C# Extension Methods

Module 2: Advanced Extension Methods (part 1)

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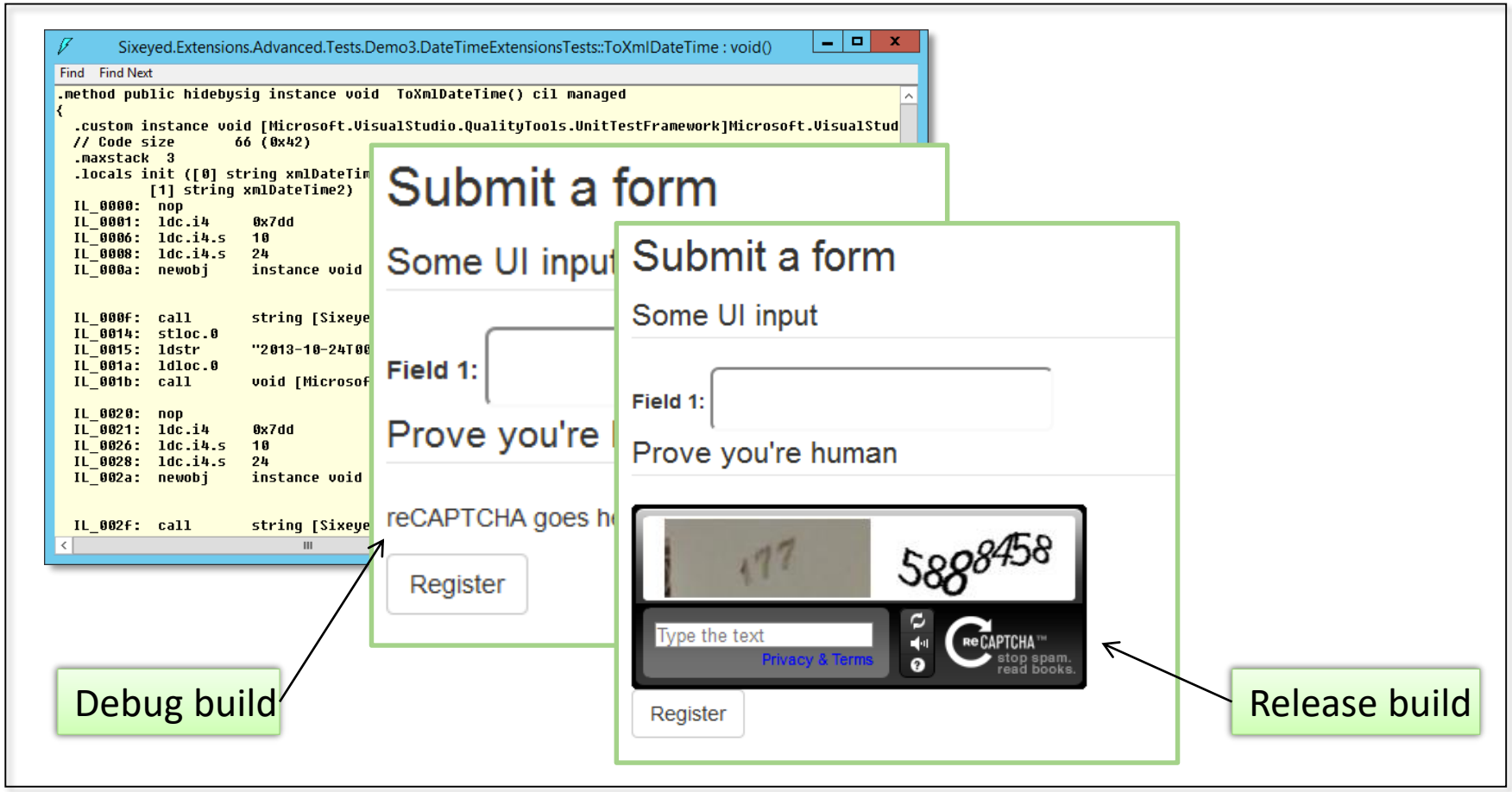
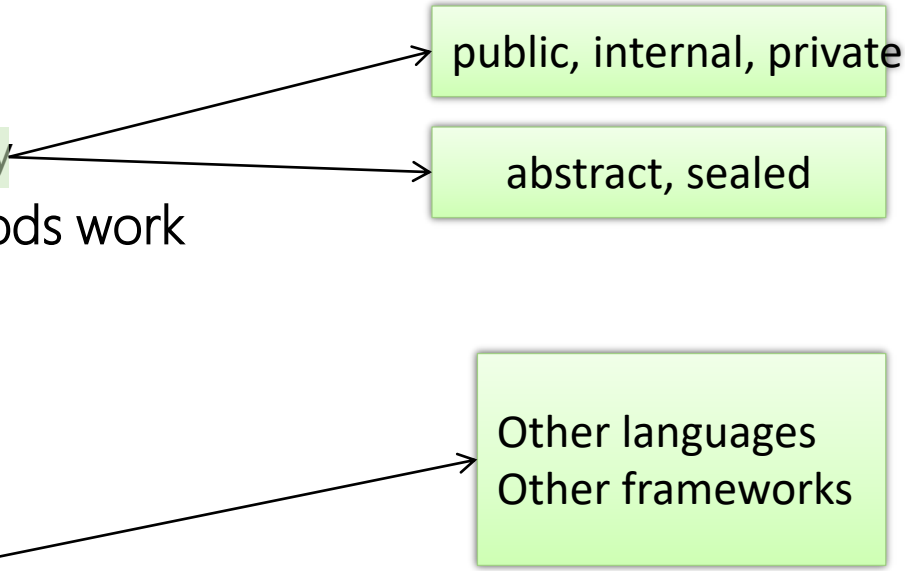
Advanced Extension Methods

