The FileMaker Web Store

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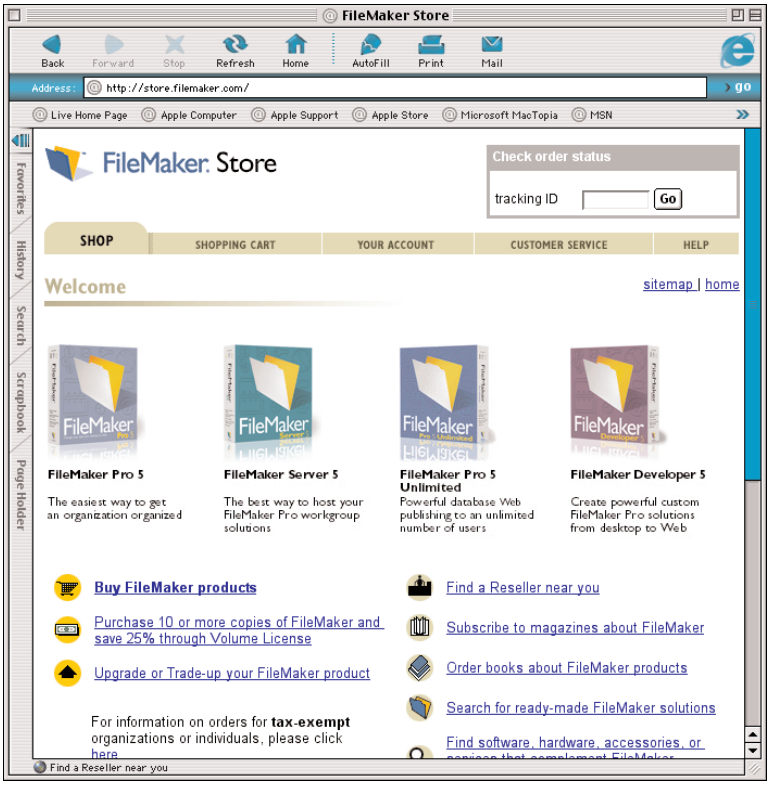

FileMaker

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In September, 2000 FileMaker, Inc. launched a web site to sell its software products online. The site was developed using FileMaker, Inc's own software line. This document details the process and tools used in developing the FileMaker Web Store.

Introduction

FileMaker Inc.'s own online store was developed using an aggregate of FileMaker database products, industry standard technologies (Java, XML, XSL, HTML, JavaScript, etc,) and Apache web server. The web store system was successfully integrated with a credit card clearing house and an Enterprise Resource Planning (ERP) system called SAP. Because FileMaker Inc. develops products for both Microsoft Windows and Macintosh platforms, a FileMaker Pro Database RAIC (Redundant Array of Inexpensive Computers) was set up in a heterogeneous client server environment using both Mac and Microsoft Windows machines. This white paper explains the FileMaker Inc. web store design, development, and the technologies used for its achievement.

E-commerce applications are transactional systems that are by nature complicated. The challenges in implementing an e-commerce based transactional system include: load balancing, scalability, fault tolerance, security, and data validation. The web interface to a transactional system not only demands the reinforcement of the traditional transactional system design methodologies, but also increases the requirements. For example, the diversity of audiences accessing the system globally over the Web requires the system architects to consider localization capabilities. Web access also creates new threats to security and calls for enhanced security. State and session management also need to be developed, as HTTP is a stateless protocol. The need to integrate/interface with the external systems like the credit card clearing house, ERP system, CRM(customer resource management) is greater than ever before.

Finally, the proliferation of new technologies related to web development makes it very hard to make decisions when developing an e-commerce system. All these challenges made the FileMaker web store development a fun learning project.

It is important to mention that beside the web server and servlet engine, the entire web store system was developed on top of a FileMaker pro database using industry standard technologies rather than proprietary e-commerce products and technologies. No application server products were used; instead, an application server was developed at FileMaker Inc. using Java.

SECTION #1

FileMaker Web Store system and technology architecture

FileMaker Web Store System and Technology Architecture

FileMaker Web Store has a five tier Architecture. Figure 1 (page 6) shows the architecture and the technologies that are related to a particular tier of FileMaker Web Store. In this section we will take a detailed look at each tier and discuss technologies that are involved at each stage.

