AddFlow for WPF 2016 Tutorial

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1 Introduction

AddFlow for WPF 2016 is a general purpose Flowcharting/Diagramming WPF component, which lets you quickly build flowchart-enabled WPF applications.

AddFlow for WPF 2016 allows the creation and the manipulation of two-dimensional diagrams (a.k.a graphs). An AddFlow diagram is a set of objects called nodes (also called vertices or entities) that can be linked each other with links (also called edges, arcs or relations). These diagrams can be created programmatically or interactively.

Each time you need to graphically display interactive diagrams, you should consider using AddFlow, a royalty-free control that offers unique support to create diagrams interactively or programmatically: workflow diagrams, database diagrams, communication networks, organizational charts, process flows, state transitions diagrams, CTI applications, CRM (Customer Relationship Management), expert systems, graph theory, quality control diagrams, …

It has been created with **VS 2013** and **.NET Framework 4** on a 64 bits machine.

Purpose of this tutorial

This tutorial provides information on:

- creating diagrams programmatically, using the AddFlow control and classes
- creating diagrams interactively
- installing AddFlow for WPF 2016
- licensing

Who should use this tutorial?

This guide is intended for application programmers using the WPF platform to build WPF applications.

Samples

AddFlow for WPF 2016 is installed with one demo sample written in C#: DemoFlow. In this tutorial, we shall call it “the demo”. Its C# source code is also installed.

2 What's new in AddFlow for WPF 2016 ?

2.1 Compatibility

AddFlow For WPF 2016 is **NOT compatible** with the previous version.

Some changes were necessary:

- to allow a better evolution of the product for the future
- to fix some design errors
- to provide a lighter product that just does its job and nothing more.
- for a better compatibility with other versions, especially the HTML5 and the Winforms versions of AddFlow.

However it is possible to load diagrams created with previous versions.

2.2 New features

There are new important features:

- **Virtualization mode** allowing working quickly with very big diagrams. This is a UI virtualization where only the visible items are displayed. The **IsVirtualizing** property determines whether virtualizing mode is allowed or not.
- **Captions**. A caption is like a label or a note. It is a new type of object allowing displaying a text or an image and that can be owned by any item.
- **Orthogonal links** . A new link line style.

2.3 Changes

2.3.1 Two major changes

1) Now, AddFlow is a Canvas. In previous versions, AddFlow was a control consisting in a Border element containing a Scrollviewer element containing a Canvas panel. Now, it is just a Canvas panel. And you have the possibility to place it yourself in a Scrollviewer element.

2) In previous versions, the diagram items were in fact DrawingVisual objects. Now there are objects that are displayed with DrawingVisual objects. Each diagram item (node, link, caption) has a **Visual** property that returns the associated DrawingVisual object.

Programmatically, the consequences are minor in your C# code. In fact it just means that the Diagram property is removed and that the list of diagram items can be obtained with the **Items** collection instead of "Visual.Children". Instead of writing for instance:

```
var nodes = this.addflow.Diagram.Visual.Children.OfType<Node>().ToArray();
```

you will write:

```
var nodes = this.addflow.Items.OfType<Node>();
```

In the xaml definition of AddFlow, you will have to replace:

```
<af:AddFlow Name="addflow" />
```

by, for intance:

```
<Border x:Name="Border"
        BorderBrush="Red"
        BorderThickness="2"
        CornerRadius="2" >
            <ScrollViewer x:Name="ScrollViewer"
                          CanContentScroll="True"
```

```
                                        HorizontalScrollBarVisibility="Auto"
                                        VerticalScrollBarVisibility="Auto"
                                        Padding="1"
                                        Background="White"
                                        BorderBrush="Transparent"
                                        BorderThickness="0"
                                        Margin="1"
                                        IsTabStop="False">
                      <af:AddFlow Name="addflow" />
                </ScrollViewer>
</Border>
```

The Border and ScrollViewer AddFlow properties are therefore removed.

TIP: Double click event

A consequence of this change is that the double click event is no more supported. The workaround is to use the ClickCount property of the parameter of the MouseLeftButtonDown event :

```
private void addflow_MouseLeftButtonDown(object sender, MouseButtonEventArgs e)
{
    if (e.ClickCount == 2) // Double click
    {
        …
```

This is demonstrated in the demo provided with AddFlow in the **Path** and **CustomUndo** examples.

2.3.2 Pins

It is now easier to define and manage the node pins, using the **PinsLayout** property of the Node object.

The ConnectorStyle and Connector properties are removed.

The PinStyle AddFlow property is also removed and replaced by the **PinSize**, **PinStroke**, **PinFill** and **PinShape** properties.

2.3.3 Renamed APIS

Some properties, methods or type have been renamed because they apply to ContentItem objects instead of nodes. The Node and Caption classes inherit from the ContentItem class.

Old names	**New names**
CanMoveNode (addflow property)	CanMoveItems
CanSizeNode (addflow property)	CanSizeItems
CanEditNode (addflow property)	CanEditContentItem
NodeTextPosition (addflow type)	TextPosition
TextPosition (link property)	TextPlacementMode and IsOrientedText

2.3.4 Creation methods

Now, there is only one version of the AddNode and AddLink methods, 3 versions of the Node constructor and 5 versions of the link constructor. (see the paragraph “Creation and deletion of items”)

3 Getting Started

3.1 Installation

The AddFlow for WPF 2016 installation package is a Windows Installer file. It is the same file for the evaluation version and the full version. However, when you install it, you install the evaluation version. As explained in the Licensing section if you purchase the product, you will receive a license key allowing turning the evaluation version into the full version.

In the AddFlow for WPF 2016 installation folder, it creates 3 subdirectories: bin, doc and demo:

- The **bin** subdirectory contains the assemblies: DLLs, demo executable. The list of the DLLs is given in the following parapagraph.
- The **doc** subdirectory contains the help file, the tutorial, the readme file and the license agreement.
- The **demo** subdirectory contains the C# source code of the demo program that demonstrates AddFlow for WPF 2016.

3.2 AddFlow DLLs

There are two DLLs.

Assembly	**Description**
Lassalle.WPF.Flow.dll	The AddFlow for WPF control
Lassalle.WPF.Flow.Layout.dll	The LayoutFlow dll is a set of graph layout algorithms. This extension is not free. You must purchase a Professional license of AddFlow for WPF to be able to use it without any restriction.

TIP: Is the source code available?

The source code of AddFlow and LayoutFlow is not provided. However you may purchase a source code license. A source code license agreement is installed with AddFlow.

Notice that all these assemblies are written in C#.

3.3 Licensing

3.3.1 Key Points

The key points are the following:

- each product is licensed **per individual developer**
- each product is **runtime royalty free**
- the evaluation version of each product has a **nag banner**. You may use it for up to **30 days** for trials and design-time evaluation purposes only.
- you may purchase either the **Standard Edition** , either the **Professional Edition** of AddFlow. The professional version provides also a set of graph layout algorithms.
- multi-pack discounts available
- It is also possible to purchase the **source code**.

3.3.2 Type of licenses

3.3.2.1 Editions

You may purchase either:

- an AddFlow for WPF 2016 **Standard** Edition license. This license does not include LayoutFlow. If you try to execute a graph layout algorithm, you will face sometimes a nag screen.
- an AddFlow for WPF 2016 **Professional** Edition license. This license includes LayoutFlow. You can execute the graph layout algorithms provided by LayoutFlow without any restriction.

3.3.2.2 Multi-pack discounts

We offer the following type of licenses:

- Single developer license: allows just one developer
- Team license: allows 4 developers
- Site license: allows unlimited developers at a single physical address.
- Enterprise license: allows all developers of an enterprise

3.3.2.3 Source code

You may also purchase the source code or not. A source code license agreement is installed with AddFlow. This agreement mainly says that you do not have the right to make a competitor product and don't have the right to divulge the code. You may purchase a source code license for AddFlow for WPF Standard Edition or for AddFlow for WPF Professional Edition. Please note that a source code license for AddFlow for WPF Standard Edition requires the purchaser to own an AddFlow for WPF Standard Edition license and that a source code license for AddFlow for WPF Professional Edition requires the purchaser to own an AddFlow for WPF Professional Edition license.

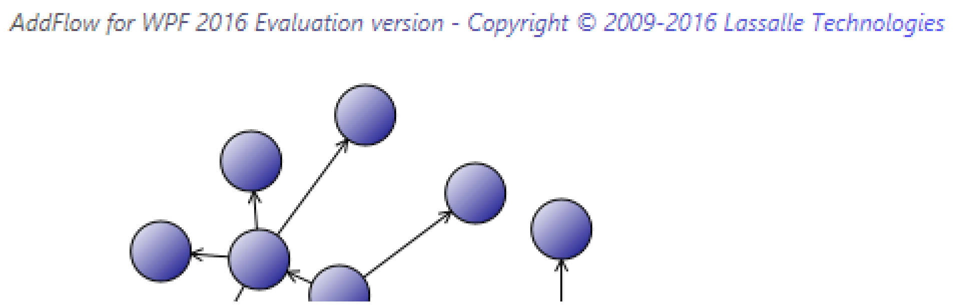
3.3.3 How it works?

The evaluation version

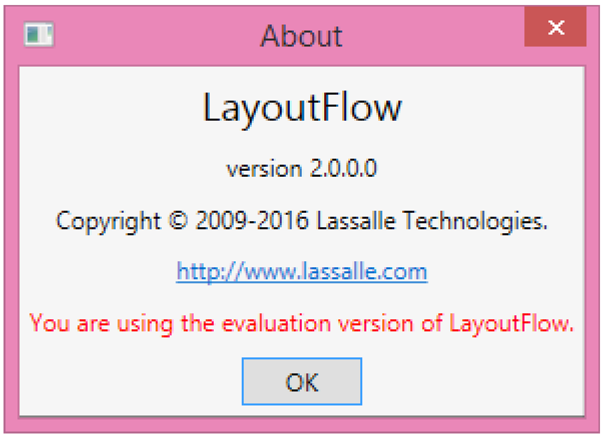
When you install AddFlow for WPF 2016, you install in fact an evaluation version of AddFlow. (And you install also an evaluation version of LayoutFlow)

If you generate ("compile") an application that uses this evaluation version of AddFlow for WPF 2016, then any attempt to use this application will display an evaluation label explaining that it has been generated only with an evaluation version of AddFlow.

In the following example, you can see the evaluation label displayed at the top of the diagram.


AddFlow for WPF 2016 Evaluation version - Copyright © 2009-2016 Lassalle Technologies

And if you execute one of the graph layout methods provided by the LayoutFlow dll, you will face sometimes a nag screen:


About

LayoutFlow

version 2.0.0.0

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http://www.lassalle.com

You are using the evaluation version of LayoutFlow.

Remark: You may use the Evaluation Version of the Software for up to **30 days** for trials and design-time evaluation purposes only.

The full version

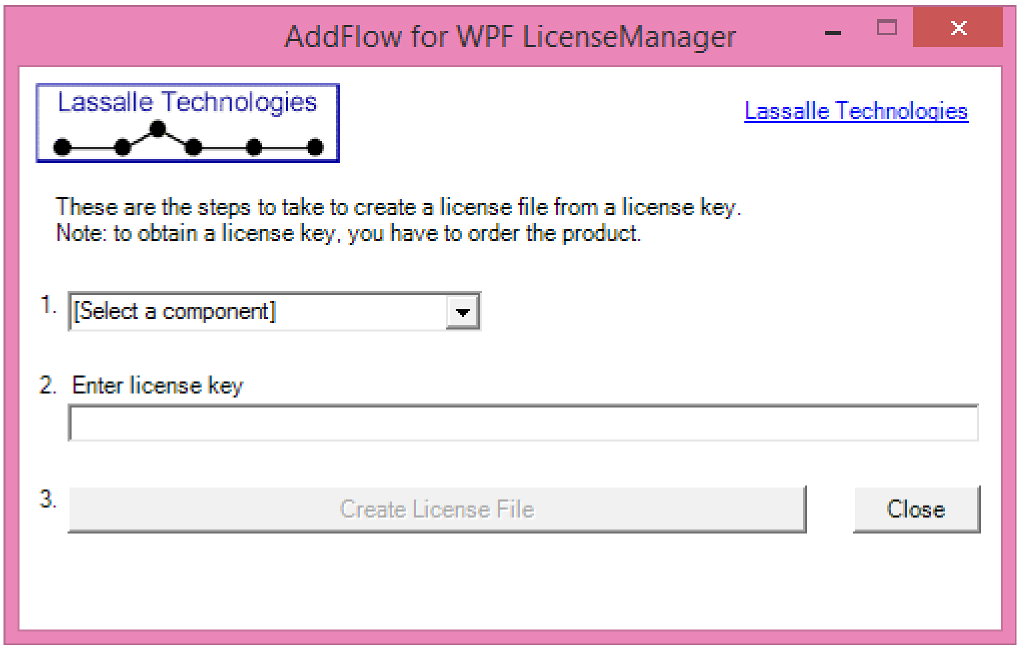
To get the full version of AddFlow, you have to purchase an AddFlow license. In such a case, you will receive an AddFlow license key (also called serial number or license number).

Now, it depends of the type of license you have purchased.

- If you have just purchased a Standard license of AddFlow for WPF 2016, the license key will alllow you removing the evaluation label. However you will continue facing the nag screen if you try to execute a graph layout method.
- If you have just purchased a Professional license of AddFlow for WPF 2016, no nag screen will be displayed if you execute a graph layout methods.

The LicenseManager program

The LicenseManager.exe program, provided with AddFlow for WPF 2016, allows generating a license file from a license key.



These are the steps to take to create a license file from a license key.
Note: to obtain a license key, you have to order the product.

The name of the license file is **Lassalle.WPF.Flow.AddFlow.LIC**. It is created in the same directory as the LicenseManager application, therefore in the bin subdirectory of the AddFlow for WPF 2016 installation folder.

When developing your application, the license file Lassalle.WPF.Flow.AddFlow.LIC must be placed in the same directory as the file Lassalle.WPF.Flow.dll.

Example

After having installed AddFlow for WPF, load the Demo solution (**demo.sln**) provided with AddFlow, then compile it and run it: the evaluation label will appear.

Now place the AddFlow license file in the bin subdirectory of the AddFlow for WPF 2016 installation folder (This is possible only if you have already created a license file with the LicenseManager program, therefore if you have already a license key, therefore if you have purchased the product!). Then re-compile the application (Rebuild All) and run it again: there is not any evaluation label this time.

And if it is a Professional license of AddFlow for WPF 2016, no nag screen will be displayed when you attempt to execute a graph layout method.

Licenses.licx file

Notice the file licenses.licx in the **Demo** project. This file is a text file that identifies which licensed classes are used in a project. There should be one licenses.licx file (as an embedded resource) for each project in a VS.NET solution. Without this file, the licensing would not work. It must contain the assembly qualified name of AddFlow.

The line in the licenses.licx file that corresponds to AddFlow is the following:

```
Lassalle.WPF.Flow.AddFlow, Lassalle.WPF.Flow, Version=2.0.0.0, Culture=neutral,
PublicKeyToken=8e9784929b011e15
```

If you use the toolbox to place an AddFlow control on your application form, the file licenses.licx is automatically created. Otherwise, you can create it manually.

4 Interactive creation of a diagram

4.1 Overview

It includes:

- the creation of items (nodes, links, captions)
- the selection of items (including multi-selection)
- the resizing of nodes or captions
- the moving of nodes or captions
- the rotation of nodes
- the stretching of links (the possibility to add or remove segments in a link)
- the possibility to change the origin or the destination of a link
- In place edition for nodes or captions.

It supports also the scrolling of diagrams and the use of grids.

Moreover, many properties allow customizing the interactive behavior of an AddFlow control. For instance, you can prevent the user to create reflexive links with the **CanReflexLink** property or to move nodes with the **CanMoveItems** properties.

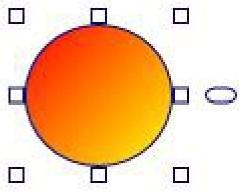
And a set of methods and properties allow implementing a powerful Undo/Redo feature.

4.2 Create a diagram interactively

4.2.1 Draw a node

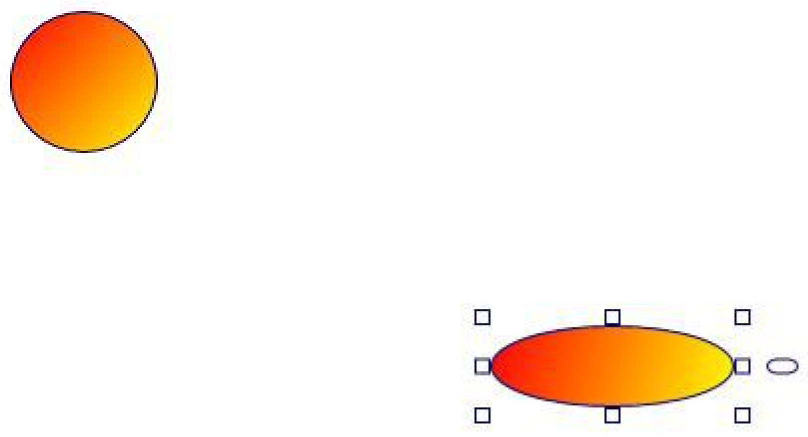
Bring the mouse cursor into the control, press the left button, move the mouse and release the left button. You have created an elliptic node. This node is selected: that's why 8 handles (little squares) are displayed.

The 8 handles allow **resizing the node** (the handle at the right allows rotating it). If you want to **move the node,** you bring the mouse cursor into the node (but not in the center), press the left button, move the mouse and release the left button.