- Looking closer at Extension Methods



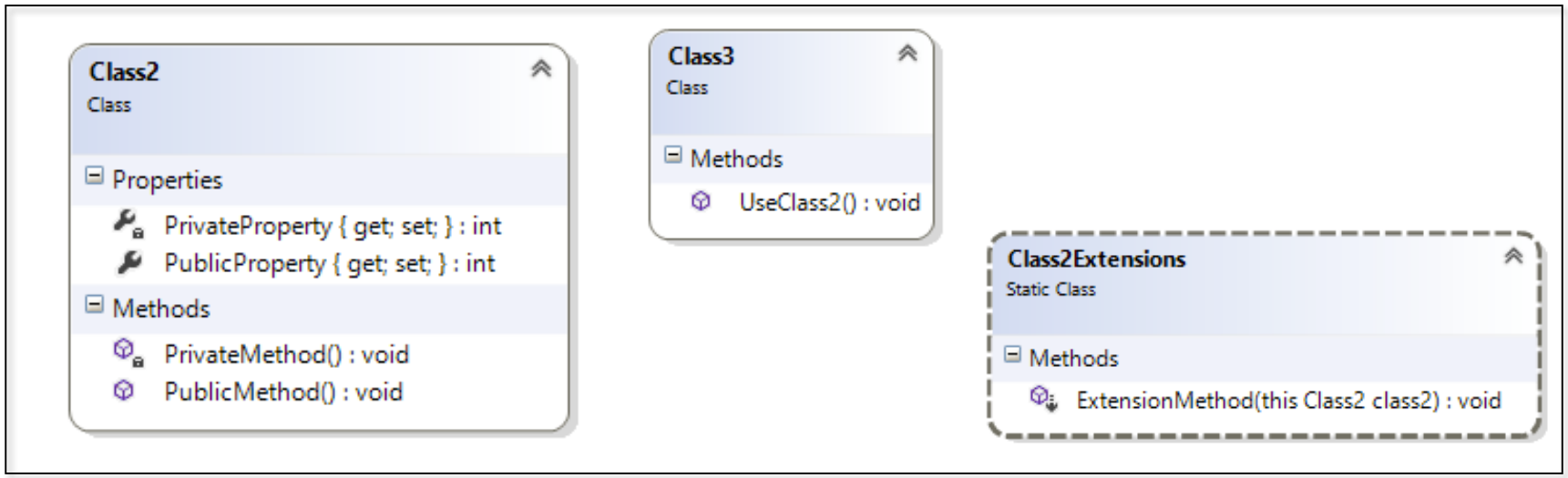
Advanced Extension Methods

- What you can't do
  - Extending state
  - Bypass accessibility
- How extension methods work
  - In the compiler
  - At runtime
- What that means
  - Limitations
  - Portability
- Resolving extension methods
  - Compile-time rules
  - Swapping implementations



What you can't do

- Access inaccessible members
  - Using the extended class externally



- Extend state
  - Static method, static class
  - Can add to class behaviour - but not state

