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(54) **DESIGNER AND PLAYER FOR WEB SERVICES APPLICATIONS**

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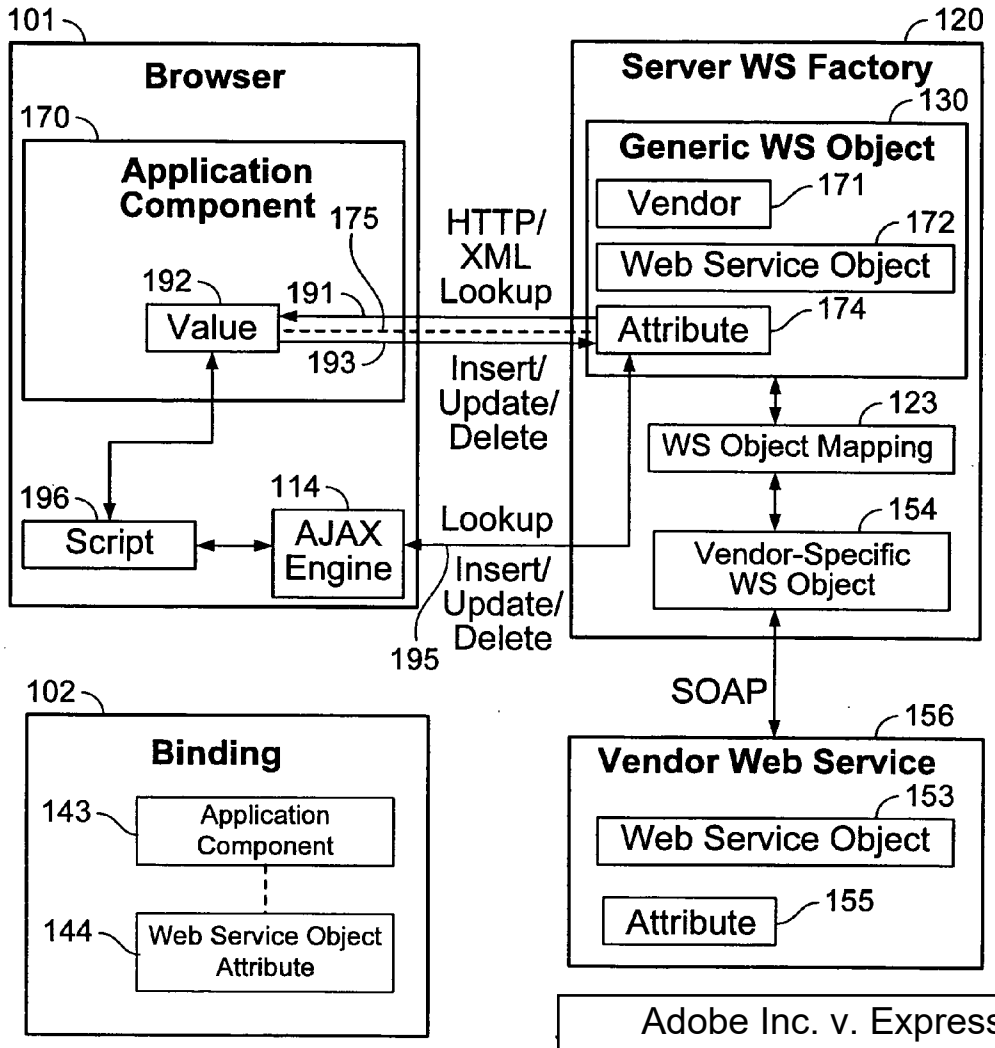
(57) **ABSTRACT**

In the computer field, method and apparatus for supporting web services so as to allow use of web services across organizations and allow use of the web services as a data source for a software application. This allows access to the database of another organization via web services with access via a web browser. One may access a field of data, a group of fields of data or a table of data or other types of software objects including logic. The present system maps or binds software object to software object between the accessing system and the accessed system. The web service access may be supported in a hosted manner by a server maintained by yet a third organization.



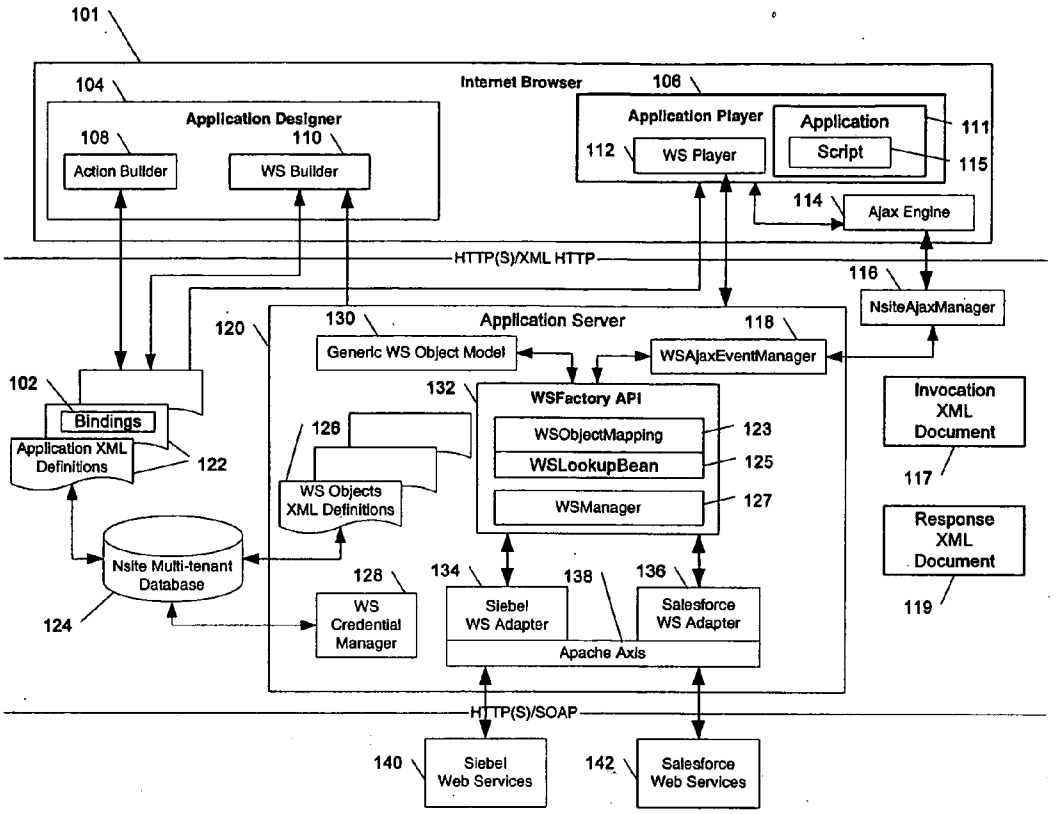

101
104
Application Designer
108
Action Builder
110
WS Builder
Internet Browser
106
Application Player
112
WS Player
Application
Script
111
115
114
Ajax Engine
HTTP(S)/XML HTTP
116
NsiteAjaxManager
120
130
Application Server
Generic WS Object Model
118
WSAjaxEventManager
102
Bindings
Application XML Definitions
122
132
WSFactory API
WSObjectMapping
123
WSLookupBean
125
WSManager
127
126
WS Objects XML Definitions
Nsite Multi-tenant Database
124
128
WS Credential Manager
134
Siebel WS Adapter
138
136
Salesforce WS Adapter
Apache Axis
Invocation XML Document
117
Response XML Document
119
HTTP(S)/SOAP
140
Siebel Web Services
142
Salesforce Web Services

FIG. 1A

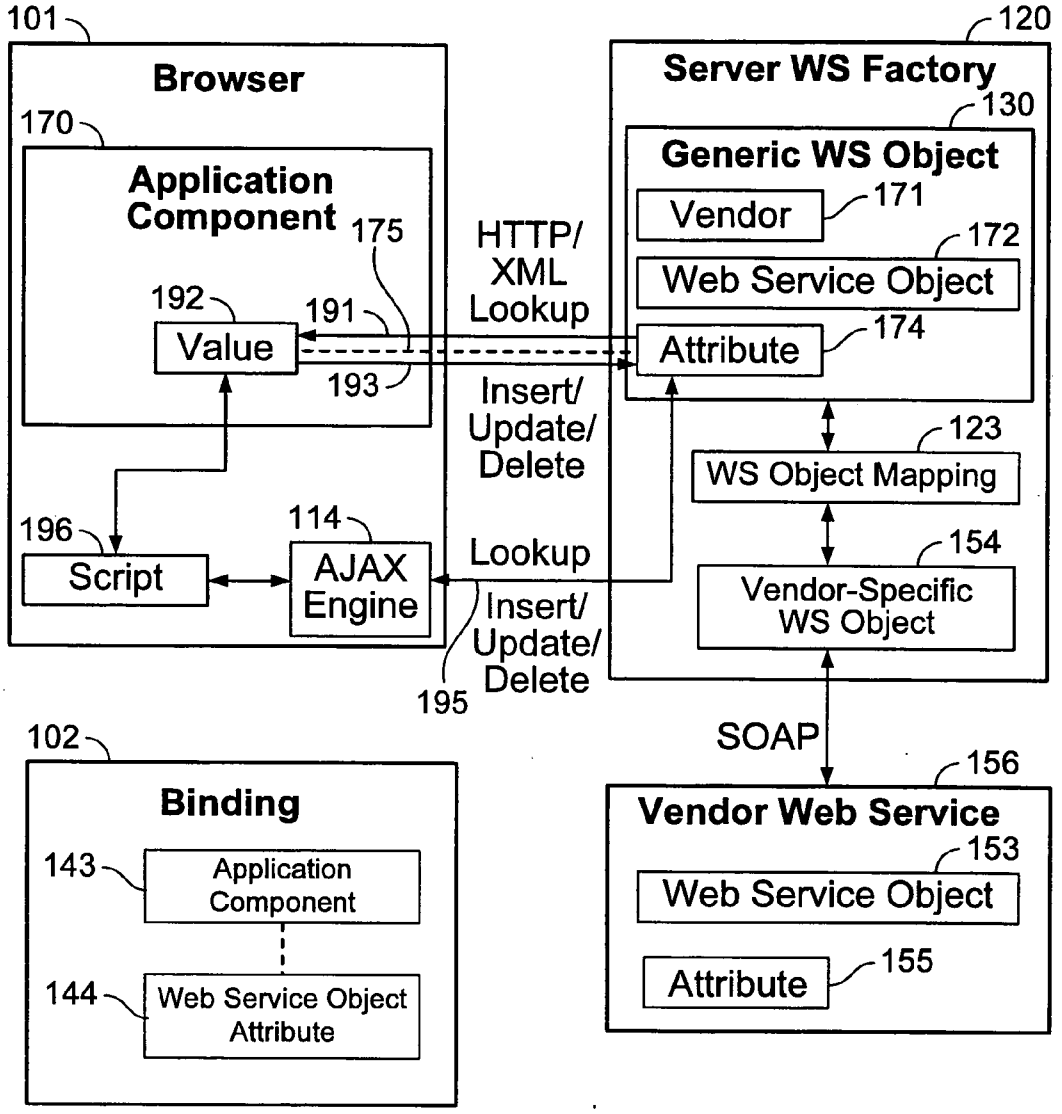

101
Browser
170
Application Component
175
192
Value
191
193
196
Script
114
AJAX Engine
HTTP/ XML Lookup
Insert/ Update/ Delete
Lookup
Insert/ Update/ Delete
195
120
Server WS Factory
130
Generic WS Object
Vendor
171
172
Web Service Object
Attribute
174
123
WS Object Mapping
154
Vendor-Specific WS Object
SOAP
156
Vendor Web Service
153
Web Service Object
Attribute
155
102
Binding
143
Application Component
144
Web Service Object Attribute

FIG. 1B

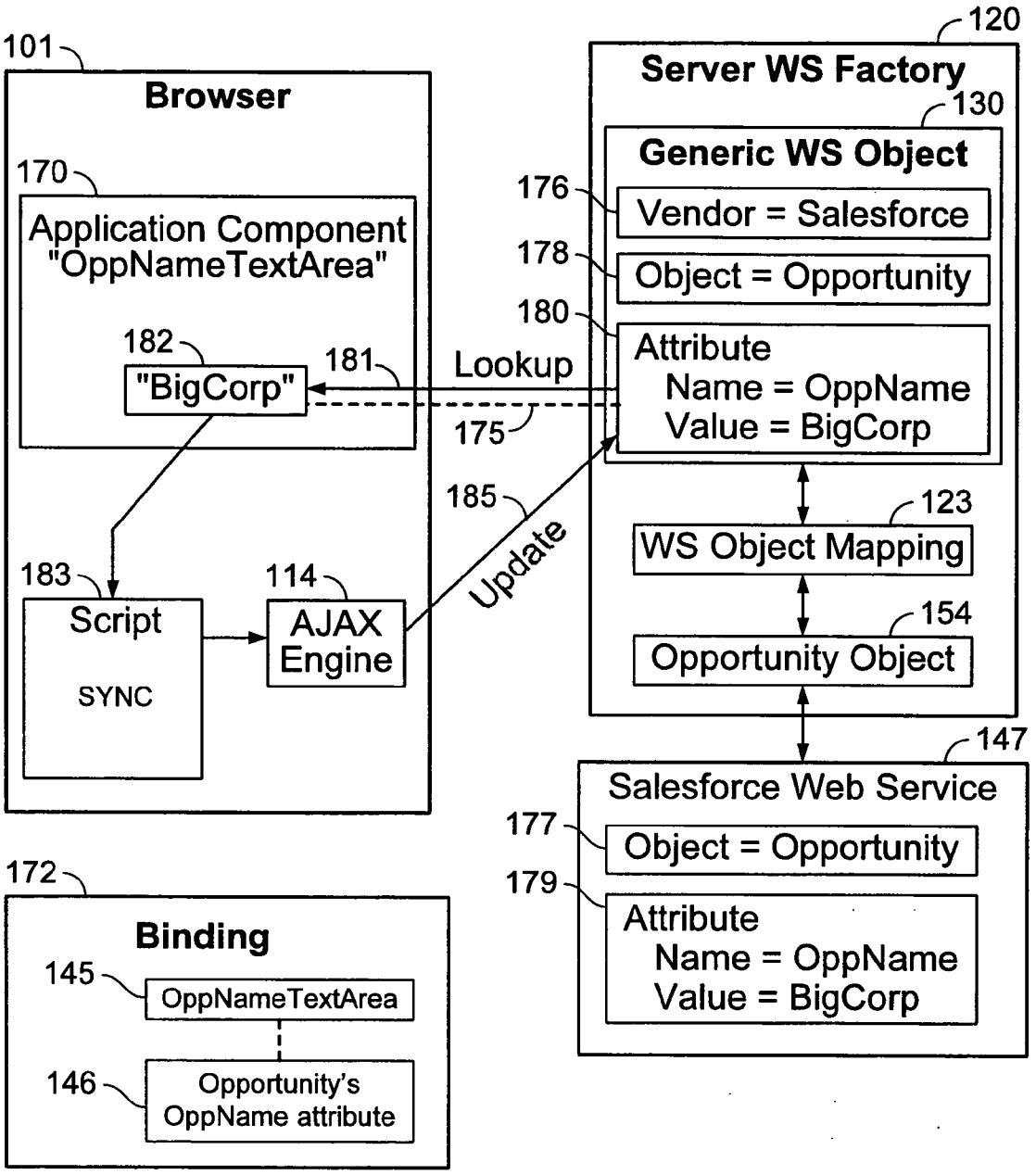

101
Browser
170
Application Component
"OppNameTextArea"
182
"BigCorp"
181
Lookup
175
183
Script
SYNC
114
AJAX
Engine
185
Update
120
Server WS Factory
130
Generic WS Object
176
Vendor = Salesforce
178
Object = Opportunity
180
Attribute
Name = OppName
Value = BigCorp
123
WS Object Mapping
154
Opportunity Object
147
Salesforce Web Service
177
Object = Opportunity
179
Attribute
Name = OppName
Value = BigCorp
172
Binding
145
OppNameTextArea
146
Opportunity's
OppName attribute

FIG. 1C

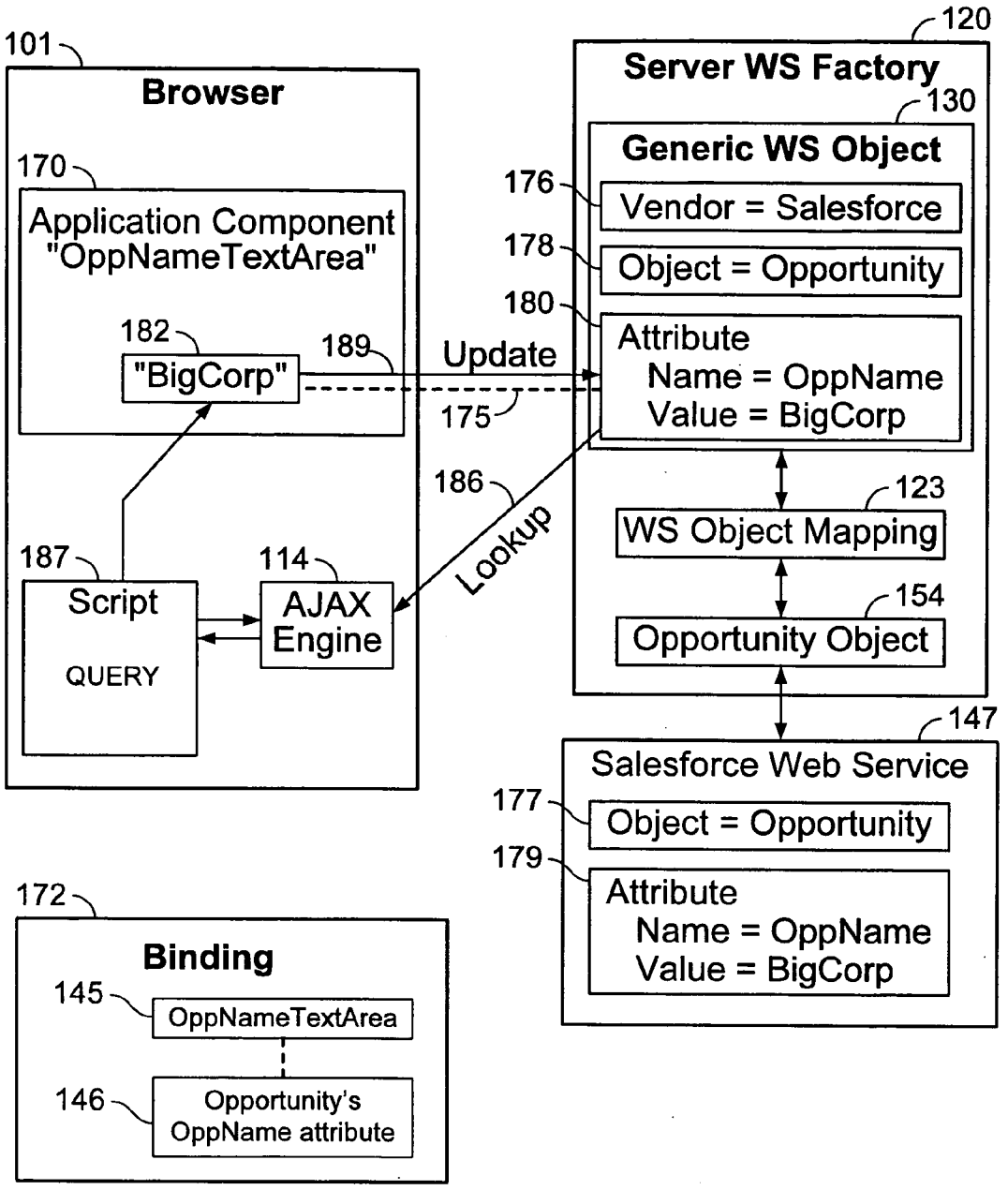

101
Browser
170
Application Component
"OppNameTextArea"
182
"BigCorp"
189
Update
175
187
Script
QUERY
114
AJAX
Engine
186
Lookup
120
Server WS Factory
130
Generic WS Object
176
Vendor = Salesforce
178
Object = Opportunity
180
Attribute
Name = OppName
Value = BigCorp
123
WS Object Mapping
154
Opportunity Object
147
Salesforce Web Service
177
Object = Opportunity
179
Attribute
Name = OppName
Value = BigCorp
172
Binding
145
OppNameTextArea
146
Opportunity's
OppName attribute

FIG. 1D

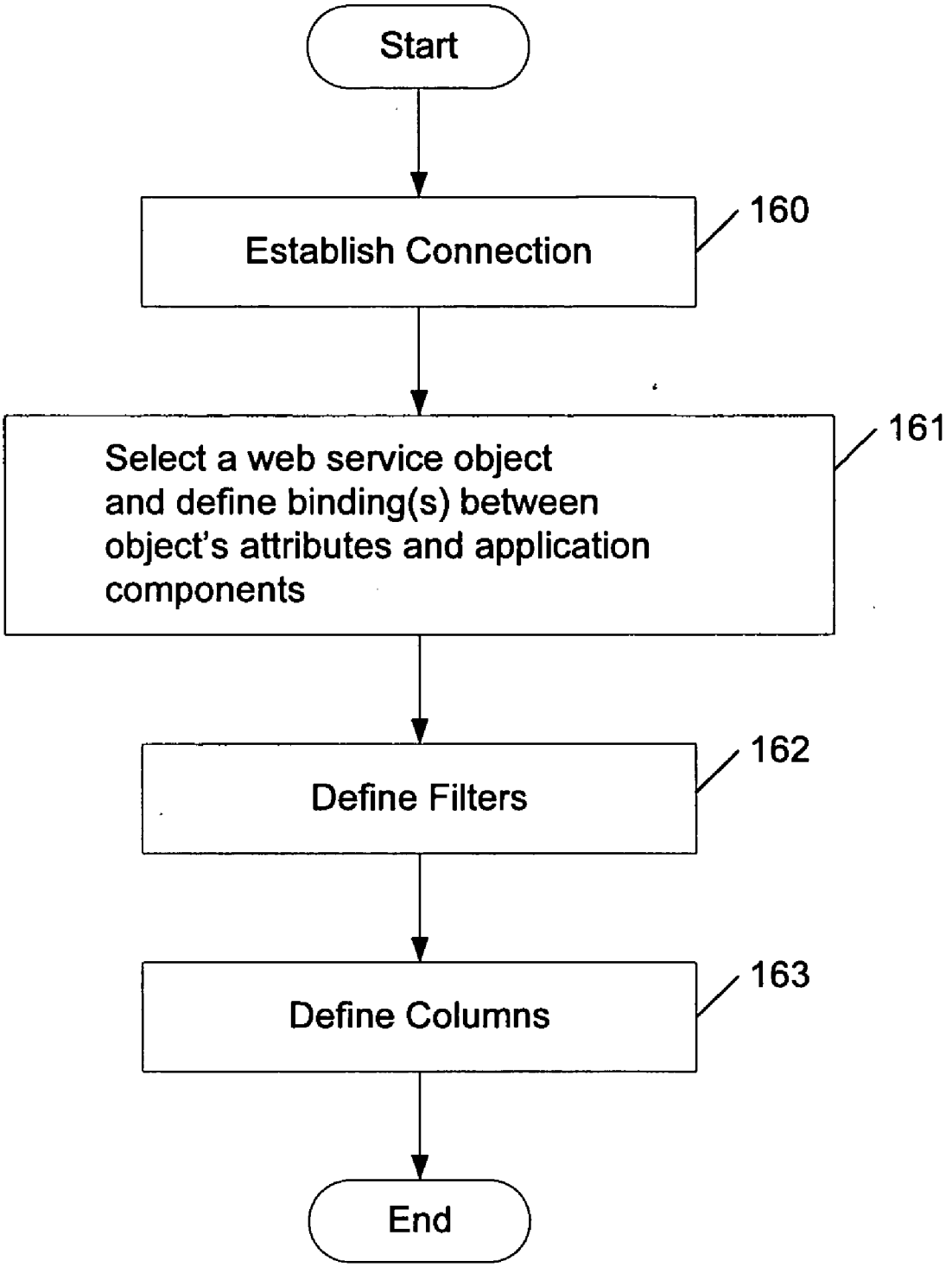

Start
Establish Connection
160
Select a web service object and define binding(s) between object's attributes and application components
161
Define Filters
162
Define Columns
163
End