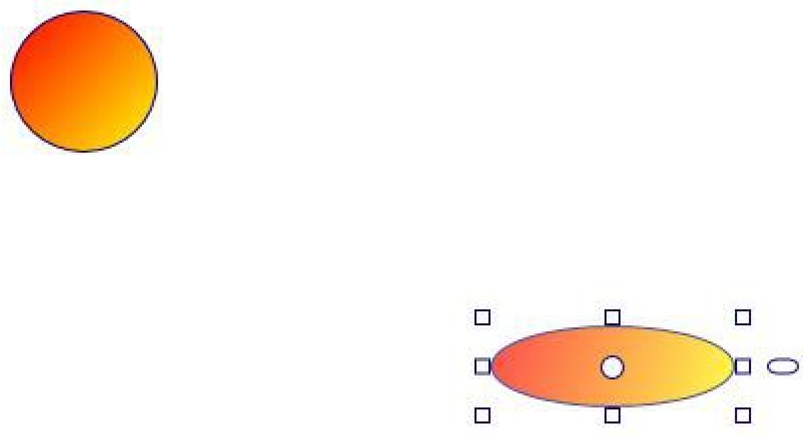


4.2.2 Draw a link

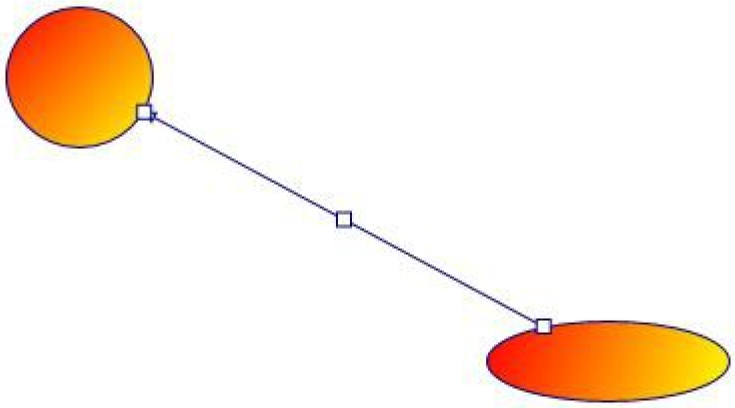
Draw a second node.



Then bring the mouse cursor above the second node. A small circle handle is then displayed at the center of the selected node.



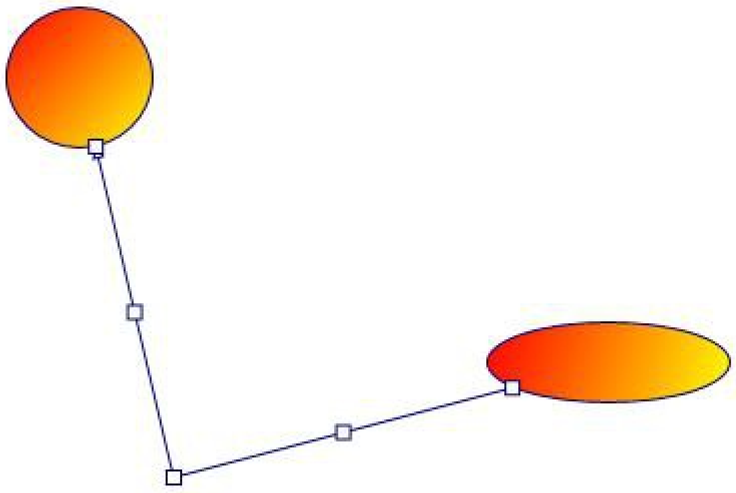
Bring the mouse over this small circle handle, press the left button, move the mouse towards the other node. When the mouse cursor is into the other node, release the left button. The link has been created. And it is selected: 3 handles are displayed in the link.



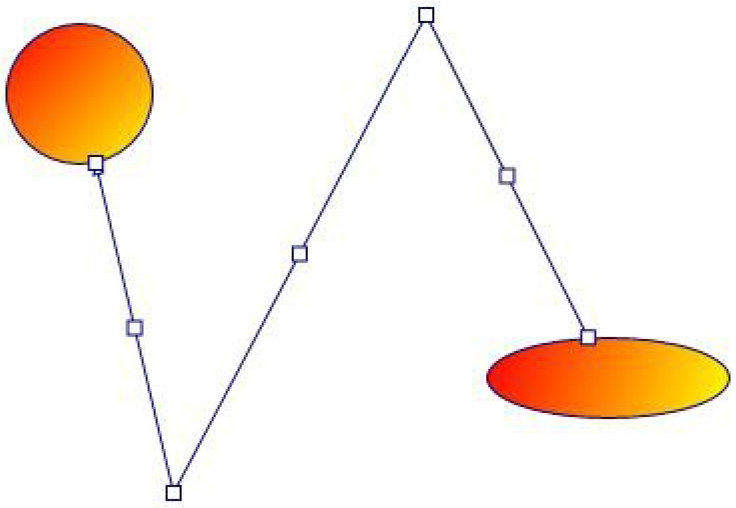
As you can see, the link stretching handles are also displayed as little rectangles. By default, those handles are small rectangles as for the nodes above. But we can change the style of those handles. The demo shows many distinct ways to display the node resizing handles and the link stretching handles.

4.2.3 Stretch a link

Bring the mouse cursor into the link handle in the middle of the link, press the left button, move the mouse and release the left button. You have created a new link segment. It has now 5 handles allowing you to add or remove segments. (The handle at the intersection of two segments allows you to remove a segment: you move it with the mouse so that the two segments are aligned and when these two segments are approximately aligned, release the left button).

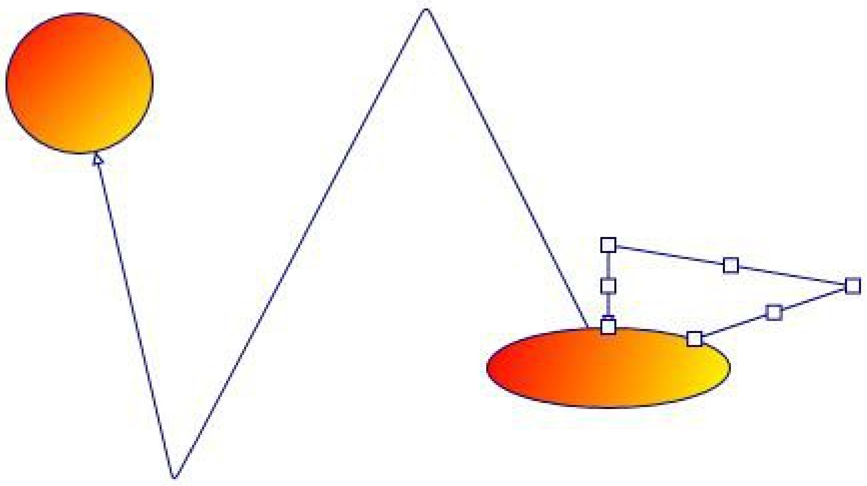


Create another segment



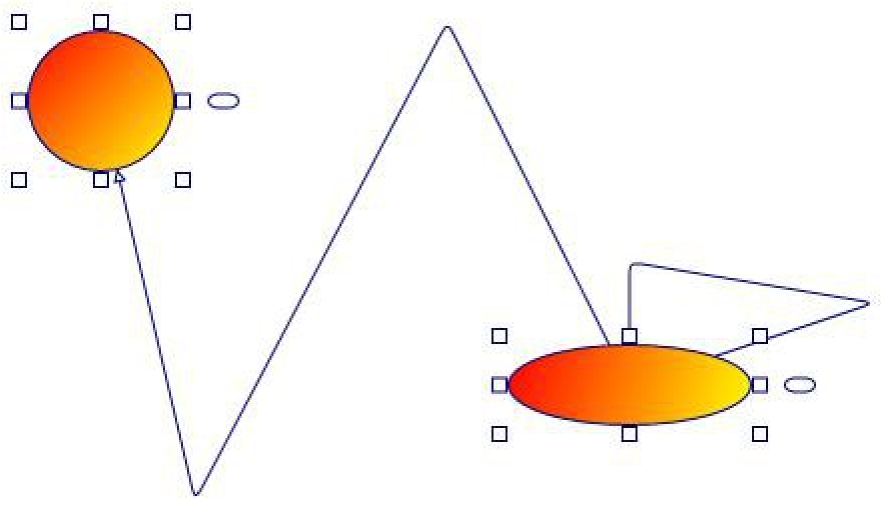
4.2.4 Draw a reflexive link

Select a node by clicking on it. Then bring the mouse cursor above the small diamond handle at the center of the selected node. Press the left button, move the mouse outside the selected node, then move it inside the selected node again, then release the left button. You have created a reflexive link, i.e. a link whose origin and destination are the same.

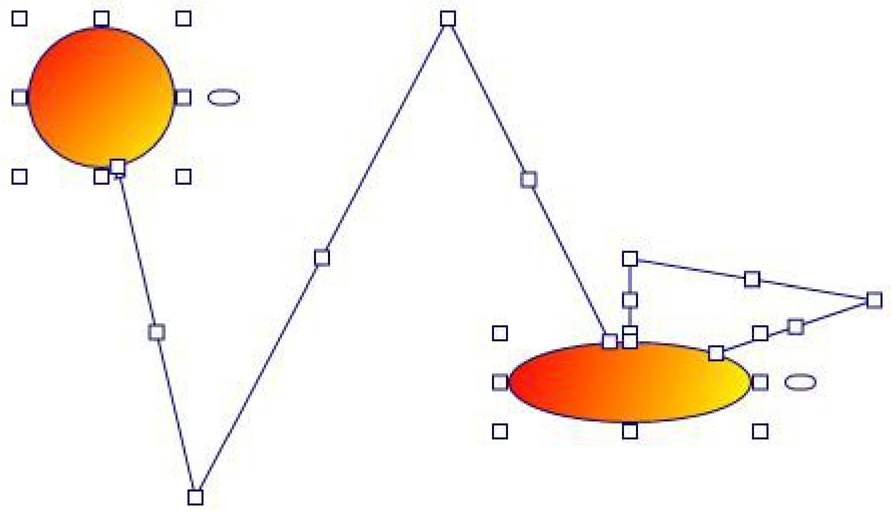


4.2.5 Multiselection

You can select several nodes or links by clicking them with the mouse and simultaneously pressing the shift or control key.



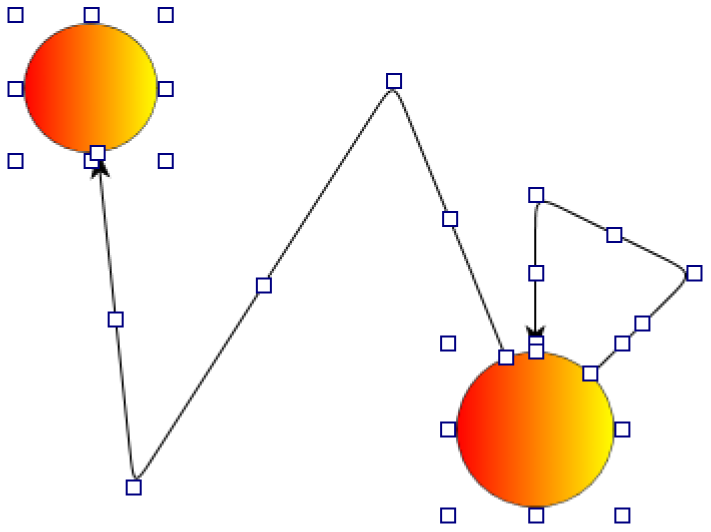
You can also select links or nodes and links.



There is another way to perform multiselection, using the **MouseSelection** property and assigning it the **MouseSelection.Selection** value. Then you can select several nodes and links: you bring the mouse cursor into the AddFlow control, press the left button, move the mouse and release the left button. All nodes or links inside the selection rectangle are selected. Then you can unselect some nodes by clicking them with the mouse and simultaneously pressing the shift or control key. You can select them again by using the same method.

4.2.6 Node rotation

Bring the mouse cursor into the handle iplaced at the right of a node, press the left button, move the mouse and release the left button. You have rotated the node.

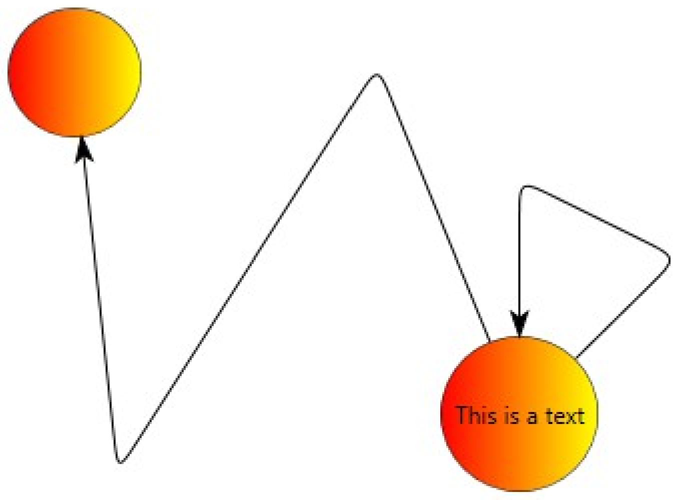


4.2.7 Change properties of a node or a link

Interactively, without adding any code, you can change the position and the size of a node (and also its text as described later). You can add segments to a link or remove them. To change the other properties (shape, styles, colors, behaviors, etc) of a node or a link, you have to write some code.

4.2.8 Add a text to a node

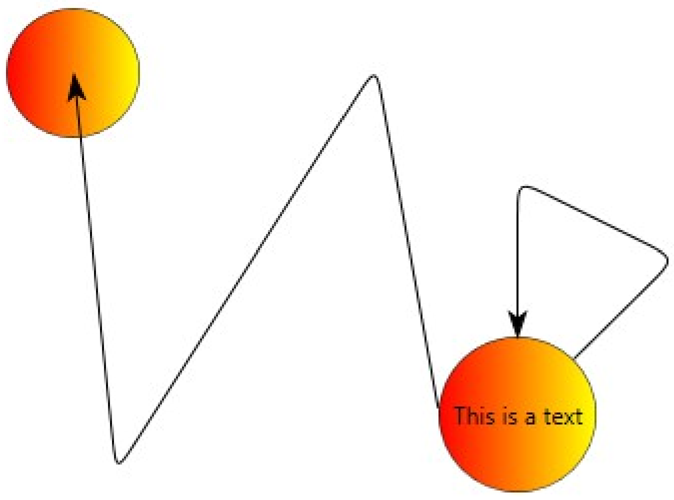
Click for instance on the blue node. This will select it. Click another time. An edit box is displayed inside the node, allowing you to enter a text.



4.2.9 Adjust the link origin and destination points

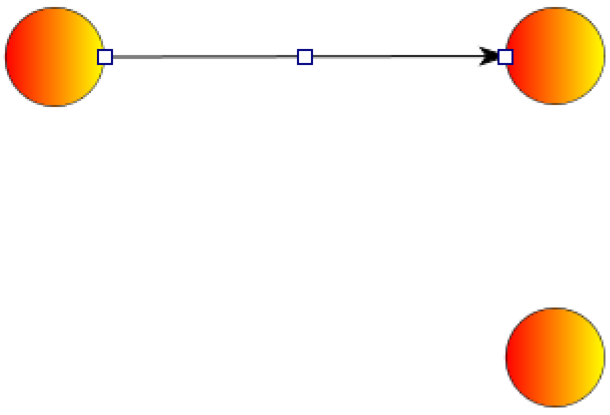
By default, you cannot adjust the extremities of the links. For instance, if you select a link and bring the mouse cursor into the last (or the first) handle of this link, press the left button, move the mouse in another place then relinquish the mouse button, the link springs back again, retrieving its initial position.
However, you can change this behavior by using the **InConnectionMode** property of the destination node of the link and the **OutConnectionMode** property of the origin node of the link.In such a case, if you bring the mouse cursor, for instance, into the last handle of the link, press the left button, move the mouse and release

it, you'll see that you have defined a new destination position for the link. If you move the destination node, the new link destination position keeps on following the node.

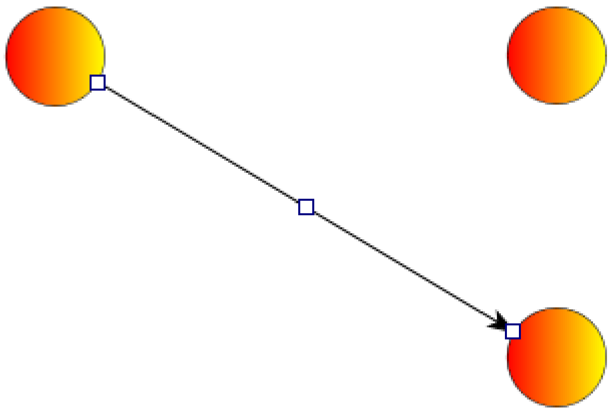


4.2.10Change the destination or the origin node of a link

You can change interactively the destination or the origin of a link.



You bring the mouse cursor into the third link handle (near the arrow head), press the left button, move the mouse until the isolated node and release the left button. The new destination of the link has changed.



5 Programmatic creation of a diagram

5.1 Overview

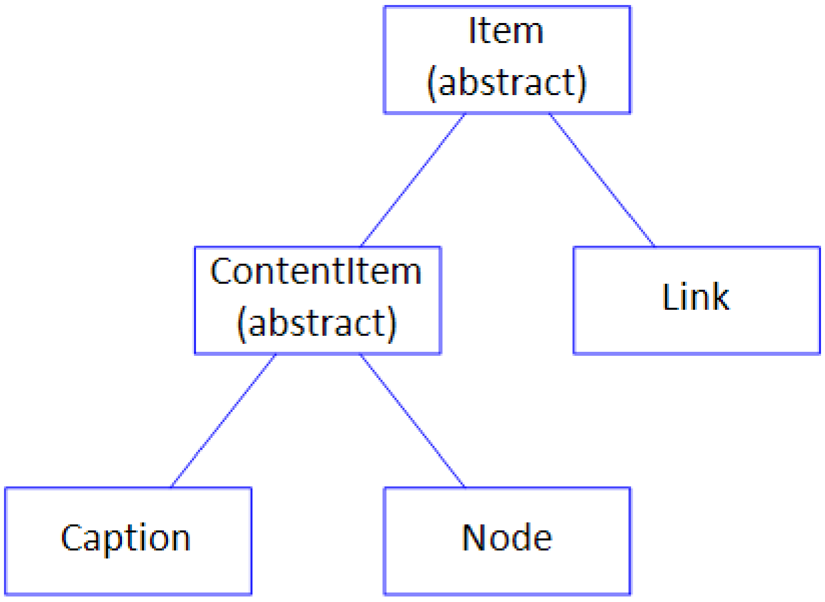
In this chapter we will focus on how to create a diagram programmatically.

