US 20070079282A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2007/0079282 A1**

**Nachnani et al.** (43) **Pub. Date: Apr. 5, 2007**

(54) **BROWSER BASED DESIGNER AND PLAYER**

(76) Inventors: **Pawan Nachnani**, Newark, CA (US); **Jin Huang**, Mountain House, CA (US); **Ramesh Kagoo**, Pleasanton, CA (US); **Sampath Thasampalayam**, Fremont, CA (US); **Lawrence Lindsey**, Livermore, CA (US); **Paul M. Tabet**, Danville, CA (US)

Correspondence Address:
**MORRISON & FOERSTER LLP**
**755 PAGE MILL RD**
**PALO ALTO, CA 94304-1018 (US)**

(21) Appl. No.: **11/241,073**

(22) Filed: **Sep. 30, 2005**

**Publication Classification**

(51) **Int. Cl.**
*G06F 9/44* (2006.01)

(52) **U.S. Cl.** ..... **717/106**

(57) **ABSTRACT**

A system for designing, deploying, and executing enterprise applications is provided. The system allows for rapid development and deployment of Web-based data-oriented applications. Multiple versions of the applications can exist simultaneously without conflicts. The applications may be web services enabled and process driven.

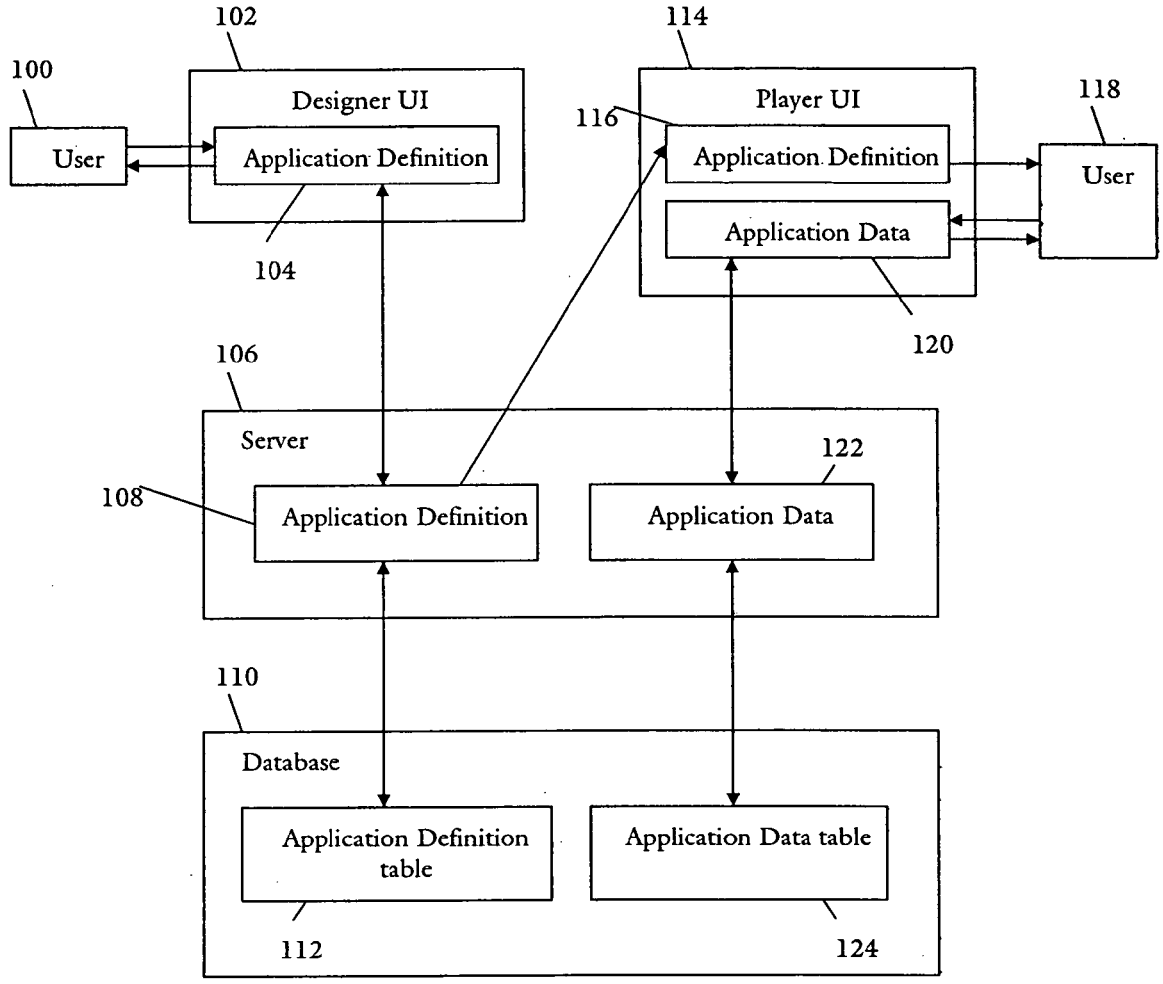


Figure 1a

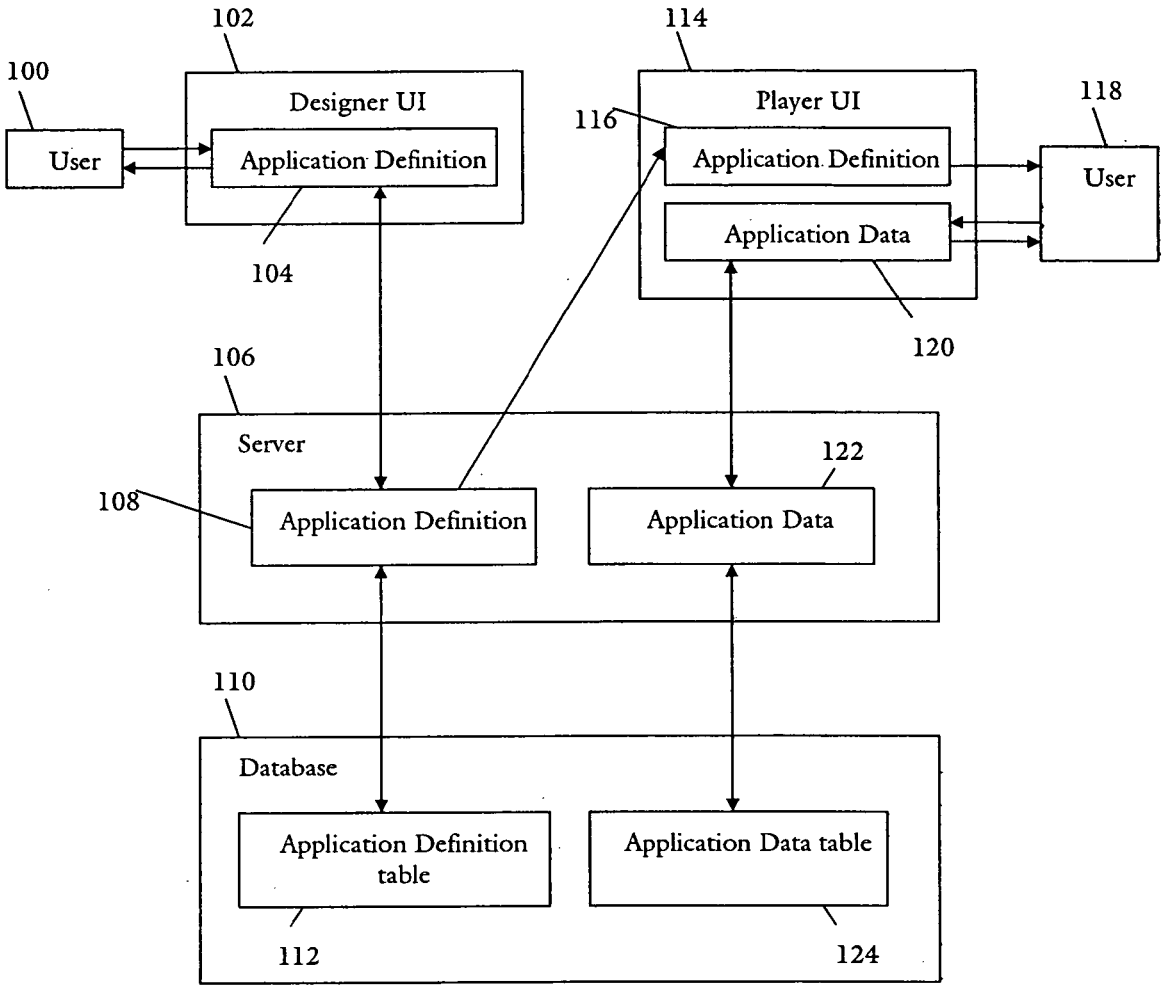

102
114
100
Designer UI
Player UI
118
116
User
Application Definition
Application Definition
User
Application Data
104
120
106
Server
122
108
Application Definition
Application Data
110
Database
Application Definition table
Application Data table
112
124

Figure 1b

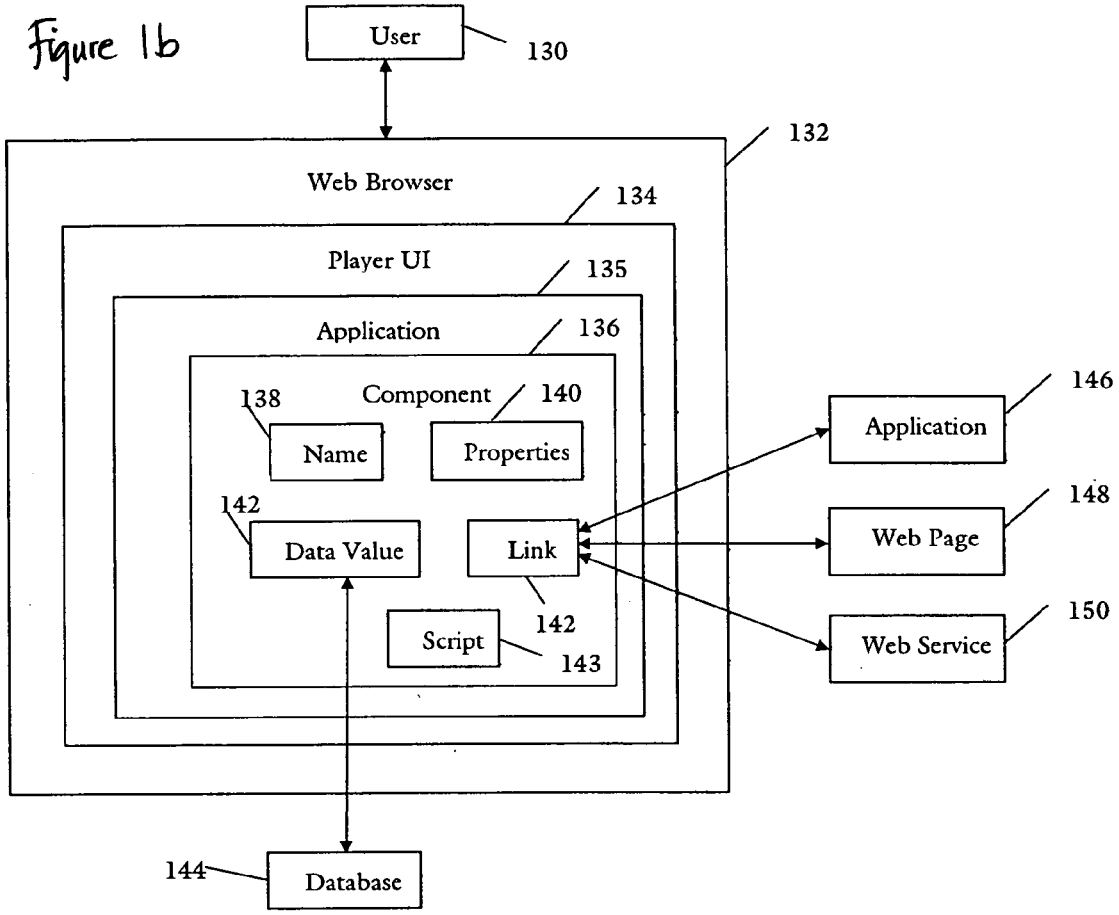
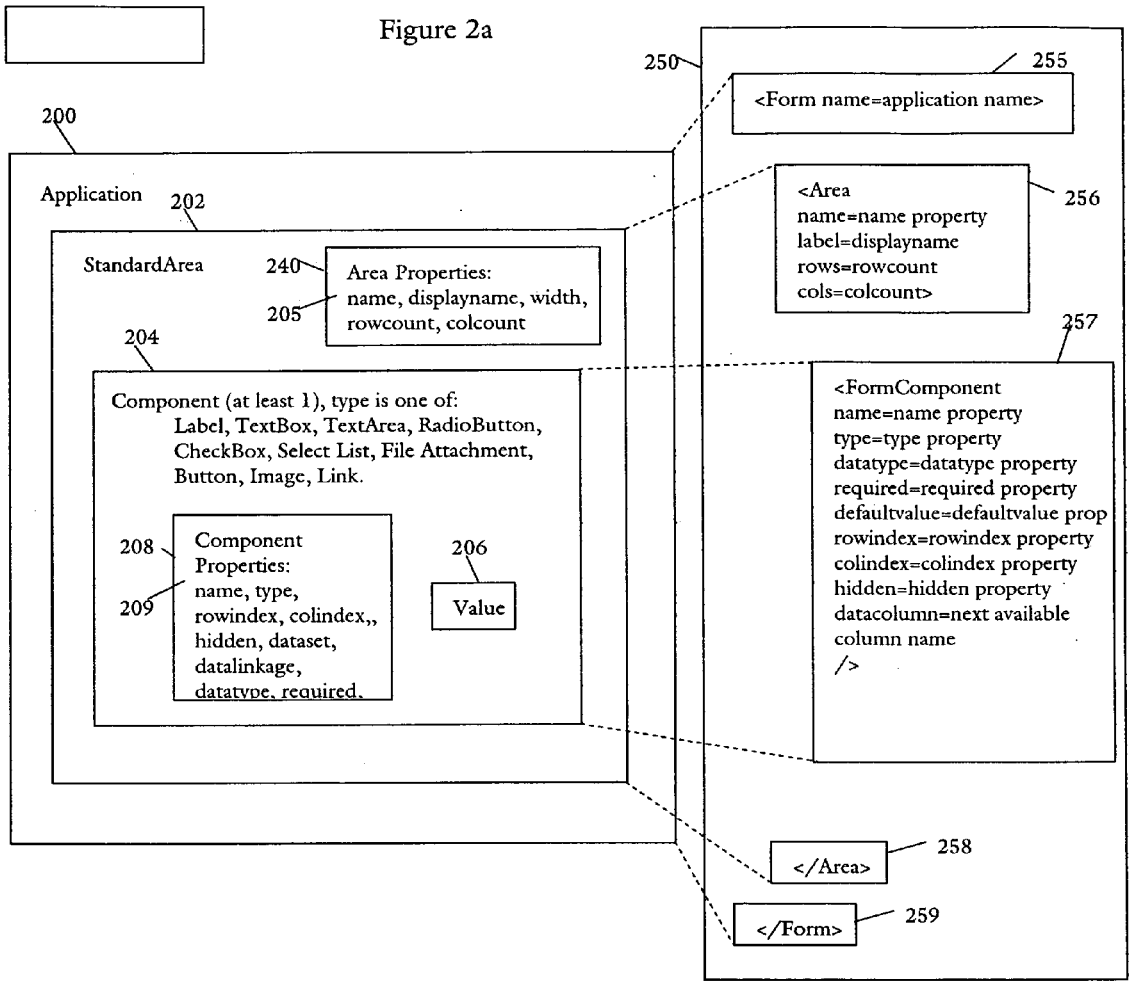

User
130
132
Web Browser
134
Player UI
135
Application
136
138
Component
140
Name
Properties
142
Data Value
Link
142
Script
143
144
Database
146
Application
148
Web Page
150
Web Service

Figure 2a


250
255
<Form name=application name>
200
Application
202
<Area
name=name property
label=displayname
rows=rowcount
cols=colcount>
256
StandardArea
240
Area Properties:
name, displayname, width,
rowcount, colcount
205
257
204
<FormComponent
name=name property
type=type property
datatype=datatype property
required=required property
defaultvalue=defaultvalue prop
rowindex=rowindex property
colindex=colindex property
hidden=hidden property
datacolumn=next available
column name
/>
Component (at least 1), type is one of:
Label, TextBox, TextArea, RadioButton,
CheckBox, Select List, File Attachment,
Button, Image, Link.
208
Component
Properties:
name, type,
rowindex, colindex,,
hidden, dataset,
datalinkage,
datatype, required,
209
206
Value
</Area>
258
</Form>
259

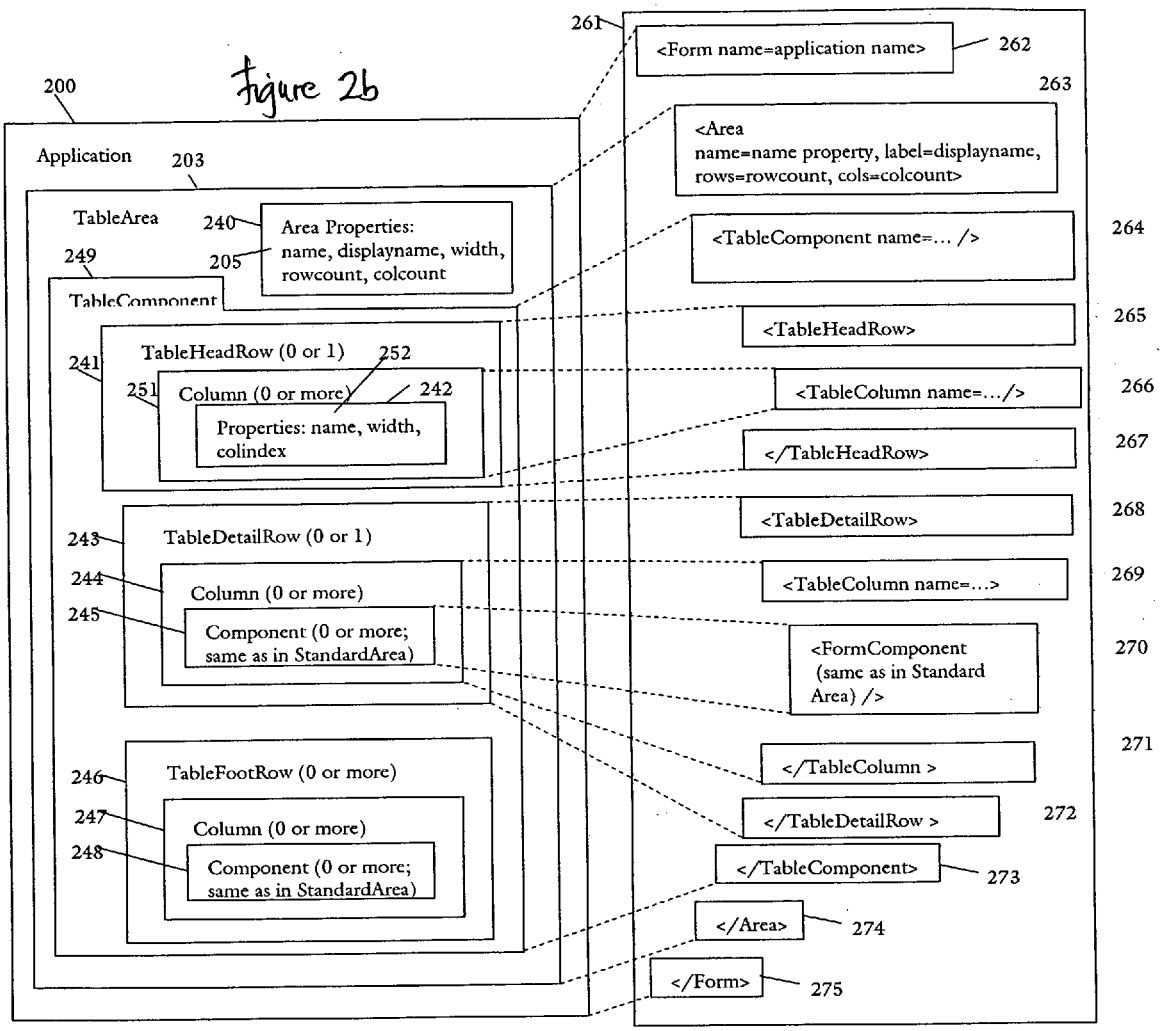


figure 2b
200
Application
203
TableArea
240
Area Properties:
name, displayname, width,
rowcount, colcount
205
249
TableComponent
241
TableHeadRow (0 or 1)
252
251
Column (0 or more)
242
Properties: name, width,
colindex
243
TableDetailRow (0 or 1)
244
Column (0 or more)
245
Component (0 or more;
same as in StandardArea)
246
TableFootRow (0 or more)
247
Column (0 or more)
248
Component (0 or more;
same as in StandardArea)
261
<Form name=application name>
262
263
<Area
name=name property, label=displayname,
rows=rowcount, cols=colcount>
<TableComponent name=... />
264
<TableHeadRow>
265
<TableColumn name=.../>
266
</TableHeadRow>
267
<TableDetailRow>
268
<TableColumn name=...>
269
<FormComponent
(same as in Standard
Area) />
270
</TableColumn >
271
</TableDetailRow >
272
</TableComponent>
273
</Area>
274
</Form>
275

Figure 3

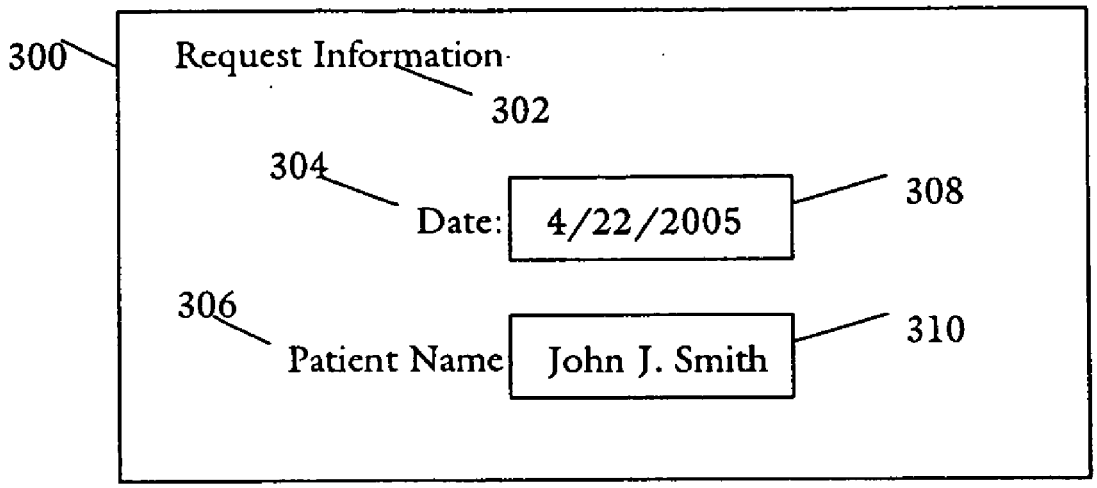

300
Request Information
302
304
Date:
4/22/2005
308
306
Patient Name
John J. Smith
310

Figure 4a

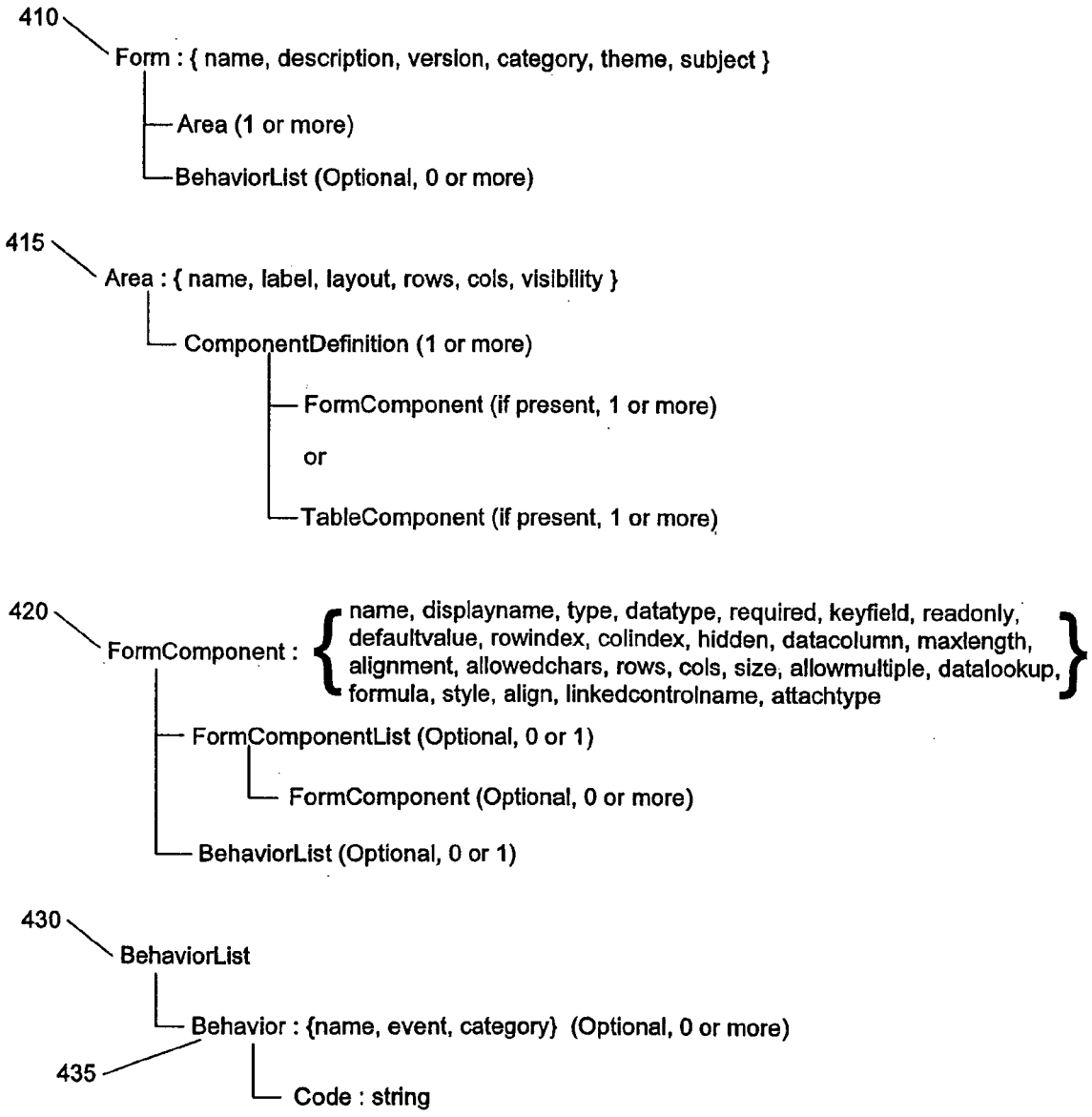

410
Form : { name, description, version, category, theme, subject }
Area (1 or more)
BehaviorList (Optional, 0 or more)
415
Area : { name, label, layout, rows, cols, visibility }
ComponentDefinition (1 or more)
FormComponent (if present, 1 or more)
or
TableComponent (if present, 1 or more)
420
FormComponent :
name, displayname, type, datatype, required, keyfield, readonly,
defaultvalue, rowindex, colindex, hidden, datacolumn, maxlength,
alignment, allowedchars, rows, cols, size, allowmultiple, datalookup,
formula, style, align, linkedcontrolname, attachtype
FormComponentList (Optional, 0 or 1)
FormComponent (Optional, 0 or more)
BehaviorList (Optional, 0 or 1)
430
BehaviorList
Behavior : {name, event, category} (Optional, 0 or more)
435
Code : string