FIG. 1E

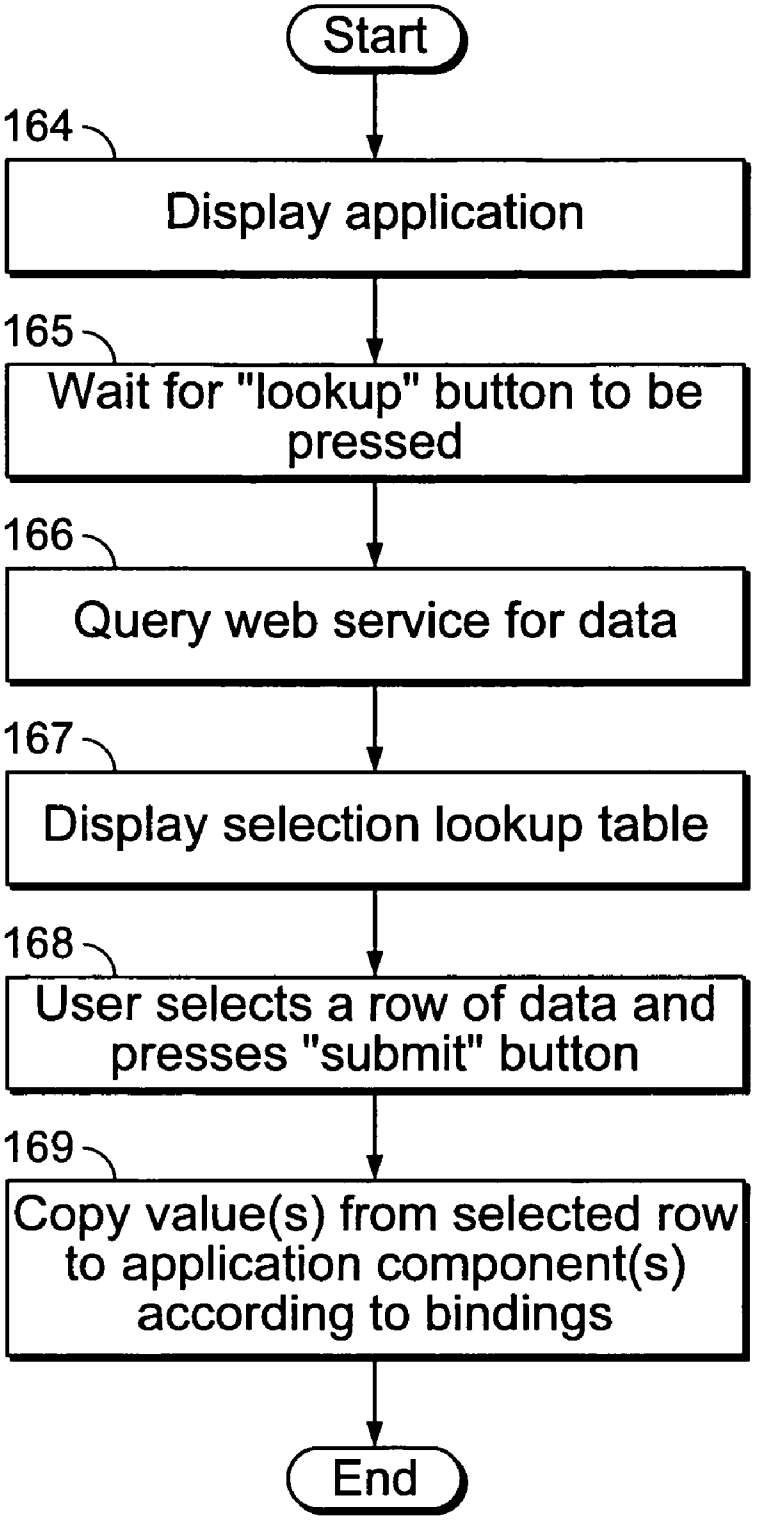

Start
164
Display application
165
Wait for "lookup" button to be pressed
166
Query web service for data
167
Display selection lookup table
168
User selects a row of data and presses "submit" button
169
Copy value(s) from selected row to application component(s) according to bindings
End

FIG. 1F

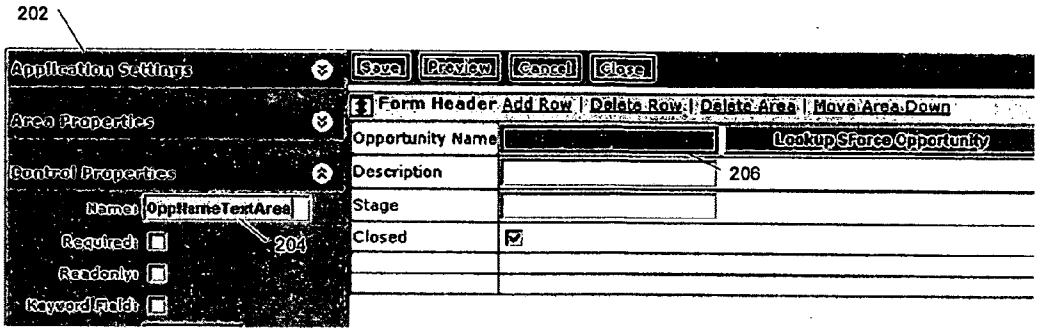

202
Application Settings
Area Properties
Control Properties
Name: OppNameTextArea
Required:
Readonly:
Keyword Field:
204
Save
Preview
Cancel
Close
Form Header Add Row | Delete Row | Delete Area | Move Area Down
Opportunity Name
Lookup SForce Opportunity
Description
206
Stage
Closed

FIG. 2A

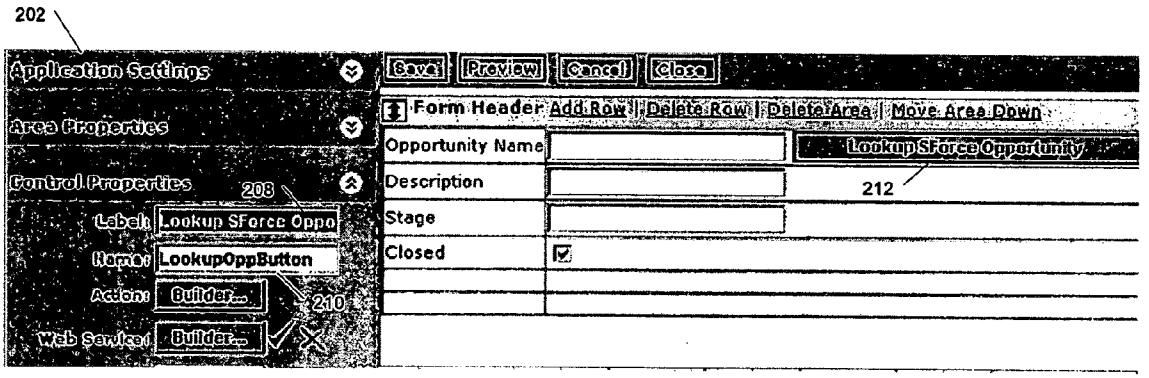

202
Application Settings
Area Properties
Control Properties
208
Label: Lookup SForce Oppo
Name: LookupOppButton
Action: Builder...
Web Service: Builder...
210
Save
Preview
Cancel
Close
Form Header Add Row | Delete Row | Delete Area | Move Area Down
Opportunity Name
Lookup SForce Opportunity
Description
212
Stage
Closed

FIG. 2B

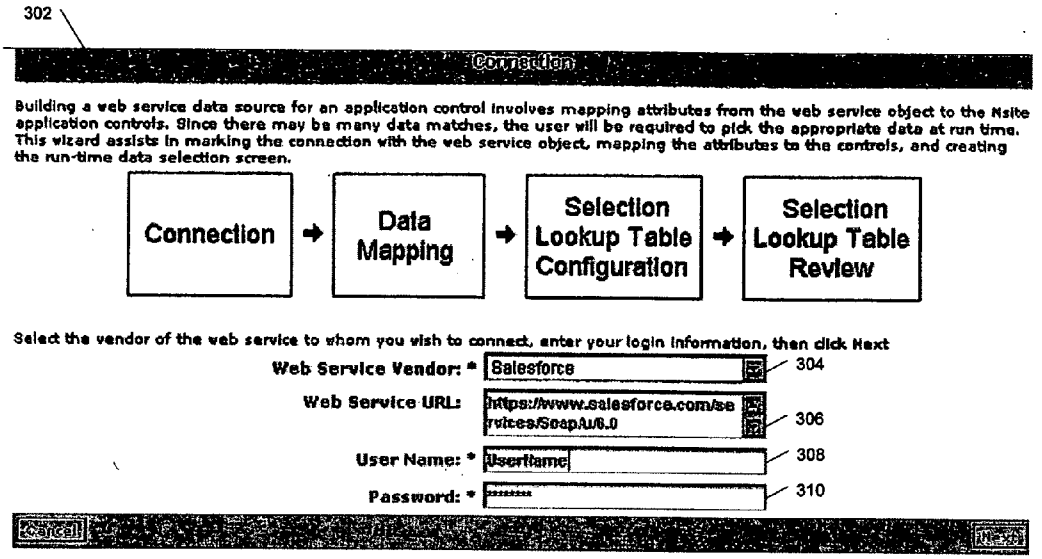

302
Connection
Building a web service data source for an application control involves mapping attributes from the web service object to the Nsite application controls. Since there may be many data matches, the user will be required to pick the appropriate data at run time. This wizard assists in marking the connection with the web service object, mapping the attributes to the controls, and creating the run-time data selection screen.
Connection
Data Mapping
Selection Lookup Table Configuration
Selection Lookup Table Review
Select the vendor of the web service to whom you wish to connect, enter your login information, then click Next
Web Service Vendor: *
Salesforce
304
Web Service URL:
https://www.salesforce.com/services/Soap/u/6.0
306
User Name: *
Username
308
Password: *
310
Cancel

FIG. 3

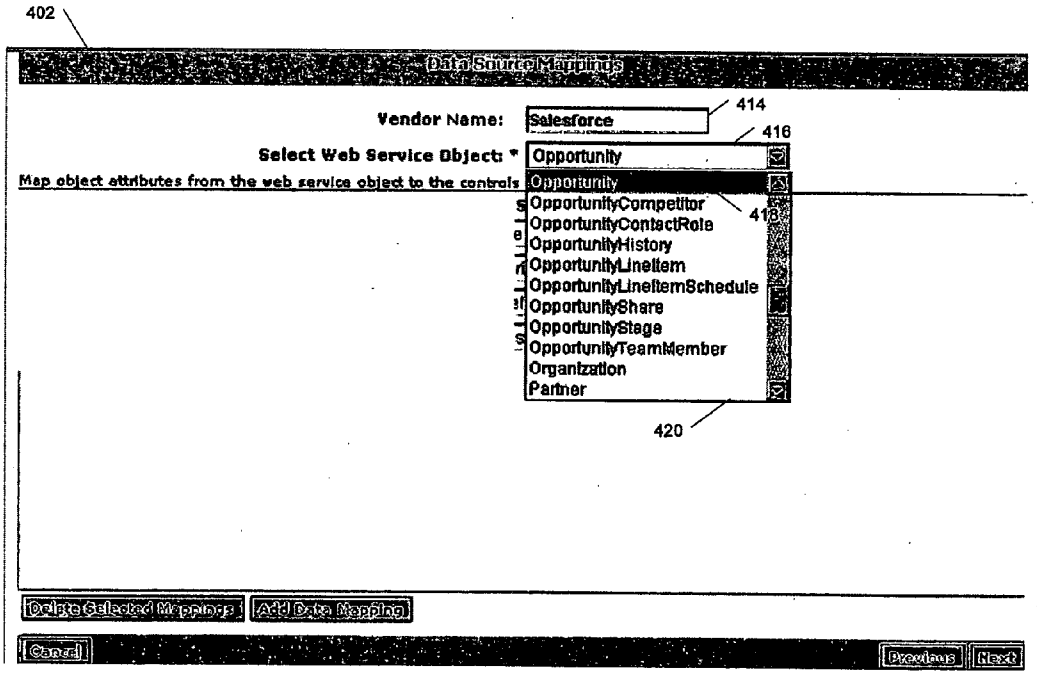

402
Data Source Mappings
Vendor Name:
Salesforce
414
Select Web Service Object: *
Opportunity
416
Map object attributes from the web service object to the controls
Opportunity
OpportunityCompetitor
OpportunityContactRole
OpportunityHistory
OpportunityLineItem
OpportunityLineItemSchedule
OpportunityShare
OpportunityStage
OpportunityTeamMember
Organization
Partner
418
420
Delete Selected Mappings
Add Data Mapping
Cancel
Previous
Next

FIG. 4A

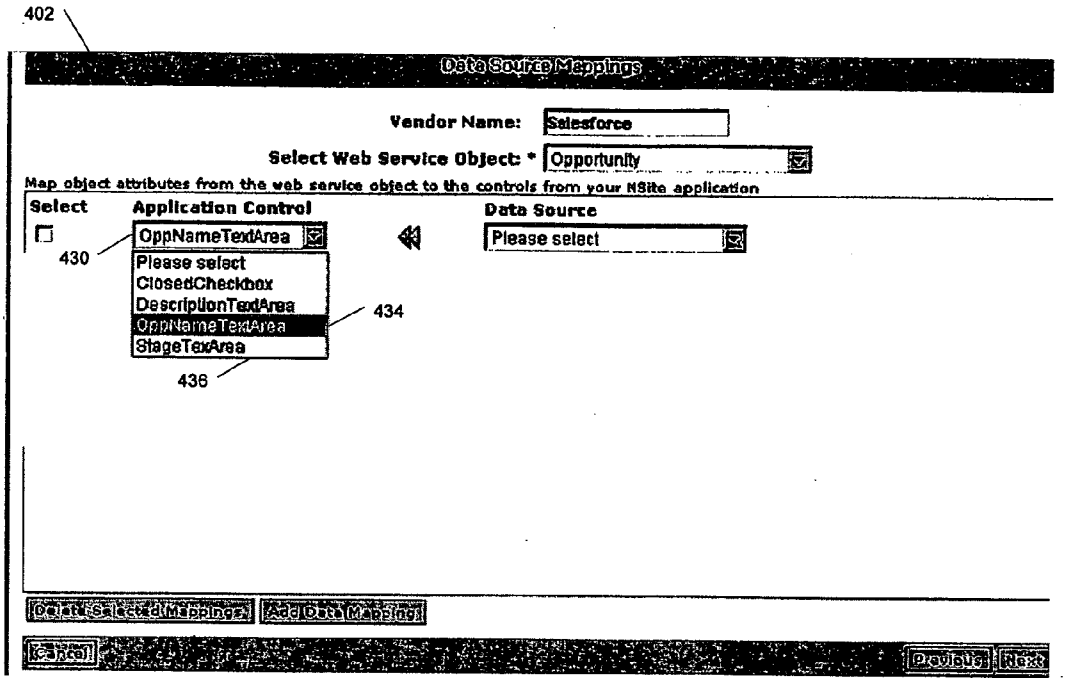

402
Data Source Mappings
Vendor Name:
Salesforce
Select Web Service Object: *
Opportunity
Map object attributes from the web service object to the controls from your NSite application
Select
Application Control
Data Source
OppNameTextArea
Please select
430
Please select
ClosedCheckbox
DescriptionTextArea
OppNameTextArea
StageTextArea
434
436
Delete Selected Mappings
Add Data Mapping
Cancel
Previous
Next

FIG. 4B

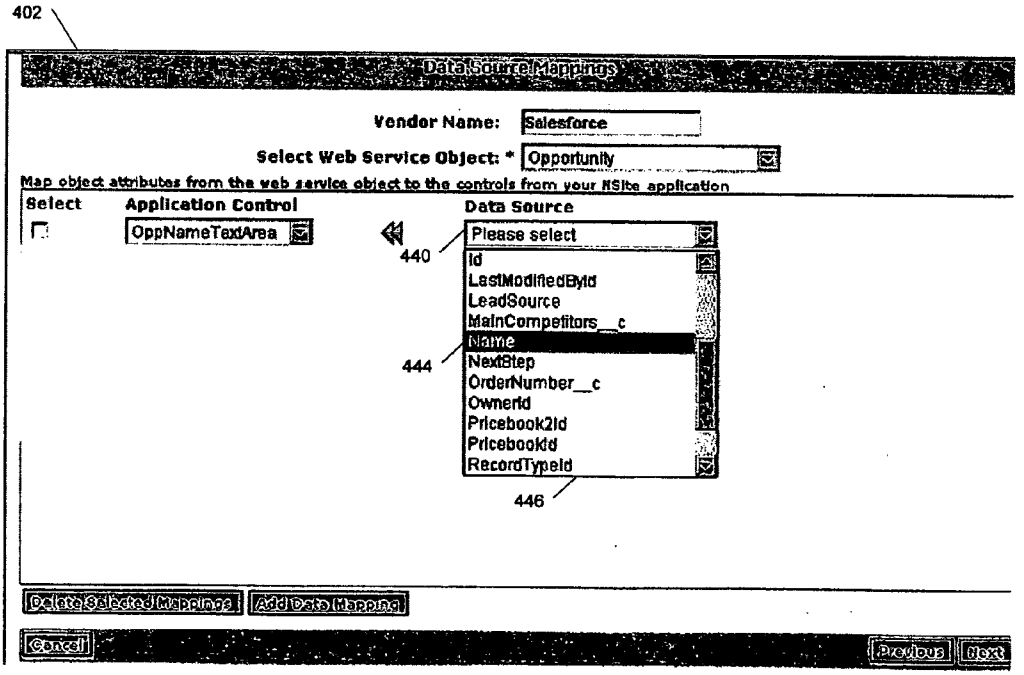

402
Data Source Mappings
Vendor Name:
Salesforce
Select Web Service Object: *
Opportunity
Map object attributes from the web service object to the controls from your NSite application
Select
Application Control
Data Source
OppNameTextArea
Please select
440
Id
LastModifiedById
LeadSource
MainCompetitors__c
Name
NextStep
OrderNumber__c
OwnerId
Pricebook2Id
PricebookId
RecordTypeId
444
446
Delete Selected Mappings
Add Data Mapping
Cancel
Previous
Next

FIG. 4C

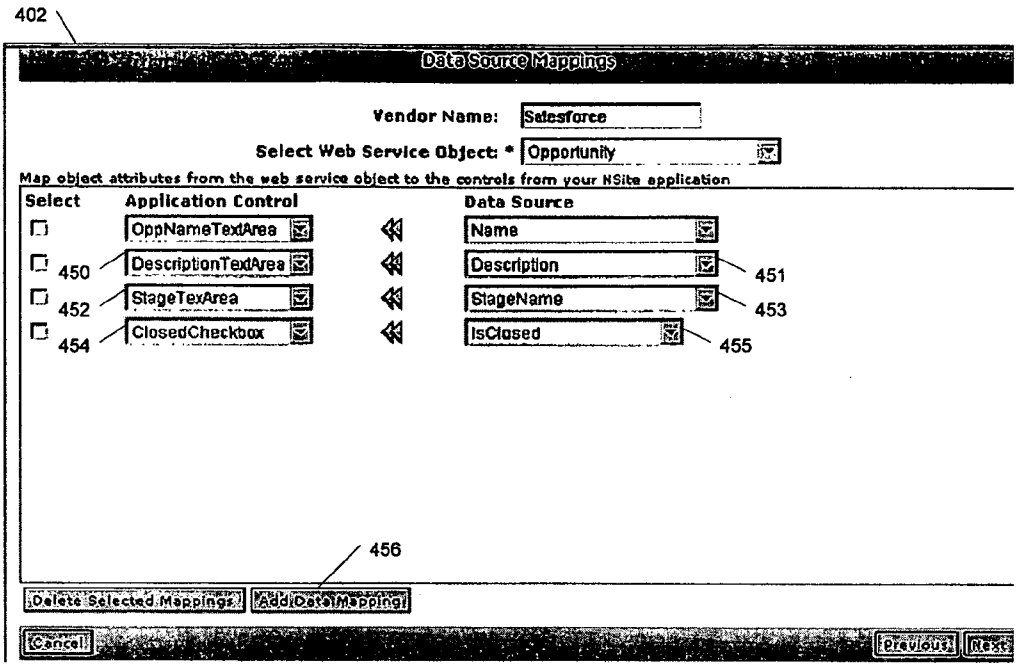

402
Data Source Mappings
Vendor Name:
Salesforce
Select Web Service Object: *
Opportunity
Map object attributes from the web service object to the controls from your NSite application
Select
Application Control
Data Source
OppNameTextArea
Name
450
DescriptionTextArea
Description
451
452
StageTexArea
StageName
453
454
ClosedCheckbox
IsClosed
455
456
Delete Selected Mappings
Add/Get Mapping
Cancel
Previous
Next