The AddFlow library is a .NET class library containing a set of classes for creating interactive diagrams very easily.

The main class is the **AddFlow** class that derives from the Canvas class. It contains a DrawingVisual object that which is used to display the diagram. The **Visual** property returns this DrawingVisual object.

An AddFlow diagram contains three kinds of objects, **Node, Link** and **Caption** objects. The Node and Caption classes derives from the **ContentItem** class. The ContentItem and Link classes derive from the **Item** class.

The Item and ContentItem classes are abstract classes. You cannot use it directly but instead use objects that derive from the Node, Link and Caption classes.



For detailed information about the types, classes and interfaces used in AddFlow, see the **Lassalle.WPF.Flow** namespace in the AddFlow for WPF 2016 help file.

WARNING: **Nodes, captions and links are not controls!** We could have decided to choose a design where nodes, captions and links are controls (as we have done for the Silverlight version of AddFlow but in this case, we had not the choice) but this would result in poor speed performance. Using DrawingVisual is the most lightweight way to perform drawing. It is the best choice if you need to create big diagrams (several thousands of nodes and links).

Notice also that a DrawingVisual object can contain a collection of DrawingVisual objects. We use this feature in the **CauseEffect** example of the demo.

5.2 AddFlow Items

5.2.1 Item

The Item class represents an item in the diagram. All classes representing diagram elements derive from Item.

The main purpose is to provide common methods and properties of every diagram element: nodes, links, captions.

Note that it is an abstract class. You cannot use it directly but instead use objects that derive from the Node, Link or Caption classes.

The Item class provides some style properties, data properties and behavior properties used by all the items of an AddFlow diagram.

Style properties

- The **Fill**, **Stroke** properties allow defining item colors.
- The **Font** property allows defining the font used to display the text associated to the item.
- The **DashStyle**, **StrokeThickness, IsOwnerDraw** properties allows defining how the item is displayed.

Data properties

- The **Text** property defines the string displayed inside or near the item.
- The **Tooltip** property defines the tooltip of the item.

Behaviour properties

IsSelected, **IsHitTestVisible, IsSelectable.**

5.2.2 ContentItem

A ContentItem object is an Item object that has a content which may be a string or/and an image. Nodes and captions are ContentItem objects.

The main purpose is to provide common methods and properties for nodes and captions. Note that it is an abstract class. You cannot use it directly but instead use objects that derive from Node or Caption classes.

The **Location, Size, RotationAngle** properties allow getting or setting the location, size and rotation of a ContentItem object.

The **Geometry** property allow getting ang setting the shape of the ContentItem object.

The **TextPosition**, **TextMargin, ImagePosition, ImageMargin** properties determine how the text and the image are positioned in the ContentItem object.

The **IsXMoveable**, **IsYMoveable**, **IsXSizeable**, **IsYSizeable** properties determine if the ContentItem object can be moved or resized.

The **IsEditable** properties determine if “in place” edition is possible in the ContentItem object.

5.2.3 Node

A node (also called vertice or entity) is a ContentItem object that can be linked to another node.

The Node class provides the **Links** collection property that allows getting all the links of the node.

The **IsInLinkable** and **IsOutLinkable** boolean properties determine if “in” or “out” links are allowed.

5.2.4 Link

A link (also called edge, relation or arc) is an Item object allowing linking two nodes. It is a line that leaves the origin node and comes to the destination node. A link cannot exist without its origin and destination nodes. If one of these two nodes is removed, the link is also removed.

The **Org** and **Dst** properties allow getting or setting the origin and destination node of the link.

The **PinOrgIndex** and **PinDstIndex** properties allow getting or setting the origin pin index and the destination pin index of the link.

The **Points** property is the collection of points that define the segments of the link.

The **LineStyle** property defines the style of link (polyline, Bezier, Spline, orthogonal)

The **IsArrowOrg**, **IsArrowDst** and **IsArrowMid** properties define if arrows are used for the link.

The **ArrowOrg**, **ArrowDst** and **ArrowMid** properties define the arrow shape.

The **JumpSize** property determines the size of the jump displayed at the intersection of 2 links.

The **RoundCornerSize** property determines the size of the rounded corners of the link segments.

The **IsOrientedText** property determines whether the link text can be drawn in the same direction as the link itself.

The **IsStretchable** property determines whether the link is stretchable or not. When a link is not stretchable, the user cannot interactively stretch it with the mouse.

The **IsAdjustDst** and **IsAdjustOrg** properties determinesvwhether it is possible to adjust the position of the last and first point of the link.

5.2.5 Caption

A caption (also called label or note) is a ContentItem object that can be owned by an AddFlow item, therefore by a node, a link or even by another caption.

The Caption class provides the **Owner** property that allows getting and setting the owner of the caption.

The **Dock** property returns/sets the DockStyle of the caption. This property is relevant only if the caption is attached to a ContentItem object.

The **AnchorPositionOnLink** property returns/sets a value which defines the position of the caption near the link. This property is relevant only if the caption is attached to a link.

5.3 Collections of items

AddFlow provide the following collections:

- **Items**: the collection of all items of the diagram
- **SelectedItems**: collection of all selected items of the diagram
- **Links**: collection of all links (in and out) of a node
- **Captions**: collection of captions of an AddFlow item.

WARNING: Those collections are provided for only for the AddFlow infrastructure and for enumeration purposes. Don't use them for adding or removing items.

5.4 Creation and deletion of items

5.4.1 Node

To add a node to a diagram, you have first to instanciate it then use the **AddNode** method to add it to the diagram. To remove it, you call the **RemoveNode** method.

The Node class has 3 constructors.

Node constructors

```
Node()
Node(float left, float top, float width, float height, string text, AddFlow addflow)
Node(float left, float top, float width, float height, string text, Node node)
```

We will often use the second constructor that creates a node with an initial position, an initial size, an initial text displayed inside the node and a reference to the AddFlow control that will supply default property values for the node.

The third constructor is working as the second one except that the default property values are copied from a node model.

5.4.2 Link

To add a link to a diagram, you have first to instanciate it then use the **AddLink** method to add it to the diagram. To remove it, you call the **RemoveLink** method.

The Link class has 5 constructors.

Link constructors

```
Link()
Link(Node org, Node dst, string text, Link link)
Link(Node org, Node dst, int pinOrgIndex, int pinDstIndex, string text, Link link)
Link(Node org, Node dst, string text, AddFlow addflow)
Link(Node org, Node dst, int pinOrgIndex, int pinDstIndex, string text, AddFlow addflow)
```

As for nodes, to supply default property values for the link, you can use a reference to the AddFlow control or use a link model.

5.4.3 Caption

To add a caption to a diagram, you have first to instanciate it then use the **AddCaption** method to add it to the diagram. To remove it, you call the **RemoveCaption** method.

The Caption class has 3 constructors.

Caption constructors

```
Caption()
Caption(float left,float top,float width,float height,string text,Item owner, AddFlow addflow)
Caption(float left,float top,float width,float height,string text,Item owner, Caption caption)
```

We will often use the second constructor that creates a caption with an initial position, an initial size, an initial text displayed inside the caption, a reference to the owner item of this caption and a reference to the AddFlow control that will supply default property values for the node.

The third constructor is working as the second one except that the default property values are copied from a caption model.

5.5 Diagram creation

5.5.1 Our first program

The **FirstDiagram.xaml.cs** file of the demo displays a small diagram that we will call “our first diagram”.

Following is the C# code that creates this simple diagram:

```
private void CreateDiagram(AddFlow addflow)
{
    // Create 3 nodes
    Node node1 = new Node(50, 50, 80, 80, "First node", addflow);
    Node node2 = new Node(280, 160, 100, 80, "Second node", addflow);
    Node node3 = new Node(50, 210, 80, 80, "Third node", addflow);

    // Create 3 links
    Link link1 = new Link(node1, node2, "link 1", addflow);
    Link link2 = new Link(node2, node2, "link 2", addflow);
    Link link3 = new Link(node2, node3, "link 3", addflow);

    // Create 1 caption
    Caption caption = new Caption(200, 30, 100, 20, "Our first diagram", null,
addflow);
```

```
    // Add the items to the diagram
    addflow.AddNode(node1);
    addflow.AddNode(node2);
    addflow.AddNode(node3);
    addflow.AddLink(link1);
    addflow.AddLink(link2);
    addflow.AddLink(link3);
    addflow.AddCaption(caption);
}
```

This code creates the following diagram:

In this diagram, the nodes and links receive default property values. For instance, the nodes have an elliptical shape. The links are composed of one line terminated by an arrow. The link 2 is reflexive and by default, it is created with 3 segments. The drawing color is black. The text color is black.

We are going to enhance this diagram. However, let us focus on the way nodes, links and captions are created. First we create objects, then we add them to the AddFlow control. If we just write:

```
Node node1 = new Node(50, 50, 80, 80, "First node", addflow);
```

the node object is created. However it is not still part of the diagram. To make this node belong to the diagram, we have to add the following line:

```
addflow.AddNode(node1);
```

Same thing for links: if we just write:

```
Link link1 = new Link(node1, node2, "link 1", addflow);
```

the link object is created. However, to give a true existence to this link, we have to add the following line:

```
addflow.AddLink(link1);
```

5.5.2 Other ways to create the diagram

We could have written this first program in the following manner:

```
void CreateDiagram2(AddFlow addflow)
{
    // Create and add the nodes to the diagram
    addflow.AddNode(new Node(50, 50, 80, 80, "First node", addflow));
    addflow.AddNode(new Node(280, 160, 100, 80, "Second node", addflow));
    addflow.AddNode(new Node(50, 210, 80, 80, "Third node", addflow));

    // We use LINQ to select in an array all the nodes of the canvas.
    var nodes = addflow.Items.OfType<Node>().ToArray();

    // Create and add the links to the diagram
    addflow.AddLink(new Link(nodes[0], nodes[1], "link 1", addflow));
    addflow.AddLink(new Link(nodes[1], nodes[1], "link 2", addflow));
    addflow.AddLink(new Link(nodes[1], nodes[2], "link 3", addflow));

    addflow.AddCaption(new Caption(200, 30, 100, 20, "Our first diagram", null,
addflow));
}
```

In this case, we use a **nodes** collection created with LINQ instead of using a reference for each Node object.

We could also use helpers functions to create nodes and links, as in the following CreateDiagram3 function where we use the helpers functions AddNode and AddLink.

```
void CreateDiagram3(AddFlow addflow)
{
    // Create and add the nodes to the diagram
    Node node1 = this.AddNode(addflow, 50, 50, 80, 80, "First node");
    Node node2 = this.AddNode(addflow, 280, 160, 100, 80, "Second node");
    Node node3 = this.AddNode(addflow, 50, 210, 80, 80, "Third node");
    // Create and add the links to the diagram
    this.AddLink(addflow, node1, node2, "link 1");
    this.AddLink(addflow, node2, node2, "link 2");
    this.AddLink(addflow, node2, node3, "link 3");

    // Create and a caption to the diagram
    this.AddCaption(addflow, 200, 30, 100, 20, "Our first diagram", null);
}

Node AddNode(AddFlow addflow, float left, float top, float width, float height, 
string text)
{
    Node node = new Node(left, top, width, height, text, addflow);
    addflow.AddNode(node);
    return node;
}

Link AddLink(AddFlow addflow, Node org, Node dst, string text)
{
    Link link = new Link(org, dst, text, addflow);
    addflow.AddLink(link);
    return link;
}

Caption AddCaption(AddFlow addflow, double left, double top, double width, double 
height, string text, Item owner)
{
    Caption caption = new Caption(left, top, width, height, text, owner, addflow);
    addflow.AddCaption(caption);
    return caption;
}
```

In the **Demo** sample, we often use this kind of helpers functions.

Now we are going to enhance our diagram.

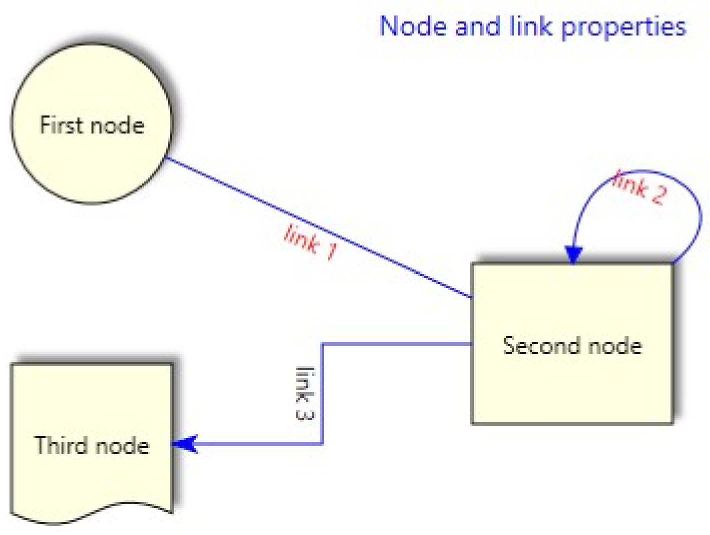
5.5.3 Changing property values

Now let us include the following “using” statement (it can be found in the demo)

```
using Lassalle.WPF.Geometries;
```

and let us use the following diagram creation method (**ItemsProperties.xaml.cs** file of the demo):

```
private void CreateDiagram(AddFlow addflow)
{
    // Create 3 yellow nodes with a shadow.
    // The second node is rectangular
    // and the third one has a Document shape style.
    Node node1 = new Node(50, 50, 80, 80, "First node", addflow);
    node1.Fill = Brushes.LightYellow;

    Node node2 = new Node(280, 160, 100, 80, "Second node", addflow);
    node2.Fill = Brushes.LightYellow;
    node2.Geometry = new RectangleGeometry(new Rect(0, 0, 64, 64));

    Node node3 = new Node(50, 210, 80, 80, "Third node", addflow);
    node3.Fill = Brushes.LightYellow;
    node3.Geometry = Geometry.Parse("M 0,0 H 60 V 40 C 30,30 30,50 0,40 Z");

    // Create 3 links.
    // Each link is blue and its BackMode property set to Opaque.
    // The second link has a Bezier style, color of its text is red, and
    // its destination arrow head angle is 30°.
    // The third link has a “HVH” style.
    Link link1 = new Link(node1, node2, "link 1", addflow);
    link1.Stroke = Brushes.Blue;
    link1.Foreground = Brushes.Red;

    Link link2 = new Link(node2, node2, "link 2", addflow);
    link2.Stroke = Brushes.Blue;
    link2.LineStyle = LineStyle.Bezier;
    link2.Foreground = Brushes.Red;
    link2.ArrowGeometryDst = Geometry.Parse("M0,0 8,4 0,8 Z");

    Link link3 = new Link(node2, node3, "link 3", addflow);
    link3.Stroke = Brushes.Blue;
    link3.LineStyle = LineStyle.Orthogonal;
    link3.ArrowGeometryDst = Geometry.Parse("M3,4 L0,0 12,4 0,8 z");

    // Create 1 caption
    Caption caption = new Caption(200, 30, 220, 20, "Node and link properties",
null, addflow);
    caption.Foreground = Brushes.Blue;
    caption.Stroke = Brushes.Transparent;
    caption.FontSize = 14;

    // Add the nodes and the links to the diagram
    addflow.AddNode(node1);
    addflow.AddNode(node2);
    addflow.AddNode(node3);
    addflow.AddLink(link1);
    addflow.AddLink(link2);
    addflow.AddLink(link3);
    addflow.AddCaption(caption);

    node1.Visual.Effect = this.dse;
    node2.Visual.Effect = this.dse;
    node3.Visual.Effect = this.dse;
}
```



Now, our nodes have distinct shapes. They have a shadow. Their filling colour is LightYellow. And our links are blue. The reflexive link is a curved line, its text is red and the angle of its arrow head is larger. Even the caption has changed.

Therefore we know how to give distinct property values for each object.

Notice however that to specify the colour of each node, we had to do it for each node, even if the colour is the same. It is the same thing for the links. For a big diagram, this may be annoying to repeat always the same code for each object.

Fortunately, AddFlow allows using default property values that apply to all the next created nodes or links.

TIP: In the previous examples, to define a node geometry or a link arrow geometry, we have used the PathGeometry Markup Syntax. For instance:

```
node.Geometry = Geometry.Parse("M 0,0 H 60 V 40 C 30,30 30,50 0,40 Z");
```

However, this method, although elegant, has also its drawbacks. We will see later another method that uses the PredefinedGeometry class used in the demo.