The first tier in the architecture is the client's web browser. The second tier is the web server and the servlet engine. The third tier is the application server that was developed for this project. The fourth tier uses FileMaker Pro 5 Unlimited to create a RAIC on top of the fifth tier which is FileMaker Server 5. The following table shows all the technologies and programming languages used to develop the FileMaker Web Store.

Technology and Programming Languages Used	
Java	Sun Micro Systems developed programming language
GCC	GNU C Compiler
PERL	Interpreted Language developed by Larry Wall
ABAP	Advanced Business Application Programming (Developed by SAP)
HTTP	Hyper Text Transfer Protocol
HTTPS	Secure Hyper Text Transfer Protocol
HTML	Hyper Text Transfer Markup Language
CSS	Cascading Style Sheets
JavaScript	Initially developed by Netscape
WML	Wireless Markup Language
XSL	Extensible Style Sheet
XML	Extended Markup Language
DHTML	Dynamic Hyper Text Transfer Markup Language
JDBC	Java Database Connectivity
Servlet	Servlet Technology Using Java Developed by Sun Microsystems
PGP	Pretty Good Privacy
ScriptMaker	Proprietary scripting tool built into the FileMaker Pro Product

Table 1

Now we will examine each tier in detail covering the technology, products, features and the reason for certain technology selection and other decisions made during the development of the FileMaker Web Store. We will start with the last tier which uses FileMaker Server.

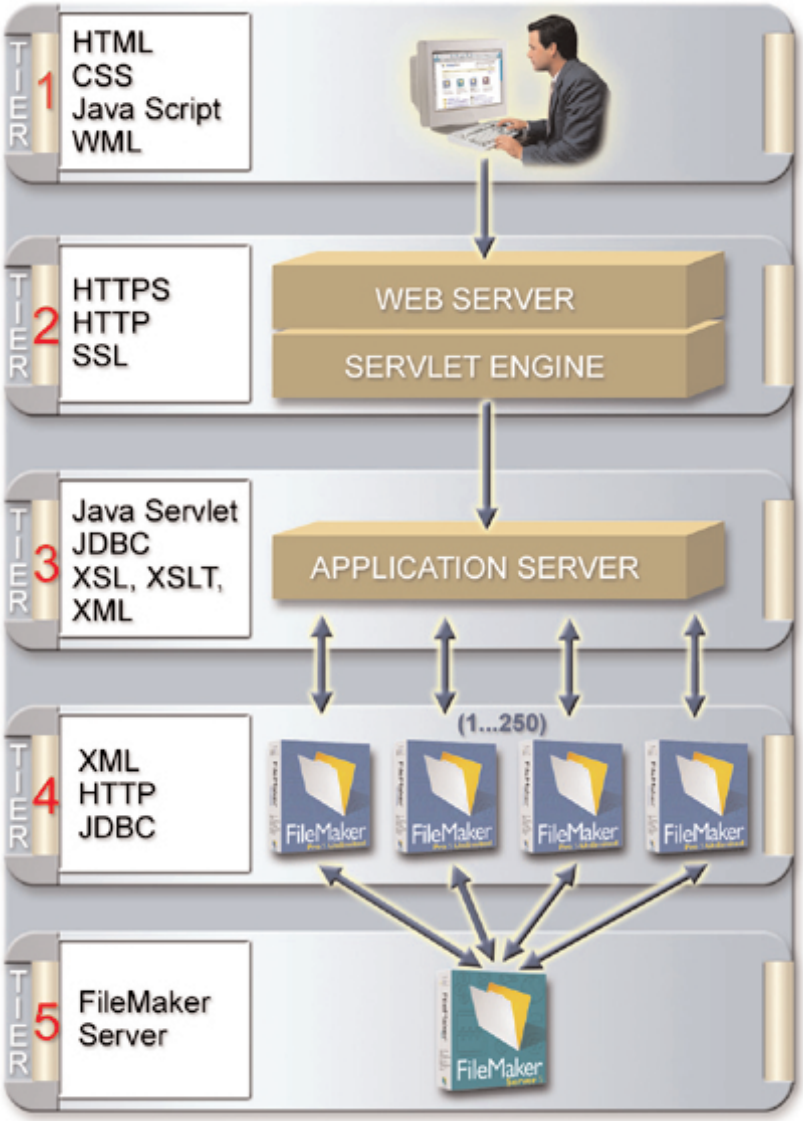
TIER 1
HTML
CSS
Java Script
WML
TIER 2
HTTPS
HTTP
SSL
WEB SERVER
SERVLET ENGINE
TIER 3
Java Servlet
JDBC
XSL, XSLT,
XML
APPLICATION SERVER
(1...250)
TIER 4
XML
HTTP
JDBC
FileMaker
TIER 5
FileMaker
Server