FIG. 4D

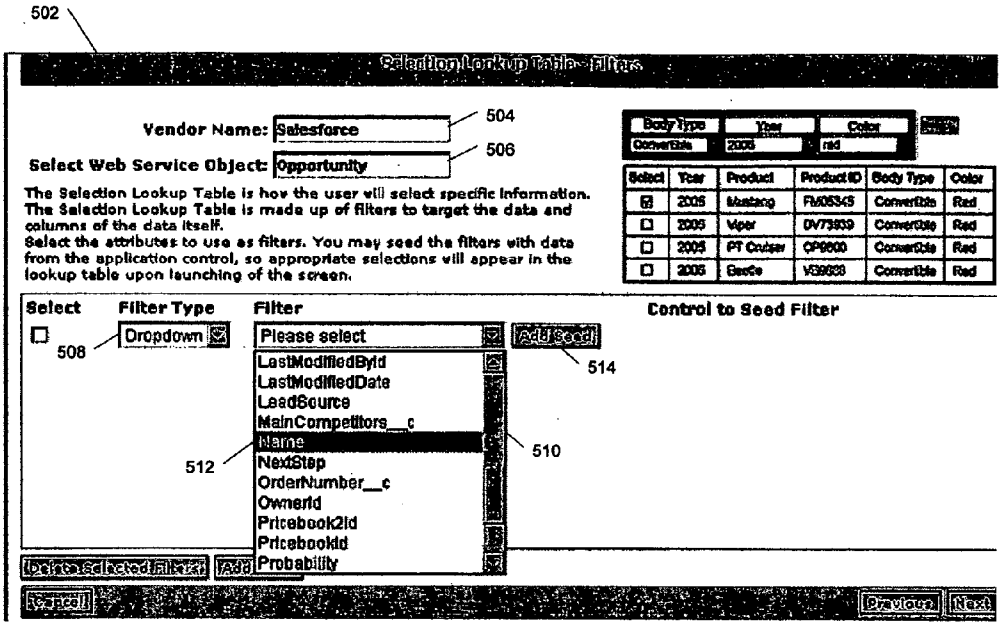

502
Selection Lookup Table - Filters
Vendor Name: Salesforce
504
Select Web Service Object: Opportunity
506
The Selection Lookup Table is how the user will select specific information.
The Selection Lookup Table is made up of filters to target the data and columns of the data itself.
Select the attributes to use as filters. You may seed the filters with data from the application control, so appropriate selections will appear in the lookup table upon launching of the screen.
Body Type
Year
Color
Select
Year
Product
Product ID
Body Type
Color
Select
Filter Type
Filter
Control to Seed Filter
508
Dropdown
Please select
Add Seed
514
LastModifiedById
LastModifiedDate
LeadSource
MainCompetitors__c
Name
NextStep
OrderNumber__c
OwnerId
Pricebook2Id
PricebookId
Probability
510
512
Delete Selected Filters
Add
Cancel
Previous
Next

FIG. 5A

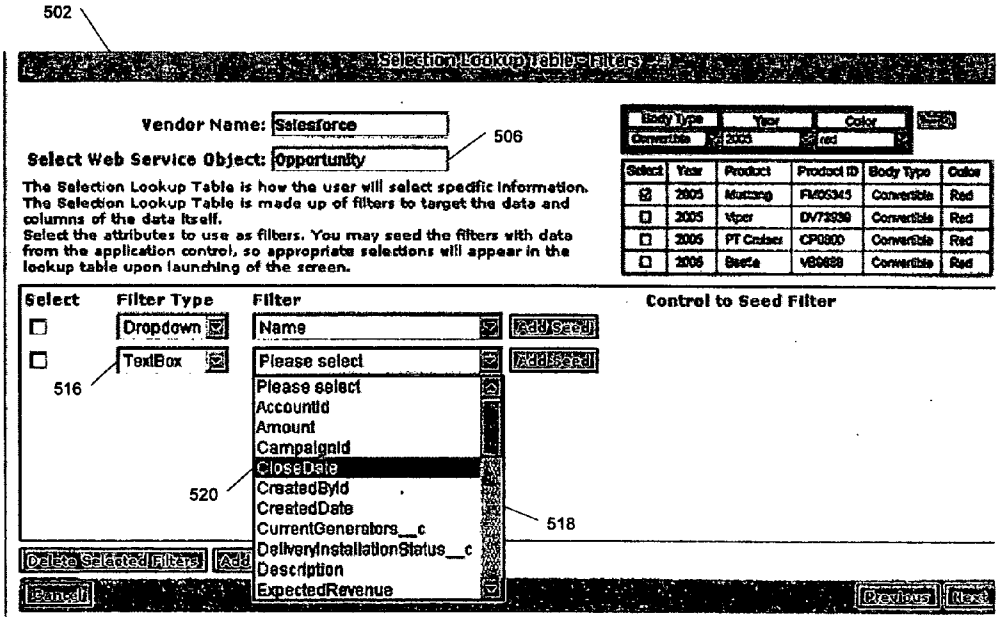

502
Selection Lookup Table - Filters
Vendor Name: Salesforce
Select Web Service Object: Opportunity
506
The Selection Lookup Table is how the user will select specific information.
The Selection Lookup Table is made up of filters to target the data and columns of the data itself.
Select the attributes to use as filters. You may seed the filters with data from the application control, so appropriate selections will appear in the lookup table upon launching of the screen.
Body Type
Year
Color
Select
Year
Product
Product ID
Body Type
Color
Select
Filter Type
Filter
Control to Seed Filter
Dropdown
Name
Add Seed
TextBox
Please select
Add Seed
516
Please select
AccountId
Amount
CampaignId
CloseDate
CreatedById
CreatedDate
CurrentGenerators__c
DeliveryInstallationStatus__c
Description
ExpectedRevenue
520
518
Delete Selected Filters
Add
Cancel
Previous
Next

FIG. 5B

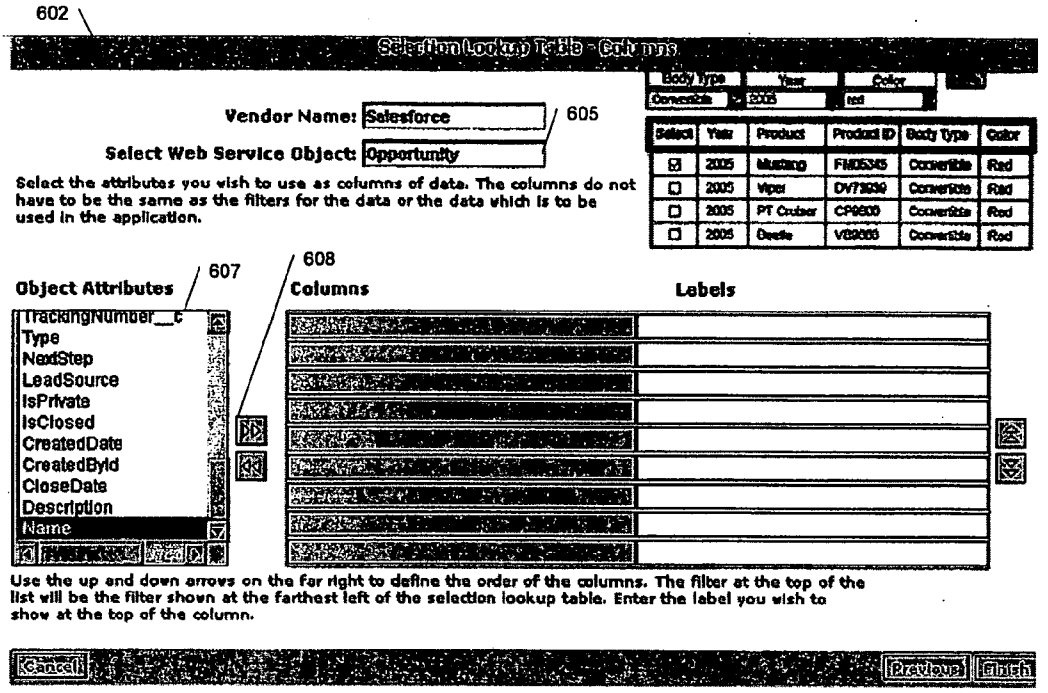

602
Selection Lookup Table - Columns
Vendor Name: Salesforce
Select Web Service Object: Opportunity
605
Select the attributes you wish to use as columns of data. The columns do not have to be the same as the filters for the data or the data which is to be used in the application.
Select
Year
Product
Product ID
Body Type
Color
2005 Mustang FM05345 Convertible Red
2005 Viper DV73039 Convertible Red
2005 PT Cruiser CP0800 Convertible Red
2005 Beetle VB9068 Convertible Red
607
608
Object Attributes
Columns
Labels
TrackingNumber__c
Type
NextStep
LeadSource
IsPrivate
IsClosed
CreatedDate
CreatedById
CloseDate
Description
Name
Use the up and down arrows on the far right to define the order of the columns. The filter at the top of the list will be the filter shown at the farthest left of the selection lookup table. Enter the label you wish to show at the top of the column.
Cancel
Previous
Finish

FIG. 6A

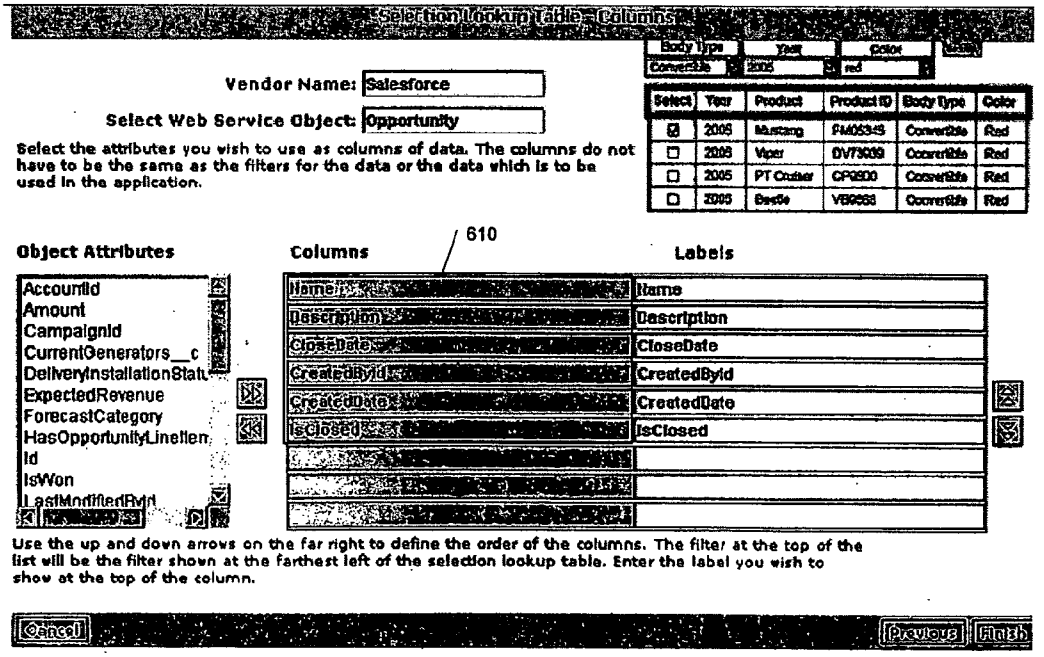

Selection Lookup Table - Columns
Vendor Name: Salesforce
Select Web Service Object: Opportunity
Select the attributes you wish to use as columns of data. The columns do not have to be the same as the filters for the data or the data which is to be used in the application.
Select
Year
Product
Product ID
Body Type
Color
2005 Mustang FM05345 Convertible Red
2005 Viper DV73039 Convertible Red
2005 PT Cruiser CP0800 Convertible Red
2005 Beetle VB9068 Convertible Red
610
Object Attributes
Columns
Labels
AccountId
Amount
CampaignId
CurrentGenerators__c
DeliveryInstallationStat
ExpectedRevenue
ForecastCategory
HasOpportunityLineIten
Id
IsWon
LastModifiedById
Name
Description
CloseDate
CreatedById
CreatedDate
IsClosed
Use the up and down arrows on the far right to define the order of the columns. The filter at the top of the list will be the filter shown at the farthest left of the selection lookup table. Enter the label you wish to show at the top of the column.
Cancel
Previous
Finish

FIG. 6B

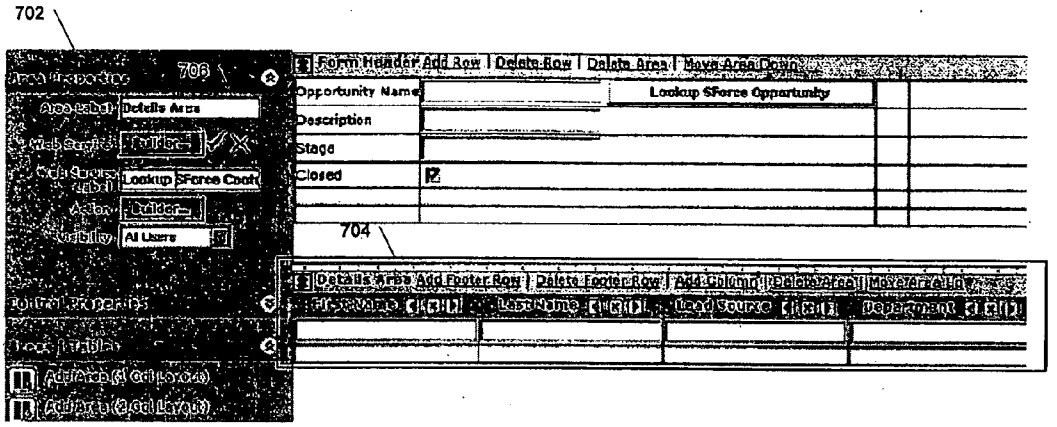

702
708
Form Header Add Row | Delete Row | Delete Area | Move Area Down
Opportunity Name
Lookup SForce Opportunity
Description
Stage
Closed
704
Default Area Add Footer Row | Delete Footer Row | Add Column | Delete Area | Move Area Up
First Name
Last Name
Lead Source
Department

FIG. 7

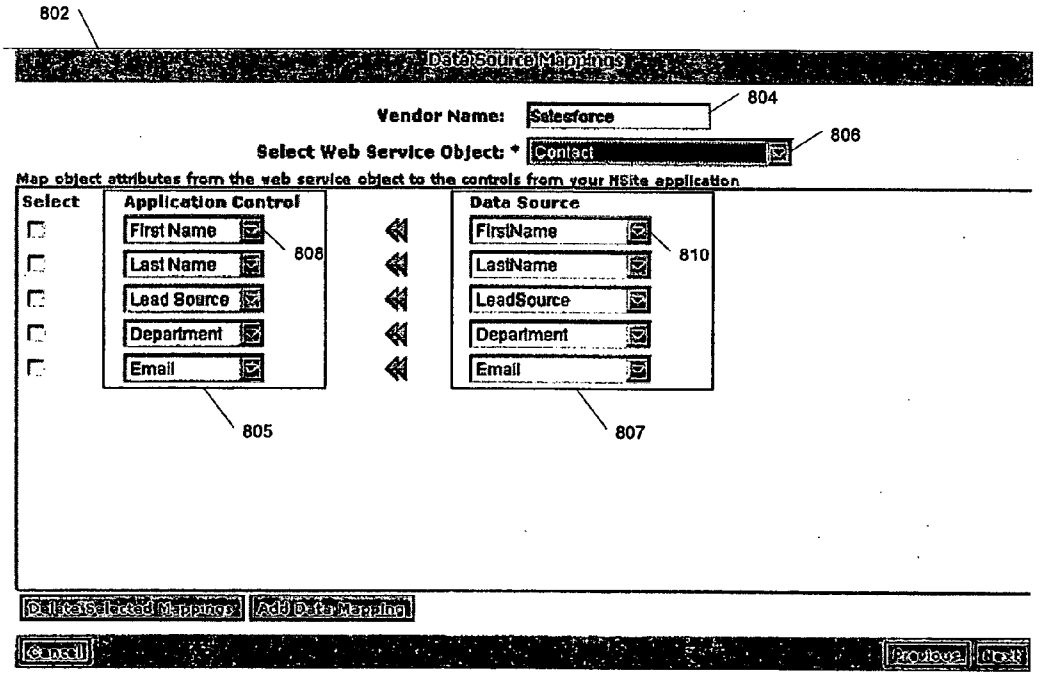

802
Data Source Mappings
Vendor Name:
Salesforce
804
Select Web Service Object: *
Contact
806
Map object attributes from the web service object to the controls from your HSite application
Select
Application Control
First Name
Last Name
Lead Source
Department
Email
808
Data Source
FirstName
LastName
LeadSource
Department
Email
810
805
807
Delete Selected Mappings
Add Data Mapping
Cancel
Previous
Next

FIG. 8

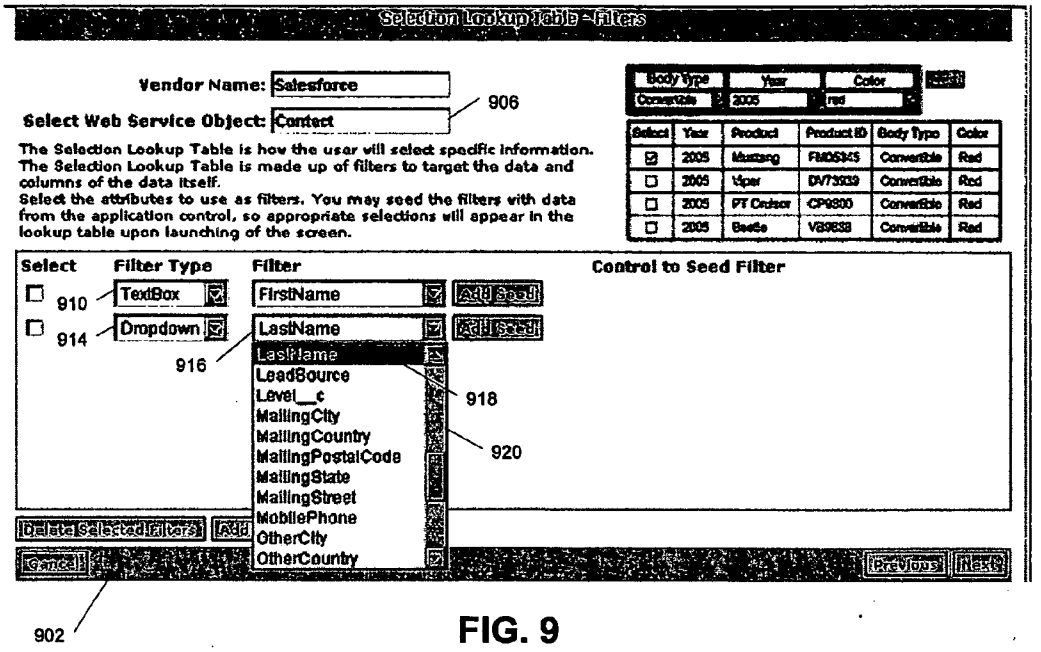

Selection Lookup Table - Filters
Vendor Name: Salesforce
Select Web Service Object: Contact
906
The Selection Lookup Table is how the user will select specific information. The Selection Lookup Table is made up of filters to target the data and columns of the data itself.
Select the attributes to use as filters. You may seed the filters with data from the application control, so appropriate selections will appear in the lookup table upon launching of the screen.
Select
Filter Type
Filter
Control to Seed Filter
910
914
TextBox
Dropdown
FirstName
LastName
916
LastName
LeadSource
Level__c
MailingCity
MailingCountry
MailingPostalCode
MailingState
MailingStreet
MobilePhone
OtherCity
OtherCountry
918
920
Delete Selected Filters
Add
Cancel
Previous
Next
902

FIG. 9

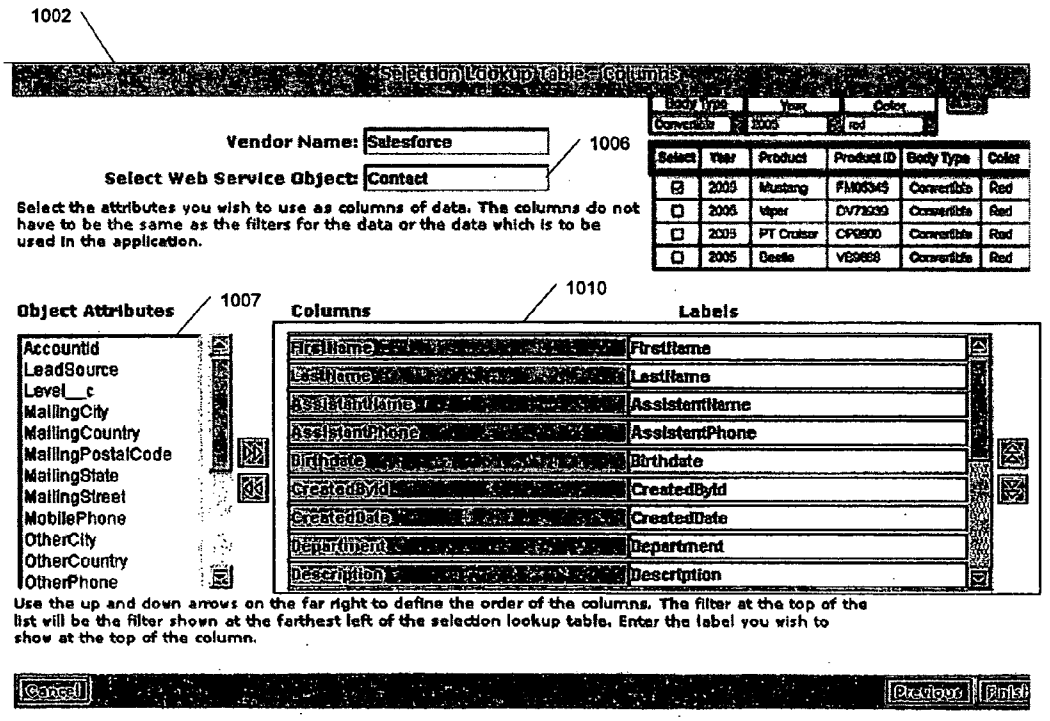

1002
Selection Lookup Table - Columns
Vendor Name: Salesforce
Select Web Service Object: Contact
1006
Select the attributes you wish to use as columns of data. The columns do not have to be the same as the filters for the data or the data which is to be used in the application.
Object Attributes
1007
Columns
1010
Labels
AccountId
LeadSource
Level__c
MailingCity
MailingCountry
MailingPostalCode
MailingState
MailingStreet
MobilePhone
OtherCity
OtherCountry
OtherPhone
FirstName
LastName
AssistantName
AssistantPhone
Birthdate
CreatedById
CreatedDate
Department
Description
Use the up and down arrows on the far right to define the order of the columns. The filter at the top of the list will be the filter shown at the farthest left of the selection lookup table. Enter the label you wish to show at the top of the column.
Cancel
Previous
Finish

FIG. 10

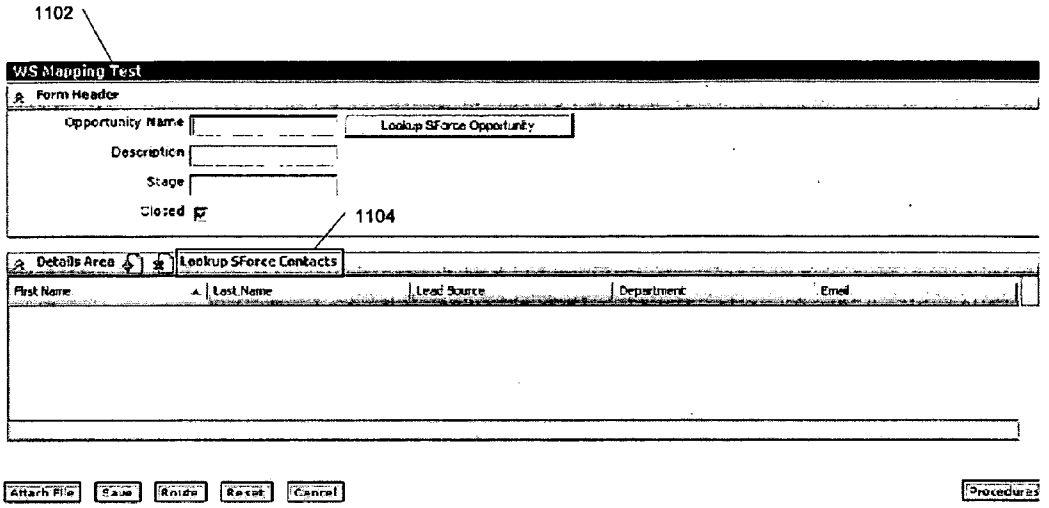

1102
WS Mapping Test
Form Header
Opportunity Name
Lookup SForce Opportunity
Description
Stage
Closed
1104
Details Area
Lookup SForce Contacts
First Name
Last Name
Lead Source
Department
Email
Attach File
Save
Reset
Cancel
Procedures