5.5.4 Default property values

Now, let us use the following diagram creation method (**DefaultProperties.xaml.cs** file of the demo):

```
private void CreateDiagram(AddFlow addflow)
{
    // Assign default property values for nodes and links
    addflow.NodeModel.Fill = Brushes.LightYellow;
    addflow.LinkModel.Stroke = Brushes.Blue;
    addflow.LinkModel.Foreground = Brushes.Red;

    // Create 3 yellow nodes with a shadow.
    // The second node is rectangular
    // and the third one has a Document shape style.
    Node node1 = new Node(50, 50, 80, 80, "First node", addflow);

    Node node2 = new Node(280, 160, 100, 80, "Second node", addflow);
    node2.Geometry = new RectangleGeometry(new Rect(0, 0, 64, 64));

    Node node3 = new Node(50, 210, 80, 80, "Third node", addflow);
    node3.Geometry = Geometry.Parse("M 0,0 H 60 V 40 C 30,30 30,50 0,40 Z");

    // Create 3 links.
    // Each link is blue and its BackMode property set to Opaque.
    // The second link has a Bezier style, color of its text is red, and
    // its destination arrow head angle is 30°.
    // The third link has a “HVH” style.
    Link link1 = new Link(node1, node2, "link 1", addflow);

    Link link2 = new Link(node2, node2, "link 2", addflow);
    link2.LineStyle = LineStyle.Bezier;
    link2.ArrowGeometryDst = Geometry.Parse("M0,0 8,4 0,8 Z");

    Link link3 = new Link(node2, node3, "link 3", addflow);
    link3.LineStyle = LineStyle.Orthogonal;
    link3.ArrowGeometryDst = Geometry.Parse("M3,4 L0,0 12,4 0,8 z");

    // Create 1 caption
    Caption caption = new Caption(200, 30, 220, 20, "Default properties", null,
addflow);
    caption.Foreground = Brushes.Blue;
    caption.Stroke = Brushes.Transparent;
    caption.FontSize = 14;

    // Add the nodes and the links to the diagram
    addflow.AddNode(node1);
    addflow.AddNode(node2);
    addflow.AddNode(node3);
    addflow.AddLink(link1);
    addflow.AddLink(link2);
    addflow.AddLink(link3);
    addflow.AddCaption(caption);

    node1.Visual.Effect = this.dse;
    node2.Visual.Effect = this.dse;
    node3.Visual.Effect = this.dse;
}
```

This new program will create the same diagram. it will create the same diagram. However, our program is smaller because we have used the **NodeModel, CaptionModel** and the **LinkModel** properties of AddFlow which allow specifying default property values for nodes and links. For instance, writing:

```
addflow.NodeModel.Fill = Brushes.LightYellow;
```

indicates that all the nodes that will be created after will be filled with a LightYellow color.

Then you just need to specify the property values that differ from the defaults.

Notice that the **NodeModel, CaptionModel** and the **LinkModel** properties have also an interactive effect. Not only the nodes created programmatically will be filled with a LightYellow colour but also the nodes created interactively with the mouse. This may be interesting or not, depending on what you intend to do.

Anyway, it is also possible to specify default values when creating a diagram programmatically and have other default values for the interactive creation.

5.5.5 The NodeModel, LinkModel and CaptionModel properties

We may also clone the NodeModel, LinkModel and CaptionModel properties respectively in a Node , a Link or a Caption object and then we change some property values of these objects before using them when creating nodes, links and captions, as in the following function:

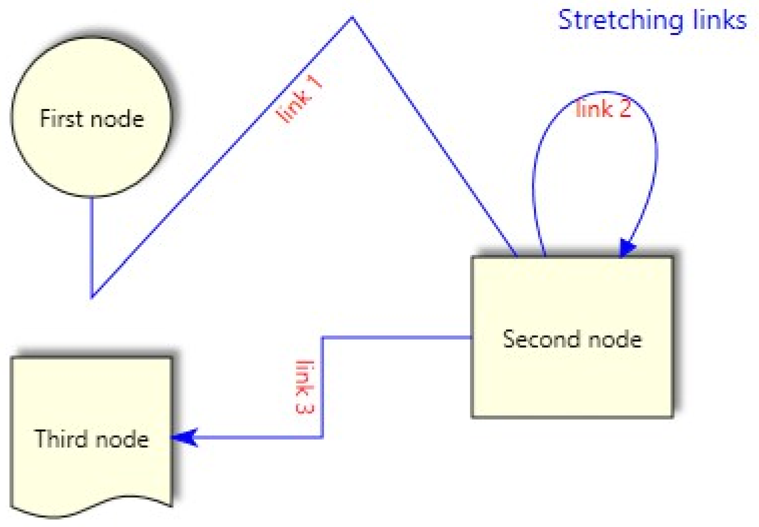
```
private void CreateDiagram(AddFlow addflow)
{
    Node dn = new Node(0, 0, 0, 0, null, addflow);
    Link dl = new Link(null, null, null, addflow);
    Caption dc = new Caption(0, 0, 0, 0, null, null, addflow);

    // Default property values for nodes created programmatically
    dn.Fill = Brushes.LightYellow;
    dn.ShadowStyle = ShadowStyle.RightBottom;

    // Default property values for links created programmatically
    dl.Stroke = Brushes.Blue;
    dl.BackMode = BackMode.Opaque;

    // Default property values for captions created programmatically
    dc.Foreground = Brushes.Blue;
    dc.Stroke = Brushes.Transparent;
    dc.FontSize = 14;

    // Create 3 yellow nodes with a shadow.
    // The second node is rectangular
    // and the third one has a Document shape style.
    Node node1 = new Node(50, 50, 80, 80, "First node", dn);

    Node node2 = new Node(280, 160, 100, 80, "Second node", dn);
    node2.Geometry = new RectangleGeometry(new Rect(0, 0, 64, 64));

    Node node3 = new Node(50, 210, 80, 80, "Third node", dn);
    node3.Geometry = Geometry.Parse("M 0,0 H 60 V 40 C 30,30 30,50 0,40 Z");

    // Create 3 links.
    // Each link is blue and its BackMode property set to Opaque.
    // The second link has a Bezier style, color of its text is red, and
    // its destination arrow head angle is 30°.
    // The third link has a "HVH" style.
    Link link1 = new Link(node1, node2, "link 1", dl);

    Link link2 = new Link(node2, node2, "link 2", dl);
    link2.LineStyle = LineStyle.Bezier;
    link2.Stroke = Brushes.Red;
    link2.ArrowGeometryDst = Geometry.Parse("M0,0 8,4 0,8 Z");

    Link link3 = new Link(node2, node3, "link 3", dl);
    link3.LineStyle = LineStyle.Orthogonal;

    // Create 1 caption
    Caption caption = new Caption(200, 30, 220, 20, "Default properties", null,
dc);

    // Add the nodes and the links to the diagram
    addflow.AddNode(node1);
    addflow.AddNode(node2);
    addflow.AddNode(node3);
    addflow.AddLink(link1);
    addflow.AddLink(link2);
    addflow.AddLink(link3);
    addflow.AddCaption(caption);
}
```

5.5.6 Stretching the links

We would like to add segments to our links. The following method (**StretchingLinks** example of the demo) demonstrates how to do that.

```
private void CreateDiagram(AddFlow addflow)
{
    // Assign default property values for nodes and links
    addflow.NodeModel.Fill = Brushes.LightYellow;
    addflow.LinkModel.Stroke = Brushes.Blue;
    addflow.LinkModel.Foreground = Brushes.Red;

    // Create 3 yellow nodes with a shadow.
    // The second node is rectangular
    // and the third one has a Document shape style.
    Node node1 = new Node(50, 50, 80, 80, "First node", addflow);

    Node node2 = new Node(280, 160, 100, 80, "Second node", addflow);
    node2.Geometry = new RectangleGeometry(new Rect(0, 0, 64, 64));

    Node node3 = new Node(50, 210, 80, 80, "Third node", addflow);
    node3.Geometry = Geometry.Parse("M 0,0 H 60 V 40 C 30,30 30,50 0,40 Z");

    // Create 3 links.
    // The first link has no arrow.
    // The second link has a Bezier style, the color of its text is red
    // The third link has a "HVH" style.

    Link link1 = new Link(node1, node2, "link 1", addflow);

    Link link2 = new Link(node2, node2, "link 2", addflow);
    link2.LineStyle = LineStyle.Bezier;
    link2.ArrowGeometryDst = Geometry.Parse("M0,0 8,4 0,8 Z");

    Link link3 = new Link(node2, node3, "link 3", addflow);
    link3.LineStyle = LineStyle.HVH;
    link3.ArrowGeometryDst = Geometry.Parse("M3,4 L0,0 12,4 0,8 z");

    // Create 1 caption
    Caption caption = new Caption(260, 30, 220, 20, "Stretching links", null,
addflow);
    caption.Foreground = Brushes.Blue;
    caption.Stroke = Brushes.Transparent;
    caption.FontSize = 14;

    // Add the nodes and the links to the diagram
    addflow.AddNode(node1);
    addflow.AddNode(node2);
    addflow.AddNode(node3);
    addflow.AddLink(link1);
    addflow.AddLink(link2);
    addflow.AddLink(link3);
    addflow.AddCaption(caption);

    // Add 2 points (therefore 2 segments) to the first link
    link1.AddPoint(new Point(90, 180));
    link1.AddPoint(new Point(220, 40));

    // Stretch the reflexive link
    link2.SetPoint(new Point(280, 50), 1);
    link2.SetPoint(new Point(420, 50), 2);

    node1.Visual.Effect = this.dse;
    node2.Visual.Effect = this.dse;
    node3.Visual.Effect = this.dse;
}
```

This program will create the following diagram:



The rules for managing the link collection of points are the following:

The **Points** property of a link is its collection of points defining its segments. This property is only provided for the AddFlow infrastructure. so don't use it except for serialization purpose (as demonstraed in the file xmlflow.cs). To manipulate the collection of link points, you should use instead the methods **AddPoint**, **RemovePoints**, **ClearPoints**, **CountPoints**, **GetPoint** and **SetPoint**.

- You can manipulate the link points only after its insertion in the diagram.
- After its insertion in the diagram, a link has at least 2 points. You cannot remove these 2 points. The Count property of the Points collection is always superior or equal to 2. If you execute the ClearPoint method, then the CountPoint method returns 2.
- You can add or delete points only if the link line style is Polyline or Spline. In other case, the number of link points is fixed. For instance, if the link line style is Bezier, then it has 4 points in any case.
- You cannot change the first point of the Points collection except if the **IsAdjustOrg** property is true or if the origin node has pins (you can change the link pin)
- You cannot change the last point of the Points collection except if the **IsAdjustDst** property is true or if the destination node has pins (you can change the link pin)
- You can change each other point of the Points collection in any case.

5.6 More informations about ContentItem objects and nodes

A ContentItem object is an item that has a text and/or an image content. And its shape can be customized.

However, only nodes accept pins: we may define for each node a set of pins to connect links.

(Remember that nodes and captions are ContentItem objects.)

5.6.1 ContentItem colors

Three properties allow setting colors for a ContentItem object:

- **Stroke** It is the brush of the ContentItem object border.
- **Fill** It is the ContentItem object filling brush.
- **Foreground** It is the brush of the ContentItem object text.

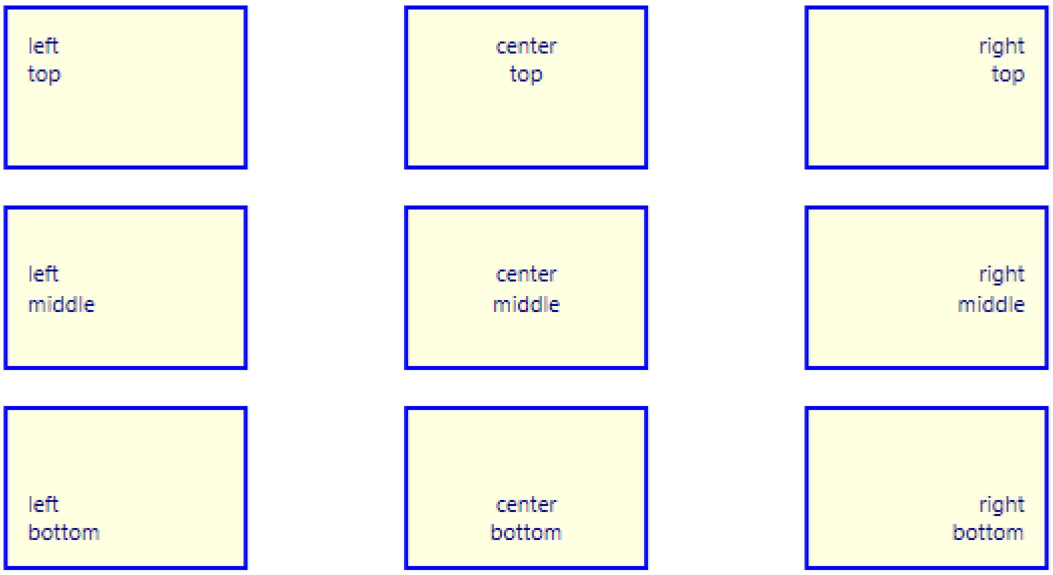
TIP: How to make the node's (or caption's) border transparent?

```
node.Stroke = Brushes.Transparent;
```

5.6.2 ContentItem object text

You can associate a text to a ContentItem object with the **Text** property. Two properties allow placing the text inside the item: **TextPosition** and **TextMargin**. This is demonstrated in the **NodeText** example of the demo. In this example, the TextMargin is set to be equal to 5 at each side.

```
this.addflow.NodeModel.TextMargin = new Thickness(10, 10, 10, 10);
```



The same could be done for a caption as it is also a ContentItem object.

Notice also the **IsClipContent** property which determines whether the content of the contentItem object is clipped or not.

5.6.3 ContentItem object custom shape

The **Geometry** property allows you associating a custom shape to a ContentItem object.

```
node.Geometry = Geometry.Parse("M 0,0 H 60 V 40 C 30,30 30,50 0,40 Z");
```

5.6.4 Predefined shapes

In the previous examples, to define a node geometry, we have used the PathGeometry Markup Syntax. For instance:

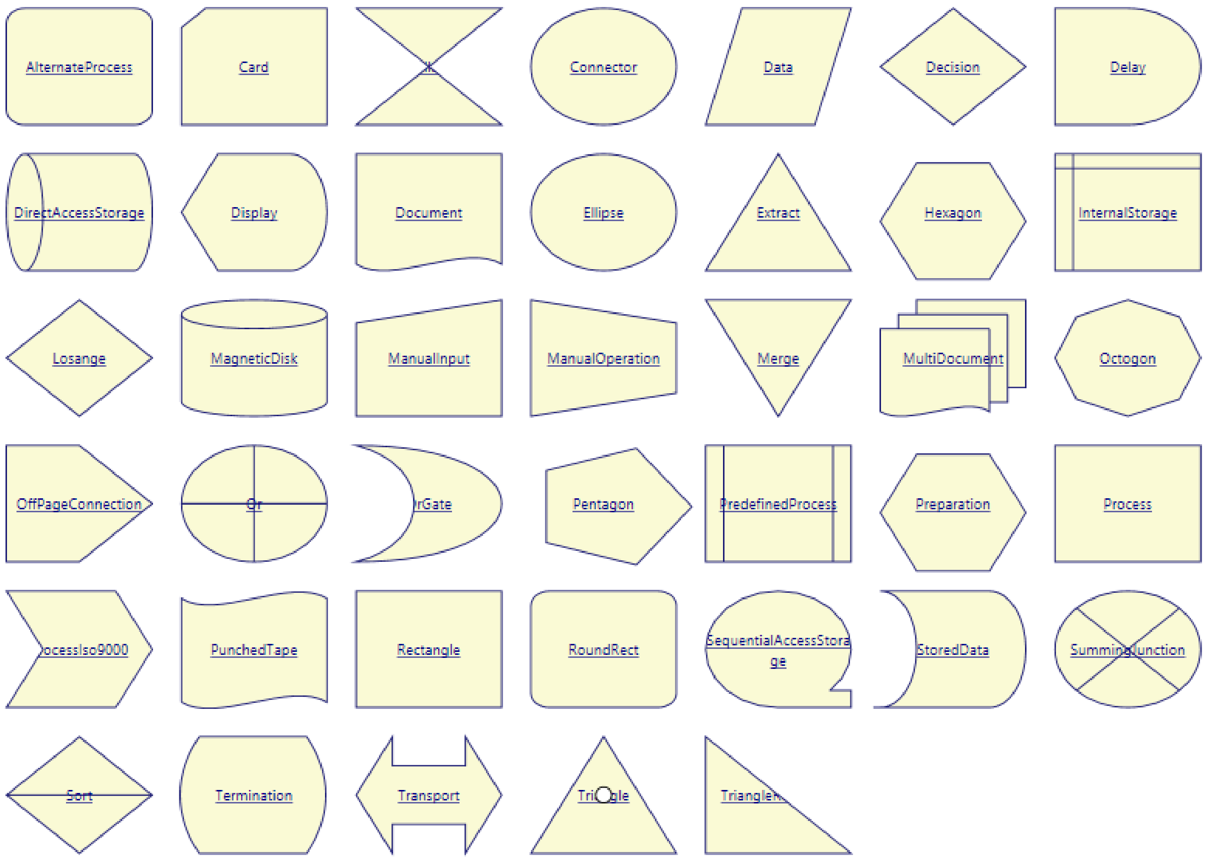
```
node.Geometry = Geometry.Parse("M 0,0 H 60 V 40 C 30,30 30,50 0,40 Z");
```

This is a good and elegant method except if you wish to export the diagram in XAML (it just does not work). However, you can write your own code to define a geometry or better, you can also use the **PredefinedGeometry** class (used in thedemo). In such a case, you could write:

```
node.Geometry = PredefinedGeometry.GetNodeGeometry(NodeShapeStyle.Document);
```

If you use this method, you will not face any problem to export the diagram to XAML, as described later in this tutorial.

