Automotive Warranty Data Analysis on the Worldwide Web

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ABSTRACT

Trillium Teamologies assembled a team possessing SAS and Java expertise to create a warranty analysis web application for an automotive OEM. This paper discusses development strategies considered in building the application, including architectural and security considerations. Criteria are provided for deciding among client load models that range from thin (webAF model) through integrated object (Enterprise Guide model) to full client (SAS/AF model) approaches. This paper includes some of the development considerations and decisions made in web-enabling an enterprise wide application:

- choice of web technology (CGI v. Java)
- applet v. servlet methodology
- development environment (AppDevStudio® v. Forte)
- populating list box controls (on-demand access v. server page caching)
- processing large tasks through a batch queue facility
- using ODS to deliver reports in .pdf form

Choice of model is dependent on cost, complexity, control, and response time requirements.

INTRODUCTION

The automotive industry spends billions of dollars to cover warranty claims each year. Analysis of repair claims is key to improvement in vehicle design, production, maintenance, and image. Reliability is associated with warranty history and directly impacts the market value of new cars sold, lease residual values, and used car values. Quality, reliability, and durability indices are the data mining gems of warranty analysis. Automotive companies strive to improve these indicators, which impact both sales and profitability.

A leading automotive manufacturer had developed a warranty analysis system called QWIK (Quality With Information and Knowledge) as a SAS/AF client server application. This system provides quality control, reliability, and durability feedback to both internal (OEM) and supplier audiences. QWIK analysis serves as a basis for allocating financial incentives to suppliers who meet and exceed quality standards set by the OEM. Likewise, the analysis of this data provides serves as one basis for risk-sharing between the OEM and the supplier community.

The OEM selected Trillium Teamologies (TTI) to develop QWIK Web, a web version of the QWIK full client product. QWIK Web is designed to reduce client-side software licensing costs, simplify report production, and re-use existing code.

Now available are QWIK (as a fully featured client/server application), QWIK Web (as a thin client subset of QWIK), and Enterprise Guide (for freestyle reporting against the data). To meet the customer's requirements, the team was confronted with a number of decisions concerning methodology, design, and choice of development toolsets. This paper offers a simple set of criteria in helping make such decisions, and a discussion of how other business requirements were met.

SOFTWARE REQUIREMENTS


The full-client edition of QWIK has fifty SAS/AF Frames containing 450 form elements. There are about 50,000 lines of SAS code that split execution cycles between client and server. The new QWIK Web application serves up fifteen pages containing 225 form elements. There are about 26,000 lines of Java, JSP, HTML, and SAS code that execute on web and application servers.

ARCHITECTURE

QWIK (full client) and QWIK Web (thin client) share the same application server and data sources. The full client interface is supplied by SAS/AF Frame entries, while the thin client interface consists of a browser that displays HTML pages sent by the web server.

The web server houses QWIK Web classes, JavaServer Pages, form design elements, and style sheets. The application server houses SAS programs, reference tables, and production files.

SECURITY

The OEM Intranet does not operate like the typical Internet environment. Communication for authentication is unidirectional, and the messages sent are "Dead on Arrival". This causes authentication problems. In addition, when the application server...
requires a user to change password, there is no way to read a request sent by the telnet session on the Unix server. Lightweight Directory Access Protocol (LDAP) was chosen to overcome the inherent limitations of server communication in the customer's environment.

The LDAP server sits on top of the web server application folder, requesting login before access to the directory. The LDAP server has several scripts to allow the user to modify the password, reset the password after the expiration period and allow only one user to have a single instance of the web application running.

Using the LDAP approach, the customer's requirements for security were met.

**DESIGN CHOICES**

A number of design and development choices are required in the course of building a product. Following are some of the design choices made in building QWIK Web.

**Web Technology (CGI v. Java)**

Java technology offers multi-threaded access, high security, and persistent connection with a single image of SAS on the application server. These features supported choice of webAF over CGI-based SAS/InterNet as development framework.

**Applet v. Servlet Methodology**

JavaServer Page, Java servlet, and JavaScript technology was selected over Java applets. Server side advantages include ease of maintenance, platform independence, security deployment, minimal impact on client resources, and consistency with industry trends in development preference.

**IDE (AppDevStudio v. Forte)**

AppDevStudio 2.02 continues to evolve as an Interactive Development Environment tool. Sun Forte 3.0 represents a more robust tool for the Java developer. Both are useful in their own way.

**Populating Controls (cache v. read)**

QWIK Web controls, and list boxes in particular, draw from several dozen SAS data sets that reside on the application server. To maximize performance, it was decided to cache selection alternatives in a class on the web server. There are now only three occasions where an application server data set must be addressed during session.