FIGURE 1

FileMaker Server

FileMaker Server 5 was used to store all the information related to products (pricing, sku, descriptions, etc), orders, and customer information. FileMaker Server 5 can have up to 250 simultaneous users connected to it which enabled us to configure a RAIC using FileMaker Pro 5 Unlimited and FileMaker Server 5, as shown in Figure 1.

❑ *Relational Architecture*

A relational database was designed using relational database principles to implement a transactional order taking system.

❑ *Controller Box*

A copy of FileMaker Pro 5 which is not part of the RAIC is also used for post order processing and to generate reports, run scripts that generate emails related to order and shipment confirmation, and to monitor the different activities related to external system interfaces with the FileMaker Web Store. Also, this copy of FileMaker Pro 5 is used to create an archiving system that is used by customer service to help customers with their questions and for other authorized staff to gather statistics or check order activities. The purpose of using a separate copy of FileMaker Pro is that while it is generating reports or running different scripts, the users on the Web Store do not have to wait. Because FileMaker Server can have 250 clients connected simultaneously it works out very well.

FileMaker Pro 5 Unlimited

FileMaker Pro Unlimited is a powerful Internet/intranet enabled database product. FileMaker Pro 5 Unlimited allows an unlimited number of web user connections. Since we are using an application server as a middleware layer between the web server and the databases, the license prohibits the use of FileMaker Pro 5, therefore we recommend using FileMaker Pro 5 Unlimited. Among other things, three features of FileMaker Pro 5 Unlimited made it really useful which are as follows: Web Companion, XML, and JDBC.

❑ *Web Companion*

The Web Companion is a plug-in component of FileMaker Pro which has a built-in HTTP server. It uses its own CGI (common gateway interface) called FMPro-CGI to request data or submit data to or from FileMaker Pro databases. Web Companion is the key to requesting data from FileMaker in XML format or accessing FileMaker to insert/delete/update records using JDBC. JDBC is Sun Microsystems implementation of Java database connectivity.

❑ *XML(Extended Markup Language)*

Another powerful feature of FileMaker Pro 5 is the XML document generation from the data collected from the FileMaker Server database based on a search criteria. FMPro-CGI commands can be used to request data in XML format from the FileMaker databases using HTTP protocol. Because FileMaker Pro 5 Unlimited generates the document, it puts limited load on the server which is able to quickly fulfill the simultaneous requests that it is receiving.

FileMaker Pro 5 Unlimited - continued

- *JDBC*

  FileMaker Pro 5, FileMaker Pro 5 Unlimited, and FileMaker Developer 5 are all JDBC compliant which helped tremendously in the development of the web store. Along with FMPro-CGI, JDBC is used by the application server and other servlets written for the web store.

FileMaker Pro 5 Unlimited is multi-platform and works seamlessly on Mac and Microsoft Windows platforms. A RAIC was set up using several copies of FileMaker Pro 5 Unlimited communicating with FileMaker Server 5. FileMaker Pro 5 was installed on both Microsoft Windows and Macintosh platforms. The RAIC provides scalability, redundancy and fault tolerance, as well as performance enhancements.

Application Server

An application server was developed at FileMaker to be used as middleware to facilitate the communication between the client's browser and the host databases while providing the following capabilities:

- *State and Session Management*

  In a web transactional system it is very important to manage the state and the session of the user. To understand how the application server manages the state and session, it is vital to understand the basics of HTTP, which is used to communicate between the client's web browser and the web server that is connected to the backend systems.

