Best Practices: Data Access Strategies

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Main Takeaway

Swing: Powerful Rich Client Platform

Learn different data access strategies and application design patterns for building occasionally connected rich client applications

Agenda

Smart Clients Defined

Application Design Overview

Demo Application

Summary

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Smart Clients

- Access to local machine resources
  - Massive hard drive capacity
  - Graphics card
  - Memory
- Rich user experience
- Connect to network resources
- Occasionally connected

Occasionally Connected

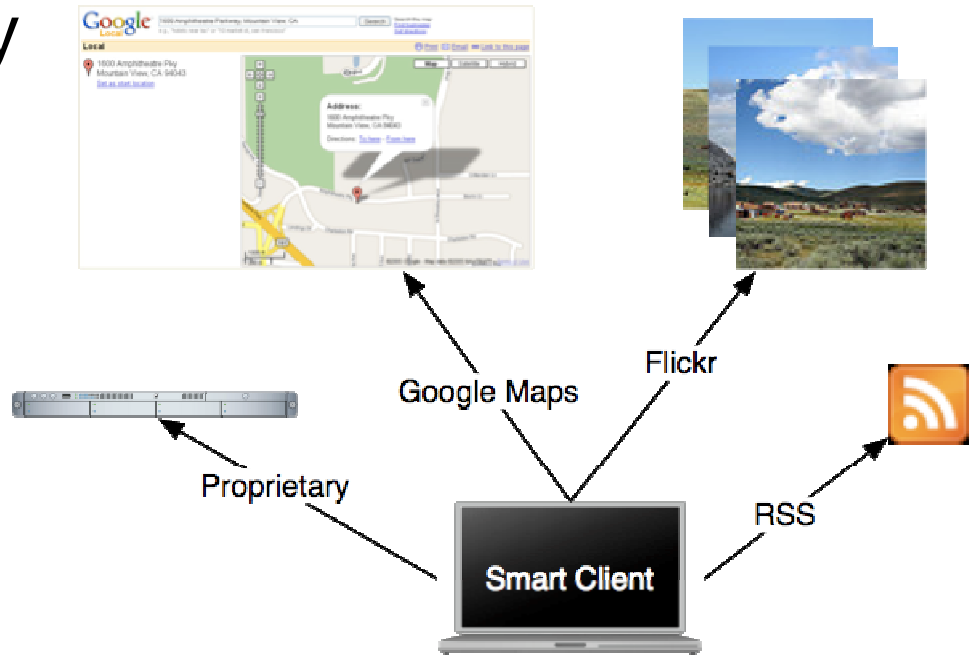
- Users demand reliable access to their data in an unreliable world
- Smart clients must be prepared to cache
  - If disconnected, users can continue working
  - Cache must be synchronized with server
  - Comprehensive caching technology is still a work in progress

ResponseCache

- ResponseCache provides a pluggable mechanism for caching the results of URL connections
  - @since 1.5
  - Works well for storing read-only data

Web Services + Smart Clients

- Smart Clients use Web Services extensively
  - Google Maps
  - Flickr
  - RSS
  - Proprietary
- Mashups work well in Smart Clients
- Best of both worlds



Why Web Services?

- Security
  - Doesn’t require any new open ports
  - Security is built in at the web server level
- Scalability
  - Load balancers, clusters, etc.
- Accessible
  - Easily accessible from any type of client on any type of platform

Web Service Types

- REST
- XML-RPC
- SOAP
- RSS
- Screen Scraping

Note: Learn With Flickr

- Flickr is excellent for learning web services
  - Supports REST, XML-RPC, SOAP, RSS
  - Good documentation
  - Tons of freely available data
  - Read access doesn't require registration
  - Resulting applications are interesting and fun
- Today's Demos use Flickr

REST

- Acronym for Representational State Transfer
- Extremely simple web service
  - It's the way the web works!
- A single URL leads to a unique resource
  - Example: http://www.flickr.com/photos/romainguy/112798971/

REST—Yes, that's it!

- REST is not a framework, its an architectural style
- Can be combined with other webservices such as XML-RPC
- Often the data returned is
  - XML
  - PDF
  - Image (PNG, JPG, SVG, etc.)

