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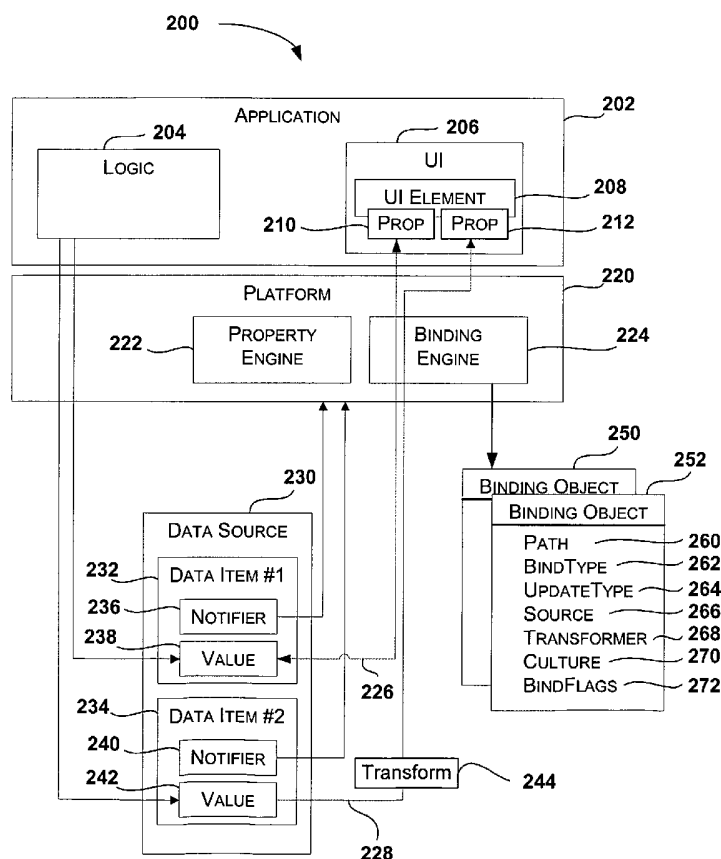
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- (71) Applicant: MICROSOFT CORPORATION [US/US]; One Microsoft Way, Redmond, WA 98052 (US).
- (72) Inventors: BENT, Samuel, W.; 2015 137th Place SE, Bellevue, WA 98005 (US). GUPTA, Namita; 12228 NE 112th Place #A4, Kirkland, WA 98033 (US). JENNI, David, J.; 4504 194th Way NE, Sammamish, WA 98074 (US). HOPMANN, Alexander, I.; 1635 35th Avenue, Seattle, WA 98122 (US).
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- (74) Agent: DAIGNAULT, Ronald, A.; Merchant & Gould P.C., P.O. Box 2903, Minneapolis, MN 55402-0903 (US).

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(54) Title: SYSTEM AND METHOD FOR CONTROLLING USER INTERFACE PROPERTIES WITH DATA



(57) Abstract: Described is a system and method for controlling user interface (UI) properties with data. A computing device (100) having an application (202) is separated into independent parts, a logic portion and a UI portion. The logic portion manipulates data values within the application. The UI portion is responsible for displaying UI properties. A binding specification describes a relationship between the UI property and data value. The binding specification is used by system level code to determine the manner in which it is notified when the data value undergoes a change and the manner in which it directs the UI portion to reflect the change in the UI property. The binding specification identifies a source data item, a path to the data value in the source data item, a target UI element, and the UI property on the target UI element. The binding may be specified using code or markup language.



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SYSTEM AND METHOD FOR CONTROLLING USER INTERFACE**PROPERTIES WITH DATA**

This application is being filed as a PCT application filed May 17, 2003 by MICROSOFT CORPORATION., a United States national and resident, designating
5 all countries except US.

Background of the Invention

The manner in which information is presented to users affects the user's ability to understand and comprehend the information. On computer displays, it has become a standard practice to add emphasis to information by using color, font
10 styles, and the like. This emphasis allows users to more readily grasp the importance of the information. The code handling the presentation of the information (user interface) and the code performing the application logic on the information are typically closely coupled. For example, the logic assigns user interface properties (e.g., color, font, position, size) directly with data. Thus, when
15 there is a change to the user interface, the logic must also change. For example, in the case of a text box, the user interface code listens to determine whether text has changed, upon a change, the user interface code validates the changed text and then displays the changed text. This tightly coupled nature of the user-interface and the logic results in very fragile code. Maintaining this fragile code is very costly and
20 time consuming.

Summary of the Invention

The present invention is directed at a system and method for controlling the user interface with data. The invention decouples the user interface and the data, along with its application logic, by providing a mechanism for
25 associating data to the user interface. The invention enables user interface designers and application authors who write the application logic to work independently. Neither the designers nor the authors need to understand the other's code or will impact the other's code development. This invention also allows changes to the user interface to be done quite easily. For example, when new and more user-appealing
30 user interface platforms become available or when the user interface designer wishes to change the look of the application, the designer does not need to change the application logic. In addition, the mechanism for associating data to the user

interface is dynamic. This allows any changes in the data to be automatically reflected in the presentation. In addition, any input from a user via the user interface can be automatically update the data. Because the present invention allows association of not only data display aspects of the user interface (e.g., text), but also
5 visual aspects (e.g., background, font size, and the like), descriptive, visually enhancing and flexible presentation of data can be provided. For example, negative numbers may be displayed in red or an arrow may appear pointing upwards when stock prices are increasing.

Thus, in accordance with the present invention, an application is
10 separated into independent parts, a logic portion and a UI portion. The logic portion manipulates data values within the application. The UI portion is responsible for the presentation of the data. A binding specification describes a relationship between the UI property and the data value. The binding specification is used by system level code to determine the manner in which it is notified when the data value undergoes a
15 change and the manner in which it directs the UI portion to reflect the change in the UI property. The binding specification identifies a source data item, a path to the data value in the source data item, a target UI element, and the UI property on the target UI element. The binding may be specified using code or markup language.

Brief Description of the Drawings

20 FIGURE 1 illustrates an exemplary computing device that may be used in illustrative implementations of the present invention.

FIGURE 2 is a functional block diagram illustrating one embodiment for controlling user interface properties with data in accordance with the present invention.

25 FIGURE 3 is a logical flow diagram illustrating a process for binding a user interface property with a data value in accordance with one embodiment of the present invention.

FIGURE 4 illustrates several exemplary syntaxes for associating the user interface properties with the data in accordance with the present invention.

Detailed Description of the Preferred Embodiment

30 The present invention is directed at a system and method for controlling the user interface with data. The invention decouples the user interface

and the application logic by providing a mechanism for associating the data with the user interface. As will be described in detail below, this decoupling of the user interface and the data, along with its associated logic, allows different groups of developers to work independently on both the user interface and the logic without
5 impacting the code development of the other group. In addition, described in detail below, the present invention provides a system and mechanism for automatically transferring values from data sources to the user interface and vice versa.

Throughout the following discussion, the term "databinding" refers to the process of associating data values with UI properties, transferring and updating the data values,
10 and the like.

