Dependency Injection

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What is Dependency Injection?

- An approach to application configuration
- Why should you care?
- Applications that use DI are more naturally 'loosely coupled'
- Loosely coupled applications
  - Are easier to test and maintain
  - Promote agile development and flexible design

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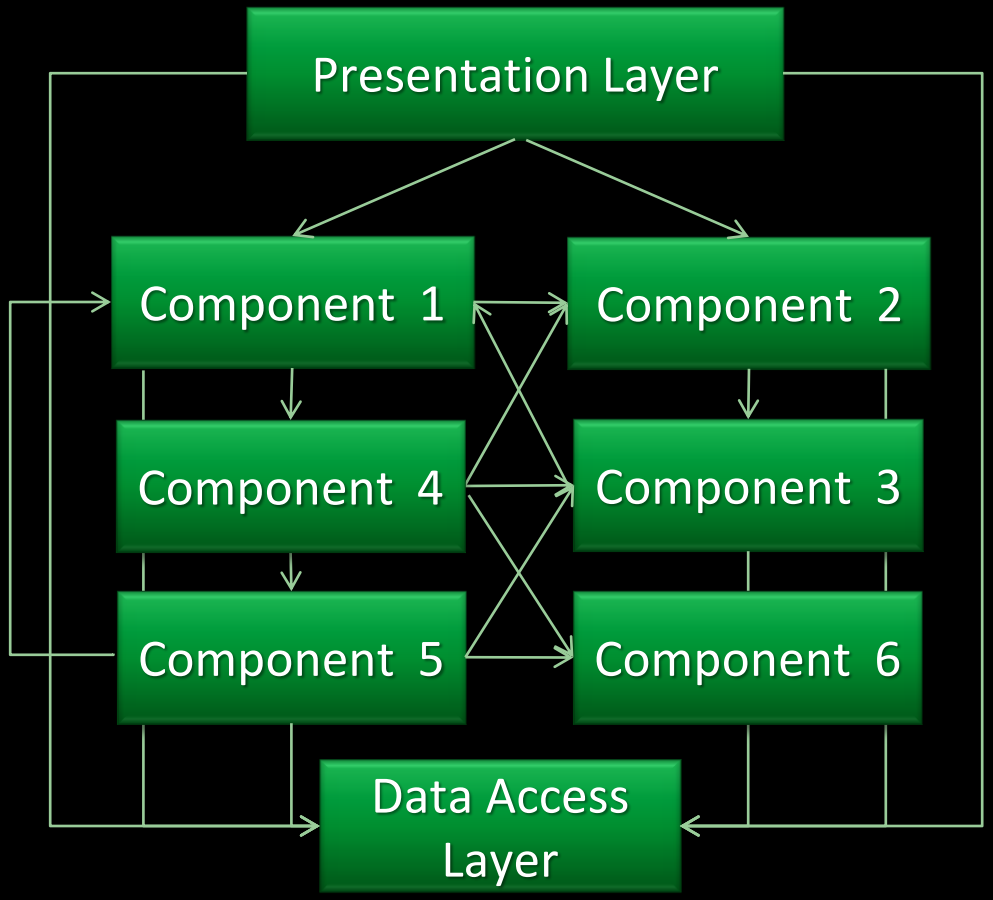
Tight coupling in action



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Example: Tight Coupling

```
public class OrderService : IOrderService {

  private SqlOrderRepository orderRepository;
  private SmtpNotificationService notificationService;
  private int alertQuantity = 10000;

  public OrderService() {
    this.orderRepository = new SqlOrderRepository();
    this.notificationService = new SmtpNotificationService();
  }

  public int AlertQuantity { set { alertQuantity = value; } }

  public string CancelOrder(long orderId) {
     // use orderRepository and notificationService
     return guid;
  }
}
```

Example: Loose coupling

```
public class OrderService : IOrderService {

  private IOrderRepository orderRepository;
  private INotificationService notificationService;
  private int alertQuantity = 10000;

  public OrderService(IOrderRepository orderRepository,
                      INotificationService notificationService) {
    this.orderRepository = orderRepository;
    this.notificationService = notificationService;
  }

  public int AlertQuantity { set { alertQuantity = value; } }

  public string CancelOrder(long orderId) {
     // use orderRepository and notificationService
     return guid;
  }
}
```

