ArcGIS Pro SDK for .NET: UI Design and MVVM

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Session Overview

- Asynchronous Programming: Introduction to QueuedTask
  - Use of async and await
  - Authoring custom asynchronous functions
- Overview of MVVM
  - Dockpane example
    - View and View Model Implementation in Pro
    - Hooking functionality of existing Pro Commands into your Add-in
- Other Framework Elements
  - Newly added Framework Elements
  - Gallery Plug-in

Asynchronous Programming

- ArcGIS Pro is a multi-threaded 64 bit application
- Important asynchronous programming patterns for the SDK:
  - Async / Await
  - Using the Pro Framework's QueuedTask class
- Asynchronous Programming allows you to keep the User Interface responsive !

ArcGIS Pro Internal Threading Model

- **ArcGIS Pro is multi-threaded**
  - Incorporates the latest asynchronous language features from Microsoft
  - Implements a threading infrastructure tailored to reduce complexity.
- **Add-In developers should only need to contend with two threads:**
  - The GUI thread
  - A single specialized worker thread called the Main CIM Thread, MCT
    - Internally, ArcGIS Pro uses a large number of threads for:
    - Rasterization, rendering, data loading, GP
    - But all this is Isolated from the API
- **Simplifies coding, ensures consistency of Pro state.**

Categories of Methods in ArcGIS Pro API

- **Coarse-grained asynchronous** methods:
  - Can be called on any thread
- **Finer grained synchronous** methods:
  - Must be called within a QueuedTask

Coarse Grained Methods

- Can be called from any thread. Typically invoked from the UI thread
  - They execute in the background on Pro internal threads
  - Use async/await semantic

```
//Execute a GP Tool
await Geoprocessing.ExecuteToolAsync("SelectLayerByAttribute_management",
     new string[] {"parcels","NEW_SELECTION", "description = 'VACANT LAND'"});
await MapView.Active.ZoomToSelectedAsync(new TimeSpan(0, 0, 3));
```

Demo:

Coarse Grained Methods

Fine Grained, Synchronous Methods

Must be called within a QueuedTask

- A much greater number of fine grained methods and classes
- No async/await. Runs on the MCT
- Designed for aggregation into your own coarse-grained async methods
- In other words: this allows you to write your business logic as a ‘background’ task

```
await ArcGIS.Desktop.Framework.Threading.Tasks.QueuedTask.Run(() =>
{
   var layers = MapView.Active.Map.FindLayers("Parcels")
                .OfType<FeatureLayer>().ToList();
   var parcels = layers[0] as FeatureLayer;
   QueryFilter qf = new QueryFilter()
   {
       WhereClause = "description = 'VACANT LAND'",
       SubFields = "*"
   };
   parcels.Select(qf, SelectionCombinationMethod.New);
});
```

QueuedTask

- QueuedTask uses the Pro framework's custom Task scheduler
- Used to run synchronous ArcGIS Pro SDK methods in the background
- These synchronous methods are listed in the API Reference guide like this:

  "This method must be called on the MCT. Use QueuedTask.Run"

- Example of synchronous methods in Pro:
  - GetSpatialReference, QueryExtent, Geometry operations
- Usage:

```
Task t = QueuedTask.Run(() =>
    {
        // Call synchronous SDK methods here
    });
```

Demo:

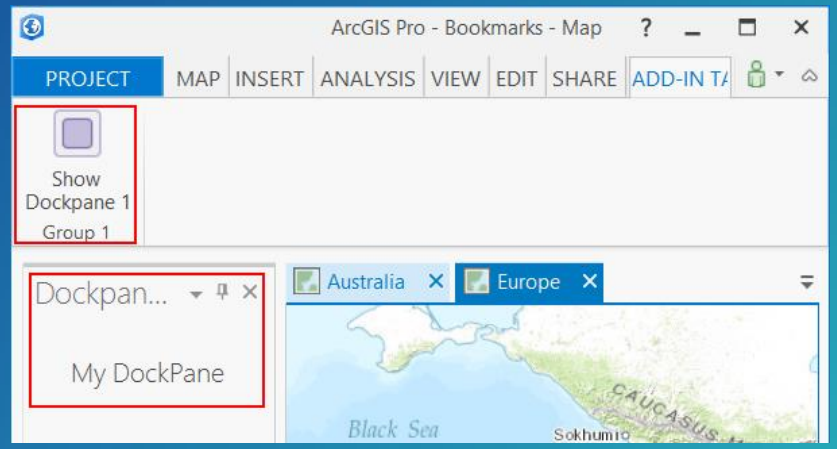
Fine Grained Methods

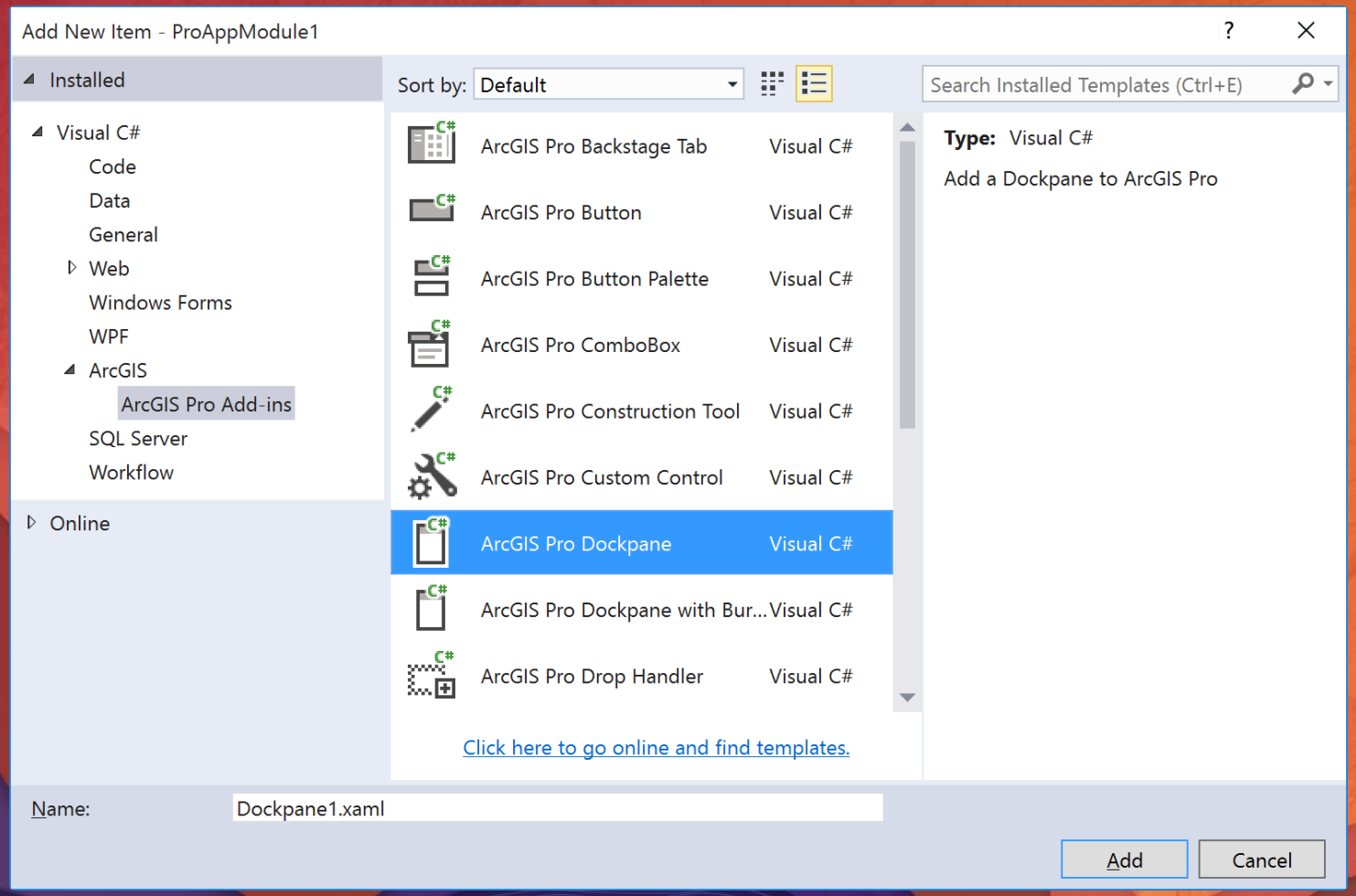
MVVM Pattern in Add-ins

- MVVM and variants are de-facto pattern for WPF UI implementations
- Pro MVVM is built on top of ActiPro (http://www.actiprosoftware.com/products/controls/wpf)
- The Basic Pattern is:
  - ViewModel declared in DAML and implemented in code
  - View referenced in DAML and implemented as WPF UserControl
  - Model is optional
- Note: To customize the Pro UI, you must use its MVVM Framework. Substitutes are not allowed.

MVVM Pattern in Add-ins

- **Model-View-ViewModel (MVVM) Pattern used for many of the Framework elements**
  - **Dockpane**
  - **Pane**
  - **Custom Control**
  - **Embeddable Control**
  - **Property Page**





Demo: New Dockpane using MVVM Dockpane template

MVVM Implementation in Add-ins

- MVVM implementation in Add-ins follows the same Pattern used in WPF / .Net
  - Model: Classes that represent the data consumed by the app
  - View: User interface (UI) elements the user interacts with (XAML)
  - ViewModel: Classes that wrap data (coming from a model) and provide business logic for the UI (views)
- Implement your Add-in UI just as you implement a user control in WPF/.Net
  - You can use many available online WPF MVVM snippets
- Differences in MVVM for Add-ins versus WPF applications:
  - Multi-threading considerations
  - ArcGIS Pro Styling