Illustrative Computing Environment

FIGURE 1 illustrates an exemplary computing device that may be used in illustrative implementations of the present invention. With reference to FIGURE 1, in a very basic configuration, computing device **100** typically includes at
15 least one processing unit **102** and system memory **104**. Depending on the exact configuration and type of computing device **100**, system memory **104** may be volatile (such as RAM), non-volatile (such as ROM, flash memory, etc.) or some combination of the two. System memory **104** typically includes an operating system **105**, one or more program modules **106**, and may include program data **107**.
20 Examples of program modules **106** include a browser application, a finance management application, a word processor, and the like. This basic configuration is illustrated in FIGURE 1 by those components within dashed line **108**

Computing device **100** may have additional features or functionality. For example, computing device **100** may also include additional data storage devices
25 (removable and/or non-removable) such as, for example, magnetic disks, optical disks, or tape. Such additional storage is illustrated in FIGURE 1 by removable storage **109** and non-removable storage **110**. Computer storage media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable
30 instructions, data structures, program modules, or other data. System memory **104**, removable storage **109** and non-removable storage **110** are all examples of computer storage media. Computer storage media includes, but is not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile

disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to store the desired information and which can be accessed by computing device 100. Any such computer storage media may be part of device 100.

- 5 Computing device 100 may also have input device(s) 112 such as keyboard, mouse, pen, voice input device, touch input device, etc. Output device(s) 114 such as a display, speakers, printer, etc. may also be included. These devices are well know in the art and need not be discussed at length here.

Computing device 100 may also contain communication connections
10 116 that allow the device 100 to communicate with other computing devices 118, such as over a network. Communication connections 116 are one example of communication media. Communication media may typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and
15 includes any information delivery media. The term “modulated data signal” means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, RF, infrared and other wireless
20 media. The term computer readable media as used herein includes both storage media and communication media.

Illustrative Implementation

FIGURE 2 is a functional block diagram illustrating one embodiment of a system 200 for controlling user interface properties with data in accordance with
25 the present invention. The system 200 includes an application 202, a platform 220, and a data source 230. Application 202 may be one of applications 106 on computing device 100 shown in FIGURE 1. The application 202 includes code (hereinafter referred to as logic 204) for manipulating a data value (e.g., source data value 238). In general, the logic 204 performs validation on data values and updates
30 the data values. Data value (e.g., data value 238) represents the content of a property (i.e., a data source property) of a data item (e.g., data item 232). The data item 232 is located within a data source (e.g., data source 230). Each data source 230 may include several data items, each data item has one or more properties, in

which the source data value is stored. Logic **203** may manipulate data values from multiple data sources. The data sources may include an XML document, an object, a dataset, and the like. As will be described in greater detail below, each property of the data item may be used to control the user interface (UI).

5 The application **202** also includes code (hereinafter referred to as user interface **206**) for presenting information. The user interface **206** includes several user interface elements (e.g., user interface element **208**). Each user interface element **208** includes one or more properties (e.g., UI properties **210** and **212**), such as for displayed text, color, font, position, size, and the like. Then, as described in
10 detail later, these UI properties **210** and **212** are associated with one or more of the data values **238** and **242** in accordance with the present invention. In general, the association occurs via a binding engine **224** within the platform **220**. The platform **220** represents a system layer of services, such as an operating system, a virtual engine, and the like. The platform **220** also includes a property engine **222** that is
15 responsible for maintaining hierarchical information pertaining to the data values **234** and **242** and for updating the associated properties with data values. Even though binding engine **224** and property engine **222** are shown as separate components, one skilled in the art will appreciate that the functionality provided by each may be included within one component without departing from the present
20 invention.

 The association (i.e., bindings) of the data values **238** and **242** to their UI properties **210** and **212** is represented in FIGURE 2 by dashed lines from the data value to the UI property (hereinafter referred to as bindings **226** and **228**). During the following discussion, the term "data value" may be used interchangeably with
25 the term "source data value". Similarly, the term UI property may be used interchangeably with the term "target property". These bindings **226** and **228** allow dynamic properties (i.e., target properties) to be automatically set from data values (i.e., source data values), such as from properties of arbitrary objects. These bindings may be dynamic so that the bound target property automatically updates to
30 reflect changes in the source data value.

 In order to provide this automatic updating capability, the present invention further provides a notification mechanism (e.g., represented in FIGURE 2 by notifiers **236** and **240** and arrows from the notifiers to platform **220**). Each data

item **232** and **234** has a corresponding notifier **236** and **240**, respectively. The notification mechanism is responsible for informing the system that the source data value has changed and that the data value can be propagated to the target property (i.e., UI property).

5 When a binding **226** and **228** is created, such as through markup, code, and the like, the binding engine **224** creates a binding object (e.g., binding objects **250** and **252**) associated with the binding. For example, binding object **252** may represent binding **228** within the binding engine **224**. Each binding object includes several properties (e.g., binding properties **260-272**). Each of these binding
10 properties **260-272** may be set programmatically. The following discussion describes each of these properties and FIGURE 4 illustrates exemplary code for activating a binding that specifies some of these properties.

 One of the binding properties (hereinafter referred to as path **260**) identifies the manner in which to locate the source data value (via the source object).
15 The path **260** may refer to a property, sub-property or indexer on the source object, a column in ADO (ActiveX Data Objects), an XPath on XML, and the like. Alternatively, the path may refer to a reflection or ADO path.

 Another one of the binding properties (hereinafter referred to as bindtype **262** defines a type for the binding **226** and **228**. In one embodiment, the
20 bindtype includes oneWay, twoWay, and oneTime. As an illustration, binding **226** represents a twoWay binding and binding **228** represent a oneWay binding. One of these binding types is set as a default. In one embodiment, twoWay binding is set as the default binding type.

 When the bindtype **262** is specified as oneWay, this signals the
25 binding engine **224** to update the target property (e.g., UI property **210**) every time a change occurs in the associated source data value. OneWay bindtype is useful for binding a data value to a non-editable UI property, such as text color, text background, and the like. Using oneWay bindtype avoids the overhead of a twoWay bindtype, described below. This decrease in overhead is most noticeable when
30 listening to changes in UI properties regarding layout content. For these UI properties, the dynamic properties of each of the children of the UI property must be listened to for changes to the UI property. OneWay bindtype may also be useful when changes in the UI property are just for showing other presentation detail.

When the bindtype **262** is specified as twoWay, this signals the binding engine **224** to update the target property every time a change occurs in the source data value and vice versa. TwoWay binding is especially helpful when binding data to an edit box where any changes made by the user in the edit box need
5 to be propagated to the source data value. Another scenario for twoWay binding is when another application is responsible for the source data field and those changes are reflected in an edit box.

When the bindtype **262** is specified as oneTime, this signals the binding engine **224** to initialize the target property once and then leave it untouched,
10 even if the associated source data value is changed. The oneTime bindtype is useful when some target property needs to be initialized with some value from a source field and the data context is not known in advance. In addition, oneTime bindtype is useful for read-only use of unchanging source data values. If the data source does not support the property notification mechanism of the present invention (e.g.,
15 IPropertyChange interface), the target property that is specified as oneWay will be updated similarly as if the binding specified oneTime as the bindtype.

