XAM320

Design an MVVM ViewModel in Xamarin.Forms

Microsoft

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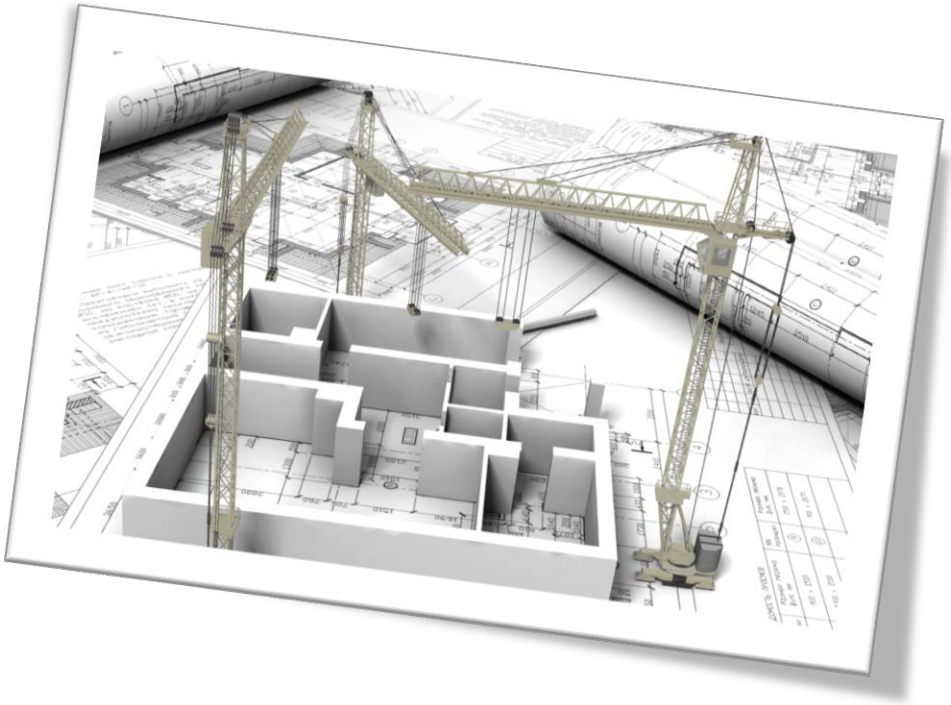
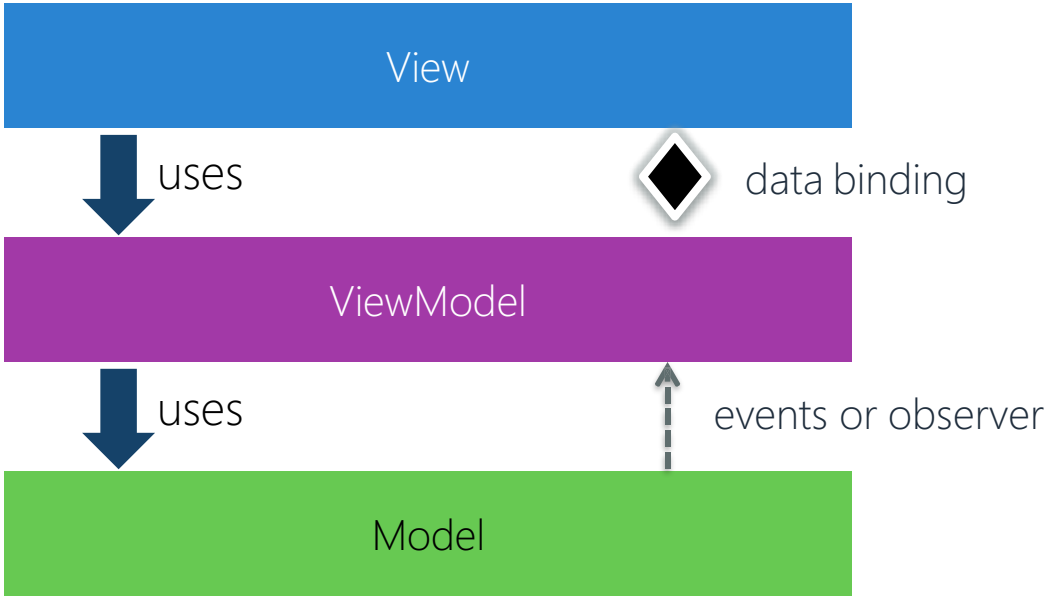
Objectives

