Windows Presentation Foundation

Presentation for CSCI 5448 OO/AD

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Intro - Windows Presentation Foundation

Introduced in .Net 3.0 alongside:

- .. Communication Foundation (WCF)
  - SOAP / Web services
- .. Workflow Foundation (WWF)
  - Workflow Engine / Activities
- .. Presentation Foundation (WPF)
  - GUI framework

- Released in Nov '06
- Pre-installed on Windows Vista

Background - WPF

Windows Forms (prev GUI framework)

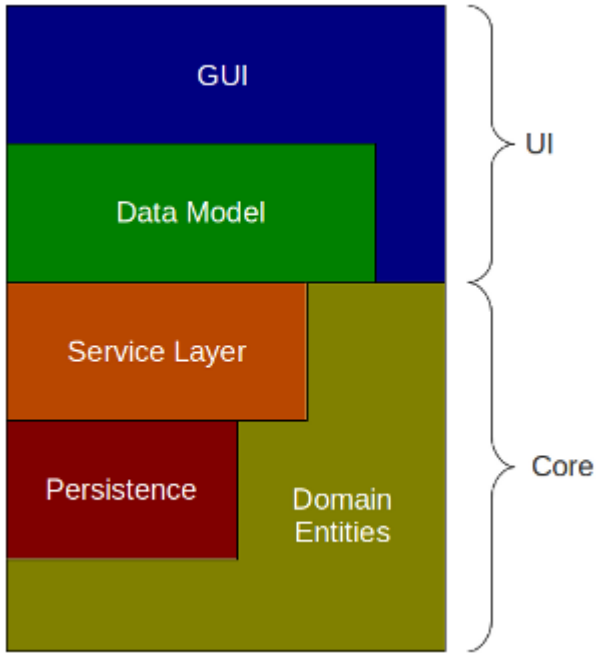
- Pixel-based rendering with GDI+
- Not suited for 3D or video / animation
- IDE "...Designer.cs" files plus A LOT of code behind

Presentation Foundation (WPF)

- Rendered with DirectX, allows mid-pixel scaling to various resolutions
- First order support for animations
- Extensible Application Markup Language (XAML)
  - !!! Declarative syntax helps reduce code behind

Patterns - GUI Layers

GUIs are generally wrapped around existing code. The "top layer" in multi-layered systems.



GUI-specific patterns

- Model View Controller (MVC)
- Model View ViewModel (MVVM)

Supporting Patterns

- Observer

Data Binding (Observer) - WPF

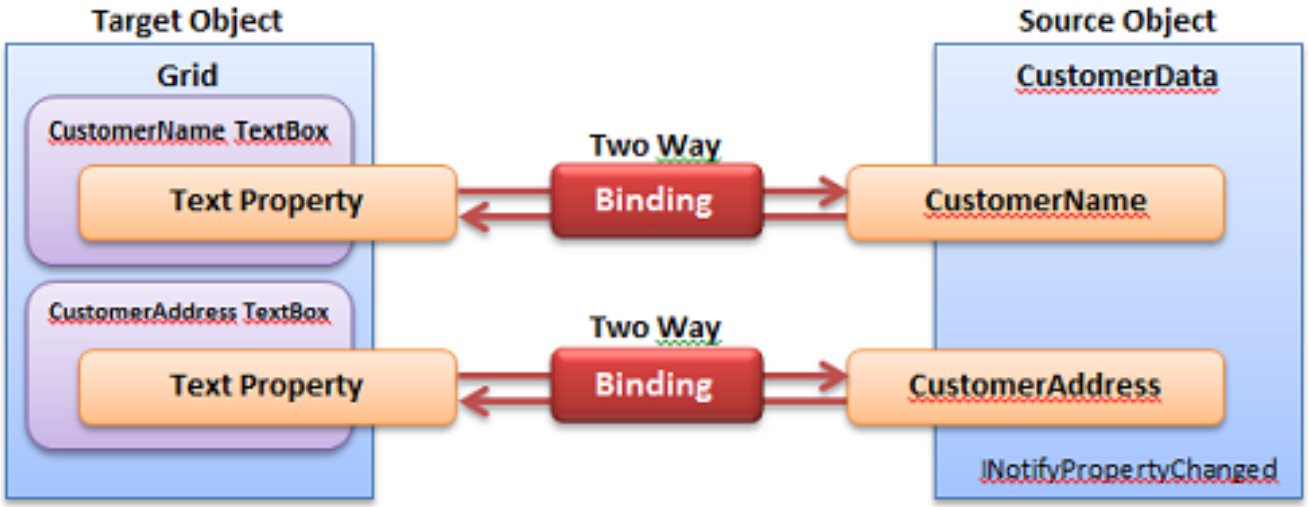
Instead of using code behind to set

```
myTextBox.Text = customer.CustomerName;
```