Figure 4b

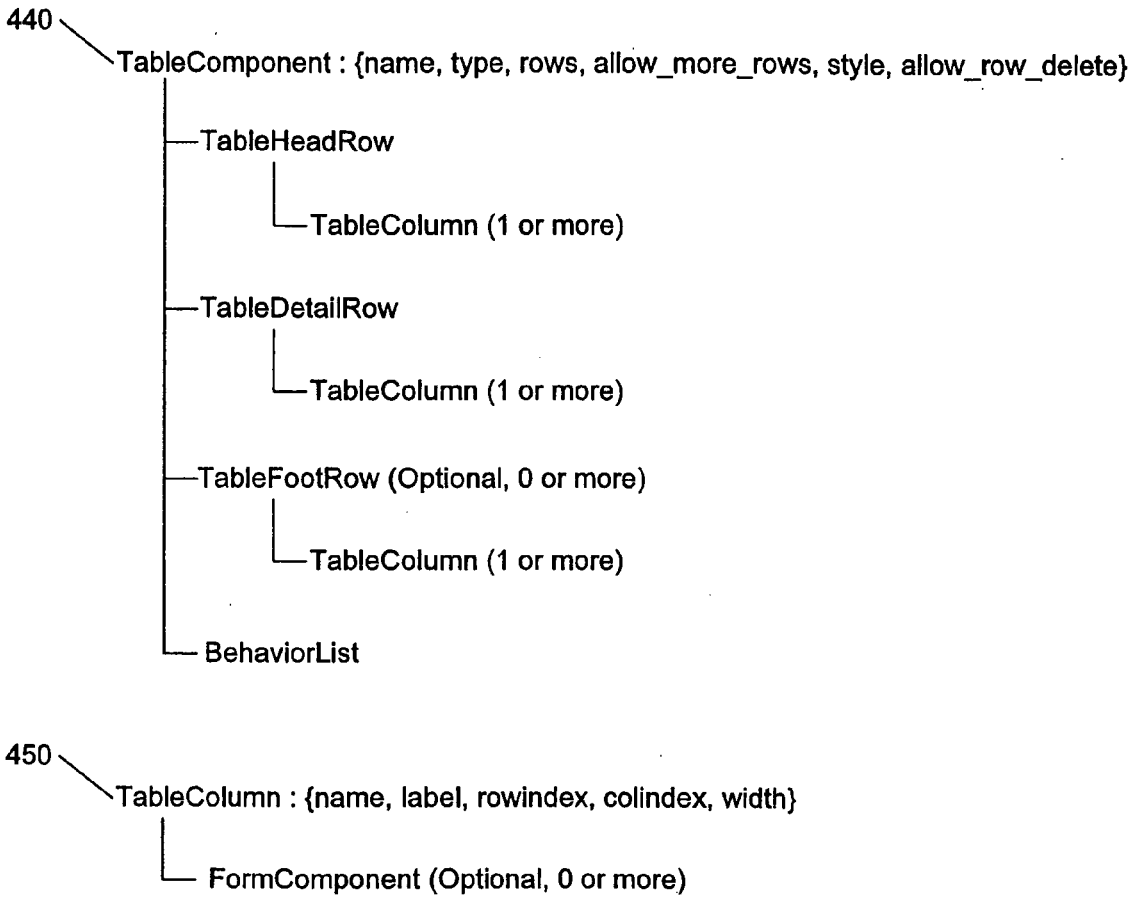

440
TableComponent : {name, type, rows, allow_more_rows, style, allow_row_delete}
TableHeadRow
TableColumn (1 or more)
TableDetailRow
TableColumn (1 or more)
TableFootRow (Optional, 0 or more)
TableColumn (1 or more)
BehaviorList
450
TableColumn : {name, label, rowindex, colindex, width}
FormComponent (Optional, 0 or more)

Figure 5a

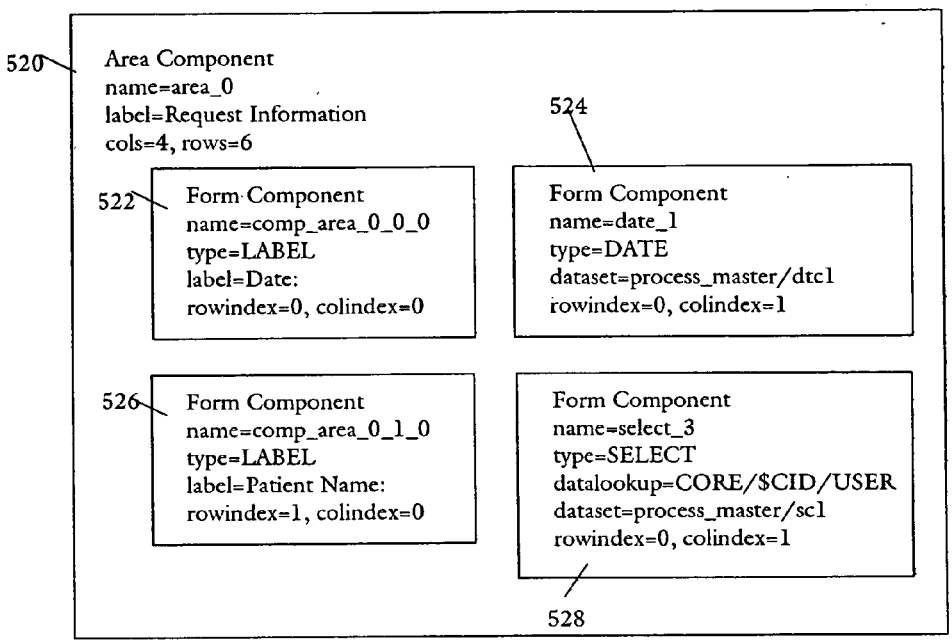



Figure 5b

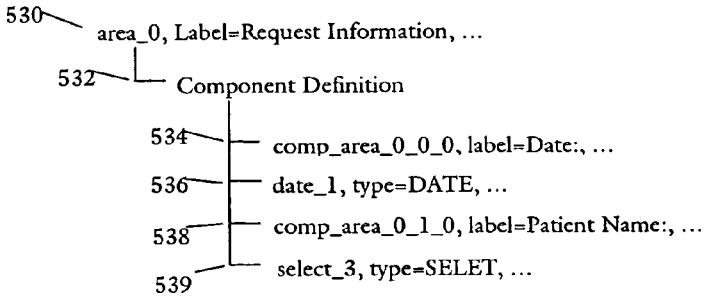


Figure 5c

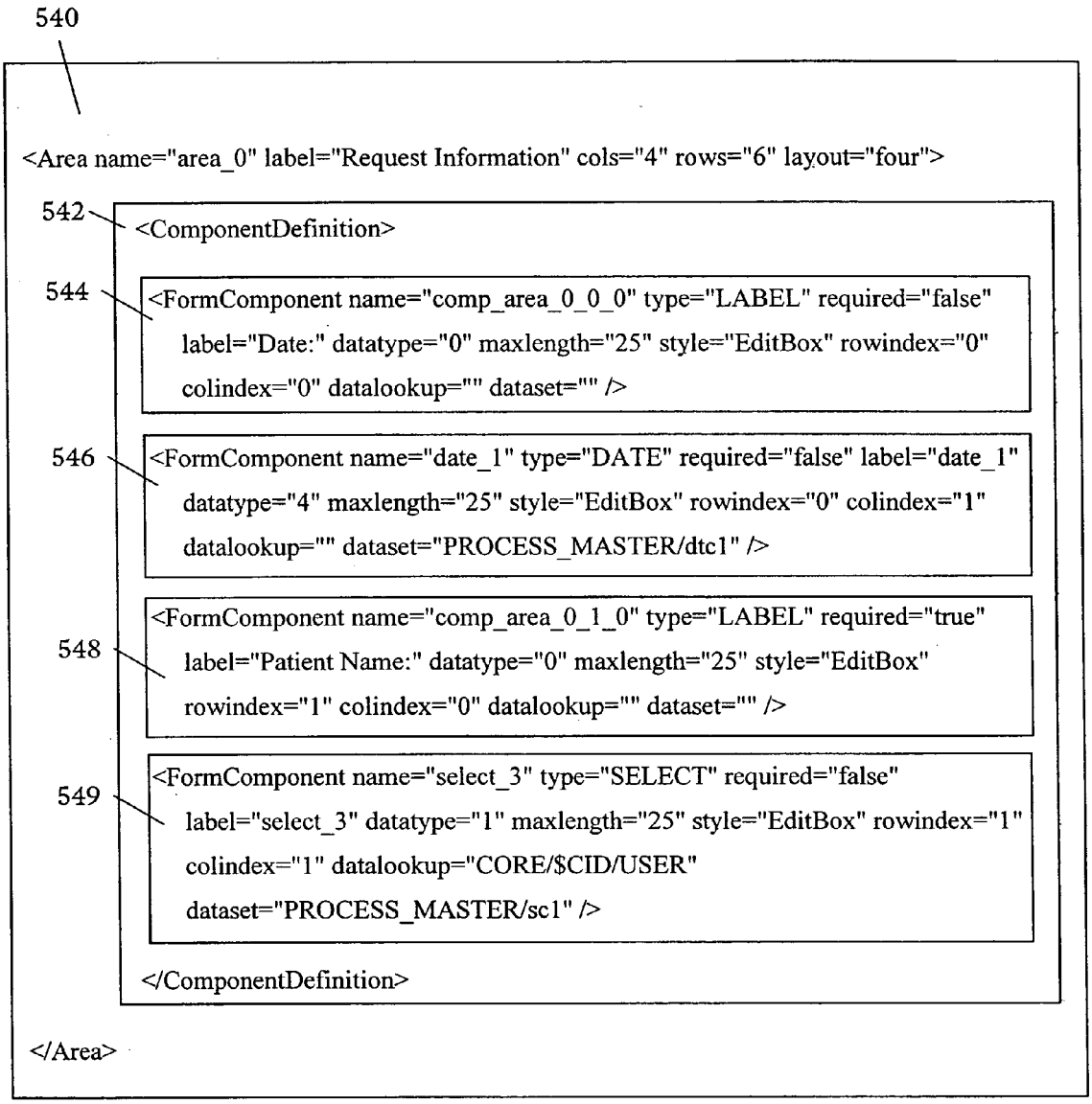
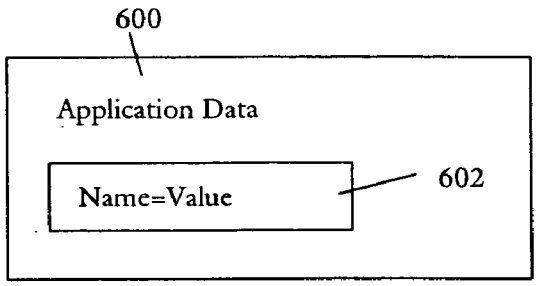
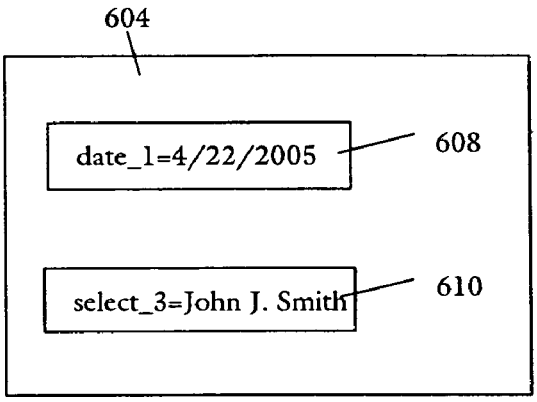

540
<Area name="area_0" label="Request Information" cols="4" rows="6" layout="four">
542
<ComponentDefinition>
544
<FormComponent name="comp_area_0_0_0" type="LABEL" required="false" label="Date:" datatype="0" maxlength="25" style="EditBox" rowindex="0" colindex="0" datalookup="" dataset="" />
546
<FormComponent name="date_1" type="DATE" required="false" label="date_1" datatype="4" maxlength="25" style="EditBox" rowindex="0" colindex="1" datalookup="" dataset="PROCESS_MASTER/dtc1" />
548
<FormComponent name="comp_area_0_1_0" type="LABEL" required="true" label="Patient Name:" datatype="0" maxlength="25" style="EditBox" rowindex="1" colindex="0" datalookup="" dataset="" />
549
<FormComponent name="select_3" type="SELECT" required="false" label="select_3" datatype="1" maxlength="25" style="EditBox" rowindex="1" colindex="1" datalookup="CORE/$CID/USER" dataset="PROCESS_MASTER/sc1" />
</ComponentDefinition>
</Area>

figure 6a




Application Data: Client Structure

Figure 6b




Example Application Data on Client

Figure 6c

Example Application Data in Database

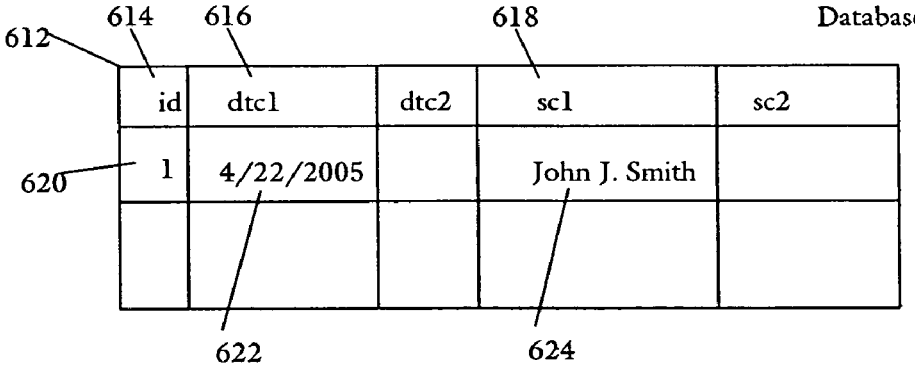


Figure 7a

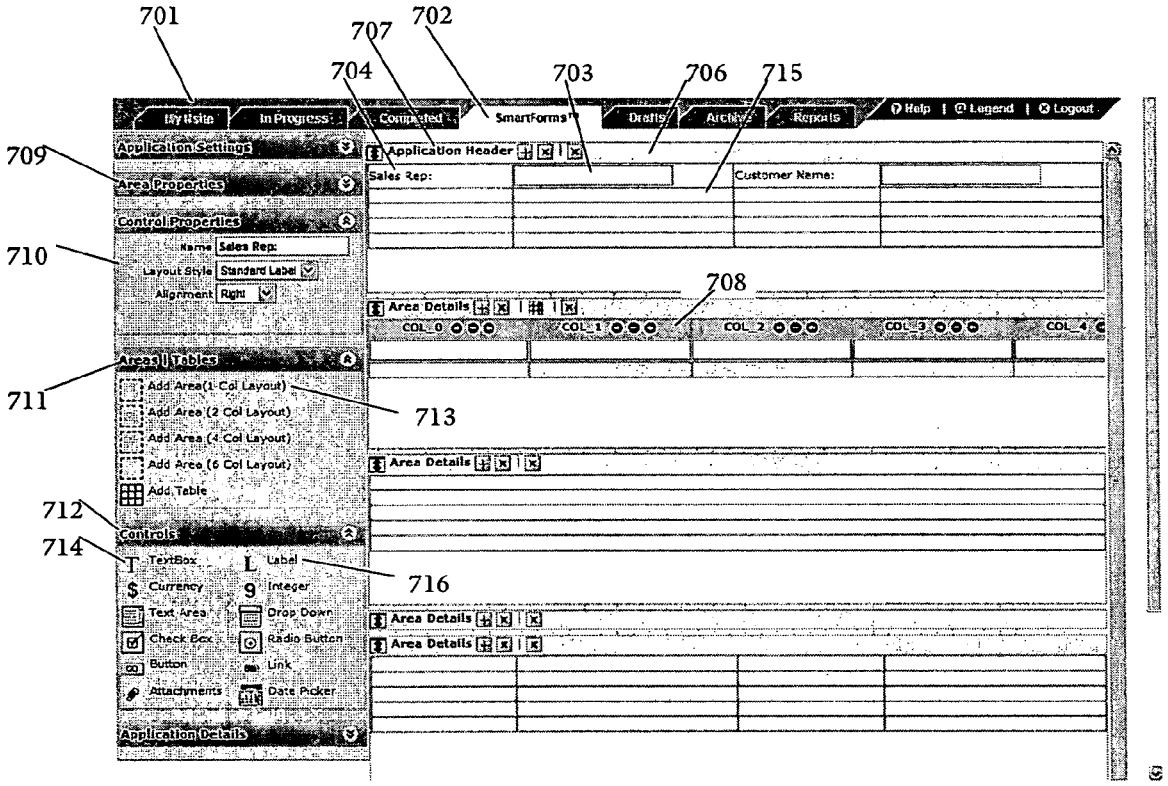

701
707
702
704
703
706
715
709
710
708
711
713
712
714
716
My Visits
In Progress
Completed
SmartForms
Drafts
Archive
Reports
Help
Legend
Logout
Application Settings
Area Properties
Control Properties
Name Sales Rep:
Layout Style Standard Label
Alignment Right
Areas | Tables
Add Area(1 Col Layout)
Add Area (2 Col Layout)
Add Area (4 Col Layout)
Add Area (6 Col Layout)
Add Table
Controls
TextBox
Label
Currency
Integer
Text Area
Drop Down
Check Box
Radio Button
Button
Link
Attachments
Date Picker
Application Details
Application Header
Sales Rep:
Customer Name:
Area Details
COL 0
COL 1
COL 2
COL 3
COL 4
Area Details
Area Details
Area Details

Figure 7b

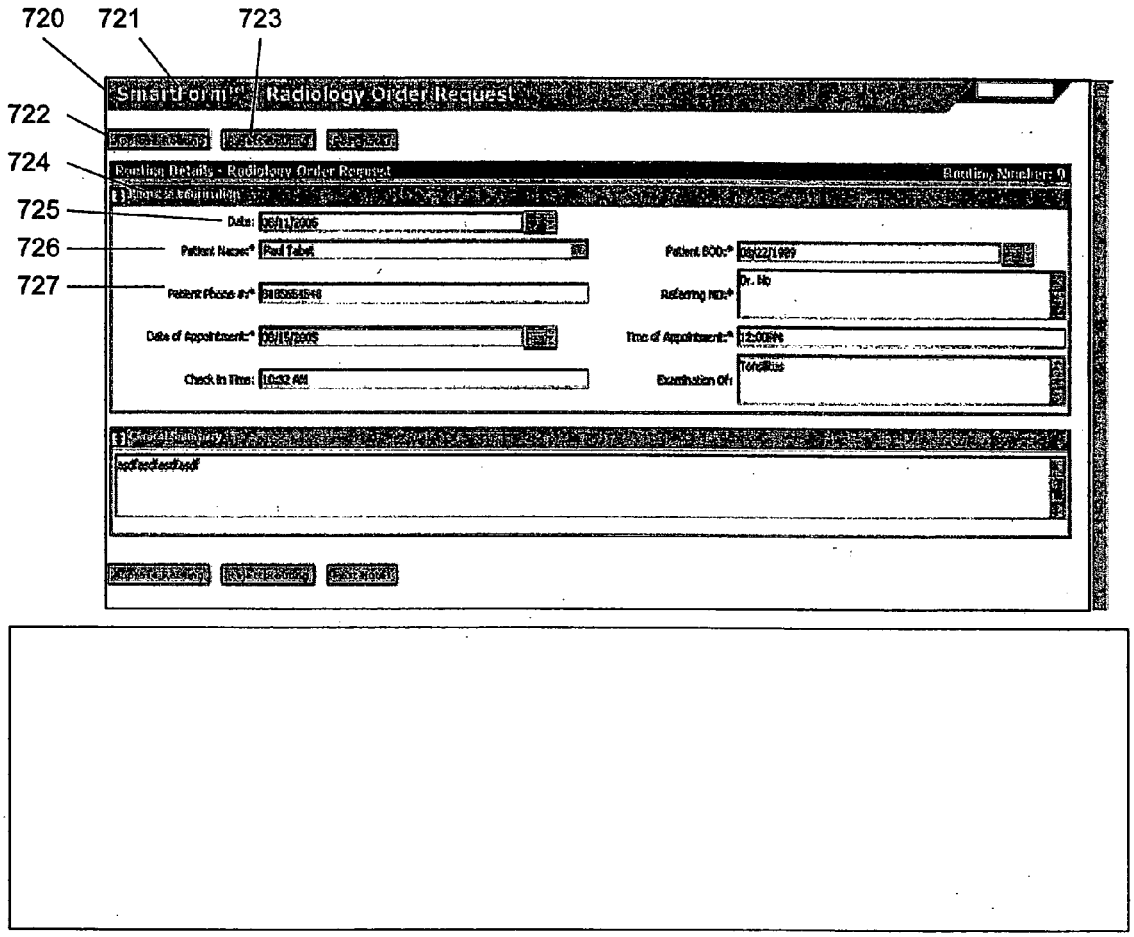

720
721
723
722
724
725
726
727
SmartForm
Radiology Order Request
Routine Details - Radiology Order Request
Routine Number: 0
Date:
Patient Name*
Paul Tabet
Patient DOB:*
08/22/1989
Patient Phone #:*
Referring MD:*
Dr. No
Date of Appointment:*
Time of Appointment:*
Check In Time:
10:32 AM
Examination Of:
Total Bilirubin

Figure 7c

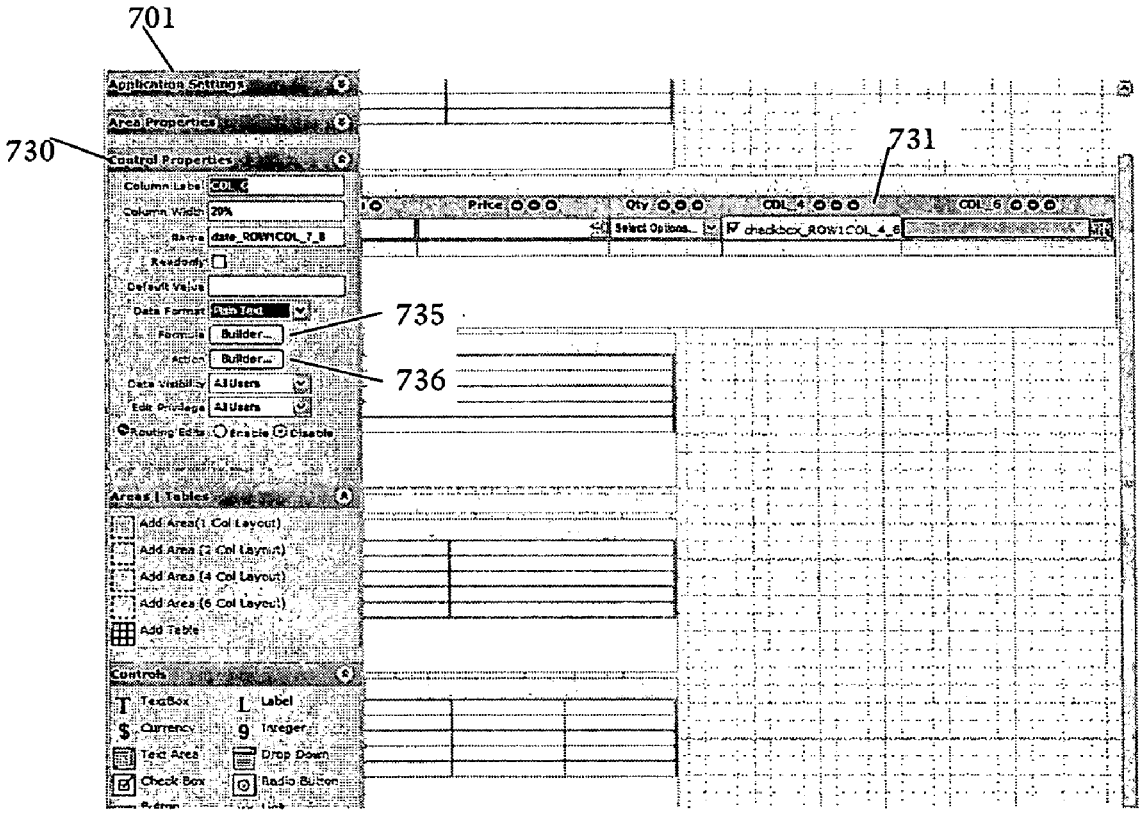

701
730
731
735
736
Application Settings
Area Properties
Control Properties
Column Label
Column Width
Name
Readonly
Default Value
Data Format
Format
Action
Data Visibility
Edit Privilege
Builder...
All Users
Areas | Tables
Add Area(1 Col Layout)
Add Area (2 Col Layout)
Add Area (4 Col Layout)
Add Area (6 Col Layout)
Add Table
Controls
TextBox
Label
Currency
Integer
Text Area
Drop Down
Check Box
Radio Button
Price
Qty
COL 4
COL 6
Select Options...
checkbox_ROW1COL_4_6