1. Define Visual Behavior
2. Use Commands
3. Test MVVM based apps



[Reminder] Model-View-ViewModel

- MVVM is a layered, **separated presentation pattern** where a data binding engine takes the place of the controller / presenter



MVVM Libraries

- You can create your own MVVM support, but there are several popular MVVM libraries available for cross platform development
  - Prism [**pnpmvvm.codeplex.com**]
  - MvvmCross [**github.com/MvvmCross**]
  - MvvmLight [**codeplex.com/MvvmLight**]
  - ReactiveUI [**reactiveui.net**]
  - Caliburn.Micro [**github.com/Caliburn-Micro**]
  - MvvmHelpers [**codeplex.com/MvvmHelpers**]
  - [your favorite goes here] ☺

Define Visual Behavior

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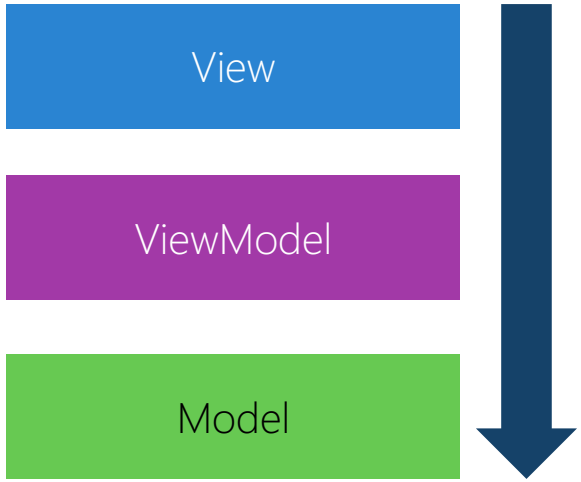
Tasks

1. Control and activate events with selection
2. Utilize properties to define Visual Behavior
3. Employ Data Triggers

View vs. ViewModel

- ViewModel is intentionally designed to support the View, but should be written to be **UI-agnostic**
  - it should *not* have dependencies on anything in Xamarin.Forms



Each layer should only have direct knowledge about the layer below it

Selection in XAML

- Managing selection with MVVM provides a clean way to control and activate elements without dealing with events

```
<ListView ItemsSource="{Binding Employees}"
          SelectedItem="{Binding SelectedEmployee, Mode=TwoWay}" />
```

Make sure to mark it *two-way* so ViewModel is notified when selection is altered by the UI

Dealing with Selection

- Managing selection with MVVM provides a clean way to control and activate elements without dealing with events

```
public partial class MainViewModel : BaseViewModel
{
   ...
   private EmployeeViewModel selectedEmp;  public
   EmployeeViewModel SelectedEmployee {
      get { return selectedEmp; }
      set { selectedEmp = value; RaisePropertyChanged("SelectedEmployee"); }
   }

   public MainViewModel() {
        SelectedEmployee = Employe
    }
}
```

Setter called when selection is changed

Dealing with Selection

- Managing selection with MVVM provides a clean way to control and activate elements without dealing with events

```
public partial class MainViewModel : BaseViewModel
{
   ...
   private EmployeeViewModel selecte
   EmployeeViewModel SelectedEmploye
      get { return selectedEmp; }
      set { selectedEmp = value; Rai
   }

   public MainViewModel() {
        SelectedEmployee = Employees.FirstOrDefault();
    }
}
```

When UI supports "selection" vs. activation, view model can default or change selection based on runtime decisions, all in a unit-testable way

Working with visual properties

- Assume a business requirement is to change the color of the employee's name in the UI if they are a supervisor

```
partial class EmployeeViewModel
{
    public Color NameColor { get; }
}
```

