     | ✓ 2018.1                                                                |

# Choosing the Right Version

Version: .NET Standard 1.3 ▾

Available APIs: 13,122 of 32,638

| .NET Implementation        | Version Support                                                         |
|----------------------------|-------------------------------------------------------------------------|
| .NET Core                  | ✓ 1.0 ✓ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |
| .NET Framework             | ✗ 4.5 ✗ 4.5.1 ✗ 4.5.2 ✓ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |
| Mono                       | ✓ 4.6 ✓ 5.4                                                             |
| Xamarin.iOS                | ✓ 10.0 ✓ 10.14                                                          |
| Xamarin.Android            | ✓ 7.0 ✓ 8.0                                                             |
| Universal Windows Platform | ✗ 8.0 ✗ 8.1 ✓ 10.0 ✓ 10.0.16299                                         |
| Unity                      | ✓ 2018.1                                                                |

# Choosing the Right Version

Version: .NET Standard 1.4 ▾

Available APIs: 13,140 of 32,638

| .NET Implementation        | Version Support                                                         |
|----------------------------|-------------------------------------------------------------------------|
| .NET Core                  | ✓ 1.0 ✓ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |
| .NET Framework             | ✗ 4.5 ✗ 4.5.1 ✗ 4.5.2 ✗ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |
| Mono                       | ✓ 4.6 ✓ 5.4                                                             |
| Xamarin.iOS                | ✓ 10.0 ✓ 10.14                                                          |
| Xamarin.Android            | ✓ 7.0 ✓ 8.0                                                             |
| Universal Windows Platform | ✗ 8.0 ✗ 8.1 ✓ 10.0 ✓ 10.0.16299                                         |
| Unity                      | ✓ 2018.1                                                                |

# Choosing the Right Version

Version: .NET Standard 1.5 ▾

Available APIs: 13,355 of 32,638

| .NET Implementation        | Version Support                                                         |
|----------------------------|-------------------------------------------------------------------------|
| .NET Core                  | ✓ 1.0 ✓ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |
| .NET Framework             | ✗ 4.5 ✗ 4.5.1 ✗ 4.5.2 ✗ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |
| Mono                       | ✓ 4.6 ✓ 5.4                                                             |
| Xamarin.iOS                | ✓ 10.0 ✓ 10.14                                                          |
| Xamarin.Android            | ✓ 7.0 ✓ 8.0                                                             |
| Universal Windows Platform | ✗ 8.0 ✗ 8.1 ✗ 10.0 ✓ 10.0.16299                                         |
| Unity                      | ✓ 2018.1                                                                |



# Choosing the Right Version

| Version:                   | <div>.NET Standard 1.6 ▾</div>                                          | Available APIs: 13,501 of 32,638 |
|----------------------------|-------------------------------------------------------------------------|----------------------------------|
| <div></div>                |                                                                         |                                  |
| .NET Implementation        | Version Support                                                         |                                  |
| .NET Core                  | ✓ 1.0 ✓ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |                                  |
| .NET Framework             | ✗ 4.5 ✗ 4.5.1 ✗ 4.5.2 ✗ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |                                  |
| Mono                       | ✓ 4.6 ✓ 5.4                                                             |                                  |
| Xamarin.iOS                | ✓ 10.0 ✓ 10.14                                                          |                                  |
| Xamarin.Android            | ✓ 7.0 ✓ 8.0                                                             |                                  |
| Universal Windows Platform | ✗ 8.0 ✗ 8.1 ✗ 10.0 ✓ 10.0.16299                                         |                                  |
| Unity                      | ✓ 2018.1                                                                |                                  |