Use declarative XAML

```
<TextBox Text="{Binding CustomerName}" />
```

GUI ***observes*** changes via ***INotify***... interface



Data Binding programatically

Binding is a class, not just xml syntax

```
<TextBox Text="{Binding CustomerName}" />
```

.. done programmatically, looks like

```
Binding binding = new Binding("CustomerName");
textBoxCusto.SetBinding(TextBox.TextProperty, binding);
```

The "{Binding ..}" XAML is a MarkupExtension

- a kind of syntax "sugar"
- ex: {StaticResource ..} we'll see later in demo

Observer Pattern for Data Binding

```
public class Customer : INotifyPropertyChanged
{
private string _customerName;
public string CustomerName {
    set
    {
        _customerName = value;
        PropertyChanged(this,
          new PropertyChangedEventArgs("CustomerName"));
    }
}

public event PropertyChangedEventHandler PropertyChanged;
}
```

Notify any Observers that CustomerName property has changed. When Bindings are created, GUI becomes an observer

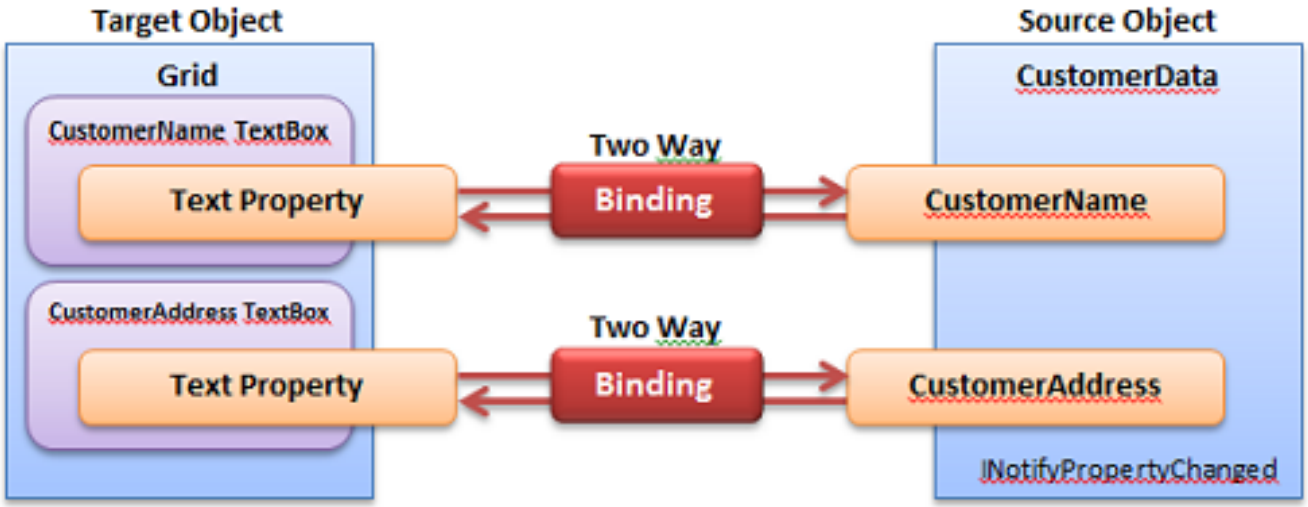
BindingModes: Do it My Way

OneWay Bindings: Source to Target (keeps GUI ***current***)