This is demonstrated in **PredefinedShapes.xaml.cs**



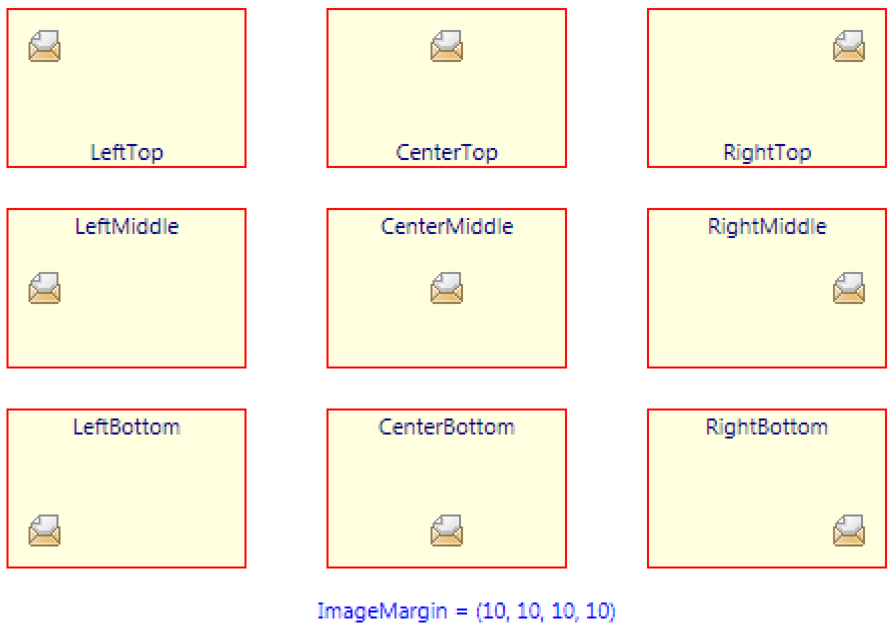
5.6.5 ContentItem object image

You can associate an image to a ContentItem object with the **Image** property. Two properties allow placing the image inside the ContentItem object : **ImagePosition** and **ImageMargin**.

This is demonstrated in the **NodeImage** example of the demo. In this example, the ImageMargin is set to be equal to 10 at each side.

```
this.addflow.NodeModel.ImageMargin = new Thickness(10, 10, 10, 10);
```

Of course, the same could be done for a caption as it is also a ContentItem object.



The source code allowing obtaining this diagram is the following:

```
private void CreateDiagram(AddFlow addflow)
{
    addflow.NodeModel.Geometry = new RectangleGeometry(new Rect(0, 0, 1, 1));
    addflow.NodeModel.Stroke = Brushes.Blue;
    addflow.NodeModel.Fill = Brushes.LightYellow;
    addflow.NodeModel.Foreground = Brushes.Navy;
    addflow.NodeModel.StrokeThickness = 2;
    addflow.NodeModel.FontSize = 11;
    addflow.NodeModel.ImageMargin = new Thickness(10, 10, 10, 10);

    Image imageMail = new Image();
    imageMail.Source = new BitmapImage(new
Uri("pack://application:,,,/Images/mail.png"));

    Node node1 = new Node(50, 20, 120, 80, null, addflow);
    node1.ImagePosition = ImagePosition.LeftTop;
    node1.Image = imageMail.Source;
    addflow.AddNode(node1);

    Node node2 = new Node(250, 20, 120, 80, null, addflow);
    node2.ImagePosition = ImagePosition.CenterTop;
    node2.Image = imageMail.Source;
    addflow.AddNode(node2);

    Node node3 = new Node(450, 20, 120, 80, null, addflow);
    node3.ImagePosition = ImagePosition.RightTop;
    node3.Image = imageMail.Source;
    addflow.AddNode(node3);

    Node node4 = new Node(50, 120, 120, 80, null, addflow);
    node4.ImagePosition = ImagePosition.LeftMiddle;
    node4.Image = imageMail.Source;
    addflow.AddNode(node4);

    Node node5 = new Node(250, 120, 120, 80, null, addflow);
    node5.ImagePosition = ImagePosition.CenterMiddle;
    node5.Image = imageMail.Source;
    addflow.AddNode(node5);

    Node node6 = new Node(450, 120, 120, 80, null, addflow);
    node6.ImagePosition = ImagePosition.RightMiddle;
    node6.Image = imageMail.Source;
    addflow.AddNode(node6);

    Node node7 = new Node(50, 220, 120, 80, null, addflow);
    node7.ImagePosition = ImagePosition.LeftBottom;
    node7.Image = imageMail.Source;
    addflow.AddNode(node7);

    Node node8 = new Node(250, 220, 120, 80, null, addflow);
    node8.ImagePosition = ImagePosition.CenterBottom;
    node8.Image = imageMail.Source;
    addflow.AddNode(node8);

    Node node9 = new Node(450, 220, 120, 80, null, addflow);
    node9.ImagePosition = ImagePosition.RightBottom;
    node9.Image = imageMail.Source;
    addflow.AddNode(node9);
}
```

Notice also the **IsImageSizeFitContentArea** property which determines whether the image of the contentItem object is adjusted to its size.

5.7 More informations about node pins

The way a link is connected to a node is managed by this node. Each node has 3 properties for this purpose: **InConnectionMode**, **OutConnectionMode** and **PinsLayout**.

The type of the InConnectionMode and OutConnectionMode properties is **ConnectionMode**. It is an enumeration that defines how the link is connected to the node.

Member	**Comment**
Center	Default. The link is directed towards the center of the node.
Anywhere	The link last (or first) point can be placed anywhere.
Pin	A pin a must be use to connect a link to the node.

When the mouse is over a node, pins are displayed on that node. Only nodes may have pins. By default, the node has only one pin placed at the center of the node. However, you are not limited to this 'central pin' and you can customize the set of pins.

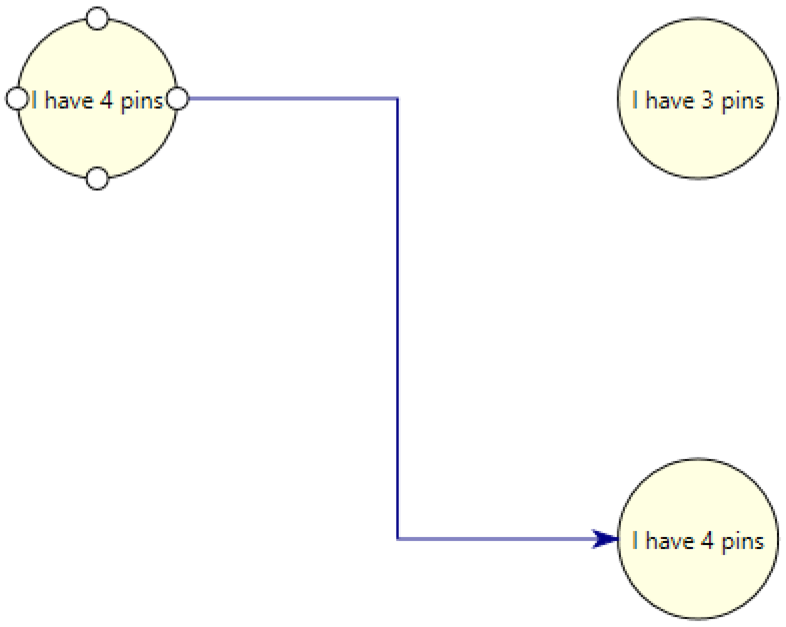
Using the **PinsLayout** property, you may attach a set of pins to a node. The PinsLayout property is an array of points whose coordinates is between 0 and 100. For instance, the following line of code create a set of 4 pins for nodes:

```
addflow.NodeModel.PinsLayout =
   new PointCollection { new Point(0, 50), new Point(50, 0),
                         new Point(100, 50), new Point(50, 100) };
```

This is demonstrated in the **NodePins** example of the demo.

```
private void CreateDiagram(AddFlow addflow)
{
    addflow.NodeModel.Fill = Brushes.LightYellow;
    addflow.NodeModel.PinsLayout =
        new PointCollection { new Point(0, 50), new Point(50, 0),
                              new Point(100, 50), new Point(50, 100) };
    addflow.NodeModel.OutConnectionMode = ConnectionMode.Pin;
    addflow.NodeModel.InConnectionMode = ConnectionMode.Pin;

    addflow.LinkModel.LineStyle = LineStyle.Orthogonal;
    addflow.LinkModel.Stroke = Brushes.Navy;
    addflow.LinkModel.ArrowGeometryDst = Geometry.Parse("M3,4L0,0 12,4 0,8z");

    // Create 3 nodes. The first two nodes have 4 pins as it is
    // defined by default for every node.
    // However the third node has only 3 pins.
    Node node1 = new Node(100, 30, 80, 80, "I have 4 pins", addflow);
    Node node2 = new Node(400, 250, 80, 80, "I have 4 pins", addflow);
    Node node3 = new Node(400, 30, 80, 80, "I have 3 pins", addflow);
    node3.PinsLayout = new PointCollection {
                    new Point(0, 50), new Point(100, 50), new Point(50, 100) };
    addflow.AddNode(node1);
    addflow.AddNode(node2);
    addflow.AddNode(node3);

    // Create one link
    this.AddLink(addflow, node1, node2, 2, 0);
}

Link AddLink(AddFlow addflow, Node org, Node dst, int pinOrgIndex, int pinDstIndex)
{
    Link link = new Link(org, dst, pinOrgIndex, pinDstIndex, "", addflow);
    addflow.AddLink(link);
    return link;
}
```

This code produces the following diagram:



In this example, the line style of the link is 'orthogonal'.

The code used to create such a link is the following:

```
        this.AddLink(addflow, node1, node2, 2, 0);
```

Notice the last two parameters that allow setting the index of the origin pin and the index of the destination pin.

Notice also that you can arrange so that certain pins can accept only “in” links or only “out” links. The Pin class exposes the 2 following properties:

Property	**Type**	**Description**
In	bool	Determines if the pin accepts "in" links
Out	bool	Determines if the pin accepts "out" links

5.8 More informations about links

5.8.1 Link colors

Three properties allow setting colors for a Link object:

- **Stroke** It is the brush used for the link line drawing
- **Fill** It is the brush used to fill the arrow head of the link.
- **Foreground** It is the brush of the link text.

5.8.2 Link text

You can associate a text to a node with the **Text** property. The **TextPlacementMode** property allows determining if the text is displayed at the middle point of the link line or at the middle point of the medium segment of the link.

5.8.3 Link arrows

The **ArrowGeometryDst** property allows you associating a custom shape for the arrow displayed at the end point of the link line.

The **ArrowGeometryOrg** property allows you associating a custom shape for the arrow displayed at the start point of the link line.

The **ArrowGeometryMid** property allows you associating a custom shape for the arrow displayed at the middle of each link segment (in the case of alink having of a polyline or orthogonal link line style).

As seen in the previous examples, to define a link arrow geometry, we can use the PathGeometry Markup Syntax. For instance:

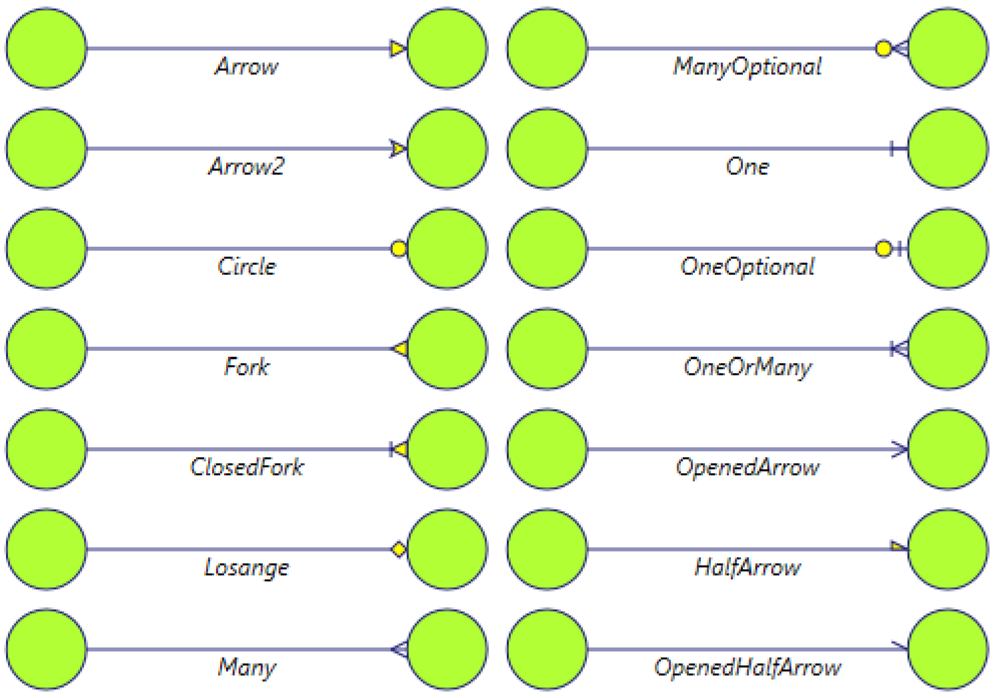
```
link.ArrowGeometryDst = Geometry.Parse("M0,0 8,4 0,8 Z");
```

As for nodes, you can also use the **PredefinedGeometry** class (used in the demo). In such a case, you could write:

```
link.ArrowGeometryDst =
       PredefinedGeometry.GetLinkArrowGeometry(LinkArrowStyle.Arrow, 8, 8);
```

The second and third parameter allows defining the size of the arrow.

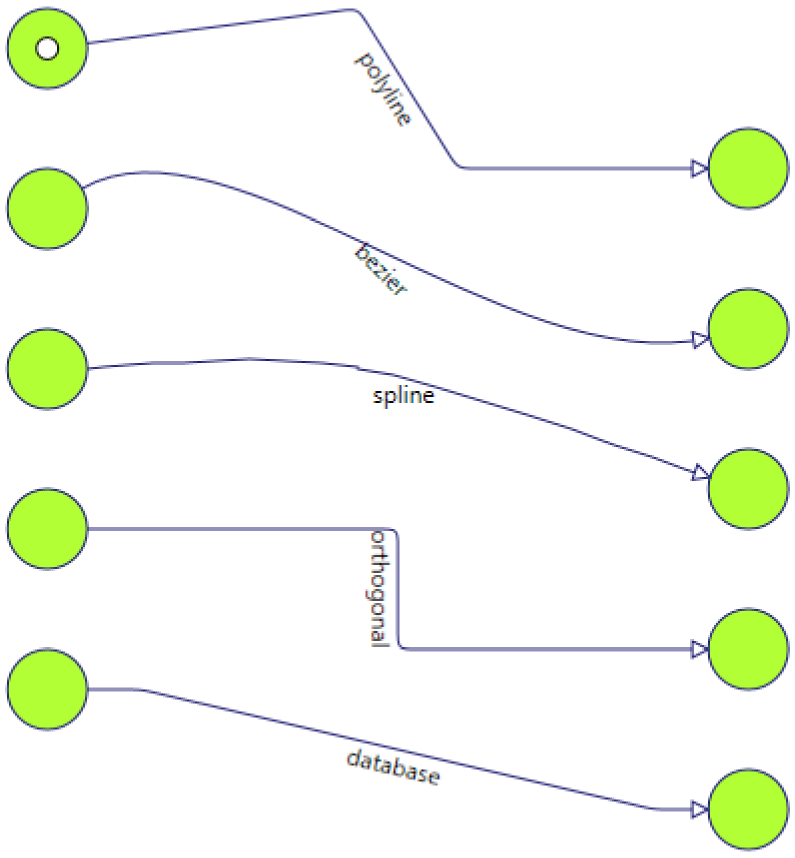
This is demonstrated in the file **PredefinedArrows.xaml.cs.**



And of course, as for node shapes, you may define your own style of arrow head shape. The source code in the file PredefinedGeometry.cs may be a starting point for you.

5.8.4 Link line styles

You can define the line style of a link using the **LineStyle** property**.** This is demonstrated in the **LineStyles** panel of the demo.



If the line style is 'polyline' or 'spline', you can add as many points as you wish to the link whereas in the other cases, the number of points is fixed: a 'bezier' link or a 'database link' has 4 points. You can move these points but you cannot add new points. The number of points of an orthogonal link is also fixed but at the creation time, depending of the origin and destination pins.

5.9 More informations on Captions

A caption may be used just to display a legend in a diagram. It may also be attached to an AddFlow item. The property that allows attaching a caption to an item is the **Owner** property. For an AddFlow item, the **Captions** property returns the collection of captions owned by this item. For instance:

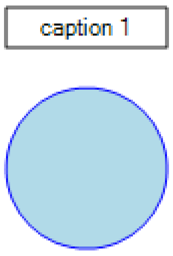
```
foreach (Caption caption in node.Captions)
{
    caption.Stroke = Brushes.Red;
}
```

WARNING: The Captions collection property is provided only for the AddFlow infrastructure and for enumeration purposes. Don't use it for adding or removing captions. Use instead the Owner property of captions.

This is demonstrated in the **Captions.xaml.cs** file of the demo.

The following code attach a caption to a node:

```
Node node1 = new Node(40, 100, 80, 80, null, addflow);
addflow.AddNode(node1);

Caption captionOwnedByNode =
new Caption(40, 60, 80, 20, "caption 1", node1,addflow);
addflow.AddCaption(captionOwnedByNode);
```

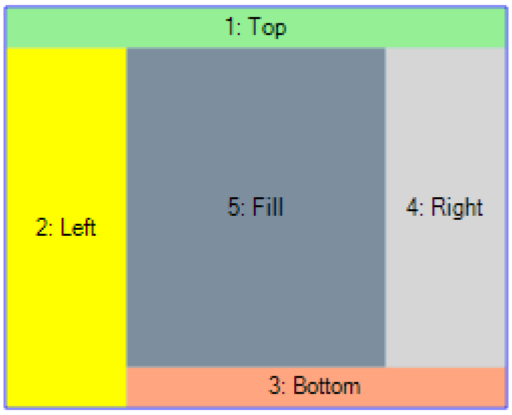


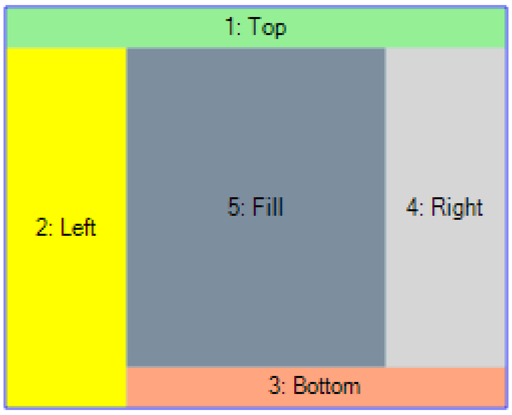
We obtain the following diagram:

And if you move the node, its caption will follow it.