Another one of the binding properties (hereinafter referred to as updatetype **264**) defines a type of update for the case in which bindtype **262** specifies twoWay. Typically, twoWay bindings listen for changes in the target
20 property and propagate those changes back to the source data value. This process is referred to as updating the source. Normally, it is desirable to update whenever the target property changes. However, in certain situations, updating after every keystroke wastes cycles and denies the user the opportunity for correcting typing errors and the like. Updatetype **264** allows the user to specify when the updates
25 should occur. In one embodiment, updatetype **264** may specify Immediate, OnLostFocus, and Explicit. Specifying Immediate will signal the binding engine to update the source data value after every change to the target property. Specifying OnLostFocus will signal the binding engine to update the source data value after the target element has lost keyboard focus. Specifying Explicit will signal the binding
30 engine to update the source data value only when the application explicitly requests an update. Typically, this explicit request is performed via a method. Even though this method may be called for any setting of updatetype **264**, the method is useful when the updatetype is set to Explicit. One exemplary method is shown below:

Binding.GetBinding(myElement, myProperty).Update();.

Another one of the binding properties (hereinafter referred to as
5 source **266**) identifies the source data item for the binding. Briefly, illustrated in
FIGURE 4 and described in conjunction therewith, the source **266** may be set
programmatically or with markup. Programmatically, the developer provides an
objectref to the object that the binding should use as the source data item. Briefly,
described in detail in conjunction with FIGURE 4, in markup, there are various
10 methods for setting the source property.

Another one of the binding properties (hereinafter referred to as
transformer **268**) accepts a class reference. The class reference may be specified
using <Namespace>. <Class>, <Assembly>. The class reference that is specified is
invoked by the binding engine **224** to transform the source data value into a format
15 accepted by the target property. A method within the class reference invokes this
transformation, represented as transform **244** in FIGURE 2. The class reference
may also specify an inverse transform (not shown) for transforming the target
property to a format accepted by the source data value. The transform **244** may
supply UI semantics or be a custom type converter.

20 Another one of the binding properties (hereinafter referred to as
culture **270**) defines the manner in which the source data value should be handled
before/after transforming the source data value. Culture **270** operates in conjunction
with transformer **268** to allow developers to specify rules for transforming source
data values. For example, the culture may specify a specific format for numbers,
25 dates, and the like. In one embodiment, the culture **270** accepts a value of a type
CultureInfo. The developer has the option of using the rules specified by the culture
270 when implementing the transform.

Another one of the binding properties (hereinafter referred to as
bindflags **272**) provides a mechanism for receiving events signaling the transfer of
30 data. Because the above described method for data binding is asynchronous, the
bindflags **272** allow a developer to know when the target has been updated with the
new value. In order to use this mechanism, the bindflags **272** is set to
"NotifyOnTransfer". A handler is then registered for the event using any customary
ways. One exemplary use for this mechanism is as follows:

```

Public static void main()
{
    //Add a handler
5    elem.AddAttachedHandler(Binding.DataTransferEvent,
                           new DataTransferEventHandler(OnDataTransfer),
                           RoutedEventArgs.EventStage.Direct);

    //Event handler
10    private static void OnDataTransfer(Element e, DataTransferEventArgs args)
    {
        DynamicProperty DP=args.DP;
        v=e.GetValue(DP);
        DoSomething(v);
15    }
    source.field="new value";
}.

```

As shown in the above example code, once the OnDataTransfer event has been triggered, the developer knows that the dynamic property has been updated. Thus, the developer may then use the target value for further processing.

FIGURE 3 is a logical flow diagram illustrating a binding mechanism in accordance with one embodiment of the present invention. In overview, the binding mechanism performs actions to set-up the binding (blocks 302-306) and then performs actions (blocks 310-338) related to changes in the target property or source data value as specified in the binding. Processing continues at block 302.

At block 302, a binding object is created based on the arguments specified during the creation. Briefly, each property (i.e., properties 260-272 shown in FIGURE 2) for the binding object 252 may be specified as an argument during the creation. The binding may be created through markup, programmatically, and the like. FIGURE 4 illustrates exemplary syntaxes for creating a binding and specifying the properties 260-272. Each manner of creation specifies a source data item, a path to the data value in the source data item, a target UI element, and a target dynamic property on the UI element. While not shown in the present flow

diagram, the properties of the binding object may also be modified dynamically during runtime, such as through the use of application programming interfaces (APIs). Processing proceeds to block 306.

At block 304, the binding is activated. In one embodiment, the
5 binding may be activated automatically once the binding engine notices that there is sufficient context for the binding, such as having the source object exist, the target element ready to display, and the like. The binding engine is responsible for recognizing activation of the binding. Processing continues at block 304.

At block 306, a value for the specified source property is found. In
10 one embodiment, reflection is used to find the value. Reflection is a general mechanism that allows a caller to obtain information about a requested object. The information includes objects that are supported, public properties, and the like. In another embodiment, when data item is a collection, the binding engine performs a number of heuristics to determine whether to use the current record or the data
15 object (collection) itself. A first heuristic is applied when the binding refers to a property or indexer. In this situation, the corresponding property or indexer on the collection object is used if such a property or indexer exists. Alternatively, the current record of the collection is used as the data item. Another heuristic is applied when no property or indexer exists. In this situation, the collection object is used for
20 the target property as long as the collection object is valid. Otherwise, the current record is used. Before continuing to block 308, a transform is applied to the value if the binding specifies a transform (block 307). The application of a transform is described in detail in conjunction with block 316 below. Processing continues at block 308.

25 At block 308, the value that was found is assigned to the target property. In one embodiment, a property engine that is responsible for maintaining the hierarchy of the properties may assign the value. In another embodiment, a transform specified during creation of the binding may be invoked to transform the value before assigning the value to the target property. In a further refinement, the
30 property engine may mark the property as having a new value. Once blocks 302-308 have been performed, the binding engine is ready for updating target properties and source data values as needed. In general, the binding mechanism is asynchronous.

Therefore, from block 308, processing continues through two asynchronous paths. A first path (blocks 310-318) is associated with updating the target property and a second path (blocks 330-338) is associated with updating the source data value. Each of these paths is described below. First, the path
5 responsible for updating the target property is discussed.

At decision block 310, the binding engine determines whether the binding associated with the source data value and the target property has specified the bindtype as oneTime. If the bindtype is oneTime, processing is complete for this binding and proceeds to the end. One skilled in the art will recognize, that if the
10 bindtype is oneTime, the binding engine does not listen for source property change events. Thus, in actual practice, the logic within the binding engine does not necessarily perform a check as shown in block 310. In addition, if the data item does not implement IPropertyChange, processing is complete. If, however, the bindtype is not oneTime, processing continues at block 312.

At block 312, the binding engine listens for notifications associated with the bindings. Because databinding does not directly update the target with the source data value, the present invention implements a notification mechanism. Notification mechanisms, such as property change notifications and collection view "CurrentChanged" notifications and the like, are known in the art and need not be
20 discussed at length here. Different actions cause a notification, such as a data value change, a page navigation, shutdown, change in record of interest in a data collection, and the like. Because the present invention triggers an update upon a change in the record of interest in a data collection, the present invention provides a convenient mechanism for further de-coupling the user interface and the logic. For
25 example, in accordance with the present invention, the developer only needs to write code in the logic to specify how to change to the next record of interest in a data collection. Once the change occurs, the binding engine, in accordance with the present invention, will update the user interface according to the bindings already specified. As mentioned before, this de-coupling of the user interface and the logic
30 provides a more robust and more easily maintained application than when the user interface and logic are intertwined.