FIG. 11

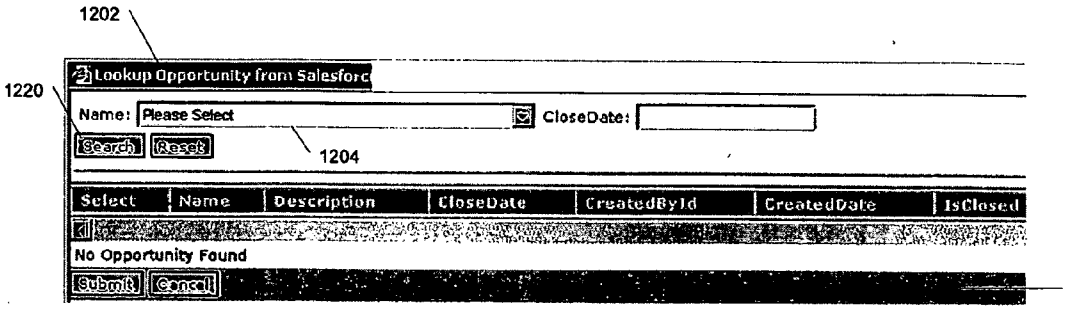


FIG. 12A

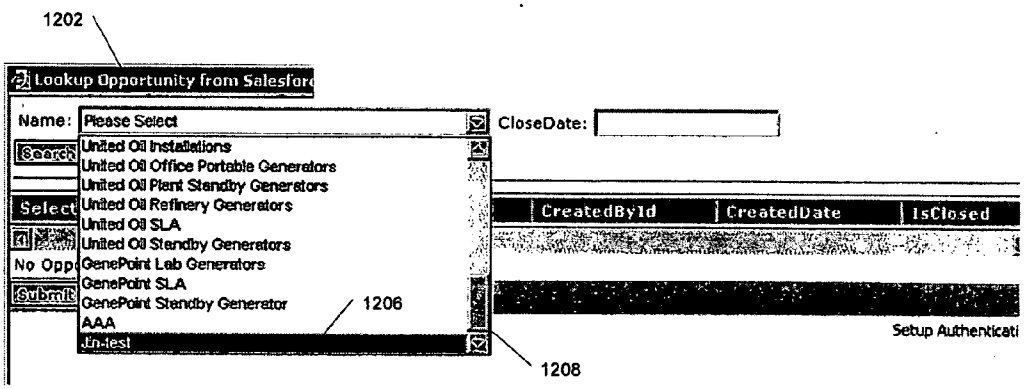


FIG. 12B

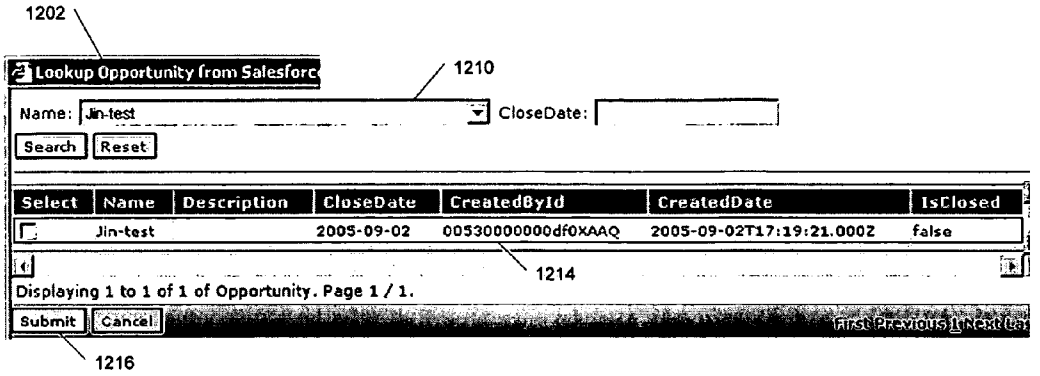


FIG. 12C

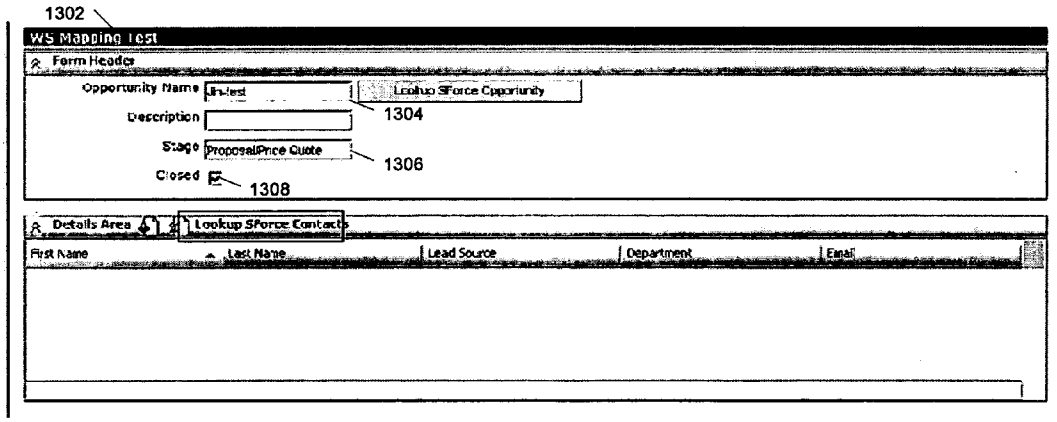


FIG. 13

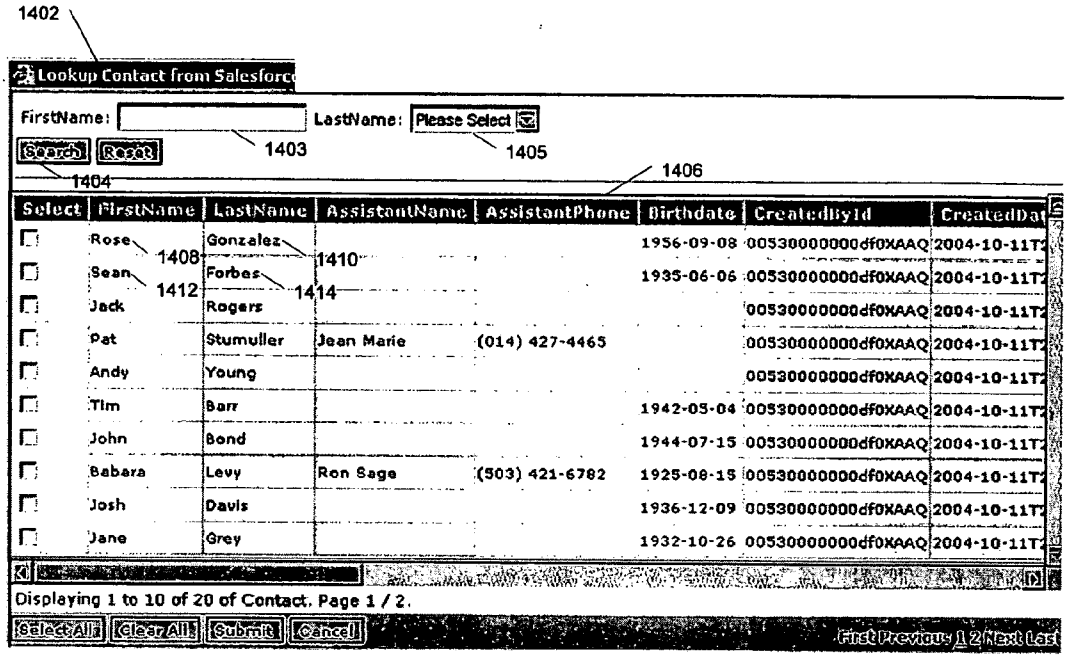

1402
Lookup Contact from Salesforce
FirstName:
LastName:
Please Select
Search
Reset
1403
1404
1405
1406
Select
FirstName
LastName
AssistantName
AssistantPhone
Birthdate
CreatedById
CreatedDat
Rose
Gonzalez
1956-09-08
00530000000df0XAAQ
2004-10-11T
1408
1410
Sean
Forbes
1935-06-06
00530000000df0XAAQ
2004-10-11T
1412
1414
Jack
Rogers
00530000000df0XAAQ
2004-10-11T
Pat
Stumuller
Jean Marie
(014) 427-4465
00530000000df0XAAQ
2004-10-11T
Andy
Young
00530000000df0XAAQ
2004-10-11T
Tim
Barr
1942-05-04
00530000000df0XAAQ
2004-10-11T
John
Bond
1944-07-15
00530000000df0XAAQ
2004-10-11T
Babara
Levy
Ron Sage
(503) 421-6782
1925-08-15
00530000000df0XAAQ
2004-10-11T
Josh
Davis
1936-12-09
00530000000df0XAAQ
2004-10-11T
Jane
Grey
1932-10-26
00530000000df0XAAQ
2004-10-11T
Displaying 1 to 10 of 20 of Contact. Page 1 / 2.
Select All
Clear All
Submit
Cancel
First Previous 1 2 Next Last

FIG. 14A

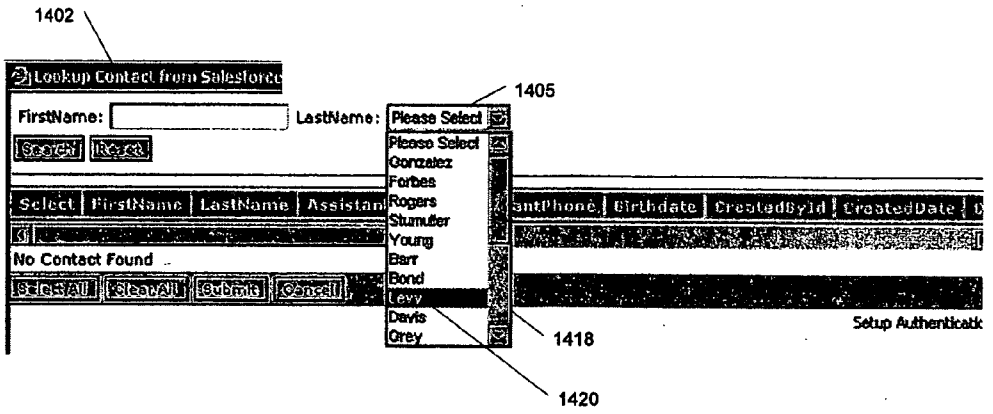


FIG. 14B

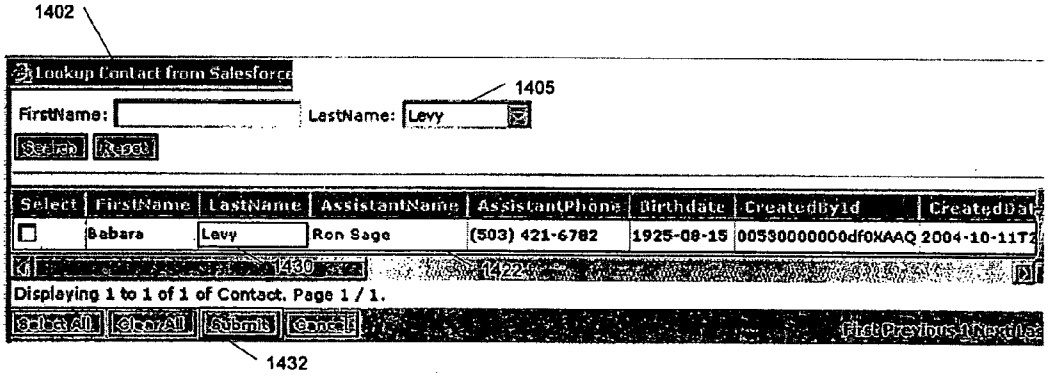


FIG. 14C

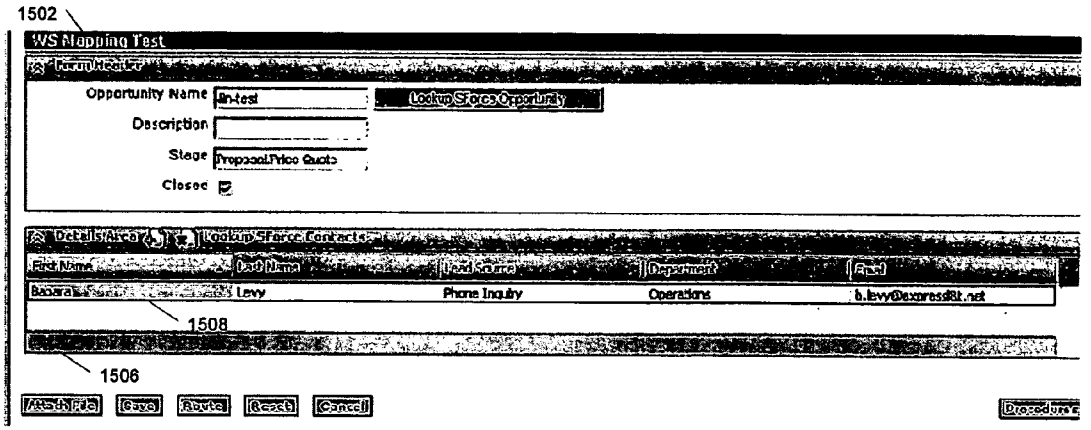

1502
WS Mapping Test
Opportunity Name
Description
Stage
Closed
Levy
Phone Inquiry
Operations
1508
1506

FIG. 15

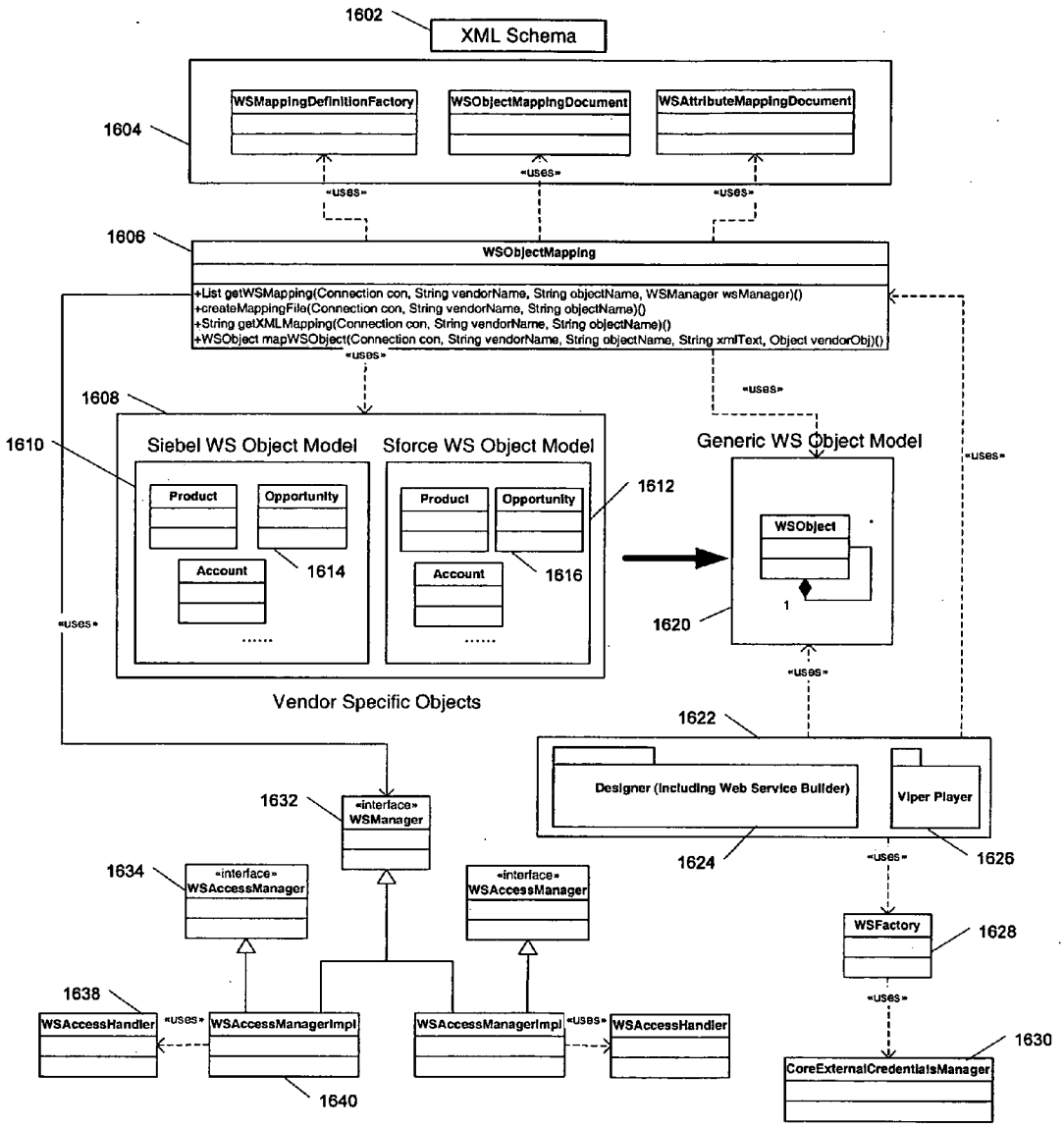

1602
XML Schema
1604
WSMappingDefinitionFactory
WSObjectMappingDocument
WSAttributeMappingDocument
«uses»
1606
WSObjectMapping
+List getWSMapping(Connection con, String vendorName, String objectName, WSManager wsManager)()
+createMappingFile(Connection con, String vendorName, String objectName)()
+String getXMLMapping(Connection con, String vendorName, String objectName)()
+WSObject mapWSObject(Connection con, String vendorName, String objectName, String xmlText, Object vendorObj)()
1608
1610
Siebel WS Object Model
Sforce WS Object Model
Product
Opportunity
Account
1614
1616
1612
Generic WS Object Model
WSObject
1620
Vendor Specific Objects
1622
Designer (including Web Service Builder)
Viper Player
1624
1626
1632
«interface»
WSManager
1634
«interface»
WSAccessManager
1638
WSAccessHandler
WSAccessManagerImpl
1640
WSFactory
1628
CoreExternalCredentialsManager
1630

FIG. 16

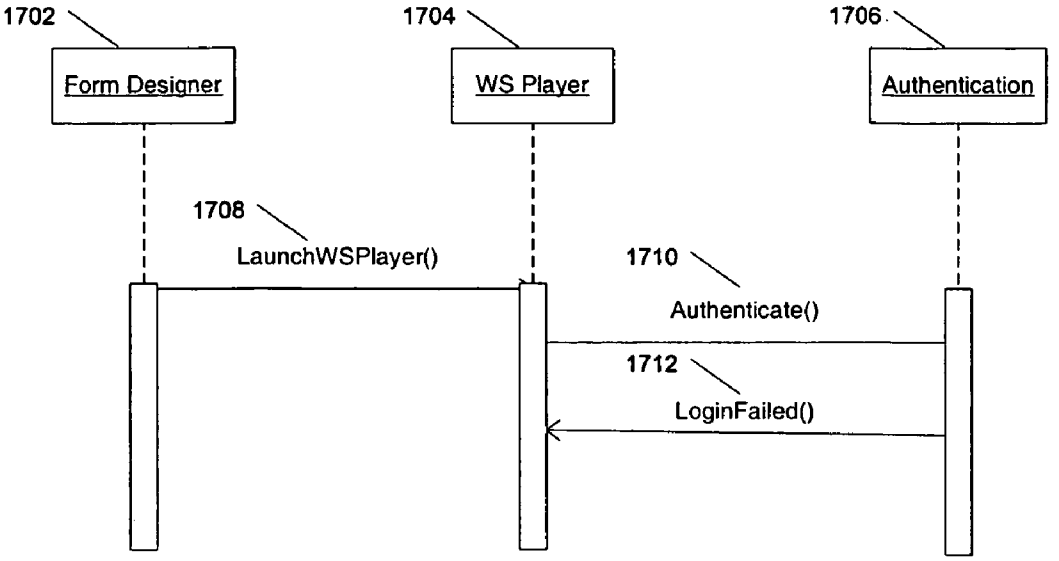

1702
Form Designer
1704
WS Player
1706
Authentication
1708
LaunchWSPlayer()
1710
Authenticate()
1712
LoginFailed()

FIG. 17

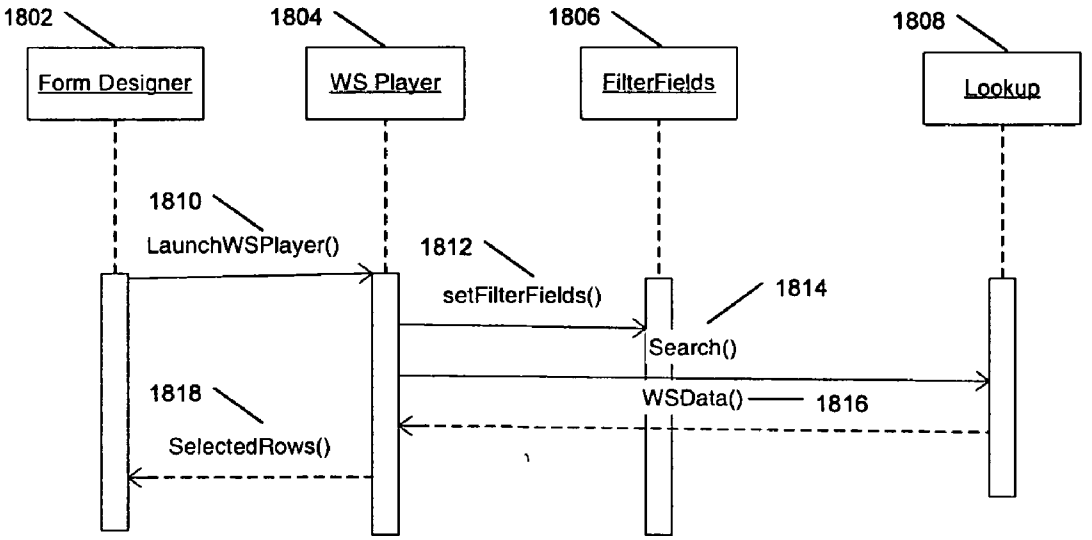

1802
Form Designer
1804
WS Player
1806
FilterFields
1808
Lookup
1810
LaunchWSPlayer()
1812
setFilterFields()
1814
Search()
WSData()
1816
1818
SelectedRows()