XML-RPC

- Somewhat more complicated that REST for binary data (such as images)
- Provides a structured XML document for making remote procedure calls
  - Supports only basic primitives
    - Usually enough to get the job done
  - Very simple
  - Supported in most programming languages

SOAP

- “Simple Object Access Protocol”
- Technically much more that RPC, but usually SOAP is used for RPC
  - A (much) more advanced form of XML-RPC
  - Sometimes too heavyweight for the job
  - Industry Support
    - Microsoft
    - IBM
    - Sun

Flickr REST Request

To request the flickr.test.echo service, invoke like this:

```
http://www.flickr.com/services/rest/?method=flickr.test.echo&name=value
```

Flickr XML-RPC Request

To request the flickr.test.echo service, send a request like this

```
<methodCall>
   <methodName>flickr.test.echo</methodName>
   <params>
      <param>
         <value>
             <struct>
                <member>
                   <name>name</name>
                   <value><string>value</string></value>
                </member>
                <member>
                   <name>name2</name>
                   <value><string>value2</string></value>
                </member>
             </struct>
          </value>
       </param>
   </params>
</methodCall>
```

Flickr SOAP Request

To request the flickr.test.echo service, send an envelope like this

```
<s:Envelope
    xmlns:s="http://www.w3.org/2003/05/soap-envelope"
    xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
    xmlns:xsd="http://www.w3.org/1999/XMLSchema"
>
    <s:Body>
        <x:FlickrRequest xmlns:x="urn:flickr">
            <method>flickr.test.echo</method>
            <name>value</name>
        </x:FlickrRequest>
   </s:Body>
</s:Envelope>
```

Flickr REST Response

A method call returns this

```
<?xml version="1.0" encoding="utf-8" ?>
<rsp stat="ok">
    [xml-payload-here]
</rsp>
```

Flickr XML-RPC Response

A simple call to the echo service returns this

```
<?xml version="1.0" encoding="utf-8" ?>
<methodResponse>
    <params>
        <param>
            <value>
                <string>
                    [escaped-xml-payload]
                </string>
            </value>
        </param>
    </params>
</methodResponse>
```

Flickr SOAP Response

A Simple Call to the Echo Service Returns This

```
<?xml version="1.0" encoding="utf-8" ?>
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-
envelope">
   <s:Body>
      <FlickrResponse xmlns="http://flickr.com/ns/api#">
         [xml-payload]
      </FlickrResponse>
   </s:Body>
</s:Envelope>
```

Flickr REST Code

```
public static List<Photo> search(String tag) {
    URL url = new URL(
        "http://www.flickr.com/services/rest/?” +
        “method=flickr.photos.search&api_key=” +
        myFlickrKey + “&tags=java");
    InputStream is = url.openStream();
    return FlickrParser.parsePhotos(is);
}
```

RSS

- Polling technology that consumes an XML document
- RSS readers subscribe to RSS “feeds” Whenever the feed is updated, it is consumed by the reader
- Very useful, simple, works well in combination with REST or some other web service
- http://www.xml.com/pub/a/2002/12/18/dive-into-xml.html

Screen Scraping

- Poor webservice
- Essentially imitating a browser
  - Parse the HTML from a URL and “scrape” out the relevant info
  - Use HTTP PUT/GET/POST requests to request pages or post forms
- Breaks whenever the page you are scraping changes incompatibly

Web Service Types Summary

- REST: easiest and most straightforward solution
- SOAP: somewhat heavyweight for typical desktop requirements
- XML-RPC: nice balance between easy and powerful

Database Roundup

- ResultSet
- RowSet
- DataSet
- EJB™ 3 Architecture/Hibernate

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ResultSet

- Traditional database access technology
- Easy to write
- Harder to read
- Hard to interact with from a GUI
  - Has a cursor
  - May be unidirectional
  - Throws checked exceptions on most methods

ResultSet Code

```
public static List<Photo> search(String tag) {
    Connection c = createConnection();
    ResultSet rs = c.createStatement().
        executeQuery("select url from PHOTO");
    List<Photo> results =
            new ArrayList<Photo>();
    while (rs.next()) {
        results.add(new Photo(rs.getString(1)));
    }
    rs.close();
    c.close();
    return results;
}
```

Database Roundup

- ResultSet
- RowSet
- DataSet
- EJB 3 Architecture/Hibernate

RowSet

- Extends ResultSet
- Provides for disconnected data (CachedRowSet)
- Provides API for serializing results to XML (WebRowSet)
- Normally has a bidirectional cursor
- Still hard to use in the GUI
  - Moving the cursor around makes it perform poorly in JTable
  - Still throws a lot of checked exceptions