The following code is one exemplary implementation for the notification mechanism. While the exemplary code written below is written in C#,

those skilled in the art will appreciate that various languages and syntax may be used to implement the notification mechanism. For any such implementation, an interface is defined for use by each data item. Each data item inherits this interface in order to implement dynamic updating.

5

```
Public interface IPropertyChange
{
    event PropertyChangedEventHandler PropertyChanged;
}.
```

10

Next, an event handler and its arguments are defined.

```
public delegate void PropertyChangedEventHandler(object sender,
PropertyChangedEventArgs e);
```

15

```
public class PropertyChangedEventArgs : EventArgs
{
    public virtual string PropertyName { get ;}
}.
```

20

The class PropertyChangedEventArgs includes one read-only property named PropertyName having a type string. The PropertyName property contains a name for the property which has changed. Each source data item then implements this interface by calling the PropertyChanged delegate whenever one of its properties has changed. The following is an illustrative example for implementing a source object (e.g., data item 232) in accordance with the embodiment for the notification mechanism.

25

```
public class myClass : IPropertyChange
{
    private string foo = "Hello World";
    public string Foo
    {
        get { return foo; }
        set { if(foo != value)
```

35

```

        {
            foo = value;
            NotifyPropertyChanged("foo");
        }
5      }

    public event PropertyChangedEventHandler Property
    Changed;

    private void NotifyPropertyChanged(string propName)
10    {
        PropertyChanged(this, new
            PropertyChangedEventArgs(propName));
    }
    }.

```

- 15 As shown above in the exemplary code, the 'set' method for the 'foo' property determines whether a new value is different than the old value. If the values differ, the handler is called. Reflection is performed to get the PropertyInfo. In a further refinement, the binding engine may cache the type of the property once it is obtained through reflection. Thus, reflection is performed once, and not each time a
- 20 notification is received for the property. In another refinement, an empty string may be passed in the arguments to signal that all bindings to each of the data item's data values should be updated. This may occur when the source object is not certain about which properties have changed and would like each binding updated. Once the binding engine receives a notification that the data source value has changed,
- 25 processing continues at decision block 314.

At decision block 314, a determination is made whether the binding associated with the source data value that changed specified a transform for the binding. If the binding does not specify a transform, processing continues at block 318. However, if the binding does specify a transform, processing continues at

30 block 316.

At block 316, the transform that is specified in the binding is performed. In one embodiment, transformer 268 is an object as described below:

```

Public interface IDataTransformer
{
    Public object Transform(object o, DynamicProperty dp, CultureInfo c) {};
}

```

5

For the above interface, o denotes the source value, dp denotes the target dynamic property, and c denotes the culture to use during the transformation. The Transform() method transforms the source value o into an object suitable for assignment to a dynamic property of type dp. The Transform() method is called

10 when propagating a data value from the source of a binding to the target property. If the Transform() method returns a value of null, the binding engine is signaled to stop propagating values.

The transformer may also be used for controlling other UI properties, such as width, height, font, positioning(x,y), and the like based on the associated

15 source data value specified in the binding. Transformers provide the ability to perform logic on the data value in order to show the data in several ways. In a further refinement, a culture may be applied during the transform as specified in the binding. Processing continues at block 318.

At block 318, the target property is updated. In one embodiment, the

20 property engine assigns the value to the target property. In addition, the target property may be marked as having a new value. Processing may then continue to block 312 and listen for the next property change notification associated with the binding. Once the application ends or the binding is otherwise terminated, processing proceeds to the end.

25 As mentioned above, from block 308, processing may continue through a second path. Thus, from block 308, processing continues at decision block 330. As mentioned above regarding decision block 310, the logic within the binding engine may not necessarily perform a check of the bindtype during decision block 310, but rather, because the binding engine was not told to listen for

30 notifications when the binding was created, the process does not flow through the second path. However, for clarity in describing the flow, a decision block reflecting the bindtype is shown. Therefore, at decision block 330, a determination is made whether the binding specified twoWay as the bindtype. As discussed earlier,

twoWay allows changes in the target property to be propagated to the source data value. If the binding does not specify twoWay as the bindtype, processing proceeds to the end. However, if the binding does specify twoWay as the bindtype, processing continues at block 332.

5 At block 332, the binding engine will recognize certain actions that trigger an update to the source data value. Once a trigger occurs, processing continues at decision block 334.

 At decision block 334, a determination is made whether the binding specifies an inverse transform for the binding. If the binding does not specify an
10 inverse transform, processing continues at block 338. However, if the binding does specify an inverse transform, processing continues at block 336.

 At block 336, the inverse transform is applied to the source property. In one embodiment, the inverse transformer is an object as described below:

```
15           Public interface IDataTransformer
           {
           Public object InverseTransform(object o, PropertyInfo pinfo, CultureInfo c)
           {;}
           }.
```

20 For the above interface, o denotes the source value, c denotes the culture to use during the transformation, and pinfo denotes the PropertyInfo of the target property. The InverseTransform() method transforms the source value o into an object suitable for assignment to a property of type info. This method is called
25 when propagating a value from the target of a binding to the source. If the InverseTransform() method returns a value of null, the binding engine does not propagate a value. Once the InverseTransform is performed, processing continues at block 338.

 At block 338, the source property is updated according to the
30 updatetype. As described above, the updatetype may be immediate, on loss of focus, explicit, and others. Once the source property is updated, processing proceeds to the end.

 FIGURE 4 illustrates several exemplary means for creating a binding. Creation means 400-410 creates the binding through markup. Creation means 410

creates the binding through code. The illustrative means shown in FIGURE 4 are not exhaustive. Other means (syntax) may be used without departing from the scope of the present invention.

Creation means **400** includes a DataContext name/value pair (hereinafter referred to as DataContext **422**) and Id name/value pair (hereinafter referred to as Id **420**) for an element **424**. Because creation means **400** also includes DataContext **422**, Id **420** is unnecessary. Id **420** is needed when it is desirable to refer to an explicit source, such as using ElementSource in markup or an IdObjectReg within code. Both of these uses are described below. DataContext **422** is a dynamic property defined on an element (e.g., element **424**). The value associated with DataContext **422** represents the default source data item and is an inheritable property. The binding engine queries DataContext **422** and utilizes DataContext **422** when creating a binding for element **424** and descendent elements (e.g., Button element **426**). The binding engine also listens for changes to DataContext **422**, which triggers an update accordingly. Thus, while not required, DataContext **422** provides a convenient mechanism for establishing scope for all properties bound to a common data item. Descendant elements may have their own DataContext, which will take precedence over the DataContext **422** of the parent element. A binding may override DataContext **422** by supplying a non-null Source, described below in conjunction with creation means **402**.