"Hand Coded DI"

```
public void Configure()
{
  IOrderRepository repo = new SqlOrderRepository();

  INotificationService smtpService =
                       new SmtpNotificationService();

  IOrderService svc =
                   new OrderService(repo, smtpService);
}
```

Now you can do unit tests…

```
public string CancelOrder(long orderId)
{
  Order order = orderRepository.FindOrder(orderId);

  string confirmationId = orderRepository.CancelOrder(order);
  if (order.Quantity > alertQuantity)
  {
    notificationService.SendCancelNotification(order);
  }
  return confirmationId;
}
```

Test code

```
[Test]
public void OrderService()
{
  IOrderRepository stubRepo = new StubOrderRepository();

  INotificationService stubService =
                          new StubNotificationService();

  IOrderService svc = new OrderService(stubRepo, stubService);

  string confirmationid = svc.CancelOrder(123);
  Assert.IsNotNull(confirmationid);

  // Assertions on INotificationService behavior
  // Was it called?

}
```

Loose Coupling

- Interface-based contracts promote loose coupling
- Assemble more of your application ‘lego style’
- But how?
  - Classes no longer manage collaborating objects
  - Abstract Factory design pattern
    - Close but no cigar…
  - Use a Dependency Injection container

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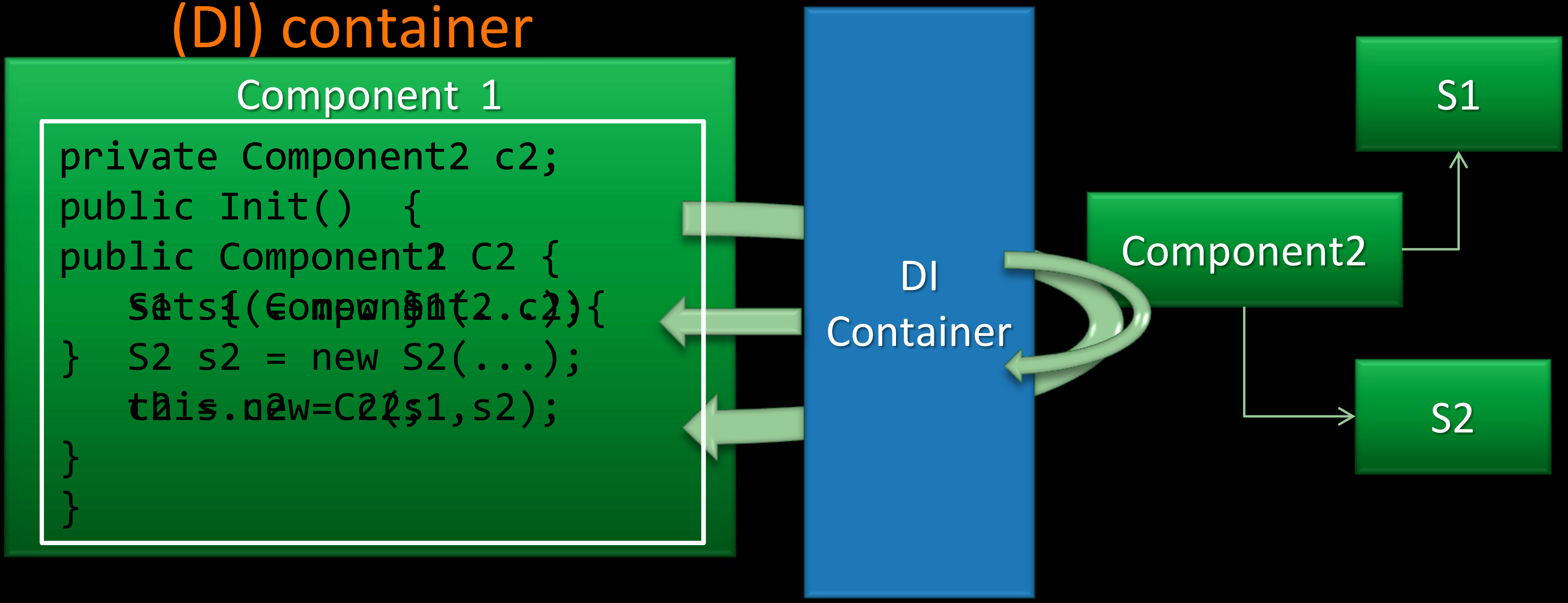
Solution

