Introducing Apache Pivot

Greg Brown
7/12/2010

Bio

- Greg Brown
  - Senior Software Architect
    - 15 years experience developing client and server applications in both services and R&D
    - Apache Pivot Project Founder

What is Apache Pivot?

- Open-source platform for building rich internet applications in Java (or any JVM scripting language: Groovy, JavaScript, Scala, etc.)
- Similar to Adobe Flex or Microsoft Silverlight, but based on the JVM rather than Flash or Silverlight player
- Pivot applications can be run as an applet or as stand-alone desktop application (installed or launched via Web Start)

What is Apache Pivot?

- Like other RIA platforms, includes features that make building modern GUI applications much easier:
  - Declarative XML-based UI markup language ("WTKX")
  - Themes (aka "skins")/styling
  - Data binding
  - Effects and transitions (animations)
  - Web services integration (JSON/REST)

Why RIA?

- Functional requirements for many web applications have begun to scale beyond the capabilities of the browser
- Difficult to create a user experience in HTML that is truly on par with that of a desktop application

Why RIA?

- RIA platforms bridge the gap between the web and desktop experiences
- Allow developers to build applications that look and feel more like native desktop applications but are deployable via the web
- Often incorporate visual effects intended to enhance the overall user experience (animations and other dynamic behaviors)

Why Pivot?

1. Provide a viable option for developers who want to build rich Internet applications in Java
   - Flex: ActionScript
   - Silverlight: C#/JavaScript
   - JavaFX: JavaFX Script

Why Pivot?

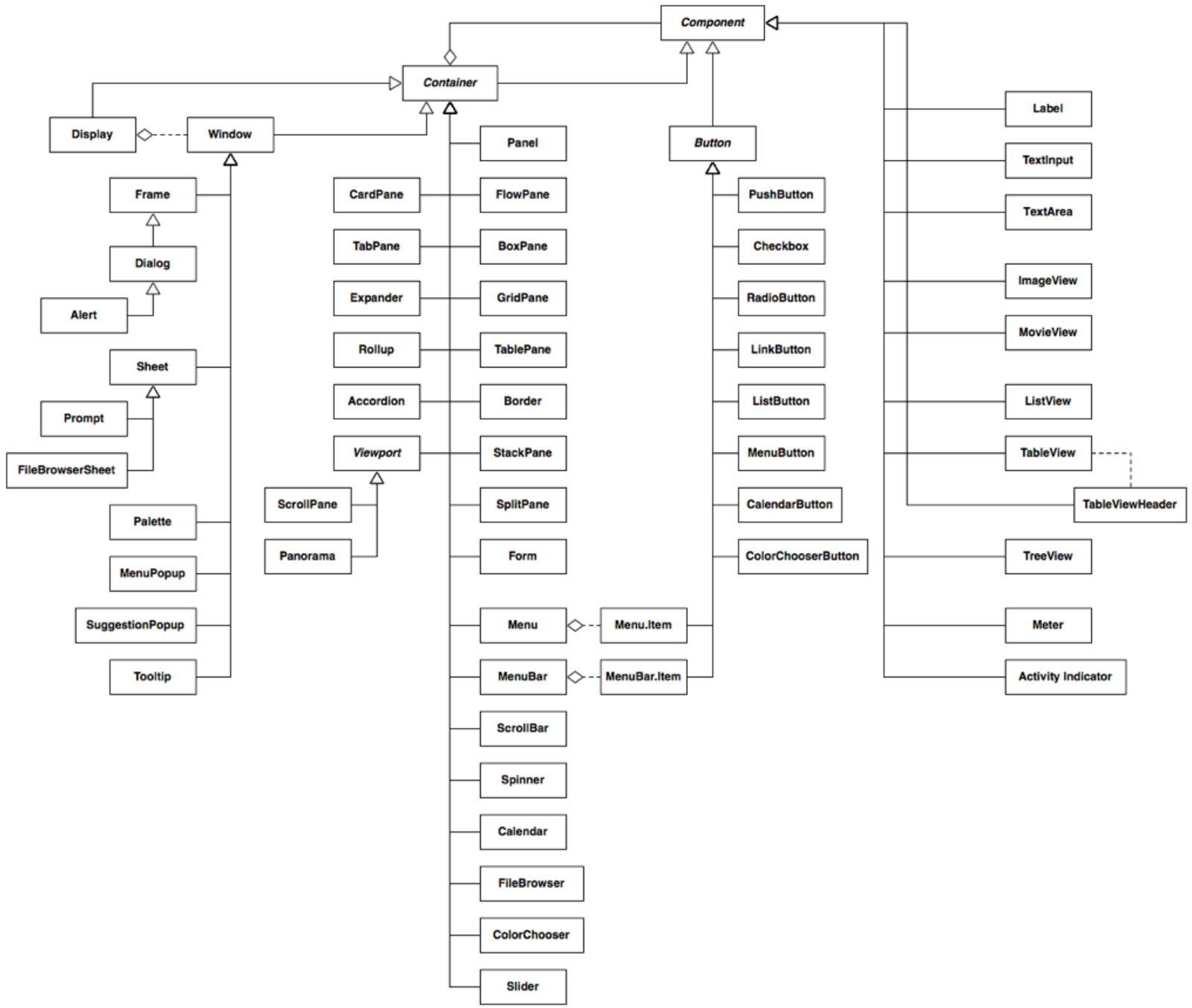
2. Provide a truly open alternative for RIA developers