  HTTP is a stateless protocol, which means that it doesn't remember the client once it sends a response back to the client's request. In other words, there is no way of identifying the client in an interactive set of transactions which is essential for e-commerce systems. This poses a significant problem for a web transactional system.

  For example, let's examine a common scenario in an e-commerce system. When a customer sends a request via web browser to add something to the shopping cart, the browser sends the request to the server which forwards it to the backend system. The backend system then adds the item to the shopping cart and then sends a response back to the client via web server to web browser. At this point, the HTTP closes the connection that it had between the browser and the web server. The next time the same user performs another operation, the system will not remember who the client is if the request is solely based on the HTTP based web browser and the server.

  To make matters worse, suppose several users access the web store and they all request to add something to the shopping cart and then ask to add another item. How will the web store remember which client is which?

Application Server - continued

❑ *State and Session Management - continued:*

To help solve this problem, the application server developed for the web store provides state and session management capabilities using the Java servlets API for session management.

❑ *Platform Independence and Portability*

One of the biggest advantages of using Java is that it is platform independent and portable to many platforms with little effort. Everyone in the software industry knows how expensive and tedious porting the software to different platforms can get.

The application server used for the FileMaker Web Store is written completely in Java, which makes it platform independent. The application server can run on any platform that can run a Java virtual machine, a web server, and a servlet engine. For example, NT, MacOS X, Linux, and Solaris are some of the operating systems that can be used to run this application server. In fact, the development of the application server was done on NT, but code was deployed on a Unix platform without making any changes.

❑ *Performance / Multithreading*

One of the biggest problems with all CGI-based applications is that every time the CGI is called, a new process is started. On the other hand, Java servlets use the multithreading capabilities of the Java programming language and the operating system on which the servlet is running on. When the servlet engine is started, and the servlet is called, a new process is initiated, which remains alive as long as the servlet and the servlet engine keeps running, which could be months. Every time a request comes to the servlet, a new thread is created to process the request and send back a response to the client.

The application server developed for the FileMaker Web Store utilizes the multithreading capabilities of both Java programming language and the operating systems. The number of active threads can be configured in the application server. This is an important and powerful feature when using a RAIC of databases to gain performance and build fault tolerance in the system.

❑ *Load Balancing, Scalability, and Fault Tolerance*

Several copies of FileMaker Pro 5 Unlimited were configured in a RAIC for the web store which provides scalability and enhances performance by providing load balancing capabilities. This is where the ability to configure the number of threads on the application server comes in very handy. The more machines we add the greater number of threads we can configure the application server to provide. The application server uses a round robin scheme to route all the requests from the web server to the database, thus building the fault tolerance capabilities in the system. If one machine goes down in the RAIC, the server will send the request to another machine. Also, adding and removing machines from the RAIC is intuitive and easy to maintain. The RAIC machines can be added or removed without ever having to start the application server.

APPLICATION SERVER - continued

❑ *SECURITY*

The application server provides an additional layer of security for the databases. The client never sees the names of databases or layouts used to query the data. The query string that the application server passes to the database for retrieving the data is also hidden from the user. For example, as shown in Figure 2, when a user adds a product to the shopping cart, all they see is the following URL: http://store.filemaker.com/servlet/WebStore

FIGURE 2

"WebStore" is the alias for the application server servlet developed for the FileMaker Web Store. Notice, no database names, query strings, layout names, or any information regarding the data storage are displayed in the URL.

Since the application server is also responsible for state and session management, it also ensures that the users don't see each others' data by synchronizing the authorized user to only the relevant data.

❑ *DATA QUERY AND XML DATA TRANSFORMATION USING XSL AND XSLT*

FileMaker products can return an XML document, but the question is how do you present this XML data to a web browser or pervasive devices like the Palm Pilot, smart phones, etc? This is where XSL comes into play.

XSL is a declarative programming language. XSL is used for both transforming and formatting an XML document. In fact, the biggest advantage of using XSL is that it gives the ability to separate the presentation from the content.