Figure 7d

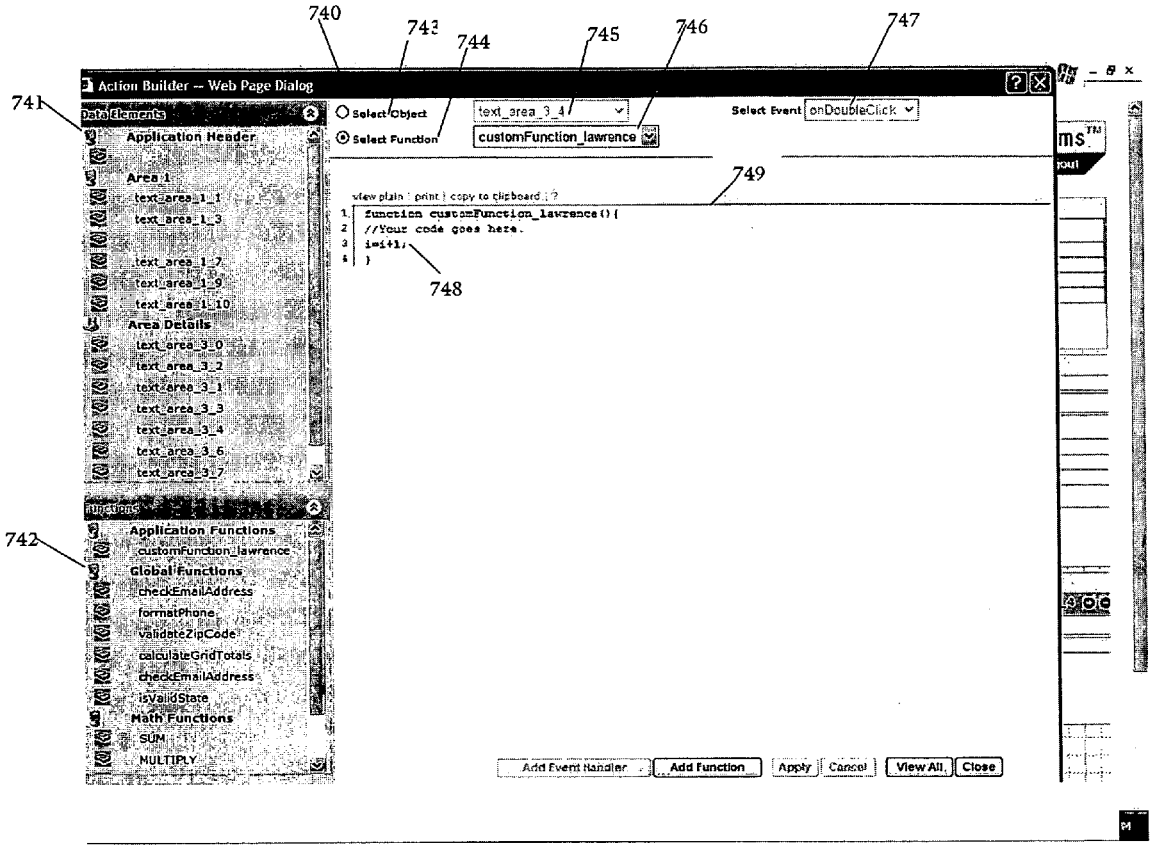

740
743
744
745
746
747
741
742
749
748
Action Builder -- Web Page Dialog
Select Object
Select Function
text_area_3_4
customFunction_lawrence
Select Event
onDoubleClick
Application Header
Area 1
text_area_1_1
text_area_1_3
text_area_1_7
text_area_1_9
text_area_1_10
Area Details
text_area_3_0
text_area_3_2
text_area_3_1
text_area_3_3
text_area_3_4
text_area_3_6
text_area_3_7
Application Functions
customFunction_lawrence
Global Functions
checkEmailAddress
formatPhone
validateZipCode
calculateGridTotals
checkEmailAddress
isValidState
Math Functions
SUM
MULTIPLY
function customFunction_lawrence(){
//Your code goes here.
}
Add Event Handler
Add Function
Apply
Cancel
View All
Close

Figure 7e

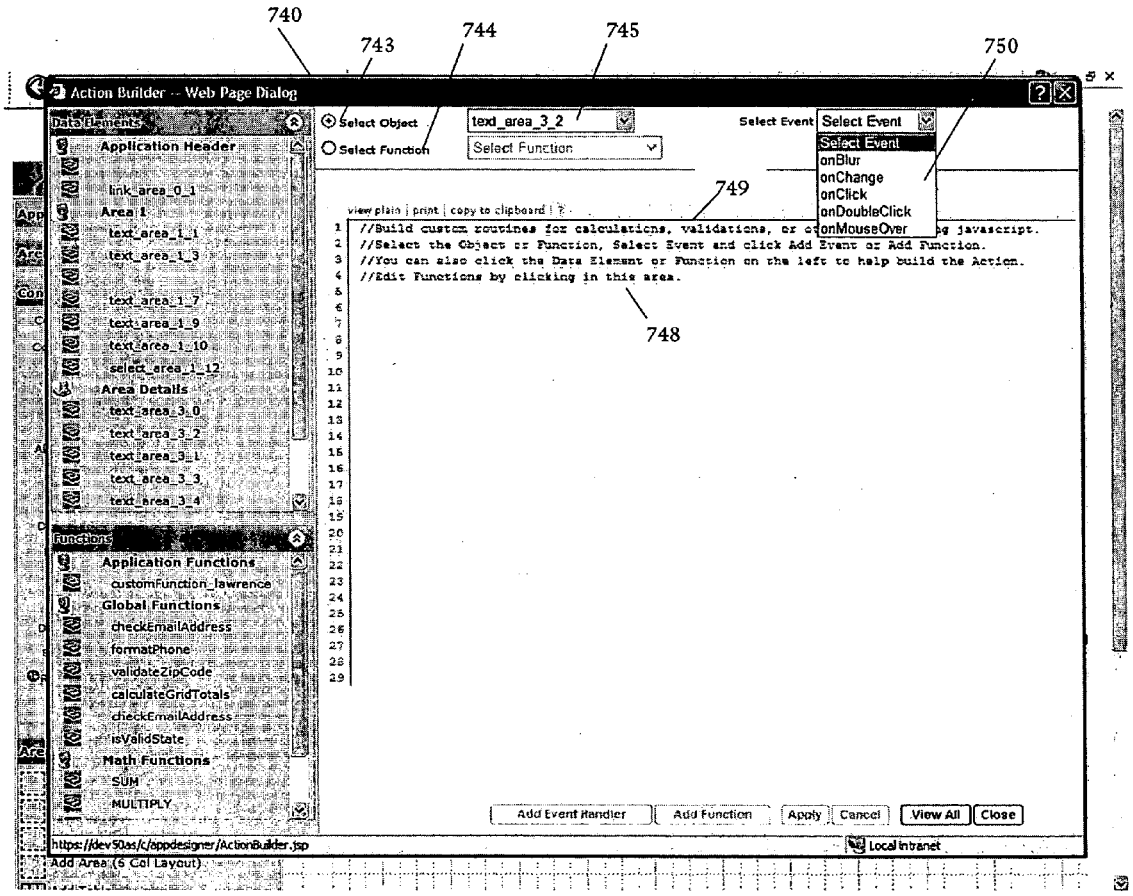
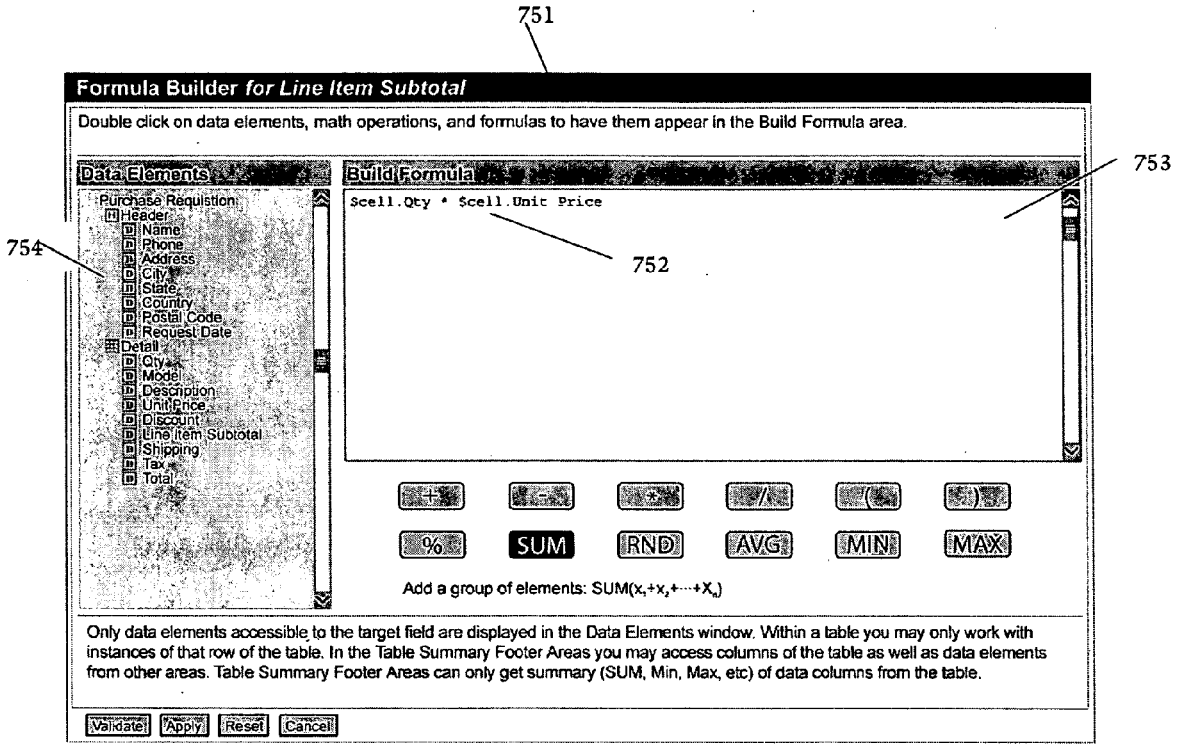

740
743
744
745
750
749
748
Action Builder -- Web Page Dialog
Select Object
Select Function
text_area_3_2
Select Function
Select Event
Select Event
onBlur
onChange
onClick
onDoubleClick
onMouseOver
Application Header
link_area_0_1
Area 1
text_area_1_1
text_area_1_3
text_area_1_7
text_area_1_9
text_area_1_10
select_area_1_12
Area Details
text_area_3_0
text_area_3_2
text_area_3_1
text_area_3_3
text_area_3_4
Application Functions
customFunction_lawrence
Global Functions
checkEmailAddress
formatPhone
validateZipCode
calculateGridTotals
checkEmailAddress
isValidState
Math Functions
SUM
MULTIPLY
view plain | print | copy to clipboard |
//Build custom routines for calculations, validations, or
//Select the Object or Function, Select Event and click Add Event or Add Function.
//You can also click the Data Element or Function on the left to help build the Action.
//Edit Functions by clicking in this area.
Add Event Handler
Add Function
Apply
Cancel
View All
Close
https://dev50as/c/appdesigner/ActionBuilder.jsp
Local intranet
Add Area (6 Col Layout)

Figure 7f


751
Formula Builder for Line Item Subtotal
Double click on data elements, math operations, and formulas to have them appear in the Build Formula area.
Data Elements
Build Formula
753
754
752
$cell.Qty * $cell.Unit Price
Purchase Requistion
Header
Name
Phone
Address
City
State
Country
Postal Code
Request Date
Detail
Qty
Model
Description
Unit Price
Discount
Line Item Subtotal
Shipping
Tax
Total
%
SUM
RND
AVG
MIN
MAX
Add a group of elements: SUM(x1+x2+···+Xn)
Only data elements accessible to the target field are displayed in the Data Elements window. Within a table you may only work with instances of that row of the table. In the Table Summary Footer Areas you may access columns of the table as well as data elements from other areas. Table Summary Footer Areas can only get summary (SUM, Min, Max, etc) of data columns from the table.
Validate
Apply
Reset
Cancel

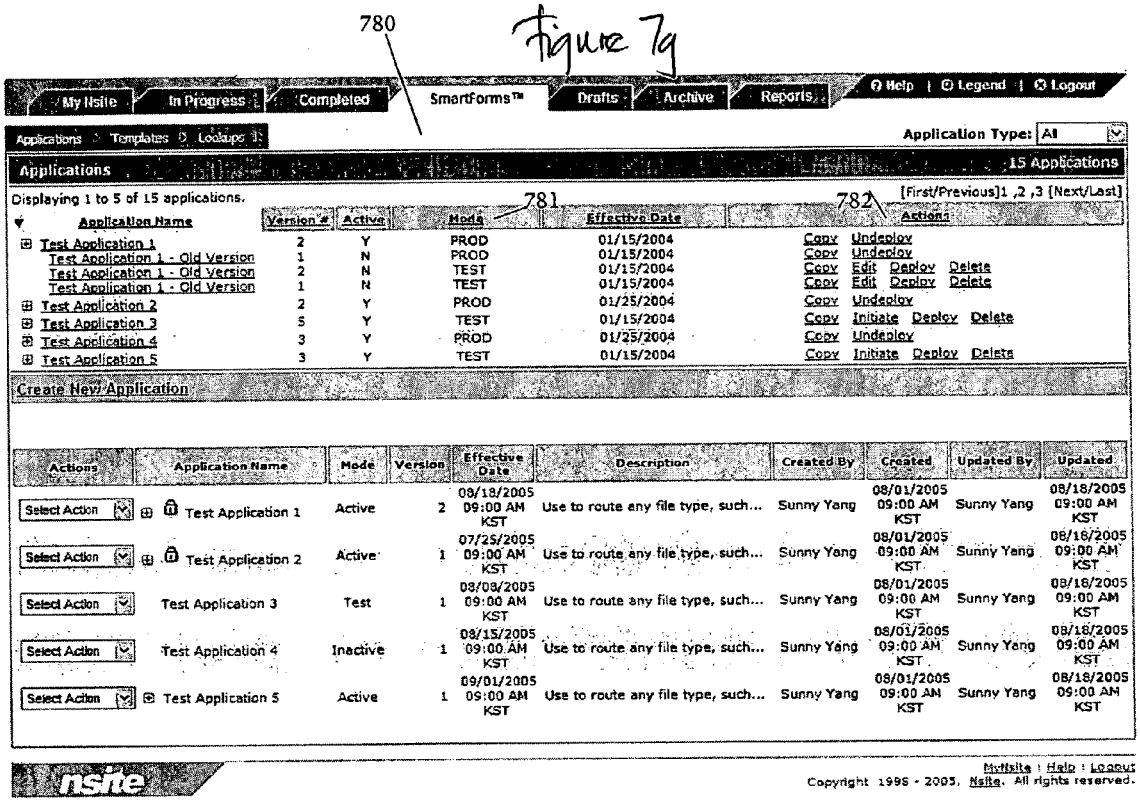

780
781
782
My Nsite
In Progress
Completed
SmartForms™
Drafts
Archive
Reports
Help | Legend | Logout
Applications
Templates
Lookups
Application Type: All
Applications
15 Applications
Displaying 1 to 5 of 15 applications.
[First/Previous]1 ,2 ,3 [Next/Last]
Application Name
Version #
Active
Mode
Effective Date
Action
Test Application 1
Test Application 1 - Old Version
Test Application 1 - Old Version
Test Application 1 - Old Version
Test Application 2
Test Application 3
Test Application 4
Test Application 5
Copy Undeploy
Copy Undeploy
Copy Edit Deploy Delete
Copy Edit Deploy Delete
Copy Undeploy
Copy Initiate Deploy Delete
Copy Undeploy
Copy Initiate Deploy Delete
Create New Application
Actions
Application Name
Mode
Version
Effective Date
Description
Created By
Created
Updated By
Updated
Select Action
Test Application 1
Active
2
09/18/2005 09:00 AM KST
Use to route any file type, such...
Sunny Yang
08/01/2005 09:00 AM KST
Sunny Yang
08/18/2005 09:00 AM KST
Select Action
Test Application 2
Active
1
07/25/2005 09:00 AM KST
Use to route any file type, such...
Sunny Yang
08/01/2005 09:00 AM KST
Sunny Yang
08/16/2005 09:00 AM KST
Select Action
Test Application 3
Test
1
08/08/2005 09:00 AM KST
Use to route any file type, such...
Sunny Yang
08/01/2005 09:00 AM KST
Sunny Yang
08/16/2005 09:00 AM KST
Select Action
Test Application 4
Inactive
1
08/15/2005 09:00 AM KST
Use to route any file type, such...
Sunny Yang
08/01/2005 09:00 AM KST
Sunny Yang
08/16/2005 09:00 AM KST
Select Action
Test Application 5
Active
1
09/01/2005 09:00 AM KST
Use to route any file type, such...
Sunny Yang
08/01/2005 09:00 AM KST
Sunny Yang
08/18/2005 09:00 AM KST
nsite
MyNsite | Help | Logout
Copyright 1998 - 2005, Nsite, All rights reserved.

Figure 7g

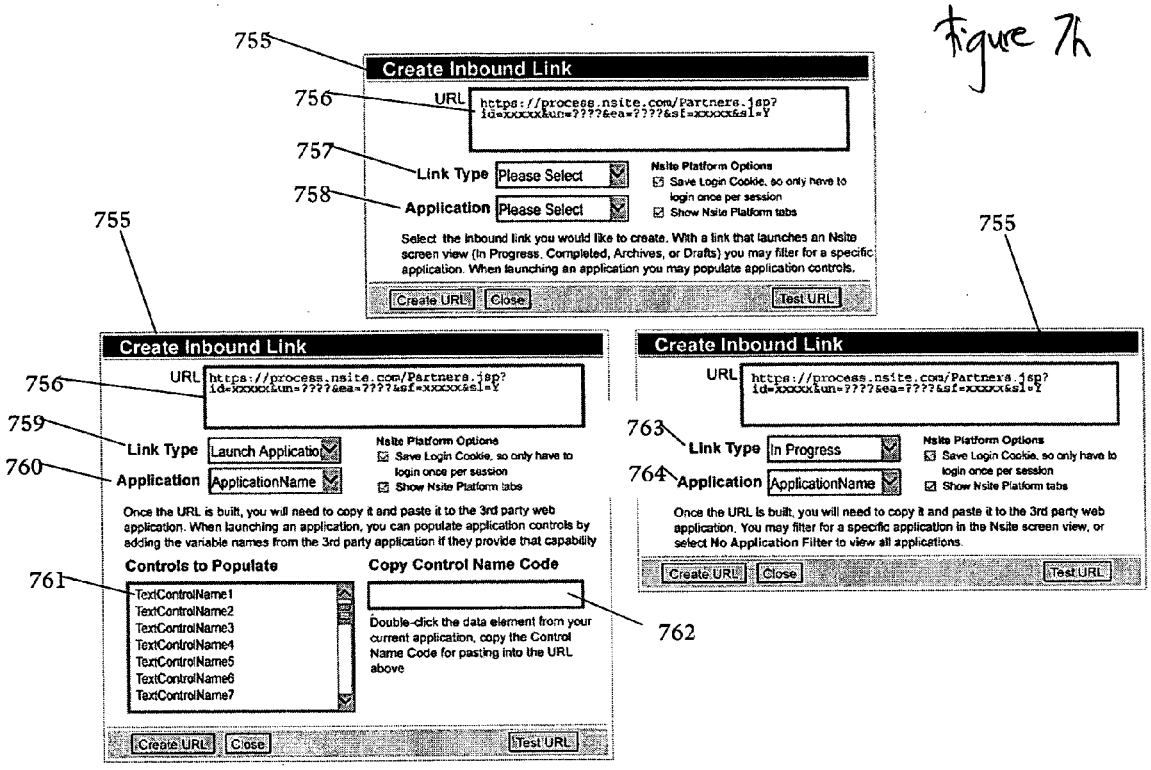


figure 7h
755
Create Inbound Link
756
URL
https://process.nsite.com/Partners.jsp?id=xxxxx&un=????&ea=????&sf=xxxxx&sl=Y
757
Link Type
Please Select
758
Application
Please Select
Nsite Platform Options
Save Login Cookie, so only have to login once per session
Show Nsite Platform tabs
Select the inbound link you would like to create. With a link that launches an Nsite screen view (In Progress, Completed, Archives, or Drafts) you may filter for a specific application. When launching an application you may populate application controls.
Create URL
Close
Test URL
755
Create Inbound Link
756
URL
https://process.nsite.com/Partners.jsp?id=xxxxx&un=????&ea=????&sf=xxxxx&sl=Y
759
Link Type
Launch Applicatio
760
Application
ApplicationName
Nsite Platform Options
Save Login Cookie, so only have to login once per session
Show Nsite Platform tabs
Once the URL is built, you will need to copy it and paste it to the 3rd party web application. When launching an application, you can populate application controls by adding the variable names from the 3rd party application if they provide that capability
Controls to Populate
761
TextControlName1
TextControlName2
TextControlName3
TextControlName4
TextControlName5
TextControlName6
TextControlName7
Copy Control Name Code
Double-click the data element from your current application, copy the Control Name Code for pasting into the URL above
762
Create URL
Close
Test URL
755
Create Inbound Link
URL
https://process.nsite.com/Partners.jsp?id=xxxxx&un=????&ea=????&sf=xxxxx&sl=Y
763
Link Type
In Progress
764
Application
ApplicationName
Nsite Platform Options
Save Login Cookie, so only have to login once per session
Show Nsite Platform tabs
Once the URL is built, you will need to copy it and paste it to the 3rd party web application. You may filter for a specific application in the Nsite screen view, or select No Application Filter to view all applications.
Create URL
Close
Test URL

Figure 7i

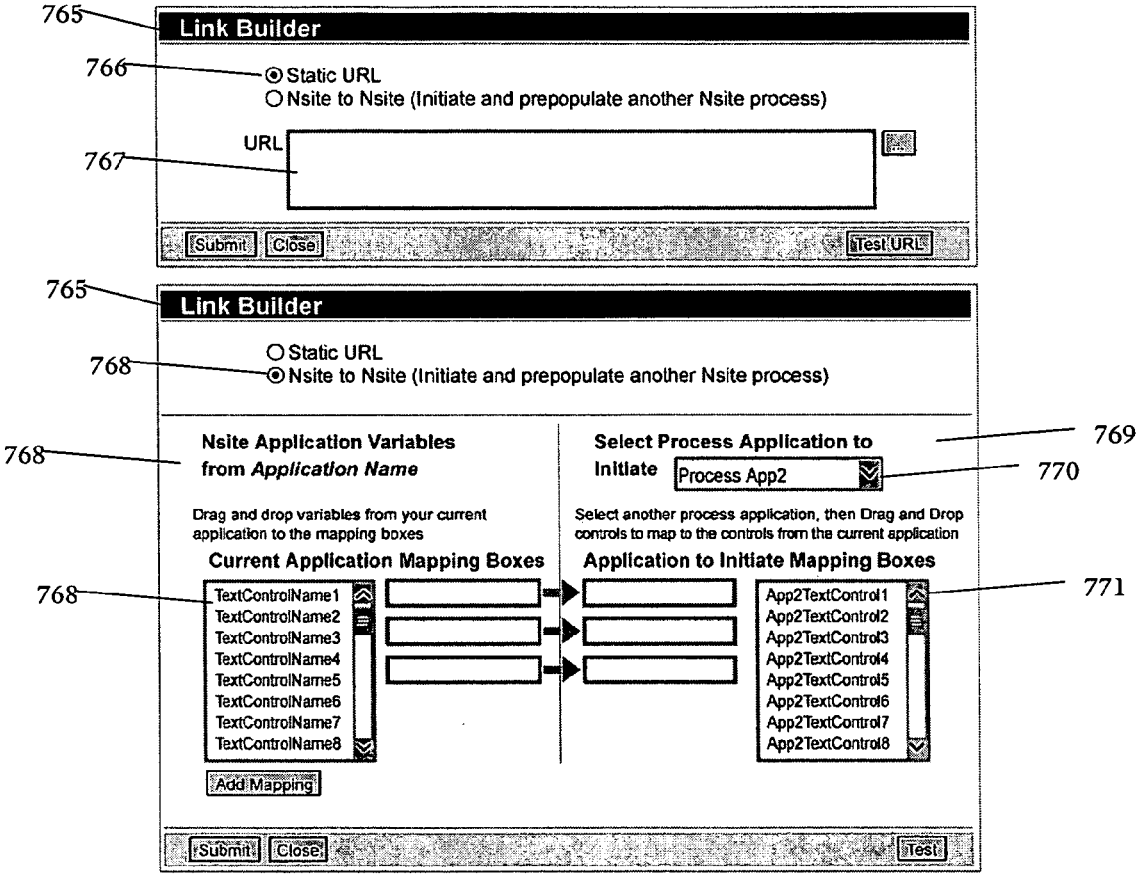

765
Link Builder
766
Static URL
Nsite to Nsite (Initiate and prepopulate another Nsite process)
URL
767
Submit
Close
Test URL
765
Link Builder
768
Static URL
Nsite to Nsite (Initiate and prepopulate another Nsite process)
768
Nsite Application Variables from Application Name
769
Select Process Application to Initiate
Process App2
770
Drag and drop variables from your current application to the mapping boxes
Select another process application, then Drag and Drop controls to map to the controls from the current application
Current Application Mapping Boxes
Application to Initiate Mapping Boxes
768
TextControlName1
TextControlName2
TextControlName3
TextControlName4
TextControlName5
TextControlName6
TextControlName7
TextControlName8
771
App2TextControl1
App2TextControl2
App2TextControl3
App2TextControl4
App2TextControl5
App2TextControl6
App2TextControl7
App2TextControl8
Add Mapping
Submit
Close
Test