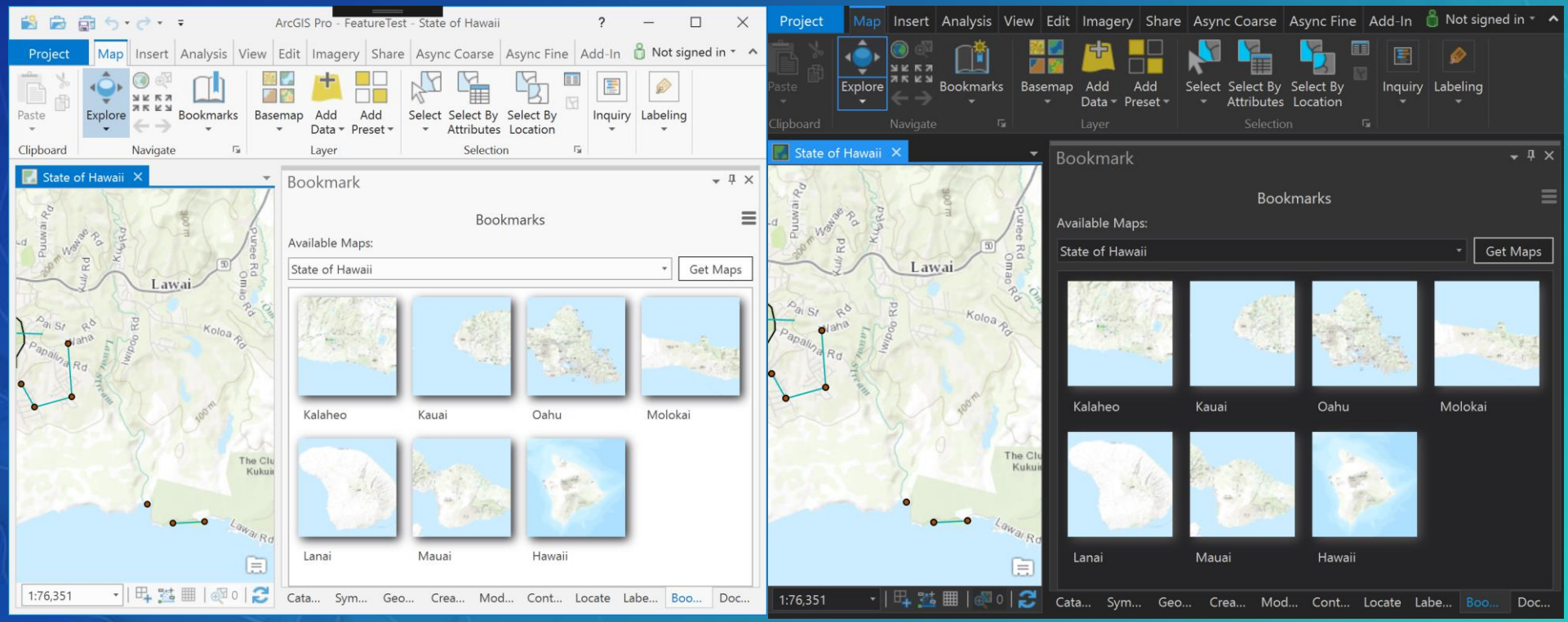
Multi-threading considerations

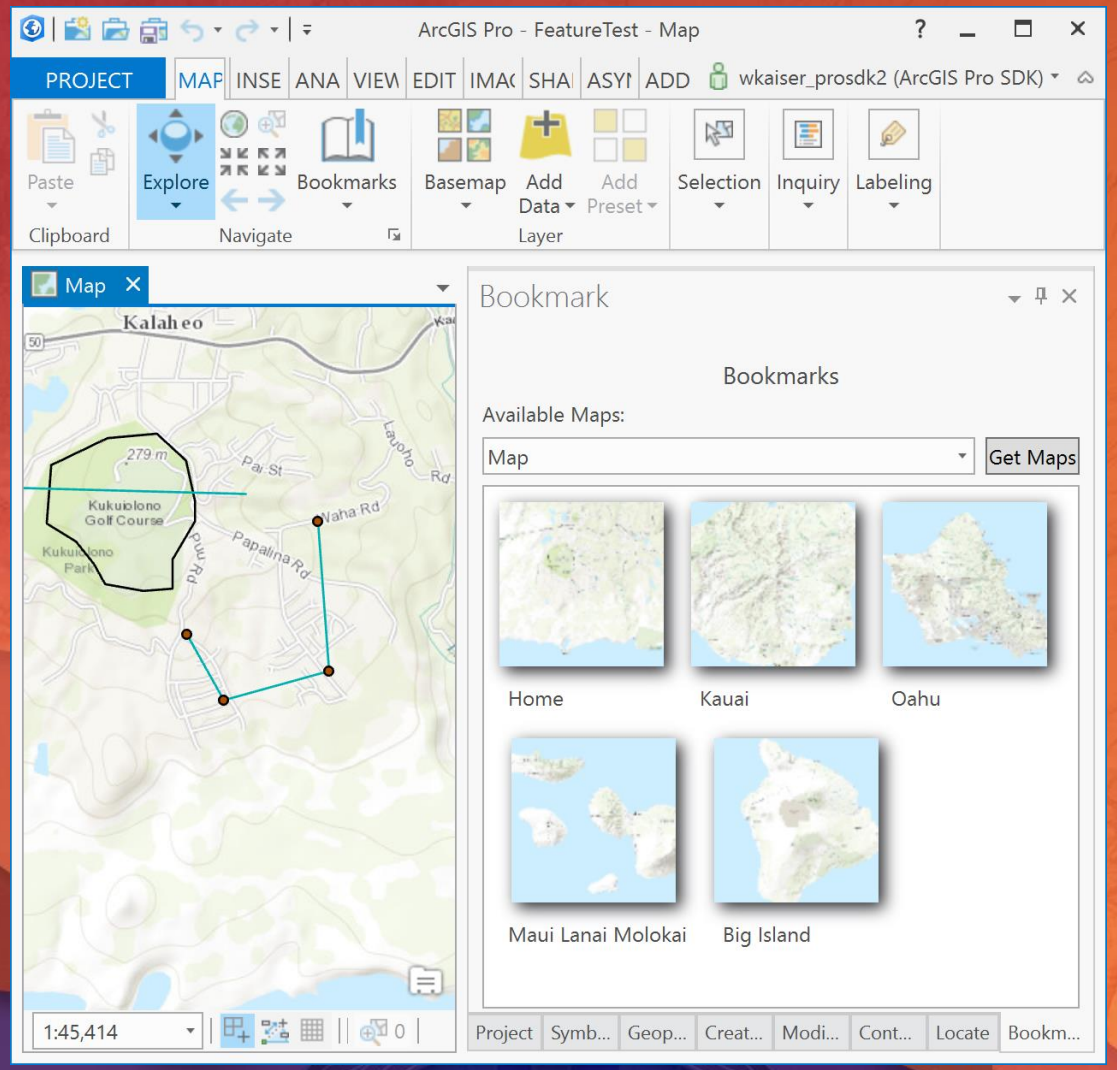
- **ArcGIS Pro Framework's managed threading model:**
  - **Framework provides `QueuedTask` to guarantee that UI actions happen in a sensible order without corruption**
- **Updating UI collections from a worker thread**
  - **Locking is required when sharing objects across threads**
- **Recommended pattern for updating collections from a worker thread**
  - **Found in .Net BindingOperations helper class: BindingOperations.EnableCollectionSynchronization**

```
private readonly object _lockListOfBookmarks = new object();

protected override Task InitializeAsync()
{
    BindingOperations.EnableCollectionSynchronization(ListOfBookmarks, _lockListOfBookmarks);
    GetBookMarkCollection();
    return base.InitializeAsync();
}
```

Add-in Styling

- New at 1.4 is Dark Theme and High Contrast
- In order for your Add-ins to “blend” when the theme is toggled they must be styled correctly
  - Note: It is not required that your Add-ins “blend” with Pro though it is desirable in most cases
- Style Guide: https://github.com/Esri/arcgis-pro-sdk/wiki/proguide-style-guide





Demo: Dockpane Bookmarks

Hooking Existing ArcGIS Pro Commands

- Get any Pro control's ICommand and use it in your add-in:
  - Done by using the Pro Framework's "GetPlugInWrapper" method.
- A Pro control's command can be added to your add-in button's click method. (or anywhere else in your add-in).

```
// ArcGIS Pro's Create button control DAML ID.
var commandId = DAML.Button.esri_mapping_createBookmark;
// get the ICommand interface from the ArcGIS Pro Button
// using command's plug-in wrapper
// (note ArcGIS.Desktop.Core.ProApp can also be used)
var iCommand = FrameworkApplication.GetPlugInWrapper(commandId) as ICommand;
if (iCommand != null)
{
    // Let ArcGIS Pro do the work for us
    if (iCommand.CanExecute(null))
       iCommand.Execute(null);
}
```

Hooking Existing ArcGIS Pro Commands

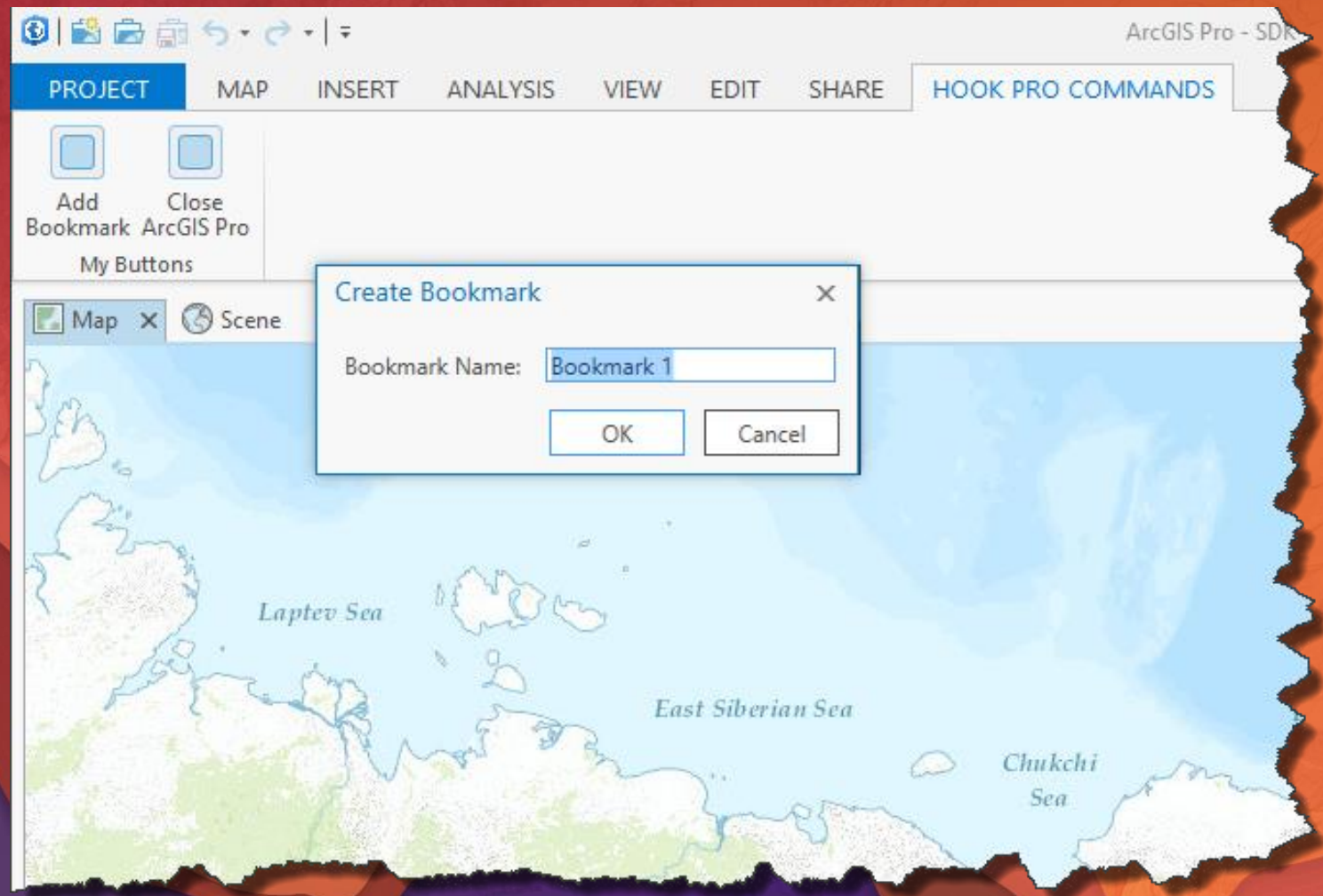
- Adding a button to the Dockpane to run the ‘Close ArcGIS Pro’ Command

```
protected Dockpane1ViewModel()
{
    CloseCmd = FrameworkApplication.GetPlugInWrapper(DAML.Button.esri_core_exitApplicationButton)
        as ICommand;
}

public ICommand CloseCmd { get; set; }
```