   - Flex, Silverlight, and JavaFX are all proprietary platforms
   - Pivot is completely open source and driven entirely by the software development community

Platform Overview

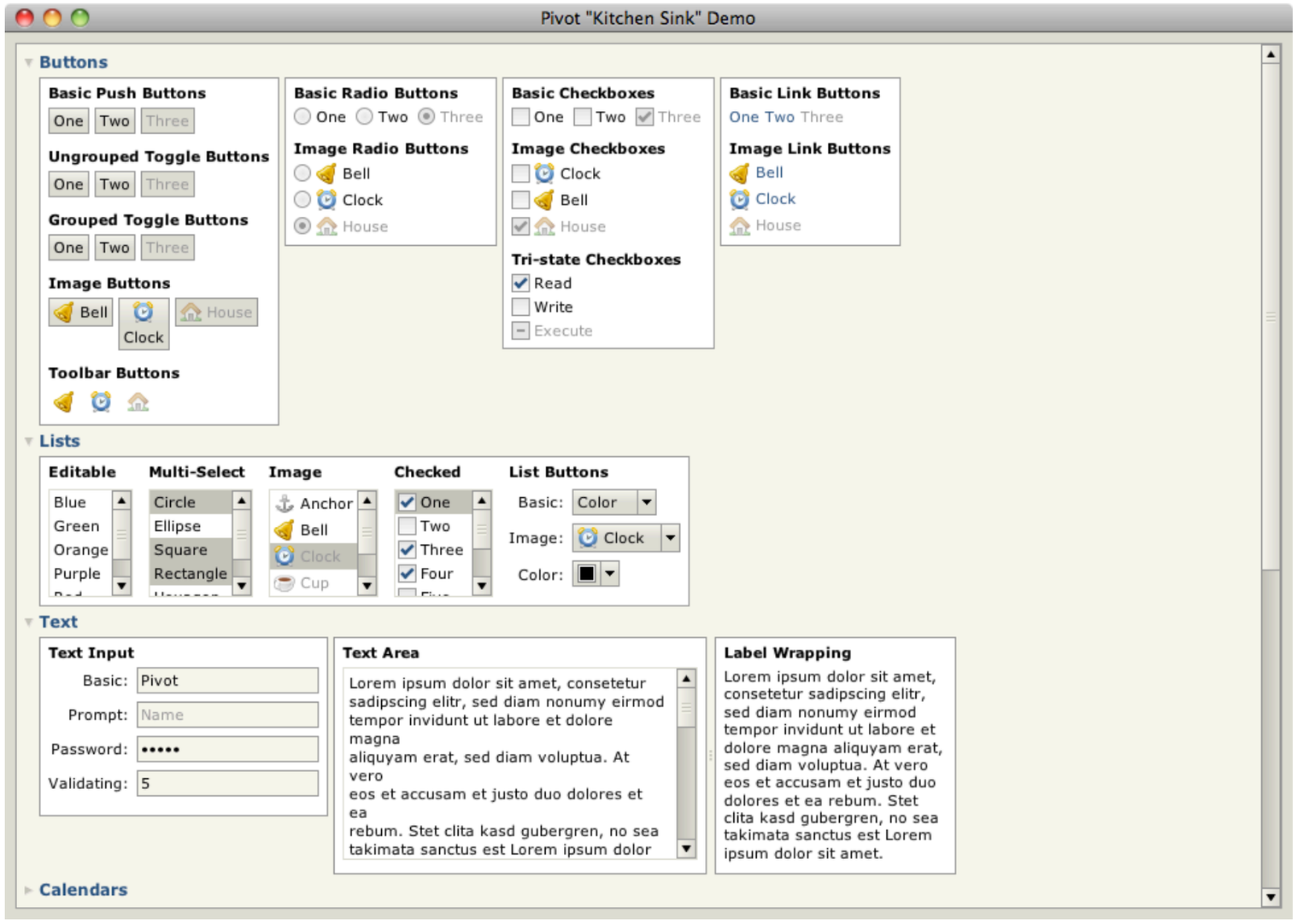
- Pivot classes are grouped into the following libraries:
  - *pivot-core-1.5.jar* - common, non-UI utility classes (collections, event processing, localization, threading, I/O, etc.)
  - *pivot-web-1.5.jar/pivot-web-server-1.5.jar* - REST client/server APIs
  - *pivot-wtk-1.5.jar/pivot-wtk-terra-1.5.jar* - WTK/Terra L&F
  - *pivot-charts-1.5.jar* - charting components (requires charting provider; currently based on JFreeChart)