Button element **426** is illustrated with a target property (e.g., Button.Text **428**). In accordance with the present invention, upon encountering "Data:Bind", the binding engine recognizes that a binding is being specified. Name/value pairs that follow, set the binding properties **260-272** as specified in FIGURE 2. One skilled in the art will appreciate that the terms "Data:Bind" to signal a binding is an arbitrary term and any number of terms may have been used without departing from the present invention. Creation means **400** represents a verbose markup format.

Creation means **402** represents a compact markup format. The UI property (e.g., Button Text) is represented in a more compact fashion. Again, "Data:Bind" is used as a signal to the binding engine that what follows is a binding. Also, the name/value pairs following Data:Bind correspond to the desired properties **260-272** described earlier for the binding object **250** in FIGURE 2. For example,

ElementSource name/value pair (hereinafter referred to as ElementSource 434) corresponds to source 266.

In markup, there are two methods for setting the source property: ElementSource and DataSource. If neither of these is used, the default value for source is null which signals the binding engine, upon creation, to get the value of the element's DataContext property and use the value as the source object.

When a creation means (e.g., creation means 402) specifies an ElementSource, the binding engine finds the element whose ID is specified by the ElementSource property. That element's DataContext is then used as the source object. Relative pathnames, such as /Parent/Parent and /Previous/Previous, may be used to specify the datasource. When the binding engine encounters /Parent, it looks for the element parent to the current element in terms of object hierarchy. For example, if the element is a customer order, specifying /Parent may signal the binding engine to look for the element which corresponds to a customer for the current order. Specifying /Parent is useful in nested repeater cases in which it is desirable to use values from an outer repeater in the scope of an inner repeater. Specifying /Previous signals the binding engine to look for the element previous to the current element under the Repeater. Specifying /Previous is useful when it is desirable to access the current-n item in addition to the current item, such as in line graphs and the like. Successive /Previous and /Parent may be used in accordance with the present invention.

In another embodiment, markup may specify a DataSource. When a DataSource is specified, the binding engine accepts the resource id of a Resource. If the Resource exposes a data property, then the binding engine will set the Source of the binding to the object returned by the data property of the DataSource resource. Otherwise, the binding engine will set the source of the binding to the resource object itself.

Those skilled in the art will appreciate that there are various ways in which properties 260-272 may be expressed using a markup language, and therefore, the manner in which each of these other properties may be expressed using a markup language is not explained in further detail herein.

The next three creation means 404-410 provide illustrative examples on the type of items that the present invention may bind. Creation means 404

illustrates support of binding to sub-properties and indexers. Creation means **404** corresponds to a binding written in C# as `di.a.b[3].c`, wherein `di` is the relevant data item. As long as the data item, the class that implements `di.a`, the class that implements `di.a.b`, and the class that implements `di.a.b[3].c` all support the notification mechanism of the present invention (e.g., `INotifyPropertyChanged`) and notify when their properties change, the binding specified using creation means **404** will cause the binding engine to automatically update the bound property (e.g., the target property) to reflect changes in the source data value.

Creation means **406** illustrates support of binding to a data collection. The binding engine will automatically use the current record of the collection at each level (wherein `a`, `b`, and `c` represent different levels). For example, if `di.a` has a type `IDataCollection`, the binding uses the current record of the collection to fetch the "`b`" property. Thus, the binding engine automatically updates values associated with a data collection whenever the current record is changed.

Creation means **408** illustrates support of binding to XML node. The path **260** to the value is supplied using an xpath expression, such as `"/Customer/Order[@OrderID=10]/Amount"`, as shown in FIGURE 4. Creation means **410** illustrates support of binding to ADO data tables. For this implementation, the path **260** to the value is supplied as a field name for a particular row, such as `"OrderID"`, as shown in FIGURE 4.

Creation means **410** creates the bindings programmatically. The developer provides an objectref to the object that the binding should use as the source data item. The program statements shown in creation means **412** create a binding with the same behavior as the one illustrated by creation means **410**. The `SetBinding` method has a number of more elaborate variants by which the programmer can specify any of the binding properties discussed above. The simple example above uses the button's `DataContext` as the source object. The following program statements create a one-way binding that uses a specific object (known at runtime) as the source:

```

Object source = ... some arbitrary object ... ;
Binding.SetBinding(myButton, Element.BackgroundProperty,
"Color", BindType.OneWay, new ExplicitObjectRef(source));

```

The following example code displays one implementation for controlling a user interface property with data via the binding mechanism of the present invention. In this example, the data value (e.g., myInteger) and the UI property (e.g., TextContent) are activated as a binding. In addition, a transform (e.g., MyTransformer) is specified for this binding.

```

    <Test TextContent="*Data:Bind(Path=myInteger)"
    Foreground="*Data:Bind(Path=MyInteger;
    Transformer=MyTransformer)"/>
10
    public class MyTransformer : IDataTransformer
    {
        public object Transform(object o, DynamicProperty dp, CultureInfo
    culture)
15
        {
            if ((int)o < 0) return Red;
            else return Black;
        }

20
        public object InverseTransform(object o, PropertyInfo info, CultureInfo
            culture)

        {
            return null;
        }

25
    }.

```

Thus, as described, the present invention provides a mechanism for associating a source data value with a target property in such a manner that changes in the coding of the user interface and the logic may be de-coupled. Thus, the present invention allows developers to easily modify and enhance the user interface without requiring them to modify the underlying logic of the application.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

WE CLAIM:

1. A computer-readable medium having computer executable instructions for controlling user-interface properties with data, the instructions comprising:
creating a binding that associates a target property with a source data value; and
upon receiving a notification that the source data value has undergone a change, reflecting the change in the target property based on the binding.
2. The computer-readable medium of claim 1, wherein the target property includes a user-interface property.
3. The computer-readable medium of claim 1, further comprising applying a transform to the source data value before reflecting the change in the target property.
4. The computer-readable medium of claim 1, wherein creating the binding includes specifying a binding type for the binding.
5. The computer-readable medium of claim 4, wherein the binding type includes a first binding type that results in the target property being updated based on the source data value when the binding is activated.
6. The computer-readable medium of claim 4, wherein the binding type includes a second binding type that results in the target property being updated when the source data value undergoes the change.
7. The computer-readable medium of claim 1, further comprising updating the source data value upon a target change to the target property.
8. The computer-readable medium of claim 7, wherein updating the source data value is performed asynchronously almost immediately after the target change.

9. The computer-readable medium of claim 7, wherein updating the source data value is performed asynchronously when focus on the target property is lost.

10. The computer-readable medium of claim 7, wherein updating the source data value is performed explicitly by an application.

11. The computer-readable medium of claim 1, wherein creating the binding is specified using code.

12. The computer-readable medium of claim 1, wherein creating the binding is specified using a markup language.

13. The computer-readable medium of claim 1, further comprising creating another binding that associates the target property with another source data value.

14. The computer-readable medium of claim 1, wherein the source data value is associated with a data source.

15. The computer-readable medium of claim 14, wherein the data source is specified through one of a XPath on XML, a column in ADO, and a reflection.