Avoid this! **Color** is a Xamarin.Forms specific type

… this is better but still not ideal – colors should be determined by the designer role and view code

```
partial class EmployeeViewModel
{
    public string NameColor { get; }
```


What we *really* want to do here is to have our UI change based on state properties such as **bool** or enumerations – we could do this with bindings and value converters

Working with visual properties

- Assume a business requirement is to change the color of the employee's name in the UI if they are a supervisor

```
partial class
{
    public Co
}
```

```
partial class EmployeeViewModel
{
    public bool IsSupervisor {
        get { ... }
        private set { ... }
    }
}
```

Let's expose a boolean property indicating whether the employee has subordinates ...

... this is better but still not ideal – colors should be determined by the designer role and view code

```
del

    public string NameColor { get; }
}
```

Working with visual properties

- Data Triggers support dynamic UI property changes based on bindings with conditional tests

```
<Label Text="{Binding Name}" TextColor="Gray">
    <Label.Triggers>
        <DataTrigger TargetType="Label"
                     Binding="{Binding IsSupervisor}"
                     Value="True">
            <Setter Property="TextColor" Value="Blue" />
        </DataTrigger>
    </Label.Triggers>
</Label>
```

Visual Behavior through properties

- Data Triggers support dynamic UI property changes based on bindings with conditional tests

```
<Label Text="{Binding Name}" TextColor="Gray">
    <Labe
        <D                                  el"
                                            ng IsSupervisor}"
            <Setter Property="TextColor" Value="Blue" />
        </DataTrigger>
    </Label.Triggers>
</Label>
```

Assign default value- this is used when no trigger is matched

Visual Behavior through properties

- Data Triggers support dynamic UI property changes based on bindings with conditional tests

```
<Label Text="{Binding Name}" TextColor="Gray">
    <Label.Triggers>
        <DataTrigger TargetType="Label"
                     Binding="{Binding IsSupervisor}"
                     Value="True">
            <Setter Property="TextColor" Value="Blue" />
        </DataTrigger>
    </Label.Triggers>
</Label>
```

Can have zero or more *triggers* in the triggers collection exposed by the **Triggers** property

Visual Behavior through properties

- Data Triggers support dynamic UI property changes based on bindings with conditional tests

```
<Label Text="{Binding Name}" TextColor="Gray">
    <Label.Triggers>
        <DataTrigger TargetType="Label"
                     Binding="{Binding IsSupervisor}"
                     Value="True">
            <Setter Property="TextColor" Value="Blue" />
```

DataTrigger is used to change visual properties of an **Element** based on data binding

Visual Behavior through properties

- Data Triggers support dynamic UI property changes based on bindings with conditional tests

```
<Label Text="{Binding Name}" TextColor="Gray">
    <Label.Triggers>
        <DataTrigger TargetType="Label"
                     Binding="{Binding IsSupervisor}"
                     Value="True">
            <Setter Property="TextColor" Value="Blue" />
```

Binding identifies the ViewModel property the Data Trigger is watching

Visual Behavior through properties

- Data Triggers support dynamic UI property changes based on bindings with conditional tests

```
<Label Text="{Binding Name}" TextColor="Gray">
    <Label.Triggers>
        <DataTrigger TargetType="Label"
                     Binding="{Binding IsSupervisor}"
                     Value="True">
            <Setter Property="TextColor" Value="Blue" />
```

… and a comparison test for that binding; e.g. when IsSupervisor = true

Visual Behavior through properties

- Data Triggers support dynamic UI property changes based on bindings with conditional tests

```
<Label Text="{Binding Name}" TextCo
    <Label.Triggers>
        <DataTrigger TargetType="Label"
                     Binding="{Binding Is      pervisor}"
                     Value="True">
            <Setter Property="TextColor" Value="Blue" />
        </DataTrigger>
    </Label.Triggers>
```

Has one or more setters to change properties when the trigger condition is matched

This is completely dynamic and is driven completely through the binding engine – so if the property changes at runtime, the trigger is re-evaluated and applied or removed!