Platform Overview



WTK Class Hierarchy

“Kitchen Sink” Demo



“Kitchen Sink” Demo Application

“Hello WTKX!”

```java
public class HelloWTKX implements Application {
    private Window window = null;

    @Override
    public void startup(Display display, Map<String, String> properties)
        throws Exception {
        WTKXSerializer wtkxSerializer = new WTKXSerializer();
        window = (Window)wtkxSerializer.readObject(this, "hello.wtkx");
        window.open(display);
    }

    @Override
    public boolean shutdown(boolean optional) {
        if (window != null) {
            window.close();
        }

        return false;
    }

    @Override
    public void suspend() {
    }

    @Override
    public void resume() {
    }

    public static void main(String[] args) {
        DesktopApplicationContext.main(HelloWTKX.class, args);
    }
}
```

```
<Window title="Hello WTKX!" maximized="true"
    xmlns:wtkx="http://pivot.apache.org/wtkx"
    xmlns="org.apache.pivot.wtk">
    <content>
        <Label text="Hello WTKX!"
            styles="{font:'Arial bold 24', color:'#ff0000',
                horizontalAlignment:'center', verticalAlignment:'center'}"/>
    </content>
</Window>
```

Source code for
“Hello World”
in Pivot

Pivot Compared to Swing

- Swing can also be used to build RIAs
- Both Pivot and Swing use Java2D under the hood
- Pivot offers numerous advantages that make it a more compelling, modern alternative

Pivot Compared to Swing

- Pivot advantages:
  - Provides XML markup language for simplifying user interface construction
  - Built-in support for JSON and REST-based data services
  - Built-in data binding support
  - Platform-level support for visual effects and transitions
  - Takes advantage of newer Java language features: generics, enums, for..each loops, varargs, and annotations

