Module 06: "Singleton"

Agenda

- Introductory Example: Today's Magic Number
- Pattern: Singleton
- 6 Different Singleton Implementations
- Overview of Singleton Pattern
- Pattern or Anti-pattern?
- Beware…!

Introductory Example: Today's Magic Number

```
class Magic
{
    public int Number { get; }

    public Magic()
    {
        Number = ...;
    }
}
```

```
Magic m1 = new Magic();
Console.WriteLine( m1.Number );

Magic m2 = new Magic();
Console.WriteLine( m2.Number );
```

Challenges

- How do we ensure that all clients receive the same, unique object when needing a **`Magic`** object?

- Equivalently; How do we ensure there will only be created a single object of a given type?

Pattern: Singleton

- *Ensure that a class only has one instance, and provide a global point of access to it.*
- Outline
  - Make sure that the entire application uses the same single instance of class
  - Create class object in a lazy manner (only if/when needed)
  - Save resources when class is resource-intensive
  - Control access to creation of instances
- Origin: Gang of Four

1. Simple Singleton

Not thread-safe!

```
sealed class Magic
{
    public static Magic Instance
    {
        get
        {
            if( _instance == null ) { _instance = new Magic(); }
            return _instance;
        }
    }
    private static Magic _instance;
    ...
    private Magic() { ... }
}
```

```
Magic m1 = Magic.Instance;
Console.WriteLine(m1.Number);

Magic m2 = Magic.Instance;
Console.WriteLine(m2.Number);
```

2. Simple Thread-safe Singleton

Inefficient locking

```
sealed class Magic
{
    public static Magic Instance
    {
        get
        {
            lock( _sync )
            {
                if( _instance == null ) {  _instance = new Magic(); }
                return _instance;
            }
        }
    }
    ...
    private static readonly object _sync = new object();
}
```

3. Double-check Lock Singleton

Hmmmm....?!

```
public static Magic Instance
{
    get
    {
        if (_instance == null)
        {
            lock (_sync)
            {
                if (_instance == null) { _instance = new Magic(); }
            }
        }
        return _instance;
    }
}
private static volatile Magic _instance;
```

4. Lock-free Thread-safe Singleton

Simple, thread-safe,
but slightly un-lazy

```
sealed class Magic
{
    public int Number { get; }

    public static Magic Instance { get; } = new Magic();

    static Magic() { } // <-- To prevent beforefieldinit in IL

    private Magic() { ... }
}
```

BeforeFieldInit in IL

- The CLI specification (ECMA 335) states in section 8.9.5:

1. *A type may have a type-initializer method, or not.*
2. *A type may be specified as having a relaxed semantic for its type-initializer method (for convenience below, we call this relaxed semantic BeforeFieldInit)*
3. *If marked BeforeFieldInit then the type's initializer method is executed at, or sometime before, first access to any static field defined for that type*
4. *If not marked BeforeFieldInit then that type's initializer method is executed at (i.e., is triggered by):*
    1. *first access to any static or instance field of that type, or*
    2. *first invocation of any static, instance or virtual method of that type*

- From Jon Skeet's brilliant discussion:
    - http://csharpindepth.com/Articles/General/Beforefieldinit.aspx

5. Lock-free, Lazy Thread-safe Singleton

```
sealed class Magic
{
    public int Number { get; }

    public static Magic Instance => Inner._instance;

    private Magic() { ... }

    private class Inner
    {
       static Inner() { } // <-- To prevent beforefieldinit in IL
       internal static readonly Magic _instance = new Magic();
    }
}
```

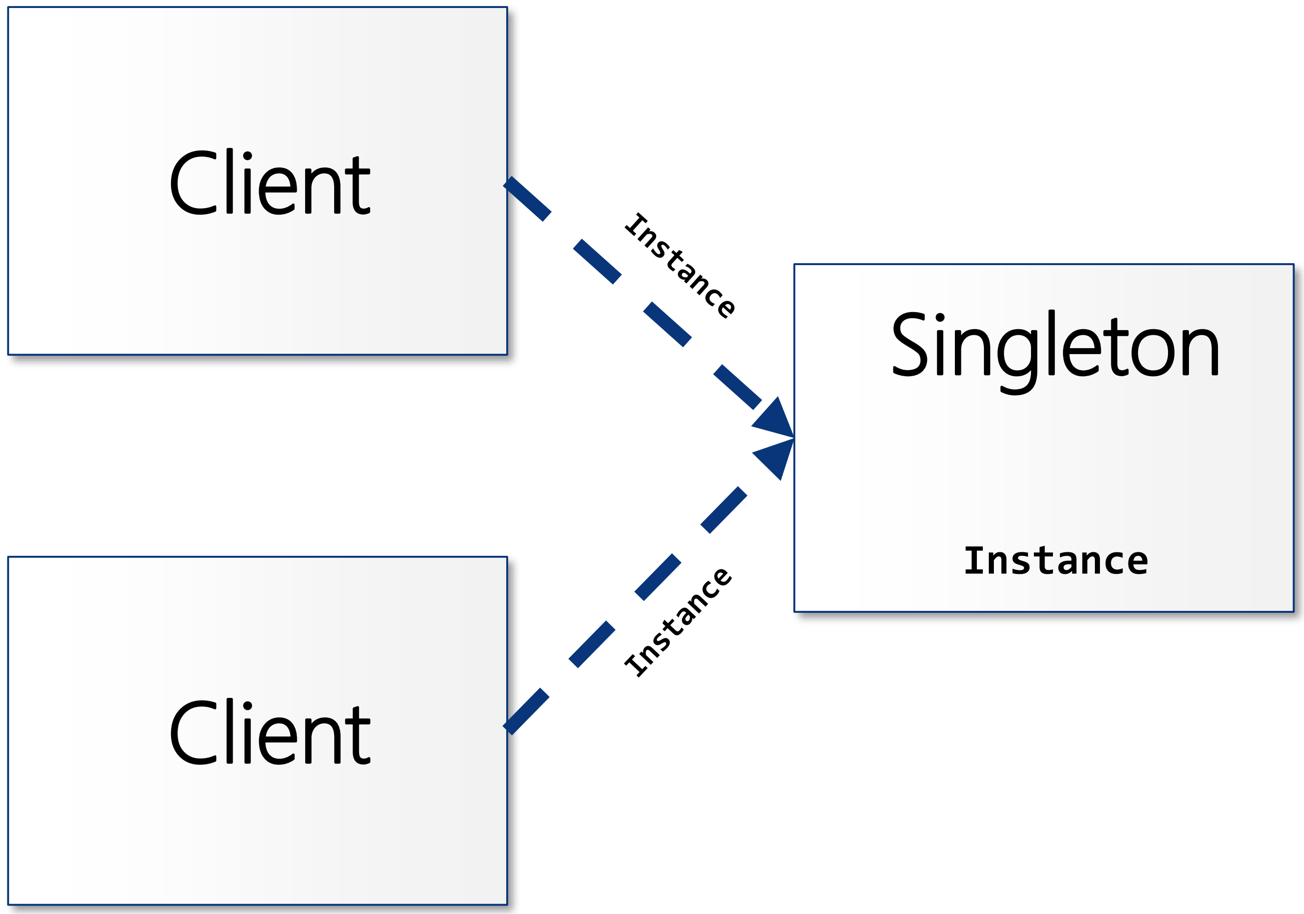
Actually works nicely!