- … Dependency Injection (DI) container



Constructor Injection / Setter Injection

Inversion of Control

- Release control of some logic to a framework
- Event-Driven Architecture
  - Framework polls or listens to an event source
  - Framework notifies or invokes a service
- Dependency Injection Container
  - Container is creating classes, setting properties
  - Container may ‘wrap’ objects with other services

Containers are not new

- MTS
- COM+ / Enterprise Services
  - Server.CreateObject("Database.Connection")
- But were 'heavyweight'
  - Inherit from 'magic' base class or interface
- Dependency Injection Containers
  - Are 'Lightweight' but provide same many benefits

Dependency Injection Containers

- Promote a component model that actually works

  PLAIN OLD CLR OBJECTS (POCO)

- Non-invasive
  - POCOs not tied to the DI container
  - Beware of DI container attributes!

What is the downside to DI?

- One more thing to learn…
  - It is worth the effort
  - A few books, but mostly online resources.
- Another level of abstraction
- Need to select a DI container

Where can I get one of these…

- Autofac
- Castle Windsor
- NInject
- Spring for .NET
- StuctureMap
- Unity

The 1st order summary…

- All provide similar DI functionality
- Try not to think of DI 'having an API'
  - Differences are how you configure the container to create objects and assemble your application
- Different extensibility models
- Some offer additional capabilities
  - AOP, Transaction Management,
  - Support for several runtime environments
    - ASP.NET WebForms/MVC, WCF, …

The quick guide to using a DI container

- Configure a DI container's object creation and configuration rules via
  - XML
  - Configuration API
  - Attributes

Classes used in the example

```
public class ConsoleReport {

  // private fields omitted

  public ConsoleReport(IOutputFormatter outputFormatter,
                       IPrimeGenerator primeGenerator) {
      _outputFormatter = outputFormatter;
      _primeGenerator = primeGenerator;
  }

  public int MaxNumber {
      get { return _maxNumber; }
      set { _maxNumber = value; }
  }
}
```

Classes used in the example

```
static void Main(string[] args)
{
    ConsoleReport report = new ConsoleReport(
        new OutputFormatter(),
        new PrimeGenerator(new PrimeEvaluationEngine())
    );
    report.MaxNumber = 1000;
    report.Write();

    Console.WriteLine("--- hit enter to exit --");
    Console.ReadLine();
}
```

Creating the Unity Container

```
class Program
{
  static void Main(string[] args)
  {
    using (var container = new UnityContainer())
    {
       //configure container

       //ask container for objects (configured) and use them
    }
```

Configuring the Unity Container

```
class Program
{
  static void Main(string[] args)
  {
    using (var container = new UnityContainer())
    {
       //configure container
       container
          .RegisterType<IOutputFormatter, OutputFormatter>()
          .RegisterType<IPrimeGenerator, PrimeGenerator>();

       //ask container for objects (configured) and use them
    }

  }
}
```

Getting Configured Objects

```
class Program {
  static void Main(string[] args) {
    using (var container = new UnityContainer()){

      //configure container
      container
        .RegisterType<IOutputFormatter, OutputFormatter>()
        .RegisterType<IPrimeGenerator, PrimeGenerator>();

      //ask container for objects (configured) and use them
      var report = container.Resolve<ConsoleReport>();
      report.Write();
    }
  }
}
```