Pivot Compared to JavaFX

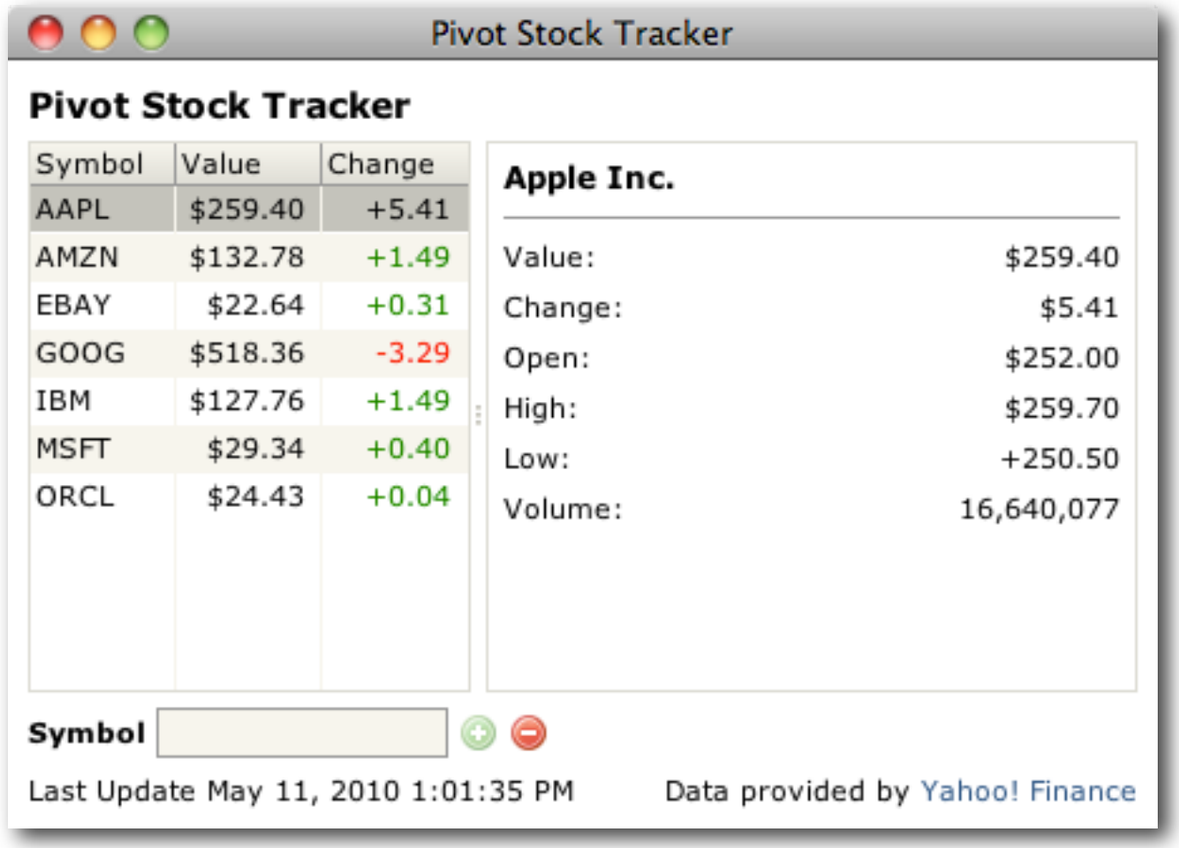
- Pivot allows developers to build applications in Java, vs. JavaFX scripting language
- Slightly different emphasis: "Application" vs. "Rich" (media delivery) in "RIA"
- Not mutually exclusive!

Pivot Compared to GWT

- GWT also allows developers to use Java to write web-based applications
- Runtime enviroment for a GWT application is the browser, not a JVM:
  - Code executes as interpreted JavaScript, not bytecode
  - Doesn't support full Java API (no I/O, networking, threading, reflection, XML, etc.) - basically, only Java language
  - Presentation performed via CSS and DOM manipulation rather than 2D drawing API

"Stock Tracker" Tutorial Application

- Simple but practical sample application
- Highlights key platform features and development best practices



Stock Tracker
Key Features

- UI markup using WTKX
- Event handling
- Web queries
- Data binding
- Localization

UI markup using WTKX

- Pivot UI often defined in WTKX
- Hierarchical structure of XML parallels the component hierarchy, makes it easy to visualize the resulting output
- Developers are familiar with markup metaphor
- Can still be defined in code - WTKX is just a "shortcut"
- Not compiled - serialized representation of object graph
  - Generally loaded at runtime from application JARs
  - Can load dynamically (from server, for example)