The **Dock** property of the Caption class allows placing several captions inside a node. It works the same way as the Dock property for controls. For instance, in the following example, the first caption is placed at the top of the owner item because its Dock property is set to DockStyle.Top.

```
// Dock property demo
// Create the "parent" node
Node node2 = new Node(460, 40, 250, 200, null, addflow);
addflow.AddNode(node2);

// Create 5 child nodes
Caption child1 = new Caption(50, 130, 90, 20, "1: Top", node2, addflow);
child1.Stroke = Brushes.Transparent;
child1.Fill = Brushes.LightGreen;
child1.Dock = DockStyle.Top;
child1.IsHitTestVisible = false;

Caption child2 = new Caption(50, 160, 60, 20, "2: Left", node2, addflow);
child2.Stroke = Brushes.Transparent;
child2.Fill = Brushes.Yellow;
child2.Dock = DockStyle.Left;
child2.IsHitTestVisible = false;

Caption child3 = new Caption(50, 190, 60, 20, "3: Bottom", node2, addflow);
child3.Stroke = Brushes.Transparent;
child3.Fill = Brushes.LightSalmon;
child3.Dock = DockStyle.Bottom;
child3.IsHitTestVisible = false;

Caption child4 = new Caption(50, 220, 60, 20, "4: Right", node2, addflow);
child4.Stroke = Brushes.Transparent;
child4.Fill = Brushes.LightGray;
child4.Dock = DockStyle.Right;
child4.IsHitTestVisible = false;

Caption child5 = new Caption(50, 250, 90, 20, "5: Fill", node2, addflow);
child5.Stroke = Brushes.Transparent;
child5.Fill = Brushes.LightSlateGray;
child5.Dock = DockStyle.Fill;
child5.IsHitTestVisible = false;

// Add the items to the diagram.
addflow.AddCaption(child1);
addflow.AddCaption(child2);
addflow.AddCaption(child3);
addflow.AddCaption(child4);
addflow.AddCaption(child5);
```



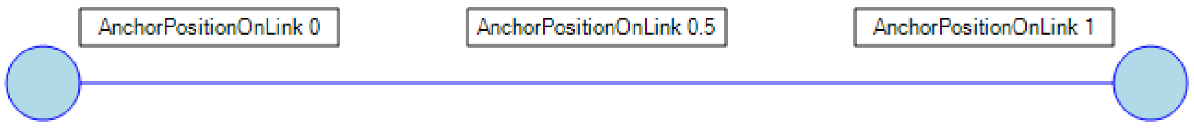


Au you can see, the captions have been placed automatically in the owner node.

Captions may also be owned by a link. The **AnchorPositionOnLink** property allows defining the position of the caption near the link. It is a value between 0 and 1. If it is 0, then the caption is placed near the origin node of the link. If it is 1, then the caption is placed near the destination node of the link. If it is for instance 0.5, then the caption is placed near the middle of the link.

```
// Caption owned by a link
Node node3 = new Node(60, 400, 40, 40, null, addflow);
addflow.AddNode(node3);

Node node4 = new Node(660, 400, 40, 40, null, addflow);
addflow.AddNode(node4);

Link link = new Link(node3, node4, null, addflow);
addflow.AddLink(link);

Caption captionOwnedByLink1 = new Caption(100, 380, 140, 20, "AnchorPositionOnLink
0", link, addflow);
captionOwnedByLink1.AnchorPositionOnLink = 0f;
addflow.AddCaption(captionOwnedByLink1);

Caption captionOwnedByLink2 = new Caption(310, 380, 140, 20, "AnchorPositionOnLink
0.5", link, addflow);
captionOwnedByLink2.AnchorPositionOnLink = 0.5f;
addflow.AddCaption(captionOwnedByLink2);

Caption captionOwnedByLink3 = new Caption(520, 380, 140, 20, "AnchorPositionOnLink
1", link, addflow);
captionOwnedByLink3.AnchorPositionOnLink = 1f;
addflow.AddCaption(captionOwnedByLink3);
```

We obtain the following diagram:

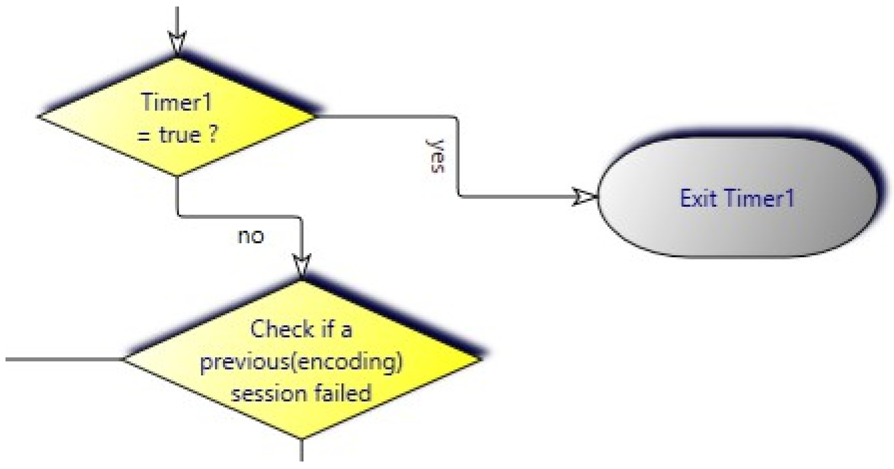


5.10Displaying shadows

The **FlowChart** example in the demo shows how to that. In the NodeCreated event handler, we use a DropShadowEffect object which is hardware rendered (and therefore quickly rendered).

```
void addflow_NodeCreated(object sender, NodeCreatedEventArgs e)
{
    Node node = e.Node;

    // Defines the shadow that shall be used for nodes
    // We use DropShadowEffect which is hardware rendered and not software rendered
    DropShadowEffect dse = new DropShadowEffect();
    dse.Color = Colors.Navy;
    dse.Direction = 45;

    node.Visual.Effect = dse;
}
```

The following figure demonstrates the use of this shadow effect.



5.11Custom visuals

It is also possible to add in the diagram some visuals that are not AddFlow items.

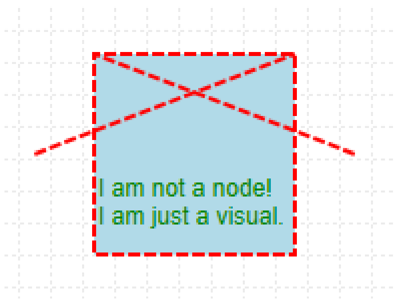
This feature is used in the **CustomDrawings** and **CauseEffect** examples of the demo.

Notice however that this is not possible in virtualization mode.

For instance, in the file CustomDrawings.xaml.cs, you will find the following function that creates a visual in the diagram.

```
void JustAddAVisual()
{
    DrawingVisual dv = new DrawingVisual();
    DrawingContext dc = dv.RenderOpen();
    Pen pen = new Pen(Brushes.Red, 2);
    dc.DrawRectangle(Brushes.LightBlue, pen, new Rect(70, 300, 100, 100));
    pen.DashStyle = DashStyles.Dash;
    dc.DrawLine(pen, new Point(70, 300), new Point(200, 350));
    dc.DrawLine(pen, new Point(170, 300), new Point(40, 350));
    Typeface font = new Typeface("Arial");
    SolidColorBrush brush = new SolidColorBrush(Colors.Green);
    FormattedText ft = new FormattedText(
        "I am not a node!\rI am just a visual.",
        System.Globalization.CultureInfo.InvariantCulture,
        FlowDirection.LeftToRight, font, 12, brush);
    dc.DrawText(ft, new Point(72, 360));
    dc.Close();
    this.addflow.Visual.Children.Add(dv);
}
```

It creates the following visual :



This not an AddFlow item (node, caption, link). You cannot select it or move it.

TIP: As said before, if the IsVirtualizing property is set, this visual will not be displayed. In such a case, the workaround is to display the visual in a caption (which can be made unselectable if its IsSelectable property is false).

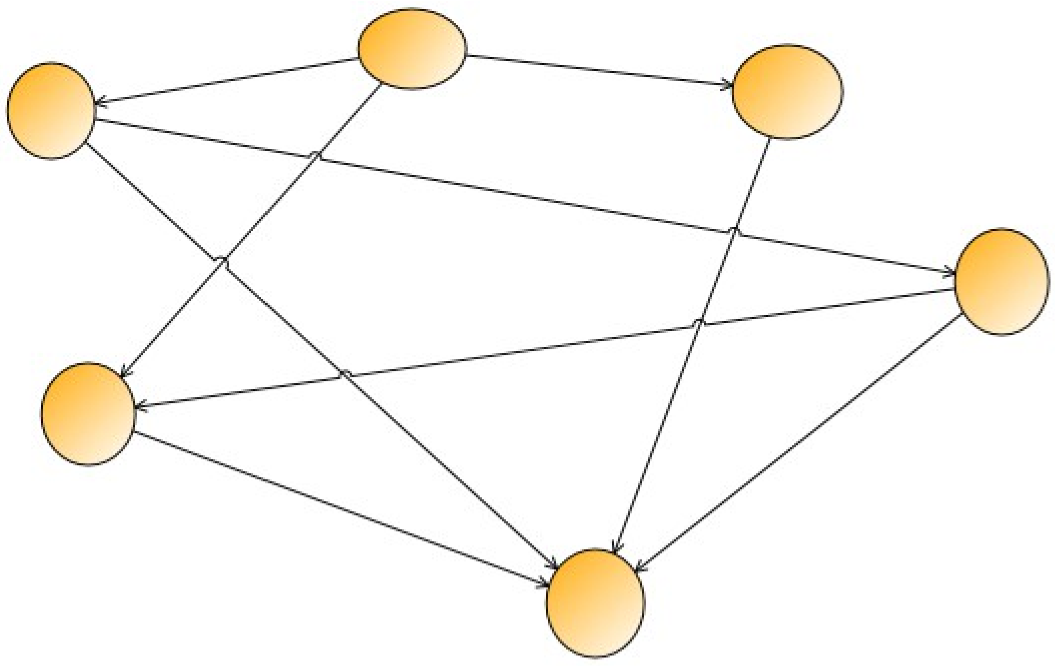
5.12Displaying link intersections

AddFlow uses a poweful algorithm to find intersections between the link segments.

If the **CanShowJumps** property of the AddFlow control is true then jumps will be displayed at the intersection of this link with other links.

However, this will not work if the link is a curved link (Bezier or Spline).

The size of jumps is determined by the value of the **JumpSize** property of the link. If this value is 0, then no jump will be displayed.



5.13Diagram navigation

AddFlow provides a set of properties and methods to navigate in a diagram ("Network traversals"). Notice that the majority of the properties and methods described here are demonstrated in the **Navig** examle of the demo.

The **Items** property of the AddFlow control allows accessing every item (nodes, links, captions) of a diagram. For instance:

```
foreach (Item item in addflow.Items)
{
  item.Stroke = Brushes.Red;
}
```

If you are interested only by nodes, you may write:

```
foreach (Item item in addflow.Items)
{
  if (item is Node)
  {
    item.Stroke = Brushes.Red;
  }
}
```

or, using LINQ to select in an array all the nodes of the canvas :

```
var nodes = addflow.Items.OfType<Node>().ToArray();
foreach (Node node in nodes)
{
    node.Stroke = Brushes.Red;
}
```

The **SelectedItems** property of the AddFlow control allows accessing every selected item (nodes, links, captions) of a diagram. For instance:

```
foreach (Item item in addflow.SelectedItems)
{
  item.Stroke = Brushes.Red;
}
```

The **Links** property of the Node object allows accessing every link that come to a node or leave it. For instance:

```
foreach (Link link in node.Links)
{
  link.Stroke = Brushes.Red;
}
```

To access only the leaving links :

```
foreach (Link link in node.Links)
{
    if (link.Org == node)
    {
        link.Stroke = Brushes.Red;
    }
}
```

(or you may use LINQ)

The **GetLinkedNode** method of the Node object returns the node connected via a given link.

```
node2 = node1.GetLinkedNode(link);
```

The **Org** property of the Link object returns/sets the reference of the origin node of the link.

The **Dst** property of the Link object returns/sets the reference of the destination node of the link.

There is also the **Captions** property of AddFlow items. For instance:

```
foreach (Caption caption in node.Captions)
{
    caption.Stroke = Brushes.Red;
}
```

5.14Selection of items

5.14.1Interactive selection

YYou can select an item interactively by clicking it with the mouse.

You can also select several items interactively by clicking them with the mouse and simultaneously pressing the shift or control key.

Or you can select items with a selection rectangle, if the **MouseSelection** property is set to MouseSelection.Selection. In this last case, you bring the mouse cursor into the AddFlow control, press the left button, move the mouse and release the left button. All nodes or links or captions partly inside the selection rectangle are selected. Then you can unselect some items by clicking them with the mouse and simultaneously pressing the shift or control key. You can select them again by using the same method.

FAQ: How to select interactively a link with the mouse?

If the link is made of one or several segments, then if you want to select it with the mouse, you have just to click near one of its segments. If the link is a Bezier or a Spline curve, then you have just to click near the curve.

5.14.2Selection handles

When an item is selected, selection handles (implemented with thumbs) are displayed, allowing resizing a node or a caption or stretching a link.

In some cases however, we do not wish displaying the selection handles. This may be useful if you wish to use your own way to show the selected items as in **Genealogy** example of the demo. For that purpose, we use the following xaml style for the thumbs:

```
<Style TargetType="Thumb" x:Key="nodeHandleStyle">
    <Setter Property="Width" Value="12"/>
    <Setter Property="Height" Value="12"/>
    <Setter Property="Visibility" Value="Collapsed"/>
</Style>
```

5.14.3Programmatic selection: ISelectable interface

Node, Caption and Link classes implement the **ISelectable** interface:

- An item (node, caption or link) can be selected either interactively, either programmatically using its **IsSelected** property, for instance:

```
node.IsSelected = true;
link.IsSelected = true;
caption.IsSelected = true;
```

- If the **IsSelectable** property of an item is false, then it is no more possible to select it.

5.14.4SelectedItems collection

The **SelectedItems** collection property of AddFlow allows getting each selected item. For instance:

```
// Make each selected nodes red
IEnumerable<Node> selnodes = this.addflow.SelectedItems.OfType<Node>();
foreach (Node node in selnodes)
{
    node.Stroke = Brushes.Red;
}
```

WARNING: there is a difference with previous versions. In this version, there is not any notion of a “current” (or “active”) item and therefore there is not any property like SelectedNode, SelectedLink or SelectedItem. When several items (nodes or links) are selected, you cannot designate one that could be the current one.

5.14.5Selection event

The **SelectionChanged** event is fired each time the selection status of an item is changed. However, you can avoid that by setting the **CanSendSelectionChangedEvent** property to false.

5.14.6Hit Testing

You can also know what object is under the mouse with the **HitItem** property that returns the reference of the item under the mouse. If several objects are under the mouse, the returned object is the one that is at the top of the Z-order list. AddFlow provide some methods allowing changing this order (**BringToFront**, **SendToBack**, ...)

If the **IsHitTestVisible** property of an item is false, then this item cannot be hit tested.

Instead of using the **HitItem** property, you may use the **GetItemAt** method.

5.15Zooming

AddFlow provides also some properties and methods that control the general aspect of a diagram:

Extent	Returns the size of the diagram.
Origin	Returns the top left location of the diagram.
Zoom	Returns/sets the zooming factor. It is a double value representing the zoom factor. Its default value is equal to 1. Notice that the zoom is isotropic ensuring a 1:1 aspect ratio.
ZoomRectangle	A method allowing zooming a rectangular portion of the diagram

TIP: How to autofit the diagram; i.e. how to adjust the zoom to its maximum while still keeping all the shapes (nodes, links etc.) in view?

You can implement this feature using the **ZoomRectangle** method:

```
Point location = this.addflow.Origin;
Size size = this.addflow.Extent;
this.addflow.ZoomRectangle(new Rect(location.X, location.Y, size.Width,
size.Height));
```

5.16Zordering

Yoy may change the z-order index of an item by using the AddFlow methods **SendToBack**, **BringToFront, SendBackward, BringForward** to send the selected items at the back of the zorder list or bring them at the front of the zorder list.

5.17Serialization

XMLFlow allows serializing an AddFlow diagram. More precisely, this assembly provides a class named **Serial** that offers methods for saving/loading an AddFlow diagram in a file or copying/pasting a portion of it onto the clipboard.

This component is free and its C# source code is provided with AddFlow.

You may also develop your own method for serializing an AddFlow diagram. In such a case, the source code of XMLFlow may be a starting point for you.

XMLFlow is used in the Demo (in the MainWindow.xaml.cs file), in the 5 following static methods:

```
static void LoadFile(AddFlow addflow, string strFileName)
{
    XElement root = XElement.Load(strFileName);
    Serial.LoadXML(addflow, XElement.Load(strFileName));
}

static void SaveFile(AddFlow addflow, string strFileName)
{
    XElement xElement = Serial.SaveXML(addflow);
    xElement.Save(strFileName);
}

static void Cut(AddFlow addflow)
{
    Serial.Cut(addflow);
}

static void Copy(AddFlow addflow)
{
    Serial.Copy(addflow);
}

static void Paste(AddFlow addflow)
{
    Serial.Paste(addflow, false);
}
```

5.18Printing a diagram

AddFlow itself does not offer any printing feature. See the **DiagramPaginator.cs** file of the demo to see how you can print a diagram.