FIG. 18

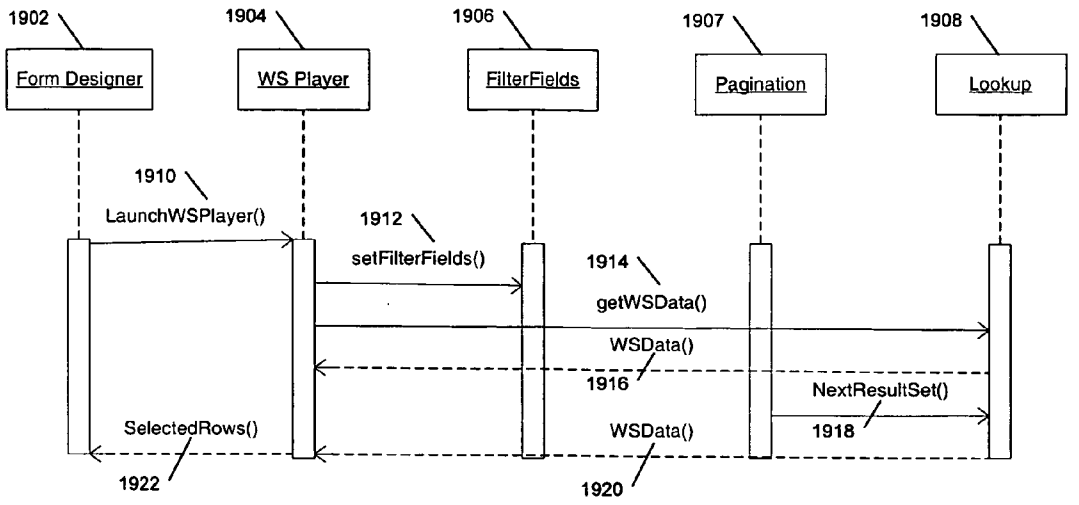

1902
1904
1906
1907
1908
Form Designer
WS Player
FilterFields
Pagination
Lookup
1910
LaunchWSPlayer()
1912
setFilterFields()
1914
getWSData()
WSData()
1916
NextResultSet()
1918
SelectedRows()
1922
WSData()
1920

Figure 19

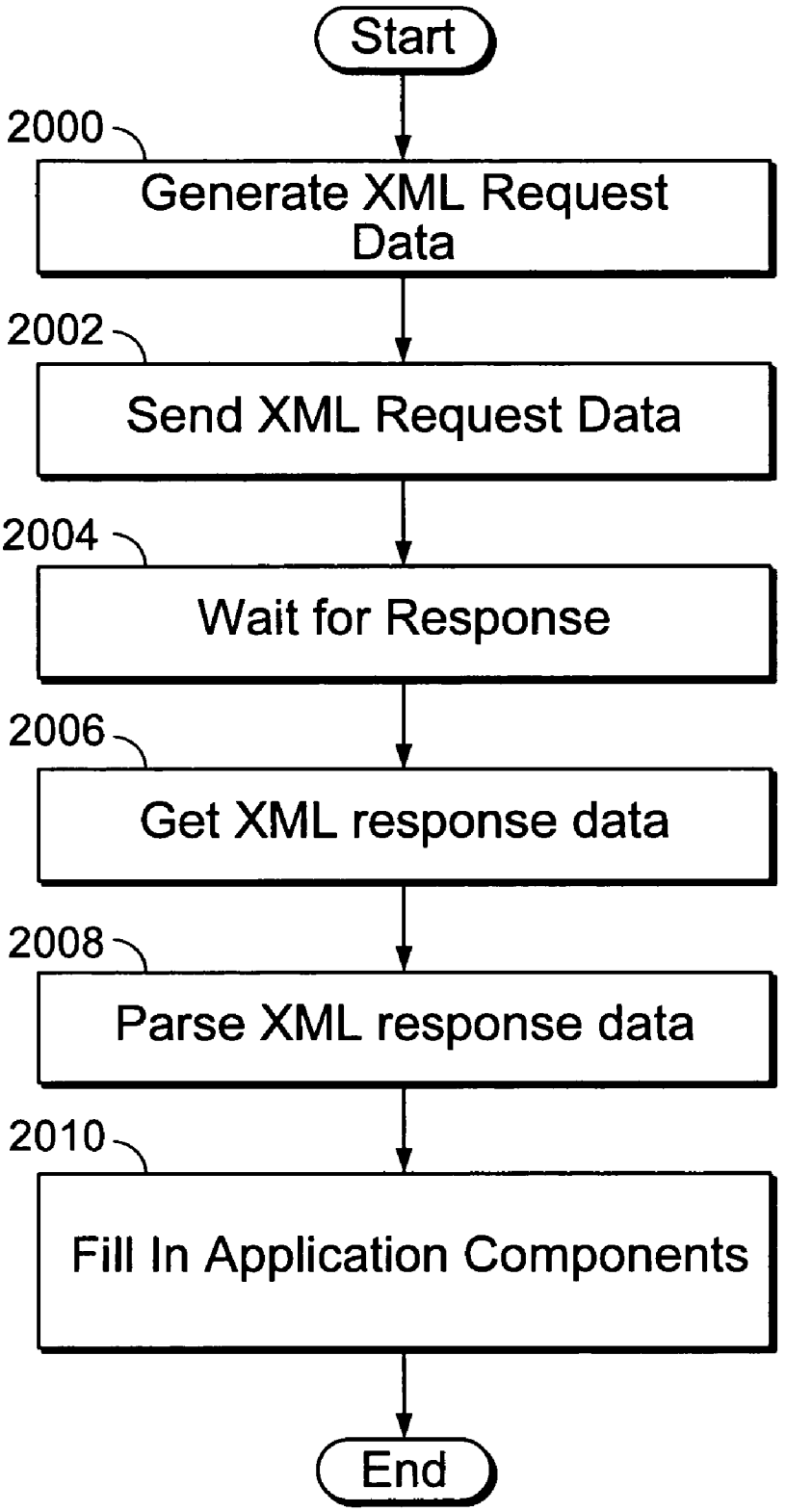

Start
2000
Generate XML Request Data
2002
Send XML Request Data
2004
Wait for Response
2006
Get XML response data
2008
Parse XML response data
2010
Fill In Application Components
End

FIG. 20

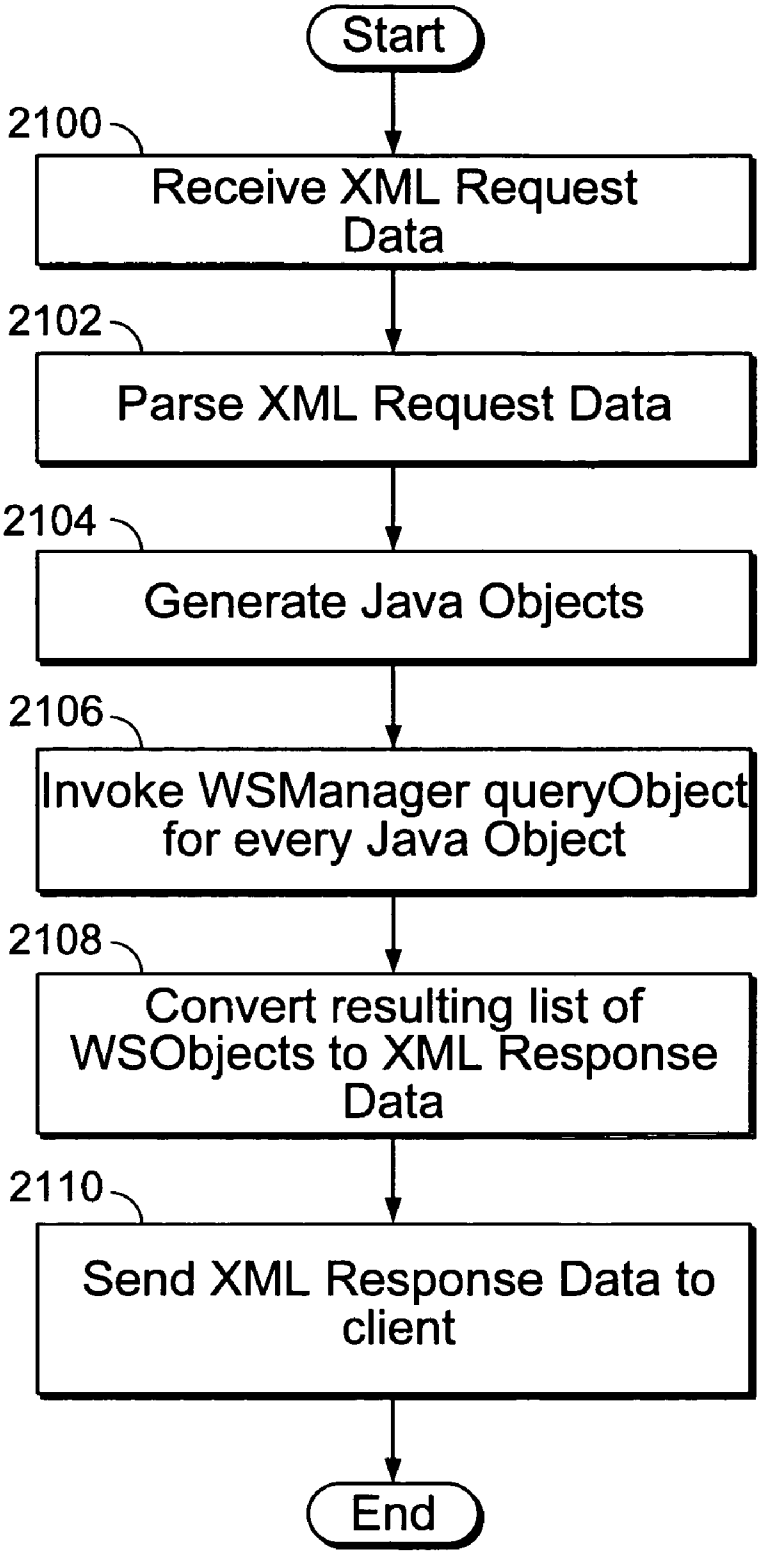

Start
2100
Receive XML Request Data
2102
Parse XML Request Data
2104
Generate Java Objects
2106
Invoke WSManager queryObject for every Java Object
2108
Convert resulting list of WSObjects to XML Response Data
2110
Send XML Response Data to client
End

FIG. 21

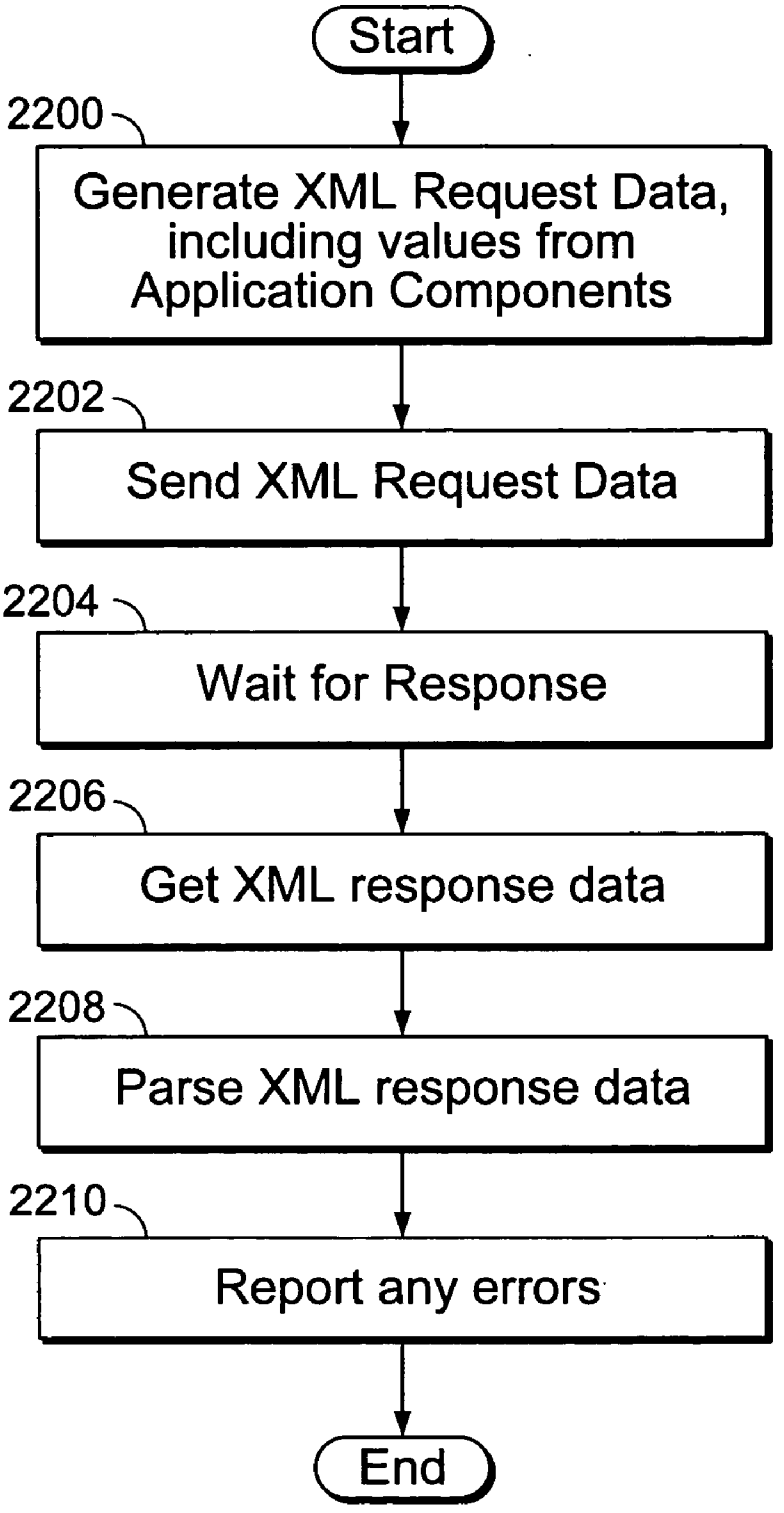

Start
2200
Generate XML Request Data, including values from Application Components
2202
Send XML Request Data
2204
Wait for Response
2206
Get XML response data
2208
Parse XML response data
2210
Report any errors
End

FIG. 22

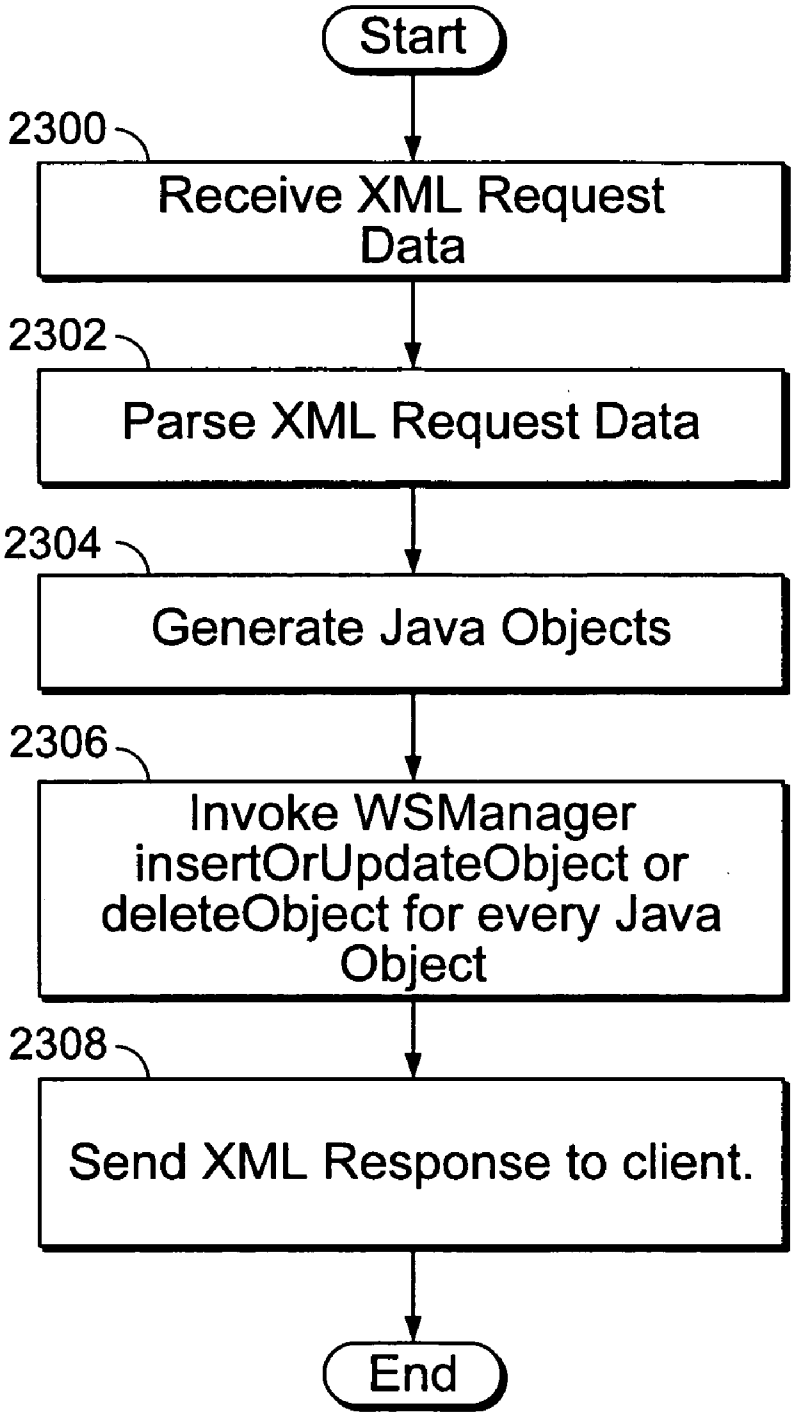

Start
2300
Receive XML Request Data
2302
Parse XML Request Data
2304
Generate Java Objects
2306
Invoke WSManager insertOrUpdateObject or deleteObject for every Java Object
2308
Send XML Response to client.
End

FIG. 23

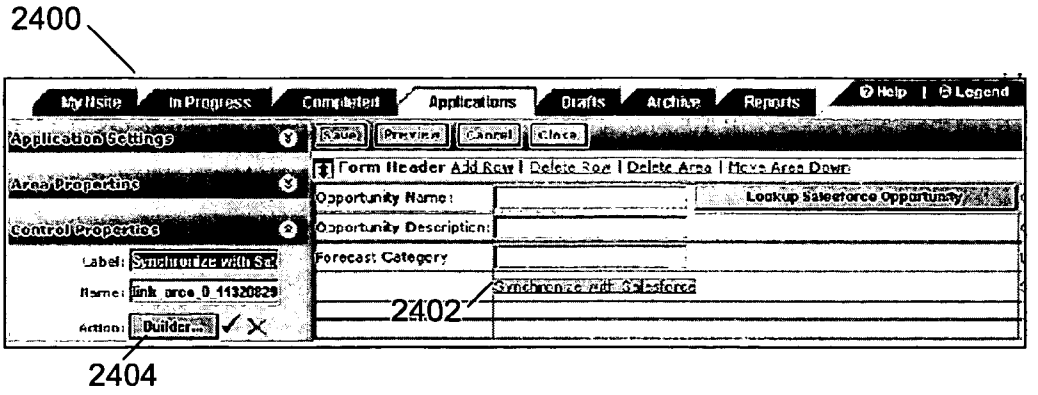

2400
My Site
In Progress
Completed
Applications
Drafts
Archive
Reports
Help
Legend
Application Settings
Area Properties
Control Properties
Label:
Name:
Action:
Builder...
Form Header Add Row | Delete Row | Delete Area | Move Area Down
Opportunity Name:
Lookup Salesforce Opportunity
Opportunity Description:
Forecast Category
2402
2404

FIG. 24

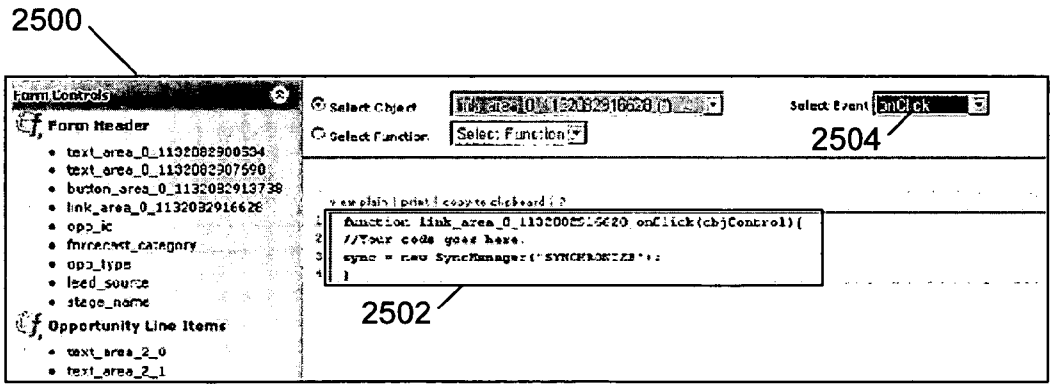

2500
Form Controls
Form Header
text_area_0_1132082900534
text_area_0_1132082907590
button_area_0_1132082913738
link_area_0_1132082916628
opp_id
forecast_category
opp_type
lead_source
stage_name
Opportunity Line Items
text_area_2_0
text_area_2_1
Select Object
Select Function
Select: Function
Select Event
onClick
2504
function link_area_0_1132082916628_onClick(objControl){
//Your code goes here.
}
2502

FIG. 25

DESIGNER AND PLAYER FOR WEB SERVICES APPLICATIONS

[0001] The specification includes Appendixes A, B, C, and D, which form part of the disclosure. Appendix A includes a schema describing the structure of an XML data mapping. Appendix B includes a format for XML-based invocations, and Appendix C contains an example invocation XML document. Appendix D contains an example XML description of attribute bindings, column bindings, and filters.

FIELD OF THE INVENTION

[0002] This invention relates to computers and the Internet, and more specifically to web services.

BACKGROUND

[0003] Web services are well known in the computer software field. Generally a web service is a computer application (software) component accessible over open protocols. Web services are intended for purposes of interoperability, for instance for enterprise application integration and business-to-business integration. This addresses the problem that enterprises (i.e., organizations) face in integrating their various software applications with one and other. Typically, even inside one organization there may be several computer systems even using different operating systems. These need to communicate and exchange information to serve the needs of the organization. This is exacerbated with cross-enterprise collaboration. Hence the need for interoperability. Web applications are also well known and are a type of distributed application built around web browsers. They typically use a computer language such as XML.

[0004] More precisely a web service is an application component that communicates via open protocols, processes XML messages, describes the messages using XML schema, and provides an endpoint description using WSDL. WSDL is the Web Service Description Language. WSDL makes it possible to describe an endpoint for a message and its behavior. WSDL layers additional information over the XML schema definitions that describe actual messages. Hence WSDL provides meta-information about, for instance, a computer file to be accessed.

[0005] Web services are web-based enterprise applications that use open XML standards and transport protocols to exchange data with calling clients (programs). The calling client may be at the same organization or at a different organization. Organization here does not necessarily refer to a particular business or legal entity, but instead any organization that maintains a networked computer system.