- Adding a button to the Dockpane with our ‘custom’ Zoom in behavior

```
protected Dockpane1ViewModel()
{
    ZoomInCmd = new RelayCommand(() => MappingModule.ActiveMapView.ZoomInFixedAsync(),
        () => MappingModule.ActiveMapView != null);
}

public ICommand ZoomInCmd { get; set; }
```

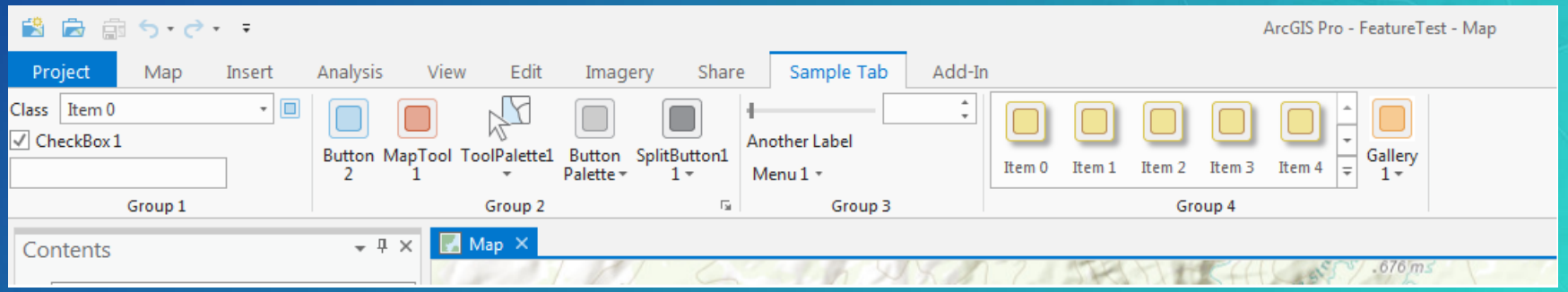
- RelayCommand is an implementation of ICommand which lets you specify your own implementation of Execute and CanExecute



Demo: Hooking Existing Pro Commands

Framework Elements

- Any Framework Element is an extensibility point
  - Controls (Button, Tool, and variants)
    - Hosted on Ribbons, Menus, Galleries
    - Checkbox, Combobox, Label Control, Custom Controls
  - Tabs, Tab Groups
  - Toolbars
  - Menus, Context Menus
  - Panes
  - Dockpanes
  - Galleries
  - Property Sheets



- All Elements have a definition within DAML

Framework Elements

- Majority of Framework Elements are represented by Visual Studio Item templates
  - Automates generation of DAML
  - Add relevant code-behind files to the project
- Some Framework Elements need a much higher degree of customization (than a template can provide)
  - Custom Control
  - Gallery
  - Dynamic Context Menus

- Note: Complete element reference is here:

  https://github.com/Esri/arcgis-pro-sdk/wiki/ProConcepts-Framework

Framework Elements

- New Framework elements:
  - Burger button – using Pro Framework's ContextMenu class
  - Circular animation
  - Message label
  - Search textbox
  - Waiting cursor

```
xmlns:controls="clr-namespace:ArcGIS.Desktop.Framework.Controls;assembly=ArcGIS.Desktop.Framework"
```