Demo 1: Extending State

Feature

Extend system instrumentation to increase precision

Task

Extend the Instrumentation class to use a Stopwatch

Demo 1: Extending State

Demo 1: Extending State

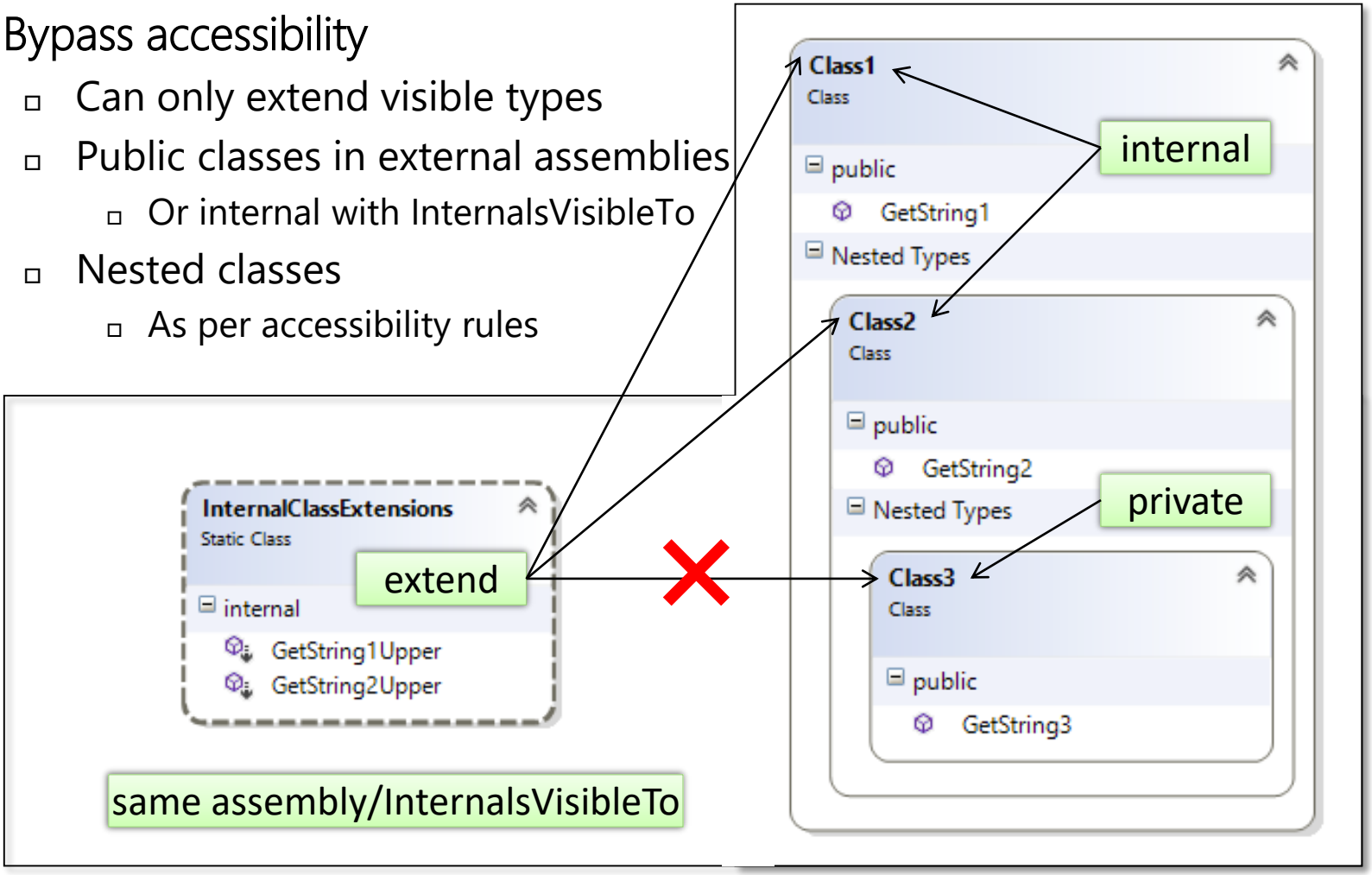
- Can access visible members
  - Public/internal methods, properties & fields
- Can't access others
  - Private/protected
  - But can use reflection
- Can't add state
  - But you can keep additional state
  - Dictionary in extension class, keyed by ID

```
private static Dictionary<Guid, Stopwatch> _Stopwatches;
```

- Not recommended
  - Reflection breaks if type changes
  - No GC for additional state

What you can't do

- Bypass accessibility
  - Can only extend visible types
  - Public classes in external assemblies
    - Or internal with InternalsVisibleTo
  - Nested classes
    - As per accessibility rules