6. Beautiful, Lazy, Thread-safe Singleton

```
sealed class Magic
{
    public int Number { get; }

    private Magic() { ... }

    public static Magic Instance => _lazyInstance.Value;

    private static readonly Lazy<Magic> _lazyInstance
        = new Lazy<Magic>(() => new Magic());
 }
```

- Uses `Lazy<T>` from .NET 4.0 (and above):
  - https://msdn.microsoft.com/en-us/library/dd642331.aspx

Overview of Singleton Pattern



Overview of Singleton Pattern

- Singleton
  - Class instantiates the one and only instance when first needed
  - Keeps track of constructed instance and supplies it to clients

- Client
  - Obtains instance by accessing Singleton`.Instance` property
  - Cannot create instances of Singleton itself

Pattern or Anti-pattern?

- Does not support construction parameters
- "Emulates" global variables
- Not easily testable
- Singleton class has multiple responsibilities
  - Managing object creation and lifetime
  - "Regular" class responsibilities
- Promotes tight coupling
  - Can be alleviated using a factory, however
  - IoC container can also help enforcing Singleton instancing

Beware…!

- Simple, but deceivingly subtle and complex
- Read the fine print:
  - Should be sealed!
  - Should not be serializable
  - Singleton instance is only unique within AppDomain boundary

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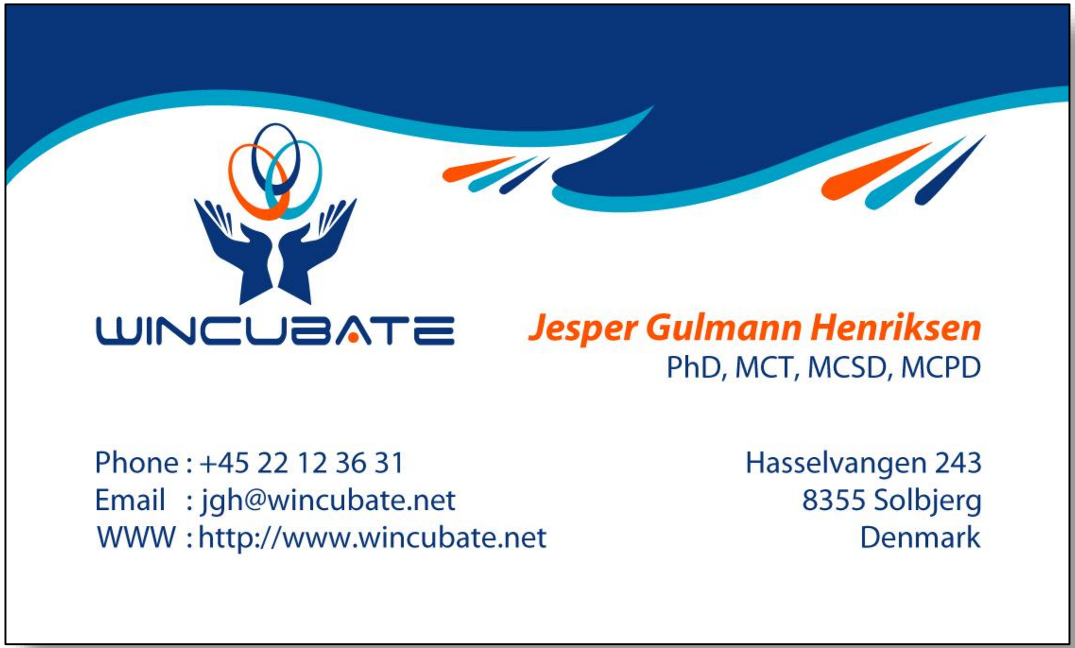

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