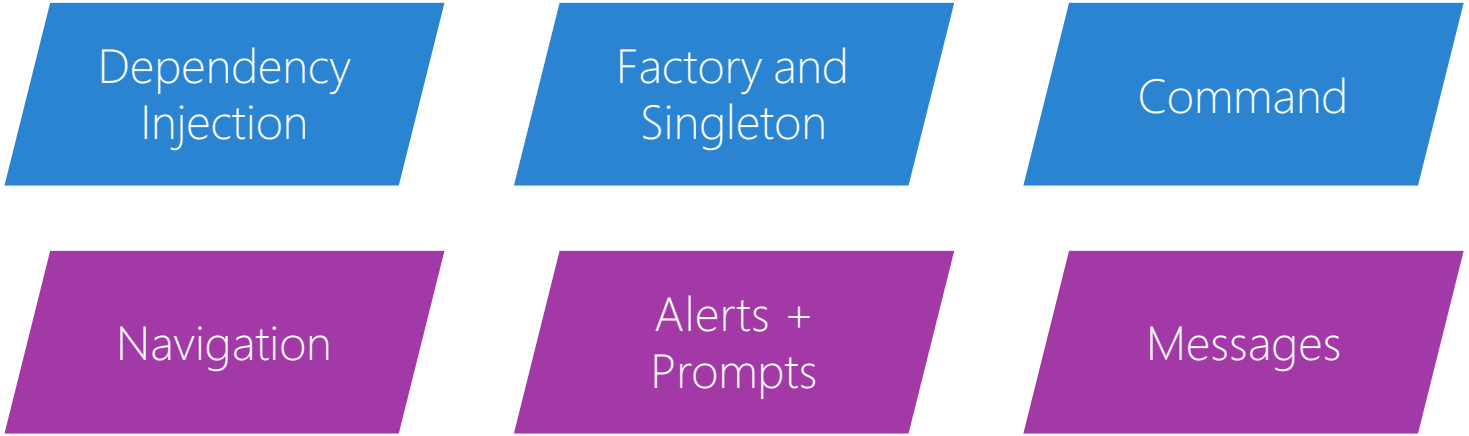
Value Converters

- Value Converters allow for *type mismatch* conversions – e.g. when the data does not match the UI requirements
- This conversion task is often taken up by the VM instead – reducing the need for value converters
- Still useful to have more primitive converters for bindings

```
BooleanToColorConverter
ArrayToStringConverter
DoubleToIntegerConverter
NotBooleanConverter
IntegerToBooleanConverter
```

MVVM + other patterns

- MVVM is not the only design pattern needed, often need to utilize other patterns to provide necessary features through abstractions



Managing navigation

- Screen navigation can be handled in different ways – easiest is just to have an app-specific service that *knows* the screens which the VM uses

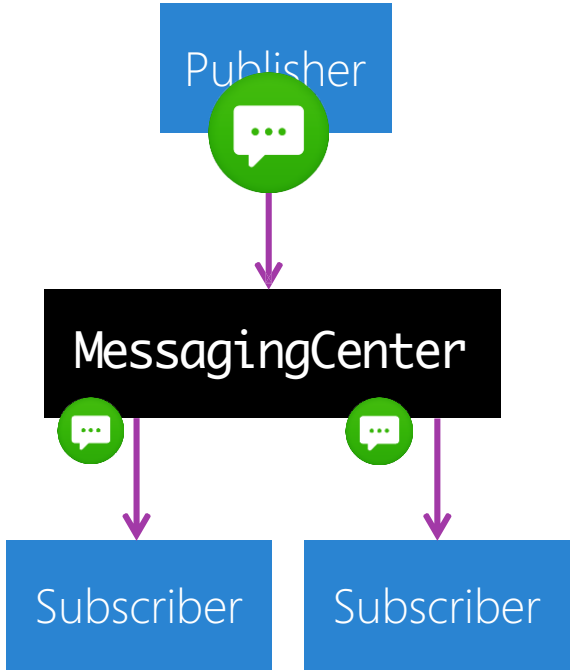
```
public enum AppScreen { Main, Detail, Edit, ... }

public class NavigationManager
{
    public Task<bool> GotoScreen(AppScreen screen) {...}
    public Task<bool> GoBack() { ... }
}
```

Enum defines the screens, and the class implements the navigation using the known app structure – master / detail, **NavigationPage**, etc.