Demo 2: Bypassing Accessibility

Feature

Extend inaccessible classes

Task

Try to extend inaccessible classes…

Demo 2: Bypassing Accessibility

Demo 2: Bypassing Accessibility

- Cannot bypass accessibility
  - Extend public classes from any assembly
  - Extend internal classes in same assembly
    - Or any assembly named with InternalsVisibleTo
  - Extend nested classes – if accessible
- Can extend inheritance
  - Extend sealed classes – if accessible
  - Extend abstract classes – if accessible

Demo 2: Bypassing Accessibility

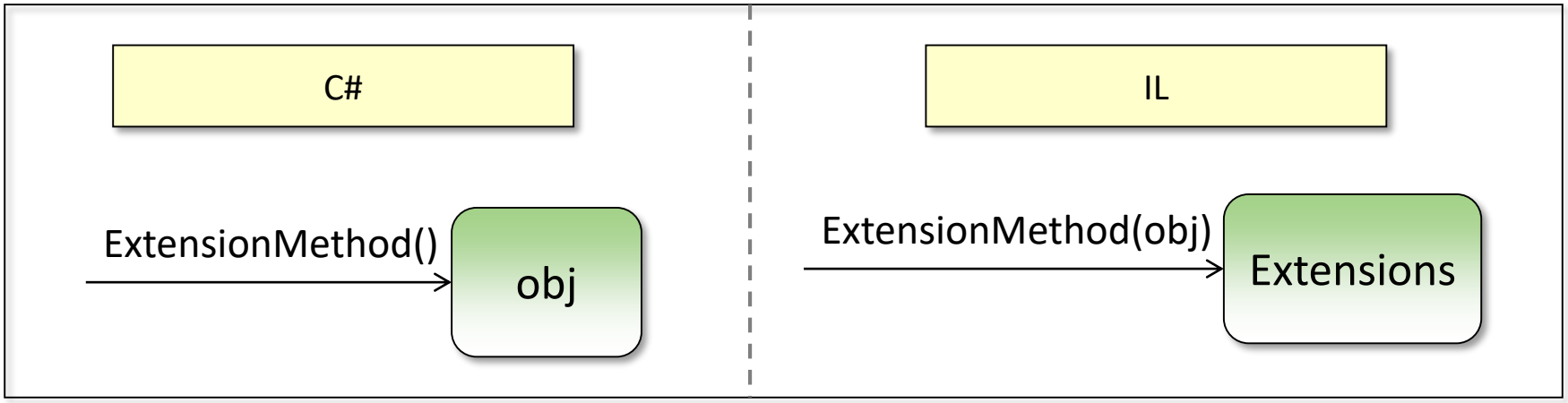
- Cannot extend invisible classes
  - Private/internal
  - Unless you use reflection

```
internal static string GetString3Upper(this object obj)
{
    var type3 = typeof(Class1.Class2)
                .GetNestedType("Class3", BindingFlags.NonPublic);
    if (obj.GetType() == type3) //etc.
```

- Not recommended
  - Reflection breaks if type changes
  - Or is removed

How Extension Methods Work

- Unique to .NET
  - At least, among major languages
  - Requested feature in Java
- Compile-time trick
  - Compiles extension method call
  - As a direct call to the static method



Demo 3: How Extension Methods Work

Feature

Compare extension method invocations

Task

Inspect IL output for extension method call & direct call

Demo 3: How Extension Methods Work

Demo 3: How Extension Methods Work

- Using extension methods
  - Calling the extension method on an instance

```
string xmlDateTime = new DateTime(2013,10,24).ToXmlDateTime();
```

  - Generates IL

```
call  string [Sixeyed.Extensions.Advanced]
       Sixeyed.Extensions.Advanced.Demo3.DateTimeExtensions::
            ToXmlDateTime(valuetype [mscorlib]System.DateTime)
```

  - Calling the static method directly

```
string xmlDateTime = DateTimeExtensions.ToXmlDateTime(
                                        new DateTime(2013,10,24));
```

  - Generates IL

```
call  string [Sixeyed.Extensions.Advanced]
       Sixeyed.Extensions.Advanced.Demo3.DateTimeExtensions::
            ToXmlDateTime(valuetype [mscorlib]System.DateTime)
```

Demo 3: How Extension Methods Work

- Writing extension methods
  - Method definition with this keyword in C#

```
public static string ToXmlDateTime(this DateTime dateTime)
```

  - Generates Extension attribute in IL for method

```
…void [mscorlib]System.Runtime.CompilerServices.ExtensionAttribute
```

  - And class

```
…void [mscorlib]System.Runtime.CompilerServices.ExtensionAttribute
```

  - And assembly

```
.assembly Sixeyed.Extensions.Advanced
{
  …void [mscorlib]System.Runtime.CompilerServices.ExtensionAttribute
```

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