Framework Element: Burger Button

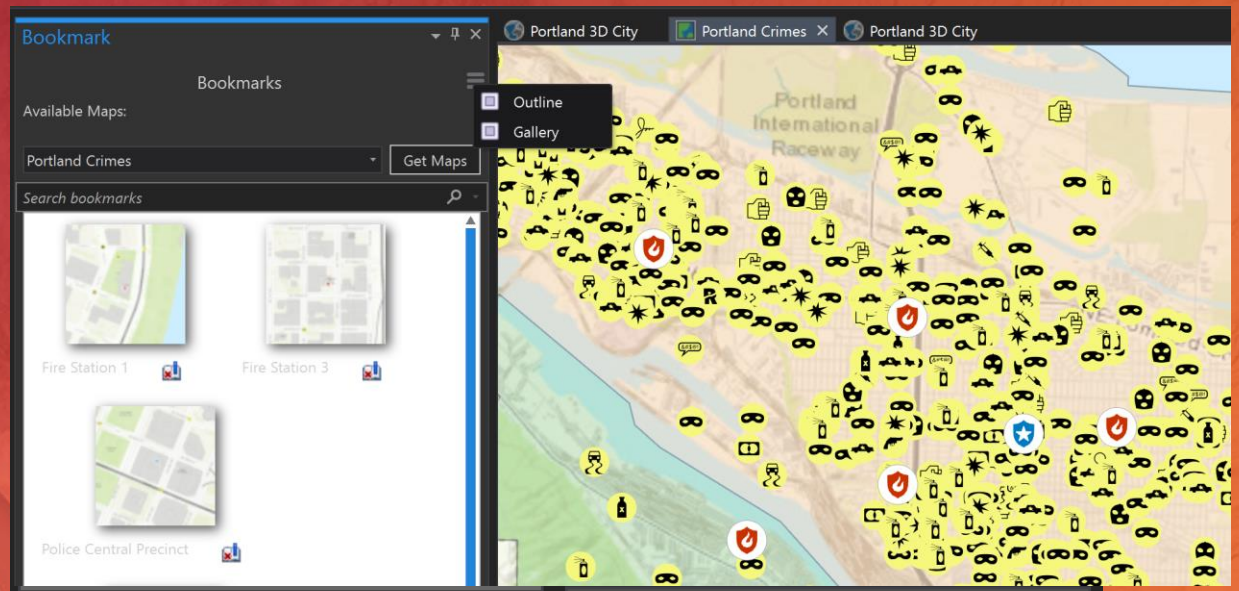
- **Add Context menu in config.daml**

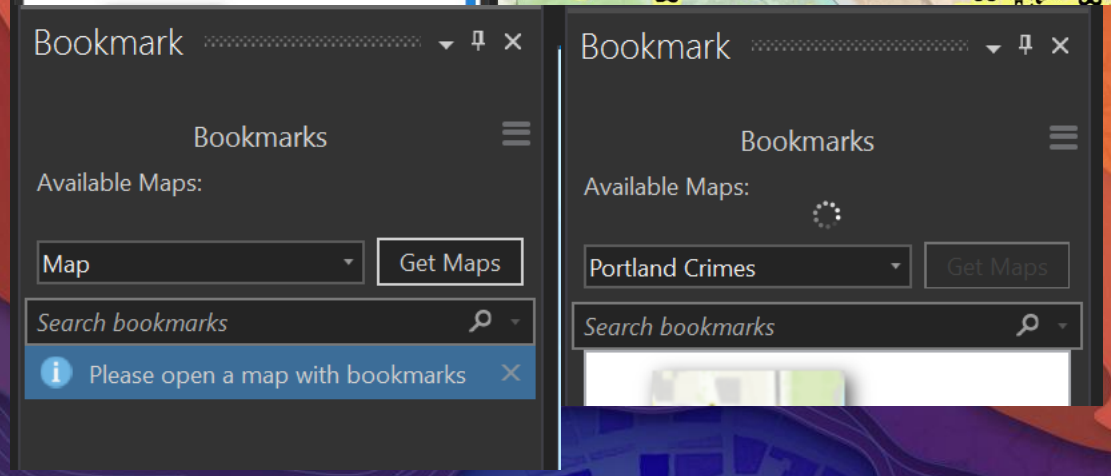
```
<menus>
        <menu id="DockPaneBookmarkAdvanced_Bookmark_Menu" caption="Change view" contextMenu="true">
          <button refID="DockPaneBookmarkAdvanced_BookmarkOutline_MenuButton" />
          <button refID="DockPaneBookmarkAdvanced_BookmarkGallery_MenuButton" />
</menu>
</menus>
```

- **Bind an instance of context menu to the BurgerButton's PopupMenu attribute.**

```
<extensionsControls:BurgerButton PopupMenu="{Binding BurgerButtonPopupMenu}"/>

public System.Windows.Controls.ContextMenu BurgerButtonPopupMenu
    {
      get { return FrameworkApplication.CreateContextMenu(MenuId); }
    }
```

- **Implement Popupmenu options in the Framework button class OnClick method.**



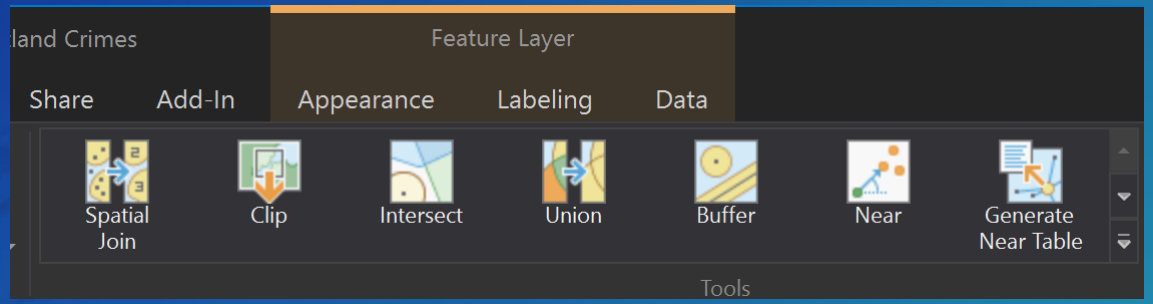


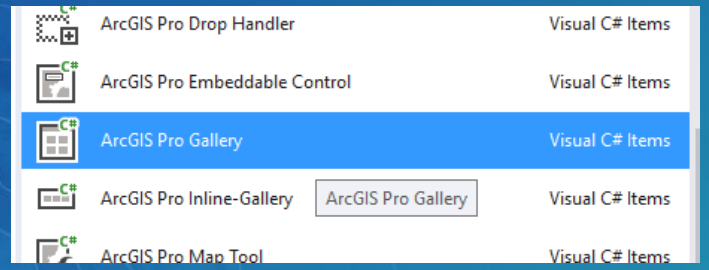
Demo: Controls

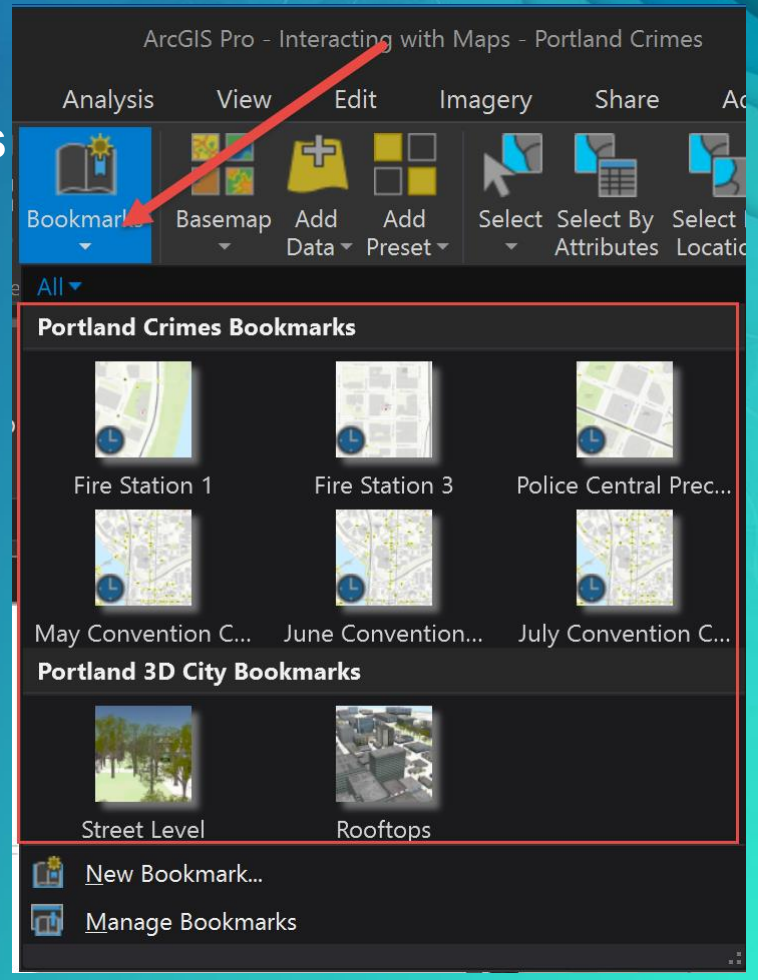
Framework controls that can be used to polish your dockpane UI.