FIGURE 3

❑ *DATA QUERY AND XML DATA TRANSFORMATION USING XSL AND XSLT - continued*

XSL is divided into two different parts which are called XSLT and XSL FO. XSLT is used to transform a document into different formats. As shown in Figure 3, one XML document can be presented in several different formats using XSLT:

- *XML to HTML*
  An XML document could be transformed into HTML to present it to a web browser. The data could also be localized into different languages before presenting.

- *XML to WML*
  The same XML document could also be transformed into WML format to present it to a wireless device that has WML browser running on it.

- *XML to XML*
  XSL can also be used to convert one XML format to another. For example, to exchange the XML document between FileMaker and SAP or any other system that understands some format of XML, an XML document generated from FileMaker can be transformed to an XML format that is required by SAP.

XSL FO (formatting Objects) is used to present the data the same way as CSS(Cascading Style Sheet) is used. Some of the other advantages of XSL include the ability to parse and perform logic checks and perform calculations using the data provided by the XML document.

For the FileMaker Web Store, only XSLT was used not XSL FO. Instead of XSL FO, CSS was used because most browsers at this point only understand CSS.

Apache Web Server / Servlet Engine

HTTP and HTTPS based Apache web server was used for the web store. HTTPS uses the SSL (secure socket layer) to provide the security. SSL encrypts all the communication that is conducted between the client's browser and the web store. A servlet engine was also configured to run all the servlets including the application server servlet. The servlet engine provides the ability to run the servlets with the web server.

Client's Web Browser

This is the last tier in the FileMaker Web Store system. In this tier, the client's browser utilizes the presentation technologies such as, CSS, HTML, DHTML, and JavaScript to show the content to the user. JavaScript was also used for data validation on the client side.

SECTION #2

EXTERNAL INTERFACES AND OTHER DESIGN CONSIDERATIONS

External Interfaces and Other Design Considerations:

❑ *Network Design For FileMaker Web Store*

Since this is a distributed application with special security needs, a separate network was designed using the layer three switching technologies to provide fast and secure communication between the different components.

❑ *Firewalls and Security*

Security is one of the most important requirements for any e-commerce system. As mentioned earlier in the Application Server Security section, names of the databases, layouts, and field names used for the FileMaker Web Store are all invisible to the web customer. Some sites hide this information using the Post method instead of Get, but the disadvantage of that is someone can still see the source code for the HTML page and figure out the names. For the FileMaker Web Store, all the data is hidden from the web pages, and even if the person looks inside the web pages source code, nothing is revealed from the HTML pages.

Firewalls are also essential for developing an e-commerce system. Multiple firewalls were placed to secure the Web Store data. Also, credit card numbers are not stored on the server.

The FileMaker Web Store was successfully integrated with some of the following external systems:

❑ *LinkShare*

LinkShare is an affiliate co-marketing program. Participants of this program put a banner ad on their web site displaying FileMaker products. When a visitor on the participant's web site clicks the banner ad, the visitor is referred to the FileMaker web site. If this particular visitor creates an order, the participant of the LinkShare program gets a check for referral. This system was successfully integrated with the FileMaker Web Store.

❑ *SAP ERP System*

The SAP ERP system provides financial, sales and distribution, and logistics capabilities to an enterprise. FileMaker Web Store was successfully integrated with SAP.

❑ *Credit Card Clearing House*

A credit card clearing house was successfully integrated with the FileMaker Web Store. Both real time and non real time capabilities were developed regarding the credit card clearing house.

Conclusion:

The FileMaker Web Store was developed using industry standard technologies. An application server was developed using Java and Java servlets technology. The application server provides capabilities like state and session management, security, multi-threading and performance enhancement to the entire system, the ability to control the scalability to match the number of machines used in the RAIC, load balancing, fault tolerance, and XSL Transformation of XML documents. The FileMaker Web Store was successfully integrated with external systems like the SAP ERP system and a credit card clearing house. The FileMaker Web Store also showcases the capabilities of the FileMaker product line. FileMaker Pro databases are capable of generating XML documents and are compliant with industry standards like JDBC. XSLT also played a key role in presenting the XML data on the web store. XSLT was used to transform the XML into HTML format. DHTML and JavaScript were also used for the web store. The FileMaker Web Store is an existing example of how standard technologies can be integrated with FileMaker products to produce outstanding solutions.