# Choosing the Right Version

| Version: .NET Standard 2.0 ▾ | Available APIs: 32,638 of 32,638                                        |
|------------------------------|-------------------------------------------------------------------------|
| .NET Implementation          | Version Support                                                         |
| .NET Core                    | ✗ 1.0 ✗ 1.1 ✓ 2.0 ✓ 2.1 ✓ 2.2 ✓ 3.0                                     |
| .NET Framework               | ✗ 4.5 ✗ 4.5.1 ✗ 4.5.2 ✗ 4.6 ✓ 4.6.1 ✓ 4.6.2 ✓ 4.7 ✓ 4.7.1 ✓ 4.7.2 ✓ 4.8 |
| Mono                         | ✗ 4.6 ✓ 5.4                                                             |
| Xamarin.iOS                  | ✗ 10.0 ✓ 10.14                                                          |
| Xamarin.Android              | ✗ 7.0 ✓ 8.0                                                             |
| Universal Windows Platform   | ✗ 8.0 ✗ 8.1 ✗ 10.0 ✓ 10.0.16299                                         |
| Unity                        | ✓ 2018.1                                                                |

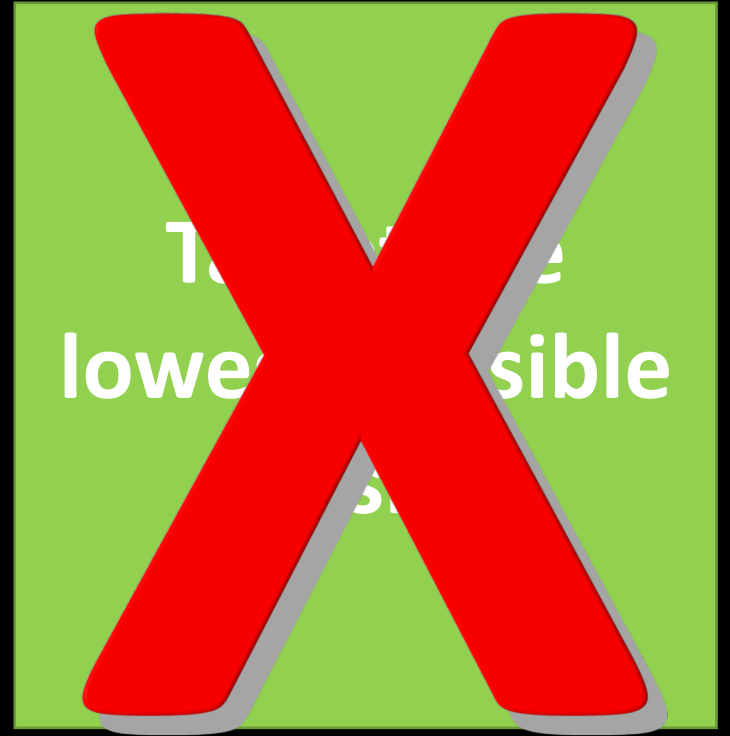
# Choosing the Right Version

<https://dotnet.microsoft.com/platform/dotnet-standard>

# Choosing the Right Version

A higher version  
means more  
APIs, but less  
platforms

A lower version  
means less APIs,  
but more  
platforms



# Choosing the Right Version

## .NET Standard 2.1

- `Span<T>`



# Choosing the Right Version

## .NET Standard 2.1

- `Span<T>`
- Foundational APIs working with spans

# Choosing the Right Version

## .NET Standard 2.1

- `Span<T>`
- Foundational APIs working with spans
- Reflection emit

# Choosing the Right Version

## .NET Standard 2.1

- `Span<T>`
- Foundational APIs working with spans
- Reflection emit
- SIMD (Single Instruction, Multiple Data)
- `ValueTask` and `ValueTask<T>`

# Choosing the Right Version

## .NET Standard 2.1

- `Span<T>`
- Foundational APIs working with spans
- Reflection emit
- SIMD (Single Instruction, Multiple Data)
- `ValueTask` and `ValueTask<T>`