TwoWay Bindings: Keeps GUI and backend ***synchronized***

UpdateSourceProperty - controls how to update source:

- **LostFocus**: When user presses Enter, or Tabs away from TextBox
- **PropertyChanged**: After each Keystroke, backend is updated



Advanced Data Binding - WPF

Binding Converters augment bindings:

Ex: Show or Hide a control depending on a boolean

```
<Grid Visibility="{Binding IsDisabled,
Converter={StaticResource bool2VisibilityConverter}}"
/>
```

ex: Boolean.False  VisibilityMode.Hidden

MultiBindingConverters can combine multiple inputs and produce a single output

ex: Boolean.False + Status.Warning  Result.Continue

ValidationRules and IDataErrorInfo provide extensible mechanisms validate user input and notify the user.

Advanced Data Binding - WPF

ListCollectionView - allows List<T> to support SelectedItem

```
<ListView ItemsSource="{Binding Customers}"
IsSynchronizedWithCurrentItem="True" />
```

codebehind can get currently selected item

```
List<Customer> customers = ... //from somewhere
int selectedIndex = CollectionViewSource
    .GetDefaultView(customers).CurrentPosition;
```

- A lot of magic going on under the hood here

REF: Bea Stollnitz's Blog (ex-Microsoft employee, now running Zag Studios)

- google "CollectionView wpf" #2 hit (best data binding info on web)

Taking a step back - code quality

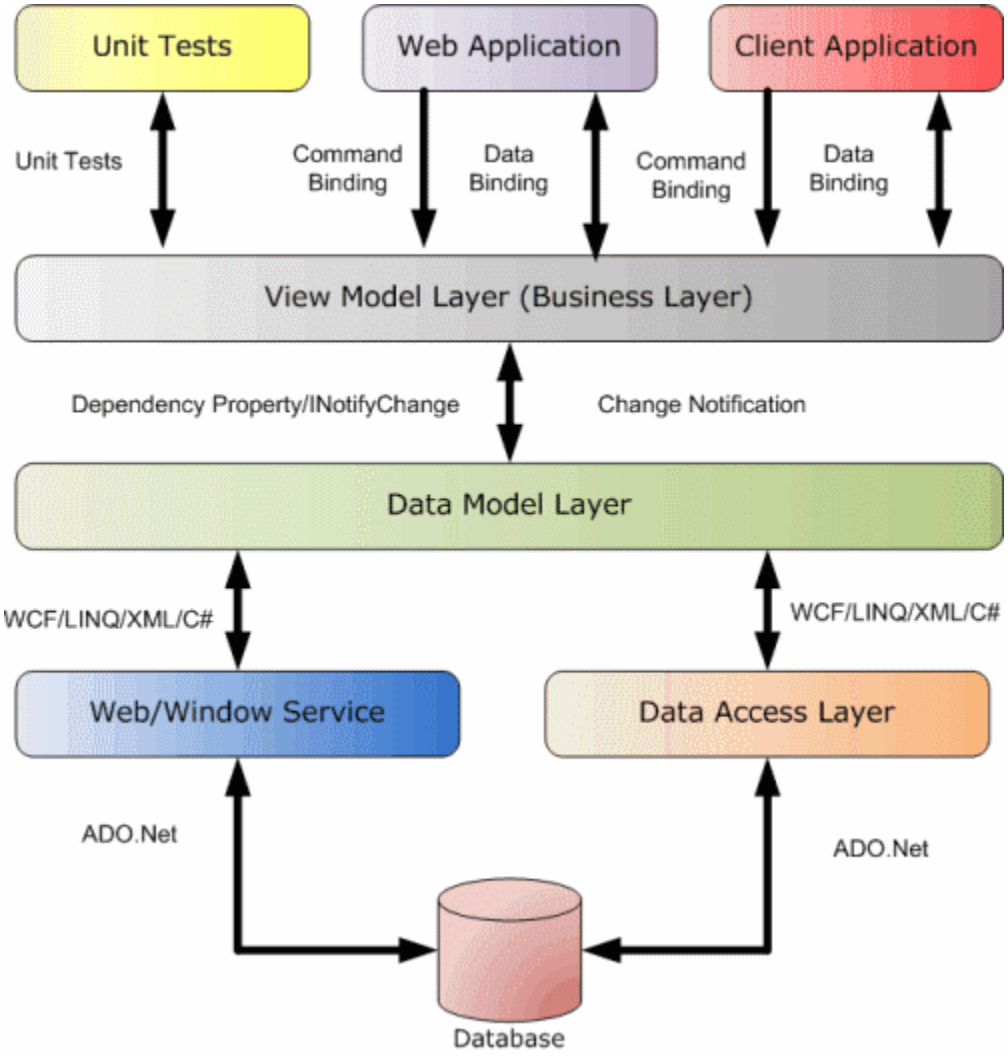
Data Binding Pros:

- Decouples model classes from codebehind
- Greatly reduces size of codebehind
- XAML is more reusable than codebehind
- GUI is tolerant of failed bindings

Data Binding Cons:

- Since Bindings are established at runtime, failed bindings are not found until runtime.
  - ex: {Binding ***misspelled***_PropertyName}
  - Debug TraceLevel helps diagnose failures

Model / View / ViewModel (MVVM)



Views = GUI layouts / dialogs

ViewModels ***support*** each view; use models

Models = data classes

Key Benefits:

Centralizes View-Support code; allows Data Models to be GUI-agnostic; Testable.

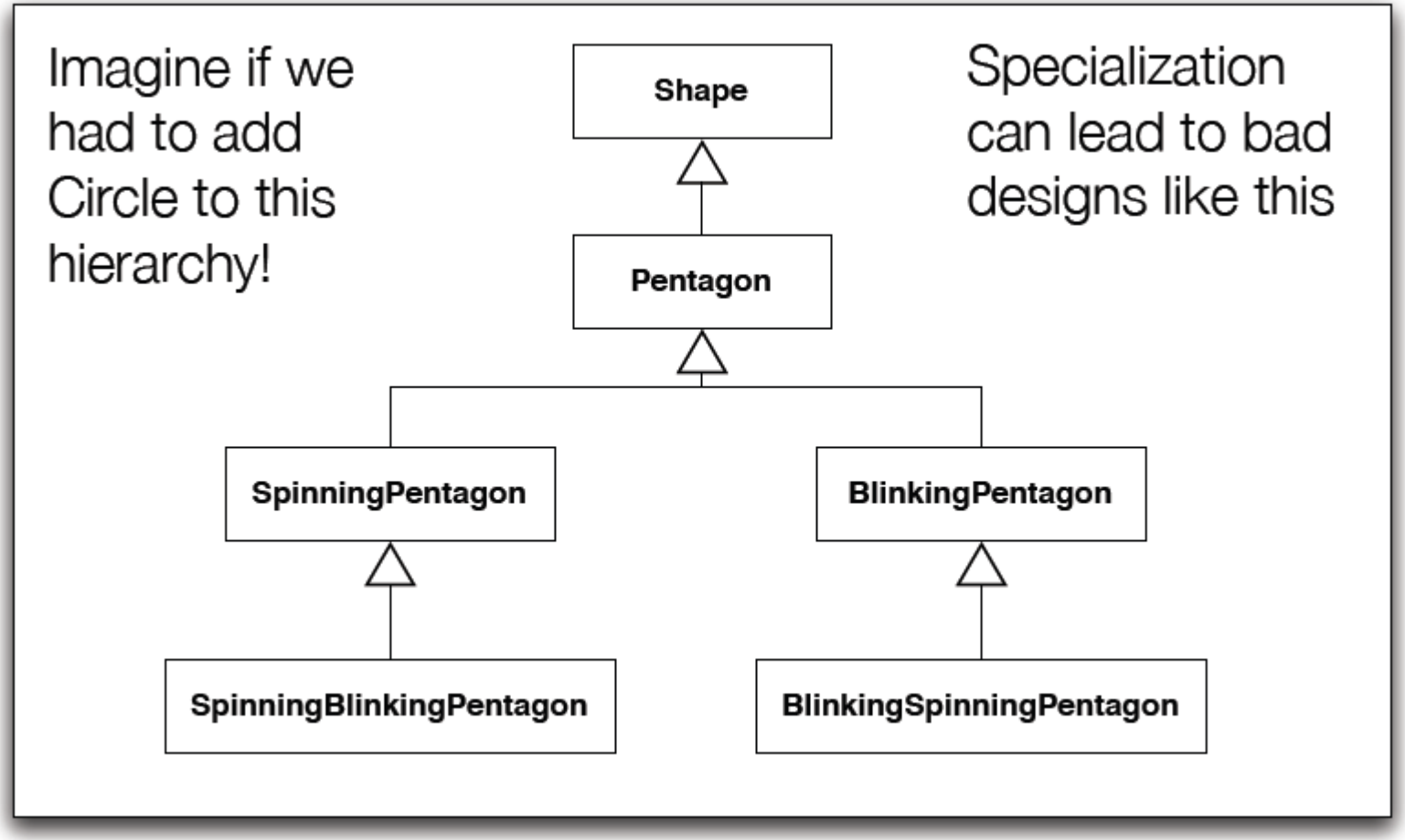
WPF & Design Patterns

Design Patterns are general solutions to common problems that the language does not solve for you.

WPFs use of data-binding, extensive Style and ControlTemplate APIs and platform-like support of the MVVM pattern help solve some problems, pre-pattern.

⇨ now to Styles, and Animations (StoryBoards)

SpinningBlinking.. Problem



WPF Spinning Blinking Styles

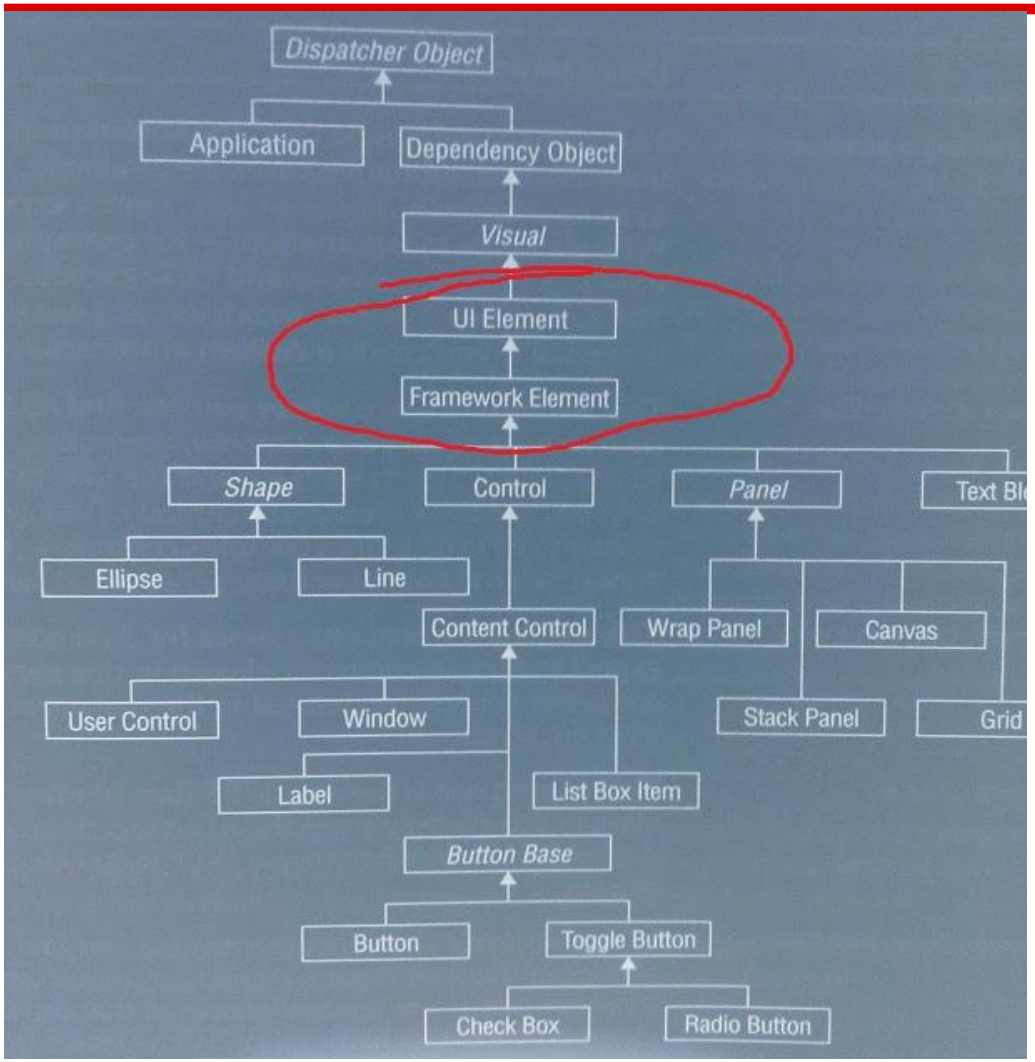
Instead of having to specialize each control