16. A computer system for controlling user interface properties with data, the computer system comprising:

a processor; and

a memory, the memory being allocated for a plurality of computer-executable instructions which are loaded into the memory for execution by the processor, the computer-executable instructions performing a method comprising:

creating a binding that associates a target property with a source data value; and

upon receiving a notification that the source data value has undergone a change, reflecting the change in the target property based on the binding.

17. The computer system of claim 16, wherein the target property includes a user-interface property.

18. The computer system of claim 16, further comprising applying a transform to the source data value before reflecting the change in the target property.

19. The computer system of claim 16, wherein creating the binding includes specifying a binding type for the binding.

20. The computer system of claim 19, wherein the binding type includes a first binding type that results in the target property being updated based on the source data value when the binding is activated.

21. The computer system of claim 19 wherein the binding type includes a second binding type that results in the target property being updated when the source data value undergoes the change.

22. The computer system of claim 16, further comprising updating the source data value upon a target change to the target property.

23. The computer system of claim 22, wherein updating the source data value is performed asynchronously almost immediately after the target change.

24. The computer system of claim 22 wherein updating the source data value is performed asynchronously when focus on the target property is lost.

25. The computer system of claim 22, wherein updating the source data value is performed explicitly by an application.

26. The computer system of claim 16, wherein creating the binding is specified using code.

27. The computer system of claim 16, wherein creating the binding is specified using a markup language.

28. A computer-readable medium having computer executable instructions for controlling user-interface properties with data, the instructions comprising:

a logic portion for manipulating a data value within an application;
a user interface portion within the application, the user interface portion being responsible for displaying a user interface property, the user interface portion being independent from the logic portion; and

at least one binding specification, the binding specification describing a relationship between the user interface property and the data value so that system level code is notified when the data value undergoes a change so that the system level code can direct the user interface portion to reflect the change in the user interface property.

29. The computer-readable medium of claim 28, wherein the binding specification is specified using code.

30. The computer-readable medium of claim 28, wherein the binding specification is specified using a markup language.

31. The computer-readable medium of claim 28, wherein the binding specification identifies a source data item, a path to the data value in the source data item, a target user interface element, and the user interface property on the target user interface element.

32. The computer-readable medium of claim 31, wherein the binding specification further identifies a transform which is applied to the data value before reflecting the change in the user interface property.

33. The computer-readable medium of claim 31, wherein the binding specification further identifies a binding type for the binding.

34. The computer-readable medium of claim 33, wherein the binding type includes a first binding type that results in the user interface property being updated based on the data value when the binding is activated.

35. The computer-readable medium of claim 33, wherein the binding type includes a second binding type that results in the user interface property being updated when the data value undergoes the change.

36. The computer-readable medium of claim 31, wherein the binding specification further specifies that the data value be updated when the user interface property undergoes a UI change.

37. The computer-readable medium of claim 36, wherein the data value is updated asynchronously almost immediately after the UI change.

38. The computer-readable medium of claim 36, wherein the data value is updated asynchronously when focus on the user interface property is lost.

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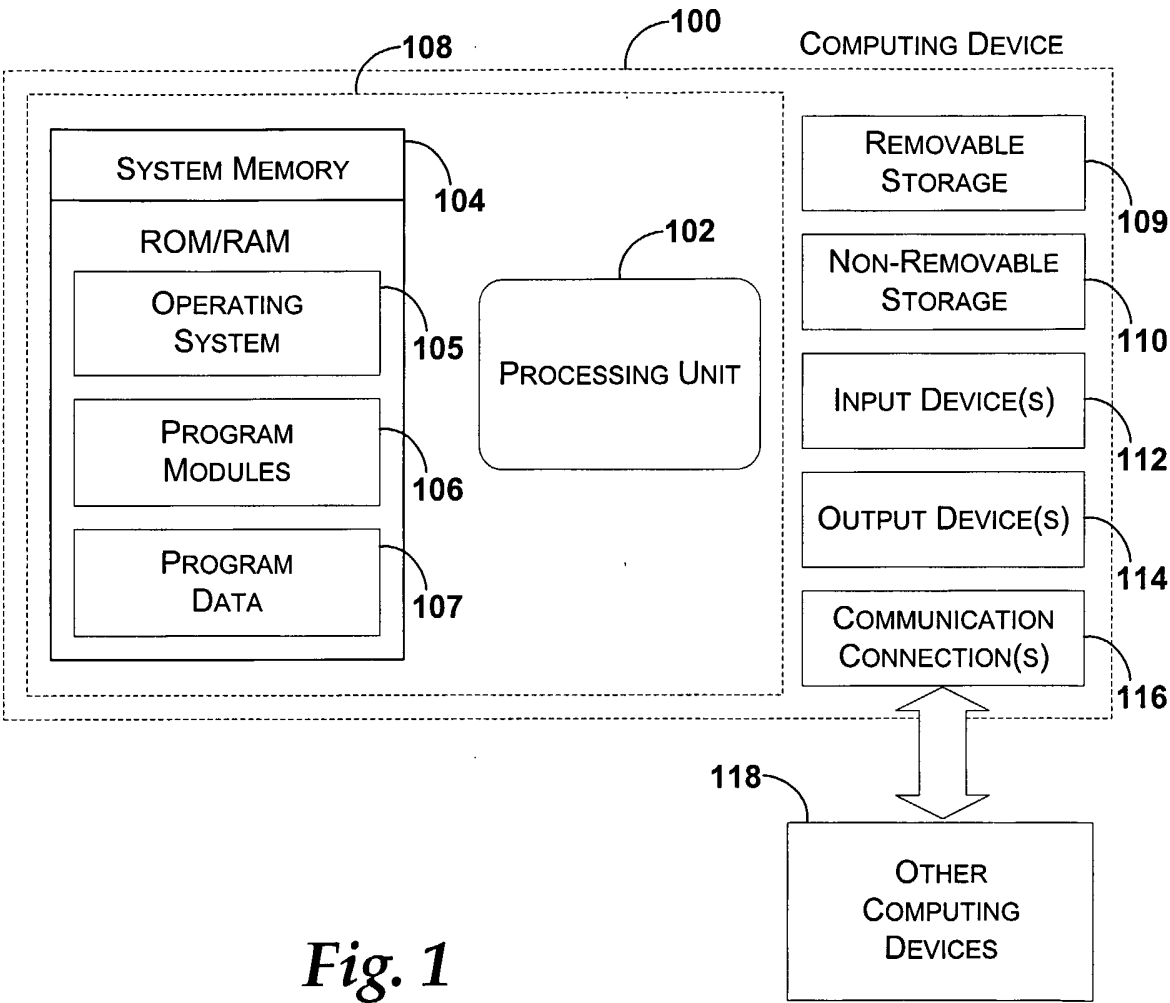


