Chapter 15

The interactive interface

Interactivity is the defining feature of modern computing. The many interactive views that Xamarin.Forms implements respond to touch gestures such as tapping and dragging, and a few even read keystrokes from the phone's virtual keyboard.

These interactive views incorporate paradigms that are familiar to users, and even have names that are familiar to programmers: users can trigger commands with `Button`, specify a number from a range of values with `Slider` and `Stepper`, enter text from the phone's keyboard using `Entry` and `Editor`, and select items from a collection with `Picker`, `ListView`, and `TableView`.

This chapter is devoted to demonstrating many of these interactive views.

View overview

Xamarin.Forms defines 20 instantiable classes that derive from `View` but not from `Layout`. You've already seen six of these classes in previous chapters: `Label`, `BoxView`, `Button`, `Image`, `ActivityIndicator`, and `ProgressBar`.

This chapter focuses on eight views that allow the user to select or interact with basic .NET data types:

Data type	Views
`Double`	`Slider`, `Stepper`
`Boolean`	`Switch`
`String`	`Entry`, `Editor`, `SearchBar`
`DateTime`	`DatePicker`, `TimePicker`

These views are often the visual representations of underlying data items. In the next chapter, you'll begin to explore data binding, which is a feature of Xamarin.Forms that links properties of views with properties of other classes so that these views and underlying data can be structured in correspondences.

Four of the remaining six views are discussed in later chapters. In Chapter 16, "Data binding," you'll see:

- `WebView`, to display webpages or HTML.

Chapter 19, "Collection views" covers these three views:

- `Picker`, selectable strings for program options.
- `ListView`, a scrollable list of data items of the same type.

- `TableView`, a list of items separated into categories, which is flexible enough to be used for data, forms, menus, or settings.

Two views are not covered in this edition of this book:

- `Map`, an interactive map display.
- `OpenGLView`, which allows a program to display 2-D and 3-D graphics by using the Open Graphics Library.

Slider and Stepper

Both `Slider` and `Stepper` let the user select a numeric value from a range. They have nearly identical programming interfaces but incorporate very different visual and interactive paradigms.

Slider basics

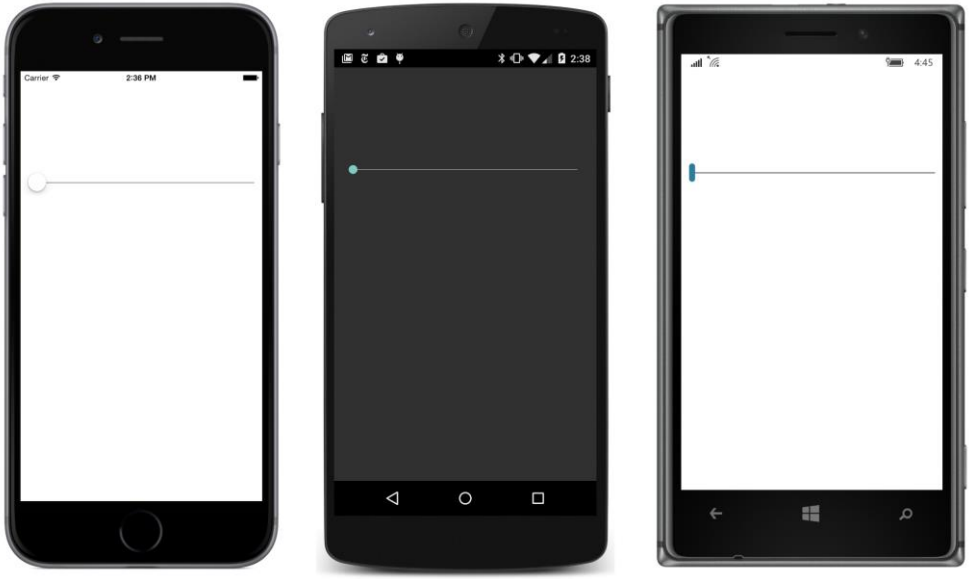
The Xamarin.Forms `Slider` is a horizontal bar that represents a range of values between a minimum at the left and a maximum at the right. (The Xamarin.Forms `Slider` does not support a vertical orientation.) The user selects a value on the `Slider` a little differently on the three platforms: On iOS devices, the user drags a round "thumb" along the horizontal bar. The Android and Windows 10 Mobile `Slider` views also have thumbs, but they are too small for a touch target, and the user can simply tap on the horizontal bar, or drag a finger to a specific location.

The `Slider` defines three public properties of type `double`, named `Minimum`, `Maximum`, and `Value`. Whenever the `Value` property changes, the `Slider` fires a `ValueChanged` event indicating the new value.

When displaying a `Slider` you'll want a little padding at the left and right to prevent the `Slider` from extending to the edges of the screen. The XAML file in the **SliderDemo** program applies the `Padding` to the `StackLayout`, which is parent to both a `Slider` and a `Label` that is intended to display the current value of the `Slider`:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="SliderDemo.SliderDemoPage">

    <StackLayout Padding="10, 0">
        <Slider VerticalOptions="CenterAndExpand"
                ValueChanged="OnSliderValueChanged" />

        <Label x:Name="label"
               FontSize="Large"
               HorizontalOptions="Center"
               VerticalOptions="CenterAndExpand" />
    </StackLayout>
</ContentPage>
```

When the program starts up, the `Label` displays nothing, and the `Slider` thumb is positioned at the far left:



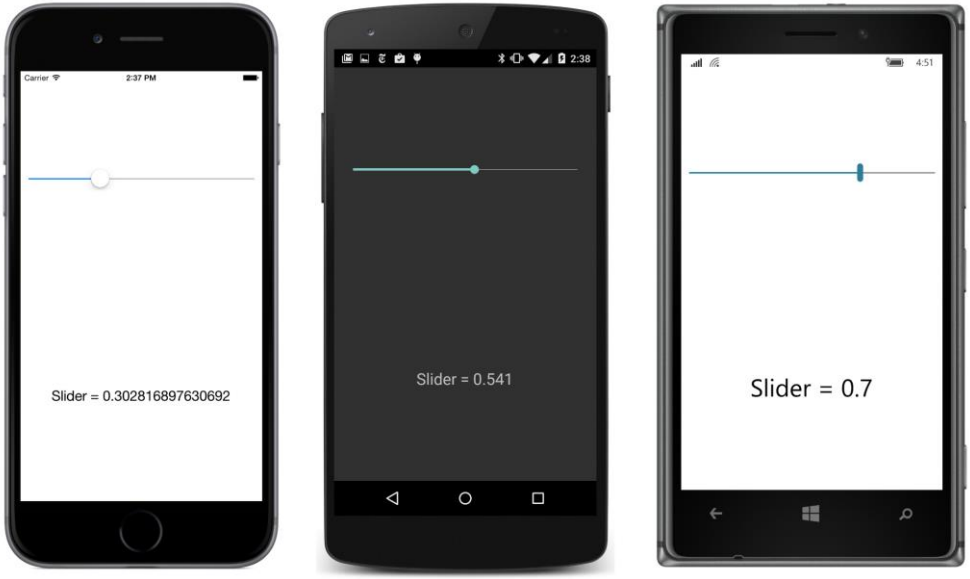
Do not set `HorizontalOptions` on the `Slider` to `Start`, `Center`, or `End` without also setting `WidthRequest` to an explicit value, or the `Slider` will collapse into a very small or even unusable width.

The `Slider` notifies code of changes to the `Value` property by firing the `ValueChanged` event. The event is fired if `Value` is changed programmatically or by user manipulation. Here's the **SliderDemo** code-behind file with the event handler:

```
public partial class SliderDemoPage : ContentPage
{
    public SliderDemoPage()
    {
        InitializeComponent();
    }

    void OnSliderValueChanged(object sender, ValueChangedEventArgs args)
    {
        label.Text = String.Format("Slider = {0}", args.NewValue);
    }
}
```

As usual, the first argument to the event handler is the object firing the event, in this case the `Slider`, and the second argument provides more information about this event. The handler for `ValueChanged` is of type `EventHandler<ValueChangedEventArgs>`, which means that the second argument to the handler is a `ValueChangedEventArgs` object. `ValueChangedEventArgs` defines two properties

of type `double` named `OldValue` and `NewValue`. This particular handler simply uses `NewValue` in a string that it sets to the `Text` property of the `Label`:



A little experimentation reveals that the default `Minimum` and `Maximum` settings for `Slider` are 0 and 1. At the time this chapter is being written, the `Slider` on the Windows platforms has a default increment of 0.1. For other settings of `Minimum` and `Maximum`, the `Slider` is restricted to 10 increments or steps of 1, whichever is less. (A more flexible `Slider` is presented in Chapter 27, "Custom renderers.")

If you're not happy with the excessive number of decimal points displayed on the iOS screen, you can reduce the number of decimal places with a formatting specification in `String.Format`:

```
void OnSliderValueChanged(object sender, ValueChangedEventArgs args)
{
    label.Text = String.Format("Slider = {0:F2}", args.NewValue);
}
```

This is not the only way to write the `ValueChanged` handler. An alternative implementation involves casting the first argument to a `Slider` object and then accessing the `Value` property directly:

```
void OnSliderValueChanged(object sender, ValueChangedEventArgs args)
{
    Slider slider = (Slider)sender;
    label.Text = String.Format("Slider = {0}", slider.Value);
}
```

Using the `sender` argument is a good approach if you're sharing the event handler among multiple `Slider` views. By the time the `ValueChanged` event handler is called, the `Value` property already has its new value.

You can set the `Minimum` and `Maximum` properties of the `Slider` to any negative or positive value, with the stipulation that `Maximum` is always greater than `Minimum`. For example, try this:

```
<Slider ValueChanged="OnSliderValueChanged"
        Maximum="100"
        VerticalOptions="CenterAndExpand" />
```

Now the `Slider` value ranges from 0 to 100.

Common pitfalls

Suppose you want the `Slider` value to range from 1 to 100. You can set both `Minimum` and `Maximum` like this:

```
<Slider ValueChanged="OnSliderValueChanged"
        Minimum="1"
        Maximum="100"
        VerticalOptions="CenterAndExpand" />
```

However, when you run the new version of the program, an `ArgumentException` is raised with the text explanation "Value was an invalid value for Minimum." What does that mean?

When the XAML parser encounters the `Slider` tag, a `Slider` is instantiated, and then the properties and events are set in the order in which they appear in the `Slider` tag. But when the `Minimum` property is set to 1, the `Maximum` value now equals the `Minimum` value. That can't be. The `Maximum` property must be *greater* than the `Minimum`. The `Slider` signals this problem by raising an exception.

Internal to the `Slider` class, the `Minimum` and `Maximum` values are compared in a callback method set to the `validateValue` argument to the `BindableProperty.Create` method calls that create the `Minimum` and `Maximum` bindable properties. The `validateValue` callback returns `true` if `Minimum` is less than `Maximum`, indicating that the values are valid. A return value of `false` from this callback triggers the exception. This is the standard way that bindable properties implement validity checks.

This isn't a problem specific to XAML. It also happens if you instantiate and initialize the `Slider` properties in this order in code. The solution is to reverse the order that `Minimum` and `Maximum` are set. First set the `Maximum` property to 100. That's legal because now the range is between 0 and 100. Then set the `Minimum` property to 1:

```
<Slider ValueChanged="OnSliderValueChanged"
        Maximum="100"
        Minimum="1"
        VerticalOptions="CenterAndExpand" />
```

However, this results in another run-time error. Now it's a `NullReferenceException` in the `ValueChanged` handler. Why is that?

The `Value` property of the `Slider` must be within the range of `Minimum` and `Maximum` values, so when the `Minimum` property is set to 1, the `Slider` automatically adjust its `Value` property to 1.

Internally, `Value` is adjusted in a callback method set to the `coerceValue` argument of the `BindableProperty.Create` method calls for the `Minimum`, `Maximum`, and `Value` properties. The callback method returns an adjusted value of the property being set after being subjected to this coercion. In this example, when `Minimum` is set to 1, the `coerceValue` method sets the slider's `Value` property to 1, and the `coerceValue` callback returns the new value of `Minimum`, which remains at the value 1.

However, as a result of the coercion, the `Value` property has changed, and this causes the `ValueChanged` event to fire. The `ValueChanged` handler in the code-behind file attempts to set the `Text` property of the `Label`, but the XAML parser has not yet instantiated the `Label` element. The `label` field is `null`.

There are a couple of solutions to this problem. The safest and most general solution is to check for a `null` value for `label` right in the event handler:

```
void OnSliderValueChanged(object sender, ValueChangedEventArgs args)
{
    if (label != null)
    {
        label.Text = String.Format("Slider = {0}", args.NewValue);
    }
}
```

However, you can also fix the problem by moving the assignment of the `ValueChanged` event in the tag to after the `Maximum` and `Minimum` properties have been set:

```
<Slider Maximum="100"
        Minimum="1"
        ValueChanged="OnSliderValueChanged"
        VerticalOptions="CenterAndExpand" />
```

The `Value` property is still coerced to 1 after the `Minimum` property is set, but the `ValueChanged` event handler has not yet been assigned, so no event is fired.

Let's assume that the `Slider` has the default range of 0 to 1. You might want the `Label` to display the initial value of the `Slider` when the program first starts up. You could initialize the `Text` property of the `Label` to "Slider = 0" in the XAML file, but if you ever wanted to change the text to something a little different, you'd need to change it in two places.

You might try giving the `Slider` a name of `slider` in the XAML file and then add some code to the constructor:

```
public SliderDemoPage()
{
    InitializeComponent();

    slider.Value = 0;
}
```

All the elements in the XAML file have been created and initialized when `InitializeComponent` returns, so if this code causes the `Slider` to fire a `ValueChanged` event, that shouldn't be a problem.

But it won't work. The value of the `Slider` is already 0, so setting it to 0 again does nothing. You could try this:

```
public SliderDemoPage()
{
    InitializeComponent();

    slider.Value = 1;
    slider.Value = 0;
}
```

That will work. But you might want to add a comment to the code so that another programmer doesn't later remove the statement that sets `Value` to 1 because it appears to be unnecessary.

Or you could simulate an event by calling the handler directly. The two arguments to the `ValueChangedEventArgs` constructor are the old value and the new value (in that order), but the `OnSliderValueChanged` handler uses only the `NewValue` property, so it doesn't matter what the other argument is or whether they're equal:

```
public partial class SliderDemoPage : ContentPage
{
    public SliderDemoPage()
    {
        InitializeComponent();

        OnSliderValueChanged(null, new ValueChangedEventArgs(0, 0));
    }

    void OnSliderValueChanged(object sender, ValueChangedEventArgs args)
    {
        label.Text = String.Format("Slider = {0}", args.NewValue);
    }
}
```

That works as well. But remember to set the arguments to the call to `OnSliderValueChanged` so that they agree with what the handler expects. If you replaced the handler body with code that casts the `sender` argument to the `Slider` object, you then need a valid first argument in the `OnSliderValueChanged` call.

The problems involving the event handler disappear when you connect the `Label` with the `Slider` by using data bindings, which you'll learn about in the next chapter. You'll still need to set the properties of the `Slider` in the correct order, but you'll experience none of the problems with the event handler because the event handler will be gone.

Slider color selection

Here's a program named **RgbSliders** that contains three `Slider` elements for selecting red, green, and blue components of a `Color`. An implicit style for `Slider` sets the `Maximum` value to 255:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
```

```
                 xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="RgbSliders.RgbSlidersPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 10"
                    Android="10, 0, 10, 10"
                    WinPhone="10, 0, 10, 10" />
    </ContentPage.Padding>

    <StackLayout>
        <StackLayout.Resources>
            <ResourceDictionary>
                <Style TargetType="Slider">
                    <Setter Property="Maximum" Value="255" />
                </Style>

                <Style TargetType="Label">
                    <Setter Property="FontSize" Value="Large" />
                    <Setter Property="HorizontalTextAlignment" Value="Center" />
                </Style>
            </ResourceDictionary>
        </StackLayout.Resources>

        <Slider x:Name="redSlider"
                ValueChanged="OnSliderValueChanged" />

        <Label x:Name="redLabel" />

        <Slider x:Name="greenSlider"
                ValueChanged="OnSliderValueChanged" />

        <Label x:Name="greenLabel" />

        <Slider x:Name="blueSlider"
                ValueChanged="OnSliderValueChanged" />

        <Label x:Name="blueLabel" />

        <BoxView x:Name="boxView"
                 VerticalOptions="FillAndExpand" />
    </StackLayout>
</ContentPage>
```

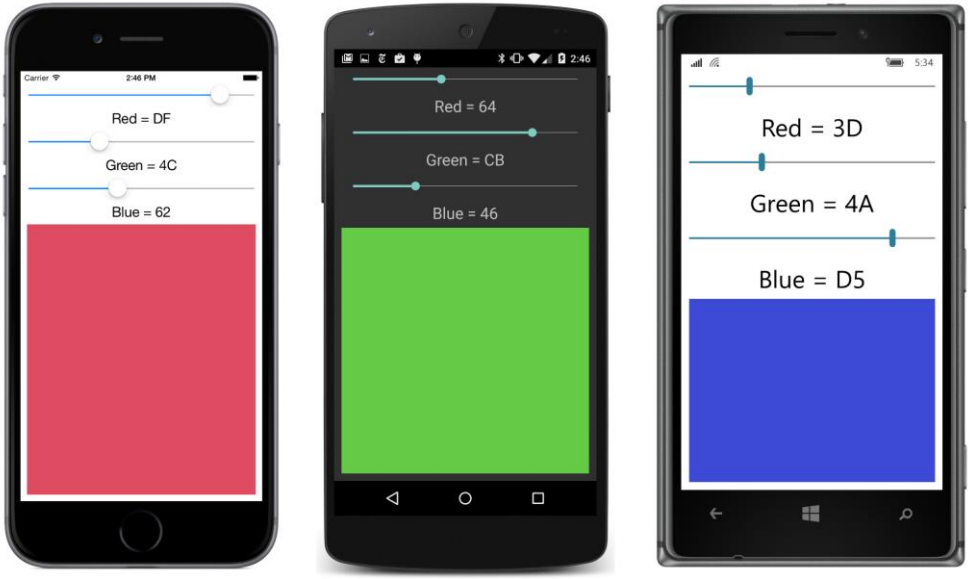
The `Slider` elements alternate with three `Label` elements to display their values, and the `StackLayout` concludes with a `BoxView` to show the resultant color.

The constructor of the code-behind file initializes the `Slider` settings to 128 for a medium gray. The shared `ValueChanged` handler checks to see which `Slider` has changed, and hence which `Label` needs to be updated, and then computes a new color for the `BoxView`:

```
public partial class RgbSlidersPage : ContentPage
{
    public RgbSlidersPage()
```

```
    {
        InitializeComponent();

        redSlider.Value = 128;
        greenSlider.Value = 128;
        blueSlider.Value = 128;
    }

    void OnSliderValueChanged(object sender, ValueChangedEventArgs args)
    {
        if (sender == redSlider)
        {
            redLabel.Text = String.Format("Red = {0:X2}", (int)redSlider.Value);
        }
        else if (sender == greenSlider)
        {
            greenLabel.Text = String.Format("Green = {0:X2}", (int)greenSlider.Value);
        }
        else if (sender == blueSlider)
        {
            blueLabel.Text = String.Format("Blue = {0:X2}", (int)blueSlider.Value);
        }

        boxView.Color = Color.FromRgb((int)redSlider.Value,
                                      (int)greenSlider.Value,
                                      (int)blueSlider.Value);
    }
}
```

Strictly speaking, the `if` and `else` statements here are not required. The code can simply set all three labels regardless of which slider is changing. The event handler accesses all three sliders anyway for setting a new color:



You can turn the phone sideways, but the `BoxView` becomes much shorter, particularly on the Windows 10 Mobile device, where the `Slider` seems to have a vertical height beyond what's required. Once the `Grid` is introduced in Chapter 18, you'll see how it becomes easier for applications to respond to orientation changes.

The following **TextFade** program uses a single `Slider` to control the `Opacity` and horizontal position of two `Label` elements in an `AbsoluteLayout`. In the initial layout, both `Label` elements are positioned at the left center of the `AbsoluteLayout`, but the second one has its `Opacity` set to 0:

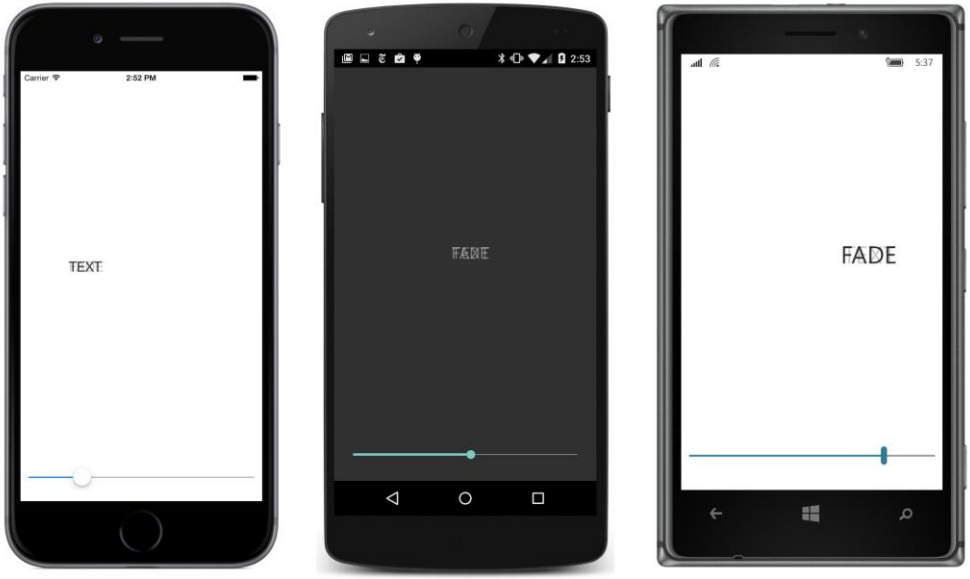
```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="TextFade.TextFadePage"
             Padding="10, 0, 10, 20">

    <StackLayout>
        <AbsoluteLayout VerticalOptions="CenterAndExpand">
            <Label x:Name="label1"
                   Text="TEXT"
                   FontSize="Large"
                   AbsoluteLayout.LayoutBounds="0, 0.5"
                   AbsoluteLayout.LayoutFlags="PositionProportional" />

            <Label x:Name="label2"
                   Text="FADE"
                   FontSize="Large"
                   Opacity="0"
                   AbsoluteLayout.LayoutBounds="0, 0.5"
                   AbsoluteLayout.LayoutFlags="PositionProportional" />
        </AbsoluteLayout>
```

```
        <Slider ValueChanged="OnSliderValueChanged" />

    </StackLayout>
</ContentPage>
```

The `Slider` event handler moves both `Label` elements from left to right across the screen. The proportional positioning helps a lot here because the `Slider` values range from 0 to 1, which results in the `Label` elements being positioned progressively from the far left to the far right of the screen:

```
public partial class TextFadePage : ContentPage
{
    public TextFadePage()
    {
        InitializeComponent();
    }

    void OnSliderValueChanged(object sender, ValueChangedEventArgs args)
    {
        AbsoluteLayout.SetLayoutBounds(label1,
            new Rectangle(args.NewValue, 0.5, AbsoluteLayout.AutoSize,
                                              AbsoluteLayout.AutoSize));
        AbsoluteLayout.SetLayoutBounds(label2,
            new Rectangle(args.NewValue, 0.5, AbsoluteLayout.AutoSize,
                                              AbsoluteLayout.AutoSize));

        label1.Opacity = 1 - args.NewValue;
        label2.Opacity = args.NewValue;
    }
}
```

At the same time, the `Opacity` values are set so that one `Label` seems to fade into the other as both labels move across the screen:



The Stepper difference

The `Stepper` view has very nearly the same programming interface as the `Slider`: It has `Minimum`, `Maximum`, and `Value` properties of type `double` and fires a `ValueChanged` event handler.

However, the `Maximum` property of `Stepper` has a default value of 100, and `Stepper` also adds an `Increment` property with a default value of 1. The `Stepper` visuals consist solely of two buttons labeled with minus and plus signs. Presses of those two buttons change the value incrementally between `Minimum` to `Maximum` based on the `Increment` property.