RowSet Code

```
public static List<Photo> search(String tag) {
    Connection c = createConnection();
    CachedRowSet rs = new CachedRowSetImpl();
    rs.setCommand("select url from PHOTO");
    rs.execute(c);
    List<Photo> results = new ArrayList<Photo>();
    while (rs.next()) {
        results.add(new Photo(rs.getString(1)));
    }
    rs.close();
    c.close();
    return results;
}
```

Database Roundup

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DataSet

- New in Mustang (Java™ SE 6 platform, pending approval from the Mustang EG)
- Part of JDBC™ 4.0 software
- Extends java.util.List
- Provides for both connected and disconnected states
- Part of the Ease Of Development enhancements in JDBC 4.0 software

DataSet Code

```
public static List<Photo> search(String tag) {
    Connection c = createConnection();
    Queries q =
          c.createQueryObject(Queries.class);
    c.close();
    return q.getAllPhotos();
}

interface Queries extends BaseQuery {
    @Select (“select * from PHOTO”)
    DataSet<Photo> getAllPhotos();
}
```

Database Roundup

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- EJB™ 3 Architecture/Hibernate

EJB 3

- Latest Enterprise JavaBeans™ (EJB) Spec, part of Java EE 5 platform
- “This is not your father’s J2EE™ platform!”

  —Bill Shannon
- Can be used in Java SE platform
  - Requires bundling some jars
  - Requires an implementation
    - Hibernate is the popular choice
  - More powerful, more complex than JDBC 4.0 software DataSet

Hibernate

- Enormously popular ORM library
- Major participant in JSR-220 (EJB 3.0 architecture)
- http://www.hibernate.org/152.html
- Suffers from dependency madness
  - 36 dependency jars shipped with Hibernate 3!
- EJB™ 3.0 technology docs don't reflect current reality

EJB 3 Architecture Code

```
public static List<Photo> search(String tag) {
    EntityManagerFactory f = Persistence.
       createEntityManagerFactory("flickr");
    EntityManager m = f.createEntityManager();
    Query q = m.
       createNativeQuery("select url from PHOTO");
    return q.getResultList();
}
```

EJB 3 Architecture Configuration

```
<?xml version="1.0" encoding="UTF-8"?>
<persistence xmlns="http://java.sun.com/xml/ns/persistence">
  <persistence-unit name="flickr"
                    transaction-type="RESOURCE_LOCAL">
    <provider>org.hibernate.ejb.HibernatePersistence</provider>
    <class>delme.hibernate.Photo</class>
    <properties>
      <property name="hibernate.connection.driver_class"
                value="org.apache.derby.jdbc.EmbeddedDriver"/>
      <property name="hibernate.connection.url"
                value="jdbc:derby:flickr;create=true"/>
      <property name="hibernate.dialect"
                value="org.hibernate.dialect.HSQLDialect"/>
    </properties>
 </persistence-unit>
</persistence>
```

Database Summary

- Desktop applications should use DataSet
  - RowSet and ResultsSet are just transport types
- Hibernate and EJB beans are too heavyweight for typical desktop needs