Loosely-coupled messages

- Another common requirement is communication between unrelated app components in a loosely-coupled fashion
  - VM to VM
  - service to VM

- This is easily solved with the built-in `MessagingCenter`



Publishing a message

- Publisher passes message key and optional parameter

Publisher identifies sending type and parameter type through generic parameters

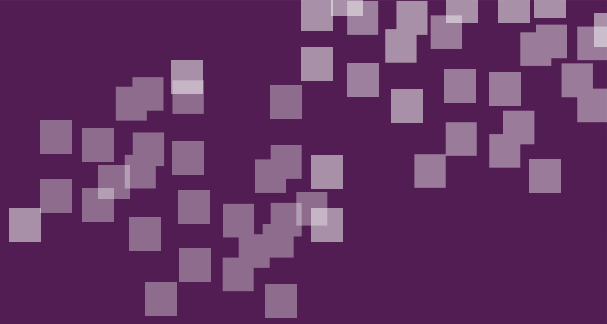
```
MessagingCenter.Send<MainViewModel, ItemViewModel>(
        this, "Select", selectedItem);
```

Subscribing to a message

- Subscribers identify the message by the sender type and message key and provide a delegate callback to run when message is received

```
MessagingCenter.Subscribe<MainViewModel, ItemViewModel> (
    this, "Select",
    (mainVM, selectedItem) => {
       // Action to run when "Select" is received
       // from MainViewModel
    });
```

Combination of the sender type, string message, and parameter type is the key for the message recipient – these must match between publisher and subscriber



Individual Exercise

Driving behavior through properties

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Summary

1. Control and activate events with selection
2. Utilize properties to define Visual Behavior
3. Employ Data Triggers

Use Commands

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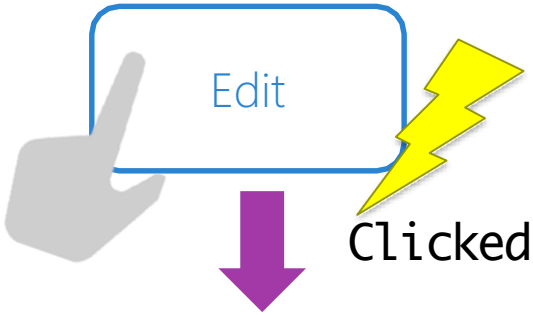
Tasks

1. Implement the ICommand interface
2. Generalize a command

Event Handling

- UI raises events to notify code about user activity
  - `Clicked`
  - `ItemSelected`
  - …
- The downside is that these events must be handled in the code behind file



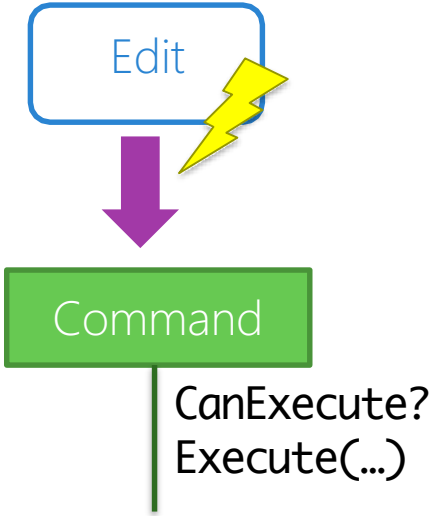

```
public MainPage()
{
    ...
    Button editButton = ...;
    editButton.Clicked += OnClick;
}

void OnClick (object sender, EventArgs e)
{
     ...
}
```

Commands

- Microsoft defined the **ICommand** interface to provide a commanding abstraction for their XAML frameworks

```
public interface ICommand
{
    bool CanExecute(object parameter);
    void Execute(object parameter);
    event EventHandler CanExecuteChanged;
}
```

Can provide an optional parameter (often `null`) for the command to work with for context