Although `Value` and other properties of `Stepper` are of type `double`, `Stepper` is often used for the selection of integral values. You probably don't want the value of ((`Maximum` – `Minimum`) ÷ `Increment`) to be as high as 100, as the default values suggest. If you press and hold your finger on one of the buttons, you'll trigger a typematic repeat on iOS, but not on Android or Windows 10 Mobile. Unless your program provides another way for the user to change the `Stepper` value (perhaps with a text `Entry` view), you don't want to force the user to press a button 100 times to get from `Minimum` to `Maximum`.

The **StepperDemo** program sets the `Maximum` property of the `Stepper` to 10 and uses the `Stepper` as a rudimentary design aid in determining an optimum border width for a `Button` border. The `Button` at the top of the `StackLayout` is solely for display purposes and has the necessary property settings of `BackgroundColor` and `BorderColor` to enable the border display on Android and Windows 10 Mobile.

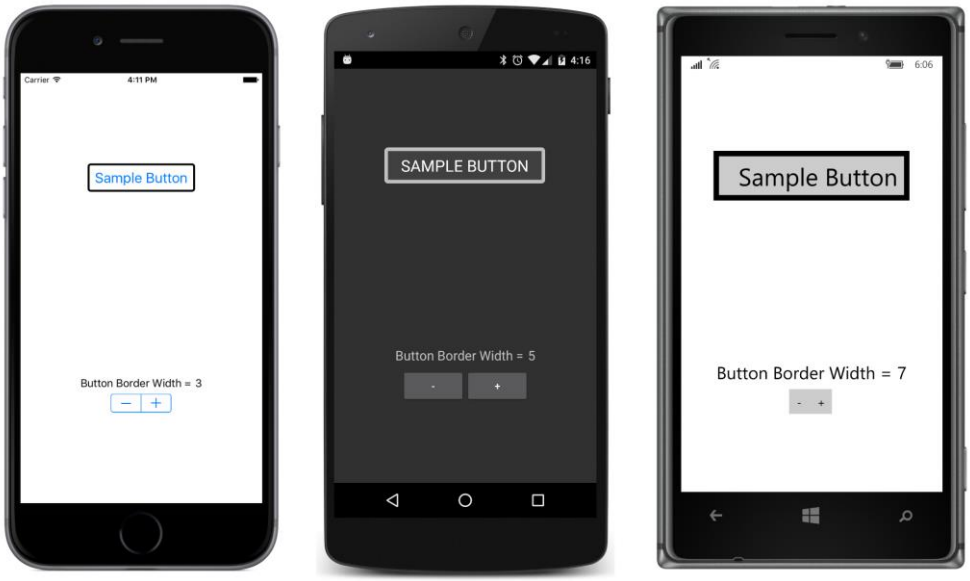
The `Stepper` is the last child in the following `StackLayout`. Between the `Button` and `Stepper` are a pair of `Label` elements for displaying the current `Stepper` value:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="StepperDemo.StepperDemoPage">

    <StackLayout>
        <Button x:Name="button"
                Text="  Sample Button  "
                FontSize="Large"
                HorizontalOptions="Center"
                VerticalOptions="CenterAndExpand">
            <Button.BackgroundColor>
                <OnPlatform x:TypeArguments="Color"
                            Android="#404040" />
            </Button.BackgroundColor>
            <Button.BorderColor>
                <OnPlatform x:TypeArguments="Color"
                            Android="#C0C0C0"
                            WinPhone="Black" />
            </Button.BorderColor>
        </Button>

        <StackLayout VerticalOptions="CenterAndExpand">

            <StackLayout Orientation="Horizontal"
                         HorizontalOptions="Center">
                <StackLayout.Resources>
                    <ResourceDictionary>
                        <Style TargetType="Label">
                            <Setter Property="FontSize" Value="Medium" />
                        </Style>
                    </ResourceDictionary>
                </StackLayout.Resources>

                <Label Text="Button Border Width =" />
                <Label x:Name="label" />
            </StackLayout>

            <Stepper x:Name="stepper"
                     Maximum="10"
                     ValueChanged="OnStepperValueChanged"
                     HorizontalOptions="Center" />

        </StackLayout>
    </StackLayout>
</ContentPage>
```

The `Label` displaying the `Stepper` value is initialized from the constructor of the code-behind file. With each change in the `Value` property of the `Stepper`, the event handler displays the new value and sets the `Button` border width:

```
public partial class StepperDemoPage : ContentPage
{
    public StepperDemoPage()
    {
```

```
        InitializeComponent();

        // Initialize display.
        OnStepperValueChanged(stepper, null);
    }

    void OnStepperValueChanged(object sender, ValueChangedEventArgs args)
    {
        Stepper stepper = (Stepper)sender;
        button.BorderWidth = stepper.Value;
        label.Text = stepper.Value.ToString("F0");
    }
}
```



Switch and CheckBox

Application programs often need Boolean input from the user, which requires some way for the user to toggle a program option to On or Off, Yes or No, True or False, or however you want to think of it. In Xamarin.Forms, this is a view called the `Switch`.

Switch basics

`Switch` defines just one property on its own, named `IsToggled` of type `bool`, and it fires the `Toggled` event to indicate a change in this property. In code, you might be inclined to give a `Switch` a name of `switch`, but that's a C# keyword, so you'll want to pick something else. In XAML, however, you can set the `x:Name` attribute to `switch`, and the XAML parser will smartly create a field named

`@switch`, which is how C# allows you to define a variable name using a C# keyword.

The **SwitchDemo** program creates two `Switch` elements with two identifying labels: "Italic" and "Boldface". Each `Switch` has its own event handler, which formats the larger `Label` at the bottom of the `StackLayout`:

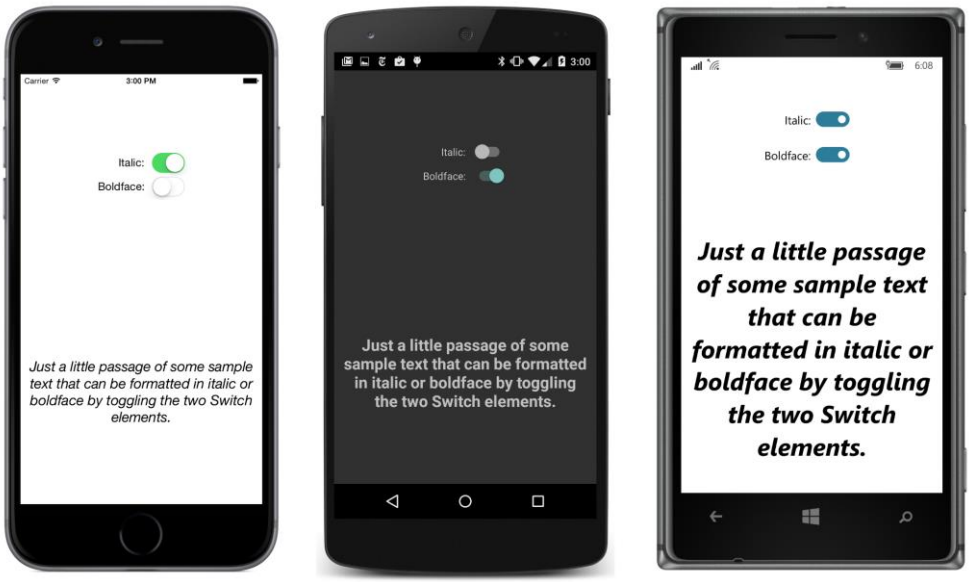
```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="SwitchDemo.SwitchDemoPage">

    <StackLayout Padding="10, 0">
        <StackLayout HorizontalOptions="Center"
                     VerticalOptions="CenterAndExpand">
            <StackLayout Orientation="Horizontal"
                         HorizontalOptions="End">
                <Label Text="Italic: "
                       VerticalOptions="Center" />
                <Switch Toggled="OnItalicSwitchToggled"
                        VerticalOptions="Center" />
            </StackLayout>

            <StackLayout Orientation="Horizontal"
                         HorizontalOptions="End">
                <Label Text="Boldface: "
                       VerticalOptions="Center" />
                <Switch Toggled="OnBoldSwitchToggled"
                        VerticalOptions="Center" />
            </StackLayout>
        </StackLayout>

        <Label x:Name="label"
               Text=
"Just a little passage of some sample text that can be formatted
in italic or boldface by toggling the two Switch elements."
               FontSize="Large"
               HorizontalTextAlignment="Center"
               VerticalOptions="CenterAndExpand" />

    </StackLayout>
</ContentPage>
```

The `Toggled` event handler has a second argument of `ToggledEventArgs`, which has a `Value` property of type `bool` that indicates the new state of the `IsToggled` property. The event handlers in **SwitchDemo** use this value to set or clear the particular `FontAttributes` flag in the `FontAttributes` property of the long `Label`:

```
public partial class SwitchDemoPage : ContentPage
{
    public SwitchDemoPage()
    {
        InitializeComponent();
    }
```

```
    void OnItalicSwitchToggled(object sender, ToggledEventArgs args)
    {
        if (args.Value)
        {
            label.FontAttributes |= FontAttributes.Italic;
        }
        else
        {
            label.FontAttributes &= ~FontAttributes.Italic;
        }
    }

    void OnBoldSwitchToggled(object sender, ToggledEventArgs args)
    {
        if (args.Value)
        {
            label.FontAttributes |= FontAttributes.Bold;
        }
        else
        {
            label.FontAttributes &= ~FontAttributes.Bold;
        }
    }
}
```

The `Switch` has a different appearance on the three platforms:



Notice that the program aligns the two `Switch` views, which gives it a more attractive look, but which also means that the text labels are necessarily somewhat misaligned. To accomplish this formatting, the XAML file puts each of the pair of `Label` and `Switch` elements in a horizontal `StackLayout`.

Each horizontal `StackLayout` has its `HorizontalOptions` set to `End`, which aligns each `StackLayout` at the right, and a parent `StackLayout` centers the collection of labels and switches on the screen with a `HorizontalOptions` setting of `Center`. Within the horizontal `StackLayout`, both views have their `VerticalOptions` properties set to `Center`. If the `Switch` is taller than the `Label`, then the `Label` is vertically centered relative to the `Switch`. But if the `Label` is taller than the `Switch`, the `Switch` is also vertically centered relative to the `Label`.

A traditional CheckBox

In more traditional graphical environments, the user-interface object that allows users to choose a Boolean value is called a `CheckBox`, usually featuring some text with a box that can be empty or filled with an X or a check mark. One advantage of the `CheckBox` over the `Switch` is that the text identifier is part of the visual and doesn't need to be added with a separate `Label`.

One way to create custom views in Xamarin.Forms is by writing special classes called *renderers* that are specific to each platform and that reference views in each platform. That is demonstrated in Chapter 27.

However, it's also possible to create custom views right in Xamarin.Forms by assembling a view from other views. You first derive a class from `ContentView`, set its `Content` property to a `StackLayout` (for example), and then add one or more views on that. (You saw an example of this technique in the `ColorView` class in Chapter 8.) You'll probably also need to define one or more properties, and possibly some events, but you'll want to take advantage of the bindable infrastructure established by the `BindableObject` and `BindableProperty` classes. That allows your properties to be styled and to be targets of data bindings.

A `CheckBox` consists of just two `Label` elements on a `ContentView`: one `Label` displays the text associated with the `CheckBox`, while the other displays a box. A `TapGestureRecognizer` detects when the `CheckBox` is tapped.

A `CheckBox` class has already been added to the **Xamarin.FormsBook.Toolkit** library that is included in the downloadable code for this book. Here's how you would do it on your own:

In Visual Studio, you can select **Forms Xaml Page** from the **Add New Item** dialog box. However, this creates a class that derives from `ContentPage` when you really want a class that derives from `ContentView`. Simply change the root element of the XAML file from `ContentPage` to `ContentView`, and change the base class in the code-behind file from `ContentPage` to `ContentView`.

In Xamarin Studio, however, you can simply choose **Forms ContentView Xaml** from the **New File** dialog.

Here's the CheckBox.xaml file:

```
<ContentView xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="Xamarin.FormsBook.Toolkit.CheckBox">
```

```
    <StackLayout Orientation="Horizontal">
        <Label x:Name="boxLabel" Text="&#x2610;" />
        <Label x:Name="textLabel" />
    </StackLayout>