# Choosing the Right Version

## .NET Standard 2.1

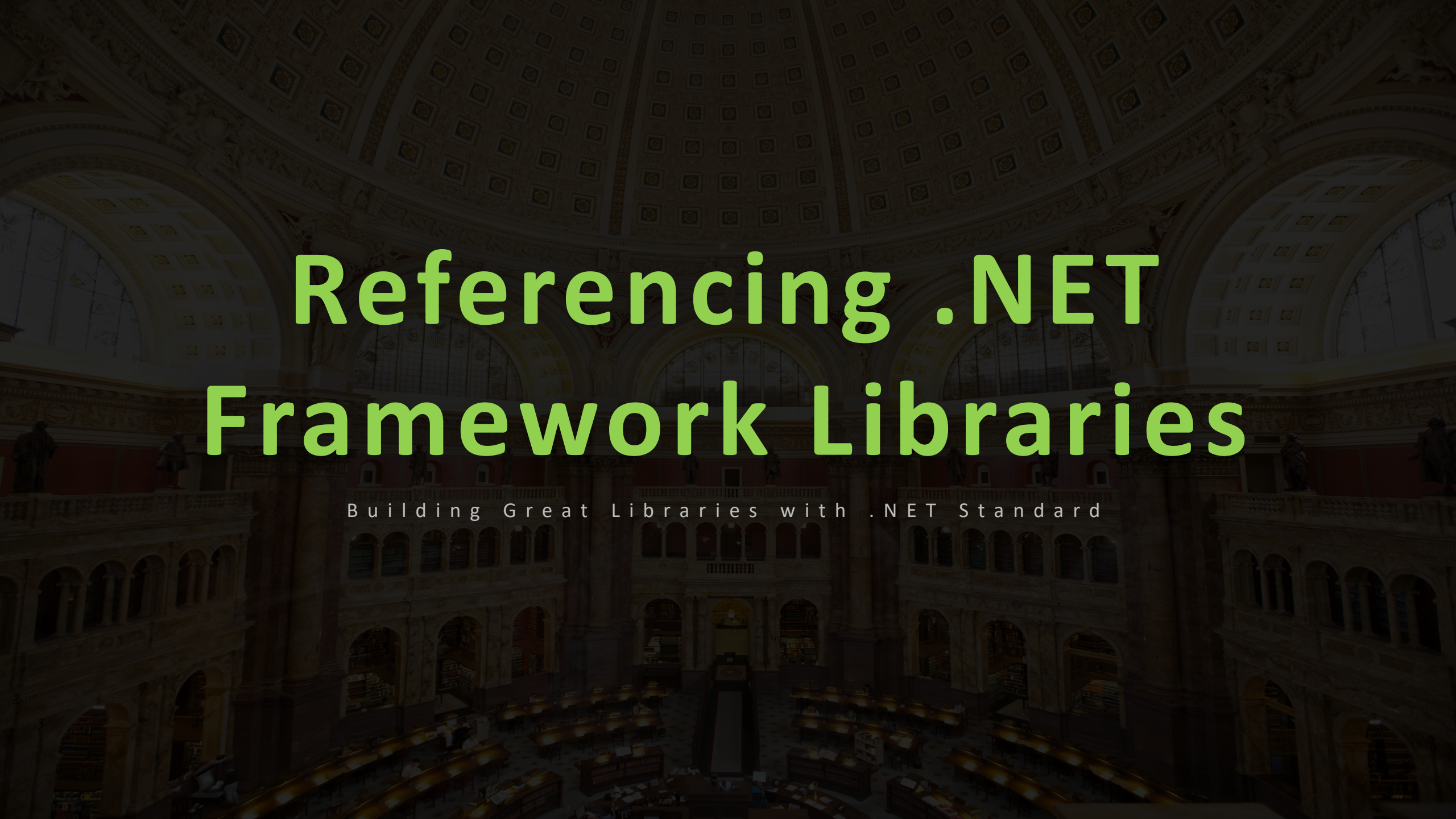
- `Span<T>`
- Foundational APIs working with spans
- Reflection emit
- SIMD (Single Instruction, Multiple Data)
- `ValueTask` and `ValueTask<T>`
- `DBProviderFactories`