Gallery

- Container control, displays a collection of related items in rows and columns
- If too many items are in the gallery an expand arrow is provided
- Contents are populated at run time
- Individual gallery items are modelled using `GalleryItem` class
- Style with a GalleryTemplate.xaml



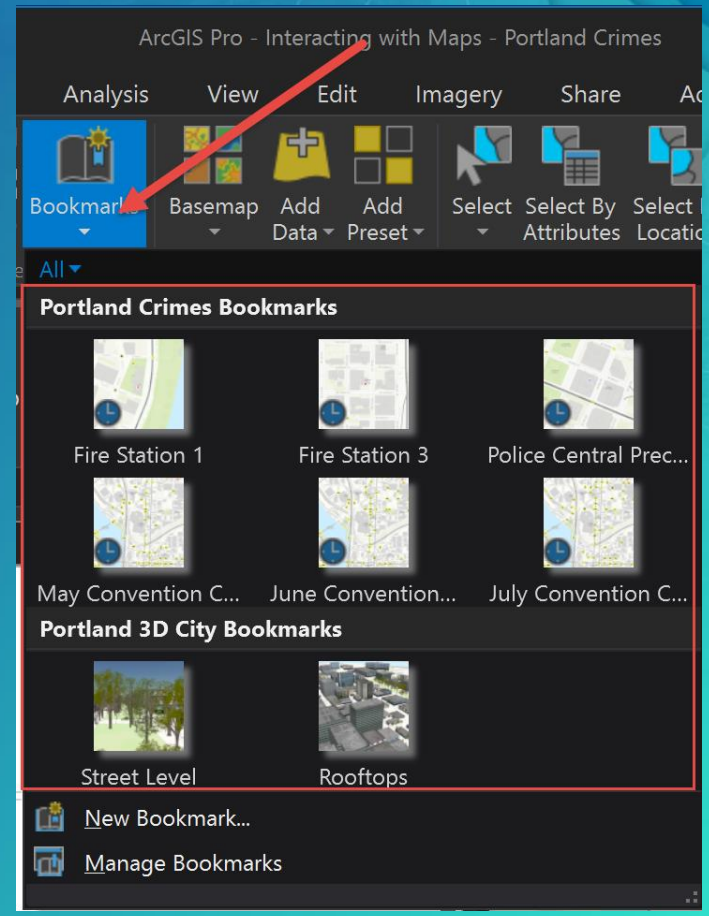




Gallery

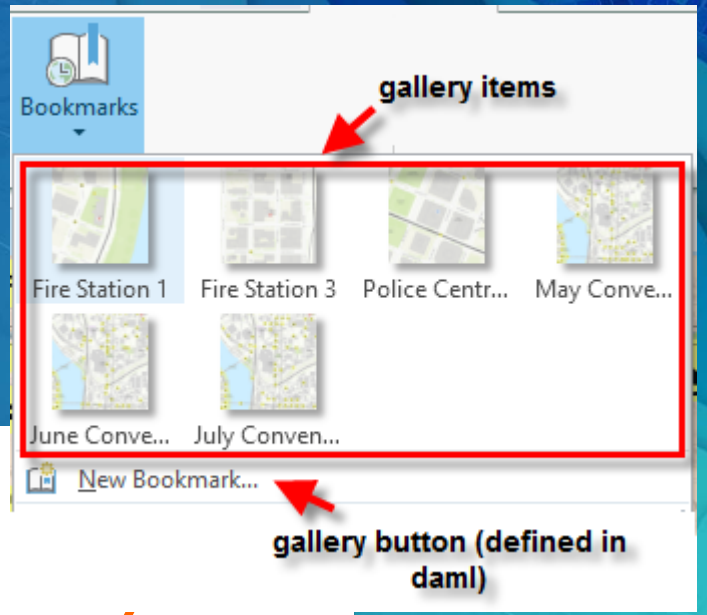
- Shown as a split-button with a dropdown that exposes gallery
- Do any content initialization in the Gallery code-behind `OnDropDownOpened`
  - `GalleryItems` are created at runtime
  - Use Add method to add items to gallery
  - Whenever a gallery item is clicked, the Gallery `OnClick` is called with the clicked GalleryItem as a parameter

```
class Gallery1 : Gallery {
    protected override void OnDropDownOpened() {
          //Handle populating gallery content
         foreach (var dataItem in lstWebmapItems)
               Add(dataItem);
    }
    private void Initialize() {
      //TODO: Init content
```



Gallery

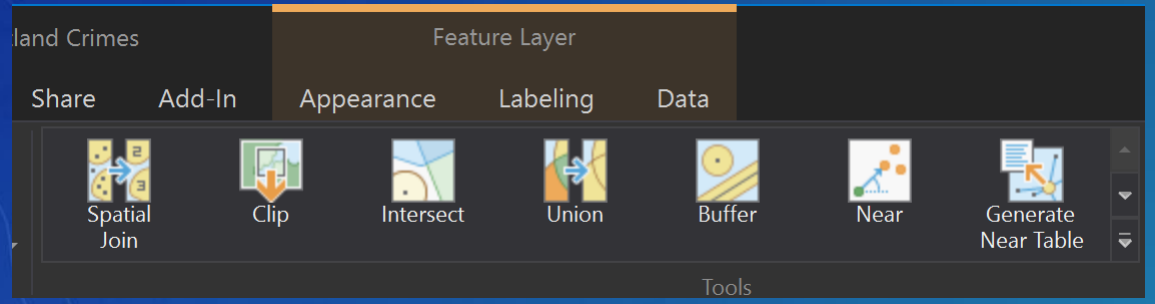
- **DAML gallery definition:**

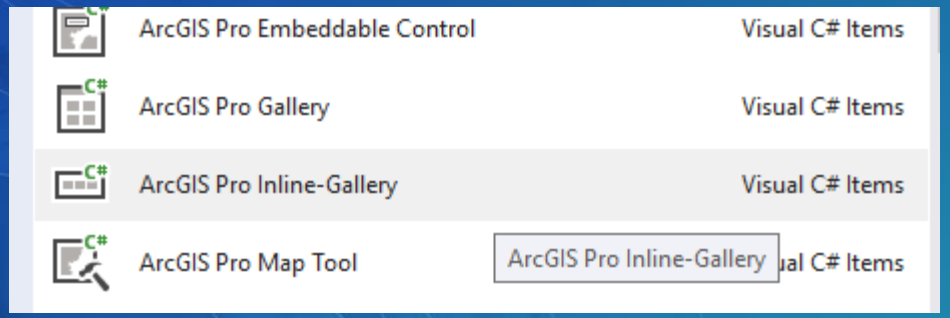



```
<!-- Config.daml
<galleries>
   <gallery id="TimeNavigation_BkmGallery" ...
      rows="4" itemsInRow="4" ← # of rows and columns
      dataTemplateFile="...TimeBkmGalleryTemplate.xaml" ← Data template
      templateID="TimeBkmItemTemplate">  ← Resource key
      <button refID="esri_mapping_createBookmark" />← Child button
   </gallery>

<!- TimeBkmGalleryTemplate.xaml
<DataTemplate x:Key="TimeBkmItemTemplate">
   <StackPanel Orientation="Vertical" ...
      <Image Source="{Binding Icon}" ...
      <TextBlock Text="{Binding Text}" ...
```