SUMMARY

[0006] In accordance with this disclosure there is provided a web services framework to support existing and future web service requirements. In one example the web services here are used with software objects such as software applications (i.e., programs) which carry out a business process. See commonly owned Patent Application entitled "Browser Based Designer and Player," filed Sep. 30, 2005, inventors Pawan Nachnani et al., Ser. No. 11/241,073, incorporated herein by reference in its entirety, which describes a method of building software applications. The sort of software applications disclosed in that Patent Application may also be used in the system of the present disclosure. The present inventors have determined that it would be useful to support web services in software applications, and other software objects, and executing same. Hence the present method and apparatus are directed to use of web services to make the web service a data source for a software application, and in one aspect to such use of web services in software applications built using the methods described in the "Browser Based Designer and Player" patent application referenced above. This use of web services may be in addition to sourcing data from a database supported by the same organization as the software application in question.

[0007] A goal is to access databases and/or business logic of other organizations via web services. Typically the web service is used to access objects, which may include data and operations (logic), in another organization's computer system. What is accessed is generally referred to herein as a software object. A software object includes data and/or operations from the other organization's computer system. The access is typically over the Internet but not so limited. The data source accessed may be a single field of data, a group of fields of data, or a table of data. Moreover there are provided adapters which allow access to web services supported by each of a number of different organizations each having a different type of computer system and/or database. In one embodiment the present system is hosted by yet a third organization which maintains a host server which includes a routing engine, a multi-tenant database and a process control module for web services.

[0008] By defining bindings between software objects such as application user interface components to other software objects such as web services or attributes of web services, one can build composite software applications which draw objects from several different organizations. These bindings can be represented as, for example, data in an Extensible Markup Language (XML) based format. Thus one software application can have objects drawn from a number of enterprises. In addition to the hosted server there is a player module which operates at runtime to run the application and a designer module which is the builder of the application. The adapters are provided for each accessed organization's objects because of differences in the objects and associated data. Typically there is at least one adapter for each web service vendor. Examples of web service vendors include Siebel® and Salesforce.com®. The present method accesses a WSDL (Web Service Definition Language) description for each vendor, this description being a standard metadata type well known in the field for describing web service interfaces. Typically there is one such WSDL description for each object or entity (enterprise or organization). Also included is a wizard which is part of the web services designer which creates the binding or mapping of meta-information to generate composite or other software applications. Typically the present system is coded in Java™, but is not so limited and is intended to be used via standard web browsers such as Microsoft Internet Explorer, again not so limited.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1**A is an illustrative drawing of a system for developing and executing browser-based applications.

[0010] FIG. **1**B is an illustrative drawing of a binding between an application component and a web service.

[0011] FIGS. 1C and 1D are illustrative drawings of an example binding between an application component and a web service.

[0012] FIG. 1E is an illustrative drawing of a flowchart of a process for defining a binding between an application and a web service.

[0013] FIG. 1F is an illustrative drawing of a flowchart of a process for defining a web service lookup in an application player.

[0014] FIG. 2A is an illustrative drawing of defining an application text input component in an Application Designer.

[0015] FIG. 2B is an illustrative drawing of defining an application button component in an Application Designer.

[0016] FIG. 3 is an illustrative drawing of defining a web service connection in a web services Designer.

[0017] FIGS. 4A-4D are illustrative drawings of binding an application component in a web services Designer.

[0018] FIGS. 5A-5B are illustrative drawings of adding filters in a web services Designer.

[0019] FIGS. 6A-6B are illustrative drawings of adding columns in a web services Designer.

[0020] FIG. 7 is an illustrative drawing of defining a table area in an Application Designer.

[0021] FIG. 8 is an illustrative drawing of binding application table columns in a web services Designer.

[0022] FIG. 9 is an illustrative drawing of adding filters in a web services Designer.

[0023] FIG. 10 is an illustrative drawing of adding columns in a web services Designer.

[0024] FIG. 11 is an illustrative drawing of an application in an Application Player.

[0025] FIGS. 12A-12C are illustrative drawings of a selection lookup table in a web services Player.

[0026] FIG. 13 is an illustrative drawing of an application in an Application Player with data retrieved from a web service.

[0027] FIGS. 14A-14C are illustrative drawings of a selection lookup table in a web services Player.

[0028] FIG. 15 is an illustrative drawing of an application in an Application Player with data retrieved from a web service.

[0029] FIG. 16 is an illustrative drawing of implementation interfaces and objects.

[0030] FIG. 17 is an illustrative drawing of a process for authenticating a user.

[0031] FIG. 18 is an illustrative drawing of a process for invoking a lookup.

[0032] FIG. 19 is an illustrative drawing of a process for processing multiple pages of results.

[0033] FIG. 20 is a flowchart of an exemplary portion of a method to be executed by a Designer or a Player for looking up web service objects.

[0034] FIG. 21 is a flowchart of an exemplary portion of a method to be executed by a server for looking up web service objects.

[0035] FIG. 22 is a flowchart of an exemplary portion of a method to be executed by a Designer or a Player for inserting, updating, or deleting web service objects.

[0036] FIG. 23 is a flowchart of an exemplary portion of a method to be executed by a server for inserting, updating, or deleting web service objects.

[0037] FIG. 24 is an illustrative drawing of a Designer user interface.

[0038] FIG. 25 is an illustrative drawing of a user-defined script in an action builder.

DETAILED DESCRIPTION

[0039] The following description is presented to enable one skilled in the art to make and use the present invention, and is provided in the context of particular uses and their requirements. Various modifications to preferred embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein and may be applied to other embodiments and applications without departing from the spirit and scope of the invention. Moreover, in the following description, numerous details are set forth for the purpose of explanation. However, one of ordinary skill in the art will realize that the invention, might be practiced without the use of these specific details. In other instances, structures and devices are shown in block diagram form in order not to obscure the description of the invention with unnecessary detail. Thus, the present invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

[0040] FIG. 1A is an illustrative drawing of a computer enabled system for developing and executing browser-based software applications. The system includes a Designer **104** and a Player **106**, as described in the commonly owned Patent Application entitled "Browser Based Designer and Player," referenced above. The Player **106** is a computer program that provides a user interface which executes a browser based application **111**, which can receive values from web services, send values to web services, and invoke other operations provided by web services. An exemplary Siebel web service **140** and an exemplary Salesforce web service **142** are shown. The Designer **104** is a computer program that provides a user interface which allows a user to create the application **111**. The Designer **104** and Player **106** execute in a conventional Internet Browser **101**, which may be, for example, Microsoft Internet Explorer or Mozilla Firefox™. Each element or component shown in FIG. 1A is a software computer program entity to be executed on a computer.

[0041] The Designer **104** and Player **106** are provided to the Internet Browser **101** by a server **120** as web pages. The web pages may be, for example, Java Server Pages (JSP) or Java Server Faces (JSF) pages, and may include HTML and JavaScript™ code that implements the Designer **104** and Player **106**. The server **120** may be, for example, an application server computer program such as JBoss® or the like. The server **120** communicates with the Internet Browser **101** via a network protocol, e.g., HyperText Transfer Protocol

(HTTP) or Secure HyperText Transfer Protocol (HTTPs). The components shown in the server **120** typically share a single address space and communicate with each other via function calls. The components shown outside the server **120** typically communicate with the server via a network protocol, such as HTTP for the Internet Browser **101**. Note that "server" here generally refers to software rather than to a physical computer.

[**0042**] Applications created by the Designer **104** are stored in Extensible Markup Language (XML) format as XML definitions **122** in a database **124**, and loaded into the Player **106** as the application **111**. The XML definitions are described in the aforementioned commonly-assigned patent application, and are described in more detail herein with respect to web services-related portions of applications. For the web services-based applications described herein, the XML definitions include bindings **102** which associate application components with web service object attributes.

[**0043**] The server **120** receives web service interaction requests from the Designer **104**, e.g., a request for a list of objects provided by a web service, and interacts with web services provided by specific vendors, such as the Siebel Web Service **140** provided by Oracle Corporation of Redwood Shores, Calif., and the Salesforce Web Service **142** provided by Salesforce.com of San Francisco, Calif. The server **120** communicates with the web services via a network protocol, such as Simple Object Access Protocol (SOAP), which may be based on the HTTP or HTTPs protocol. The server **120** includes components implemented in a computer programming language, e.g., Java™, C#™, or the like.

[**0044**] The components of the server **120** include a Generic Web Service Object Model **130** (also referred to herein as a Genetic WS Object or a WSObject), and a Web Service Factory Application Programming Interface **132** (also referred to herein as a WSFactory API). The WSFactory API **132** includes a WSObjectMapping **123**, which maps, i.e., converts, the Generic WS Object Model **130** (WSObject) to vendor-specific Application Programming Interfaces, such as a Siebel Web Service Adapter **134** for interacting with the Siebel Web Service **140**, and a Salesforce Web Service Adapter **136** for interacting with the Salesforce Web Service **142**. More specifically, the WSObjectMapping **123** generates the Generic WSObjects **130** for substantially all object types provided by a web service (e.g. an Opportunity object type that represents a sales opportunity). The mapping between the Generic WS Object Model **130** and the vendor-specific adapters, such as the Siebel WS (Web Services) Adapter **134**, is represented as a WS Object XML definition **126**, which is stored in the database **124**. The WS Object XML definition **126** is also referred to herein as an XML mapping file and is described in more detail below.

[**0045**] The adapters, e.g., the Siebel WS Adapter **134**, interact with the vendor specific objects **138** generated by, e.g., Apache Axis. Apache Axis is a programming tool available from the Apache Software Foundation. The vendor specific objects **138** are generated by a software tool, such as the Axis WSDL2Java command line tool, from vendor specific web service interface descriptions, as is known to those skilled in the art. The web service interface descriptions are typically provided by the web service vendor in a format such as WSDL.

[**0046**] The WSFactory API **132** includes a WSManager **127**, which has functions for querying, inserting, updating, and deleting objects provided by web services. The functions provided by the WSManager **127** are shown in Table 1.

TABLE 1

WSFactory Function	Description
queryObject	Get a list of instances of an object.
insertOrUpdateObject	Inserts or updates a specified instance with specified values.
deleteObject	Deletes a specified object.

[**0047**] In the WSFactory API **132**, web service data is represented as objects with attributes. In the user interfaces of the Designer **104** and Player **106**, these objects are presented to the user as rows in a table. Each row has one or more columns, which correspond to the attributes of the object. For example, there could be an object named Opportunity with attributes named OpportunityName and OpportunityId. There could be any number of Opportunity object instances in the web service, and each Opportunity object would have an OpportunityName and OpportunityId. These objects can be retrieved by the queryObject method, created or updated by the insertOrUpdateObject method, and deleted by the deleteObject method.

[**0048**] The queryObject method supports filter and column restrictions. A user can specify a filter to reduce the number of objects returned in the query, and a set of columns to reduce the number of attributes in each object returned in the query. For example, a filter restriction could indicate that only Opportunity instances for which the name contains the value "BigCo" are to be returned in query results. A column restriction could indicate that only the OpportunityName column is to be returned in query results. The filters and column specifications can thereby reduce the quantity of data retrieved from the web service.

[**0049**] The WSFactory API **132** creates an instance of the WSManager **127** for each type of adapter. The WSManager **127** invokes the adapters, e.g., the Siebel Adapter **134** and the Salesforce adapter **136**, to perform web service invocations in response to user requests. For example, when a user submits data values in an application, the WSManager **127** inserts into or updates the web service using the new values. As another example, when a user requests data in an application, the WS Manager **127** performs a lookup operation to query the web service for the data. The WSManager **127** may be invoked by the Designer **104**, e.g., to get a list of web service objects, or by the Player **106**, e.g., to submit or lookup data values. The WSManager **127** may also be invoked by a WSAjaxEventManager **118** to process requests from scripts, as described below with reference to AJAX.

[**0050**] The server **120** also includes a web services Credential Manager **128**, which manages security information such as user names and passwords. The security information is provided by a user and is in turn provided by the server **120** to the web services, e.g. the Siebel Web Service **140**, to authenticate the user.

[**0051**] A Web Services AJAX API and associated methods are provided for allowing scripts executed by the Internet Browser **101** to invoke server-side computer program code,

such as the WSFactory API. The Web Services AJAX API is provided because the commonly-used HTTP request/response communication model for retrieving web pages does not allow a client, e.g., a script or web page executing in the Internet Browser **101**, to invoke server-side logic at arbitrary times, without reloading the web page. However, such client invocations are useful because they allow a user to write scripts in a language such as JavaScript™ to customize the behavior of applications. The Web Services AJAX API allows users to write such scripts to customize application behavior by interacting with web services.

[**0052**] The Web Services AJAX API is based on the AJAX technique, which is known to those skilled in the art, for making asynchronous JavaScript invocations using XML between a browser and a web server. The asynchronous JavaScript invocations can be made at arbitrary times without requiring the web page displayed in the browser to be reloaded. In the AJAX-based invocation method, a script associated with an application component of the Application Player **106** can call programming interfaces of the server **120**, such as the WSFactory API **132**. For example, a user-defined script that is called when a button component is pressed can call the WSFactory API **132** to interact with web services, such as the Siebel web service **140** and the Salesforce web service **142**. The Web Services AJAX API uses an AJAX Engine **114**, which, as known to those skilled in the art, includes an XmlHttpRequest interface (not shown) that allows JavaScript code to send requests to and receive responses from a web server such as the server **120** without reloading, or changing the appearance of, the web page displayed in the Internet Browser **101**. The AJAX Engine **114** communicates with an NsiteAjaxManager **116** by sending and receiving an invocation XML document **117** containing interaction requests and responses via an HTTP connection. The NsiteAjaxManager **116** receives and responds to HTTP requests and may be, for example, a Java™ servlet. The NsiteAjaxManager **116** invokes a WSAjaxEventManager **118** of the server **120** via in-process procedure calls to perform web service invocations such as lookups, inserts, updates, and deletions as specified in HTTP request messages received by the NsiteAjaxManager **116** from the AJAX Engine **114**. The WSAjaxEventManager **118** in turn invokes the WSFactory API **132** to perform the requested web service interactions, and the WSFactory API **132** invokes the appropriate lookup, insert, update, or delete methods of the WSManager **127**.

[**0053**] The invocation XML document **117** is an XML-format representation of a web service interaction, such as a lookup, insert, update, or delete of data in a web service object. The invocation XML document includes a method name and parameters, encoded in XML format, which are extracted by a servlet in the NsiteAjaxManager **116**, and the NsiteAjaxManager **116** invokes the corresponding method of the WSManager **127** to perform the web service interaction specified in the invocation XML document **117**. Upon completion of the interaction, the WSManager **127** returns a result to the NsiteAjaxManager **116**, which encodes the results in a reply XML document **119**. The reply XML document **119** is sent back to the AJAX Engine **114** as a reply. The XML documents are transmitted between the NsiteAj axMAnager **116** and the AJAX Engine **114** using an XmlHttpRequest component (not shown), which is provided by the Internet Browser **101**.

[**0054**] The Designer **104** includes a web services builder **110**, which is a computer program that provides a user interface for defining web services interactions in browser-based applications **111**. The Player **106** executes browser-based applications **111**, which have application user interface components, such as text fields, for receiving data values from a user. Examples of applications **111** include forms-based applications for entering information about a sales opportunity or, as another example, for scheduling a medical procedure in a hospital. A WS Player **112** component of the Player **106** allows applications executing in the Player **106** to interact with web services by, for example, looking up a value from a web service and storing the value in an application component associated with the application **111**, or inserting, updating, or deleting a value in a web service object, where the value is specified by an application component. These web services interactions are performed according to bindings **102** defined by a user using the web services builder **110**.

[**0055**] The web services builder **110** allows a user to define bindings **102** between components of the application, e.g. buttons and tables, and web service attributes, e.g. values that can be stored in or retrieved from web services. Note that this application-to-web-service binding is essentially a mapping between objects and so is conceptually similar to the WSObject-to-vendor-object mappings described above as WS Object XML definitions **126**, but the two types of mappings are described separately herein for clarity. There is no requirement that the bindings **102** be represented using-the structures described herein. Other structures that represent the information contained in the bindings **102** could also be used. For example, the bindings **102** could all be represented by a single data structure.

[**0056**] FIG. **1**B is an illustrative drawing of a binding between an application component and a web service according to one example. The binding **193** associates a value **192** of an application component **170** with an attribute **155** of a web service **156**. The binding **193** is a two-way mapping which specifies that a particular web service attribute **155** can be set to the value **192** of the application component **170**, and, conversely, that the value of the application component **170** can be set to the value of the attribute **155**. The actual setting of these values occurs as part of a web service interaction such as a lookup, insert, update, delete, or user-defined interaction. The lookup interaction, which retrieves data from the web service **156**, causes the value **192** of the application component **170** to be set to the value of the attribute **155**. The insert and update operations, which send data to the web service **156**, cause the value of the attribute **155** to be set to the value **192** of the application component. The delete interaction causes a specified web service object to be deleted from the web service. User-defined interactions, such as invocation of web service methods, can be performed by the script **196**.

[**0057**] FIG. **1**B illustrates the flow of data between an application component **170** and the web service **156** via the WS Factory **120** according to one example. As described above with reference to FIG. **1**A, an application running in an Application Player **106**, which is in turn running in the browser **101**, interacts with the WS Factory **120** running in a server **120**. The application includes at least one application component **170**. The application component includes a value **192**, which is displayed to a user and may be set by a

user, e.g., as a value of a text box or of a drop-down list. The application component **170** may be associated with a script **196**, which is part of the application. The script **196** includes user-defined computer program code in a programming language such[]as JavaScript™ or the like. The script **196** can access, i.e., set and get, the value **192**, as shown by the arrow between the script **196** and the value **192**. The script can invoke the AJAX Engine **114** to perform web service interactions, such as setting and getting the value of a web service attribute **155** associated with a web service object **153** provided by a vendor web service **156**. The vendor web service as stated above may be, for example, a web service provided by Siebel Systems Inc., an entity of Oracle Corporation of Redwood Shores, Calif., or by Salesforce.com of San Francisco, Calif. Each vendor web service **156** typically has a vendor-specific data model, e.g., a model based on sales opportunities in the Salesforce web service, but it is desirable to allow the Designer **104** and Player **106** applications to work with multiple web services, typically provided by different vendors, that have different data models. To allow the Designer **104** and Player **106** to be vendor-independent and work with multiple web services without the need for vendor-specific code in the Designer **104**, the Player **106**, or the Internet Browser **101**, a Generic WS Object **130** is provided in the server **120**. The Designer **104** and Player **106** use the Generic WS Object **130** to interact with the vendor web service **156**, e.g., to set and get values of the vendor-specific attribute **155**. The WS Factory **120** maps the generic WS Object interface **130** to a vendor-specific object **154**, e.g., an Opportunity object generated by Axis from WSDL via a WSObjectMaping **123**.

[**0058**] The bindings **102** can be defined and associated with an application by a user using the web services builder **110** to enable the application to set and get values of the attribute **155** of the web service object **153**. Multiple bindings **102** can be associated with an application. In one aspect, a set of bindings **102** is associated with a user interface component, such as button or link, that, when selected by a user, causes a web service interaction such as a lookup or insert. A user defined script in a programming language such as JavaScript™ can also be associated with a user interface component. The user defined script can dynamically create bindings **102** while the application is running in the Player **106**, and can invoke any type of web service interaction, including lookups, inserts, updates, and deletes. Data values will be transferred between the application components and web service attributes specified in the bindings **102**, and the direction of data transfer will be determined by the user interface component or script that initiated the interaction.

[**0059**] The bindings **102** are represented in XML A binding between an application component and a web services object attribute is specified using XML: The XML element format for attribute bindings, column bindings, and filters is shown in Appendix D.

[**0060**] An attribute binding can be specified using a WSAttributeMapping XML element, which includes a formentity value that identifies the application component, and a wsattribute value that identifies the web service attribute bound to the application component. For example, Appendix D shows a WSAttributeMapping with a formentity=OppNameTextArea and a wsattribute=OppName, which means that the OppNameTextArea application component is bound to the OppName web service attribute. A list of multiple bindings can be specified as an XML WSAttributeBindingList, which is a list of WSAttributeMapping elements, each defining a binding.

[**0061**] A binding between a column of an application table and a web services object can be specified using a WSLookupTableColumn XML element, which includes a wsobjattribute that identifies the web service attribute bound to a table column, and a label that specifies a name for the column. For example, Appendix D shows a WSLookupTableColumn element with a wsobjattribute=OppName and a label=Name, which means that the OppName attribute is bound to a table column that corresponds to the WSLookupTableColumn element, and the table column's name is Name. A list of multiple column bindings can be specified as a WSTableBindingList, which is a list of WSLookupTableColumn elements, each defining a binding.

[**0062**] As introduced above with reference to the WSFactory API **132**, a filter can be defined to reduce the quantity of data to be retrieved from a web service. A filter can be specified as a WSFilterField element, which includes a filterfieldwsattribute that specifies a web service attribute, an optional formentity that specifies an associated application component, and a filterfieldtype that specifies the type of filter, e.g., attribute-based or condition-based. Condition-based filters are specified using logical conditions similar to those used in where clauses in the well-known Structured Query Language (SQL). An attribute-based filter specifies an attribute of the web service for which filtering can be performed by a user of the WS Player **112**. For example, Appendix D shows a WSFilterFeild element which includes a filterfieldwsattribute=OppName, which means that filtering is to be applied to lookups so that a user of the WS Player **112** can restrict the web services objects that will be retrieved to those for which the OppName attribute has a specified filtering value. The WSFilterField element also includes a filterfieldtype=Dropdown, which means that the attribute filter will appear as a drop-down menu in the WS Player **112**. The drop-down menu will include a list of possible values for the OppName attribute, and the user will be able to select a value from the drop-down menu to use as the filtering value. A user of the WS Player **112** can then select a value from the drop-down menu to cause the WS Player **112** to retrieve objects for which the corresponding attribute is equal to the selected value from the web service.

[**0063**] The bindings **102** are used by the WS Player **112** when a web service interaction is performed, e.g., in response to a user selecting a web services trigger component, such as a button, in the WS Player **112**, as follows. When a lookup interaction is performed, e.g., in response to a user of an application **111** running in the WS Player **112** pressing a button for which bindings **102** have been defined using the WS Builder **110**, the bindings **102** associated with the application component are executed by setting the value of each bound application component to the value of the corresponding attribute., where the corresponding attribute is specified in the binding.

[**0064**] When an insert or update interaction is performed, e.g., when a user submits an application page that includes data to be saved to the web service, the bindings **102** of the application are executed by setting the value of each bound

attribute the value of the corresponding application component., where the corresponding application component is specified in the binding.

[0065] There is also a synchronize interaction, which is a combination of the insert or update interaction and a delete interaction. When a synchronize interaction is performed, e.g., when a user clicks a button that is associated with a script that invokes a synchronize operation, the bindings **102** of the application **111** are executed as shown by the pseudo code representation in Table 2.