Figure 8

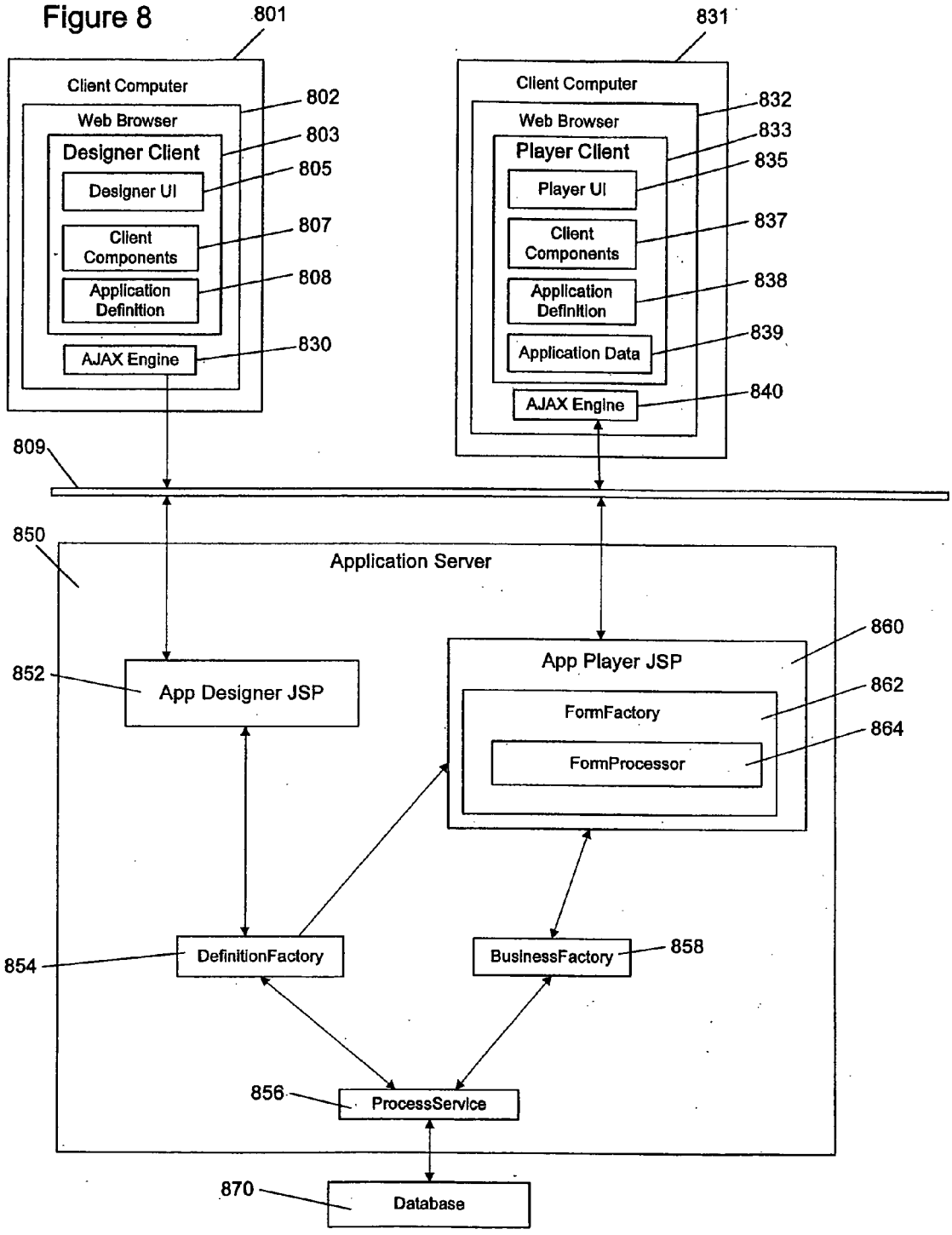

801
Client Computer
802
Web Browser
803
Designer Client
805
Designer UI
807
Client Components
808
Application Definition
830
AJAX Engine
831
Client Computer
832
Web Browser
833
Player Client
835
Player UI
837
Client Components
838
Application Definition
839
Application Data
840
AJAX Engine
809
850
Application Server
852
App Designer JSP
860
App Player JSP
862
FormFactory
864
FormProcessor
854
DefinitionFactory
BusinessFactory
858
856
ProcessService
870
Database

Figure 9

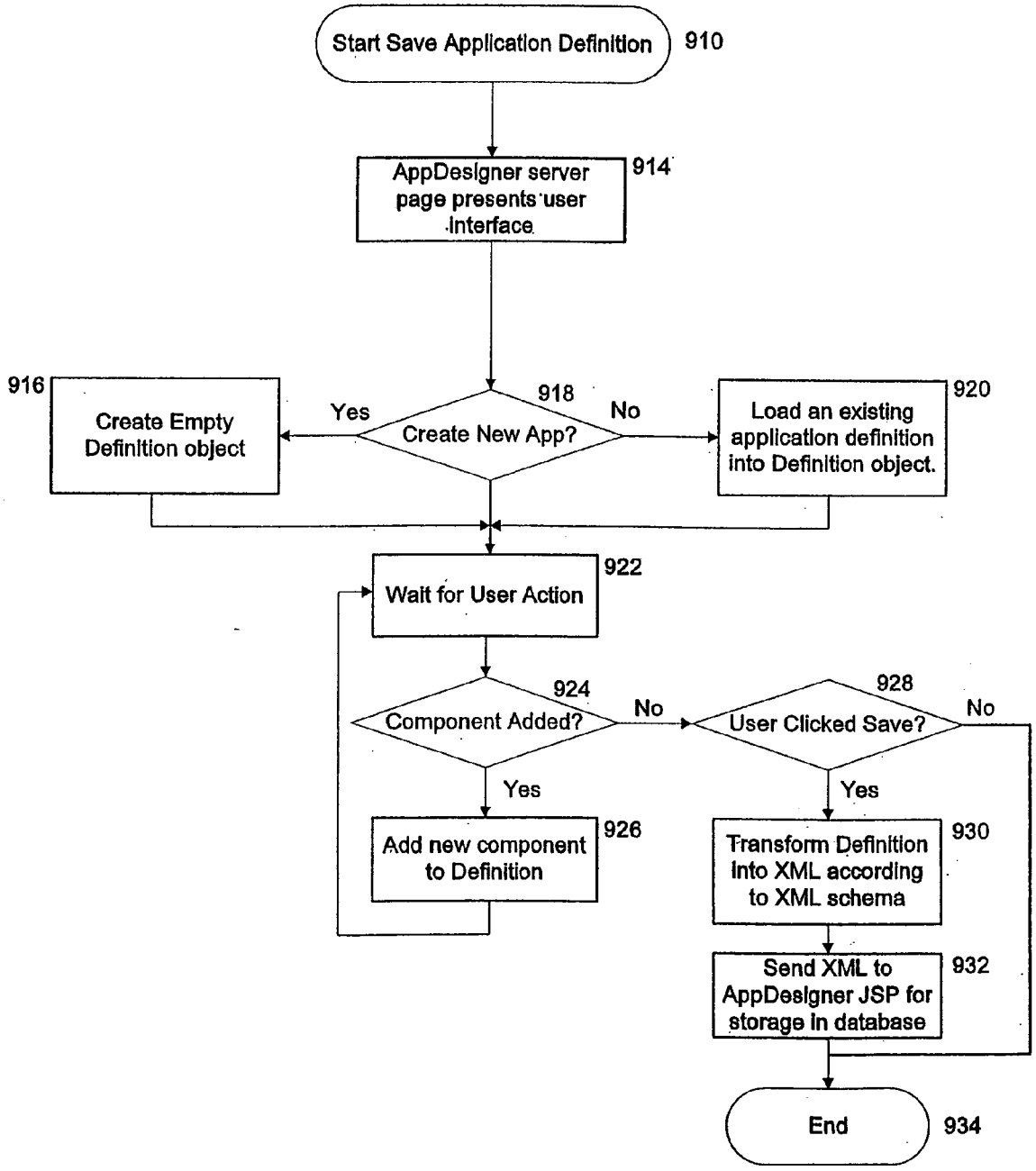

Start Save Application Definition
910
AppDesigner server page presents user interface
914
Create New App?
918
Yes
No
916
Create Empty Definition object
920
Load an existing application definition into Definition object.
Wait for User Action
922
Component Added?
924
No
User Clicked Save?
928
No
Yes
Yes
Add new component to Definition
926
Transform Definition into XML according to XML schema
930
Send XML to AppDesigner JSP for storage in database
932
End
934

Figure 10a

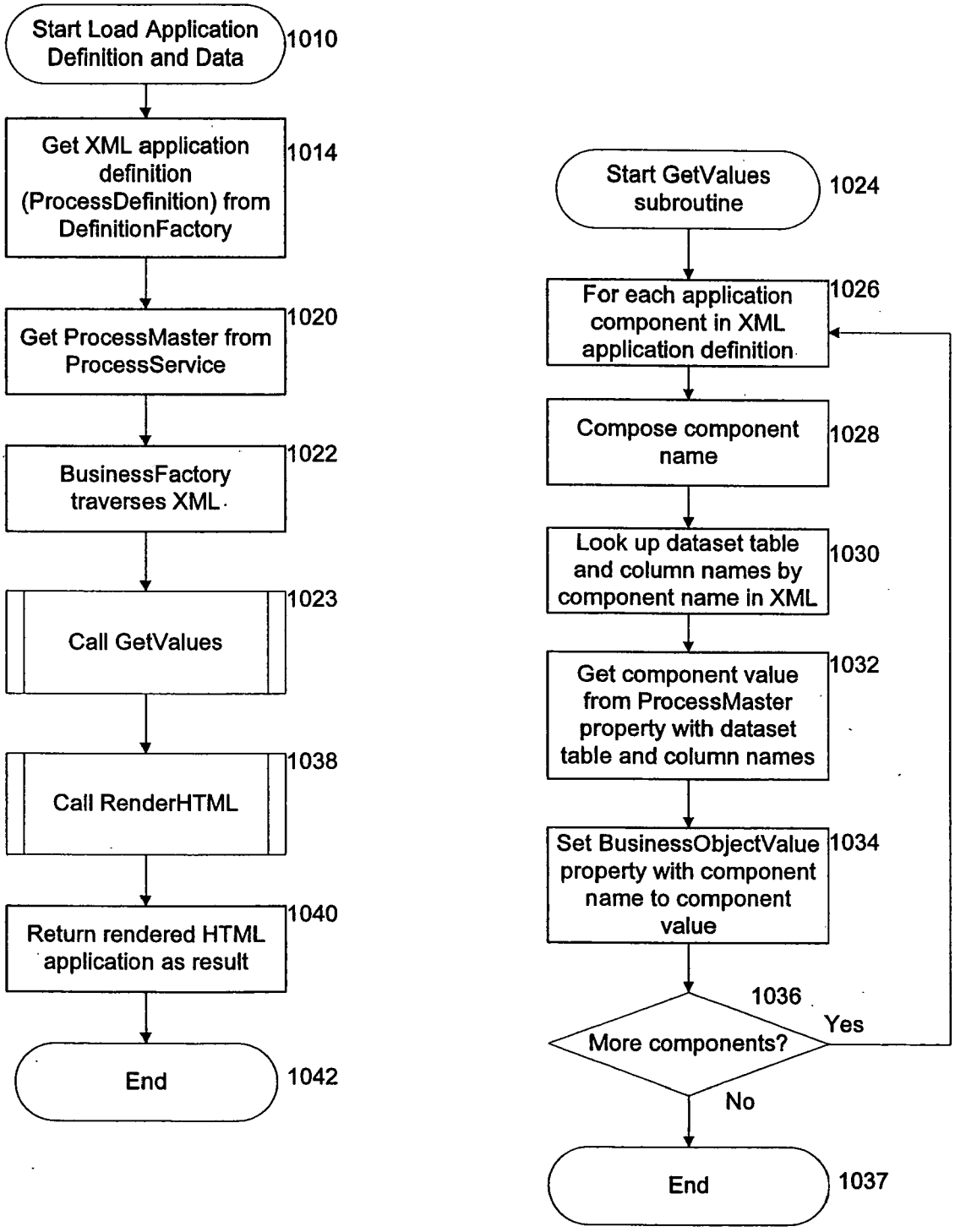

Start Load Application Definition and Data
1010
Get XML application definition (ProcessDefinition) from DefinitionFactory
1014
Get ProcessMaster from ProcessService
1020
BusinessFactory traverses XML
1022
Call GetValues
1023
Call RenderHTML
1038
Return rendered HTML application as result
1040
End
1042
Start GetValues subroutine
1024
For each application component in XML application definition
1026
Compose component name
1028
Look up dataset table and column names by component name in XML
1030
Get component value from ProcessMaster property with dataset table and column names
1032
Set BusinessObjectValue property with component name to component value
1034
1036
More components?
Yes
No
End
1037

Figure 10b

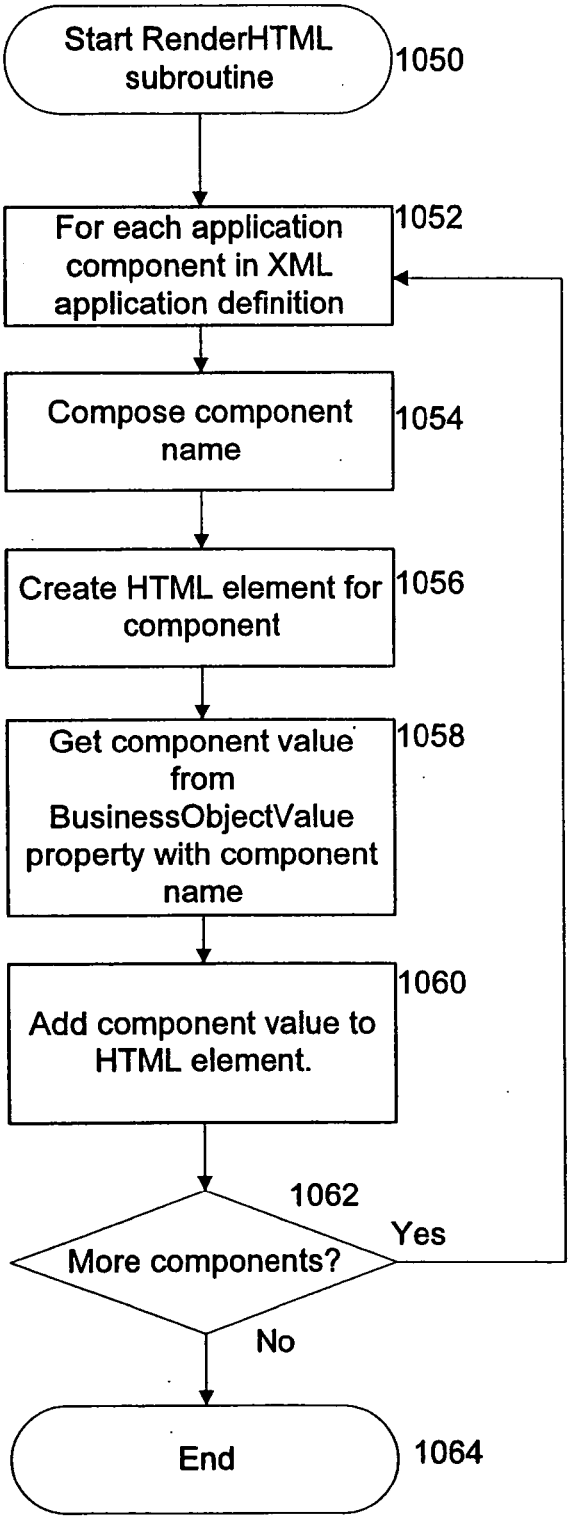

Start RenderHTML subroutine
1050
For each application component in XML application definition
1052
Compose component name
1054
Create HTML element for component
1056
Get component value from BusinessObjectValue property with component name
1058
Add component value to HTML element.
1060
1062
More components?
Yes
No
End
1064

Figure 11

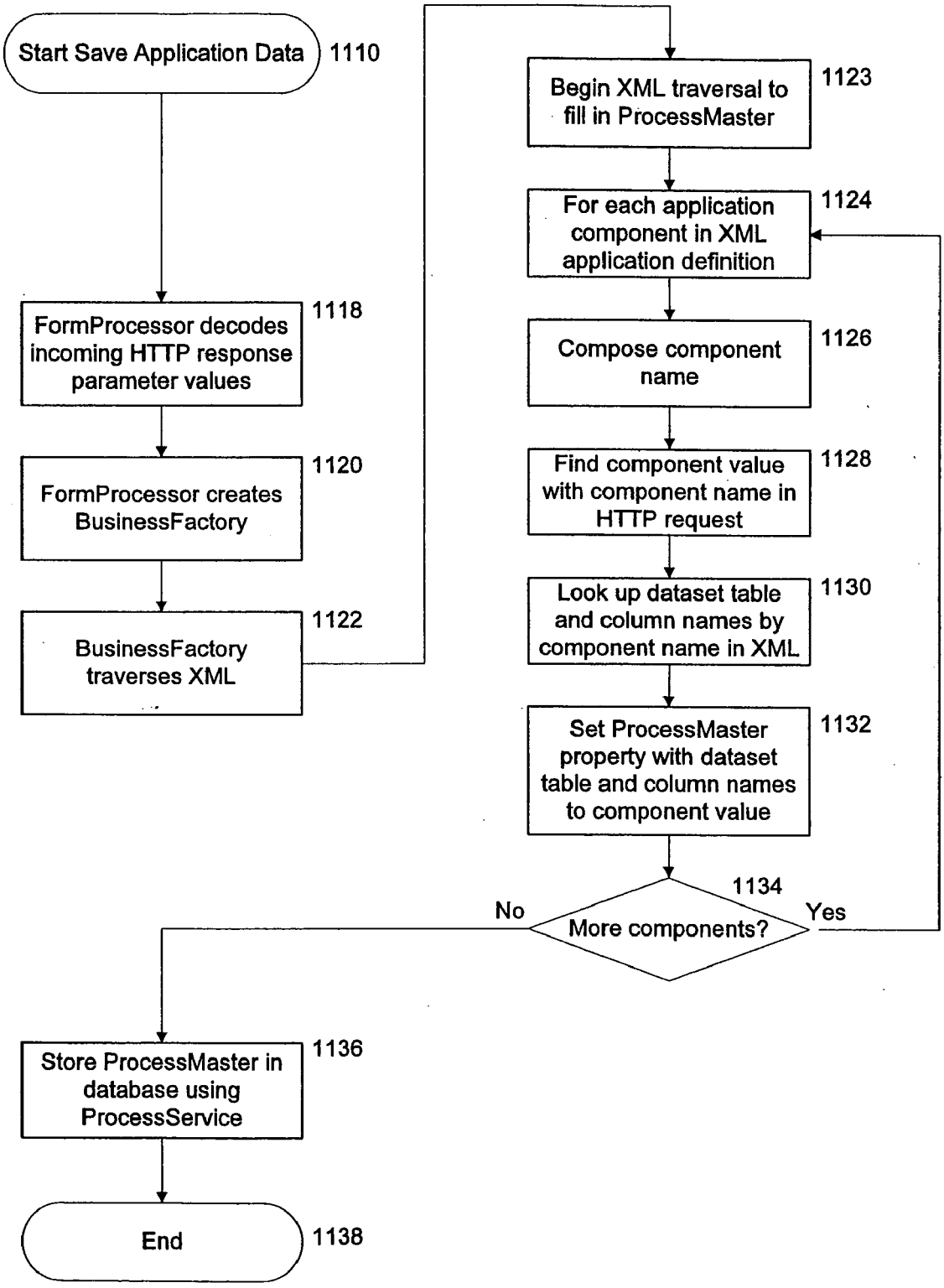

Start Save Application Data
1110
FormProcessor decodes incoming HTTP response parameter values
1118
FormProcessor creates BusinessFactory
1120
BusinessFactory traverses XML
1122
Begin XML traversal to fill in ProcessMaster
1123
For each application component in XML application definition
1124
Compose component name
1126
Find component value with component name in HTTP request
1128
Look up dataset table and column names by component name in XML
1130
Set ProcessMaster property with dataset table and column names to component value
1132
More components?
1134
No
Yes
Store ProcessMaster in database using ProcessService
1136
End
1138

Figure 12a

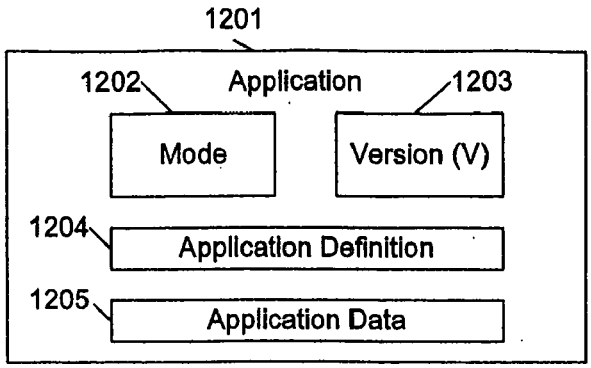



Figure 12b

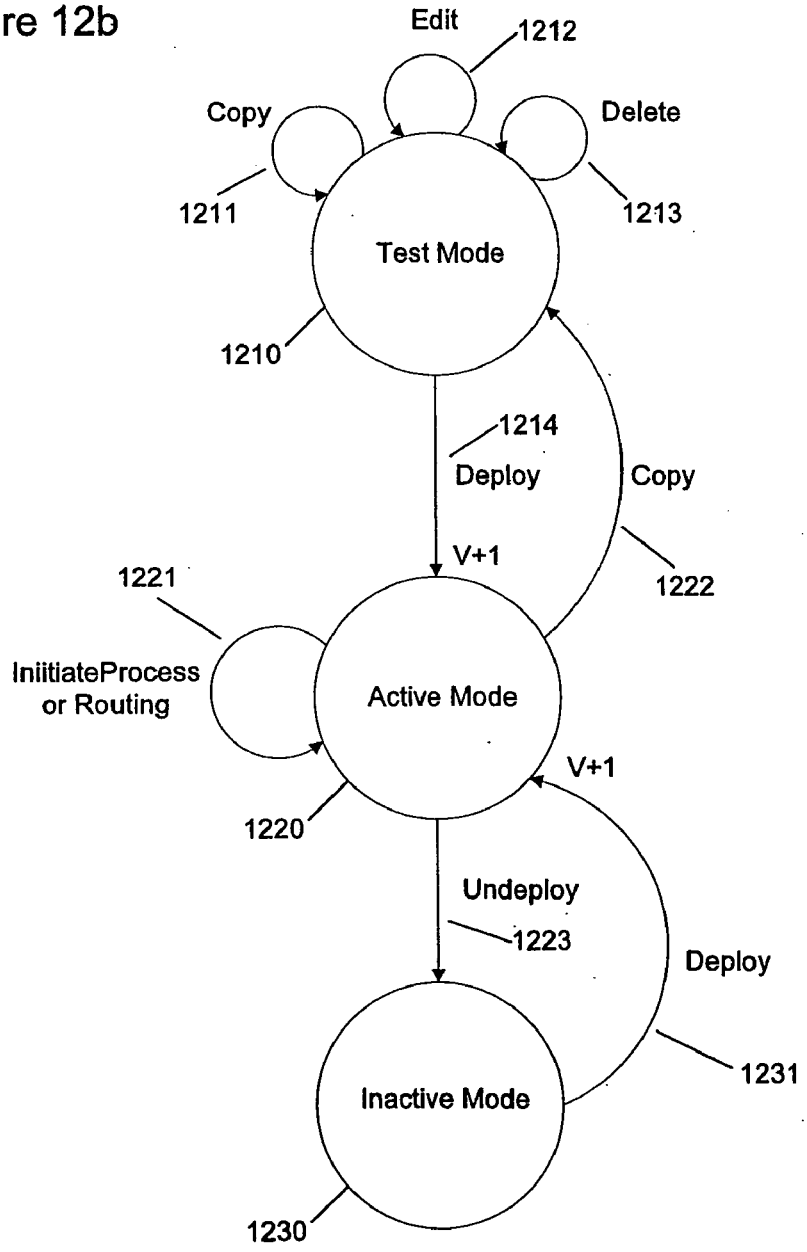
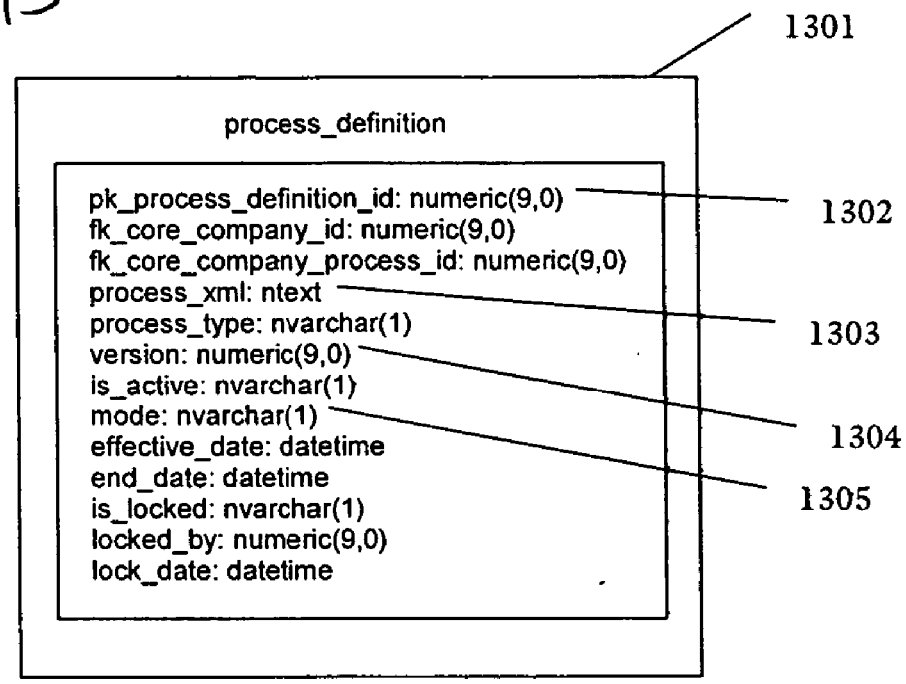


figure 13


1301
process_definition
pk_process_definition_id: numeric(9,0)
fk_core_company_id: numeric(9,0)
fk_core_company_process_id: numeric(9,0)
process_xml: ntext
process_type: nvarchar(1)
version: numeric(9,0)
is_active: nvarchar(1)
mode: nvarchar(1)
effective_date: datetime
end_date: datetime
is_locked: nvarchar(1)
locked_by: numeric(9,0)
lock_date: datetime
1302
1303
1304
1305