Fig. 1

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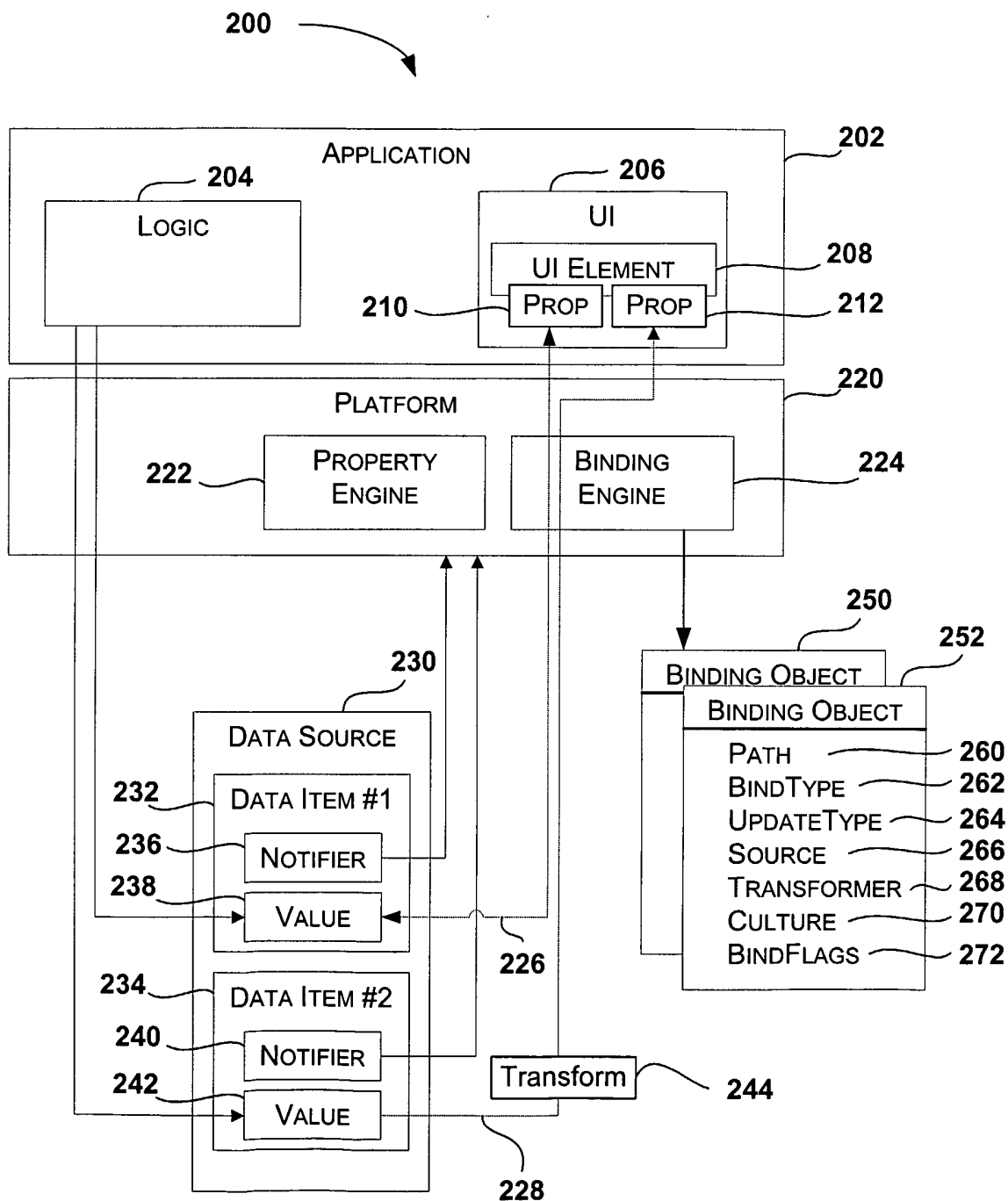
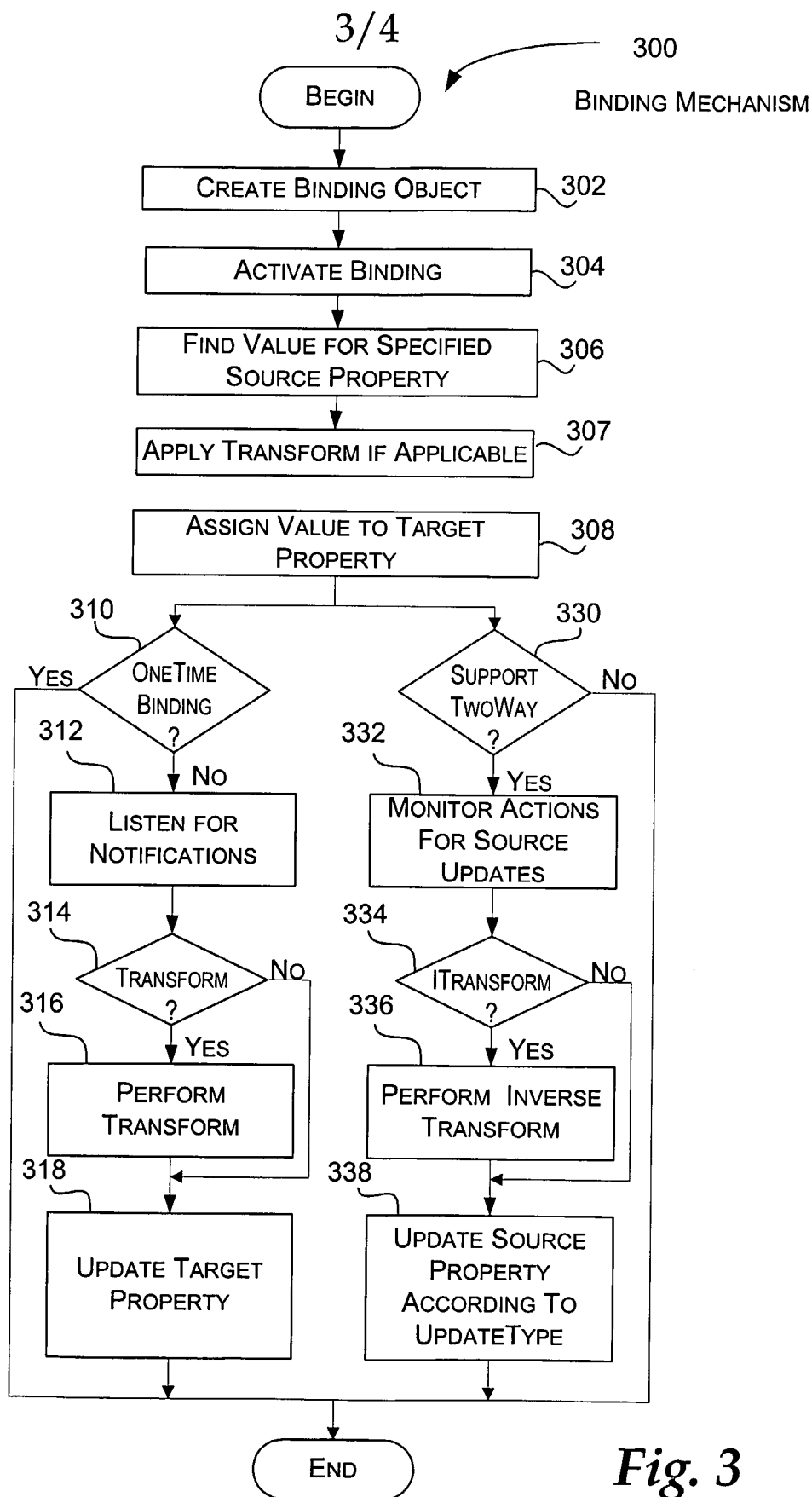
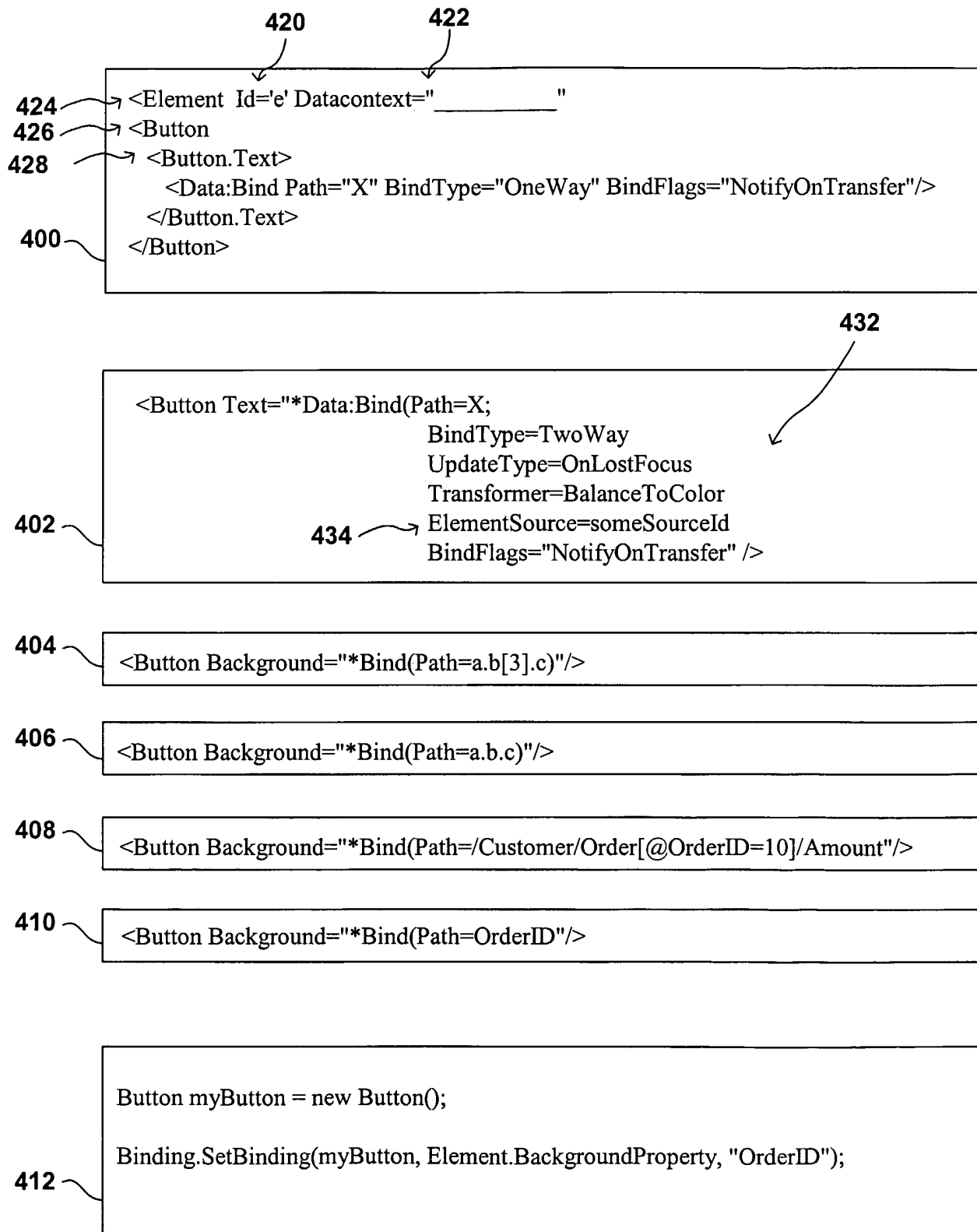