UI markup using WTKX

```
<stocktracker:StockTrackerWindow title="%stockTracker" maximized="true"
    xmlns:wtkx="http://pivot.apache.org/wtkx"
    xmlns:content="org.apache.pivot.wtk.content"
    xmlns:stocktracker="org.apache.pivot.tutorials.stocktracker"
    xmlns="org.apache.pivot.wtk">
    <content>
        <TablePane styles="{padding:8, horizontalSpacing:6, verticalSpacing:6}">
            <columns>
                <TablePane.Column width="1*" />
            </columns>

            <rows>
                ...

                <TablePane.Row height="1*">
                    <SplitPane splitRatio="0.4">
                        <left>
                            ...
                        </left>
                        <right>
                            <Border styles="{padding:6, color:10}">
                                <content>
                                    <wtkx:include wtkx:id="detailPane" src="detail_pane.wtkx"/>
                                </content>
                            </Border>
                        </right>
                    </SplitPane>
                </TablePane.Row>

                <TablePane.Row height="-1">
                    <BoxPane styles="{horizontalAlignment:'left', verticalAlignment:'center'}">
                        <Label text="%symbol" styles="{font:{bold:true}}" />
                        <TextInput wtkx:id="symbolTextInput" textSize="10"
                            maximumLength="8" />
                        ...
            </rows>
        </TablePane>
    </content>
</stocktracker:StockTrackerWindow>
```

UI markup using WTKX

- Quick WTKX primer:
  - Elements
    - Uppercase = class instance
    - Lowercase = property/listener list
  - Attributes = property/event listener
  - Namespaces = Java packages
  - “wtkx” prefix (IDs, includes, etc.)
  - Script code (logic)

UI markup using WTKX

- Resolution operators:
  - Used in WTKX attribute values
  - ‘%’ = resource resolution (localization)
  - ‘@’ = location resolution (relative URL)
  - ‘$’ = variable resolution

UI markup using WTKX

- WTKX binding:
  - Maps objects defined in WTKX to Java member variables (“dependency injection”)
- wtkx:id maps to @WTKX annotation

```
@WTKX private TextInput symbolTextInput = null;
@WTKX private Button addSymbolButton = null;
@WTKX private Button removeSymbolsButton = null;
@WTKX private BoxPane detailPane = null;
@WTKX private Label lastUpdateLabel = null;
@WTKX private Button yahooFinanceButton = null;
```

UI markup using WTKX

- Implementing Bindable interface ensures that bindings are processed
- Resources argument allows bound instance to retain reference to the resource bundle used to process the WTKX file

```
20
21 /**
22  * Allows WTKX serializer to automatically bind to an instance of a
23  * deserialized class.
24  */
25 public interface Bindable {
26     /**
27      * Called to initialize the class after it has been completely
28      * processed and bound by the serializer.
29      */
30     public void initialize(Resources resources);
31 }
32
```

Event Handling

- WTKX = *structure*, code = *behavior*
- Logic generally executed in response to an "event" (button pressed, selection changed, etc.)
- Event listeners often wired up in Bindable#initialize()
- Can also be registered in inline script, similar to HTML

```
01 @Override
02 public void initialize(Resources resources) {
03     stocksTableView.getTableViewSelectionListeners().add(new TableViewSelectionListener.Adapter() {
04         @Override
05         public void selectedRangesChanged(TableView tableView, Sequence<Span> previousSelectedRanges) {
06             ...
07         }
08     });
09
10     ...
11
12     addSymbolButton.setAction(addSymbolAction);
13     removeSymbolsButton.setAction(removeSymbolsAction);
14
15     ...
16
17     yahooFinanceButton.getButtonPressListeners().add(new ButtonPressListener() {
18         @Override
19         public void buttonPressed(Button button) {
20             ...
21         }
22     });
23 }
```

Event Handling

- Actions:
  - Extend abstract org.apache.pivot.wtk.Action class
  - Defines abstract perform() method
  - Used to attach application behaviors to multiple UI elements (e.g. toolbar button, menu item, etc.)
  - Can be enabled/disabled; attached components reflect state

Web Queries

- Pivot's native means of server communication
- Part of "Web" class library
- Similar to XMLHTTPRequest in web browser
- Facilitate communication with and implementation of REST services
- Use JSON by default, but can use any data format (XML, CSV, Java serialization, etc.)