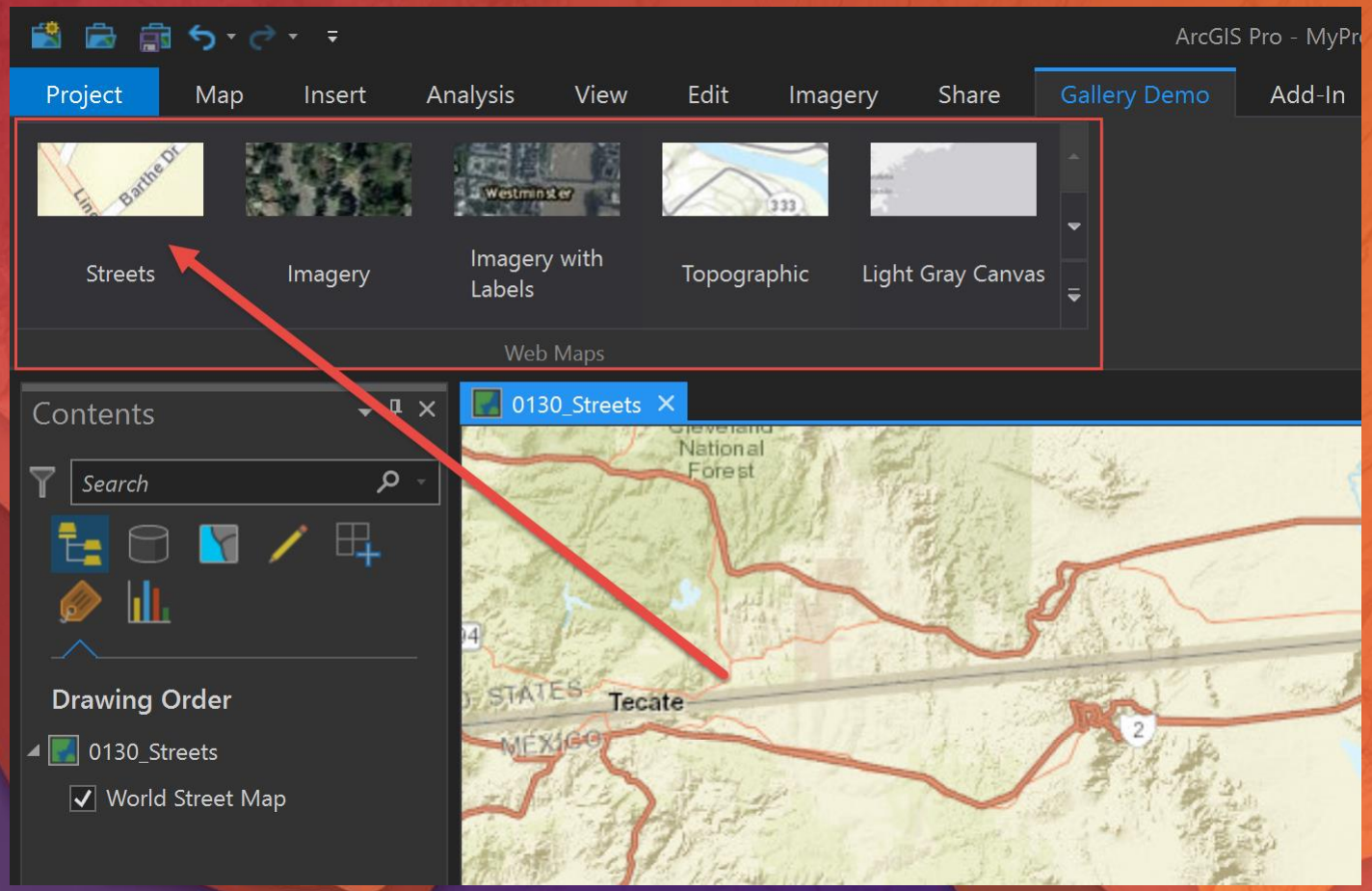
Gallery

- Galleries can also be defined as “inline”
- Inline shows gallery items directly in the ribbon (not in a dropdown)
- Set the inline attribute on the gallery reference to true
- (Done automatically for you via the inline gallery template)






```
<groups>
    <group id=“Time_Group" caption="Map Time">
        <gallery refID="Time_InlineGallery1"
                 inline="true" size="large"/>
    </group>
```



Demo: Gallery

Inline gallery control that hosts a collection of webmaps.

ArcGIS Pro SDK Sessions

Technical Workshops

ArcGIS Pro SDK for .NET: UI Design and MVVM

- Tuesday, July 11, 8:30 am – 9:45 am. Location: SDCC – Room 33 A
- Wednesday, July 12, 8:30 am – 9:45 am. Location: SDCC – Room 33 A