    <ContentView.GestureRecognizers>
        <TapGestureRecognizer Tapped="OnCheckBoxTapped" />
    </ContentView.GestureRecognizers>
</ContentView>
```

That Unicode character \u2610 is called the Ballot Box character, and it's just an empty square. Character \u2611 is a Ballot Box with Check, while \u2612 is a Ballot Box with X. To indicate a checked state, this `CheckBox` code-behind file sets the `Text` property of `boxLabel` to \u2611 (as you'll see shortly).

The code-behind file of `CheckBox` defines three properties:

- `Text`
- `FontSize`
- `IsChecked`

`CheckBox` also defines an event named `IsCheckedChanged`.

Should `CheckBox` also define `FontAttributes` and `FontFamily` properties like `Label` and `Button` do? Perhaps, but these additional properties are not quite as crucial for views devoted to user interaction.

All three of the properties that `CheckBox` defines are backed by bindable properties. The code-behind file creates all three `BindableProperty` objects, and the property-changed handlers are defined as lambda functions within these methods.

Keep in mind that the property-changed handlers are static, so they need to cast the first argument to a `CheckBox` object to reference the instance properties and events in the class. The property-changed handler for `IsChecked` is responsible for changing the character representing the checked and unchecked state and firing the `IsCheckedChanged` event:

```
namespace Xamarin.FormsBook.Toolkit
{
    public partial class CheckBox : ContentView
    {
        public static readonly BindableProperty TextProperty =
            BindableProperty.Create(
                "Text",
                typeof(string),
                typeof(CheckBox),
                null,
                propertyChanged: (bindable, oldValue, newValue) =>
                {
                    ((CheckBox)bindable).textLabel.Text = (string)newValue;
                });
```

```
public static readonly BindableProperty FontSizeProperty =
    BindableProperty.Create(
        "FontSize",
        typeof(double),
        typeof(CheckBox),
        Device.GetNamedSize(NamedSize.Default, typeof(Label)),
        propertyChanged: (bindable, oldValue, newValue) =>
        {
            CheckBox checkbox = (CheckBox)bindable;
            checkbox.boxLabel.FontSize = (double)newValue;
            checkbox.textLabel.FontSize = (double)newValue;
        });

public static readonly BindableProperty IsCheckedProperty =
    BindableProperty.Create(
        "IsChecked",
        typeof(bool),
        typeof(CheckBox),
        false,
        propertyChanged: (bindable, oldValue, newValue) =>
        {
            // Set the graphic.
            CheckBox checkbox = (CheckBox)bindable;
            checkbox.boxLabel.Text = (bool)newValue ? "\u2611" : "\u2610";

            // Fire the event.
            EventHandler<bool> eventHandler = checkbox.CheckedChanged;
            if (eventHandler != null)
            {
                eventHandler(checkbox, (bool)newValue);
            }
        });

public event EventHandler<bool> CheckedChanged;

public CheckBox()
{
    InitializeComponent();
}

public string Text
{
    set { SetValue(TextProperty, value); }
    get { return (string)GetValue(TextProperty); }
}

[TypeConverter(typeof(FontSizeConverter))]
public double FontSize
{
    set { SetValue(FontSizeProperty, value); }
    get { return (double)GetValue(FontSizeProperty); }
}
```

```
        public bool IsChecked
        {
            set { SetValue(IsCheckedProperty, value); }
            get { return (bool)GetValue(IsCheckedProperty); }
        }

        // TapGestureRecognizer handler.
        void OnCheckBoxTapped(object sender, EventArgs args)
        {
            IsChecked = !IsChecked;
        }
    }
}
```

Notice the `TypeConverter` on the `FontSize` property. That allows the property to be set in XAML with attribute values such as "Small" and "Large".

The `Tapped` handler for the `TapGestureRecognizer` is at the bottom of the class and simply toggles the `IsChecked` property by using the C# logical negation operator. An even shorter statement to toggle a Boolean variable uses the exclusive-OR assignment operator:

```
IsChecked ^= true;
```

The **CheckBoxDemo** program is very similar to the **SwitchDemo** program except that the markup is considerably simplified because the `CheckBox` includes its own `Text` property:

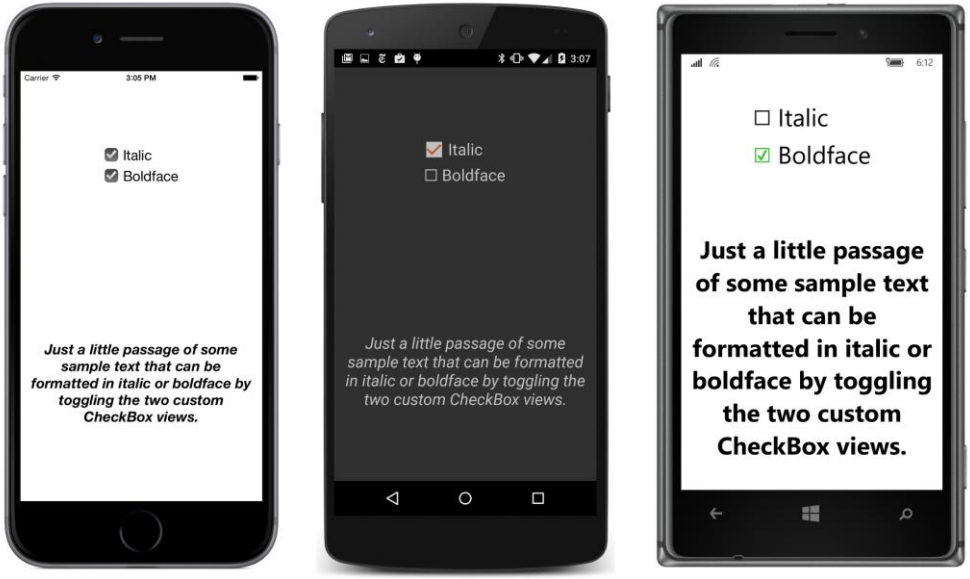
```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             xmlns:toolkit=
                 "clr-namespace:Xamarin.FormsBook.Toolkit;assembly=Xamarin.FormsBook.Toolkit"
             x:Class="CheckBoxDemo.CheckBoxDemoPage">

    <StackLayout Padding="10, 0">
        <StackLayout HorizontalOptions="Center"
                     VerticalOptions="CenterAndExpand">

            <toolkit:CheckBox Text="Italic"
                              FontSize="Large"
                              CheckedChanged="OnItalicCheckBoxChanged" />

            <toolkit:CheckBox Text="Boldface"
                              FontSize="Large"
                              CheckedChanged="OnBoldCheckBoxChanged" />
        </StackLayout>

        <Label x:Name="label"
               Text=
"Just a little passage of some sample text that can be formatted
in italic or boldface by toggling the two custom CheckBox views."
               FontSize="Large"
               HorizontalTextAlignment="Center"
               VerticalOptions="CenterAndExpand" />
    </StackLayout>
```

```
</ContentPage>
```

The code-behind file is also very similar to the earlier program:

```
public partial class CheckBoxDemoPage : ContentPage
{
    public CheckBoxDemoPage()
    {
        InitializeComponent();
    }

    void OnItalicCheckBoxChanged(object sender, bool isChecked)
    {
        if (isChecked)
        {
            label.FontAttributes |= FontAttributes.Italic;
        }
        else
        {
            label.FontAttributes &= ~FontAttributes.Italic;
        }
    }

    void OnBoldCheckBoxChanged(object sender, bool isChecked)
    {
        if (isChecked)
        {
            label.FontAttributes |= FontAttributes.Bold;
        }
        else
        {
            label.FontAttributes &= ~FontAttributes.Bold;
        }
    }
}
```

Interestingly, the character for the checked box shows up in color on the Android and Windows platforms:



Typing text

Xamarin.Forms defines three views for obtaining text input from the user:

- `Entry` for a single line of text.
- `Editor` for multiple lines of text.
- `SearchBar` for a single line of text specifically for search operations.

Both `Entry` and `Editor` derive from `InputView`, which derives from `View`. `SearchBar` derives directly from `View`.

Both `Entry` and `SearchBar` implement horizontal scrolling if the entered text exceeds the width of the view. The `Editor` implements word wrapping and is capable of vertical scrolling for text that exceeds its height.

Keyboard and focus

`Entry`, `Editor`, and `SearchBar` are different from all the other views in that they make use of the phone's onscreen keyboard, sometimes called the *virtual keyboard*. From the user's perspective, tapping the `Entry`, `Editor`, or `SearchBar` view invokes the onscreen keyboard, which slides in from the bottom. Tapping anywhere else on the screen (except another `Entry`, `Editor`, or `SearchBar` view) often makes the keyboard go away, and sometimes the keyboard can be dismissed in other ways.

From the program's perspective, the presence of the keyboard is closely related to *input focus*, a concept that originated in desktop graphical user interface environments. On both desktop environments and mobile devices, input from the keyboard can be directed to only one user-interface object at a time, and that object must be clearly selectable and identifiable by the user. The object that receives keyboard input is known as the object with *keyboard input focus*, or more simply, just *input focus* or *focus*.

The `VisualElement` class defines several methods, properties, and events related to input focus:

- The `Focus` method attempts to set input focus to a visual element and returns `true` if successful.
- The `Unfocus` method removes input focus from a visual element.
- The `IsFocused` get-only property is `true` if a visual element currently has input focus.
- The `Focused` event is fired when a visual element acquires input focus.
- The `Unfocused` event is fired when a visual element loses input focus.

As you know, mobile environments make far less use of the keyboard than desktop environments do, and most mobile views (such as the `Slider`, `Stepper`, and `Switch` that you've already seen) don't make use of the keyboard at all. Although these five focus-related members of the `VisualElement` class appear to implement a generalized system for passing input focus between visual elements, they really only pertain to `Entry`, `Editor`, and `SearchBar`.

These views signal that they have input focus with a flashing caret showing the text input point, and they trigger the keyboard to slide up. When the view loses input focus, the keyboard slides back down.

A view must have its `IsEnabled` property set to `true` (the default state) to acquire input focus, and of course the `IsVisible` property must also be `true` or the view won't be on the screen at all.

Choosing the keyboard

`Entry` and `Editor` are different from `SearchBar` in that they both derive from `InputView`. Interestingly, although `Entry` and `Editor` define similar properties and events, `InputView` defines just one property: `Keyboard`. This property allows a program to select the type of keyboard that is displayed. For example, a keyboard for typing a URL should be different from a keyboard for entering a phone number. All three platforms have various styles of virtual keyboards appropriate for different types of text input. A program cannot select the keyboard used for `SearchBar`.

This `Keyboard` property is of type `Keyboard`, a class that defines seven static read-only properties of type `Keyboard` appropriate for different keyboard uses:

- `Default`
- `Text`

- `Chat`
- `Url`
- `Email`
- `Telephone`
- `Numeric`

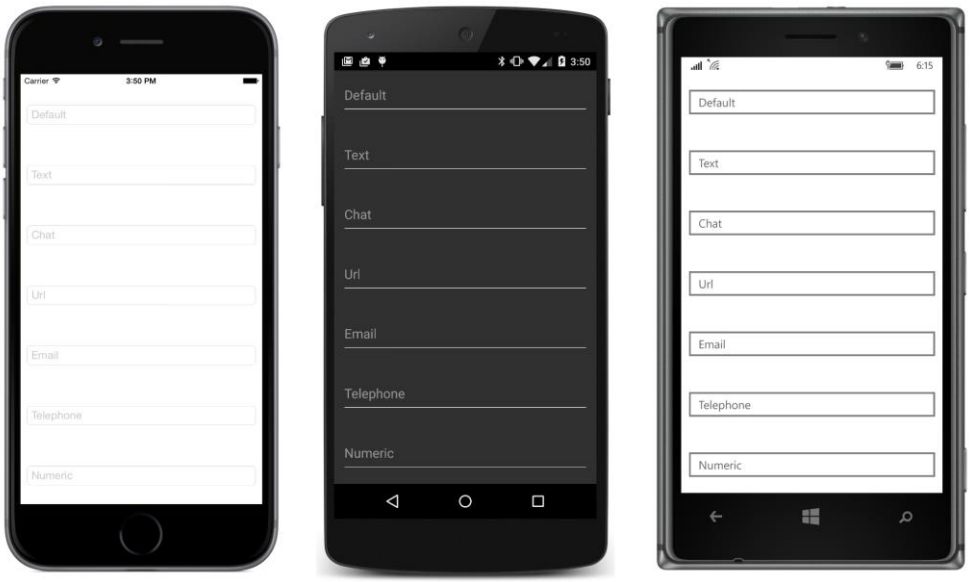
On all three platforms, the `Numeric` keyboard allows typing decimal points but does not allow typing a negative sign, so it's limited to positive numbers.

The following program creates seven `Entry` views that let you see how these keyboards are implemented in the three platforms. The particular keyboard attached to each `Entry` is identified by a property defined by `Entry` named `Placeholder`. This is the text that appears in the `Entry` prior to anything the user types as a hint for the nature of the text the program is expecting. Placeholder text is commonly a short phrase such as "First Name" or "Email Address":

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="EntryKeyboards.EntryKeyboardsPage">

    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <ScrollView>
        <StackLayout>
            <StackLayout.Resources>
                <ResourceDictionary>
                    <Style TargetType="Entry">
                        <Setter Property="VerticalOptions" Value="CenterAndExpand" />
                    </Style>
                </ResourceDictionary>
            </StackLayout.Resources>

            <Entry Placeholder="Default"
                   Keyboard="Default" />

            <Entry Placeholder="Text"
                   Keyboard="Text" />

            <Entry Placeholder="Chat"
                   Keyboard="Chat" />

            <Entry Placeholder="Url"
                   Keyboard="Url" />

            <Entry Placeholder="Email"
```

```
                Keyboard="Email" />

            <Entry Placeholder="Telephone"
                Keyboard="Telephone" />

            <Entry Placeholder="Numeric"
                Keyboard="Numeric" />
        </StackLayout>
    </ScrollView>
</ContentPage>
```