TABLE 2

```
for each binding in the application,
        if the binding is for an application table then
                for each row in the application table
                    if the current row is bound to an existing
web service object and the attributes have been changed in the
application table then
                        update the existing web service object
with the new attributes
                    end if
                    if the current row is new then
                        insert a new web service object with
the column values in the application table
                    end if
                    if a row has been deleted from the
application table then
                        delete the corresponding web service
object
                    end if
        end if
        if the binding is for a group of components then
                update the corresponding web service object with the
new attributes from the group of components
        end if
    end for
```

[0066] FIG. **1**B shows how data is transferred between the application component **170** and the vendor web service **156**. A value **192** of the application component **170** can be retrieved from the web service **156** by a lookup interaction, as shown by the arrow **191** from the attribute **174** of the Generic WS Object **130**. The mapping **175** specifies that the value of the attribute **174** can be transferred or copied to the application component value **192** when a lookup operation is performed. The lookup operation can be invoked by the WS Player **112** in response to a user request. The lookup operation can also be invoked by a user-defined script **196** at any time during execution of the application. Conversely, the mapping **175** also specifies that the value **192** can be copied to the attribute **174** when an insert or update operation is performed. As with the lookup operation, the insert or update operation can be invoked by the WS Player **112** in response to a user request. The insert or update operation can also be invoked by the user-defined script **196** at any time during execution of the application.

[0067] A binding **175** associates a text area component of an application with a Name attribute of a Sales Opportunity web service object. A user of the application player **106** can lookup values for the application component (e.g., the text area), from the associated web service attribute, as well as insert the application component's value into the web service attribute and delete a value from the web service. Those web services interactions can be defined using the web services builder **110** of the application designer **104**, typically by using the web service builder **110** to associate web service bindings **175** with a button component of the application **111**. The web services builder **110** can be used to bind an application component to an attribute of a web service, and specify whether the interaction type is lookup, insert, modify, or delete. Users can define additional types of interactions by providing a script **115** to be executed as a computer program as part of the application **111**. The script may include, for example, code in the JavaScript™ language. The script **115** is associated with a component (not shown), e.g., a user interface component, of the application **111**, and can access the values of application components. The script can also invoke web services, as described elsewhere herein.

[0068] FIG. **1**C is an illustrative drawing of an example binding **175** and interactions between an application component and a web service. A lookup **181** is performed in response to a user's request, e.g., a user pressing a Search button, followed by an update **185** performed by a script **183** which invokes a SyncManager("SYNCHRONIZE") call. Note that other combinations are possible. This combination is shown as an illustration. In general, as shown in FIG. **1**B, a lookup can be invoked by either a user action or a script, and an insert or update can be invoked by either a user action or a script. This figure shows a lookup **181** invoked by a user action, followed by an update **185** invoked by a script **183**. The lookup **181** transfers data from the web service **147** to the application component **170**, and the update **185** transfers data in the opposite direction. A binding description **172** is also shown. The binding description **172** illustrates that the binding **175** is represented as an association between a component **145**, named OppNameTextArea, and a web service attribute **146**, named OppName.

[0069] FIG. **1**D is an illustrative drawing of an example binding and interactions between an application component and a web service. FIG. **1**D shows the combination of a lookup **186** performed by a script **187** which invokes a SyncManager("QUERY") call, and an update **189** performed in response to a user action, e.g., a user pressing a Submit button. The lookup **186** retrieves the value **182** of the application component **170** from the Generic WS Object **130** identified by the binding **175**. The update **189** sets the value of the attribute **180** of the Generic WS Object **130** to the value of the value **182** of the application component **170**.

[0070] For lookup interactions, when an application is executed in the Player **106**, a user may press a button component previously associated with a web service binding to query the web service and display a list of one or more values returned by the web service according to the binding. The user can then select a value from the list, and the selected value will appear in the corresponding application component. The list of values is referred to herein as a Selection Lookup Table.

[0071] A web service object, such as the Sales Opportunity object, may have multiple instances, e.g., multiple sales opportunities, in which case a user may select one or more instances in the application player **106** as the values to be used for the application. Filters can be defined in the web services builder (typically after defining the bindings), to restrict the displayed instances of a web service object to a subset of all instances according to a condition. For example, a filter may restrict the sales opportunities to be displayed to those in a specific country by specifying a specific value for a country attribute. The set of attributes to

be displayed in the Selection Lookup Table can also be restricted to a subset of all attributes by defining specific columns to be displayed. For example, the country attribute could be excluded from the attributes displayed by excluding the country column in the web services builder.

[0072] The WS Player **112** uses binding information that establishes a mapping between WS object attributes and application components to display a Web Service lookup user interface for storing or retrieving the values of those components to or from web services. The binding information is stored in the Application XML Definitions **122**.

[0073] The web services player **112** is launched by the application player **106** when a user clicks on a component that has been configured to invoke a web service by the web services builder **110**. Components that can be configured to invoke a web service include button components and area components. The WS Player **112** uses the information stored in the WSBuilderObject to render its own user interface components. The WS Player **112** presents a Selection Lookup Table user interface component, which allows a user to select any number of data rows returned from a Web Service. The selected rows will be passed to the WS Player **112**, and, in one example, included in application user interface components which have been previously bound to the Web Service.

[0074] One approach to invoking the web service object would be to call vendor-specific objects directly from applications. That approach requires the application to know details about each vendor specific object, and ties the application to a particular web services vendor. Therefore a generic web services object is introduced. Each vendor-specific object is mapped to the generic web services object by a definition stored in an XML mapping file. Applications interact with the generic web services object and need not contain hard-coded dependencies on vendor specific objects.

[0075] The generic web services object is represented in the Java™ programming language by the WSObject class. Note that although the Java™ language is used in this description, any programming language may be used to implement the features described herein. The WSObject class represents each attribute of a vendor-specific Web Service object as a vendor-independent generic object. An instance of the WSObject class can includes an arbitrary number of fields, which are stored in a list. A pseudocode definition of the structure of the WSObject class is shown in Table 3.

TABLE 3

```
public class WSObject {
    public String Vendor;          // Web Service vendor name
    public String objectName;      // Web Service object name
    public String xmlMapping;      // xml mapping for WS object
    public ArrayList object;       // list of object fields
    public Object getFieldValue(String fieldName) {.....}
}
```

[0076] The getFieldValue method returns the value of a field (also referred to herein as an attribute), where the field is specified by a field name. The WSObject's Vendor attribute is set to the vendor name, and the WSObject's objectName attribute is set to the vendor-specific object name. Each vendor-specific object is mapped to a corresponding generic web services object by defining a mapping (also referred to herein as a binding) which maps each attribute in the vendor specific object to a corresponding field in the generic web services object. The binding is represented as an XML mapping document. The xmlMapping attribute of a WSObject contains the XML mapping document for that WSObject. A WSObject has all the information needed to represent a vendor specific object's attribute names and values.

[0077] A Generic WS Objects **130** is created by a WSFactory **132** based on a URL supplied to the WS Factory **132**. The URL refers to a web service provided by a particular vendor, such as a Siebel Web Service **140** or a Salesforce Web Service **142**. The WSFactory **132** retrieves objects from the web service via a communication protocol such as SOAP (Simple Object Access Protocol) over HTTP (HyperText Transfer Protocol). The WSFactory **132** uses an Apache Axis interface library or the like to read the objects, and uses-a vendor-specific adapter such as a Siebel WS Adapter **134** or a Salesforce WS Adapter **136** to create the Generic WSObject(s) **130** that corresponds to the objects read from the web service, e.g. the Siebel Web Service **140**. The Adapter objects include vendor-specific types and functions for accessing the vendor-specific web services. The Generic WS Objects **130** provide a generic object model which does not have any vendor-specific types or functions. Instead, the names and types of vendor-specific web services attributes are represented in the WS as data, particularly as XML data. Therefore, applications such as the Designer **104** and the Player **106** can interact with a web service from any vendor without modification of the applications themselves. For example, if a third vendor Web Service, e.g., an Oracle Web Service (not shown) were available, then the existing Designer **104** and Player **106** would be able to interact with the Oracle Web Service if an Oracle WS Adapter (not shown) were added between the WSFactory **132** and the Apache Axis **138**.

[0078] The most common form of interactions between applications in the browser **101** and web services such as Siebel web services **140** is the interaction through the Generic WSObjects **130** and the WSFactory **132** as described above. Those interactions can be implemented for common uses of application components, e.g. getting and setting data values, by the Designer **104** and Player **106**, in which case the user defines the interactions using the Application Designer **104**. However, it is also desirable to allow users to define program scripts, i.e., code logic, as part of the applications to perform custom behavior, and to allow that logic to invoke web services. User-defined scripts can invoke web services using an AJAX-based API (application programming interface). The user defines such scripts by associating script code with application components using an action builder portion (not shown) of the Designer **104**. As introduced above, the AJAX-based API passes web services invocations from the browser **101** to the WSFactory API **132** via an AJAX Engine **114** embedded in the browser **101**, an NsiteAjaxManager **116** that communicates with the AJAX Engirie **114**, and a WSAj axEventManager **118** which is included in the WSFactory **120** and communicates with the NsiteAjaxManager **116**. The AJAX-based API also receives responses from web services invocations from the WSFactory. These web services invocations and responses are passed between the AJAX-based API and the WSFactory as data in an XML format. The XML format is shown in

Appendix B, and an example of an XML document passed via AJAX is shown in Appendix C.

[0079] A web service invocation can also be made from the Internet Browser **101** by a call embedded in the web page, e.g. a Java™ language call embedded in a Java™ Server Page (JSP) that provides the application player **106**. Such an invocation is included in the web page sent by the server to the Internet Browser **101**

[0080] For example, consider a mapping between an exemplary vendor specific Account object and a generic WSObject. The exemplary vendor-specific Account object has a Name attribute and a LastModifiedDate attribute. A Java™ class definition representing the exemplary vendor-specific Account object is shown in Table 4.

TABLE 4

```
public class Account {
    java.lang.String Name;
    java.util.Calendar LastModifiedDate;
}
```

[0081] The XML mapping file defines a mapping between each attribute of a generic class such as the Account class shown above, and a class or classes in the specific web service vendor's interface. For example, for the Account class shown above, the XML mapping file defines a mapping between the generic Account class and a vendor-specific class named com.aspecificvendor.soap.enterprise.object.Account. The XML mapping file also defines a mapping between each attribute of the generic class and an attribute of the vendor specific class or classes. For example, the Name attribute of the generic Account class is mapped to an attribute named object**0** of the vendor specific class. The XML Mapping for the Account object is shown in Table 5.

TABLE 5

```
<?xml version="1.0" encoding="UTF-8"?>
<WSObjectMapping xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:noNamespaceSchemaLocation="WSMapping.xsd"
wsvendorname="ASpecificVendor"
wsobjectname="com.aspecificvendor.soap.enterprise.object.Account" >
    <WSAttributeMapping wsattributename="Name"
wsattributetype="java.lang.String" wsobjectattributename="object0"
/>
    <WSAttributeMapping wsattributename="LastModifiedDate"
wsattributetype="java.util.Calendar"
wsobjectattributename="object3" />
</WSObjectMapping>
```

[0082] The Designer **104** uses the XML file to decide the meaning of attributes for the generic WS object. The XML mapping file can be generated automatically from the vendor specific WS object and WSDL definition by using a program named WSFactory.

[0083] The mapping between generic objects and specific web service vendor objects allows the Player **106** to query a vendor specific object for records, i.e., rows of data, or object instances. A function named getWSMapping is defined internally for querying vendor specific objects for all records. The getWSMapping function takes a vendor name, an object name, and a WSManager as parameters, as follows:

[0084] public List getWSMapping(Connection con, String vendorName, String objectName, WSManager wsManager)

[0085] The getWSMapping function returns a list of WSObject objects. Each vendor specific object returned from the web service call is mapped into a WSObject and put in a list and returned to the caller. If an attribute in a vendor specific object is another vendor specific object then the child vendor specific object is mapped into a generic WSObject and assigned to the corresponding attribute in the parent WSObject to form a nested WSObject.

[0086] Now consider the vendor-specific Account object mentioned above. A vendor-specific Account object returned by a web service call will be mapped to a WSObject object that contains values as shown in Table 6.

TABLE 6

Data Member	Value
Vendor	A vendor name.
objectName	A name for the object. For example, com.aspecificvendor.soap.enterprise.object.Account
xmlMapping	the xml mapping file for the object
object[0]	A String object with the value of the Name attribute from Account object
object[1]	A calendar object with the value of the LastModifiedDate attribute from Account object

[0087] The structure of the XML mapping file is described by the XML schema shown in Appendix A. As specified by the schema, the WSObject definition includes a set of WSObjectMapping and WSAttributeMapping XML elements.

[0088] The WS Player **106** has four user interface sections, which are an Authentication Section, a Filter Fields section, a Lookup Table section, and a Pagination section.

[0089] In the Authentication section, the user enters login credentials such as username, password and the Web Service URL, which is an Internet address of a web service. The user will be authenticated against the Web Service vendor with the login credentials. The filter fields and the lookup columns will be displayed only if the authentication is successful, i.e. the Web Service vendor accepts the logic credentials as valid.

[0090] The Filter Fields section defines filter fields based on which Web Service objects will be queried. Filter Fields allow the user to narrow the result set if the number of web services objects is too large. The filter fields also include custom fields.

[0091] The Filter Fields section is constructed from values selected by the user. The user can select values for filter fields from a list of values, or alternatively enter filter values in text boxes. The lookup data retrieved from the Web Service will be filtered so that only data matching the filter fields is displayed in the Selection Lookup Table of the Player **106**. If multiple filter fields are selected, the query string will be an AND expression of the selected filter fields. If the user does not select any value for a filter field, that field will not be included in the search query.

[0092] The lookup table section will be constructed from the values selected by the user in step **4** in the WSBuilder.

The first column in the table will be a checkbox which will allow the user to select the rows to be inserted into the application. Then all the columns selected by the user in the WSBuilder are displayed. If all the columns do not fit into the page then horizontal scrolling is used. If the WS Player **112** is launched from a Button or Link then the user can select only ibe row from the table and the data from that row will be used to populate the fields in application. If WS Player **112** is launched from a table then the user can select multiple rows and the table in the application will be populated with the values from selected rows. If a lookup column is selected as sortable in the WSBuilder then the result set can be sorted by that column.

[**0093**] When the query is complete we will be returning a generic a list of WSObject to the WS Player **112**. The WS Player **112** will use the WSObject and the XMLMapping file for the corresponding object to populate the lookup table.

[**0094**] In the web service lookup table, a number of records will be displayed per page. After the lookup table the page numbers and page navigation links are displayed. Information about the current rows and the current page number are displayed on the left side. For example the string will be "Displaying 1 to 10 of 20 Products. Page 1/2". The navigation links are displayed on the right side such as "First Previous 1 2 3 n Next Last". A lazy fetch method is used to retrieve the data from the WS server so that performance is not affected. When the last page of the current result set is reached a new web service call is made to get the next batch of result set data.

[**0095**] A web service vendor may have a size attribute which indicates the total number of records that will be returned by the query. This attribute can be used to find out the total number of pages that the result set will occupy. For example if the query returns 125 records and the display size is 10 records per page, then there will be 13 pages. The number of records returned by the query can be controlled by the attribute batchsize. After the end of the current result set, a subsequent call to a query method returns the next result set.

[**0096**] If the web service vendor does not have an attribute which indicates the total number of records that will be returned by the query, then the WS Player **112** will not display a "Last" link in the navigation section for that vendor. The query method has a parameter called startRowNum which determines which result set will be fetched.

[**0097**] There are two types of Web service lookups. The first type of lookup retrieves, updates, or inserts at most one row of data from a web service, e.g. a set of attributes for a single object instance. The first type of lookup is referred to herein as a header lookup and is typically associated with a component, such as a Button, in the application. In the Player **106**, a Selection Lookup Table for a header lookup can be displayed by clicking a Web Service builder link that appears in the component properties panel. In the Selection Lookup Table of the Player **106**, only a single row of data can be selected for a header lookup.

[**0098**] The second type of lookup retrieves, updates, or inserts any number of rows of data from a web service, e.g. sets of attributes for multiple object instances. The second type of lookup is referred to herein as a table lookup and is typically associated with an area that has a table. In the Player **106**, a Selection Lookup Table for a table lookup can be displayed by clicking on a Web Service builder link that appears in the area properties panel.

[**0099**] FIG. **1**E is an illustrative drawing of a flowchart of a process for defining a binding and a lookup between an application and a web service. The web services builder **110** of FIG. **1**A leads a user through this process. The process begins at block **160** by establishing a connection to a web service, e.g. to a Siebel or SAP web service. Next, at block **161**, the user selects a particular web service object and defines bindings. When a user selects an object, the web services builder **110** displays a list of attributes for the object and allows the user to define bindings between the attributes and components of the application. The binding specifies how an application interacts with the web service as described elsewhere herein. At block **162**, the web services builder **110** allows the user to define filters which restrict the data that will be displayed when the lookup is performed in the WS Player **112**. A web service object,may have a large quantity of data, and the filters reduce the quantity of data presented to a user to simplify the task of selecting an appropriate data value for an application component in the WS Player **112**. Finally, at block **163**, the web services builder **110** allows the user to define which columns, i.e., attributes of web service objects, will be retrieved when a lookup is performed in the WS Player **112**.

[**0100**] The steps of the process of establishing a binding are described individually in more detail below.

[**0101**] FIG. **1**F is an illustrative drawing of a flowchart of a process for defining a web service lookup in an application player. The WS Player **112** of FIG. **1**A leads a user through this process. The process begins at block **164** by displaying the application, which corresponds to the application **111** of FIG. **1**A. At block **165**, the process waits for the user to press a lookup button to retrieve data from a web service. The lookup button, bindings, data filter conditions, and specific columns of interest that will be used to retrieve data were previously added to the application by the user (or by a different user) using the Designer **104**. After the lookup button has been pressed, block **166** queries the web service for data as specified by the bindings, filters, and columns. At block **167**, a Selection Lookup Table is displayed. The Selection Lookup Table displays the data returned from the web service query as a set of rows and columns. Each column corresponds to an attribute of the web service object specified in the bindings and included in the columns of interest, and each row corresponds to an instance of the web service object, where the attributes of the instance meet the filter conditions, if filter conditions are present. At block **168**, the user selects one or more rows of data and presses a submit button. At block **169**, the selected row or rows are transferred to corresponding application components according to the bindings to fill in the application fields with data from the web service.

[**0102**] FIGS. **2**A-**15** illustrate user interface screens displayed in a web browser defining a header lookup. These screens, like all exemplary screens shown herein, are presented to the user on a computer display that allows the user to interact with the screens.

[**0103**] FIG. **2**A is an illustrative drawing of defining an application component in an application Designer. The

Designer **202** corresponds to the Designer **104** of FIG. **1**A. The Designer **202** includes a web services builder interface, which corresponds to the web services builder **110** of FIG. **1**A. The Designer **202** is being used to create an application component **206** of an application. The application component **206** is a text input component and has an associated name **204**, OppNameTextArea.

[**0104**] FIG. **2**B is an illustrative drawing of defining an application button component in an application Designer. The button component **212** is labeled Lookup SForce Opportunity. When the button **212** is pressed by a user in the application Player, a script associated with the button by an action builder is executed. The script may perform a web services interaction, such as a lookup, insert, update, or delete.

[**0105**] FIG. **3** is an illustrative drawing of defining a web service connection in an application Designer. A Connection screen **302** of a web services builder is shown, which allows a user to define parameters for communicating with a web service, including a vendor **304** of the web service, a URL **306** of the web service, and a user name **308** and a password **310** for logging in to the web service.

[**0106**] FIGS. **4**A-**4**D are illustrative drawings of binding an application component in a web services builder. With reference to FIG. **4**A, the application can bind an application component to a web service to perform any type of operation provided by the web service. In particular, an application component can perform Query, Update, Insert, Delete, and other types of operations on web services. Query, Update, Insert, and Delete operations can be specified using the web services builder. The Data Source Mappings screen **402** shows a vendor name **414**, which is the vendor selected in the previous screen (i.e., the vendor **304** of FIG. **3**), and also includes a web services object selection menu **420**, which allows a user to choose a selected web service object **416**. An Opportunity object **418** has been selected by the user. The selected object **416** will be used in the next screen to establish bindings.

[**0107**] FIG. **4**B shows a data binding screen **402**, which allows a user to establish bindings between application components (also referred to herein as controls), and attributes of the selected web service object **416** that was selected in the screen of FIG. **4**B. The bindings correspond to the bindings **102** of FIG. **1**A. The data binding screen **402** includes a set of application component-to-data source bindings. An application component selector **436** is displayed for each application component. A user can choose an application component **420** from the selector **436**, which includes a list of components of the application.

[**0108**] FIG. **4**C shows a web service attribute selector **446** of the data binding screen **402**. The web service attribute selector is associated with the application component selector **436**. A binding is created by selecting an application component and a web service attribute using the application component selector **430** and the web service attribute selector **440**, respectively. Note that the web service attribute is referred to as a Data Source in FIG. **4**C. Once an application component and web service attribute have been selected, a binding that links the component to the attribute can be added to the application by pressing an Add Data Mapping button. After the Add Data Mapping button has been pressed, another row having another application component selector and corresponding attribute selector will appear in the data binding screen **402** to allow the user to define another binding. In this way, a set of bindings **102** can be associated with an application XML definition **122**.

[**0109**] The bindings can be executed in a web services Player **112**. For Query operations, the web services Player **112** includes a "Vendor Selection" field, which allows a user of to select a vendor from a pull down list (e.g. Siebel® or Salesforce.com®), and an "Object Selection" field, which allows a user to select a WS object from a list of WS objects based on the selected vendor. The web services Player **112** then displays a Selection Lookup Table showing a list of selected web services object instances. The table typically contains at least three columns (e.g., object_id, meaningful_column**1**, meaningful_column**2**). The user can select two meaningful columns for a given web services object to display, and supply values for those columns to form key/value pairs. By default, if the key/value pairs are empty, all instances of the selected web services object will be retrieved from the web service. If the user specifies one or more key/value pairs, a subset of all instances of the selected web services object will be retrieved from the web service and presented in the Selection Lookup Table by the Player **106**.

[**0110**] For Update operations, the user can start with an existing Selection Lookup Table presented as a query result. The name and/or description fields can be made editable, and new columns can be added at the end of the Selection Lookup Table by pressing an update button. In this way, the user can query a web service to generate a list of objects, make changes to the name and/or description fields in the list, and then click the update button to store and commit the changes to the web service. A subsequent query will return the updated values.

[**0111**] For Insert operations, there is an Insert button in the user interface of the web services Player **112**. When the Insert button clicked, the user interface will display required fields as editable for the selected objects in one row, and the last field will be an Insert button which can be pressed to actually insert the current values of the fields in the appropriate web service object.