**Queuing Execution Intensive Tasks**

One of the most significant features of the QWIK full client edition that has been replicated in QWIK Web is the batch facility. Web users are accustomed to sub-second response time, yet applications that work against large files using complex logical operations take more than a second to complete process. The batch queue facility conditions customers to the prospect of a longer wait, yet frees up time to submit other requests or go on to other tasks as the job submitted works its way to completion.

**Presentation of Results**

Finally, trial and error taught us that some forms of presentation through a browser are better than others. After repeated attempts to encapsulate heavily annotated SAS/GRAPH output in HTML as *.gif and *.jpg files, we discovered that Adobe Acrobat Reader 5.0 (*pdf) provides an excellent Output Delivery System (ODS) target.

**QWIK WEB OPERATION**

QWIK Web guides the warranty analyst through two distinct phases. The first phase involves selection of vehicle, claim, and report attributes that may be stored in a filter under the user's ID. The second phase consists of queuing the request, processing millions of rows, and delivering results. The following image depicts selection of vehicle attributes.

Other pages provide for selection of issues, choice of report type, review of current criteria, submission of a request to the application server, retrieval of results, and administrative functions.

No request to process is granted until all required information has been supplied. There is extensive error handling associated with the process of defining a QWIK Web report. JavaScript is the primary tool used in trapping errors at the form element level, while JSP code handles errors that occur within and across pages.

Selections are stored in a Java Bean. The act of submitting a request is that point where Java data structures on the web server transfer content to SAS data structures on the application server. A batch record is created, and the user's personal queue is displayed. The "Batch Retrieval" page is the user's link to report product.

Once processing completes, a report can be retrieved and then printed or exported using Adobe Acrobat Reader 5.0.
Report options include a top issue chart, control charts, reports on claim incidence and cost by category, and detail listings that drill down to specific vehicles and associated claims.

JAVA GLOSSARY

Java uses the `package.class.method(parameters)` statement style. This syntax is common in object oriented languages like SAS, C++, C#, VB.NET, Eiffel, and Smalltalk. Any new object is defined as an instance of a class in the Java class hierarchy. Each new class inherits the attributes and behaviors of its parent, and can subsequently be modified to suit a particular purpose. Classes reside in packages that must be identified at the top of each Java program. Here are definitions for a few of the many web development constructs.

HTTP: HyperText Transfer Protocol v 1.1 is a request-response protocol consisting of a request method (e.g., GET, POST), a URI, header fields, and a body. HTTP Servlets written in Java manage state (sessions) on top of stateless HTTP, process data submitted by an HTML form, and provide dynamic content to the user through a browser.

HTML: HyperText Markup Language v 4.0 is the publishing language of the World Wide Web. HTML provides for publication of text, media, hyperlinks, scripting languages, style sheets, and printing facilities.


Servlet: Java Servlets v 2.2 are modules developed by a programmer that run in a server application to answer client requests. Servlets make use of the Java packages "javax.servlet" and "javax.servlet.http".

JSP: JavaServer Pages v 1.1 technology is an extension of servlet methods. The JSP combines static HTML templates with code for generating dynamic content.

Java Classes: In object oriented design, a class is the set of all programming objects that share common attributes and behaviors. Methods are program behaviors that act upon objects. A character variable is an instance of a class, while a trim operation on this variable's value would exemplify use of a method on the object.

JavaScript: JavaScript is an interpreted language that serves to extend HTML by handling events on the client side. Error trapping, messaging, and dialogs are often implemented in JavaScript.

RMI: Java Remote Method Invocation enables the programmer to create distributed applications in which the methods of remote Java objects can be invoked from other Java virtual machines, possibly on different hosts.

ROCF: The SAS Remote Object Class Factory is the entity which, given a connection and an interface to a model, creates the remote object and returns a handle to the remote object back to the viewer. For example, ROCF can serve as interface between a model SCL object on the application server and a Java object on the web server. Remote objects can be used, via the model interface, just like any other Java object. Client side Java objects include applets, servlets, Java beans, and JavaServer Pages.