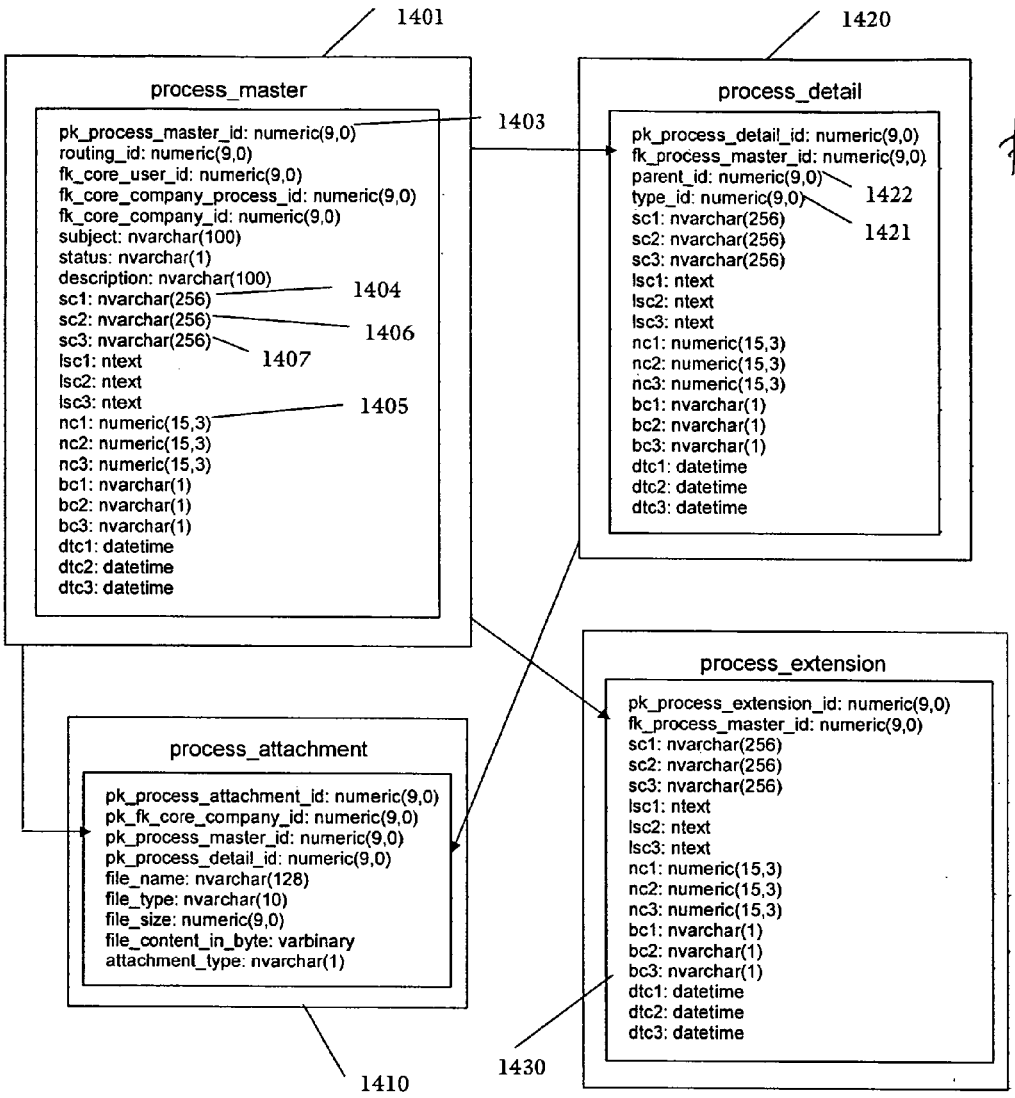

1401
1420
process_master
pk_process_master_id: numeric(9,0)
routing_id: numeric(9,0)
fk_core_user_id: numeric(9,0)
fk_core_company_process_id: numeric(9,0)
fk_core_company_id: numeric(9,0)
subject: nvarchar(100)
status: nvarchar(1)
description: nvarchar(100)
sc1: nvarchar(256)
sc2: nvarchar(256)
sc3: nvarchar(256)
lsc1: ntext
lsc2: ntext
lsc3: ntext
nc1: numeric(15,3)
nc2: numeric(15,3)
nc3: numeric(15,3)
bc1: nvarchar(1)
bc2: nvarchar(1)
bc3: nvarchar(1)
dtc1: datetime
dtc2: datetime
dtc3: datetime
1403
1404
1406
1407
1405
process_detail
pk_process_detail_id: numeric(9,0)
fk_process_master_id: numeric(9,0)
parent_id: numeric(9,0)
type_id: numeric(9,0)
sc1: nvarchar(256)
sc2: nvarchar(256)
sc3: nvarchar(256)
lsc1: ntext
lsc2: ntext
lsc3: ntext
nc1: numeric(15,3)
nc2: numeric(15,3)
nc3: numeric(15,3)
bc1: nvarchar(1)
bc2: nvarchar(1)
bc3: nvarchar(1)
dtc1: datetime
dtc2: datetime
dtc3: datetime
1422
1421
process_attachment
pk_process_attachment_id: numeric(9,0)
pk_fk_core_company_id: numeric(9,0)
pk_process_master_id: numeric(9,0)
pk_process_detail_id: numeric(9,0)
file_name: nvarchar(128)
file_type: nvarchar(10)
file_size: numeric(9,0)
file_content_in_byte: varbinary
attachment_type: nvarchar(1)
1410
process_extension
pk_process_extension_id: numeric(9,0)
fk_process_master_id: numeric(9,0)
sc1: nvarchar(256)
sc2: nvarchar(256)
sc3: nvarchar(256)
lsc1: ntext
lsc2: ntext
lsc3: ntext
nc1: numeric(15,3)
nc2: numeric(15,3)
nc3: numeric(15,3)
bc1: nvarchar(1)
bc2: nvarchar(1)
bc3: nvarchar(1)
dtc1: datetime
dtc2: datetime
dtc3: datetime
1430

Figure 14

# BROWSER BASED DESIGNER AND PLAYER

## BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to methods for programming a machine to perform data processing, and in one aspect to methods for programming a machine to perform specific data processing tasks described in a simplified manner.

[0003] 2. Description of the Related Art

[0004] Today, most types of software applications are installed directly on a user's computer. Examples of such applications include the Microsoft™ Word™, Adobe™ Photoshop™, and Intuit™ Quicken™ computer programs. A user of such an application generally is limited to using that application on the computers on which it has been installed. This limitation is problematic if a user is traveling and does not have physical access to the computer on which an application is installed. Furthermore, updating these applications to add new features or fix defects requires installation of updates directly on the user's computer, which is often a time-consuming process.

[0005] Web applications, also referred to herein as browser-based applications, solve such usability and installation problems by using a web browser, e.g. Microsoft Internet Explorer™ or Mozilla Firefox™, and a web server, e.g. Apache™ or Microsoft™ Internet Information Services™. An application can be divided into at least two main parts: a user interface, which is presented to a user and interacts with the user, and business logic, which performs the tasks required of the application, in accordance with user input received from the user interface. The web browser runs the user interface. The web server provides the user interface to the web browser and runs the business logic, possibly in cooperation with other servers such as an application server, e.g. JBoss™ or BEA™ WebLogic™, and a database server, e.g. Oracle™. The web application need not be installed directly on the user's computer. The term server or web server here refers to software executed on a computer, also referred to generally in the field as a server platform.

[0006] A web browser is a type of specialized software application, typically installed directly on the user's computer, which allows a user to view and interact with web pages. Web pages are documents, typically in HyperText Markup Language (HTML) format that the web browser retrieves from a web server computer via a network, using a protocol such as the HyperText Transfer Protocol (HTTP). Web pages may include software code in a programming language such as JavaScript™ which will be executed by the web browser when the page is retrieved. A web application includes a user-interface component that is loaded as part of a web page by a browser via a network connection. A web application's user interface may be implemented as a web page using HTML and JavaScript™. A browser-equipped computer, therefore, uses a network connection to permit a user to access a web application running on a remote server, for example. Furthermore, web applications can be updated at any time by installing the update on the server.

[0007] Computer software applications are often required to perform operations that are specific to a particular user or organization. For example, a software application may be used to in a hospital to request clinical tests. The software application may include a set of data fields for which a user provides data values, such as a patient name and a test name. A particular hospital may also require a patient medical record number in a format defined by that hospital. In general, the set of data fields, and actions to be taken after data values have been provided, are dependent on the needs of the hospital, and may change over time. Therefore there is a need for customization of software to meet specific requirements. Customization of software may include developing new software or modifying existing software. Customization can be done by a programmer using a programming language such as C++, Java, or BASIC. However, the use of such languages often requires substantial time and effort, as well as specialized knowledge of the programming language, so such customization by programming can be expensive. Rapid Application Development (RAD) tools address these problems by simplifying programming tasks. A typical RAD tool is software that includes a graphical user interface for laying out application user interfaces and defining application behaviors in terms of predefined actions such as data entry and database access. A RAD tool may present a list of predefined behaviors or actions from which a user can choose when creating or extending an application. RAD tools are generally easier to learn and use than conventional programming-language based approaches for developing applications, and can shorten the time required to develop applications. Existing RAD tools include Borland Delphi™, Microsoft Visual Basic™, and Macromedia/Adobe ColdFusion™, which can be used to develop a wide range of applications, but often require some programming. RAD tools such as Intuit QuickBase and Microsoft InfoPath can be used to develop applications that involve filling out data forms and accessing databases.

[0008] There is a need for non-programmers to design, develop, and deploy simple to complex, composite and monolithic applications in the business world today. Application development is a costly, time consuming, and risky proposition for even capable engineering organizations, let alone business analysts and other non-technical staff. Few organizations have the resources to use complex development tools and deployment environments to build and deploy applications. This engineering capability void has fostered a large and thriving software industry as known today. Even so, packaged software applications are expensive to purchase and even more expensive to install, configure and maintain. A new breed of Software As A Service, (SAAS,) vendors have evolved to deliver complex software as a service to further eliminate complexity and reduce costs to leverage software application benefits. Even with SAAS vendors providing robust pre-built applications, only a small percentage of business software application requirements are met and hence, the need for both applications and infrastructure that is aimed at business analysts and programmers to design, develop and deploy applications quickly and efficiently.

[0009] Several of the RAD tools described above provide support for creating web applications. Delphi™, Visual Basic™, and ColdFusion™ simplify the development of web applications created using programming languages. That is, those tools simplify the creation of user interfaces by providing graphical user interface builder tools that can be easily connected to business logic implemented in a programming language, but it is still necessary to write code in

a programming language for some portions of the application, such as the business logic. QuickBase™ provides for rapid development of forms-based web applications using a graphical user interface. Furthermore, QuickBase itself is a web application, which means that it allows web applications to be developed using the same web application model in which the applications will be deployed. That is, users of QuickBase can develop applications on any computer running a web browser, without directly installing QuickBase software on their own computer. QuickBase applications may also be hosted on web servers provided by a software vendor, for example, Intuit, so that users are not required to provide a web server to host QuickBase applications they develop.

[0010] InfoPath™ from Microsoft™ provides for rapid development of forms. InfoPath forms can optionally be made available as web applications, but the InfoPath form designer itself is not a web application and must be installed directly on a user's computer. Furthermore, InfoPath depends on other Microsoft products such as Internet Explorer™ and does not work with browsers from other vendors, such as Mozilla Firefox™. Therefore InfoPath forms can only be accessed from computers on which InfoPath™ and related Microsoft™ products are installed.

[0011] Existing RAD tools do not combine the benefits of web applications with features such as customizable processing in a scripting language, linkage with external data sources such as databases, and linkage to web services. We have recognized that it would be desirable to have an easy-to-use RAD tool which is itself a web application, and which allows a user to quickly develop and customize web-based data processing applications that can include data input, validation, processing, and linkage with web services. Such a RAD tool could be used to quickly and efficiently develop and customize applications using any computer that has a standard web browser and access to the Internet. Furthermore, web applications typically require complex business logic for their activities. This logic is typically written in strongly typed languages and the logic requires recompilation and redeployment. It would be desirable to provide a RAD tool with a scripting language which can change or extend the behavior of web applications without the additional overhead of recompilation or redeployment.

[0012] Existing Web-based RAD tools do not provide a single unified interface and environment for building a web application that includes a user interface linked to persistent data stored in a database. Existing Web-based RAD tools disadvantageously use a multi-step process that starts at the level of individual data elements, and expect the user to perform a series of steps to define a user interface linked to persistent data. These steps typically include defining a field, defining an object, defining a container, linking the objects, defining a user interface, and linking the user interface to the objects and fields, all of which are complex and time-consuming.

## SUMMARY OF THE INVENTION

[0013] In general, in a first aspect, the invention features a computer enabled method of creating a software application. The method includes the acts of providing a user interface for designing the software application on a web browser, defining aspects of the application via the web browser using the user interface, and transmitting the defined aspects to a server over a computer network to create a web-based software application. Embodiments of the invention may include one or more of the following features. The method of creating a software application may include the acts of providing a set of components on the web browser and implementing aspects of the application using the components. The method may include the steps of providing a library on the browser and using the library as an intermediary between the defined aspects at the browser and the server. The computer network may include the Internet. The method may include, at the server, the steps of rendering a representation of the application from the transmitted defined aspects, retrieving data associated with the application from a storage, and transmitting the representation and retrieved data to a client. The method may include, at the client, the act of executing the representation and data on a web browser. The method may include the acts of providing a library on the web browser of the client and using the library as an intermediary between the web browser of the client and the server. The method may include the acts of tracking multiple versions of the software application, maintaining each version as compatible with prior versions of the software application, and allowing multiple of the versions to be active at the same time.

[0014] In a second aspect, the invention features a computer enabled method of providing a software application, including the acts of receiving at a server over a computer network from a first client web browser a software application including defined aspects of the application, rendering a representation of the application from the received defined aspects, retrieving data associated with the application from a storage, and transmitting the representation and retrieved data to a second client. Embodiments of the invention may include one or more of the following features. In the method of providing a software application, the computer network may include the Internet. The method of providing a software application may include, at the second client, the steps of providing a web browser and providing a user interface to a user on the web browser from the received representation and data. The method of providing a software application may include, at the second client, the acts of: providing a library on the browser and using the library as an intermediary between the browser and the server. The method of providing a software application may include the acts of providing a user interface on the web browser at the first client for designing the software application, defining the aspects of the application using the user interface, and transmitting the defined aspects to the server over the computer network. The method of providing a software application may include the acts of tracking a plurality of versions of the software application, maintaining each version as compatible with prior versions of the software application, and allowing a plurality of the versions to be active at the same time.

[0015] In general, in a third aspect, the invention features a computer enabled method of providing a software application, including the acts of receiving over a computer network aspects of an application from a server, executing the application on a web browser, providing a user interface, and allowing use of the application via the user interface.

[0016] In general, in a fourth aspect, the invention features a client to be executed on a computer. The client includes a

user interface adapted for designing a software application on a web browser and an application definition module which defines aspects of the software application via the web browser using the user interface. Furthermore, the web browser may transmit the defined aspects to a server over a computer network to create the software application. Embodiments of the invention may include one or more of the following features. Multiple components may be on the web browser, and some of the aspects of the application may be implemented using the components. The client may include a library on the browser, and the library may be used as an intermediary between the defined aspects at the browser and the server. The computer network may include the Internet.

[0017] In general, in a fifth aspect, the invention features an application server to be executed on a computer. The application server includes an application definition module for receiving over a computer network from a first client web browser a software application, including defined aspects of the application, and rendering a representation of the application from the received defined aspects. The application server also includes a service for retrieving data associated with the application from a storage, and an application player module for transmitting the representation and retrieved data to a second client. The application server may include, at the server, a version control for tracking multiple versions of the software application, maintaining each version as compatible with prior versions of the software application, and allowing multiple versions to be active at the same time.

[0018] In general, in a sixth aspect, the invention features a player client to be executed on a computer. The player client includes a definition module for receiving over a computer network aspects of an application from a server, a data module for receiving over the computer network from the server data relating to the application, and a user interface for executing the application on a web browser. Embodiments of the invention may include one or more of the following features. The player client may use a library on the browser as an intermediary between defined aspects of the application and the server.

[0019] In general, in a seventh aspect, the invention features a method of running an application program in a web browser, including the acts of providing at least one client computer and one server computer in communication with the network, executing a web browser on the client computer, executing a client portion of the application program on the web browser, wherein the client portion presents a runtime user interface according to an application definition. The application definition includes a component described by a component definition, the component includes a name and a data value, and the client portion receives the data value from a user. The method of running an application program further includes the step of executing a server portion of the application program on the server computer, wherein the server portion receives the data value from the client portion and stores the data value in a database, as specified by the application definition. Embodiments of the invention may include one or more of the following features. The component may include a link, the link may refer to a web service, and the client program may receive the data value from the web service in response to a user action. The component may include a script operable to execute in response to an application event, and the script may perform calculations based on a data value associated with another component. The script may set a data value associated with another component. The component may be associated with a row of a table component.

[0020] In general, in an eighth aspect, the invention features a method for designing an application program in a web browser, including the acts of providing at least one client computer and one server computer in communication with the network, executing a web browser on the client computer, and executing a designer program on the web browser. The 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 being associated with a component data value. The designer program creates an application definition, the application definition describing properties of the interface component, including an association between the component data value and a corresponding component data value in a database.

[0021] Embodiments of the invention may include one or more of the following features. The component may be associated with a link, and the designer program may receive a Uniform Resource Locator associated with the link from a user. The component may be associated with a computer program code script, the designer program may receive the computer program code script from a user, and the computer program code script may perform calculations based on the value of another component. The computer program code script may set the value of another component. The user may place a table component upon the workspace. The table component may include a table header row having at least one column definition and a table detail row having at least one column corresponding to the at least one column definition, and the column may be associated with a detail component having a detail data value. The application definition may describe the table component and an association between the at least one detail data value and a corresponding detail column in a database.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1***a* is an illustrative drawing of an enterprise application design and deployment system according to one embodiment of the invention.

[0023] FIG. **1***b* is an illustrative drawing of a browser-based application according to one embodiment of the invention.

[0024] FIGS. **2***a* and **2***b* are illustrative drawings of application definitions according to one embodiment of the invention.

[0025] FIG. **3** is an illustrative drawing of an application user interface according to one embodiment of the invention.

[0026] FIGS. **4***a* and **4***b* are illustrative drawings an application definition format according to one embodiment of the invention.

[0027] FIGS. **5***a*, **5***b*, and **5***c* are illustrative drawings of application definitions according to one embodiment of the invention.

[0028] FIGS. **6***a*, **6***b*, and **6***c* are illustrative drawings of an application data format and application data values according to one embodiment of the invention.

[0029] FIGS. **7***a*-**7***i* are illustrative drawings of an Application Designer and Application Player user interfaces, according to one embodiment of the invention.

[0030] FIG. **8** is an illustrative drawing of client and server components of an enterprise application design and deployment system according to one embodiment of the invention.

[0031] FIG. **9** is an illustrative drawing of a method of creating or updating an application according to one embodiment of the invention.

[0032] FIGS. **10***a* and **10***b* are illustrative drawings of flowcharts of a method of loading an existing application according to one embodiment of the invention.

[0033] FIG. **11** is an illustrative drawing of a method of saving application data according to one embodiment of the invention.

[0034] FIG. **12***a* is an illustrative drawing of an application including a mode and a version number according to one embodiment of the invention.

[0035] FIG. **12***b* is an illustrative drawing of application mode transitions according to one embedment of the invention.

[0036] FIG. **13** is an illustrative drawing of a database schema for storing an application definition according to one embedment of the invention.

[0037] FIG. **14** is an illustrative drawing of database schemas for storing application data according to one embedment of the invention.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0038] The following description is presented to enable any person skilled in the art to make and use the invention, and is provided in the context of particular applications and their requirements. Various modifications to the preferred embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein 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, well-known 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.

[0039] FIG. **1***a* is an illustrative drawing of an enterprise application design and deployment system according to one embodiment of the invention. A user **100** interacts with the Designer UI (user interface) **102** to design an application, e.g. a data input form, and a user **118**, which may be the same user as user **100**, or may be a different user, interacts with a Player UI (user interface) **114** to execute the application. The Designer UI and Player UI are software programs that are executed by a web browser running on a computer (shown in FIG. **8**). Application Data **120** may be provided by the user **118** when the Player UI **114** executes the application. The Application Data **120** may include, for example, data entered by a user, such as data concerning a particular person or transaction. An application may include dynamic behavior, calculations, lookups, validations, and linkages to other data via, for example, a Uniform Resource Locator (URL) query string. The term application is used herein to refer to applications designed by the Designer UI, e.g. forms-based applications. The application is represented by an Application Definition **104**, which is a structured list of components, e.g. text fields and logic, and other entities included in the application. A server **106** receives the application from the Designer UI **102** as an Application Definition **108** and stores the application in an Application Definition table **112** of database **110**. The server **106** also sends the application to the Player UI **114** by retrieving an Application Definition **108** and any associated Application Data **122**, e.g. values for the data input form, from the Application Definition table **112** and Application Data table **124**, respectively, of the database **110**. The user **118** provides Application Data **120** to the Player UI **114**, which sends the Application Data **120** to the server **106**, where the Application Data is converted to an intermediate format Application Data **122** and then stored in Application Data table **124**. The server **106** and database **110** are software programs that are executed by computers (now shown).

[0040] FIG. **1***b* is an illustrative drawing of a browser-based application according to one embodiment of the invention. A web browser **132** executes a Player UI **134**, which in turns executes an application **135**. The Player UI **134** presents the application **135** to a user **130** via the web browser **132**. The application **135** includes at least one component **136**, which represents a user interface element such as a text box or a web link. The component **136** includes a name **138**, which uniquely identifies the component. The component **136** is accessible by the name **138** in a Document Object Model associated with the web browser **132** in scripting languages, e.g. JavaScript™ or the like. The user **130** can provide computer program code as a script **143**, which is associated with the component **136**, for performing calculations based on the data value **142** in response to events, such as a user changing the data value **142**. A script **143** can also set the data value **142**. The component **136** also includes properties **140**, which describe the component, e.g., the location of the component on a web page, and the type of component, e.g. a text box or link component. The properties **140** may include the name **138**. The component **136** also includes a data value **142**, e.g. a text string or numeric value, which can be specified by a user via the Player UI **134**. The data value **142** is stored in a database **144** in a database column specified in the properties **140**. The component **136** also includes a link **142**, which has an associated Uniform Resource Locator (URL) that can refer to another application **146**, or a web page **148**, or a web service **150**. The link **142** may send or receive the data value **142** to or from the application **146**, the web page **148**, or the web service **150**, in response, for example, to input from the user **130**. A description of the component **136**, including the properties **140**, is stored in the application definition **108** of FIG. **1***a*.