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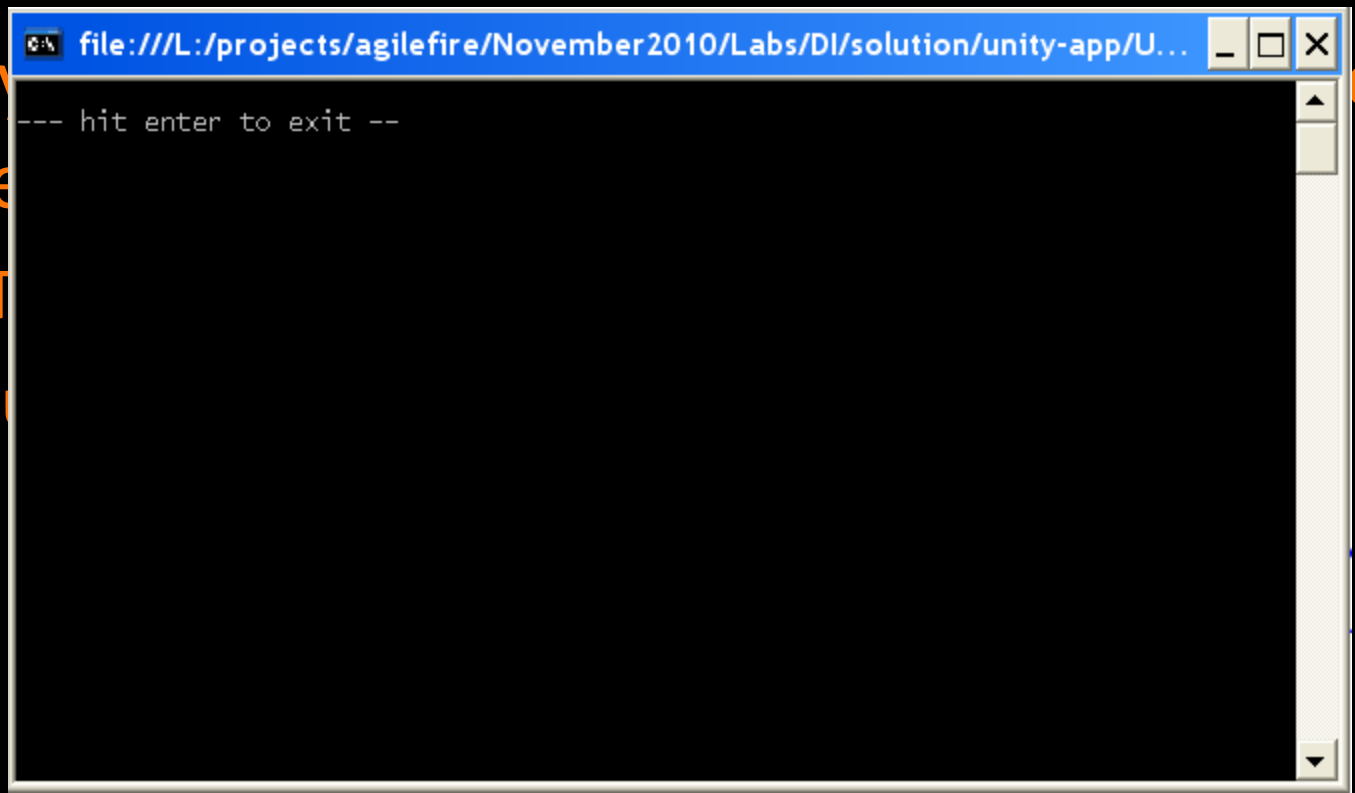
However…

- Runs but no output ☹
  - Default max number is set to 0
- Onl ect type
  - ‘T
  - B



Configuring Simple Properties

```
class Program {
  static void Main(string[] args) {
    using (var container = new UnityContainer()) {

      //configure container
      container
        .RegisterType<IOutputFormatter, OutputFormatter>()
        .RegisterType<IPrimeGenerator, PrimeGenerator>();

      container.Configure<InjectedMembers>()
               .ConfigureInjectionFor<ConsoleReport>(
                    new InjectionProperty("MaxNumber", 1000)
                );
      //ask container for objects (configured) and use them
      var report = container.Resolve<ConsoleReport>();
      report.Write();
    }
  }
}
```