[**0112**] FIGS. **5**A-**5**B are illustrative drawings of adding filters in a web services Designer when defining a Selection Lookup Table. FIG. **5**A shows a web services builder filter definition screen **502** with a single filter definition, which includes a filter type **508** (Dropdown) and a filter value **512** (Name). A Dropdown filter with the value Name allows a user of the web services Player **112** to restrict the results of a web services lookup (as displayed in a Selection Lookup Table) to include only web services objects that have a Name attribute equal to a value that the user selects from a list of choices presented in a Dropdown list in the web services Player **112**. FIG. **5**B shows a second filter definition being added, with a filter type **516** (TextBox) and a filter value **520** (CloseDate). A TextBox filter with the value CloseDate allows a user of the web services player **112** to restrict the results of a web services lookup to include only objects that have a CloseDate attribute equal to a value that the user specifies in a text box in the web services Player **112**.

[**0113**] FIGS. **6**A-**6**B are illustrative drawings of adding columns in a web services Designer when defining a Selection Lookup Table. FIG. **6**A shows a web services builder

column definition screen **602**. The screen **602** allows a user to select columns from the column list **607** by pressing a button **606**. FIG. **6**B shows a list of selected columns **610**, which includes the columns Name, Description, CloseDate, CreatedById, CreatedDate, and IsClosed. Each column has an associated label, which is a text string that will be displayed for the column in the Selection Lookup Table. Only values for web services attributes that are associated with the selected columns will be retrieved from the web service when a web service lookup is performed-in the Selection Lookup Screen.

[**0114**] FIG. **7** is an illustrative drawing of defining a table area in an Application Designer. The application Designer **702** includes a table area **704**, in which each column can be associated with a web service attribute.

[**0115**] FIG. **8** is an illustrative drawing of binding application table columns in a web services Designer. A data source mappings screen **802** of the web services builder is shown. The Data Source Mappings screen **802** is similar to the Data Source Mappings screen **402** of FIGS. **4**A-**4**D. The screen **402** is used for defining bindings to individual application components, whereas the screen **802** is used for defining bindings to columns of a table. The first binding shown in FIG. **8** is between a First Name table column **808** and a FirstName web services object attribute **810**.

[**0116**] FIG. **9** is an illustrative drawing of adding filters for a table lookup in a web services Designer. The filter definition screen **902** of FIG. **9** is similar to the screen **502** of FIG. **5**A and displays a list **920** of attributes that can be used to filter results.

[**0117**] FIG. **10** is an illustrative drawing of adding columns in a web services Designer. The column definition screen **1002** of FIG. **10** is similar to the screen of FIG. **6**B and displays a list **1007** of object attributes that can be selected as the attributes that are to be retrieved from the web service when a lookup interaction is performed.

[**0118**] FIG. **11** is an illustrative drawing of an application in an Application Player. The application **1102** includes a Lookup SForce Contact button **1104**, which was defined using the application Designer user interface shown in FIG. **2**B. A user of the application **1102** can press the Lookup SForce Contact button **1104** to display a Selection Lookup Table for retrieving values for the application components, e.g., a Opportunity Name and a Description, from a web service according to the bindings.

[**0119**] FIGS. **12**A-**12**C are illustrative drawings of a Selection Lookup Table in a web services Player. FIG. **12**A shows a Selection Lookup Table **1202** which includes an object name selector **1204** and a search button **1220**. The object name selector **1204** can be used-to choose a particular web services object. FIG. **12**B shows a list of web services objects, which is displayed as a menu **1208** when the object name selector **1204** is activated by a user, e.g., by clicking a mouse on the object name selector **1204**. The menu **1208** includes a selected web services object **1208**, which has been selected by a user. In FIG. **12**C, a web services object **1210** has been selected, and the search button **1220** has been pressed. As a result of pressing the search button **1220**, a list of web service object instances has been generated. The list includes a single instance **1214**, which includes values for Name, ClassDate, CreatedById, CreatedDate, and IsClosed attributes. When a user clicks the submit button **1216**, those values will be copied to a table in the web services Player **112** as specified by the bindings.

[**0120**] FIG. **13** is an illustrative drawing of an application in an Application Player with data retrieved from a web service. An Opportunity Name component **1304**, a Stage component **1306**, and a Closed component **1308** have received values from corresponding web service attributes according to the bindings.

[**0121**] FIGS. **14**A-**14**C are illustrative drawings of a selection lookup table in a web services Player. In FIG. **14**A, a search button **1404** has been pressed, and as a result, multiple rows of data have been retrieved into a table **1406** from a web service according to the bindings. FIG. **14**B shows filtering by an attribute (LastName) **1405** using a Dropdown list **1418**. A user has selected a value **1420** (Levy) from the last name list. As a result, the table **1406** is restricted to displaying only the rows for which the LastName attribute is equal to Levy. In this example, there is only one such row **1422**. Finally, in FIG. **14**C, the user can click the submit button **1432** to transfer the values of all selected rows to the corresponding components of the application, according to the mappings.

[**0122**] FIG. **15** is an illustrative drawing of an application in an Application Player with data retrieved from a web service. The application **1502** includes a table **1506**, which has a single row of data **1508** transferred from the Selection Lookup Table **1402** of FIG. **14**C. The row of data **1508** includes the LastName Levy **1430** and other values as shown in FIG. **14**C.

[**0123**] FIG. **16** is an illustrative drawing of implementation interfaces and objects. FIG. **16** shows a WSObjectMapping class **1606**, which corresponds to the WSObjectMapping **123** of FIG. **1**A. The WSObjectMapping class **1606** maps vendor specific objects **1608**, including a Siebel Opportunity **1614** and a Salesforce Opportunity **1616**, to a Generic-web services object model **1620**, which is used by a Designer **1624** and a Player **1626**. The WSObjectMapping class **1606** includes a getWSMapping method for retrieving existing mappings, a createMapping method for creating mappings, and a getXMLMapping method for getting an XML representation of the mappings.

[**0124**] Details of the implementation of the WS Player **112** will now be described with reference to the features shown in the preceding figures and the components shown in FIG. **1**A. The WS Player **112** calls the WS Credential Manager **128** authenticate the user credentials. The WS Player **112** displays the Selection Lookup Table and the results list **1402** of FIG. **14**A. The WS Player **112** uses a Pagination component (not shown) to display the page numbers and navigation links in the results list **1402**. When the end of the current result set returned from the server **120** is reached, the Pagination component calls the WSLookupBean **125** to get the next result set. The WS Player **112** calls the WSLookupBean **125** whenever the user clicks the Selection Lookup Table Search button **1220** shown in FIG. **12**A. The WS Player **112** passes the filter field values and lookup table columns to the WSLookupBean **125**. The WSLookupBean **125** creates a query string based on the filter fields and lookup table columns and passes the query string to the WSFactory **132**, which receives the query string and makes the underlying web service call to the web service, e.g., the

Siebel web service **140**, via the Siebel WS adapter **134**. The WSFactory **132** then returns the result set of the web service call to the WSLookupBean **125**. The WSLookupBean **125** calls the WSObjectMapping **123** with the result set to convert the vendor specific object into a generic WSObject **130**. The WSObjectMapping **123** returns the WSObject **130** to the WSLookupBean **125**, which returns the WSObject **130** to the WS Player **112**, which displays the result set data in the Selection Lookup Table, e.g., as the result list **1402** of FIG. **14**A. The user then selects the required rows and clicks a Submit button. Then the WS Player **112** populates the application components of the Player **106** according to the bindings **102**.

[**0125**] FIG. **17** is an illustrative drawing of a process for authenticating a user. The user must authenticate himself to the WS Vendor. If the authentication fails then the user will not be able to see the filter columns and the lookup table.

[**0126**] FIG. **18** is an illustrative drawing of a process for invoking a lookup. The WS Player **112** first be started[]and p resented to a user. The user will then select the filter fields and click a submit button. The WS Player **112** will call the lookup component, which makes a web service call and displays web service data in the lookup table.

[**0127**] FIG. **19** is an illustrative drawing of a process for processing multiple pages of results. The WS Player **112** is first started and presented to a user. The user will then select the filter fields and then click submit. The WS Player **112** will then call the lookup component which makes a corresponding web service call and displays the web service data in the lookup table. When the end of the current result set is reached the pagination component will request the next result set from the Lookup component.

[**0128**] FIG. **20** is a flowchart of an exemplary portion of a method to be executed by a Designer or a Player for looking up web service objects. The method can be used to lookup web service objects via AJAX. The method begins at block **2000** by generating an XML representation of the request data, which corresponds to the invocation XML document **117** of FIG. **1**A. The request data is sent to a server (e.g., an application server or web server) at block **2002**, and the method waits for a response from the server at block **2004**. After receiving a response, the method gets the XML data from the response at block **2006**. The XML response data corresponds to the response XML document **119** of FIG. **1**A. Next, the XML response data is parsed at block **2008** into a format suitable for processing in the programming language in use (e.g., JavaScript™). Finally, at block **2010**, the response data is used to fill in the application components with values.

[**0129**] FIG. **21** is a flowchart of an exemplary portion of a method to be executed by a server for looking up web service objects. The method can be used by a server to process requests to lookup web service objects. The method begins at block **2100** by receiving a request, e.g., from an AJAX component of a browser. The request includes XML data in the format of the invocation XML document **117** of FIG. **1**A (and Appendixes B and C). At block **2102**, the method parses the data in the XML request to extract the input data for the lookup, e.g., a web service object name, filters, and columns. At block **2104**, the method generates Java objects which represent the data in the XML request. At block **2106**, the method invokes the WSManager's queryObject method for every Java object generated in block **2104** to retrieve objects from the web service. The queryObject method returns a list of WSObjects that represent the web service object instances retrieved from the web service by queryObject. At block **2108**, the method converts the WSObjects to XML data in the format of the response XML document **119** of FIG. **1**A (and Appendixes B and C). At block **2110**, the method sends the XML data as a response, e.g., to a client such as the Internet Browser **101** of FIG. **1**A, or to software running in the browser, such as the Designer **104** or the Player **106** of FIG. **1**A, which delivers the data to the application.

[**0130**] FIG. **22** is a flowchart of an exemplary portion of a method to be executed by a Designer or a Player for inserting, updating, or deleting web service objects. The method can be used to insert, update, or delete web service objects via AJAX. The method begins at block **2200** by generating an XML representation of the request data, which corresponds to the invocation XML document **117** of FIG. **1**A. The request data is sent to a server at block **2202**, and the method waits for a response from the server at block **2204**. After receiving a response, the method gets the XML data from the response at block **2206**. The XML response data corresponds to the response XML document **119** of FIG. **1**A. Next, the XML response data is parsed at block **2208** to check for any errors that may have occurred on the server. The server sends error indications as part of the XML response data. Any errors that occur can then be reported to the user.

[**0131**] FIG. **23** is a flowchart of an exemplary portion of a method to be executed by a server for inserting, updating, or deleting web service objects. The method can be used by a server to process requests to insert, update, or delete web service objects. The method begins at block **2300** by receiving a request, e.g., from an AJAX component of a browser such as the Internet Browser **101** of FIG. **1**A. The request includes XML data in the format of the invocation XML document **117** of FIG. **1**A (and Appendixes B and C). At block **2302**, the method parses the data in the XML request to extract an operation type (e.g., insert, update, or delete), a web service object name, and data that is to be inserted, updated, or deleted from the web service object. At block **2304**, the method generates Java objects which represent the data in the XML request. At block **2306**, the method invokes the WSManager's insertOrUpdateObject method if the operation to be performed is an insert or update, or the WSManager's deleteObject method if the operation is a delete. The WSManager method is invoked for every object specified in the XML request data. At block **2308**, the method sends the XML data as a response, e.g., to the AJAX client, which delivers the data to the application.

[**0132**] FIG. **24** is an illustrative drawing of a Designer user interface. The Designer interface **2400** is being used to design an application. The application includes a link **2402** named Synchronize with Salesforce. A user can create a script to be associated with the button **2402** by clicking an action builder button **2404**.

[**0133**] FIG. **25** is an illustrative drawing of a user-defined script in an action builder. An action builder **2500** is a user interface component of the Application Designer **104**. The action builder appears when a user clicks the action builder button **2404** for an application component such as the link

2402 of FIG. **24**. The action builder **2500** allows a user to write a script **2502** associated with an event **2504**. The action builder is described in more detail in commonly owned Patent Application entitled "Browser Based Designer and Player," filed Sep. 30, 2005, inventors Pawan Nachnani et al., incorporated by reference above. The script **2502** includes a SyncManager SYNCHRONIZE call, which causes data values in application components (e.g., text fields and other components) to be stored in associated web service according to the bindings present in the application. The SYNCHRONIZE call also updates application components with values from the web service according to the bindings.

[0134] In addition to the SYNCHRONIZE call, the script can also call the SyncManager to insert, update, delete, or query objects in the web service according to the bindings, as shown in Table 7.

TABLE 7

Script Call	Description
SyncManager("INSERTUPDATE")	Inserts new (or updates existing) values from the application into object(s) in the web service.
SyncManager("DELETE")	Deletes object(s) from the web service.
SyncManager("QUERY")	Looks up and retrieves objects from the web service.
SyncManager("SYNCHRONIZE")	Performs INSERTUPDATE followed by DELETE to delete web service objects that no longer exist in the application.

[0135] The SyncManager calls automatically extract data from the application based on the bindings. The bindings can be either those created by a web services builder or bindings created programmatically in the script prior to calling the SyncManager.

[0136] This disclosure is illustrative and not limiting; further modifications will be apparent to those skilled in the art in light of this disclosure and are intended to fall within the scope of the appended claims.

APPENDIX A

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema">
    <xs:elementname="WSObjectMapping">
        <xs:complexType>
            <xs:sequence maxOccurs="unbounded">
                <xs:element ref="WSAttributeMapping"/>
            </xs:sequence>
            <xs:attribute name="wsvendorname" type="xs:string"
            use="required"/>
            <xs:attribute name="wsobjectname" type="xs:string"
            use="required"/>
        </xs : complexType>
    </xs:element>
    <!--Attribute has properties-->
    <xs:elementname="WSAttributeMapping">
        <xs:complexType>
            <xs:attribute name="wsattributename" type="xs:string"
            use="required"/>
            <xs:attribute name="wsattributetype" type="xs:string"
            use="required"/>
            <xs:attribute name="wsobjectattributename"
            type="xs:string"
use="required"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

[0137]

APPENDIX B

```
<document pid='some_number' ppid='some_number'>
<object name='some_object' vendor='vendor_name'
action='INSERTUPDATE'>
    <record>
        <field name='attribute_name1'><![CDATA[some
        text]]></field>
        <field name='attribute_name2'><![CDATA[some
        text]]></field>
        <field name='attribute_name3'> <![CDATA[some
        text]]></field>
        <field name='attribute_name4'> <![CDATA[some
        text]]> </field>
    </record>
</object>
<object name='some_object' vendor='vendor_name'
action='DELETE'>
    <record>
        <field name='wsAttributeID'><![CDATA[some
        id value]]>
        </field>
        </field>
    </record>
    <record>
        <field name='wsAttributeID'><![CDATA[some
        id value]]>
        </field>
        </field>
    </record>
</object>
</document>
```

[0138]

APPENDIX C

```
<?xml version='1.0' encoding='UTF-8'?>
<document pid='5124' ppid='441'>
<object name='Account' vendor='Salesforce'
action='INSERTUPDATE'>
<record>
<field name='Fax'>(212) 555-1212</field>
<field name='Name'>http://www.uos.com</field>
<field name='Website'>http://www.uos.com</field>
</record>
<record><field name='Fax'>+44 555 1234567</field>
<field name='Name'>http://www.uos.com</field>
<field name='Website'>http://www.uos.com</field>
</record>
<record>
<field name='Fax'>(555) 551-1234</field>
<field name='Name'>www.universityofarizona.com</field>
<field name='Website'>www.universityofarizona.com</field>
</record>
</object>
<object name='Account' vendor='Salesforce'
action='INSERTUPDATE'>
</object>
</document>
```

[0139]

APPENDIX D

```
<WebServiceBinding vendorname="Salesforce"
objectname="Opportunity"
username="" wsurl="https://www.salesforce.com/services/Soap/u/6.0 ">
<WSAttributeBindingList>
<WSAttributeMapping formentity="OppNameTextArea"
wsattribute="OppName"/>
<WSAttributeMapping formentity="DescriptionTextArea"
wsattribute="Description"/>
<WSAttributeMapping formentity="StageTexArea"
wsattribute="StageName"/>
<WSAttributeMapping formentity="ClosedCheckbox"
wsattribute="IsClosed"/>
</WSAttributeBindingList>
<WSFilterBindingList>
<WSFilterField filterfieldwsattribute="OppName"
formentity=""
filterfieldtype="Dropdown"/>
<WSFilterField filterfieldwsattribute="CloseDate"
formentity=""
filterfieldtype="TextBox"/>
</WSFilterBindingList>
<WSTableBindingList>
<WSLookupTableColumn wsobjattribute="OppName"
label="Name" sortable="false"/>
<WSLookupTableColumn wsobjattribute="Description"
label="Description" sortable="false"/>
<WSLookupTableColumn wsobjattribute="CloseDate"
label="CloseDate" sortable="false"/>
<WSLookupTableColumn wsobjattribute="CreatedById"
label="CreatedById" sortable="false"/>
<WSLookupTableColumn wsobjattribute="CreatedDate"
label="CreatedDate" sortable="false"/>
<WSLookupTableColumn wsobjattribute="IsClosed"
label="IsClosed" sortable="false"/>
</WSTableBindingList>
</WebServiceBinding>
```

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A computer enabled method for using a web service, comprising the acts of:

a first organization accessing a web services object of a second organization, wherein the accessing is via a web browser and over a computer network; and

binding at least a portion of the accessed web services object to a software object of the first organization, wherein the web services object is operable to interact with the software object.

2. The method of claim 1, wherein the software object is an application component, further comprising the acts of:

receiving a request for the accessed web services object, wherein the request is associated with the software object; and

executing the accessed web services object using a portion of the application component bound to the software object.

3. A computer enabled method for using a web service which supports a web services object, comprising the acts of:

identifying the web services object;

receiving a request for the web services object, wherein the request is associated with an application component; and

executing the web services object in response to the request.

4. The method of claim 1, wherein the accessed web services object has an associated description, and the act of accessing includes accessing the description.

5. The method of claim 4, wherein the description is in Web Services Description Language format.

6. The method of claim 1, further comprising the act of providing an adapter associated with the web services object.

7. The method of claim 1, wherein the act of binding binds a first software object to a second software object.

8. The method of claim 2, further comprising the act of providing a builder adapted to carry out the acts of accessing and binding thereby to enable the subsequent act of executing.

9. The method of claim 8, further comprising the act of providing a player adapted to carry out the act of executing.

10. The method of claim 8, wherein the builder is embodied in a web page executed on a web browser.

11. The method of claim 9, wherein the player is embodied in a web page executed on a web browser.

12. The method of claim 1, wherein the act of accessing includes making a web service call.

13. The method of claim 2, wherein the act of executing includes making a web service call.

14. The method of claim 1, further comprising the acts of:

accessing a software object of the first organization; and

combining the object of the first organization with the accessed web services object of the second organization.

15. The method of claim 14, wherein the software object of the first organization includes data.

16. The method of claim 1, wherein the web services object is accessible via an open protocol.

17. The method of claim 1, further comprising the act of binding at least a portion of the web services object to the software object of the first organization.

18. The method of claim 1, further comprising the act of enabling the method by a server of a third organization.

19. A computer enabled method for using a web service, comprising the acts of:

a second organization allowing a first organization access to a web services object of the second organization, wherein the accessing is via a web browser and over a computer network; and

binding at least a portion of the accessed web services object to a software object of the first organization, wherein the software object is operable to interact with the bound portion of the web services object.

20. The method of claim 19, wherein the accessed web services object has an associated description, and the act of accessing includes accessing the description.

21. The method of claim 20, wherein the description is in Web Services Description Language format.

22. The method of claim 19, further comprising the act of providing an adapter associated with the web services object.

23. The method of claim 19, wherein the act of binding binds a first software object to a second software object.

24. The method of claim 19, further comprising the act of providing a builder adapted to carry out the acts of accessing and binding.

25. The method of claim 19, further comprising the act of providing a player adapted to execute the web services object.

26. The method of claim 24, wherein the builder is embodied in a web page executed on a web browser.

27. The method of claim 25, wherein the player is embodied in a web page executed on a web browser.

28. The method of claim 19, wherein the act of accessing includes making a web service call.

29. The method of claim 19, wherein the software object is operable to interact with the bound portion of the web services object by making a web service call.

30. The method of claim 19, further comprising the acts of:

accessing the software object of the first organization; and

combining the software object of the first organization with the accessed web services object of the second organization.

31. The method of claim 30, wherein the software object includes data.

32. The method of claim 19, wherein the web services object is accessible via an open protocol.

33. The method of claim 19, further comprising the act of enabling the method by a server of a third organization.

34. A computer enabled apparatus for using a web service, comprising:

a factory module which creates instances of a web services object;

a credentials manager coupled to the factory module and which verifies a web services object accessed via a web browser and over a computer network;

a web services manager coupled to the factory module and which manages web service sessions;

an event manager which manages access to the accessed web services object; and

an adapter coupled to the web services manager and which maps the accessed web services object to the created instance of the web services object.

35. The apparatus of claim 34, wherein the factory module binds software objects in the accessed web services object to software objects in the created instance.

36. The apparatus of claim 34, further comprising a software application that accesses data using the web services object.

37. The apparatus of claim 34, further comprising an access handler coupled to the adapter.

38. The apparatus of claim 34, wherein the accessed application component has an associated description, and the accessing accesses the description.

39. The apparatus of claim 38, wherein the description is in Web Services Description Language format.

40. The apparatus of claim 34, wherein the accessing includes making a web service call.

41. The apparatus of claim 34, wherein the web services object is accessible via an open protocol.

42. A computer enabled method for generating a generic object which represents a web service, comprising the acts of:

identifying the generic object representing the web service, the web service having a plurality of attributes; and

creating a field in the generic object for each attribute of the web service, wherein the field has a name, a type, and a value based upon a corresponding attribute of the web service.

43. A computer enabled method for generating a description of a web service in XML format, comprising the acts of:

identifying a plurality of fields of the web service object; and

creating an XML element for each identified field of the web service object.

44. A computer enabled method for invoking a web service, comprising the acts of:

generating a request according to a predefined format;

sending the request to a web service by using AJAX;

waiting for a response from the web service;

receiving a response from the web service, wherein the response is in a predefined format; and

updating application components based on the response.

45. The method of claim 44, wherein the method is performed by a computer program code script executed by an application player in response to a user's selection of an application component associated with the script.

46. The method of claim 44, wherein the predefined format is XML.

47. A computer enabled method for invoking a web service, comprising the acts of:

receiving a request from a client , wherein the request includes request data in a predefined format;

generating objects based on the request data;

invoking a web service by using AJAX, wherein invoking is based on the objects;

converting at least one result of invoking the web service to at least one generic object;

converting the at least one generic object to response data in a predefined format; and

sending the response data to the client.

48. A method of designing an application program in a web browser, comprising the acts of:

executing a designer program on a web browser, wherein the designer program presents a user interface that includes a workspace upon which a user can place an interface component at a specified location,

the interface component associated with a component data value; and

associating the component with a computer program code script received from a user, wherein the computer program code script includes a web service call.

49. The method of claim 48, wherein the computer program code script is operable to set the value of another component based on a value received from a web service call.

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