[0041] FIG. **2***a* is an illustrative drawing of an application definition according to one embodiment of the invention. An application **200** may include at least one StandardArea **202**. A StandardArea **202** includes area properties **240** and at least

one component **204**. There is a second type of area, called a table area, which is shown as TableArea **203** in FIG. **2***b*. Table areas are described in more detail below. An area contains a grid of cells (nor shown) to allow users to place the components of an area in specific locations within the area. The locations are specified in terms of numeric row and column numbers. More specifically, the location of a component in a grid is specified by a row index value and column index value, where row **0**, column **0** is the top left corner of the grid. The area properties **240** are a set of name-value pairs that describe the area. The area properties **240** include a name property, which specifies the name of the standard area **202**, and width, rowindex, and colindex properties, which specify the width, grid row, and grid column of the area, respectively.

[**0042**] A component **204** is a user interface element of a specific type. The component **204** may be a Label, Text Box, Text Area, Radio Button, Check Box, Select List (e.g. a drop-down list), File Attachment, Button, Image, or link. Each component has associated properties. The component types and the properties associated with each component type are descrobed in the table below.

| COMPONENT TYPE | DESCRIPTION | PROPERTIES |
|---|---|---|
| Text Box | A text input field for reading data of a specific type, e.g. string or numeric data. Contains a text value. | Name, Required, Readonly, Keyword Field, Data Type, Allowed Characters, Visibility Privileges, Edit privileges, Routing edits (enable or disable), data type, data format, max characters, default value, action (event handler). |
| Text Area | A text edit box for editing a text string. Can display multiple rows of text and allow the user to edit the text. Contains a text value. | Name, required, read only, keyword field, visibility and edit privileges, routing edits (enable or disable), allowed characters, data format, max characters, max rows, max chars, default value, action (event handler). |
| Date Picker | A data selector. Contains a date value. | Name, required, read only, keyword field, visibility and edit privilege, routing edits (enabled or disabled), data format, default value, action (event handler). |
| Check Box | A check box with two possible values (checked or unchecked). Contains a boolean value. | Label, name, edit and visibility privileges, routing edits (enable or disable), initial state (checked or unchecked), action (event handler). |
| Radio Buttons | A set of buttons, one of which can be selected. Contains a value representing a selected button. | Name, radio group, edit privileges, routing edits, initial state, checked value, action (event handler). |
| Combo Box | A drop-down box for selecting one item from a list of items. | Name, required, keyword field, visibility and edit privileges, routing edits (enable or disable), data type, height, allow multiple selections (yes or no), data lookup source, action (event handler). |
| Label | A text label for displaying information. Does not contain a value. | Name, layout style, alignment. |
| Button | A button that can be selected by a user to cause an event handler to be called. | Label, name, visibility and edit privileges, action (event handler), web service, link. |
| Attachment | A file associated with the application. | Name, attachment type, visibility privileges, action privileges. |
| Link | A web link that refers to a web page, web service, or other resource. When the link is selected in the Player UI, the web page, web service, or other resource will be accessed. | Label, name, visibility and edit privileges, action (event handler), web service, link (URL). |

[0043] The component **204** has component properties **208**. If the component **204** is a data-holding component, e.g., a TextBox, TextArea, Select List, RadioButton, CheckBox, or File Attachment, then the component **204** has a value **206**. The component properties **208** include a name property, which uniquely identifies the component within the area **204**, a type property, e.g. label or text box, a label property, the value of which is displayed in the user interface for some component types, such as the label component type. The component properties **208** also include rowindex and colindex properties, which indicate the position of the component within the area, a hidden property, which indicates whether the component is to be displayed or hidden in the Player UI, and a datalinkage property, which indicates a source of values for the component, e.g. a database column containing values for a selection list, a datatype property, which indicates the permitted type of the value **206**, and a required property, which indicates whether a value is required for the component **204**.

[0044] The component properties **208** further include a dataset property, which may specify a database column in which the component's value **206** is stored. Because of the differences in data representations between the web browser's HTML-based data model, the Java object model used by the server, and the relational database model in which data is stored persistently, the XML application definition establishes a mapping between application data and database data, based on a component naming convention in which a unique name is assigned to each component. A DATASET attribute is also assigned to each component. The DATASET attribute specifies a database table and column name and thereby binds the component's value to a database column. The application data value of the component is stored in the specified database column. Multiple instances of application data are stored as separate database rows, so that each instance of application data, e.g. each Radiology Order Request instance associated with a Radiology Order Request application, is stored as a separate row in the database. The unique component name is generated by concatenating the names of enclosing components, such as areas and tables, with the component name and numeric counter values as described below.

[0045] Application definitions are specified using the Extensible Markup Language (XML). An XML document structure **250**, shows how an application **200** that includes the StandardArea **202** can be defined using XML. The XML document structure has XML elements that correspond to the elements of the StandardArea **202**. Specifically, the XML structure has a Form element **255**, an Area element **256**, and at least one FormComponent **257**.

[0046] The Area element **256** and the Form element **255** enclose the FormComponent(s) **257**, as shown by an Area element end marker **258** and a Form element end marker **259**. The Form element **255** has a name attribute, which is assigned a value such as the name of the application. The Area element **256** includes four attributes: a name attribute, and label, rows, and cols attributes. The name attribute specifies a name for the area, and gets its value from an area name property **205** of Area properties **240**. The area name property **205** is assigned a value, e.g. "area_0", by a string concatenation method based a counter value, e.g. 0, for the first area, that is incremented for each area in the Application **200**. The value of the area name property **205** is assigned, for example, when the StandardArea **202** is added to the application. The label attribute specifies a name to be displayed for the area in the user interface, and gets its value from the dispalyname property of Area properties **240**. The rows and cols attributes specify the number of rows and columns, respectively, in the area, and get their values from the rowcount and colcount properties, respectively, of Area properties **240**. The FormComponent element **257** is an XML representation of the user interface component **204** and includes attributes, such as name and type attributes, which are assigned values from corresponding component properties **208** of the component **204**, e.g. name and type properties, respectively. A component name property **209** is assigned a value, e.g. "comp_area_0_0_0", by a string concatenation method based on the type of component, e.g. "comp_", the name of the enclosing area, e.g. "area_0", and a counter value that is incremented for each component **204** in the application, e.g. 0 for the first component. The value of the component name property **209** is assigned, for example, when the StandardArea **202** is added to the application. Generally, the name of a component in a StandardArea is generated by the following expression:

<ComponentType>+"_"+<AreaName>+"_"+<CounterValue>

[0047] where ComponentType is a string that corresponds to the type of the component, e.g. "comp" for data input components such as selection boxes, or "lbl" for label components, AreaName is the name of the enclosing Area, and CounterValue is a number that uniquely identifies the component within the enclosing Area. The counter values are assigned based on the number of components of the same type that have been previously processed in the enclosing Area. All non-alphanumeric characters in the name are replaced with underscores (_) when the component name is generated.

[0048] FIG. **2***b* is an illustrative drawing of an application definition according to one embodiment of the invention. An application **200** may contain at least one table area **203**, which defines a table of rows and columns that will be presented to a user in the Application Player. A table area **203** includes area properties **240** and at least one TableComponent **249**. A TableComponent **249** includes a TableHeadRow **241**, a TableDetailRow **243**, and zero or more TableFootRows **246**. The TableHeadRow **241** describes the names, sizes, and positions of columns in the table. The TableHeadRow **241** includes zero or more column definitions **251**. Each column definition **251** has column properties **241**, which include a column name property **252**, a width property that specifies the width of the column, and a colindex property that specifies the position of the column in the table.

[0049] A column name property **252** is assigned a value, e.g. "tcol_hdr_table_area_1_0", by concatenating the type of the table row, e.g. "tcol_hdr" for a table header row, with the name of the enclosing TableComponent **249**, e.g. "table_area_1" and a counter value, e.g. 0, that is incremented for each column **251** in the application. The value of the component name property **209** is assigned, for example, when the StandardArea **202** is added to the application. Generally, the name of a component in a TableArea is generated by the following concatenation expression:

<RowType>+"_"+<AreaName>+"_"+<TableName>+"_+<TableColumnName>+"_"+<FormComponentName>+"_"+<CounterValue>

[0050] where RowType is a string based on the type of row. Specifically, RowType is set to tcol_hdr for header rows, dcol_dtl for detail rows, and fcol_ftr<counter> for footer rows, which have an associated counter value because there can be multiple footer rows), AreaName is the name of the enclosing Area, and CounterValue is a number that uniquely identifies the component within the enclosing Area. The counter values are assigned based on the number of components of the same type that have been previously processed in the enclosing Area. All non-alphanumeric characters in the name are replaced with underscores (_) when the component name is generated.

[0051] Table values are stored in detail rows, which are described by a TableDetailRow **243** that has zero or more columns **244**. Each column has zero or more components **245** which store data values associated with column. The TableDetailRow is associated with a database table, e.g., a process_detail table (described below with reference to FIG. **14**), The values of components **245** are stored in the database table. A TableFootRow **246** is similar to the TableDetailRow, except that the TableFootRow **246** is associated with a different database table, e.g. a PM table. A TableFootRow component **248** can include formulas that that specify a value for the component **248** based on the values of one or more TableDetailRow components **245**.

[0052] An XML document structure **261** shows how an application **200** that includes the TableArea **203** can be described using XML. The XML document structure **261** has XML elements that correspond to the elements of the TableArea **203**. Specifically, the XML structure **261** has a Form element **262**, which corresponds to the Application **200**. The Form element **262** encloses an Area element **263**, which corresponds to the TableArea **203** and encloses at least one TableComponent **264**. The Area element **263** has a name property, which is assigned to the value of the name property **205** of theTableArea **203**. The name property **205** of the TableArea **203** is assigned a value based on a concatenation method as described above. There is one TableComponent **264** element for each TableComponent **249** object of the Application **200**. Each TableComponent **264** element has attributes, which are assigned values from corresponding column properties **242** of the column **251**, e.g. name, width, and colindex properties. The TableComponent element **264** encloses a TableHeadRow element **265**, a TableDetail row **268**, and zero or more TableFootRows (not shown). A TableHeadRow element **265** encloses zero or more TableColumns **266**, which correspond to the columns **251** of the application **200**. Each TableColumn element **266** has XML attributes with the same names and values as the properties **242** of the column **251**. The TableDetailRow element **268** similarly corresponds to the TableDetailRow **243** of the application **200** and encloses zero or more TableColumn elements **269** corresponding to the columns **244** of the application. Table detail rows can contain components such as text boxes, so the TableColumn elements **269** of the TableDetailRow **268** include zero or more FormComponent elements **270** that describe components **245** of the application **200**. The FormComponent elements **270** are of the same form as the FormComponent elements **257** of FIG. **2***a*. Finally, each element has an end marker that closes the element definition and completes the definition of the elements scope in the XML document structure **261**. There is a TableHeadRow end marker **267**, a TableColumn end marker **271**, a TableDetailRow end marker **272**, a TableComponent end marker **273**, an Area end marker **274**, and a Form end marker **275**.

[0053] An application can be defined in a Web browser using client components implemented in a programming language, e.g. JavaScript, to create a representation of the application in terms of an object model. The object model includes objects such as an application object that has an array of area objects with properties, an area object that has an array of component objects, including basic components such as labels and text boxes with their properties, as well as table components. The table component object has an array of row objects, including a table head row object and a table detail row object that has an array of column objects, each of which has an array of component objects. A table foot row object would be similar to the table detail row object. The client components are also able to traverse the object in the object model to generate an XML application definition.

[0054] An XML application definition is generated by traversing the objects in the object model, e.g. by starting at the application object, looping through the application's area objects, generating the appropriate XML element begin marker for each area object, e.g. <Area> as shown in FIG. **2***a,* and then looping through the area's array of component objects, generating an XML FormComponent element for each component object, and generating XML attributes for the FormComponent, e.g. the name attribute, based on the component object's properties, e.g. the name property. A table component is traversed in a similar manner to generate an XML TableComponent element. The table head row, table detail row, and table foot row objects of the table component are each processed, and corresponding TableHeadRow, TableDetailRow, and TableFootRow XML elements are generated according to the XML structure **261** illustrated in FIG. **2***b.* Specifically, a table detail row object is processed by generating a <TableDetailRow> XML element and then looping through the table detail row's array of column objects. For each column object, a <TableColumn> XML element is generated with attributes, such as the column name, row index, and column index, taken from the column object. After all columns have been processed, a </TableHeadRow> end marker is generated. The table detail row is processed in a similar manner, by generating a <TableColumn> element before processing the columns, except that each column object in a table detail row has an array of components corresponding to the components that a user can add to a table column. When the XML is generated for a column in a table detail row, a <TableColumn> element begin marker is generated, then a <FormComponent > element is generated for each component in the column, as described above, and a </TableColumn> element end marker is generated after the last <FormComponent> element. For components that can contain data values, such as text areas, text boxes, selection lists, radio buttons, checkboxes, and attachments, a database column name for the data value is generated according to a convention based on the type of the component and a numeric index assigned to the component based on the number of components of the same type that have been previously processed. For example, the database column name for the first component that has a value of type string would be "sc1", and the database column name for the third component that has

a value of type Boolean would be "bc3". Other components of the system use this same convention to locate the values of components in a database.

[0055] FIG. **3** is an illustrative drawing of an application user interface according to one embodiment of the invention. The application **300** has a name **302**, "Request Information", and four components. The components include a Date label component **304**, a date input component **308** for reading a date value from a user, a Patient Name label **306**, and a patient name input component **310**, which may be, for example, a text input box or a selection list that allows a user to select a name from a list of names stored in a database.

[0056] FIGS. **4***a* and **4***b* illustrate a schema describing a format for an application definition according to one embodiment of the invention. The schema may be, for example, an XML Schema describing the format of an XML document that represents an application. An application is stored, e.g. in a database, as an XML document that conforms to a Form schema **410**. With reference to FIG. **4***a*, the Form schema **410** describes the structure and types of data in an application definition. A Form represents an application and has attributes (also referred to herein as properties), which are name-value pairs. The attributes of a Form include a name that specifies a name for the form, e.g. name= "Radiology Order Request", a description that describes the form, a category, a theme, and a subject. A Form **410** includes one or more Areas and 0 or more BehaviorLists. An Area **415** provides for grouping and positional layout of components within a region defined by the boundaries of the Area and by cells arranged in rows and columns within the Area. Each Area **415** has properties, including a name, a label, a layout, a number of rows, a number of columns, and a visibility indicator. Each Area **415** includes one or more ComponentDefinitions. Each ComponentDefinition includes either one or more FormComponents **420**, or one or more TableComponents **440**.

[0057] A FormComponent **420** represents a component, e.g. a Text Box, and has attributes, including a name, a dispalyname, a type, a datatype, a required flag, a keyfield, a readonly flag, a defaultvalue, a rowindex which specifies the vertical position of the FormComponent **420** as a row number on an enclosing Area's grid, a colindex which specifies the vertical position of the FormComponent **420** as a column number on the enclosing Area's grid, a hidden flag, a datacolumn, which specifies a database column in which the value of the FormComponent is stored, a datalookup which specifies a database table from which a list of possible values for the FormComponent can be retrieved. A FormComponent **420** may include a FormComponentList, which may include one or more FormComponents **420**. Note that the FormComponent definition is recursive and allows a FormComponentList to include multiple FormComponents. A FormComponent **420** may also include a BehaviorList **430**.

[0058] A BehaviorList **430** may include Behaviors. A Behavior **435** represents executable code and has properties, including a name, an event, which may specify a type of event for which the behavior will be invoked, e.g. onchange, onClick, and the like, and a category. A Behavior **435** includes a Code element. The Code element includes code, e.g., JavaScript, which implements an event handler. The event handler will be called by the Player UI when a specific event occurs for the component, e.g. JavaScript code that is called when the component's value changes.

[0059] With reference to FIG. **4***b*, a TableComponent **440** represents a table and includes one TableHeadRow, one TableDetailRow, one optional TableFootRow, and one BehaviorList. A TableHeadRow, TableDetailRow, orTableFootRow includes at least one TableColumn **450**. A TableColumn **450** describes the contents of a table column. A TableColumn has properties, including a name, a label, a rowindex, which is 0 by convention, a colindex which identifies the particular column described by the TableColumn, e.g. colindex=1 for the first column, and colindex=1 for the second column. A TableColumn also has a width property, which specifies the width of the column, e.g. as a percentage of the entire width of the table, such as "20%". A TableColumn may include FormComponents. That is, a table column may contain form components such as text boxes.

[0060] FIGS. **5***a*, **5***b*, and **5***c* are illustrative drawings of application definitions according to one embodiment of the invention. FIG. **5***a* shows an application definition **520** that corresponds to the application **300** illustrated in FIG. **3**. The application definition **520** includes properties such as a name, area_**0**, and a label, "Request Information". The, application definition **520** also includes four Form Component definitions corresponding to the four components of FIG. **3**. A Date Label Form Component **522** describes the Date label, and has properties that include a name, comp_area_**0**_**0**_**0**, a type, "LABEL", a label, "Date:", and rowindex and colindex positions, **0**, **0**, which position the component at the top left of the area **520**. A Date input form component **524** has a name, date_**1**, a type, "DATE", and a dataset, "process_master/dtc1", which indicates that a value entered by the user will be stored in the "dtc" column of the process_master database table. The rowindex and colindex properties of the Form Component **524** indicate that the component is to be placed in the second column of the first row in the Area **520**.

[0061] A Patient Name form component **526** describes the Patient Name label, and has properties that include a name, comp_area_**0**_**1**_**0**, a type, "LABEL", and a label, "Patient Name:". A Patient Name input form component **528** has a name, select_**3**, a type, "SELECT", i.e. selection list, a datalookup, "CORE/$CID/USER", which indicates that the list of values for the selection list will be loaded from the USER column of the $CID database, a dataset, "process_master/sc1", which indicates that a value selected by the user will be stored in the "sc1" column of the process_master database table. The rowindex and colindex properties of the Form Component **528** indicate that the component is to be placed in the second column of the second row in the Area **520**.

[0062] FIG. **5***b* illustrates a tree-representation of an application definition according to one embodiment of the invention. The tree shown in FIG. **5***b* corresponds to the application definition shown in FIG. **5***a*. Each tree element includes the same name, value, and properties as a corresponding component of FIG. **5***a*. Specifically, the tree's root is an area_**0** component, which has the same properties as the Area Component **520**, and a Component Definition **532**, which is an intermediate level that groups the components in the area **530**. The Component Definition **532** includes the

definitions of the Form Components of FIG. **5***a,* including a Date label **534** with name comp_area_**0_0_0**, a date input component **536** with name date_**1**, a Patient Name label **538** with name comp_area_**0_1_0**, and a patient name input selection list **539** with name select_**3**.

[**0063**] FIG. **5***c* is an illustrative drawing of an application definition according to one embodiment of the invention. The application definition **540** is a text document in Extensible Markup Language (XML) format and includes nested elements definitions. An Area element **540** defines the area, and corresponds to the Area component **520** of FIG. **5***a*. A ComponentDefinition element **542** contained in the Area element **540** corresponds to the Component Definition **532** of FIG. **5***b*. The ComponentDefinition element **542** contains four FormComponent elements **544-549**, which correspond to the Form Component elements **522-528** of FIG. **5***a*. The FormComopnent elements **544-549** include XML attributes that correspond to the properties shown in FIG. **5***a,* such as the name, type, and label.

[**0064**] FIG. **6***a* illustrates application data **600**, which includes a list of name-value pairs **602** corresponding to data values provided a user for an application according to one embodiment of the invention. With reference to FIG. **1***a,* the name-value pair format of application data **600** is used by the Player UI **114** to provide Application Data **120** to the Server **106**.

[**0065**] FIG. **6***b* illustrates example application data according to one embodiment of the invention. The example application data **604** includes an example date value **608**, with the name date_**1** and the value "4/33/2005", and an example selection list value **610**, with the name "select_3" and the value John J. Smith". These application data values correspond to the values provided in data input component **308** and patient name input component **310**, respectively.

[**0066**] FIG. **6***c* illustrates an example database table containing application data according to one embodiment of the invention. Database table **512**, e.g. a table named process_detail stored in the Database **110** of FIG. **1***a,* has an "id" column **614**, a "dtc1" column **616** for storage of the date component's value, and an "sc1" column **618** for storage of the selection list component's value. Database tables that store application data according to one embedment are described in more detail below with respect to FIG. **14**. Other columns may be present as well for storage of additional component values, e.g. "dtc2" for a second date component and sc**2** for a second selection component, and so on, up to an arbitrary number of columns One row of data is shown, which includes a value "1" for the "id" column **614**, a value "4/22/2005"**622** for the "dtc1" column **616**, and a value "John J. Smith"**624** for the "sc1" column **618**.

[**0067**] FIG. **7***a* is an illustrative drawing of an Application Designer user interface (UI) according to one embodiment of the invention. The Application Designer user interface (UI) **701** corresponds to the Designer UI **102** of FIG. **1***a*. The Application Designer UI **701** includes a workspace **702**, which represents an application being designed, an area properties interface **709**, a control properties interface **710**, an areas palette **711**, and a controls palette **712**. The user can select a tool or a control from the palette, and can use the tool or control to place or drop areas, tables, and components, e.g., text boxes on the workspace. Components can be moved or dragged to alternate locations within the area as well after they are placed or dropped. The area palette **711** includes an Add Area tool **713** for adding a new area to the workspace, and the controls palette **712** includes a Text Box control **714** for adding text box components to the workspace. An area **707** includes a grid of cells. A cell **715** is empty when the area is added to the workspace, but a user can add one or more components, such as a label **704**, to each cell by clicking on a control, such as label control **716** and dragging the control to the desired cell, such as the empty cell **715**. As a result, a component, such as the label **704**, will be added to the application in the desired cell **715**. The cells allow the Designer UI to assign row and column positions to the components that a user adds to an area.

[**0068**] Once a component has been placed on the workspace, the user can set properties of the component to define specific behaviors, such as default values, table headings, mappings between controls and a database, and mappings between controls and web services. The workspace **702** includes a graphical representation of an example application definition that is being constructed by a user. In one embodiment, the application definition includes a data field **703** in which the user will enter data when the application is run in the Player. The data field **703** is associated with a label **704**, which provides a textual description of the data field to a user. The workspace also includes an area **706** and a table area **708**. The area **706** provides for grouping and positioning the locations of other fields, and contains the field **703** and the label **704**. The table **708** includes a header row and five columns, named COL_**0** through COL_**4**.

[**0069**] Palettes such as palette **712** shown in FIG. **7***a* provide easy access to the tools without cluttering the workspace. Palettes can include one or more tabs, each containing common properties. For example, all standard components are stored in the Components palette. Each palette provides a special function based on the selection in the designer workspace. Some palettes such as the Field Properties and Area Properties allow users to specify properties for the selected field/area.

[**0070**] FIG. **7***c* is an illustrative drawing of an Application Designer user interface (UI) according to one embodiment of the invention. The Application Designer user interface **701** includes a Control Properties interface **730**, which allows a user to view and set properties of a selected component **731**, which is a table column in this example. The table column's properties shown in the Control Properties interface **730** include a column label, a column width, and a component name. A user can change the values a property by entering a new value for the property. The Control Properties interface **730** also includes a Formula Builder button **735** and an Action Builder button **736**. All Designer objects have unique properties. The properties for a numeric field have possible calculations while a drop down list may have a data source to populate the list of variables. The Control Properties interface **730** displays the properties available for the selected component type.

[**0071**] FIGS. **7***d* and **7***e* are illustrative drawings of an Action Builder user interface according to one embodiment of the invention. The Action Builder **740** allows a user to associate one or more actions with each component of the application. Actions include event handlers and custom functions. Event handlers are functions implemented in a programming language, e.g., JavaScript, which are called by

the Player UI when associated events occur, e.g. when a user changes a component's value. Custom functions are functions implemented in a programming language, e.g. JavaScript, which can be called by event handlers and by other custom functions.

[0072] The Action Builder **740** allows the user to implement event handlers and custom functions by writing code in a programming language such as JavaScript The Action Builder **740** is displayed by the Application Designer user interface in response to a user request, e.g. in response to a user pressing the Action Builder button **736** of FIG. **7***c*.

[0073] The Action Builder **740** has a Select Function option **744** which a user can use to create create a custom function. The user can provide a custom function name **746**, which will identify the custom function, and will also be the name by which the custom function is invoked from JavaScript. Then a user can then use a code editor **749** to write JavaScript code **748** that will be called when the custom function is invoked. In the example of FIG. **7***d*, the custom function simply increments the variable i.

[0074] The Player UI executes actions and evaluates formulas in response to events that are associated with user interface components such as buttons and tables. Events include user interface events, such as onClick, which occurs when the user has clicked on a table, or onchange, which occurs when a data value changes. The user interface event types include onBlur, onchange, onClick, onDoubleClick, and onMouseOver. Additional events are available for tables, such as onRowAdded. The event types are described in the table below.

| EVENT TYPE | DESCRIPTION |
|---|---|
| | Form Components |
| onBlur | Called when focus moves away from a control |
| onChange | Called when data changes in a component.. |
| onClick | Called when a user clicks on a component. |
| onDoubleClick | Called when a user double-clicks on a component. |
| onMouseOver | Called when mouse pointer is positioned over a component. |
| | Grid |
| onCellEnter | Caled when a user enters a table cell. |
| onModified | Called when a cell's contents are modified. |
| onAfterInsert | Called after a row is added to a grid. |
| onAfterDelete | Called after a row is deleted from a grid. |
| onColumnResize | Called when a column is resized. |

[0075] An event handler is a function implemented by code in a programming language, e.g. JavaScript. A user defines an event handler by providing implementation code for an associated event type. The event handler is called by the Player UI when an event of the associated type occurs. To define an event handler, a user first selects a component of the application in an object selection box **745**. In the example of FIG. **7***e*, a component named text_area_**3_2** has been selected. The user then selects an event type, e.g. onClick, from an event type menu **750** of event types available for the selected component, and provides JavaScript implementation code **748** using the code editor **749**. Thereafter, when the Player UI is executing an application, the user's JavaScript code will be called whenever the specified event occurs for the specified object.