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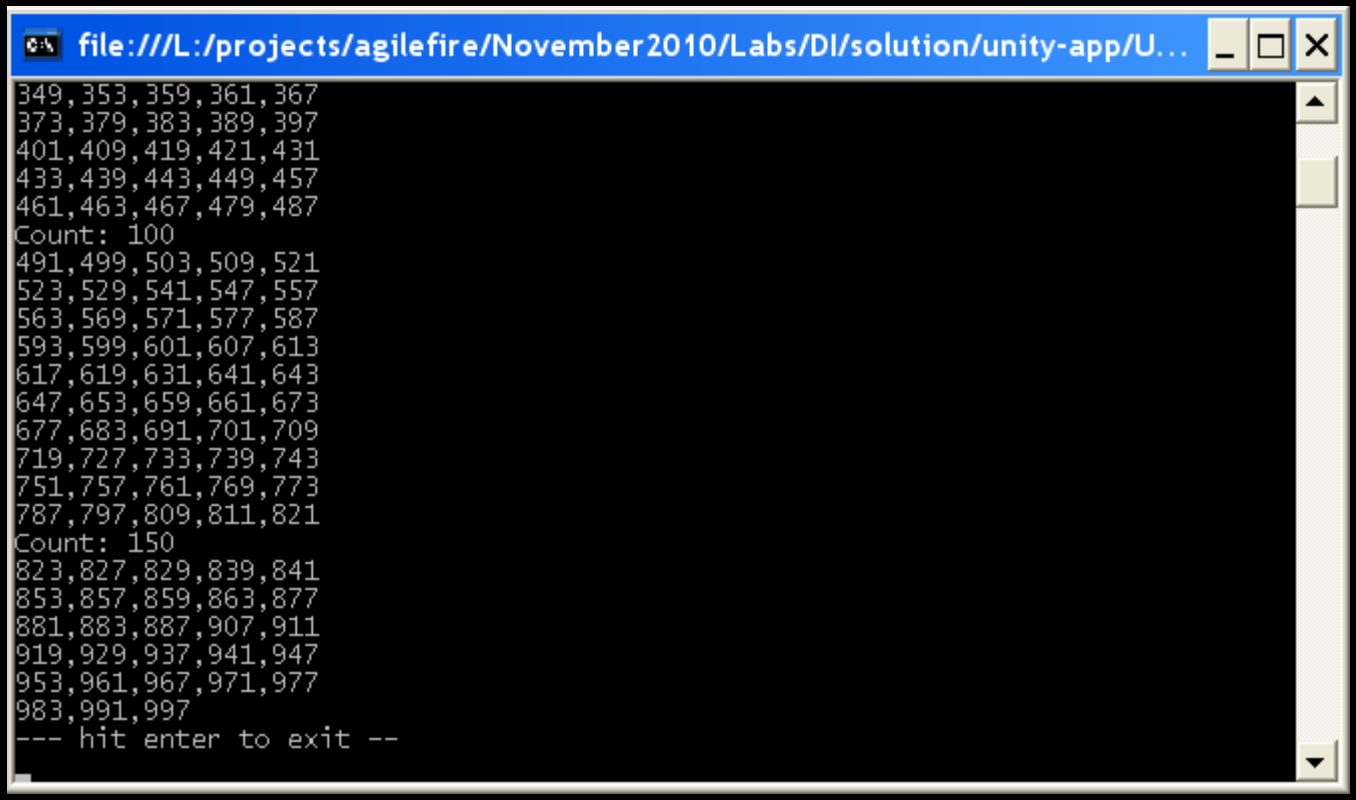
Now we get our prime numbers…



Object Lifecycle

- What happens if you call
  - `container.Resolve<ConsoleReport>();`

    Twice…?
- Container has options to control the lifecycle
  - Transient/"Prototype" – new one each time
    - The default option
  - Singleton – one for the life of the container
    - `ContainerControlledLifetimeManager`
  - Externally Controlled – one for the life of the container
    - But container holds a weak reference to the object
    - `ExternallyControlledLifetimeManager`
  - `LifetimeManager` base class to customize