WPF Allows us to

- Establish Transformations
- Animate Properties (ex: Opacity)
- Animated Transforms (ex: Angle)

And Styles make it applicable to any FrameworkElement

WPF Type Hierarchy



UIElement
and
FrameworkElement

are ***very high*** in the hierarchy.

All Controls
are FrameworkEl..;
support Transforms and Animations

DirectX - Enabling Transforms

In WindowsForms, any UserDraw control was responsible for drawing pixels.

In WPF, DirectX can easily manipulate the drawing before rasterizing it to the screen.

Common Transforms:

- Rotate Transform
- SkewTransform
- ScaleTransform

Spinning: start with the transform

```
<Rectangle>
    <Rectangle.RenderTransform>
        <RotateTransform Angle="23" />
    </Rectangle.RenderTransform>
</Rectangle>


<Storyboard x:Key="spinningStoryboard">
    <DoubleAnimation Storyboard.TargetProperty
          ="RenderTransform.Angle"
          From="0" To="360" Duration="0:0:5"
       RepeatBehavior="Forever"/>
</Storyboard>
```

when attached, we'll animate the Angle property (i.e spinning)

Programmatically: Start Animation

```
Transform transform = new RotateTransform();
rectangle.RenderTransform = transform;

//define the animation duration, range, etc.
var spinningAnimation = new DoubleAnimation(0, 360, new
    Duration(TimeSpan.FromSeconds(2)));

//Tell the RotateTransform to begin an animation
transform.BeginAnimation(RotateTransform.AngleProperty,
    spinningAnimation);
```

Abstraction: The ***Transform*** supports animation

Start from XAML

Most WPF developers play a game (challenge)

- All XAML, no codebehind

We can trigger spinning on the ..Loaded event

```
<Rectangle.Triggers>
    <EventTrigger RoutedEvent="FrameworkElement.Loaded">
        <BeginStoryboard><Storyboard>
                <DoubleAnimation Storyboard.TargetProperty
                    ="RenderTransform.Angle"
                    From="0" To="360" Duration="0:0:5"
/>
            </Storyboard></BeginStoryboard>
    </EventTrigger>
</Rectangle.Triggers>
```

Reduce / ReUse / ReCycle (Code)

Write the animation once, and put it in a Style

give it a name, so we can find it later

RotateTransform was already defined as Resource, just re-use it

```
<Style x:Key="SpinningStyle">
    <Setter Property="UIElement.RenderTransform"
       Value="{StaticResource rotateTransform}" />
    <Style.Triggers>
        <EventTrigger RoutedEvent="FrameworkElement.
Loaded">
            <BeginStoryboard Storyboard="{StaticResource
             spinningStoryboard}" />
        </EventTrigger>
    </Style.Triggers>
</Style>
```

ReUse / ReCycle (code)

Now we can apply that ***spinningStyle*** to any FrameworkElement.