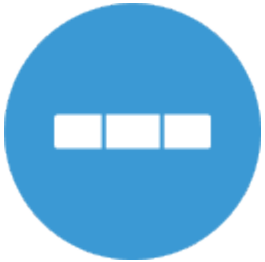


Commands in Xamarin.Forms

- Many Xamarin.Forms controls expose a **`Command`** property for the main action of a control

`Button`

`Menu`



`ToolbarItem`

`TextCell`

Commands in Xamarin.Forms

- A few Xamarin.Forms controls expose a **Command** property for the main action of a control

```
public ICommand GiveBonus { get; }
```

```
<Button Text="Give Bonus"
        Command="{Binding GiveBonus}" />
```

Can data bind a property of type **ICommand** to the **Command** property

Gesture-based commands

- Xamarin.Forms also includes a **TapGestureRecognizer** which can provide a command interaction for other controls or visuals

```
<Image Source="IDareYouToTapMe.jpg">
    <Image.GestureRecognizers>
        <TapGestureRecognizer
            Command="{Binding BeBraveCommand}"
            CommandParameter="TheyTookTheDare!" />
    </Image.GestureRecognizers>
</Image>
```

CommandParameter property supplies the command's parameter – in this case as a **string**

Implementing commands in the VM

- Command should be exposed as a public property from the ViewModel

```
public class EmployeeViewModel : INotifyPropertyChanged
{
    public ICommand GiveBonus { get; private set; }
    ...
    public EmployeeViewModel(Employee model) {
        this.model = model;
        GiveBonus = new GiveBonusCommand(this);
    }
    ...
}
```

```
public class GiveBonusCommand : ICommand
```

Implementing ICommand

- **ICommand** has three required members you must implement

CanExecute is called to determine whether the command is valid, this can enable / disable the control which is bound to the command

```
public interface ICommand
{
    bool CanExecute(object parameter);
    void Execute(object parameter);
    event EventHandler CanExecuteChanged;
}
```

Implementing ICommand

- **ICommand** has three required members you must implement

Execute is called to actually run the logic associated with the command when the control is activated – it will only be called if **CanExecute** returned **true**


```
public interface ICommand
{
    bool CanExecute(object parameter);
    void Execute(object parameter);
    event EventHandler CanExecuteChanged;
}
```

Implementing ICommand

- **ICommand** has three required members you must implement

CanExecuteChanged is an event which the binding will subscribe to, the ViewModel should raise this event when the validity of the command changes

```
public interface ICommand
{
    bool CanExecute(object parameter);
    void Execute(object parameter);
    event EventHandler CanExecuteChanged;
}
```

The binding will then call **CanExecute** and enable / disable the UI in response

```
public partial class GiveBonusCommand : ICommand
{
    public event EventHandler CanExecuteChanged = delegate {};

    MainViewModel viewModel;
    public GiveBonusCommand(MainViewModel vm)
        {  this.viewModel = vm;
    }

    public bool CanExecute(object parameter) {
        return this.viewModel.SelectedEmployee != null
            && (DateTime.Now -
            this.viewModel.SelectedEmployee.HireDate)
                  .TotalHours > 8;
    }

    public void Execute(object parameter) {
        this.viewModel.SelectedEmployee.GiveBonus(1000)
        ;
    }
    public void RaiseCanExecuteChanged() {
        CanExecuteChanged(this,
        EventArgs.Empty);
}    }
```

Command relies heavily on the data in the ViewModel … could we move this logic?

Implementing commands generically

- Can use built-in **Command** and **Command<T>** to forward command to VM

```
public class Command<T> : ICommand
{
    Action<T> _function;
    public void Execute(object parameter) {
        _function.Invoke((T) parameter);
    }

    public bool CanExecute(object parameter)  {...}
    public event EventHandler CanExecuteChanged;
}
```

Initialize with delegates for each of the required methods – then you can define each command with logic in the ViewModel