Now as singletons…

```
class Program {
  static void Main(string[] args) {
    using (var container = new UnityContainer())
    {
        //configure container
         container
          .RegisterType<IOutputFormatter, OutputFormatter>(new
                                          ContainerControlledLifetimeManager())
          .RegisterType<IPrimeGenerator, PrimeGenerator>(new
                                          ContainerControlledLifetimeManager())
          .RegisterType<ConsoleReport>(new ContainerControlledLifetimeManager());

         container.Configure<InjectedMembers>()
                  .ConfigureInjectionFor<ConsoleReport>(
                      new InjectionProperty("MaxNumber", 1000)
                  );
        //ask container for objects (configured) and use them
        var report = container.Resolve<ConsoleReport>();
        report.Write();
    }
  }
}
```

Setter Dependency Injection

```
class Program {
  static void Main(string[] args) {
    using (var container = new UnityContainer()) {
       //configure container
      container
        .RegisterType<IOutputFormatter, OutputFormatter>()
        .RegisterType<IEmailService,    EmailService>()
        .RegisterType<IPrimeGenerator,  PrimeGenerator>();

      container.Configure<InjectedMembers>()
                .ConfigureInjectionFor<ConsoleReport>(
                     new InjectionProperty("EmailService",
                         new ResolvedParameter<IEmailService>())
                );
       //ask container for objects (configured) and use them
       var report = container.Resolve<ConsoleReport>();
       report.Write();
     }
  }
}
```

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Setter Dependency Injection (II)

```
public class ConsoleReport
{
  private IEmailService _emailService;
  private IOutputFormatter _outputFormatter;
  private IPrimeGenerator _primeGenerator;

  public ConsoleReport(IOutputFormatter outputFormatter,
                       IPrimeGenerator primeGenerator)
  {
    _outputFormatter = outputFormatter;
    _primeGenerator = primeGenerator;
  }

  [Dependency]
  public IEmailService EmailService
  {
    set { _emailService = value; }
  }
}
```

No longer a POCO

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Unity XML Configuration Outline

```
<configuration>
  <configSections>
    <section name="unity" type="...”/>
</configSections>
<unity>
  <typeAliases>
    <!-- register alias to reduce verbosity -->
  </typeAliases>

  <containers>
    <container>
      <types>
        <type type="Primes.ConsoleReport, Primes">
          <lifetime type="singleton" />
          <typeConfig extensionType="…”>
             <!- configure constructor and properties -->
          </typeConfig>
        </type>
        <!- repeat for more more type configurations -->
      </types>
    </container>
  </containers>
</unity>
```

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Unity XML Configuration - I

```
<?xml version="1.0" encoding="utf-8" ?>
<configuration>
  <configSections>
    <section name="unity"
type="Microsoft.Practices.Unity.Configuration.UnityConfigurationSection,
Microsoft.Practices.Unity.Configuration"/>
  </configSections>
  <unity>
    <typeAliases>
       <!-- register alieas to reduce verbosity -->
      <typeAlias alias="singleton"

type="Microsoft.Practices.Unity.ContainerControlledLifetimeManager,
Microsoft.Practices.Unity" />
      <typeAlias alias="IOutputFormatter"
           type="Primes.IOutputFormatter, Primes" />
      <typeAlias alias="IPrimeGenerator"
                 type="Primes.IPrimeGenerator, Primes" />
    </typeAliases>
```

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Unity XML Configuration - II

```
<containers>
    <container>
      <types>
        <type type="Primes.ConsoleReport, Primes">
          <typeConfig
extensionType="Microsoft.Practices.Unity.Configuration.TypeInjectionElement,
Microsoft.Practices.Unity.Configuration">
            <constructor>
              <param name="outputFormatter" parameterType="IOutputFormatter"/>
              <param name="primeGenerator" parameterType="IPrimeGenerator"/>
            </constructor>
            <property name="MaxNumber" propertyType="System.Int32, mscorlib">
              <value value="1000" type="System.Int32"/>
            </property>
          </typeConfig>
        </type>

        <type type="IOutputFormatter" mapTo="Primes.OutputFormatter, Primes">
          <lifetime type="singleton" />
        </type>
```