And we can build other styles upon it

```
<Style x:Key="BlinkingSpinningStyle"
       BasedOn="{StaticResource SpinningStyle}">
    <Style.Triggers>
        <EventTrigger RoutedEvent="FrameworkElement.
Loaded">
            <BeginStoryboard Storyboard
                ="{StaticResource blinkingStoryboard}" />
        </EventTrigger>
    </Style.Triggers>
</Style>
```

Blinking Style - Animates Opacity

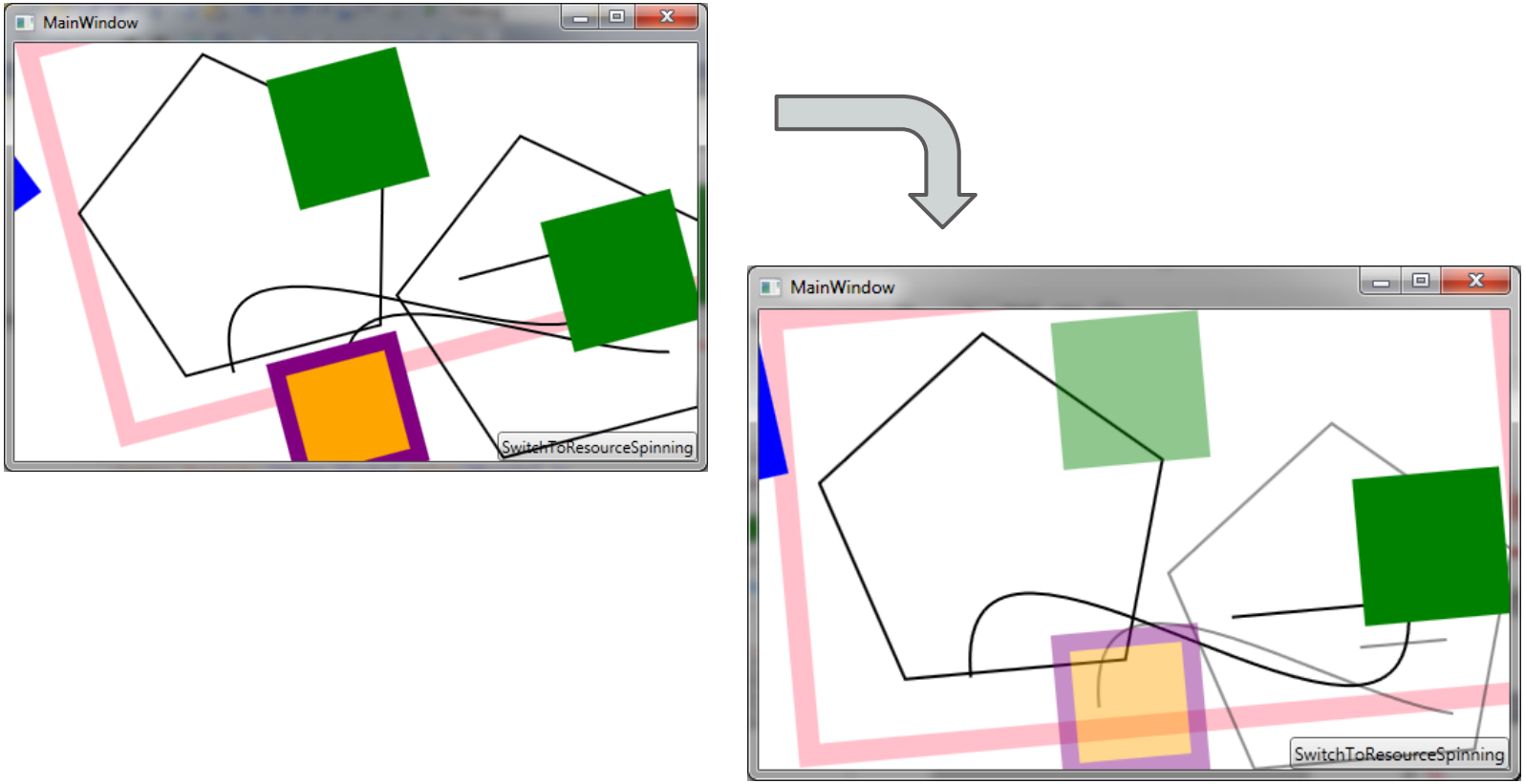
UIElements also support Animating properties:

- Opacity, Color, Width, Margins, etc.

```
<Style x:Key="BlinkingStyle">
...
            <BeginStoryboard><Storyboard>
                <DoubleAnimation
                    Storyboard.TargetProperty="Opacity"
                 From="1.1" To="0.1"
                 Duration="0:0:0.8" AutoReverse="True" />
            </Storyboard></BeginStoryboard>
...
</Style>
```

SpinningBlinking...