Web Queries

- Quote data returned by HTTP GET request to http://download.finance.yahoo.com/d/quotes.csv/
- Query string arguments specify symbols and fields to retrieve, returns CSV file:

```
"AAPL","APPLE INC",171.06,169.59,172.17,166.00,+2.88,12995693
"AMZN","AMAZON.COM INC",72.54,72.35,73.83,70.52,+1.10,2748930
"EBAY","EBAY INC",27.09,27.35,27.44,27.04,-0.02,3426369
```

Web Queries

- Stock Tracker uses an instance of org.apache.pivot.web.GetQuery to retrieve the data
- POST, PUT, and DELETE also supported
- Uses an instance of org.apache.pivot.serialization.CSVSerializer to deserialize the data
- Returns the quotes as an instance of org.apache.pivot.collections.List which is used as the model data for the table view

Web Queries

- By default, CSVSerializer returns an ArrayList of HashMaps
  - Untyped - all data are strings
- Can be configured to return instances of any Java Bean type
- Stock Tracker uses a StockQuote bean class to convert strings to numbers (for sorting)

Web Queries

- org.apache.pivot.web.Query extends org.apache.pivot.util.concurrent.Task
- Abstract (generic) base class for executing background operations
- Defines a single abstract execute() method that returns the result of the operation
- GetQuery returns Object (in this case, the result data)

Web Queries

- execute() is synchronous - blocks UI
- Task provides an overload that takes an instance of org.apache.pivot.util.concurrent.TaskListener
- Caller is notified asynchronously via callback when task has succeeded or failed
- UI remains responsive

```
18
19 /**
20  * Task listener interface.
21  *
22  * @param <V>
23  * The return type of the task.
24  */
25 public interface TaskListener<V> {
26     /**
27      * Called when the task has completed successfully.
28      *
29      * @param task
30      * The source of the task event.
31      */
32     public void taskExecuted(Task<V> task);
33
34     /**
35      * Called when task execution has failed.
36      *
37      * @param task
38      * The source of the task event.
39      */
40     public void executeFailed(Task<V> task);
41 }
42
```

Data Binding

- Maps values between a set of user interface elements and a data structure, called the "bind context"
- Eliminates tedious boilerplate code for manually populating field data

Data Binding

- Uses a load/store model:
  - load() populates UI with values from context
  - store() populates context with values from UI
- Maps well to REST-based applications:
  - GET - load()
  - POST/PUT - store()

Data Binding

- Bind context is either an instance of org.apache.pivot.collections.Dictionary or a Java Bean that can be wrapped in org.apache.beans.BeanAdapter (which implements Dictionary)
- Easy to bind to JSON data returned by web query - JSON Objects are returned as instances of HashMap, which implements Dictionary

Data Binding

- Stock Tracker uses binding to populate quote detail form:

```
<Form styles="{padding:0, fill:true, showFlagIcons:false, showFlagHighlight:false,
    leftAlignLabels:true}">
    <sections>
        <Form.Section>
            <wtkx:define>
                <stocktracker:ValueMapping wtkx:id="valueMapping"/>
                <stocktracker:ChangeMapping wtkx:id="changeMapping"/>
                <stocktracker:VolumeMapping wtkx:id="volumeMapping"/>
            </wtkx:define>

            <Label wtkx:id="valueLabel" Form.label="%value"
                textKey="value" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="changeLabel" Form.label="%change"
                textKey="change" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="openingValueLabel" Form.label="%openingValue"
                textKey="openingValue" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="highValueLabel" Form.label="%highValue"
                textKey="highValue" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="lowValueLabel" Form.label="%lowValue"
                textKey="lowValue" textBindMapping="$changeMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="volumeLabel" Form.label="%volume"
                textKey="volume" textBindMapping="$volumeMapping"
                styles="{horizontalAlignment:'right'}"/>
        </Form.Section>
    </sections>
</Form>
```