JAVA CODE

QWIK Web application flow consists of:

- starting the application
- caching form element values
- providing for selection of values
- error handling
- processing and storing selections
- sending selections to the application server
- producing a report

"Model Year" is among the vehicle attributes required for a report to run. The following code fragments trace the life of "Model Year" as a list box selectable item.

```java
QWIK Common Web application classes extend Java and SASServlet classes. These are stored in the "tt" package. All .java files are compiled into "class files, and are made available to one another by "import" statements in Java programs and "include" directives in JSP programs.

StartServlet.java initiates population of application controls

```
private com.sas.collection.StringCollection staticModelYearValues;
private com.sas.collection.StringCollection staticModelYearDescriptions;

try{
dataSet.setDataSet(TABLE_MODEL_YEAR);
dataSet.setDisplayedColumns(new String[]{"llvinyr","IImodelyr"});
  iTotalNumberOfRows=dataSet.getRowCount();
  codes=new String[iTotalNumberOfRows];
  values=new String[iTotalNumberOfRows];
  for (iCurrentRow=0;
iCurrentRow<iTotalNumberOfRows;
iCurrentRow++) {
    values[iCurrentRow]=(String)dataSet.getCell(iCurrentRow+1,1).toString().trim();
    descriptions[iCurrentRow]=(String)dataSet.getCell(iCurrentRow+1,2).toString().trim();
  }
  staticModelYearValues=new com.sas.collection.StringCollection(values);
  staticModelYearDescriptions=new com.sas.collection.StringCollection(descriptions);
}

QWIKUserOptions.java stores user selections in Java collections.

QWIKUserOptions.java is the central event processing module of
the application. The following method (getModelYear) uses the
SAS ListBox interface method for storing selected Model Year
codes and associated descriptions.

public com.sas.servlet.beans.ListBoxInterface
getModelYear(){
  return new com.sas.servlet.beans.ListBoxInterface()
  (staticModelYearValues.toStringArray());
}

Another QWIKUserOptions public method gets up to the minute
user selections stored in the user bean.

// Public GET method
public com.sas.servlet.beans.StringCollection
getModelYearData(HttpServletRequest request){
  return userBean.collModelYear;
}
with each maintenance release.
solutions provide a structured environment for the user.
the most robust, but require distribution of client side modules
Enterprise Guide is very user friendly, but requires a relatively
reporting process.
Minimize user training and support:
Minimize development cost:
Minimize No Yes No
Minimize response Yes Yes Yes
Standardize Yes No Yes
Requirements webAF for processing
CHOICE OF MODEL
QWIK Web, Enterprise Guide, and QWIK form a continuum from
thin through integrated object to full client technologies. Choice
of technology depends on requirements. We suggest use of the
following table in considering these options.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Build with webAF</th>
<th>Use Enterprise Guide</th>
<th>Build with SAS/AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize development cost</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Minimize maintenance cost</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Minimize user training and support</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Standardize reporting</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Minimize response time</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Minimize development cost: Commercial off the shelf software
(COTS) is often preferred over custom development. If you don't
have a budget for software development, then Enterprise Guide
is a great tool for communicating with a Version 8 SAS Server.
However, if you have very specific requirements that cannot be
addressed by a reporting tool, then development could proceed
using webAF for a web based solution, or SAS/AF as a client
server solution.

Minimize maintenance cost: The only maintenance required of a
COTS product is upgrading to newer releases. webAF represents
somewhat lower maintenance cost because most changes occur only on the server side. SAS/AF solutions can be
the most robust, but require distribution of client side modules
with each maintenance release.

Minimize user training and support: Both web and client server
solutions provide a structured environment for the user.
Enterprise Guide is very user friendly, but requires a relatively
sophisticated audience. Opportunity for error is often greater
when there is greater flexibility in defining elements of the
reporting process.

Standardize reporting: Since the automotive OEM is sharing risk
and reward with the supplier community on the basis of QWIK
Web reports, it is essential that both parties have an opportunity
to replicate findings without resorting to code review. Structured
applications provide uniformity in results, all other things being
equal.

Minimize response time: All three models offer efficient means
of responding, whether target data reside in SAS data sets or
data base tables on the server. QWIK and QWIK Web feature a
batch queue facility that sets appropriate expectations regarding
time to completion for tasks that are more resource (CPU and
I/O) intensive.

Casual users benefit most from a webAF based solution. The
Enterprise Guide solution is good for the slightly more
adventurous analyst. And a full client solution based on the
SAS/AF model provides for both structured interaction with an
application, and free form exploration on the client side with
subsets drawn down from the server.

CONCLUSION
Providing web access to corporate data in a securely managed
environment is the direction that all companies are exploring
today. Web enabled applications are platform independent,
providing access to many more users than the full client
alternative. The user need only have a web browser to access a
complex analytical production application that provides summary
and decision support feedback based on user selections. It
demonstrates that a SAS based application can be distributed
over the web, without losing significant functionality. Further, it
represents a cost-effective solution to the problem of sharing
corporate data with suppliers while maintaining security.

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