The placeholders appear as gray text. Here's how the display looks when the program first begins to run:



Just as with the `Slider`, you don't want to set `HorizontalOptions` on an `Entry` to `Left`, `Center`, or `Right` unless you also set the `WidthRequest` property. If you do so, the `Entry` collapses to a very small width. It can still be used—the `Entry` automatically provides horizontal scrolling for text longer than the `Entry` can display—but you should really try to provide an adequate size. In this program each `Entry` is as wide as the screen minus a 10-unit padding on the left and right.

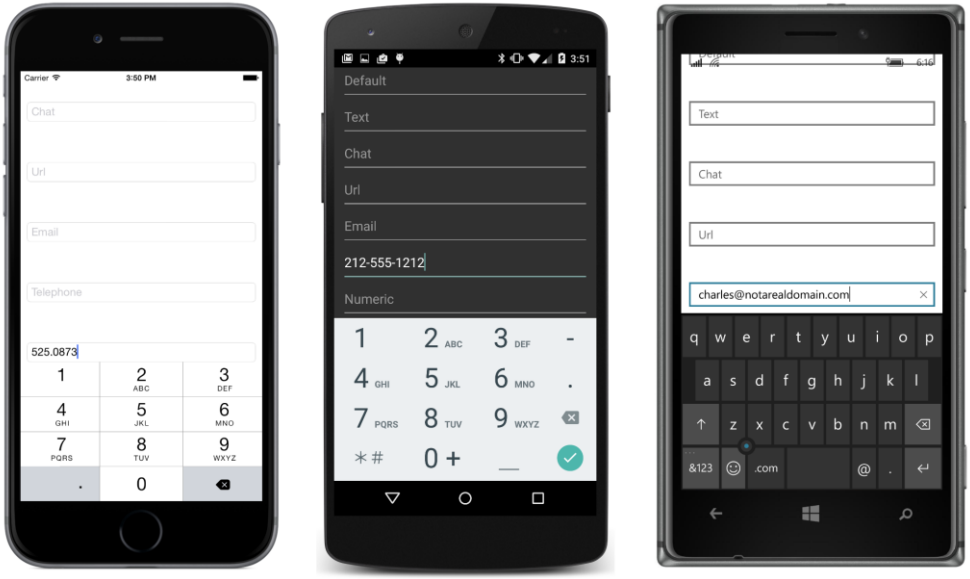
You can estimate an adequate `WidthRequest` through experimentation with different text lengths. The next program in this chapter sets the `Entry` width to a value equivalent to one inch.

The **EntryKeyboards** program evenly spaces the seven `Entry` views vertically using a `VerticalOptions` value of `CenterAndExpand` set through an implicit style. Clearly there is enough vertical room for all seven `Entry` views, so you might be puzzled about the use of the `ScrollView` in the XAML file.

The `ScrollView` is specifically for iOS. If you tap an `Entry` close to the bottom of the Android or

Windows 10 Mobile screen, the operating system will automatically move up the contents of the page when the keyboard pops up, so the `Entry` is still visible while you are typing. But iOS doesn't do that unless a `ScrollView` is provided.

Here's how each screen looks when text is being typed in one of the `Entry` views toward the bottom of the screen:



Entry properties and events

Besides inheriting the `Keyboard` property from `InputView`, `Entry` defines four more properties, only one of which you saw in the previous program:

- `Text` — the string that appears in the `Entry`
- `TextColor` — a `Color` value
- `IsPassword` — a Boolean that causes characters to be masked right after they're typed
- `Placeholder` — light-colored text that appears in the `Entry` but disappears as soon as the user begins typing.

Generally, a program obtains what the user typed by accessing the `Text` property, but the program can also initialize the `Text` property. Perhaps the program wishes to suggest some text input.

The `Entry` also defines two events:

- `TextChanged`

- `Completed`

The `TextChanged` event is fired for every change in the `Text` property, which generally corresponds to every keystroke (except shift and some special keys). A program can monitor this event to perform validity checks. For example, you might check for valid numbers or valid email addresses to enable a **Calculate** or **Send** button.

The `Completed` event is fired when the user presses a particular key on the keyboard to indicate that the text is completed. This key is platform specific:

- iOS: The key is labeled **return**, which is not on the `Telephone` or `Numeric` keyboard.
- Android: The key is a green check mark in the lower-right corner of the keyboard.
- Windows Phone: The key is an enter (or return) symbol (↵) on most keyboards but is a go symbol (→) on the `Url` keyboard. Such a key is not present on the `Telephone` and `Numeric` keyboards.

On iOS and Android, the completed key dismisses the keyboard in addition to generating the `Completed` event. On Windows 10 Mobile it does not.

Android and Windows users can also dismiss the keyboard by using the phone's **Back** button at the bottom left of the portrait screen. This causes the `Entry` to lose input focus but does not cause the `Completed` event to fire.

Let's write a program named **QuadraticEquations** that solves quadratic equations, which are equations of the form:

$$ax^2 + bx + c = 0$$

For any three constants *a*, *b*, and *c*, the program uses the quadratic equation to solve for *x*:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

You enter a, b, and c in three `Entry` views and then press a `Button` labeled **Solve for x**.

Here's the XAML file. Unfortunately, the `Numeric` keyboard is not suitable for this program because on all three platforms it does not allow entering negative numbers. For that reason, no particular keyboard is specified:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="QuadaticEquations.QuadraticEquationsPage">

    <ContentPage.Resources>
        <ResourceDictionary>
            <Style TargetType="Label">
                <Setter Property="FontSize" Value="Medium" />
                <Setter Property="VerticalOptions" Value="Center" />
            </Style>
```

```
            <Style TargetType="Entry">
                <Setter Property="WidthRequest" Value="180" />
            </Style>
        </ResourceDictionary>
    </ContentPage.Resources>

    <StackLayout>
        <!-- Entry section -->
        <StackLayout Padding="20, 0, 0, 0"
                     VerticalOptions="CenterAndExpand"
                     HorizontalOptions="Center">

            <StackLayout Orientation="Horizontal">
                <Entry x:Name="entryA"
                       TextChanged="OnEntryTextChanged"
                       Completed="OnEntryCompleted" />
                <Label Text=" x&#178; +" />
            </StackLayout>

            <StackLayout Orientation="Horizontal">
                <Entry x:Name="entryB"
                       TextChanged="OnEntryTextChanged"
                       Completed="OnEntryCompleted" />
                <Label Text=" x +" />
            </StackLayout>

            <StackLayout Orientation="Horizontal">
                <Entry x:Name="entryC"
                       TextChanged="OnEntryTextChanged"
                       Completed="OnEntryCompleted" />
                <Label Text=" = 0" />
            </StackLayout>
        </StackLayout>

        <!-- Button -->
        <Button x:Name="solveButton"
                Text="Solve for x"
                FontSize="Large"
                IsEnabled="False"
                VerticalOptions="CenterAndExpand"
                HorizontalOptions="Center"
                Clicked="OnSolveButtonClicked" />

        <!-- Results section -->
        <StackLayout VerticalOptions="CenterAndExpand"
                     HorizontalOptions="Center">
            <Label x:Name="solution1Label"
                   HorizontalTextAlignment="Center" />

            <Label x:Name="solution2Label"
                   HorizontalTextAlignment="Center" />
        </StackLayout>
    </StackLayout>
</ContentPage>
```

The `Label`, `Entry`, and `Button` views are divided into three sections: data input at the top, the `Button` in the middle, and the results at the bottom. Notice the platform-specific `WidthRequest` setting in the implicit `Style` for the `Entry`. This gives each `Entry` a one-inch width.

The program provides two ways to trigger a calculation: by pressing the completion key on the keyboard, or by pressing the `Button` in the middle of the page. Another option in a program such as this would be to perform the calculation for every keystroke (or to be more accurate, every `TextChanged` event). That would work here because the recalculation is very quick. However, in the present design the results are near the bottom of the screen and are covered when the virtual keyboard is active, so the page would have to be reorganized for such a scheme to make sense.

The **QuadraticEquations** program uses the `TextChanged` event but solely to determine the validity of the text typed into each `Entry`. The text is passed to `Double.TryParse`, and if the method returns `false`, the `Entry` text is displayed in red. (On Windows 10 Mobile, the red text coloring shows up only when the `Entry` loses input focus.) Also, the `Button` is enabled only if all three `Entry` views contain valid `double` values. Here's the first half of the code-behind file that shows all the program interaction:

```
public partial class QuadraticEquationsPage : ContentPage
{
    public QuadraticEquationsPage()
    {
        InitializeComponent();

        // Initialize Entry views.
        entryA.Text = "1";
        entryB.Text = "-1";
        entryC.Text = "-1";
    }

    void OnEntryTextChanged(object sender, TextChangedEventArgs args)
    {
        // Clear out solutions.
        solution1Label.Text = " ";
        solution2Label.Text = " ";

        // Color current entry text based on validity.
        Entry entry = (Entry)sender;
        double result;
        entry.TextColor = Double.TryParse(entry.Text, out result) ? Color.Default : Color.Red;

        // Enable the button based on validity.
        solveButton.IsEnabled = Double.TryParse(entryA.Text, out result) &&
                                Double.TryParse(entryB.Text, out result) &&
                                Double.TryParse(entryC.Text, out result);
    }

    void OnEntryCompleted(object sender, EventArgs args)
    {
        if (solveButton.IsEnabled)
        {
            Solve();
```

```
        }
    }

    void OnSolveButtonClicked(object sender, EventArgs args)
    {
        Solve();
    }
    …
}
```

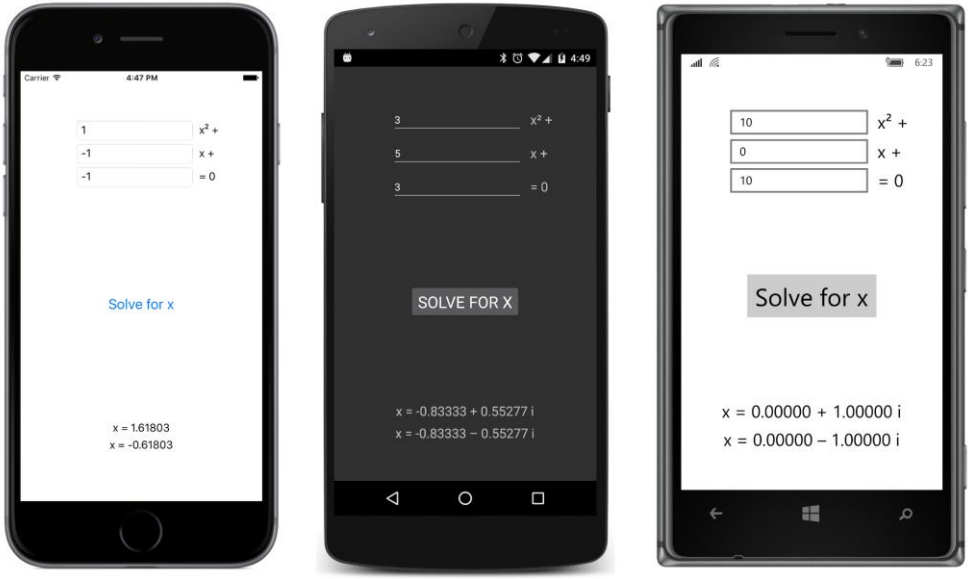
The `Completed` handler for the `Entry` calls the `Solve` method only when the `Button` is enabled, which (as you've seen) indicates that all three `Entry` views contain valid values. Therefore, the `Solve` method can safely assume that all three `Entry` views contain valid numbers that won't cause `Double.Parse` to raise an exception.

The `Solve` method is necessarily complicated because the quadratic equation might have one or two solutions, and each solution might have an imaginary part as well as a real part. The method initializes the real part of the second solution to `Double.NaN` ("not a number") and displays the second result only if that's no longer the case. The imaginary parts are displayed only if they're nonzero, and either a plus sign or an en dash (Unicode \u2013) connects the real and imaginary parts:

```
public partial class QuadraticEquationsPage : ContentPage
{
    …
    void Solve()
    {
        double a = Double.Parse(entryA.Text);
        double b = Double.Parse(entryB.Text);
        double c = Double.Parse(entryC.Text);
        double solution1Real = 0;
        double solution1Imag = 0;
        double solution2Real = Double.NaN;
        double solution2Imag = 0;
        string str1 = " ";
        string str2 = " ";

        if (a == 0 && b == 0 && c == 0)
        {
            str1 = "x = anything";
        }
        else if (a == 0 && b == 0)
        {
            str1 = "x = nothing";
        }
        else
        {
            if (a == 0)
            {
                solution1Real = -c / b;
            }
            else
            {
```

```
                double discriminant = b * b - 4 * a * c;

                if (discriminant == 0)
                {
                    solution1Real = -b / (2 * a);
                }
                else if (discriminant > 0)
                {
                    solution1Real = (-b + Math.Sqrt(discriminant)) / (2 * a);
                    solution2Real = (-b - Math.Sqrt(discriminant)) / (2 * a);
                }
                else
                {
                    solution1Real = -b / (2 * a);
                    solution2Real = solution1Real;

                    solution1Imag = Math.Sqrt(-discriminant) / (2 * a);
                    solution2Imag = -solution1Imag;
                }
            }
            str1 = Format(solution1Real, solution1Imag);
            str2 = Format(solution2Real, solution2Imag);
        }
        solution1Label.Text = str1;
        solution2Label.Text = str2;
    }

    string Format(double real, double imag)
    {
        string str = " ";

        if (!Double.IsNaN(real))
        {
            str = String.Format("x = {0:F5}", real);

            if (imag != 0)
            {
                str += String.Format(" {0} {1:F5} i",
                                     Math.Sign(imag) == 1 ? "+" : "\u2013",
                                     Math.Abs(imag));
            }
        }
        return str;
    }
}
```

Here are a couple of solutions:



The Editor difference

You might assume that the `Editor` has a more extensive API than the `Entry` because it can handle multiple lines and even paragraphs of text. But in Xamarin.Forms, the API for `Editor` is actually somewhat simpler. Besides inheriting the `Keyboard` property from `InputView`, `Editor` defines just one property on its own: the essential `Text` property. `Editor` also defines the same two events as `Entry`:

- `TextChanged`
- `Completed`

However, the `Completed` event is of necessity a little different. While a return or enter key can signal completion on an `Entry`, these same keys used with the `Editor` instead mark the end of a paragraph.

The `Completed` event for `Editor` works a little differently on the three platforms: For iOS, Xamarin.Forms displays a special **Done** button above the keyboard that dismisses the keyboard and causes a `Completed` event to fire. On Android and Windows 10 Mobile, the system **Back** button—the button at the lower-left corner of the phone in portrait mode—dismisses the keyboard and fires the `Completed` event. This **Back** button does *not* fire the `Completed` event for an `Entry` view, but it does dismiss the keyboard.

It is likely that what users type into an `Editor` is not telephone numbers and URLs but actual words, sentences, and paragraphs. In most cases, you'll want to use the `Text` keyboard for `Editor` because it provides spelling checks, suggestions, and automatic capitalization of the first word of sentences. If you don't want these features, the `Keyboard` class provides an alternative means of specifying a keyboard by using a static `Create` method and the following members of the `KeyboardFlags` enumeration:

- `CapitalizeSentence` (equal to 1)
- `Spellcheck` (2)
- `Suggestions` (4)
- `All` (\xFFFFFFFF)

The `Text` keyboard is equivalent to creating the keyboard with `KeyboardFlags.All`. The `Default` keyboard is equivalent to creating the keyboard with `(KeyboardFlags)0`. You can't create a keyboard in XAML using these flags. It must be done in code.

The **JustNotes** program is intended as a freeform note-taking program that automatically saves and restores the contents of an `Editor` view by using the `Properties` collection of the `Application` class. The page basically consists of a large `Editor`, but to give the user some clue about what the program does, the name of the program is displayed at the top. On iOS and Android, such text can be set by the `Title` property of the page, but to display that property, the `ContentPage` must be wrapped in an `ApplicationPage` (as you discovered with the **ToolbarDemo** program in Chapter 13). That's done in the constructor of the `App` class:

```
public class App : Application
{
    public App()
    {
        MainPage = new NavigationPage(new JustNotesPage());
    }

    protected override void OnStart()
    {
        // Handle when your app starts
    }

    protected override void OnSleep()
    {
        // Handle when your app sleeps
        ((JustNotesPage)(((NavigationPage)MainPage).CurrentPage)).OnSleep();
    }

    protected override void OnResume()
    {
        // Handle when your app resumes
    }
}
```

The `OnSleep` method in `App` calls a method also named `OnSleep` defined in the `JustNotesPage` code-behind file. This is how the contents of the `Editor` are saved in application memory.

The root element of the XAML page sets the `Title` property. The remainder of the page is occupied by an `AbsoluteLayout` filled with the `Editor`:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
```

```
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="JustNotes.JustNotesPage"
             Title="Just Notes">

    <StackLayout>
        <AbsoluteLayout VerticalOptions="FillAndExpand">
            <Editor x:Name="editor"
                    Keyboard="Text"
                    AbsoluteLayout.LayoutBounds="0, 0, 1, 1"
                    AbsoluteLayout.LayoutFlags="All"
                    Focused="OnEditorFocused"
                    Unfocused="OnEditorUnfocused" />
        </AbsoluteLayout>
    </StackLayout>
</ContentPage>
```

So why does the program use an `AbsoluteLayout` to host the `Editor`?

The **JustNotes** program is a work in progress. It doesn't quite work right for iOS. As you'll recall, when an `Entry` view is positioned toward the bottom of the screen, you want to put it in a `ScrollView` so that it scrolls up when the iOS virtual keyboard is displayed. However, because `Editor` implements its own scrolling, you can't put it in a `ScrollView`.

For that reason, the code-behind file sets the height of the `Editor` to one-half the height of the `AbsoluteLayout` when the `Editor` gets input focus so that the keyboard doesn't overlap it, and it restores the `Editor` height when it loses input focus:

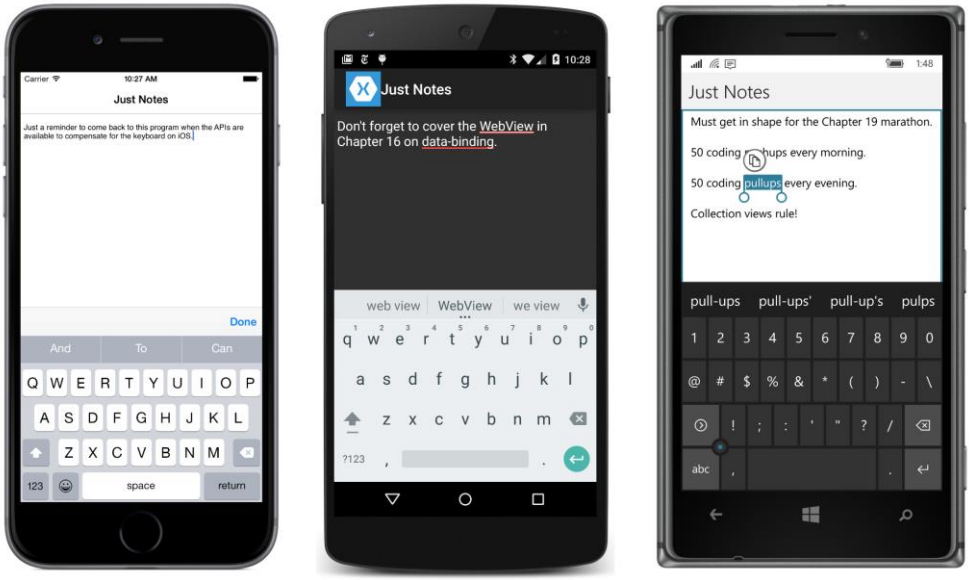
```
public partial class JustNotesPage : ContentPage
{
    public JustNotesPage()
    {
        InitializeComponent();

        // Retrieve last saved Editor text.
        IDictionary<string, object> properties = Application.Current.Properties;

        if (properties.ContainsKey("text"))
        {
            editor.Text = (string)properties["text"];
        }
    }

    void OnEditorFocused(object sender, FocusEventArgs args)
    {
        if (Device.OS == TargetPlatform.iOS)
        {
            AbsoluteLayout.SetLayoutBounds(editor, new Rectangle(0, 0, 1, 0.5));
        }
    }

    void OnEditorUnfocused(object sender, FocusEventArgs args)
    {
        if (Device.OS == TargetPlatform.iOS)
```

```
        {
            AbsoluteLayout.SetLayoutBounds(editor, new Rectangle(0, 0, 1, 1));
        }
    }

    public void OnSleep()
    {
        // Save Editor text.
        Application.Current.Properties["text"] = editor.Text;
    }
}
```

That adjustment is only approximate, of course. It varies by device, and it varies by portrait and landscape mode, but sufficient information is not currently available in Xamarin.Forms to do it more accurately. For now, you should probably restrict your use of `Editor` views to the top area of the page.

The code for saving and restoring the `Editor` contents is rather prosaic in comparison with the `Editor` manipulation. The `OnSleep` method (called from the `App` class) saves the text in the `Properties` dictionary with a key of "text" and the constructor restores it.

Here's the program running on all three platforms with the `Text` keyboard in view with word suggestions. On the Windows 10 Mobile screen, a word has been selected and might be copied to the clipboard for a later paste operation:



The SearchBar

The `SearchBar` doesn't derive from `InputView` like `Entry` and `Editor`, and it doesn't have a `Key-`

board property. The keyboard that SearchBar displays when it acquires input focus is platform specific and appropriate for a search command. The SearchBar itself is similar to an Entry view, but depending on the platform, it might be adorned with some other graphics and contain a button that erases the typed text.

SearchBar defines two events:

- TextChanged
- SearchButtonPressed

The TextChanged event allows your program to access a text entry in progress. Perhaps your program can actually begin a search or offer context-specific suggestions before the user completes typing. The SearchButtonPressed event is equivalent to the Completed event fired by Entry. It is triggered by a particular button on the keyboard in the same location as the completed button for Entry but possibly labeled differently.