Fig. 2



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*Fig. 4*

SHEET NO.

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1. If in any of the Boxes, the space is insufficient to furnish all the information: in such case, write "Continuation of Box No. ..." [indicate the number of the Box] and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient in particular:

- (i) if more than two persons are involved as applicants and/or inventors and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;
- (ii) if, in Box No. II or in any of the sub-boxes of Box No. III, the indication "the States indicated in the Supplemental Box" is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;
- (iii) if in Box No. II or in any of the sub-boxes of Box No. III, the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;
- (iv) if, in addition to the agent(s) indicated in Box No. IV, there are further agents: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;
- (v) if in Box No. V, the name of any State (or OAPI) is accompanied by the indication "patent of addition," or "certificate of addition," or if, in Box No. V, the name of the United States of America is accompanied by an indication "continuation" or "continuation-in-part": in such case, write "Continuation of Box No. V" and the name of each State involved (or OAPI), and after the name of each such State (or OAPI), the number of the parent title or parent application and the date of grant of the parent title or filing of the parent application;
- (vi) if there are more than three earlier applications whose priority is claimed: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI.
- (vii) if, in Box No. VI, the earlier application is an ARIPO application: in such case, write "Continuation of Box No. VI," specify the number of the item corresponding to that earlier application and indicate at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed.

2. If, with regard to the precautionary designation statement contained in Box No. V, the applicant wishes to exclude any State(s) from the scope of that statement: in such case, write "Designation(s) excluded from precautionary designation statement" and indicate the name or two-letter code of each State so excluded.

3. If the applicant claims, in respect of any designated Office, the benefits of provisions of the national law concerning non-prejudicial disclosures or exceptions to lack of novelty: in such case, write "Statement Concerning Non-Prejudicial Disclosures or Exceptions to Lack of Novelty" and furnish that statement below.

Declaration as to non-prejudicial disclosures or exceptions to lack of novelty (Rules 4.17(v) and 51bix.1(a)(v)):

in relation to this international application No. PCT/US03/15708

MICROSOFT CORPORATION declares that the subject matter claimed in this international application was disclosed as follows:

- i. Kind of Disclosure: Abusive Disclosure on the Internet by a third party
- ii. Date of Disclosure: 19 November 2002
- iii. Title of Disclosure: Windows Longhorn Alpha Leaks to the Web
- iv. Place of Disclosure: eWeek Enterprise News & Reviews on the internet
- v. This Declaration is made for the purpose of the following designations for national and/or regional patents: All designations

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/15708

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G06F 15/163

US CL : 709/242, 318

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 709/242, 318

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
east

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,438,618 B1 (LORTZ et al) 20 AUGUST 2002, ABSTRACT, FIGURE 1, COL. 1, LINES 9-63	1-38
A	US 6,378,004 B1 (GALLOWAY et al) 23 APRIL 2002, ABSTRACT, COL. 3, LINES 10-67 AND COL. 4, LINES 1-32	1-38

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

15 December 2003 (15.12.2003)

Date of mailing of the international search report

28 JAN 2004

Name and mailing address of the ISA/US

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P.O. Box 1450

Alexandria, Virginia 22313-1450

Facsimile No. (703) 305-3230

Authorized officer

William C. Vaughn, Jr.

Telephone No. (703) 305-9700