[0076] The Action Builder **740** includes a data element list **741**, a function list **742**, and a code editor **749**. The data element list **741** is a list of the application's components. The data element list **741** has an entry corresponding to each area in the application, e.g. Area **1**. Nested below each area entry is a list of the components in that area entry, e.g. text_area_**1_1**, text_area_**1_3**, and so on. The data element list **741** corresponds to a Document Object Model (not shown) associated with the application. The function list **742** includes user-defined functions, which are sometimes referred to herein as custom functions, and a set of commonly-used functions such as validateZipCode and SUM.

[0077] The code editor **749** allows a user to create and modify JavaScript implementation code **748** associated with a specified event **747**, e.g. onClick, of a specified object **745**, e.g., text_area_**3_2**, or with or a specified custom function **746**, e.g. customFunction. The , JavaScript implementation code **748** associated with an event **747** of a specified object **745** will be called by the Player UI when the event occurs, e.g. when the user clicks on the specified object.

[0078] The JavaScript implementation code **748** for event handlers and custom functions can refer to any component of the application using JavaScript variables that are provided by the Document Object Model. A JavaScript variable is provided for each component of the application, and the variable has a name of the $<component>, where <component> is the name of the component. These component variables allow user-provided JavaScript code to read, write, and control other components. JavaScript code can get and set the value of a data-holding component, e.g., a TextBox, TextArea, Select List, Radio Button, CheckBox, or File Attachment by referring to a variable named $<component>.value.

[0079] The Action Builder **740** allows a user to select components from the Data Elements list **741** using, for example, a mouse pointer. When a component has been selected, the Action Builder **740** inserts a JavaScript variable name corresponding to the selected component into the code editor **749** at a current cursor position (not shown), so that the variable name becomes part of the JavaScript implementation code **748**.

[0080] The JavaScript implementation code for custom functions and event handlers is stored in the XML application definition. In particular, the JavaScript code associated with a component is stored in a Behavior XML element of a BehaviorList element associated with the component. For example, an the JavaScript code for an onRowAdded event handler associated with a TableComponent would be stored as a Code element associated with a Behavior element, which is in turn associated with a BehaviorList element, which is associated with the TableComponent.

[0081] A link is a component that refers to an object such as an application or web page. The object may be located on a server specified by the link. The reference may be, for example, a Uniform Resource Locator (URL) that refers to a value on a web server. A Link can be associated with a Button component or a Link component.

[0082] FIG. **7***h* is an illustrative drawing of a Link Builder according to one embodiment of the invention. The Application Designer provides the Link Builder, which can be used to add two types of links, inbound links and outbound

links, to an application. An inbound link is a reference that can be used to start or access a particular application on a server. The application may be, for example, with reference to FIG. **1***a*, an application previously created on the server **106** by the Designer UI **102**. An inbound link includes the address or host name of a server, and parameters that identify an application on the server and provide default values for the application. An inbound link may appear on, for example, any web page. When a user selects an inbound link, for example, by clicking on the inbound link in a web browser, a request, e.g. in the HTTP protocol, is sent to the server specified in the inbound link along with the parameters specified in the inbound link. The server starts a Player UI, and loads the application specified by the inbound link into the Player UI, using the parameters in the link to identify the application and a user account under which to run the application. The server also provides the application with any data values, e.g., values for application components, specified in the inbound link's parameters. The server responds to the request by sending the application as a response, e.g. as an HTML/JavaScript web page in an HTTP response.

[**0083**] Inbound links are used, for example, when the originating web page or application is an external application such as Siebel or SalesForce.com. The user will use the Link Builder interface to build the link and then update the foreign application by pasting this link into the foreign application's user interface. The parameter values in an inbound link may be specified as attribute variables, for which values will be substituted by the Player UI when the link is presented to the Player UI. Attributes have the form name=value, where name is an attribute name and value is an attribute value. Attribute values are either literal values or placeholders. Placeholders have the syntax {!x }, where x specifies how to retrieve a value. An attribute variable appears in a link as, for example, un={!User_Username }, where {!User_Username} is a URL string replacement placeholder that will be replaced with actual values by the Player UI. For example, {!user_username} would be replaced with "John Smith" when the link is embedded and executed in another web page by a user named "John Smith". The Player UI will retrieve an actual value for each attribute variable from the database and DefintionFactory, substitute the actual values into the link in place of the attribute variables, and pass the link with substituted values to the application. An outbound link is a reference to an object on a server, such as a web page on a web server. Outbound links may be included in button and link components of an application, and are displayed in the Player UI **114** of FIG. **1***a*. An outbound link may include attribute variables as described above. When a user selects an outbound link, the application substitutes the values into the query string attributes and launches the link as defined by the UI with the substituted query string values.

[**0084**] Links can be used to define actions such as launching a Business Object Lookup dialog. The link may define properties related to launching the Business Object Lookup dialog and may also include JavaScript code that will populate application components with data from the Business Object Lookup dialog. Links can refer directly to business objects, in which case each instance of a business object can be identified, displayed, and invoked via a URL. The URL includes a generic server resource string and a unique ID for the business object. The URL may also include an instance identifier to identify of the business object. The business object will be invoked when the URL is selected, e.g. by a user clicking the associated link in the Player UI,

[**0085**] Table rows can also be populated by a link by including a link to a business object in the table definition. In this case, the Business Object Lookup dialog returns an array of values, and a function loops through all the lookup values and populates the table rows with the values.

[**0086**] The Application Designer supports Conditional Sections, which provide the ability to conditionally hide or show sections of the user interface. Each Conditional Section can include multiple elements. A user of the Application Player can insert or remove the components on a conditional section when filling out a form, for example. Conditional sections are hidden by default in the Form Player until an associated condition becomes true. For example, a travel request form could include a conditional Car Rental section that is not shown by default. Users will see the Car Rental section if they click on an associated button in the Form Player user interface.

[**0087**] Applications created using the Application Designer can invoke Web Services when executed in the Application Player. In a typical Web services scenario, an application sends a request to a service at a given URL using the Simple Object Access Protocol (SOAP) over HTTP. The service receives the request, processes it, and returns a response.

[**0088**] The Application Designer provides a Web Services Builder that can be used to select a Web Service for a button or Link component. The Web Service may provide a value for the component, or, vice versa, the component may provide a value for the Web Service. The Web Services Builder allows the user to select the web service to be invoked for component. Specifically, the user can select a web service vendor, an object, and a field. The user can also specify the invocation type, which can be query, update, insert, or delete. When the user selects a vendor, the Web Services Builder displays a list of objects based on the selected vendor. The user then selects an object, and the Web Services Builder displays a table of fields. The user selects a field and an operation to perform on the field. For example, the vendor Siebel may have an object named Opportunity, which has a number of fields, each of which corresponds to a sales opportunity. The Web Services Builder is described in more detail in application Ser. No. _____, filed one the same date as the present application and incorporated herein by reference.

[**0089**] FIG. **7***b* is an illustrative drawing of an application displayed in an Application Player user interface according to one embodiment of the invention. An Application Player user interface, e.g. the Player UI **114** of FIG. **1***a*, presents the application to a user and receives application data from the user. FIG. **7***b* shows an example Radiology Order Request application **721** displayed in an Application Player UI **720**. The radiology order request application **721** includes an area **724**, which contains data fields that allow a user to enter application data. The input fields shown in FIG. **7***b* are a Date field **725**, a Patient Name field **726**, and a Patient Phone Number field **727**. The application data values associated with the Date and Patient Name fields are "08/11/2005" and "Jane Doe", respectively. Multiple different application data

sets, sometimes referred to herein as instances of application data, may be associated with an application and stored using distinct identifying numbers or names. For example, the data values shown in FIG. **7***b*, including "08/11/2005", could be saved as a first Radiology Order Request application data set, and another set of data values, for example, "8/12/2005" and "John Smith", could be saved as a second Radiology Order Request application data set.

[**0090**] FIG. **7***f* is an illustrative drawing of a Formula Builder user interface according to one embodiment of the invention. The Formula Builder **751** allows a user to define component values in terms of a formula **752**. The formula **752** is an expression that can include the values of other components. The formula **752** is $cell.Qty*$cell.UnitPrice, which sets the value of the component associated with the formula to the product of a Qty and an ItemPrice, which are values in of a ProductDetails component. A user can enter the formula in a Formula Area **753**. A data element list **754** shows a list of data elements. Each data element corresponds to a data-holding component of the application. When a user selects a data element from the list **754**, e.g. by using a mouse, the name of the selected data element will be inserted into the formula. A formula can be based on the value of any component, including components that are in tables.

[**0091**] In one embodiment, an application also includes the ability to route data, e.g., by sending a copy of the application and associated data to another user. Routing may be performed, by example, by sending a link to the application in an email message. A routing is a specification of how an application is to be routed, e.g. via email to a particular email address. The radiology order request application **721** has been routed to a recipient user via email. The recipient user can approve the routing by selecting the Approve Routing button **722**, or reject the routing by selecting the Reject Routing button **723**.

[**0092**] FIG. **7***g* is an illustrative drawing of an Application List user interface according to one embodiment of the invention. The Application List user interface **780** lists applications, templates, and lookups that have previously been created using the Application Designer. A user can select an application displayed on the Application List **780** for modification in the Application Designer or execution in the Application Player.

[**0093**] Each application has a name and a version number. The name is a string, such as "Radiology Order Request", that identifies the application, and the version number is a number that is incremented when an application is modified in the Application Designer. Applications can be saved as templates. An application can be in one of three modes: design mode, test mode, or production mode.

[**0094**] FIG. **7***h* is an illustrative drawing of an Inbound Link Builder user interface according to one embodiment of the invention. A user can start the Inbound Link Builder **755** from the Designer UI, e.g., by selecting a Create Inbound Link option from an Application menu (not shown). A user can use the Inbound Link Builder **755** to create an inbound link **756**, e.g. a URL, by specifying a link type **757** and an application **758**. An inbound link **756** is a web link, e.g., a URL, which can be exported to an external document, e.g. a web page, or an external application. Subsequently, selecting the inbound link from a web application can create a new application and open a Player UI for the new application, or can open an application list showing applications of a specified type.

[**0095**] In particular, FIG. **7***h* shows three views of the Inbound Link Builder **755**, each with a selected link type **757**. The user can set the link type **757** to one of the following: Launch Application, In Progress, Completed, Archives, or Drafts. If the user sets the Link Type **759** to Launch Application, then the link will start an application in the Player UI, and the user can also specify an application name **760** and controls to populate **761**, and the link will cause the specified application **760** to be started in a Player UI. The Copy Control Name Code **762** displays a control name code for an associated data element selected in the control list **761**. The user can copy the Control Name Code **762** to the link **756**. Values such as the Control Name Code **762** are copied to the link as placeholders. Actual values will be substituted for the placeholders by the Player UI when the application is executed. The user can alternatively set the Link Type **763** to In Progress, which means that the link will open an application list showing all applications that are in progress. Similarly, setting the Link Type **763** to Completed, Archives, or Drafts, would configure the link to open an application list showing applications that are completed, archived, or drafts, respectively.

[**0096**] FIG. **7***i* is an illustrative drawing of an Outbound Link Builder user interface according to one embodiment of the invention. An outbound link, e.g. a URL, may be associated with a Button or a Link component of the application. An outbound link can open a web page specified by a static URL, or can initiate execution of another application. A user can use the Outbound Link Builder **765** to create an outbound link, e.g. a URL. A user can start the Outbound Link Builder **765** from the Designer UI, e.g., by clicking on a Link Builder button (not shown) that is present on the Control Properties panel **710** of the Designer UI **701** of FIG. **7***a*. The user can select either Static URL **766** or Nsite to Nsite **768** to indicate whether the link is a static link, e.g. to an arbitrary web page, or a link to another application. If the user selects Static URL **766**, then the user can provide the link, e.g., as a URL, in the link box **767**. If the user selects Nsite to Nsite **768**, then the user can select an application to initiate **770**. The user can define an input data mapping for the application to initiate **770** by selecting controls from a current application control list **768** and, for each selected control, selecting a corresponding control of the application to initiate from a control list **771** for the application to initiate **770**. Subsequently, when the link is followed, e.g. when a user clicks on an associated Link component in the Player UI, the application to initiate **770** will be started, and the controls of the application to initiate **770** will be initialized with values from the controls of the current application as defined by the input data mapping. For example, if TextControlName1 is selected from the current application control list **768**, and App**2**TextControl**3** is selected from the control list **771** for the application to initiate, then the value of TextControlName1 would be copied to App**2**TextControl**3** when the link is followed in the Player UI.

[**0097**] FIG. **8** is an illustrative drawing of client and server components of an enterprise application design and deployment system according to one embodiment of the invention. FIG. **8** is a more detailed view of the components illustrated

in FIG. **1***a*. Client computers **801** and **831** are running web browsers **802** and **832**, respectively. A web browser **802** is shown running an Application Designer client **803**. A user interacts with the Application Designer client **803** to create an application. In one embodiment, the Designer client **803** saves the application as an application definition **808**, which is a description of the application in a format such as XML. A second web browser **832** is shown running an Application Player client **833**. A user interacts with the Application Player client **833** to provide data to an application and view data associated with the application. The Player client **833** allows users to load and execute application definitions and save and load application data. Note that the arrangement of the two clients on two different computers as shown is one of many possible arrangements. The Player client can, for example, alternatively be run on the same client computer **801** in the same web browser **802** as the Designer client. The web browser, e.g., Microsoft Internet Explorer™, Mozilla Firefox™, or the like, is able to load and display a web page specified by a Uniform Resource Locator (URL) from a server **850** running on a server computer (not shown) via a computer network **809**. The web browser allows the clients **803** and **833** to run on client computers **801** and **831** without being installed directly on the client computers **801** and **831**. The web browser downloads the clients **803** and **833** from the server **850** via the computer network **809**, presents user interface portions of the clients to a user, executes any code associated with the clients, e.g. JavaScript code, allows the user to interact with the client user interfaces, and sends any results of the user interaction to the server. The web browser also includes an AJAX Engine **830**, which is a software library that is loaded into the web browser from the server **850**. The AJAX Engine improves the user experience by maintaining information so that the client need not send a request to the server in certain situations, so that there is no delay between a user's action and the client's response in these situations. The AJAX Engine **830** also provides services used by the clients **803** and **833**.

[**0098**] The Designer client **803** includes client components **807**, and the Player Client **833** includes client components **837**. The client components include JavaScript Definition object that implement a hierarchy of forms, areas, components, tables, properties, behaviors, methods, requests, responses, and parameters.

[**0099**] The Designer UI **805** and Player UI **835** are presented to a user as web pages. The web pages are provided by the server **850** to the web browsers **802** and **832** via the network **809** when a user enters a corresponding URL into the web browser. On the server, these web pages are App Designer JSP **852** and App Player JSP **860**, for the designer and player, respectively. The web browser presents clients **803** and **833** to the user by displaying web pages generated by the App Designer JSP **852** and App Player JSP **860**, respectively. These generated web pages include JavaScript code that uses JavaScript Client Components **807** and **837** to implement the Designer and Player user interfaces.

[**0100**] The App Designer JSP **852** is a page controller JSP that implements several action commands, including getDefinition, saveDefinition, saveDefinitionAsTemplate, createNewVersion, and lockdefinition, as described in the table below. These operations are invoked in response to corresponding user requests from the Designer UI **805** and Player UI **835**.

| COMMAND | DESCRIPTION |
|---|---|
| getDefinition | Returns a Definition Javascript object. |
| saveDefinition | Saves a Definition to the database and unlocks the Definition for edits by other users. |
| saveDefinitionAsTemplate | Saves a Definition to the database and marks it as a template. |
| createNewVersion | Creates a new version of a Definition. |
| lockDefinition | Marks a Definition as locked before a user edits the Definition. |

[**0101**] The application server **850** may be JBoss™ from JBoss Inc. of Atlanta, Ga., or the like, and may include a container framework, e.g. the Spring Application Framework from Interface**21** of London, United Kingdom, or the like, and provides services for executing the App Designer JSP **852** and the App Player JSP **860**. These services may include a web server, HTTP network communication, fault tolerance, load balancing, application management, transaction management, dependency injection, and internationalization. The database **870** may be a relational database, e.g. Oracle™ or the like, and runs on a database server computer (not shown).

[**0102**] The application server **850** may be run by a service provider to provide the App Designer and App Player as hosted applications.

[**0103**] The application server **850** also includes a DefinitionFactory **854** a FormFactory **862** and a BusinessFactory **858**. The DefinitionFactory **854** is a Java object that uses an object-relational mapping tool to create ProcessDefinition objects that correspond to rows in a process_definition database table. A ProcessDefiniton object contains an application definition in the form of an XML document. The DefinitionFactory **854** can generate a new empty application definition, or can load an existing application definition from the database **870**, in which case the application is retrieved from the database **870** using an application identifier as a key. The application definition is used to render user interface portions of the App Designer JSP **852** and FormPlayer JSP **860**. The ProcessService **856** provides an object-relational mapping for saving and loading the application definition and application data o and from the database **535**.

[**0104**] The FormFactory **862** uses an XML application definition to render an HTML representation of the application, which may include application data retrieved from the database **870** if application data has previously been saved. The HTML representation is sent to a browser **832** running a Player Client **833** by the FormPlayer JSP **860**. The FormPlayer JSP **860** uses a FormProcessor **864** to process incoming requests, e.g. HTTP messages, received from the Player Client **833** by extracting applicaton data, e.g. in the form of HTTP parameters, from the request and passing the application data to a BusinessFactory **858** for storage in the database **870**. The ProcessService **856** uses an object-relational mapping tool, e.g. Hibernate from JBoss Inc., to convert the application definition from the server programming language, e.g. Java, to and from a relational table format such as that shown in FIG. **6***c* for persistent storage in the database **870**. In particular, the application definition is represented in Java as a ProcessDefinition object, which

is stored in a process_definition table, and the application data is represented in the Java programming language as ProcessMaster, ProcessDetail, ProcessAttchment, and ProcessExtension Java objects, which are stored in a corresponding process_master table and related process_detail, process_attachment, and process_extension tables, respectively. These tables are described below with respect to FIGS. **13** and **14**.

[**0105**] With reference to FIG. **1***a*, after a user **100** has provided an Application Definition **104**, e.g., a definition of an application for collecting data or executing a transaction, to Player UI **102**, the user **100** may invoke a save command in the Designer UI **102** to cause the Application Definition **104** to be saved to persistent storage such as a database **110**.

[**0106**] FIG. **9** is a flowchart illustrating a method of saving a specified application definition to persistent storage, e.g. to a database, according to one embodiment of the invention. This method saves an application to a database by creating an XML application definition from user interface components created by a user in the Designer UI **102** of FIG. **1***a* and sending the application definition to the Server **106** of FIG. **1***a*. This method is executed by a web browser running the Designer UI when a user requests that an application be saved, e.g. by clicking a save button in the Designer UI. The method begins at block **914**, in which the App Designer UI presents the user interface. Next, block **918** checks whether a new application is being created or an existing application is being modified. If a new application is being created, an empty Definition JavaScript object is created at block **916**. If an existing application is being modified, the existing application is loaded at block **920** into a Definition object. In either case, the method now waits for the user to add components to the form. When a new component such as a text field is added, the Definition is updated to include the new component, e.g. a JavaScript object representing the text field is added to the Definition. A loop starting at block **922** waits for a user action, such as the addition of a component to an area, or a mouse click on a control button such as a save button. After such a user action is received, block **924** determines if a component has been added to an area by the user, in which case the component is added to the Definition at block **926**, and the loop returns to block **922** to wait for another user action. If block **924** instead determines that the user has not added a component, then block **928** determines if the user has clicked save. If the user did click save, then block **930** transforms the Definition into an XML document according to the XML schema, and block **932** sends the XML document to the App Designer JSP via HTTP for storage in database tables. The App Designer JSP receives the XML document, creates a ProcessDefinition object containing the XML document, and passes the ProcessDefinition object to the ProcessService, which stores the XML document in the process_xml column of the process_definition table. Note that although only two types of user actions are shown in FIG. **9**, adding a component and clicking save, the application designer includes support for additional user actions that are not shown in FIG. **9**, such as deleting, moving, or editing a component, loading a form, and so on. When the method of FIG. **9** is complete, the specified application has been saved to persistent storage as an XML document.

[**0107**] With reference to FIG. **1***a*, a user **100** of the Designer UI may invoke a command to load a previously-saved application definition from the database **110** into the Designer UI. After the application definition has been loaded, the Designer UI can be used to modify the application and subsequently save any changes. When the modified application is saved, it will be saved with an associated version identifier that uniquely identifies the application. The previous version of the application definition will not be deleted. Any references to the previous application definition, e.g. a reference in an email message that includes the application as an attachment, will include the version number of the previous application definition, and will continue use the previous application definition.

[**0108**] A user **118** of the Player UI **114** may invoke a command to load a previously-saved application, including application data, such as data concerting a particular person or transaction, data from the database **110** into the Player UI **114**. After the Application Data **120** has been loaded, the Player UI **114** can be used to modify the Application Data **120** and save the modifications by invoking the save command as described above with reference to FIG. **9**.

[**0109**] FIG. **10***a* is a flowchart illustrating a method of loading an application according to one embodiment of the invention. This method loads a specified application definition and a specified instance of application data, if such an instance exists, into the Application Player. This method is executed on an application server by the App Player JSP page. The method produces a web page that includes HTML and JavaScript elements. The web page can be displayed in a web browser to provide the Application Player UI. The method of FIG. **10** is executed, for example, when a user selects a specific application and application data instance to execute in the Application Player. The method is described in terms of objects, such as a DefinitionFactory that produces a ProcessDefinition, which represents an application. These objects are instances of corresponding classes that include code and data. The method and its associated objects may be implemented in an object-oriented programming language, e.g., Java™, C++, C#™, or the like. The method starts at block **1014** by retrieving an XML application definition for a specific application. The XM application definition is represented as a ProcessDefinition Java object, which is retrieved from a DefinitionFactory. The DefinitionFactory retrieves the ProcessDefinition from a database via a ProcessService (not shown). The ProcessService reads the data values necessary to construct the ProcessDefinition, including the XML document describing the application, from the database. At block **1020**, a ProcessMaster object containing a previously-saved application data instance is loaded from the database via the ProcessService. If no application data instance has previously been saved, block **1020** has no effect. Application data may have been previously-saved by, for example, a previous execution of the Application Player in which the user saved the application data. Block **1022** calls a GetValues subroutine to load the application data from the process_master table into a BusinessObjectValue object. Block **1038** calls a RenderHTML subroutine to create an HTML web page that includes any loaded application data and can be used by a web browser to provide the App Player UI. Finally, block **1040** returns the HTML web page as a result, e.g. by sending the HTML to a browser as an HTTP response. The HTML web page then be displayed in a browser by the application player.

[0110] The GetValues and RenderHTML subroutines both traverse the XML application description. These subroutines process an XML application definition data structure.

[0111] To load application data from the Database **110** of FIG. **1***a*, the GetValues subroutine traverses the XML application definition to create a BusinessObjectValue object that contains the application data values retrieved from the database for a particular instance. These data values are loaded from a database row that corresponds to a specified application data instance. The GetValues subroutine begins at block **1026** by starting a loop to process each component in the XML application definition. The components are processed using a traversal that visits each component in the tree formed by the XML nodes. For each component, the subroutine gets the associated data value from the process_master table and stores the data value in the BusinessObjectValue. Specifically, for each component, block **1028** composes a unique component name using the same concatenation method that is used when components are initially added to the application by a user, as described above with reference to FIGS. **2***a* and **2***b*.

[0112] Block **1030** uses the unique component name to look up dataset table and column names in the XML application definition. The dataset table and column names identify the database column in which the data value for the component is stored. At block **1032**, the component's data value is retrieved from the database by requesting the value of the database column from the process_master table. At block **1034**, the component's data value is stored in the BusinessObjectValue as a name-value pair, with the unique component name as the name portion of the pair, and the component's data value as the value portion of the pair. Finally, block **1036** checks if there are more components in the XML document to process. If so, the loop repeats for the next component.

[0113] The RenderHTML subroutine illustrated in FIG. **10***b* traverses an XML application definition to generate an HTML document according to one embodiment of the invention. The App Player client displays the HTML document to provide the App Player UI. The RenderHTML subroutine begins at block **1052** by starting a loop to process each component in the XML application definition. The components are processed by the recursive-bypass method described for the GetValues subroutine above. For each component, the RenderHTML subroutine generates a corresponding HTML element, gets an associated data value from the BusinessObjectValue, and sets the value of the HTML element to the associated data value. Specifically, for each component, block **1054** composes a unique component name and HTML ID by concatenating parent component names, such as an Area name, with the component name and a numeric counter value, as described for the GetValues subroutine above. The unique HTML name and ID are embedded in the HTML produced by the RenderHTML subroutine. The unique HTML name is used for request processing when application data to be saved is received from a browser, and the HTML ID is used in the JavaScript code. At block **1056**, an HTML element is generated for the application component. An Area XML component can be rendered into a <TABLE> or <DIV> HMTL element. A CheckBox XML component is converted to an EDITBOX of type CHECKBOX in HTML. The XML attributes, e.g. DATASET, of a component are copied to HTML element generated for that component. At block **1058**, the component's data value is retrieved from the application data, and at block **1060** the data value is added to the HTML element. If there is no data value associated with the component, e.g. because no data has been saved, then blocks **1058** and **1060** do nothing. Finally, block **1060** checks if there are more components to process. If so, the loop repeats. Otherwise, the subroutine returns the generated HTML elements as a result value and ends.