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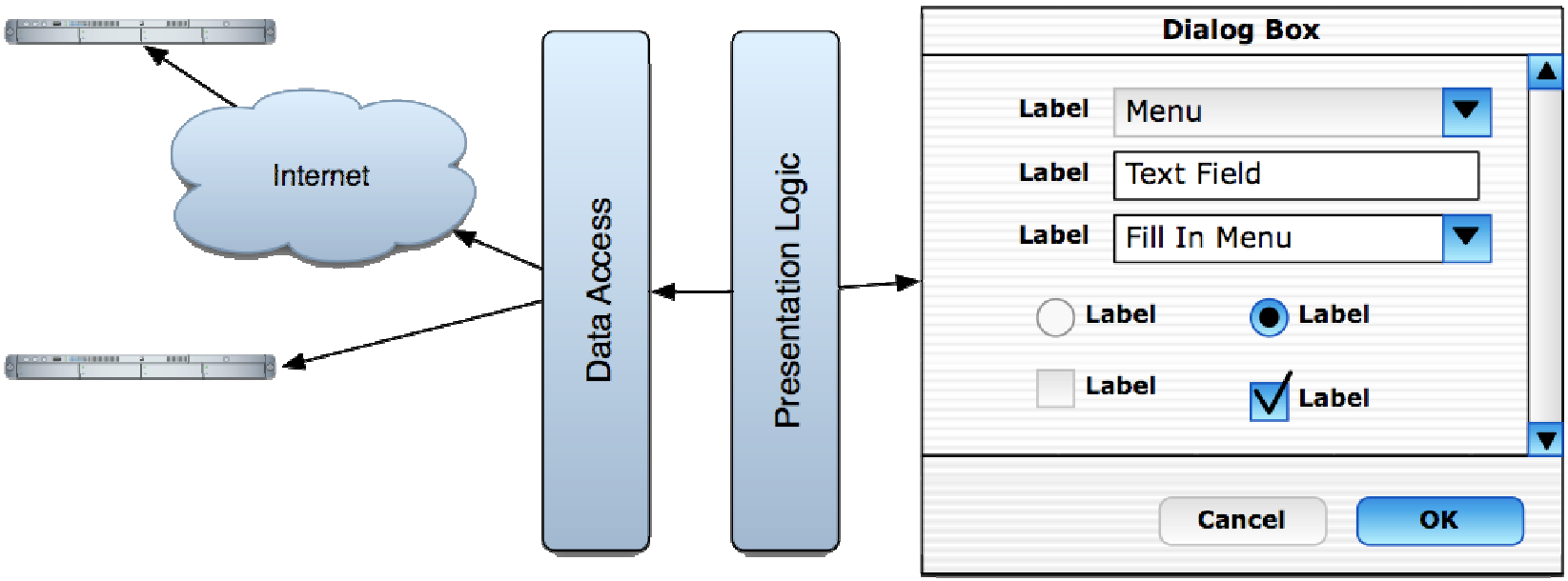
Separate Data Access Logic From UI!

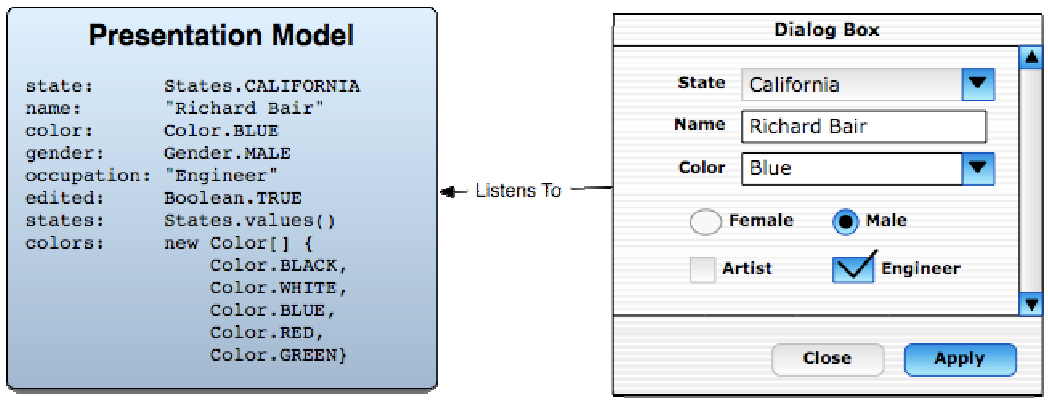


Separate Concerns

- Single most important concept
- UI should evolve according to users needs
- Data access should evolve according to technical needs
- Presentation Logic layer acts as adaptive layer to “glue” the UI to the data layer
  - Popular pattern: Presentation Model
- Individual circumstances may require adaptation

Observability

- Key part of JavaBeans™ architecture component model
- Allows construction of loosely coupled components
- Extremely useful in the data access layer and in the GUI layer



Typical Uses

- Data binding
  - Allows framework to observe changes and synchronize between beans
- Tools
  - For both visual and non visual components
- Observe status and update GUI as appropriate
  - isLoaded()

Design Problem #1

How Do I Send a Diff to the Server?

"How do I efficiently synchronize the server with small changes to data that is cached locally?"

Solution: Observability

- Write a DataObserver
  - Listens to property change events on your data objects
  - Records what data has been changed
  - Records the original value
- When preparing the diff
  - Consult the DataObserver for those fields that have changed

Design Problem #2

What Do I Do About Conflicts?