SearchBar defines five properties:

- Text — the text entered by the user
- Placeholder — hint text displayed before the user begins typing
- CancelButtonColor — of type Color
- SearchCommand — for use with data binding
- SearchCommandParameter — for use with data binding

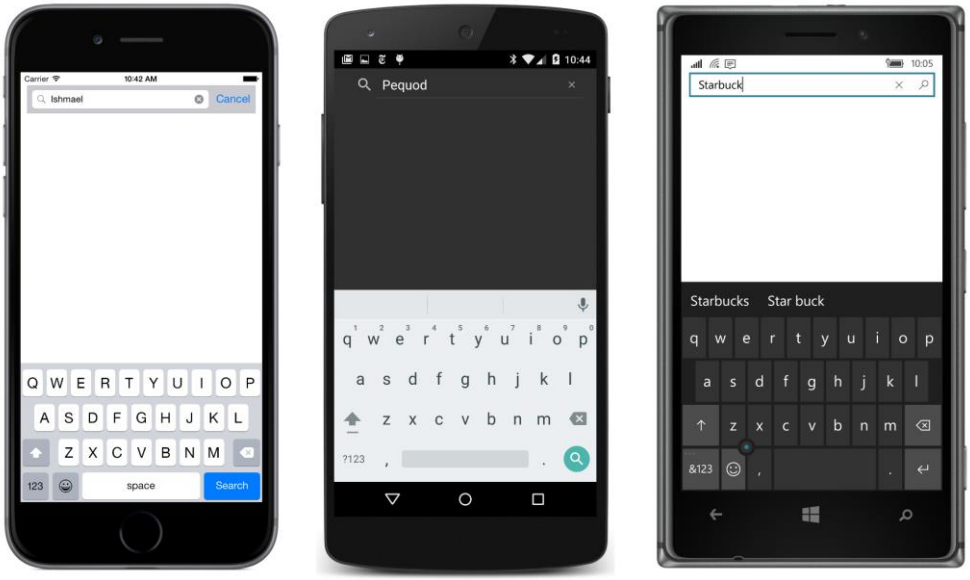
The **SearchBarDemo** program uses only Text and Placeholder, but the XAML file attaches handlers for both events:

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="SearchBarDemo.SearchBarDemoPage">
    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 20, 10, 0"
                    Android="10, 0"
                    WinPhone="10, 0" />
    </ContentPage.Padding>

    <StackLayout>
        <SearchBar x:Name="searchBar"
                   Placeholder="Search text"
                   TextChanged="OnSearchBarTextChanged"
                   SearchButtonPressed="OnSearchBarButtonPressed" />

        <ScrollView x:Name="resultsScroll"
                    VerticalOptions="FillAndExpand">
            <StackLayout x:Name="resultsStack" />
        </ScrollView>
```

```
    </StackLayout>
</ContentPage>
```

The program uses the scrollable `StackLayout` named `resultsStack` to display the results of the search.

Here's the `SearchBar` and keyboard for the three platforms. Notice the search icon and a delete button on all three platforms, and the special search keys on the iOS and Android keyboards:



You might guess from the entries in the three `SearchBar` views that the program allows searching through the text of Herman Melville's *Moby-Dick*. That is true! The entire novel is stored as an embedded resource in the **Texts** folder of the Portable Class Library project with the name MobyDick.txt. The file is a plain-text, one-line-per-paragraph format that originated with a file on the Gutenberg.net website.

The constructor of the code-behind file reads that whole file into a string field named `bookText`. The `TextChanged` handler clears the `resultsStack` of any previous search results so that there's no discrepancy between the text being typed into the `SearchBar` and this list. The `SearchButtonPressed` event initiates the search:

```
public partial class SearchBarDemoPage : ContentPage
{
    const double MaxMatches = 100;
    string bookText;

    public SearchBarDemoPage()
    {
        InitializeComponent();
```

```
        // Load embedded resource bitmap.
        string resourceID = "SearchBarDemo.Texts.MobyDick.txt";
        Assembly assembly = GetType().GetTypeInfo().Assembly;

        using (Stream stream = assembly.GetManifestResourceStream(resourceID))
        {
            using (StreamReader reader = new StreamReader(stream))
            {
                bookText = reader.ReadToEnd();
            }
        }
    }

    void OnSearchBarTextChanged(object sender, TextChangedEventArgs args)
    {
        resultsStack.Children.Clear();
    }

    void OnSearchBarButtonPressed(object sender, EventArgs args)
    {
        // Detach resultsStack from layout.
        resultsScroll.Content = null;

        resultsStack.Children.Clear();
        SearchBookForText(searchBar.Text);

        // Reattach resultsStack to layout.
        resultsScroll.Content = resultsStack;
    }

    void SearchBookForText(string searchText)
    {
        int count = 0;
        bool isTruncated = false;

        using (StringReader reader = new StringReader(bookText))
        {
            int lineNumber = 0;
            string line;

            while (null != (line = reader.ReadLine()))
            {
                lineNumber++;
                int index = 0;

                while (-1 != (index = (line.IndexOf(searchText, index,
                                                    StringComparison.OrdinalIgnoreCase))))
                {
                    if (count == MaxMatches)
                    {
                        isTruncated = true;
                        break;
                    }
                    index += 1;
```

```
                    // Add the information to the StackLayout.
                    resultsStack.Children.Add(
                        new Label
                        {
                            Text = String.Format("Found at line {0}, offset {1}",
                                                 lineNumber, index)
                        });

                    count++;
                }

                if (isTruncated)
                {
                    break;
                }
            }
        }

        // Add final count to the StackLayout.
        resultsStack.Children.Add(
            new Label
            {
                Text = String.Format("{0} match{1} found{2}",
                                     count,
                                     count == 1 ? "" : "es",
                                     isTruncated ? " - stopped" : "")
            });
    }
}
```

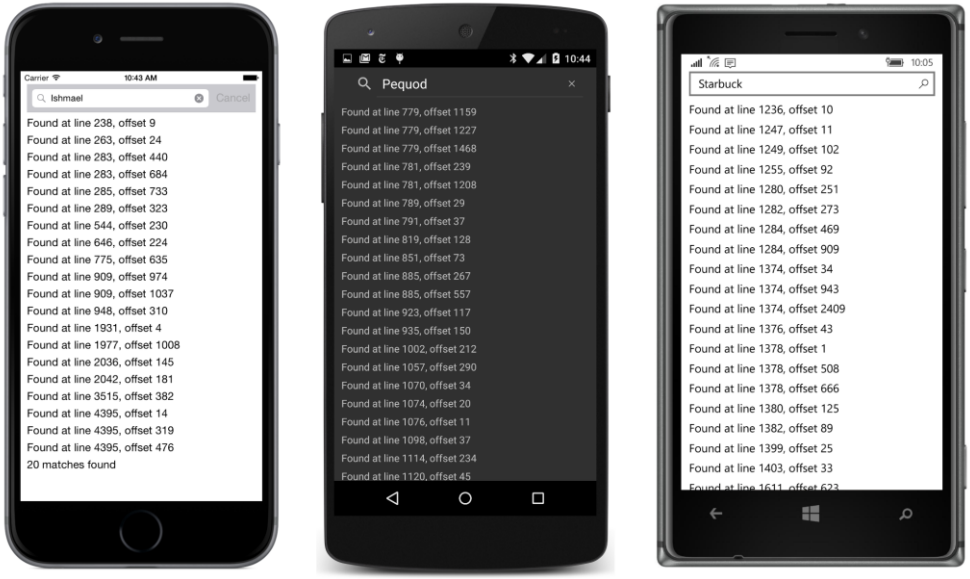
The `SearchBookForText` method uses the search text with the `IndexOf` method applied to each line of the book for case-insensitive comparison and adds a `Label` to `resultsStack` for each match. However, this process has performance problems because each `Label` that is added to the `StackLayout` potentially triggers a new layout calculation. That's unnecessary. For this reason, before beginning the search, the program detaches the `StackLayout` from the visual tree by setting the `Content` property of its parent (the `ScrollView`) to `null`:

```
resultsScroll.Content = null;
```

After all the `Label` views have been added to the `StackLayout`, the `StackLayout` is added back to the visual tree:

```
resultsScroll.Content = resultsStack;
```

But even that's not a sufficient performance improvement for some searches, and that is why the program limits itself to the first 100 matches. (Notice the `MaxMatches` constant defined at the top of the class.) Here's the program showing the results of the searches you saw entered earlier:



You'll need to reference the actual file to see what those matches are.

Would running the search in a second thread of execution speed things up? No. The actual text search is very fast. The performance issues involve the user interface. If the `SearchBookForText` method were run in a secondary thread, then it would need to use `Device.BeginInvokeOnMainThread` to add each `Label` to the `StackLayout`. If that `StackLayout` is attached to the visual tree, this would make the program operate more dynamically—the individual items would appear on the screen following each item added to the list—but the switching back and forth between threads would slow down the overall operation.

Date and time selection

A Xamarin.Forms application that needs a date or time from the user can use the `DatePicker` or `TimePicker` view.

These are very similar: The two views simply display a date or time in a box similar to an `Entry` view. Tapping the view invokes the platform-specific date or time selector. The user then selects (or dials in) a new date or time and signals completion.

The DatePicker

`DatePicker` has three properties of type `DateTime`:

- `MinimumDate`, initialized to January 1, 1900

- `MaximumDate`, initialized to December 31, 2100
- `Date`, initialized to `DateTime.Today`

A program can set these properties to whatever it wants as long as `MinimumDate` is prior to `MaximumDate`. The `Date` property reflects the user's selection.

If you'd like to set those properties in XAML, you can do so using the `x:DateTime` element. Use a format that is acceptable to the `DateTime.Parse` method with a second argument of `CultureInfo.InvariantCulture`. Probably the easiest is the short-date format, which is a two-digit month, a two-digit day, and a four-digit year, separated by slashes:

```
<DatePicker … >
    <DatePicker.MinimumDate>
        03/01/2016
    </DatePicker.MinimumDate>

    <DatePicker.MaximumDate>
        10/31/2016
    </DatePicker.MaximumDate>

    <DatePicker.Date>
        04/24/2016
    </DatePicker.Date>
</DatePicker>
```

The `DatePicker` displays the selected date by using the normal `ToString` method, but you can set the `Format` property of the view to a custom .NET formatting string. The initial value is "d"—the short-date format.

Here's the XAML file from a program called **DaysBetweenDates** that lets you select two dates and then calculates the number of days between them. It contains two `DatePicker` views labeled **To** and **From**:

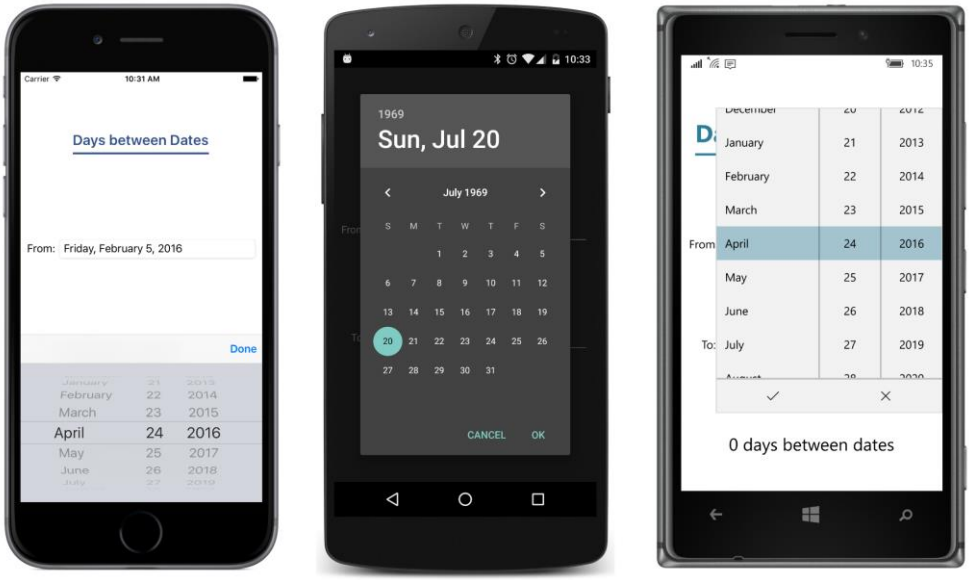
```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="DaysBetweenDates.DaysBetweenDatesPage">

    <ContentPage.Padding>
        <OnPlatform x:TypeArguments="Thickness"
                    iOS="10, 30, 10, 0"
                    Android="10, 10, 10, 0"
                    WinPhone="10, 10, 10, 0" />
    </ContentPage.Padding>

    <StackLayout>
        <StackLayout.Resources>
            <ResourceDictionary>
                <Style TargetType="DatePicker">
                    <Setter Property="Format" Value="D" />
                    <Setter Property="VerticalOptions" Value="Center" />
                    <Setter Property="HorizontalOptions" Value="FillAndExpand" />
```

```
            </Style>
        </ResourceDictionary>
    </StackLayout.Resources>