It moves... (download code first)



Other Topics

You can create composite custom controls, that derive from UserControl.

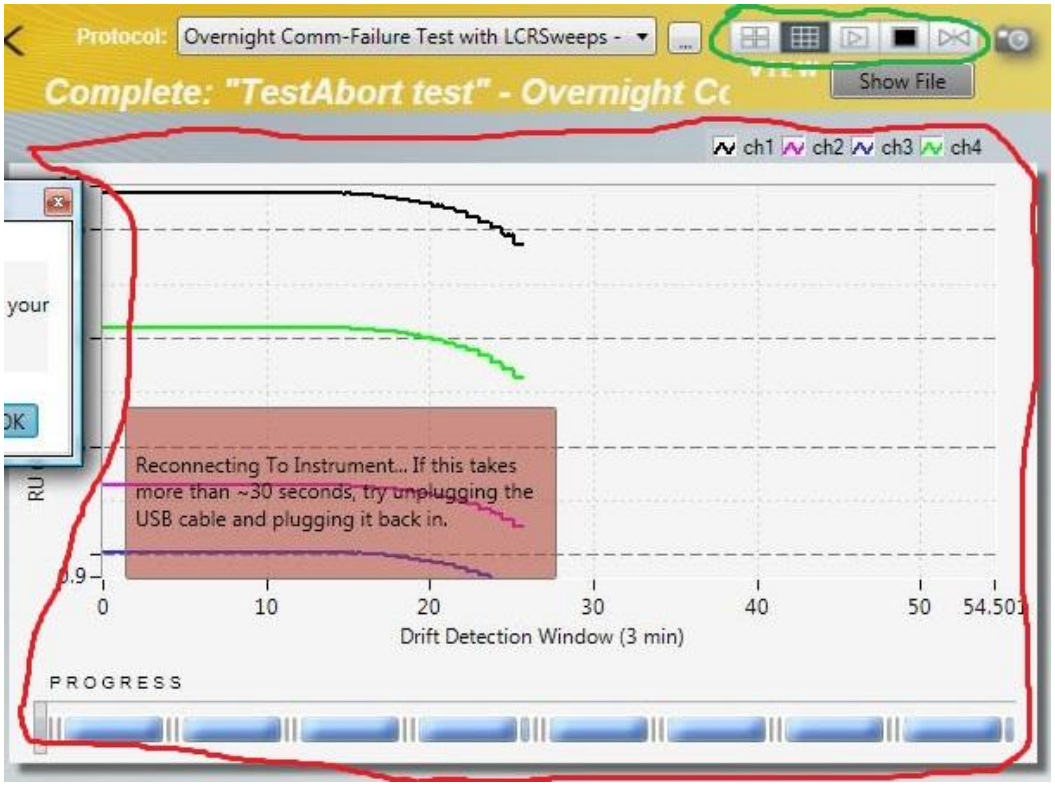
- Adding DependencyProperties allows Binding
- AttachedProperies allow you influence parent controls

High Level Shader Language (HLSL)

- DirectX architecture allows some impressive 2D/3D effects

UserControl Example from Day Job

Single UserControl (circled in Red): bars across bottom have color and size data-bound to backend model.



ToggleButtons (circled in Green) are TwoWay bound to UserControl DependencyProperties

This graph is re-used in 3 different applications at my work.

End

More Info:

http://www.zagstudio.com/blog

Code for Download

https://docs.google.com/open?id=0B-7GE2fNRs7SRjZfVUpTQ1p2VjA

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