Using delegate commands

- **Command<T>** and **Command** provides mechanism to centralize the logic for the commands into the VM

```
public class EmployeeViewModel : INotifyPropertyChanged
{
    public ICommand GiveBonus { get; private set; }
    public EmployeeViewModel(Employee model) {
        GiveBonus = new Command(OnGiveBonus, OnCanGiveBonus);
    }

    void OnGiveBonus() { ... }
    bool OnCanGiveBonus() { return ... }
}
```

Existing MVVM Libraries

- Easy to roll your own MVVM support, but there are several really good MVVM libraries available for cross platform development which include a lot of additional features
  - Prism [pnpmvvm.codeplex.com]
  - MvvmCross [github.com/MvvmCross]
  - MvvmLight [codeplex.com/MvvmLight]
  - ReactiveUI [reactiveui.net]
  - Caliburn.Micro [github.com/Caliburn-Micro]
  - MvvmHelpers [codeplex.com/MvvmHelpers]
  - [your favorite goes here] ☺

Flash Quiz

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Flash Quiz

① Commands are ***not*** supported on which control?

a) Button
b) Switch
c) MenuItem
d) Trick question - commands are supported on all of them!

Flash Quiz

① Commands are ***not*** supported on which control?

a) Button

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d) Trick question - commands are supported on all of them!

Flash Quiz

② Commands are described through _____.

a) IDelegateCommand
b) DelegateCommand
c) ICommand
d) Command

Flash Quiz

② Commands are described through _____.

a) IDelegateCommand
b) DelegateCommand
c) ICommand
d) Command

Group Exercise

Using commands to run behavior

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Summary

1. Implement the ICommand interface
2. Generalize a command

Test MVVM based apps

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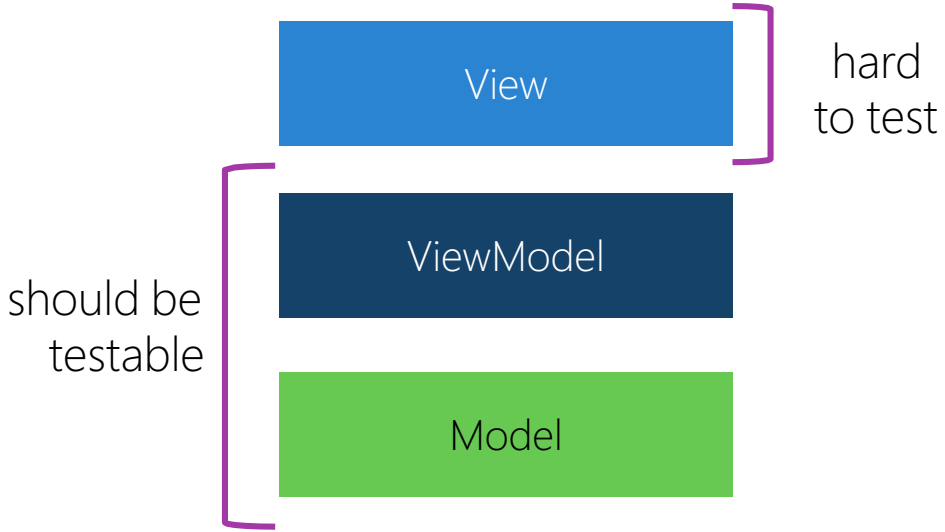
Tasks

1. UnitTest the ViewModel

Testing Surface

- Unit tests involve testing small, isolated pieces of our application independently; that's very hard to do for tightly coupled GUI applications

- Testable code is code which does not have dependencies on a UI being present



Testing the ViewModel

- ViewModel can be tested independently of the UI / platform
- Allows for testing of business logic *and* visual logic
- Can use well-known unit testing frameworks such as NUnit or MSTest

Testing the ViewModel

set properties and invoke command – just like UI would

```
[TestMethod]
void Employee_GiveBonus_Succeeds()
{
    var data = new Employee(...);
    var vm = new EmployeeViewModel(data);
    vm.GiveBonus.Execute("500");

    Assert.AreEqual(500,
            data.GetNextPaycheckData().Extras);
}
```

… and then test the results to verify it does what you expect

Demonstration

Adding unit tests for View Models

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Summary

1. UnitTest the ViewModel

Thank You!