[0114] With reference to FIG. **1***a*, after a user **118** has provided Application Data **120**, e.g. data concerning a particular person or transaction, to Player UI **114**, the user **118** may. invoke a save command in the Player UI **114** to cause the Application Data **120** to be saved to persistent storage such as a database **110**.

[0115] FIG. **11** is a flowchart illustrating a method of saving application data according to one embodiment of the invention. This method is invoked by the Player JSP server page when a user invokes a save command in the Player UI. The data values are submitted by the Player UI as HTTP parameters in an HTTP response message sent from a browser. The method saves the data values to a database. Specifically, the method begins when an HTTP response message containing application data is received from an Application Player client. At block **1118**, a FormProcessor object decodes the HTTP-format parameters from the HTTP response message. At block **1120**, the FormProcessor creates a BusinessFactory object. At blocks **1124-1134**, the BusinessFactory traverses the XML application definition, which is available in the Player UI's memory. The traversal begins at block **1124**, which starts a loop iteration for each component in the XML application definition. The components are processed by the recursive bypass method described for the GetValues subroutine above. For each component, the method writes the corresponding value from the HTTP response to the database. Specifically, for each component, block **1126** composes a unique component name by concatenating parent component names, such as an Area name, with the component name and a numeric counter value, as described for the GetValues subroutine above. At block **1128**, the unique component name is used as a lookup key to retrieve from the HTTP response a parameter that has a name equal to the component name. The retrieved parameter is the application data value for the component. The value is then stored in the database by looking up the database table and column names at block **1130** and setting a property of the ProcessMaster, ProcessDetail or ProcessExtension object, for which the property's name is equal to the column name, to the retrieved parameter.

[0116] FIG. **12***a* is an illustrative drawing of an application **1201** including a mode **1202** and a version number **1202** according to one embodiment of the invention. The application **1201** also includes an application definition **1203** and a set of application values **1204**. These values may be included in a data structure that represents the application, or may be referred to by reference from such a data structure. Once an application has been defined, it can be used as part of a complex process, e.g. a procurement process that involves multiple steps. An application can also be routed to one or more users, e.g. via email, and the users must access the application in sequence. In both cases, users run the application in the Player UI and provide input data. Since an application's definition may be loaded multiple times in

these processes or routings, it is important that application definitions not be modified, e.g. by the Designer UI, while such processes or routings are in progress. To prevent applications from being modified while processes or routings are in progress, the application mode **1202** is associated with each application, and the actions that a user may perform on an application are restricted based on the mode. The mode has one of the following values: Test, Active, or Inactive.

[**0117**] Furthermore, when an application is modified by the Designer UI, it is possible that the modification will remove or change components of the application. Any processes or routings that use the application and are in progress at the time of modification will become invalid if the application is saved with modifications to a component used by those in-progress processes or routings. To allow users to continue to modify applications in the Designer UI while processes or routings are in progress, the version number **1203** is associated with each application, and the version number is incremented every time the application is placed in active mode as described below.

[**0118**] FIG. **12***b* is an illustrative drawing of application mode transitions according to one embedment of the invention. FIG. **12***b* shows three states that correspond to the three modes: a Test Mode **1210**, in which the application can be modified by the Designer UI, an Active mode **1220**, in which the application can be executed by the Player UI, and an Inactive mode **1230**, in which the application can be neither modified nor executed. The mode of an application is displayed in a browser, e.g. as part of an Application List user interface as shown in FIG. **7***g*, in which the Test mode is shown in a Mode column **781** as PROD, and the Active mode is shown as PROD. As shown in FIG. **12***b*, only certain actions can be taken in each mode. In Test Mode **1210**, it is possible to perform a Copy action **1211**, an Edit action **1212**, which opens a Designer UI, a Delete action **1213**, and a Deploy action **1214**. In Active Mode **1220**, it is possible to perform an Initiate Process or Routing action **1221**, a Copy action **1222**, or a Deactive action **1223**. In Inactive Mode **1230**, it is possible to perform an Active action **1231**.

[**0119**] The effects of each action will now be described. With reference to the Application List of FIG. **7***g*, a user can change the mode to one of the allowed modes by clicking a link in an Actions column **782** to perform an action such as Copy, Edit, Deploy, Undeploy, Initiate, or Delete. As shown in FIG. **12***b*, the Copy action **1211** creates a new application, which is a copy of an original application, except the new application is in Test Mode **1210**. The Edit action **1212** opens a Designer UI for the application, and does not change the application's mode. In Test Mode **1210**, the Deploy action **1214** changes the mode to Active and increments the version number. In Active Mode **1220**, the Initiate Process or Routing Action **1221** initiates execution of a process or routing, which causes the application to be sent or displayed to a user in a Player UI. The Copy action **1222** changes the mode to Test Mode and creates a copy of the application. The copy can be modified by the Designer UI, but the application in active mode cannot be modified. The Undeploy action **1223** changes the mode to Inactive. The mode can be returned to Active by the Deploy action **1231**, which increments the version number and sets the mode to active.

[**0120**] The allowed actions for an application for display in the Actions column **782** can be determined from the application's current mode as illustrated by the following pseudocode.

```
GetAllowedActions:
    If mode == Test then
      Allowed actions = (Copy, Edit, Delete, Deploy)
    Else if mode == Active then
      Allowed actions = (Initiate, Undeploy)
    Else if (mode == Inactive) then
      Allowed actions = Deploy
    End if
End of GetAllowedActions
```

[**0121**] When an action is selected, the mode and version number are incremented as shown by the following pseudocode:

```
HandleAction:
If mode == Test Mode then
    If action == Deploy then
        mode = Active
        version = version + 1
Else if mode == Active then
    If action == Initiate then
        Initiate process or routing
    Else if Action = Copy then
        mode = Test
    Else if Action = Undeploy then
        mode = Inactive
    End if
Else if mode == Inactive then
    If Action = Actiate then
        mode = Active
        version= version + 1
    End if
End if
End of HandleAction
```

[**0122**] Components can never be removed from an application, so backward compatibility is assured. Processes or routings that are executing with a version will always have access to all components of that version. There is no need to merge different versions together or lock an application definition to prevent modifications. An application definition can always be modified by creating a copy with a new version number. When a new version is created, all subsequent processes and routings will use the new version. Components can be hidden in the user interface by setting their hidden property to true, so that users will not see or interact with the components in future versions, but the components will be available for existing processes or routings that use those components. Multiple versions of an application can be active at any given time.

[**0123**] FIG. **13** is an illustrative drawing of a database table schema for storing an application definition according to one embedment of the invention. The tables of FIG. **14** together correspond to the application data table **124** stored in the database **110** of FIG. **1***a*. A process_definition schema **1301** describes the content of data in the application definition table **112** stored in the database **110** of FIG. **1***a*. The database **110** may be, for example, a relational database storing data records as rows in a table, where individual

items in a data record are accessible as columns of a row. The process_definition schema **1301** includes a primary key column **1302** (named pk_process_definition_id), which has a unique value for each row of data in the process_definition table **1301**. The process_definition schema **1301** also includes a process_xml column **1303**, which stores an application definition as an XML string, a version column **1304**, which stores the application version number, and a mode **1305**, which stores the application mode.

[**0124**] FIG. **14** is an illustrative drawing of database table schemas for storing application data according to one embedment of the invention. The tables of FIG. **14** together correspond to the application data table **124** stored in the database **110** of FIG. **1***a*. A process_master table **1401** stores application data associated with application components and table footer rows, a process_attachment table **1410** stores attachment data associated with application components, and a process_detail table **1420** stores application data associated with table rows of table components of an application. The process_master table **1401** includes a primary key value, which uniquely identifies each row in the table. Each row in the table corresponds to a single set of data values for an application. The mapping between the application components and the tables of FIG. **14** is specified by the application definition **108** of FIG. **1***a*. For example, if an application has a single text box component that has a string value, then that text box component will be automatically associated with an sc**1** field **1404** of the process_master table **1401**, and the string value will be stored in the sc**11404** field. If the application has two text boxes, the first text box will be associated with the sc**11404** field, and the second text box will be associated with an sc**2** field **1406**. A third text box would be associated with an sc**3** field **1407**. Values of other types are stored similarly, but in columns with different names. For example, a numeric values for the first numeric text boxes added to an application would be stored in the nc**1** field **1405**. Although only three fields of each type are shown in FIG. **14**, e.g. sc**11404**, sc**21406**, and sc**31407**, any number of fields could be included in the schema, e.g. 15 fields, named sc**1** through sc**15**, to support 15 compnents with string values, and nc**1**-nc**15** to support 15 fields with numeric values. In general, the tables of FIG. **14** include a set of fields for each type of data, including string, numeric, single character, and datetime. The Designer UI **102** of FIG. **1***a*, the App Designer JSP **852**, and the App Player JSP **860** of FIG. **8** all use the a predefined convention for mapping components to database columns. The convention is that the components in an application definition are assigned to database fields of corresponding type in the database schema (e.g. a text box is assigned to a string field such as sc**1**, and a date field is assigned to a datetime field such as dtc**1** of the process_master table **1401**), and the components are assigned to database fields in the order that they appear in the application definition, e.g. the order that the XML elements representing the components occur in the application definition, where the database fields are ordered by the numbers appended to their names. A process_extension table **1430** stores application data for components that exceed the maximum number of components of a typeor table footer rows that can be represented in the process_master **1401** (e.g. a maximum of three string components, sc**1**, sc**2**, and sc**3**, can be stored in process_master table **1401**), process_attachment **1410**, or process_detail **1420** tables.

[**0125**] With reference to FIG. **1***b*, association of the data value **142** with a particular column of the database **144** and with the script **143** is established by the Designer UI based on minimal input from a user. When a user adds a component to an application using the Designer UI, the data type of the component's value is determined automatically based on the component. The database table in which the component's value is to be stored is also determined automatically by the Designer UI. For example, if a user adds a date component to an application, the Designer UI determines the database column to be associated with the date component. Referring to FIG. **14**, that database column is the next available date column in the process_master table **1401**. If the process_master table **1401** is full, e.g. the dtc**1**-dtc**3** columns have been already been assigned to three previously-added date components, the Designer UI associates the date component with a column of the process_extension table **1430**, e.g. dtc**1** in the process_extension table **1430**. If a user adds a date component to a table area, the Designer UI associates the date component with a corresponding column of the process_detail table **1420**, based on the component type. A user can change the data type of a component. Furthermore, a user can provide values for the formatting, required, readonly, allowed characters, allowed data format, and formula component properties in the Designer UI and the Designer UI will generate the corresponding code to handle validations, formatting, and calculations.

[**0126**] The process_master table **1401** is related to the process_detail table **1420** by a process_master_id value, which is stored in the fk_process_master_id field **1403** of the process_master table **1401**, and in the fk_process_master_id field of the process_detail table **1420**. The process_master table **1401** and the process_extension table **1430** are similarly related by a process_master_id value. This process_master_id relation allows additional rows to be used for storing information about an application, e.g. additional application data values, which may be stored in the process_extension table. In particular, if an application contains more components than can be represented in the process_master table (more than 3 components of the same type, in the example of FIG. **14**), then the values for components beyond the limit (e.g. beyond the third component) can be stored in the process_extension table **1420** by inserting or updating a row in the process_extension table with the same process_master_id value as the row for the component in the process_master table **1401**. The values for components beyond the limit can subsequently be retrieved from the process_extension table by selecting a row that has the same process_master_id value (stored in the fk_process_master_id column of the process_extension table **1420**) as the corresponding row for the component in the process_master table **1401**.

[**0127**] The process_attachment table **1410** is related to the process_master table **1401** by a process_master_id value, which allows attachments to be stored in the process_attachment table **1410** and retrieved by selecting a row from the process_attachment table that has the same process_master_id value as a corresponding row of the process mater table **1401**.

[0128] The process_detail table **1420** has a TYPE_ID column **1421** and a PARENT_ID column **1422** for representing complex, hierarchical data relationships. A unique TYPE_ID **1421** is associated with each table area. All data rows of a table area will have the same value for the TYPE_ID **1421**. Different tables will have different values for the TYPE_ID **1421**. The TYPE_ID **1421** is used for applications whose data relationships are of type Master-(n) Detail, i.e. a single set of components with an associated table of rows, such as most web applications of medium complexity. Each data row in the process_detail table also Parent_ID **1422**, which is associated with each data row in a table area. The Parent_ID **1422** is used for applications whose data relationships are of type Master-(n) Detail-(n) Detail, i.e., a single set of components with an associated table of rows, which in turn has another table of rows. Examples of the latter type of application include Bill of Materials applications used in manufacturing and Enterprise Resource Planning systems to represent hierarchical product configurations.

[0129] Specific examples of how an application design and deployment system is used will now be described. Each example includes a set of steps to be performed by the user and the system. The examples include creating an application, saving an application, saving an application as a template, editing an application in test mode, previewing an application in design mode, initiating test routings in test mode, editing saved routings in test mode, saving a new application version in test mode, deploying an application to production mode, deactivating an application from production mode, copying an application from production mode to test mode, and deleting an application in test mode. A routing is, for example, a message that transmits an application between users, such as an email message that contains a URL link to an application.

[0130] Creating a new application involves the following steps:

| CREATE NEW APPLICATION |
|---|
| 1. A user launches the Application Designer UI.<br>2. The user drags and drops components, tables, and the like from the palette to the workspace.<br>3. The user updates component properties, selects data types, adds formulas, and the like.<br>4. The system stores the new application definition in the database, updates the application mode to test, sets the version to 1, and displays the Application List screen. An application name, either provided by the user or generated by the system, is determined at or before this step and associated with the application. |

[0131] When these steps are complete, the new application screen has been saved in test mode and is available for initiating test routings and deployment to production. Creating a new application from a template involves the same steps, except step 1 includes launching the Application Designer UI with a selected template UI displayed in the workspace.

[0132] Editing an application in test mode involves the following steps:

| EDIT EXISTING APPLICATION |
|---|
| 1. A user launches the Application Designer UI with a selected application.<br>2. The system loads the selected application from the database and displays the application in the Application Designer UI workspace.<br>3. The system locks the application definition record in the database and updates the lock columns with the user name and current time.<br>4. The user drags and drops components, tables, and the like from the palette to the workspace.<br>5. The user updates component properties, selects data types, adds formulas, and the like.<br>6. The user clicks save.<br>7. The system updates the application definition in the database, resets the lock flags, updates the application mode to test mode, and displays the Application List screen. |

[0133] When these steps are complete, the application definition has been updated and saved in test mode. The application definition is available for initiating test routings and for deployment to production mode.

[0134] Initiating test routings in test mode involves the following steps:

| INITIATE TEST ROUTINGS |
|---|
| 1. A user launches the Application Player UI with a selected application<br>UI displayed in the browser.<br>2. The system displays a Test background image to visually differentiate<br>test routings from production routings.<br>3. The user updates the user interface, adds data, adds rows to tables, selects lookup data from lookup dialogs, adds attachments, and clicks save.<br>4. The system stores the new application data in the database. |

[0135] Editing saved routings in test mode involves the same steps listed above for initiating test routings in test mode, except that in step 2, the system also populates the existing application data in the user interface.

[0136] Deploying an application to production mode involves the following steps:

| DEPLOY APPLICATION TO PRODUCTION MODE |
|---|
| 1. A user clicks the Deploy link in the Application List screen. The Deploy Link is only shown for applications that are in test mode.<br>2. The system displays a Deploy Applications dialog with the selected application name, and sets the application's effective date to the current date.<br>3. The user clicks submit.<br>4. If an existing application has been deployed to production, one of the following two actions can be taken:<br>a. Automatically deactivate the existing production application.<br>b. Display an alert dialog that notifies the user that the existing application will be deactivated. The dialog can also indicate the number of in-progress routings for this application. The user can click OK or Cancel. Clicking |

-continued

| DEPLOY APPLICATION TO PRODUCTION MODE |
| --- |
| Cancel will cancel the current operation. If the user clicks OK, then the existing application is un-deployed, i.e. made inactive.<br>5. The system creates a new application record in the database, copies the XML definition from the selected application, updates the application mode to production, sets the version number of the new application to 1 or updates the existing version number if the application has been deployed previously.<br>6. Finally, the system displays the Application List screen with the new application in production. |

[0137] When these steps are complete, a new application definition has been created with a new version number and saved in production mode. The effective date of the application is set to the current date or whatever date the user specifies in the deployment dialog.

[0138] An application may be deactivated, for example, when an application administrator wants to un-deploy a production application to make modifications to the application. Deactivating from production mode involves the following steps:

| DEACTIVATE FROM PRODUCTION |
| --- |
| 1. A user clicks the UnDeploy link in the Application List screen. The UnDeploy Link is only shown for applications that are active and in production mode. Only one version of an application can be active and in production at any given point in time.<br>2. The system displays an UnDeploy Applications dialog with the selected application name.<br>3. The user clicks submit.<br>4. The system updates the record in the database by marking the selected definition as inactive.<br>5. Finally, the system displays the Application List screen. |

[0139] When these steps are complete, the selected production application is inactivated.

[0140] Copying an application from production mode involves the following steps:

| COPY APPLICATION FROM PRODUCTION TO TEST MODE |
| --- |
| 1. A user clicks the Copy link in the Application List screen.<br>2. The system creates a new application record in the database, copies the XML definition from the selected application, updates the application mode to "test", and sets the version number of the new application to max(test_version_number) + 1. The system also sets the "Copy from Production" flag to Y. When this flag is set to Y, existing controls cannot be deleted from the application; instead, they can be hidden from the UI.<br>3. Finally, the system displays the Application List screen with the new application in test. |

[0141] When these steps are complete, a new application definition has been created with a new version number and saved in test mode.

[0142] Copying from an application in test mode involves the following steps:

| COPY APPLICATION IN TEST MODE |
| --- |
| 1. A user clicks the Copy link in the Application List screen.<br>2. The system creates a new application record in the database, copies the XML definition from the selected application, updates the application mode to "test", and sets the version number of the new application to max(test_version_number) + 1.<br>3. The user clicks the Edit link in the Application List screen.<br>4. The App Designer UI is displayed with the selected application. The user can add new controls, including fields, tables, and the like, and can delete existing controls and tables from the UI. |

[0143] When these steps are complete, a new application definition has been created with a new version number and saved in test mode.

[0144] Deleting an application in test mode is accomplished by setting a delete indicator for the application's definition in the database and hiding the definition from the UI. All test routings based on the definition will still work with the existing definition.

[0145] Initiating routings in production is accomplished by initializing the Player UI with the latest application version in production that is marked as active. Previous versions of the application are only used for in-progress routings.

[0146] The Application Designer and Player meet the need for an easy-to-use tool for developing Web-based data processing applications that allow for data input, validation, processing, and linkage with Web services, and enable the creation of applications by the non-technical user community. Since the Designer and Player are Web-based, they can be used by any user who is familiar with a web browser. The Designer's user interface allows a user to create Web-based applications that include forms for accepting data input. A web application's user interface can be defined in terms of a user interface and data values. Linkage between the data values, a database, and scripts are determined by the Designer based on minimal input from a user.

[0147] The Designer's action builder adds processing in scripting language, the link builder adds input and output of data from and to external sources, and the Web Services builder adds interaction with Web Services. The combination of these features provides a comprehensive, easy-to-use, application development tool.

[0148] The above description is exemplary only and it will be apparent to those of ordinary skill in the art that numerous modifications and variations are possible. For example, various exemplary methods and systems described herein may be used alone or in combination with various other computer and computer peripheral systems and methods. Additionally, particular examples have been discussed and how these examples are thought to address certain disadvantages in related art. This discussion is not meant, however, to restrict the various examples to methods and/or systems that actually address or solve the disadvantages.

1. A computer enabled method of creating a software application, comprising the acts of:

providing a user interface for designing the software application on a web browser;

defining aspects of the application via the web browser using the user interface; and

transmitting the defined aspects to a server over a computer network thereby to create a web-based software application.

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

providing a plurality of components on the web browser; and

implementing some of the aspects of the application using the components.

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

providing a library on the browser; and

using the library as an intermediary between the defined aspects at the browser and the server.

4. The method of claim 1, wherein the computer network includes the Internet.

5. The method of claim 1, further comprising, at the server, the acts of:

rendering a representation of the application from the transmitted defined aspects;

retrieving data associated with the application from a storage; and

transmitting the representation and retrieved data to a client.

6. The method of claim 5, further comprising, at the server, the acts of:

tracking a plurality of versions of the software application;

maintaining each version as compatible with prior versions of the software application; and

allowing a plurality of the versions to be active at the same time.

7. The method of claim 5, further comprising, at the client, the act of:

executing the representation and data on a web browser.

8. The method of claim 7, further comprising the acts of:

providing a library on the web browser of the client; and

using the library as an intermediary between the web browser of the client and the server.

9. A computer enabled method of providing a software application, comprising the acts of:

receiving at a server over a computer network from a first client web browser a software application including defined aspects of the application;

rendering a representation of the application from the received defined aspects;

retrieving data associated with the application from a storage; and

transmitting the representation and retrieved data to a second client.

10. The method of claim 9, further comprising the acts of:

providing a user interface on the web browser at the first client for designing the software application;

defining the aspects of the application using the user interface; and

transmitting the defined aspects to the server over the computer network.

11. The method of claim 9, further comprising the acts of:

tracking a plurality of versions of the software application;

maintaining each version as compatible with prior versions of the software application; and

allowing a plurality of the versions to be active at the same time.

12. The method of claim 9, wherein the computer network includes the Internet.

13. The method of claim 10, further comprising, at the second client, the acts of:

providing a web browser; and

providing a user interface to a user on the web browser from the received representation and data.

14. The method of claim 13, further comprising, at the second client, the acts of:

providing a library on the browser; and

using the library as an intermediary between the browser and the server.

15. A computer enabled method of providing a software application, comprising the acts of:

receiving over a computer network aspects of an application from a server;

executing the application on a web browser;

providing a user interface; and

allowing use of the application via the user interface.

16. A client to be executed on a computer, comprising:

a user interface adapted for designing a software application on a web browser; and

an application definition module which defines aspects of the software application via the web browser using the user interface;

wherein the web browser transmits the defined aspects to a server over a computer network thereby to create the software application.

17. The client of claim 16, wherein a plurality of components are on the web browser; and

some of the aspects of the application are implemented using the components.

18. The client of claim 16, further comprising

a library on the browser, wherein

the library being used as an intermediary between the defined aspects at the browser and the server.

19. The client of claim 16, wherein the computer network includes the Internet.

**20**. An application server to be executed on a computer, comprising:

an application definition module for receiving over a computer network from a first client web browser a software application including defined aspects of the application and rendering a representation of the application from the received defined aspects;

a service for retrieving data associated with the application from a storage; and

an application player module for transmitting the representation and retrieved data to a second client.

**21**. The server of claim 20, further comprising:

a version control for tracking a plurality of versions of the software application, maintaining each version as compatible with prior versions of the software application, and allowing a plurality of the versions to be active at the same time.

**22**. A player client to be executed on a computer, comprising:

a definition module for receiving over a computer network aspects of an application from a server;

a data module for receiving over the computer network from the server data relating to the application; and

a user interface for executing the application on a web browser.

**23**. The client of claim 22, further comprising using a library on the browser as an intermediary between defined aspects of the application and the server.

**24**. A method of running an application program in a web browser, comprising the acts of:

providing at least one client computer and one server computer in communication with the network,

executing a web browser on the client computer;

executing a client portion of the application program on the web browser, wherein the client portion presents a runtime user interface according to an application definition, the application definition includes a component described by a component definition, the component includes a name and a data value, and the client portion receives the data value from a user; and

executing a server portion of the application program on the server computer, wherein the server portion receives the data value from the client portion and stores the data value in a database, as specified by the application definition.

**25**. The method of claim 24, wherein the component further includes a link, the link refers to a web service, and the client program receives the data value from the web service in response to a user action.

**26**. The method of claim 24, wherein the component further includes a script operable to execute in response to an application event, the script further operable to perform calculations based on a data value associated with another component.

**27**. The method of claim 24, wherein the component further includes a script operable to execute in response to an application event, the script further operable to set a data value associated with another component.

**28**. The method of claim 24, wherein the component is associated with a row of a table component.

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

providing at least one client computer and one server computer in communication with the network,

executing a web browser on the client computer;

executing a designer program on the 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 being associated with a component data value, and the designer program creates an application definition, the application definition describing properties of the interface component, the application definition including an association between the component data value and a corresponding column of a table in a database.

**30**. The method of claim 29, wherein the component is associated with a link, the designer program receives from a user a Uniform Resource Locator associated with the link and the program adds the link to the application definition in association with the interface component.

**31**. The method of claim 29, wherein the component is associated with a computer program code script, the designer program receives from a user the computer program code script, the computer program code script is operable to perform calculations based on the value of another component, and the designer program adds the computer program code script to the application definition in association with the interface component.

**32**. The method of claim 29, wherein the computer program code script is operable to set the value of another component.

**33**. The method of claim 29, wherein the user can further place a table component upon the workspace, the table component comprising:

a table header row, comprising at least one column definition; and

a table detail row, comprising at least one column corresponding to the at least one column definition, wherein the at least one column is associated with at least one detail component having a detail data value; wherein

the application definition describes the table component and an association between the at least one detail data value and a corresponding detail column in a database.

* * * * *