ArcGIS Pro SDK for .NET: Configurations

- Wednesday, July 12, 1:30 pm – 2:45 pm. Location: SDCC – Room 32 A

Demo Theaters

Beginning Pro SDK Project Development: Tips and Tricks for Troubleshooting

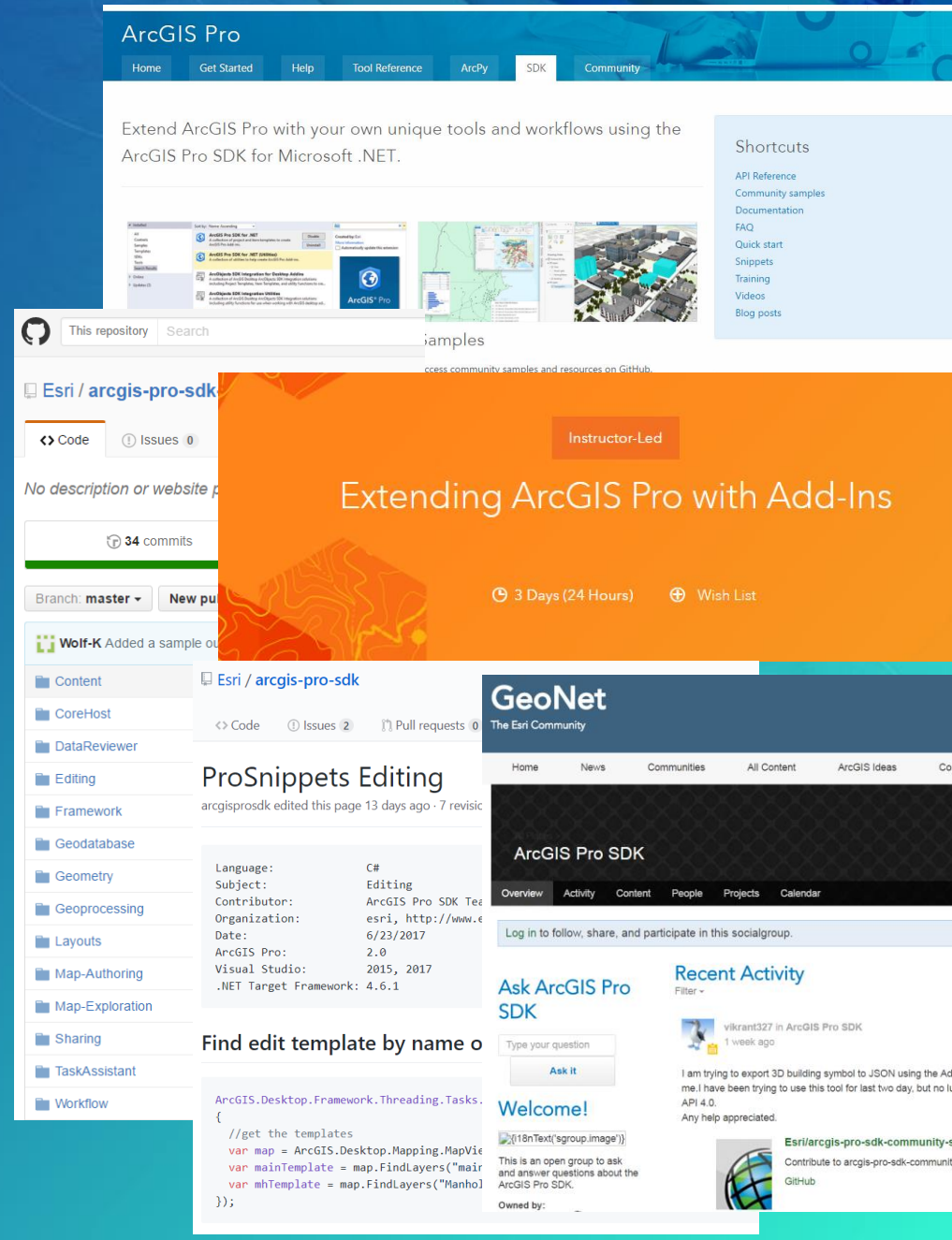
- Tuesday, July 11, 2:30 pm – 3:15 pm. Location: SDCC – Demo Theater 09 – Technical Support

Getting Started with ArcGIS Pro SDK Add-Ins and Configurations

- Tuesday, July 11, 3:30 pm – 4:15 pm. Location: SDCC – Demo Theater 11 – Developer
- Wednesday, July 12, 11:30 am – 12:15 pm. Location: SDCC – Demo Theater 11 – Developer

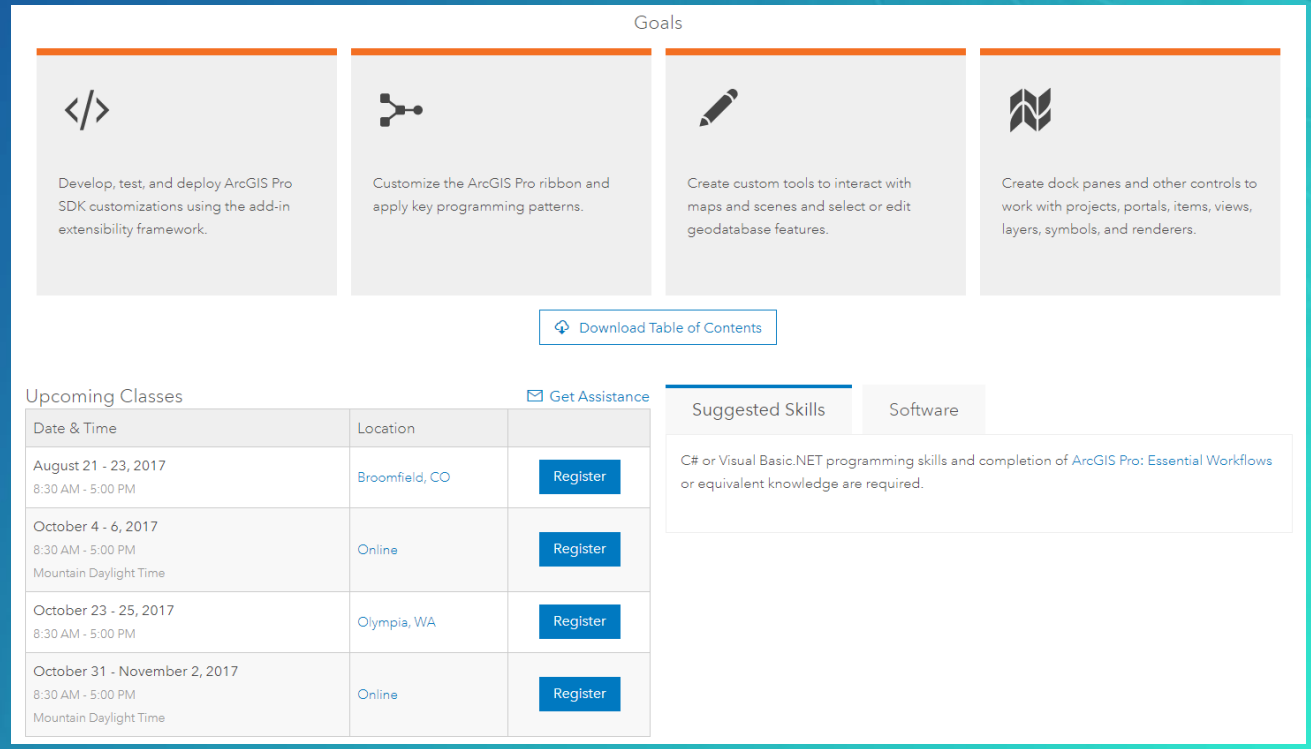
Many Pro SDK Resources

- SDK home page – main resource page
- Esri Training – instructor-led Esri training course
- Documentation Wiki – primary documentation site with concept and guide docs, and much more
- Community Samples – ready to use code solutions categorized by functional area
- Snippets – code snippets by functional area
- GeoNet Pro SDK Group – developer community
- API Reference – full API reference
- FAQ – answers to common questions
- Blog posts – focused on the Pro SDK



Pro SDK Training

- Extending ArcGIS Pro with Add-Ins – Esri Instructor-led training course on the Pro SDK
- Great way to get a comprehensive introduction
- Online offerings – very interactive and productive
- Esri.com/training

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