# Choosing the Right Version

## .NET Standard 2.1

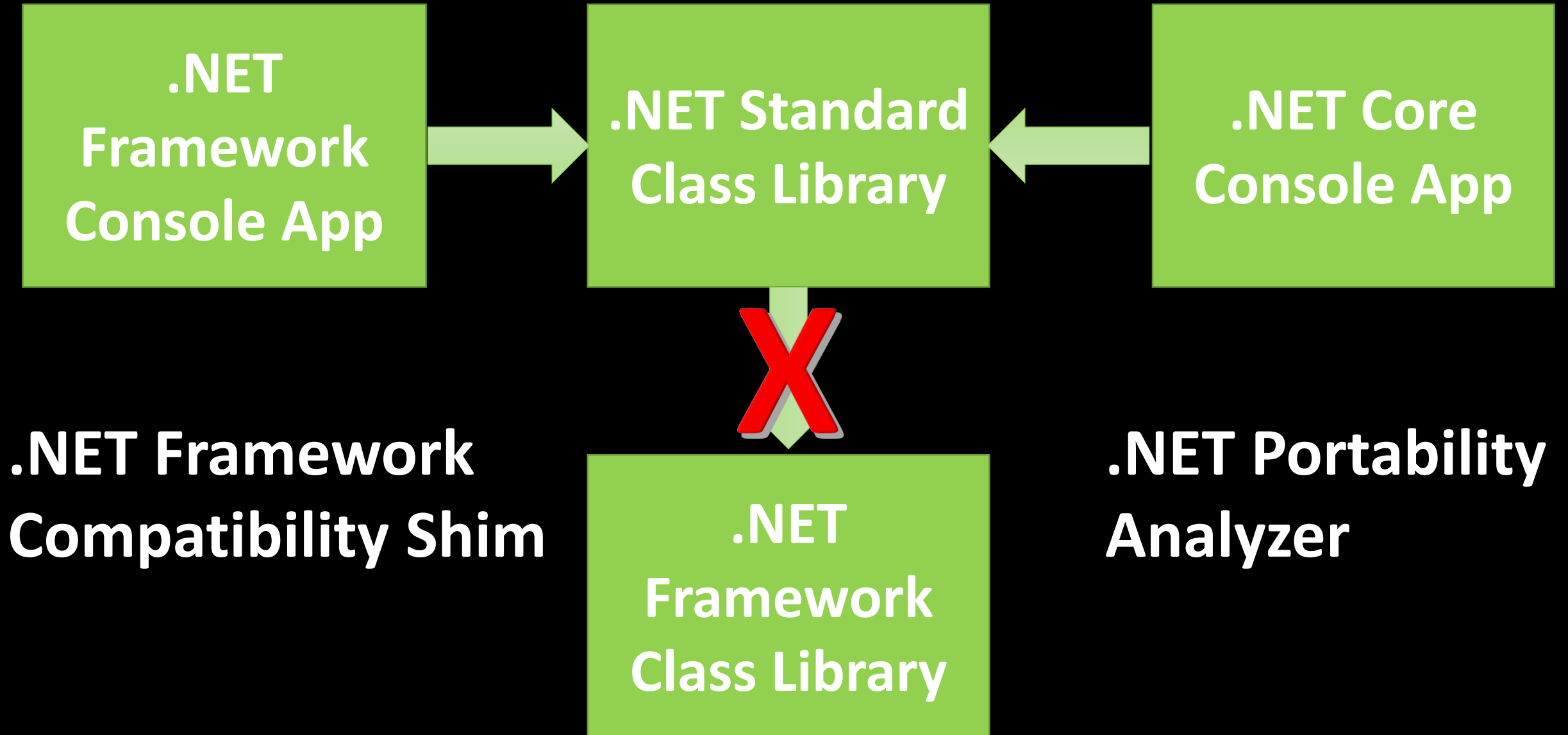
- `Span<T>`
- Foundational APIs working with spans
- Reflection emit
- SIMD (Single Instruction, Multiple Data)
- `ValueTask` and `ValueTask<T>`
- `DBProviderFactories`
- General Goodness