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Unity XML Configuration - III

```
          <type type="IPrimeGenerator" mapTo="Primes.PrimeGenerator, Primes">
            <lifetime type="singleton"/>
            <typeConfig
extensionType="Microsoft.Practices.Unity.Configuration.TypeInjectionElement,
Microsoft.Practices.Unity.Configuration">
              <constructor>
                <param name="primeEvaluationEngine"
parameterType="Primes.PrimeEvaluationEngine, Primes"/>
              </constructor>
            </typeConfig>
          </type>

          <type type="Primes.PrimeEvaluationEngine, Primes"/>

        </types>
      </container>
    </containers>
  </unity>

</configuration>
```

Spring.NET Code Configuration

(see http://www.springframework.net/codeconfig

```
[Configuration]
public class PrimesConfiguration {

  [Definition]
  public virtual ConsoleReport ConsoleReport() {
    return new ConsoleReport(OutputFormatter(), PrimeGenerator())
                             {MaxNumber = 1000};
  }

  [Definition]
  public virtual IOutputFormatter OutputFormatter() {
    return new OutputFormatter();
  }

  [Definition]
  public virtual IPrimeGenerator PrimeGenerator() {
    return new PrimeGenerator(new PrimeEvaluationEngine());
  }
}
```

Creating and Configuring Spring.NET Container using Code Config

```
class Program
{
  static void Main(string[] args)
  {
    using (var container = new ScanningApplicationContext())
    {
       //scan over all .dll/.exe to find object definitions
       container.ScanAllAssemblies();
       //initialize object definitions
       container.Refresh();
       //ask container for objects (configured) and use them
       var report = container.GetObject<ConsoleReport>();
       report.Write();
    }
  }
```

Creating and Configuring Spring.NET Container using XML object definitions

```
class Program
{
  static void Main(string[] args)
  {
    using (var container = new XmlApplicationContext("context.xml"))
    {
       //ask container for objects (configured) and use them
       var report = container["ConsoleReport"] as ConsoleReport;
       report.Write();
    }
  }
}
```

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Spring.NET XML Configuration

```
<objects xmlns="http://www.springframework.net"
         default-autowire="autodetect">

  <object name="ConsoleReport" type="Primes.ConsoleReport, Primes">
    <property name="MaxNumber" value="1000"/>
  </object>

  <object type="Primes.PrimeGenerator, Primes"/>

  <object type="Primes.OutputFormatter, Primes"/>

  <object type="Primes.PrimeEvaluationEngine, Primes"/>

</objects>
```

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Spring.NET XML Configuration Explicit Wiring

```
<objects xmlns="http://www.springframework.net">

  <object name="ConsoleReport" type="Primes.ConsoleReport, Primes">
    <constructor-arg ref="PrimeGenerator"/>
    <constructor-arg ref="OutputFormatter"/>
    <property name="MaxNumber" value="1000"/>
  </object>

  <object name="PrimeGenerator" type="Primes.PrimeGenerator, Primes">
    <constructor-arg>
      <object type="Primes.PrimeEvaluationEngine, Primes"/>
    </constructor-arg>
  </object>

  <object name="OutputFormatter" type="Primes.OutputFormatter, Primes"/>

</objects>
```

Dependency Injection Summary

- Benefits
  - Code easier to test and maintain
  - Promotes loose coupling between
    - Classes
    - “Modules”/Subsystems
  - Will see signs of
    - Reuse
    - Better code – ‘harder to do bad things’
- Drawbacks
  - Another level of abstraction
  - Need to learn a DI container technology

Insert Tab A into Slot B…

DEPENDENCY INJECTION LAB

Lab Exercise

- Configure the Prime Number application using
  - Unity
    - Fluent API
    - XML
  - Spring.NET
    - XML
    - C#
- Following instructions in docs…