"Data on the server has changed; how do I detect conflicts between local data and changed data on the server?"

Solution: Observability

- Write a DataObserver
  - Listens to property change events on your data objects
  - Records what data has been changed
  - Records the original value
- Consult the DataObserver for conflicts
- Notify the UI of conflicts so the user can resolve them

Easy Observability

```
import org.jdesktop.swingx.JavaBean;
public class MyDataObject extends JavaBean {
    private boolean loaded;

    public boolean isLoaded() {
        return loaded;
    }
    protected void setLoaded(boolean b) {
        boolean old = isLoaded();
        this.loaded = b;
        firePropertyChange("loaded", old,
                isLoaded());
    }
}
```

Code Notes

- SwingLabs provides the JavaBeans technology class
  - Methods for adding/removing listeners
  - Methods for firing events
  - Trivial to implement observability
- “isLoaded()” is called in the setLoaded method
  - Notification works correctly even if “isLoaded” is overridden
- Methods don’t have to be public

Designing for the Network

- The network is unreliable
- Users are impatient

Rule #1: The Network Is Unreliable

- Network requests may not succeed
- Network response time may be unpredictable
  - Typical requests range from 150–5000 milliseconds

Rule #2: Users Are Impatient

- If an application is unresponsive users may
  - Distrust the application
  - Think the application has crashed
  - Quit the application and lose data
  - Look for other competing solutions
  - Take you off their Christmas list
- Users must be kept informed of progress

Solution: Threading

- Spawn a thread for all network related requests
  - SwingWorker makes it easier to manage background threads
    - http://swingworker.dev.java.net
  - Where possible, keep track of progress
    - HTTP responses may have a header indicating the number of bytes in the “page”

Threading

- The data access layer or presentation model layer is responsible for creating and managing these threads
- The UI layer must be notified of the status of these tasks
  - Progress indicators may need to be shown
  - Components may need to be disabled until the task is completed
- Threads must be cancelable, where possible

Threading

- Swing GUI should be updated only on the Event Dispatch Thread (EDT)
- This happens by default in Swing
  - Swing listeners always run on the EDT
- To update the GUI from a background thread
  - SwingUtilities.invokeLater (asynchronous)
  - SwingUtilities.invokeAndWait (synchronous)
- In Java 1.5 platform, java.util.concurrent package contains many very useful threading utilities
  - Thread pools
  - Cancelable tasks
  - Concurrent collections

Async Data Access

- Presentation Model for a GUI is notified of some action (button press)
- PM notifies data access layer to load some data
- Data Access layer creates background thread, returns a SwingWorker
- PM observes SwingWorker, updates UI state to reflect the loading status
- PM updates UI state when task is complete

Async Redux

- Presentation Model for a GUI is notified of some action (button press)
- PM observes “loaded” property of data object
- While not loaded, PM observes “status” property of data object, updates UI accordingly
- When “loaded”, UI is updated with data

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Swing + Mashups = Smashups

- Easy and powerful
  - The hard work is done by the web service providers on the server
  - Many popular web services already have data access logic written for Java technology
  - New Swing components for popular web services are being implemented in SwingLabs
- Best of both worlds

Slickr

- Sample “Smashup” application
  - The beginnings of a general Flickr client
  - Flickr photo viewer and trip reporter
- http://aerith.dev.java.net

Demo

Aerith

Demo Notes

- Flickr images are wrapped in a PhotoWrapper
  - PhotoWrapper notifies when the real photo image is loaded
- Google Map tiles are wrapped in a Tile
  - Notifies when the tile image is loaded
  - Maintains a SoftReference for the image
- ResponseCache implementation for caching images (both tiles and photos)

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- Smart Clients use WebServices
- Smashups are easy and powerful additions to your applications
- Cache data for offline use
- Perform network tasks asynchronously
  - Inform the user!
- Inform the user of their connection state
- Many database access options available

For More Information

- Technical Sessions
  - TS-1074: Desktop Patterns and Data Binding
  - TS-4855: Swing Threading 101
- BOFs
  - BOF-0614: SwingLabs
- URLs
  - http://www.martinfowler.com/eaaDev/PresentationModel.html
  - http://swinglabs.org
  - Google for: Microsoft Smart Client design guide
  - http://www.flickr.com/services/api

Q&A

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