The background image is a high-angle, wide shot of a magnificent library interior. The space is characterized by a massive, coffered dome that dominates the upper half of the frame. The walls and ceiling are adorned with intricate architectural details, including statues and decorative moldings. Multiple levels of arched galleries are visible, each lined with rows of bookshelves. The floor is filled with long, wooden study tables and chairs, arranged in a way that suggests a quiet place of learning and research. The overall atmosphere is one of grandeur and intellectual pursuit.

# Referencing .NET Framework Libraries

Building Great Libraries with .NET Standard

# Referencing .NET Framework Libraries





The background image is a high-angle, wide shot of a magnificent library interior. The space is characterized by a massive, coffered dome that dominates the upper half of the frame. The walls are lined with multi-story arcades of bookshelves, and the floor is filled with long, illuminated study tables and chairs. The overall atmosphere is one of grandeur and intellectual pursuit.

# When to Use .NET Standard

Building Great Libraries with .NET Standard

When to Use .NET Standard – New

*Always?*



# When to Use .NET Standard – Migration

Target lowest possible version

Library is .NET  
Standard  
Compatible

Need to use it  
on different  
.NET Platforms

Already  
reference it in a  
.NET Standard  
class library



# Platform Specific Code

Building Great Libraries with .NET Standard

# Windows Compatibility Pack

- Microsoft.Windows.Compatibility (NuGet package)
  - Can be referenced from .NET Core as well as .NET Standard
  - Has ~21k APIs (Windows-only as well as cross-platform)

- Contents

ACLs  
Code Pages  
Code Dom  
Configuration  
Crypto  
DirectoryServices

Drawing  
EventLog  
MEF v1  
ODBC  
Perf Counters  
Permissions

Ports  
Registry  
Runtime Caching  
WCF  
Windows Services

# Multi-Targeting Best Practices

- DO start with the .NET Standard 2.0
  - Most general purpose libraries will not need APIs outside this set
- CONSIDER targeting multiple frameworks
  - If you need to call platform-specific APIs outside of .NET Standard
- DO NOT drop support for .NET Standard
  - Instead, throw from the implementation and offer capability APIs. This way, your library can be used anywhere and supports runtime light-up.
- DO share your component using a NuGet package
  - It shields consumers from having to pick the appropriate implementation



The background image is a photograph of a grand, ornate library interior. It features a large, domed ceiling with a grid of decorative panels. The walls are lined with multiple levels of arched bookshelves. In the foreground, there are long, wooden study tables with chairs, and a central staircase. The overall atmosphere is one of a historic and prestigious institution.

# Guidelines for Great Libraries

Building Great Libraries with .NET Standard

# Versioning

| Kind                  | When to increment | Comment                                                                       |
|-----------------------|-------------------|-------------------------------------------------------------------------------|
| Package Version       | Every change      | The ID of the NuGet package.                                                  |
| Assembly Version      | As you see fit    | The version number of the assembly. Used by the loader to resolve assemblies. |
| File Version          | Every change      | Generic concept, used by installers to determine which file is newer.         |
| Informational Version | As you see fit    | Display string, does not need to be a version.                                |



# Best Practices

- DO follow the API Design Guidelines
- Do target .NET Standard 2.0
- CONSIDER using multi-targeting to allow for platform-specific code
  - CONSIDER dual-targeting for .NET Framework 4.6.1
  - DO use NuGet for packaging multi-targeted libraries
  - DO throw PlatformNotSupportedException for unsupported APIs
- DO strong name your libraries
  - AVOID if your library cannot be used on .NET Framework
  - DO check in the public & private key

# Questions

Building Great Libraries with .NET Standard

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Slides will be available on my site