    <!-- Underlined text header -->
    <StackLayout Grid.Row="0" Grid.Column="0" Grid.ColumnSpan="2"
                 VerticalOptions="CenterAndExpand"
                 HorizontalOptions="Center">
        <Label Text="Days between Dates"
               FontSize="Large"
               FontAttributes="Bold"
               TextColor="Accent" />
        <BoxView Color="Accent"
                 HeightRequest="3" />
    </StackLayout>

    <StackLayout Orientation="Horizontal"
                 VerticalOptions="CenterAndExpand">
        <Label Text="From:"
               VerticalOptions="Center" />

        <DatePicker x:Name="fromDatePicker"
                    DateSelected="OnDateSelected" />
    </StackLayout>

    <StackLayout Orientation="Horizontal"
                 VerticalOptions="CenterAndExpand">
        <Label Text="    To:"
               VerticalOptions="Center" />

        <DatePicker x:Name="toDatePicker"
                    DateSelected="OnDateSelected" />
    </StackLayout>

    <Label x:Name="resultLabel"
           FontSize="Medium"
           HorizontalOptions="Center"
           VerticalOptions="CenterAndExpand" />
</StackLayout>
</ContentPage>
```

An implicit style sets the `Format` property of the two `DatePicker` views to "D", which is the long-date format, to include the text day of the week and month name. The XAML file uses two horizontal `StackLayout` objects for displaying a `Label` and `DatePicker` side by side.

Watch out: If you use the long-date format, you'll want to avoid setting the `HorizontalOptions` property of the `DatePicker` to `Start`, `Center`, or `End`. If you put the `DatePicker` in a horizontal `StackLayout` (as in this program), set the `HorizontalOptions` to `FillAndExpand`. Otherwise, if the user selects a date with a longer text string than the original date, the result is not formatted well. The **DaysBetweenDates** program uses an implicit style to give the `DatePicker` a `HorizontalOptions` value of `FillAndExpand` so that it occupies the entire width of the horizontal `StackLayout` except for what's occupied by the `Label`.

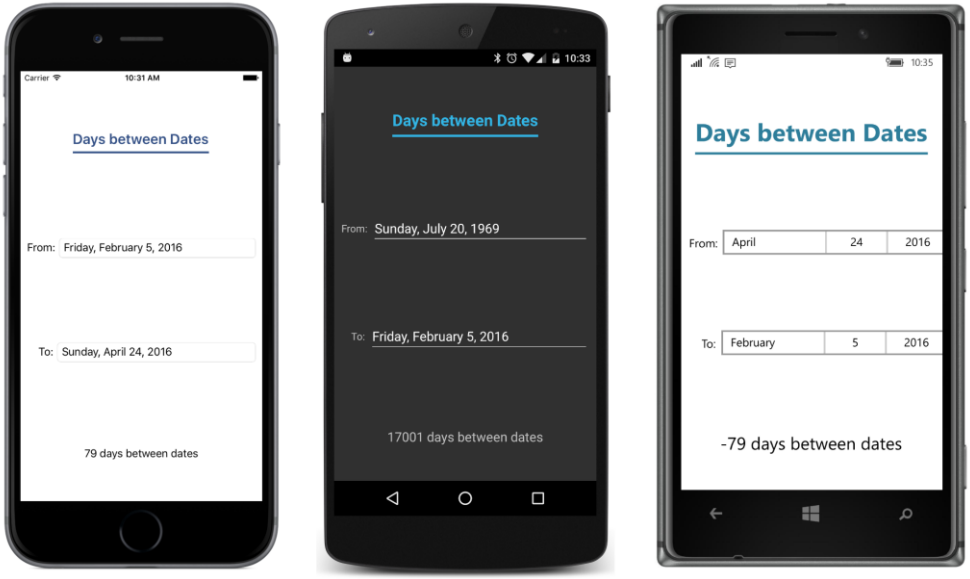
When you tap one of the `DatePicker` fields, a platform-specific panel comes up. On iOS, it occupies just the bottom part of the screen, but on Android and Windows 10 Mobile, it pretty much takes over the screen:



Notice the **Done** button on iOS, the **OK** button on Android, and the check-mark toolbar button on Windows Phone. All three of these buttons dismiss the date-picking panel and return to the program with a firing of the `DateSelected` event. The event handler in the **DaysBetweenDates** code-behind file accesses both `DatePicker` views and calculates the number of days between the two dates:

```
public partial class DaysBetweenDatesPage : ContentPage
{
    public DaysBetweenDatesPage()
    {
        InitializeComponent();

        // Initialize.
        OnDateSelected(null, null);
    }

    void OnDateSelected(object sender, DateChangedEventArgs args)
    {
        int days = (toDatePicker.Date - fromDatePicker.Date).Days;
        resultLabel.Text = String.Format("{0} day{1} between dates",
                                         days, days == 1 ? "" : "s");
    }
}
```

Here's the result:



The TimePicker (or is it a TimeSpanPicker?)

The `TimePicker` is somewhat simpler than `DatePicker`. It defines only `Time` and `Format` properties, and it doesn't include an event to indicate a new selected `Time` value. If you need to be notified, you can install a handler for the `PropertyChanged` event.

Although `TimePicker` displays the selected time by using the `ToString` method of `DateTime`, the `Time` property is actually of type `TimeSpan`, indicating a duration of time since midnight.

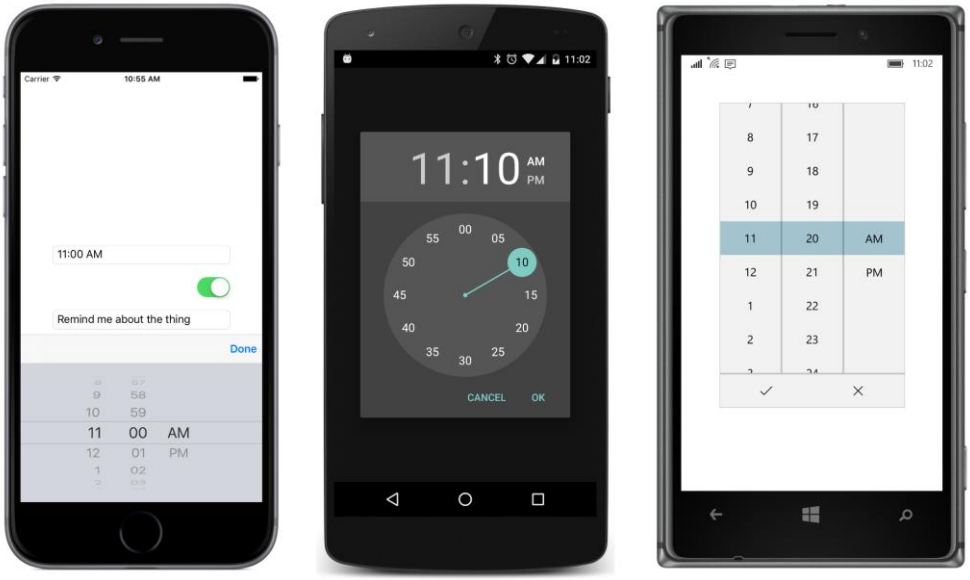
The **SetTimer** program includes a `TimePicker`. The program assumes that the time picked from the `TimePicker` is within the next 24 hours and then notifies you when that time has come. The XAML file puts a `TimePicker`, a `Switch`, and an `Entry` on the page.

```
<ContentPage xmlns="http://xamarin.com/schemas/2014/forms"
             xmlns:x="http://schemas.microsoft.com/winfx/2009/xaml"
             x:Class="SetTimer.SetTimerPage"
             Padding="50">

    <StackLayout Spacing="20"
                 VerticalOptions="Center">
        <TimePicker x:Name="timePicker"
                    PropertyChanged="OnTimePickerPropertyChanged" />

        <Switch x:Name="switch"
                HorizontalOptions="End"
                Toggled="OnSwitchToggled" />

        <Entry x:Name="entry"
               Text="Sample Timer"
```

```
                Placeholder="label" />
    </StackLayout>
</ContentPage>
```

The `TimePicker` has a `PropertyChanged` event handler attached. The `Entry` lets you remind yourself what the timer is supposed to remind you of.

When you tap the `TimePicker`, a platform-specific panel pops up. As with the `DatePicker`, the Android and Windows 10 Mobile panels obscure much of the screen underneath, but you can see the `SetTimer` user interface in the center of the iPhone screen:



In a real timer program—a timer program that is actually useful and not just a demonstration of the `TimePicker` view—the code-behind file would access the platform-specific notification interfaces so that the user would be notified even if the program were no longer active.

SetTimer doesn't do that. **SetTimer** instead uses a platform-specific alert box that a program can invoke by calling the `DisplayAlert` method that is defined by `Page` and inherited by `ContentPage`.

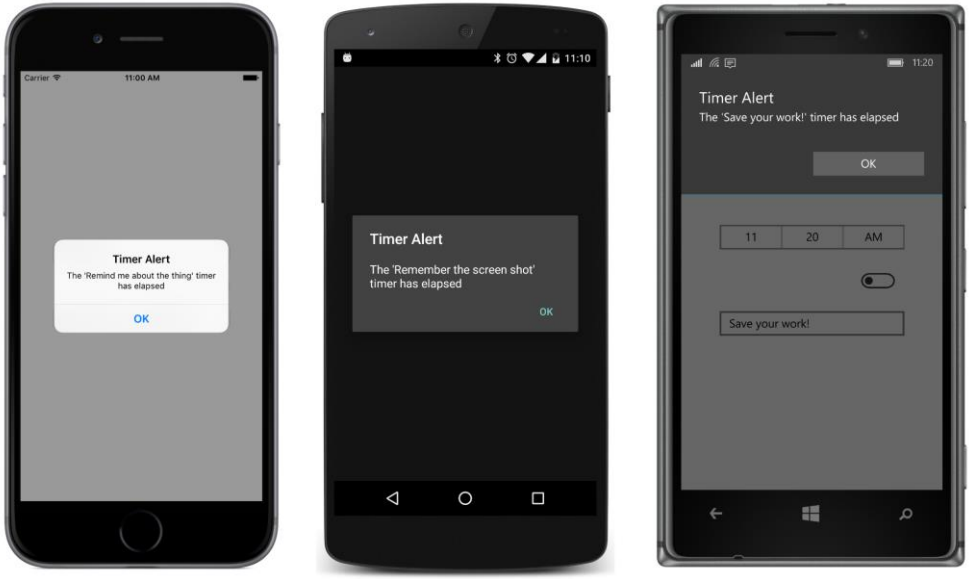
The `SetTriggerTime` method at the bottom of the code-behind file (shown below) calculates the timer time based on `DateTime.Today`—a property that returns a `DateTime` indicating the current date, but with a time of midnight—and the `TimeSpan` returned from the `TimePicker`. If that time has already passed today, then it's assumed to be tomorrow.

The timer, however, is set for one second. Every second the timer handler checks whether the `Switch` is on and whether the current time is greater than or equal to the timer time:

```
public partial class SetTimerPage : ContentPage
{
    DateTime triggerTime;
```

```
    public SetTimerPage()
    {
        InitializeComponent();

        Device.StartTimer(TimeSpan.FromSeconds(1), OnTimerTick);
    }

    bool OnTimerTick()
    {
        if (@switch.IsToggled && DateTime.Now >= triggerTime)
        {
            @switch.IsToggled = false;
            DisplayAlert("Timer Alert",
                         "The '" + entry.Text + "' timer has elapsed",
                         "OK");
        }
        return true;
    }

    void OnTimePickerPropertyChanged(object obj, PropertyChangedEventArgs args)
    {
        if (args.PropertyName == "Time")
        {
            SetTriggerTime();
        }
    }

    void OnSwitchToggled(object obj, ToggledEventArgs args)
    {
        SetTriggerTime();
    }

    void SetTriggerTime()
    {
        if (@switch.IsToggled)
        {
            triggerTime = DateTime.Today + timePicker.Time;

            if (triggerTime < DateTime.Now)
            {
                triggerTime += TimeSpan.FromDays(1);
            }
        }
    }
}
```

When the timer time has come, the program uses `DisplayAlert` to signal a reminder to the user. Here's how this alert appears on the three platforms:



Throughout this chapter, you've seen interactive views that define events, and you've seen application programs that implement event handlers. Often these event handlers access a property of the view and set a property of another view.

In the next chapter, you'll see how these event handlers can be eliminated and how properties of different views can be linked, either in code or markup. This is the exciting feature of *data binding*.