Notice that currently, print previewing is not still implemented.

5.19Exporting a diagram in XAML

AddFlow itself does not offer any exporting feature. However, the file **ExportXaml.xaml.cs** of the demo shows how to do that.

If you click on the “Export to XAML” button, all the drawings of the AddFlow control are saved in a XAML file, then this XAML file is loaded and displayed as the content in a Label control placed at the right of the AddFlow control.

This is accomplished by the following routine:

```
void ExportToXaml()
{
    // Add all the Addflow drawings to the Children collection of
    // a DrawingGroup object
    DrawingGroup drawingGroup = new DrawingGroup();
    foreach (DrawingVisual dv in this.addflow.Visual.Children)
    {
        DrawingGroup dg = dv.Drawing.Clone();
```

```
            dg.Append();
            foreach (DrawingVisual child in dv.Children)
            {
                dg.Children.Add(child.Drawing);
            }
            drawingGroup.Children.Add(dg);
        }

        // Wrap the DrawingGroup in an image
        Image image = new Image();
        image.Stretch = Stretch.None;
        DrawingImage drawingImage = new DrawingImage();
        drawingImage.Drawing = drawingGroup;
        image.Source = drawingImage;

        // Save the image in a XAML file
        System.Xml.XmlTextWriter writer =
          new System.Xml.XmlTextWriter(@"ExportedDiagram.xaml", null);
        System.Windows.Markup.XamlWriter.Save(image, writer);
        writer.Close();

        // Load the obtained XAML file and display it in a Label control
        // at the right of the AddFlow control
        System.IO.FileStream fs =
          new System.IO.FileStream(@"ExportedDiagram.xaml", System.IO.FileMode.Open);
        Image img = System.Windows.Markup.XamlReader.Load(fs) as Image;
        this.XAMLView.Content = img;
    }
```

WARNING: It will not work if you use the PathGeometry Markup Syntax to define the node geometries or the link arrow geometries. You have to define them programmatically.

For instance, if you use the following code to create a node:

```
 node.Geometry = Geometry.Parse("M 0,20 L 30,0 L 60,20 L 30,40 Z");
```

Instead you have to use the following:

```
 node.Geometry = PredefinedGeometry.GetNodeGeometry(NodeShapeStyle.Decision);
```

And you cannot define a link arrow geometry using for instance:

```
link2.ArrowGeometryDst = Geometry.Parse("M3,4 L0,0 12,4 0,8 Z");
```

Instead you have to use the following:

```
link2.ArrowGeometryDst =
     PredefinedGeometry.GetLinkArrowGeometry(LinkArrowStyle.Arrow2, 8, 8);
```

This suppose that, as in the demo, you have added a reference to Lassalle.WPF.Geometries. But you are not forced to use this class. You may also define your geometry yourself. For instance, the code to create a losange geometry would be the following:

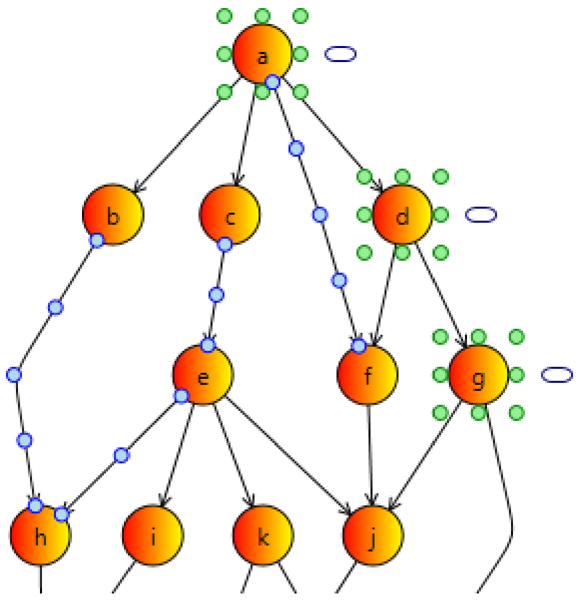
```
node.Geometry = MakeDecisionGeometry(new Rect(0, 0, 64, 64));
```

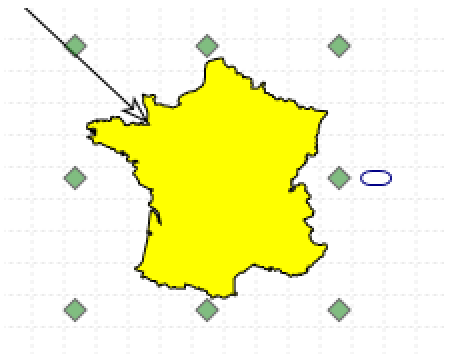
The MakeDecisionGeometry method could be the following:

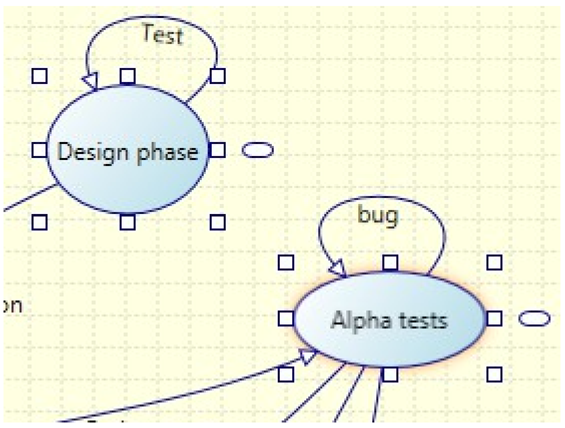
```
static Geometry MakeDecisionGeometry(Rect rc)
{
    PathGeometry pathGeometry = new PathGeometry();
    PathFigure pathFigure = new PathFigure();

    PolyLineSegment polylineSegment = new PolyLineSegment();
    polylineSegment.Points.Add(new Point(rc.Left, rc.Top + rc.Height / 2));
    polylineSegment.Points.Add(new Point(rc.Left + rc.Width / 2, rc.Top));
    polylineSegment.Points.Add(new Point(rc.Right, rc.Top + rc.Height / 2));
    polylineSegment.Points.Add(new Point(rc.Left + rc.Width / 2, rc.Bottom));
    pathFigure.StartPoint = polylineSegment.Points[0];
    pathFigure.Segments.Add(polylineSegment);
    pathFigure.IsClosed = true;

    pathGeometry.Figures.Add(pathFigure);
    return pathGeometry;
}
```

5.20Customizing the user interface

If you look at the different diagram examples of the demo, you will see that the thumbs used to resize a node, to rotate a node or to stretch a link have not the same appearance.







For changing the style of the node resizing handles, you can use the **ResizeHandleStyle** property of AddFlow. For changing the style of the rotation handle, you can use the **RotateHandleStyle** property of AddFlow. And for changing the style of the link stretching handles, you can use the **StretchHandleStyle** property of AddFlow. The type of these properties is **Style**. And you can define a style in xaml.

For instance the following style is defined in the file Flowchart.xaml:

```
<Style TargetType="Thumb" x:Key="thumbStyle">
    <Setter Property="Width" Value="8"/>
    <Setter Property="Height" Value="8"/>
    <Setter Property="Cursor" Value="Cross"/>
    <Setter Property="Template">
        <Setter.Value>
          <ControlTemplate TargetType="Thumb">
           <Ellipse x:Name="thumbArea" Stretch="Fill" Fill="Silver" Stroke="Navy"/>
           <ControlTemplate.Triggers>
                 <Trigger Property="IsEnabled" Value="True">
                     <Setter TargetName="thumbArea" Property="Fill" >
                         <Setter.Value>
                             <RadialGradientBrush Center="0.2, 0.2"
                                                  GradientOrigin="0.2, 0.2"
                                                  RadiusX="0.8" RadiusY="0.8">
                                 <GradientStop Color="White" Offset="0.0" />
                                 <GradientStop Color="LightGray" Offset="0.8" />
                             </RadialGradientBrush>
                         </Setter.Value>
                     </Setter>
                    </Trigger>
             </ControlTemplate.Triggers>
           </ControlTemplate>
        </Setter.Value>
    </Setter>
</Style>
```

And the following one is used in the file CustomDrawing.xaml:

```
<Style TargetType="Thumb" x:Key="nodeHandleStyle">
    <Setter Property="Width" Value="12"/>
    <Setter Property="Height" Value="12"/>
    <Setter Property="Cursor" Value="Cross"/>
    <Setter Property="Template">
        <Setter.Value>
            <ControlTemplate TargetType="Thumb">
                <Path x:Name="thumbArea" Fill="Silver" Stretch="Fill"
                                    Stroke="Black"
                                    Opacity="0.6"
                                    Data="M 0 6 L 6 0 L 12 6 L 6 12 Z" />
                <ControlTemplate.Triggers>
                    <Trigger Property="IsEnabled" Value="True">
                        <Setter TargetName="thumbArea" Property="Fill"
                                Value="ForestGreen" />
                    </Trigger>
            </ControlTemplate.Triggers>
        </ControlTemplate>
      </Setter.Value>
    </Setter>
</Style>
```

Then, to use these styles, you have just to assign them to the **ResizeHandleStyle**, **RotateHandleStyle** and **StretchHandleStyle** properties of the AddFlow control. For instance:

```
<af:AddFlow Name="addflow"
      GridDraw="True" GridSnap="True" GridColor="DarkGray"
      BorderThickness="6"
      ResizeHandleStyle="{StaticResource nodeHandleStyle}"
      StretchHandleStyle="{StaticResource linkHandleStyle}"/>
```

6 Avanced topics

6.1 Undo/Redo

6.1.1 General features

AddFlow has a property named **TaskManager** of type TaskManager that provides a powerful multilevel Undo/Redo feature. The history length is limited only by available memory. However, you can limit it yourself with the **UndoLimit** property of the TaskManager class. You can also enable/disable the undo/redo with the **CanUndoRedo** property of AddFlow.

6.1.2 Updating the user interface

Some properties and methods allow you to properly update the user interface. The **CanUndo** and **CanRedo** methods will tell you if there is something to undo or redo and therefore will allow you to grey out the menu options. The **RedoCode** and **UndoCode** properties return a code that describes the action waiting to be redone or undone. This will allow your application to give descriptions of the actions on the undo and redo history.

6.1.3 Grouping basic actions

Every basic action has a code. However, the **BeginAction** and **EndAction** methods allow you to define a group of actions and to assign a code to this group. This is useful if for instance, in your application, the user can open a dialog box allowing changing several properties of a node (for instance, its text, its shape and its filling color). You will certainly wish to allow the user to undo these 3 basic actions in one time.

Notice that you can also stop recording actions with the **SkipUndo** method and also clear the Undo/Redo buffer with the **Clear** method.

Another interesting method is the **AddToLastAction** method. For instance, it allows grouping some actions with the last recorded action or group of actions.

Notice that you have to call the **EndAction** to terminate the group of actions.

6.1.4 What can be undone and redone?

The rule is the following: every interactive action that changes a diagram can be undone or redone. This includes actions like moving or resizing nodes or stretching links or changing a text.

However, making a selection does not change the document so you will not be able to undo a selection. Changing properties of the AddFlow control (zoom, grid, default filling color, etc) does not change the document too. Therefore, it will not be possible to undo these actions. And finally, file, print and export operations are clearly not undoable.

WARNING: there is a difference with some previous versions (ActiveX version for instance). In the WPF version, only the interactive actions can be undone and redone. In the previous versions, all actions changing a node or a link could be undone or redone. For instance, you could undo a change of the XMoveable property of a node. In the WPF version, you will have to write a custom task to be able to undo a change of the IsXMoveable property. This is explained in the following paragraph.

6.1.5 Undo/Redo customization

The undo/redo can be customized. For that, you have to create a custom Task class by deriving the Task class and then you can insert it in the undo list with the **SubmitTask** method. The file **CustomUndo** example of the demo shows how to do that: if you double-click on a node, a dialog box allows you changing the text and the tooltip of that node. And then, you can undo this action.

For doing that, we have created a class deriving from the Task class. This new class implements the task consisting in changing both the node text and node tooltip.

```
internal class NodePropertiesTask : Task
{
    private string oldText;
    private string oldTooltip;
    private Node node;

    private NodePropertiesTask() { }

    internal NodePropertiesTask(Node node, string oldText, string oldTooltip)
    {
        this.Code = (Lassalle.WPF.Flow.Action)1002;
        this.node = node;
        this.oldText = oldText;
        this.oldTooltip = oldTooltip;
    }

    public override void Redo()
    {
        this.Undo();
    }

    public override void Undo()
    {
        string oldText = this.node.Text;
        this.node.Text = this.oldText;
        this.oldText = oldText;

        string oldTooltip = this.node.Tooltip as string;
        this.node.Tooltip = this.oldTooltip;
        this.oldTooltip = oldTooltip;
    }
}
```

The code of the mouse double click event handler is the following:

```
private void addflow_MouseLeftButtonDown(object sender,
                                     System.Windows.Input.MouseButtonEventArgs e)
{
    if (e.ClickCount == 2)
    {
        if (this.addflow.SelectedItems != null &&
            this.addflow.SelectedItems.Count > 0)
        {
            if (this.addflow.SelectedItems[0] is Node)
            {
                Node node = this.addflow.SelectedItems[0] as Node;
                NodePropDlg nodePropDlg = new NodePropDlg(node);
                Point pt = this.addflow.PointToScreen(node.Location);
                nodePropDlg.Left = pt.X;
                nodePropDlg.Top = pt.Y;
                if (nodePropDlg.ShowDialog() == true)
                {
                    this.addflow.TaskManager.SubmitTask(
                              new NodePropertiesTask(node,
                                         node.Text, node.Tooltip as string));
                    node.Text = nodePropDlg.NodeText;
                    node.Tooltip = nodePropDlg.NodeToolTip;
                }
            }
        }
    }
}
```

As you can see, after having closed the dialog box and if it returns true (in such a case, the action is accepted) and before the node receives new values for its Text and Tooltip properties, you can find the following code line:

```
this.addflow.TaskManager.SubmitTask(new NodePropertiesTask(node,
                              node.Text, node.Tooltip as string));
```

This causes the new custom action to be registered in the list of tasks (undo/redo buffer).

6.1.6 Undo/Redo API

The following table gives the list of all properties and methods available to manage the undo/redo feature.

AddToLastAction	Add the following actions in the last group of actions
BeginAction	Start a group of actions that can be undone in one time.
CanRedo	Indicates if there is an action that can be redone.
CanUndo	Indicates if there is an action that can be undone.
CanUndoRedo	Determines whether undo/redo is allowed.
Clear	Clears the undo/redo buffer.
EndAction	Terminate a group of actions that can be undone in one time.
Redo	Redo, if possible, the last action.
RedoCode	Returns the code of the next redoable action.
RedoItem	Returns the item involved in the next redoable action
SkipUndo	Determines whether the following actions are recorded in the undo manager.
SubmitTask	Submit a task (or action) that can be undone and redone.
RemoveLastTask	Remove the last task that has been added in the undo list.
Undo	Undo, if possible, the last action.
UndoCode	Returns the code of the next undoable action.
UndoItem	Returns the item involved in the next undoable action.
UndoLimit	Sets and returns the number of undo commands that can be performed.

6.2 Performance tuning

6.2.1 BeginUpdate and EndUpdate methods

To maintain performance while items are added to the AddFlow control, you should call the **BeginUpdate** method. The BeginUpdate method prevents the control from painting until the **EndUpdate** method is called.

Also, between the calls to BeginUpdate and EndUpdate, the size of the diagram is not updated. It is updated only when the EndUpdate method is called. If you need the size of the diagram before the call to EndUpdate, you can use the **GetDiagramBounds** method.

The two methods BeginUpdate and EndUpdate are often used in the demo.

6.2.2 IsVirtualizing property

The **IsVirtualizing** property determines whether virtualizing mode is allowed or not. This mode allows working quickly with very big diagrams. This is a UI virtualization where only the visible items are displayed. It is demonstrated in the **Stress** example of the demo. It is a very efficient way to work with big diagrams. In fact you can use it with all diagrams.

If this property is true, it is not possible to use custom visuals. However there is a workaround (see the paragraph about custom visuals).

6.2.3 Other tips for better performances

- Disable the Undo/Redo! If you are creating programmatically a big diagram (as in the **Stress** example of the demo), it may also be interesting to disable the undo/redo with the **CanUndoRedo** property.

- Do not create link jumps! You should use jumps only for small diagrams (less than 200 nodes) because the algorithm used to find intersections requires considerable computational resources. By default however, link jumps are not created (See the **JumpSize** property of links).

6.3 Data Customization

6.3.1 Framework's Tag property

Nodes, captions and links do not offer a Tag property but it is not a problem because you can use the Framework's Tag dependency property and you can attach it to a node or a link. This is demonstrated in the **CauseEffect** example of the demo. For instance, to associate the string "Financial" to a node:

```
node.SetValue(FrameworkElement.TagProperty, "Financial");
```

And to retrieve that string:

```
string s = node.ReadLocalValue(FrameworkElement.TagProperty) as string;
```

6.3.2 Attached properties

Attached properties is an extensibilty mechanism that can be used for storing any data with each node or each link.

This feature is used in the AlgoFlow.cs file of the demo..

For instance, when you write a depth first search algorithm to visit all the nodes of a graph, you need a boolean variable to mark a node as "visited". You can use an attached property for that. You can declare it as follows:

```
static readonly DependencyProperty IsVisitedProperty =
     DependencyProperty.RegisterAttached("IsVisited", typeof(bool),
             typeof(Connect), new FrameworkPropertyMetadata(false));

public static bool GetIsVisited(DependencyObject item)
{
    if (item == null)
        return false;
    return (bool)item.GetValue(IsVisitedProperty);
}

public static void SetIsVisited(DependencyObject item, bool value)
{
    if (item != null)
        item.SetValue(IsVisitedProperty, value);
}
```

Then you can use it to mark a node as visited:

```
Connect.SetIsVisited(node, true);
```

6.3.3 Derivation of Node and Link classes

Using inheritance, you can create a new class by adding to or otherwise modifying an existing class. You can do that with the Node, Caption and Link classes and add custom data to each class.