Data Binding

- "textKey" property associates Label text with bind key
- Bind context is an instance of the StockQuote bean returned by GetQuery/CSVSerializer
- Uses "bind mapping" to transform data during binding:

```
01 public class ValueMapping implements Label.TextBindMapping {
02     private static final DecimalFormat FORMAT = new DecimalFormat("$0.00");
03
04     @Override
05     public String toString(Object value) {
06         return Float.isNaN((Float)value) ? null : FORMAT.format(value);
07     }
08
09     @Override
10     public Object valueOf(String text) {
11         throw new UnsupportedOperationException();
12     }
13 }
```

Localization

- Translatable text and other resources stored in “resource bundles”
- In Pivot, resource bundles are JSON files rather than .properties files
- Use UTF-8 natively, vs. ISO-8859
- May be hierarchical, vs. flat

Localization

- Stock Tracker resource bundles (default and ‘fr’):

```
{   stockTracker: "Pivot Stock Tracker",
    symbol: "Symbol",
    companyName: "Company",
    value: "Value",
    openingValue: "Open",
    highValue: "High",
    lowValue: "Low",
    change: "Change",
    volume: "Volume",
    addSymbol: "Add symbol",
    removeSymbol: "Remove selected symbols",
    lastUpdate: "Last Update",
    dataProvidedBy: "Data provided by",
    yahooFinance: "Yahoo! Finance"
}
```

StockTracker.json

```
{   stockTracker: "La Bourse Pivot",
    symbol: "Code",
    companyName: "Société",
    value: "Cours",
    openingValue: "Ouverture",
    highValue: "+ Haut",
    lowValue: "+ Bas",
    change: "Variation",
    volume: "Volume",
    addSymbol: "Ajouter un code",
    removeSymbol: "Enlever codes sélectionnés",
    lastUpdate: "Dernier échange",
    dataProvidedBy: "Données fournies par",
    yahooFinance: "Yahoo! Finance"
}
```

StockTracker_fr.json

Localization

- Quote detail form uses localized form labels:

```
<Form styles="{padding:0, fill:true, showFlagIcons:false, showFlagHighlight:false,
    leftAlignLabels:true}">
    <sections>
        <Form.Section>
            <wtkx:define>
                <stocktracker:ValueMapping wtkx:id="valueMapping"/>
                <stocktracker:ChangeMapping wtkx:id="changeMapping"/>
                <stocktracker:VolumeMapping wtkx:id="volumeMapping"/>
            </wtkx:define>

            <Label wtkx:id="valueLabel" Form.label="%value"
                textKey="value" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="changeLabel" Form.label="%change"
                textKey="change" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="openingValueLabel" Form.label="%openingValue"
                textKey="openingValue" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="highValueLabel" Form.label="%highValue"
                textKey="highValue" textBindMapping="$valueMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="lowValueLabel" Form.label="%lowValue"
                textKey="lowValue" textBindMapping="$changeMapping"
                styles="{horizontalAlignment:'right'}"/>
            <Label wtkx:id="volumeLabel" Form.label="%volume"
                textKey="volume" textBindMapping="$volumeMapping"
                styles="{horizontalAlignment:'right'}"/>
        </Form.Section>
    </sections>
</Form>
```

Localization

- Et voilà!

La Bourse Pivot

Code	Cours	Variation
AAPL	$259,85	-3,27
AMZN	$126,71	-2,05
EBAY	$22,57	+0,39
GOOG	$505,70	+0,10
IBM	$126,56	-1,40
MSFT	$26,40	-0,46
ORCL	$22,73	-0,11

Apple Inc.

Cours:	$259,85
Variation:	-$3,27
Ouverture:	$258,47
+ Haut:	$261,90
+ Bas:	+257,10
Volume:	10 813 601

Code

Dernier échange 4 juin 2010 12:02:20 Données fournies par Yahoo! Finance

Summary

- Pivot is a platform for building modern GUI applications in Java that can be deployed via the web or to the desktop
- Stock Tracker tutorial demonstrates some key features and is a great quick-start example

Further Information

- http://pivot.apache.org
- http://pivot.apache.org/demos/
- http://pivot.apache.org/tutorials/
- http://pivot.apache.org/1.5/docs/api/

Q & A