7 Automatic Graph Layout

WARNING: this feature is available without any restriction (nag screen) only if you have purchased a Professional license of AddFlow for WPF.

The primary purpose of an automatic graph layout feature is to offer a way to display graphs or flow charts in a reasonable manner, following some aesthetic rules.

AddFlow does not provide directly any automatic graph layout feature. However, we propose **LayoutFlow which provides** a set of 5 graph layout algorithms:

- Hierarchic layout
- Orthogonal layout
- Symmetric layout
- Series Parallel layout
- Tree layout

Each of these graph layout algorithms performs a layout on a graph. Performing a layout automatically positions its nodes (also called vertices) and links (also called edges).

Typically, you can first create your nodes and links inside AddFlow, using the AddFlow API, giving each node a random or a (0,0) position. Then you call the layout method of the graph layout control of your choice. This method will position the nodes and the links in a **reasonable** manner in the AddFlow control, following some aesthetic rules that depend on the chosen control (hierarchical, symmetric, orthogonal...).

Remarks

- Currently, LayoutFlow is an AddFlow extension and you cannot use it without AddFlow. If you just want to perform a layout on a graph without displaying them in an AddFlow control (for instance because you have already a way to display the diagram), then you can use both a hidden AddFlow control and LayoutFlow to do that. In such a case, AddFlow is just used to store the logical structure of the graph and to retrieve via its API, the resulting positions of its nodes and links.
- The demo shows how to use each graph layout component.
- Reflexive links are not taken into account by layout algorithms. Reflexive links are just translated to follow their origin (and also destination) node.

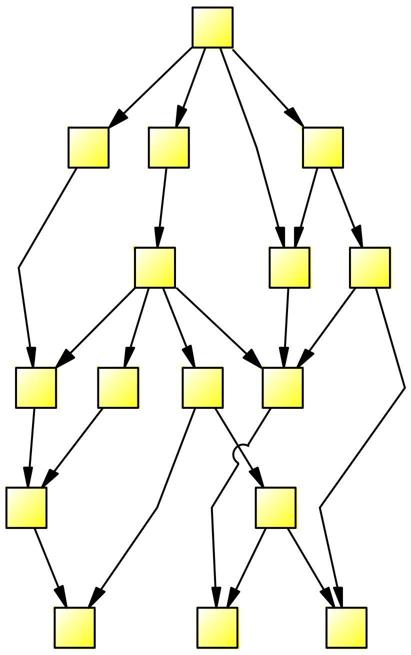
TIP: How to manage so that the layout algorithm applies only to a subset of the graph?

LayoutFlow provides an attached property: **IsLogical**. Only the nodes and links whose IsLogical property is true are involved in each layout. This will allow you to make the layout algorithm to ignore some nodes or links. By default, the IsLogical property is true.

7.1 Hierarchic layout

7.1.1 Purpose

This algorithm performs a hierarchical layout on a graph. The hierarchical layout arranges vertices in horizontal layers. The order of the nodes on the layers is chosen so that the number of crossings is kept as small as possible.



- Hierarchic layout -

7.1.2 Code example

The following code is all you need to do to perform a hierarchical layout:

```
LayoutFlow.TreeLayout(this.addflow,
             50, // Sets the distance between adjacent levels
             50, // Sets the distance between adjacent nodes
             Orientation.North,
             new Size(20, 20), // Margin
             0); // No limitation in the number of nodes in a level
```

This code supposes that you have a form containing an AddFlow control. You create the graph in the AddFlow control, either interactively, either programmatically (in this case, giving each node a random position or a (0,0) position). Then you apply the layout to this graph. And each bode will be placed at a reasonable position.

7.1.3 Limitation

It works with any graph, connected or not.

7.1.4 Side Effect

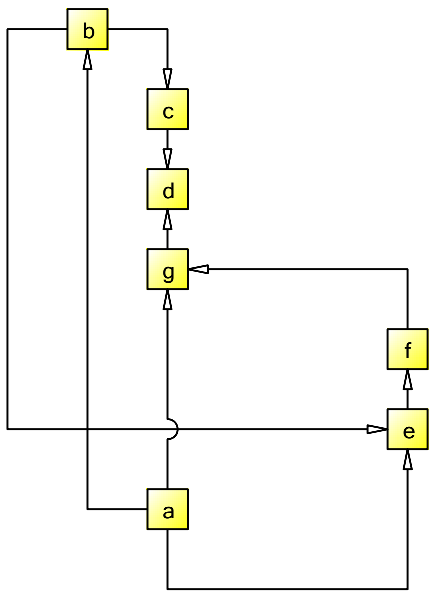
After the layout execution:

- the line style of the links is Polyline
- the InConnectionMode property of the destination node of a link is set to Center.
- the OutConnectionMode property of the origin node of a link is set to Center.

7.2 Orthogonal layout

7.2.1 Purpose

This algorithm performs an orthogonal layout on a graph. The layout is orthogonal since it produces an orthogonal drawing where each link is drawn as a polygonal chain of alternating horizontal and vertical segments. The algorithm used is the Biedl and Kant algorithm.



- Orthogonal layout -

7.2.2 Code example

The following code is all you need to do to perform an orthogonal layout:

```
LayoutFlow.OrthogonalGridLayout(this.addflow,
      Orientation.North,
      new Size(40, 40), // The horizontal and vertical grid size
      nodeSizeRatio, // The node size (in percentage of the grid size)
      new Size(20, 20)); // Margin
```

7.2.3 Limitation

It works with any graph, connected or not.

Note however that this algorithm is making generous use of space and the resulting layout is good only with small graphs.

7.2.4 Side Effect

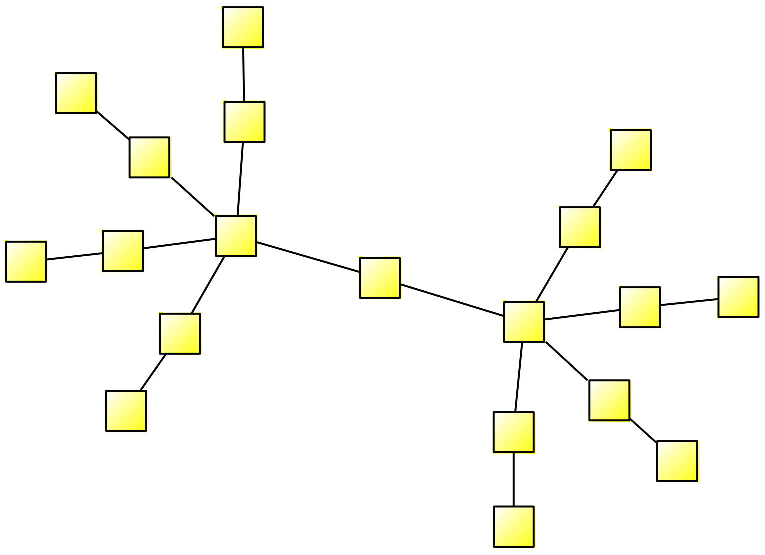
After the layout execution:

- the size of the nodes is changed. If the graph is a graph of maximum degree four, then each node has the same size (determined by the **GridSize** property). If the degree of a node is higher than four, then the height of the node is expanded.
- the line style of the links is Polyline.
- the InConnectionMode property of the destination node of a link is set to Anywhere.
- the OutConnectionMode property of the origin node of a link is set to Anywhere.

7.3 Symmetric layout

7.3.1 Purpose

This algorithm performs a symmetric layout on a graph. This layout produces a high degree of symmetry and is particularly useful for undirected graphs, where the directions of the links are not important. It is using a force-directed algorithm (the GEM method of Frick, Ludwig and Mehldau) where a graph is viewed as a system of bodies with forces acting between the bodies.



- Symmetric layout -

7.3.2 Code example

The following code is all you need to do to perform a symmetric layout on a graph:

```
LayoutFlow.SymmetricLayout(this.addflow,
                      50,                // Sets the distance between nodes
                      new Size(20, 20)); // Margin
```

7.3.3 Limitation

It works with any graph, connected or not. However, it is recommended to work only with small graphs (less than 200 nodes) because it is using a force-directed method and force-directed methods are using considerable computational resources.

7.3.4 Side Effect

After the layout execution:

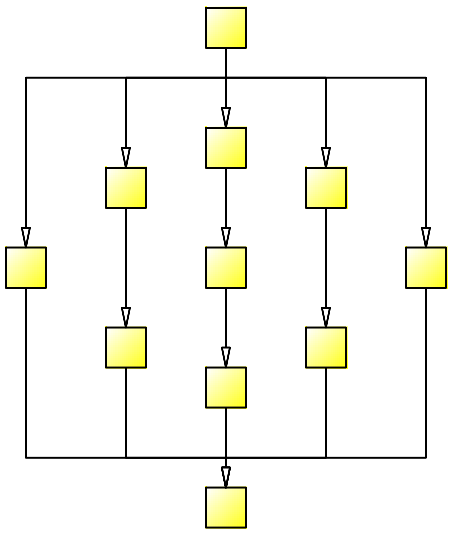
- the line style of the links is Polyline and each link is composed of only one segment.
- the InConnectionMode property of the destination node of a link is set to Center.
- the OutConnectionMode property of the origin node of a link is set to Center.

7.4 Series-parallel layout

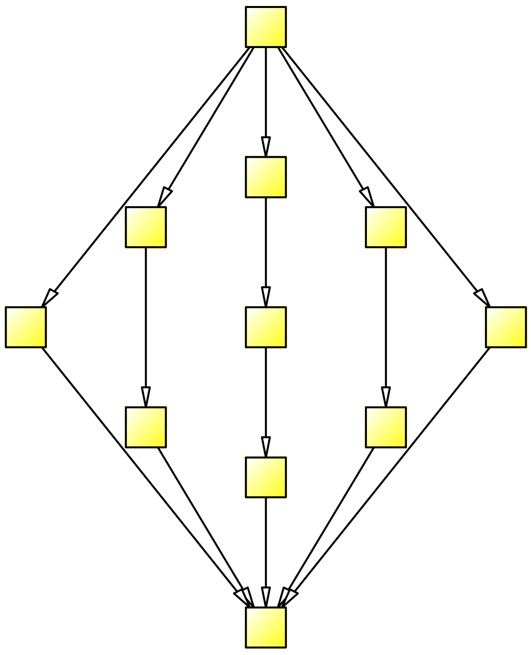
7.4.1 Purpose

This algorithm performs a series-parallel layout on a graph. The SP layout applies only to a specific subset of graphs: series-parallel digraph (more precisely, a set of series-parallel diagraphs). A series-parallel digraph is defined recursively as follows.
A digraph consisting of two nodes, a source s and a sink t joined by a single link is a series-parallel digraph.
If G1 and G2 are series-parallel digraphs, so are the digraphs constructed by each of the following operations:
- the parallel composition: identify the source of G1 with the source of G2 and the sink of G1 with the sink of G2.
- the series composition: identify the sink of G1 with the source of G2.

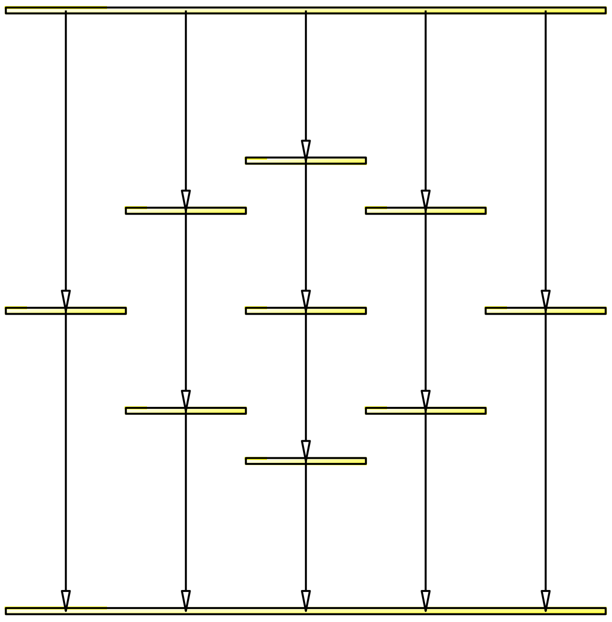
We use an algorithm (described in the book "Drawing Graphs" Michael Kaufmann - Dorothea Wagner) that allows drawing series-parallel digraphs with as much symmetry as possible.



- SP layout: DrawingStyle = BusOrthogonalDrawing



- SP layout: DrawingStyle = StraightLine -



- SP layout: DrawingStyle = VisibilityDrawing -

7.4.2 Code example

The following code is all you need to do to perform a series-parallel layout on a graph:

```
LayoutFlow.SeriesParallelLayout(this.addflow,
       DrawingStyle.BusOrthogonalDrawing,
       Orientation.North,
         80,                 // Sets the distance between adjacent levels
         80,                 // Sets the distance between adjacent nodes
         new Size(30, 30),   // The vertex size
         new Size(20, 20)); // Margins
```

If the graph is not a set of series-parallel digraph, an exception is generated.

7.4.3 Limitation

The layout applies only to a specific subset of graphs: series-parallel digraphs. One of the requirements is that this diagram has only one starting node and only one ending node. However, it is not actually a limitation. If, for instance, the number of ending nodes is greater than one, then a workaround is to create a dummy node and create a link from each ending node to this dummy node, then execute the layout and then delete the dummy node (which causes all the dummy links to be deleted too).

7.4.4 Side Effect

After the layout execution:

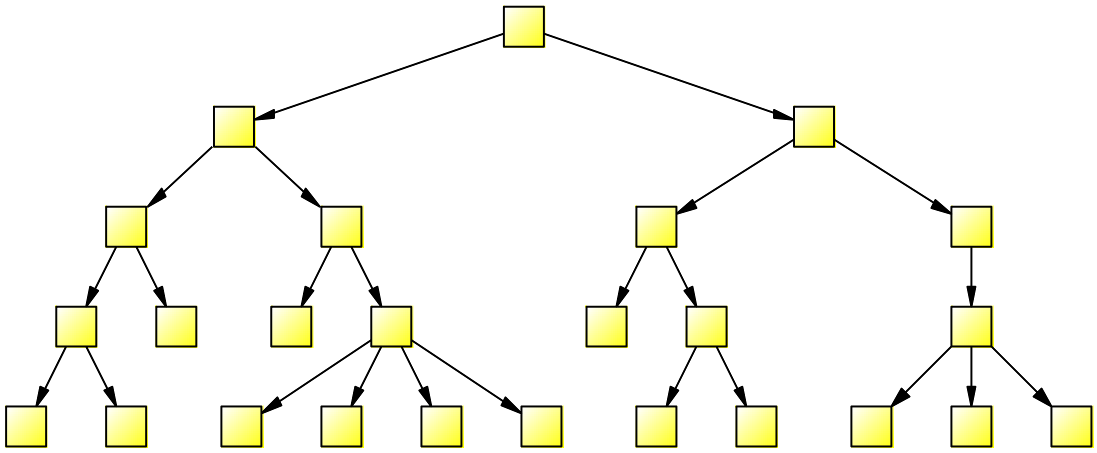
- the line style of the links is Polyline. Moreover, if the DrawingStyle property is not BusOrthogonalDrawing, then each link is composed of only one segment.
- the InConnectionMode property of the destination node of a link is set to Center.
- the OutConnectionMode property of the origin node of a link is set to Center.

7.5 Tree layout

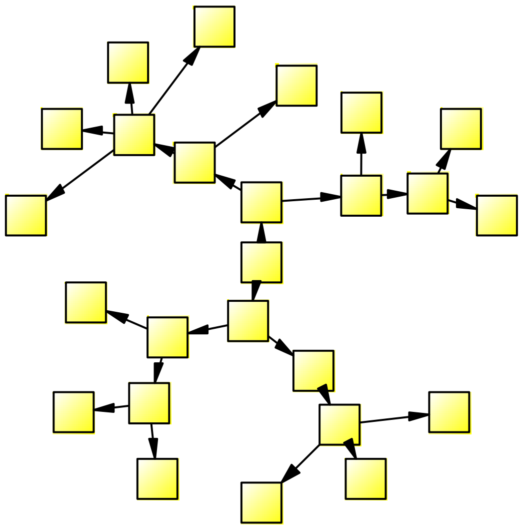
7.5.1 Purpose

This algorithm performs a tree layout on a graph. This layout applies only to a specific subset of graphs: rooted trees. In such a graph, no node may have more than one parent. It offers two drawing styles (**DrawingStyle** property).

- If the DrawingStyle is **Layered**, then the drawing of the tree occupies as little space as possible while satisfying certain aesthetics: nodes at the same level of the tree are placed on the same line and a parent is centred over its children.
- If the DrawingStyle is **Radial**, then the root of the tree is placed at the origin and the layers are concentric circles centred at the origin.



- Tree layout: DrawingStyle = Layered -



- Tree layout: DrawingStyle = Radial -

7.5.2 Code example

The following code is all you need to do to perform a tree layout on a graph:

```
LayoutFlow.TreeLayout(this.addflow,
                                50, // Layer distance
                                50, // Vertex distance
                                DrawingStyle.Layered,
                                Orientation.North,
                                new Size(20, 20)); // Margin
```

If the graph is not a forest of rooted trees, an exception is generated.

7.5.3 Limitation

The layout applies only to a specific subset of graphs: rooted trees. More precisely, the layout applies to forests (sets of rooted trees).

7.5.4 Side Effect

After the layout execution:

- the line style of the links is Polyline
- the InConnectionMode property of the destination node of a link is set to Center.
- the OutConnectionMode property of the origin node of a link is set to Center.