

A WEB-ENABLED MOBILE AGENT PLATFORM FOR E-COMMERCE AND M-COMMERCE

“The Havana Platform”

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Keywords: E-commerce, m-commerce, mobile agents, web agents, agent business model

Abstract: A side effect to our increasingly information-driven economy and lifestyle is the annoyance and headaches of information overload. Everywhere we go, we are bombarded by email, spam, online advertisements, beepers beeping, cell phones ringing, and incoming SMS messages. The wealth of information available at our fingertips online is both a blessing and a curse in disguise. This paper presents the Havana mobile agent platform, which can be integrated with the existing Web infrastructure, designed to be used for e-commerce and m-commerce applications. The platform features some unique characteristics such as its business model where all participants are locked in business contracts. With the aid of user location information, mobile agents are deployed to engage in the process of wading through the mountains of information online in order to comparison shop on behalf of the user while filtering out irrelevant information.

1 INTRODUCTION

In this consumerist world that we all live in, ourselves, as consumers, are constantly being bombarded with advertisements anywhere we look: on TV, on the radio, in magazines, on billboards etc. This situation is best summarized by Ranganathan and Campbell (Ranganathan and Campbell, 2002), as they point out, “[c]ompanies constantly struggle to find the best advertising strategies to promote their goods and services. They need to be able to reach the segment of population that is potentially interested in their products. They need to deliver the advertisement in an appropriate manner that will ‘stick’ in the users’ minds. They need to make sure that the products and services they advertise are those that meet the user’s needs. And they also need to ensure that their advertising does not annoy anybody, since that could result in a negative impact”.

In this paper, we will discuss the idea behind our novel mobile agent system that tries to automate the process that a user engages in when comparison-shopping. The contribution of this paper will be a business-driven mobile agent platform and a proof-of-concept regarding the use of mobile agents in the e-commerce and m-commerce world.

The rest of this paper is organized as follows. Section 2 discusses comparison shopping difficulties in wired and wireless environments. Section 3 presents a revolutionary business model for mobile agents. The system architecture of the Havana platform is discussed in Section 4. Security features are discussed in Section 5. Finally concluding remarks and future work are discussed in Section 6.

2 COMPARISON SHOPPING

Despite the proliferation of e-commerce nowadays, the current searching process that a user undergoes leaves much to be desired. With the use of bigger screens and more efficient user input devices, even the most patient amongst the desktop computer users soon become frustrated when trying to go through the current tedious process of comparison shopping on the Internet. The current process entails first finding out a list of online retailers through some sort of online directory service, and logging in turn into each of their websites sequentially, and manually searching for the desired products and noting their prices and repeating for each subsequent retailers. All at the same time, the user will need to mentally discard much of the irrelevant information and bogus websites that she is bound to run into. In

addition, the whole process provides little to none customization based on the locale of the user. The process leaves much to be desired.

Here, we wish to use the same system that we are building to assist mobile users to also help wired users in their quest for good online deals. To demonstrate the ability of mobile agents to act on the behalf of their users in an e-commerce setting to complete tedious tasks and to filter out irrelevant information, we provide an agent business model.

2.1 Comparison Shopping in the Wireless Environment

In this age, we are witnessing PDAs and cell phones that are slowly rivalling the capabilities of that of a desktop. However, accessing the Internet using these tiny devices is a fundamentally different experience from that of doing the same on a desktop.

The small sizes of the devices inevitably limit the size of their screens and input keys. Along with the lower CPU power, lower memory capacity and slower and less reliable network connections associated with these devices greatly reduces the usability of these devices, and presents tough challenges for software designers. Generally, users that are accessing the Internet from wireless devices are on-the-go, more hurried, less likely to be using the device while sitting, and more likely to be inputting data using one only hand (Kamba et al, 1996). Picture the frustration a user must feel if she wants to compare the prices of a CD in 10 different online stores by punching the same CD information on the cell phone again and again single-handedly while walking through a crowd! A mobile user's need for direct access to information with minimal browsing and minimal user input is what prompts us to investigate in using mobile agents to perform information filtering and retrieval in an m-commerce setting.

3 MOBILE AGENTS

Mobile agents represent a new paradigm in distributed systems programming wherein a thread of program execution can be transported from one host to another amidst execution. It is a markedly different approach to distributed computing when compared to the traditional client-server approach. When the time comes for a mobile agent to move from one host to another, the program state is marshalled, and sent over the network to the other machine. Over on the other machine, the exact opposite happens where the program state is

unmarshalled, and program execution resumes on this new host (Lange and Oshima, 1998).

3.1 Business Model

We propose a revolutionary business model in the E-and M-commerce world where mobile agents are sent out from a gateway server that visits a list of retailers in turn to lessen the workload on the shopper. In this novel system, the gateway will be run by a wireless voice/data service provider and will enter into business contracts with retailers that require each party to hold up their end of the bargain. Retailers will agree to install the necessary server components to allow mobile agents from the gateway to run on their websites; and in return, the gateway agrees to let each retailer insert one piece of advertisement to be incorporated as part of the mobile agent's search results.

The newly formed business relationships between the gateway and the retailers will be mutually benefiting. The retailers benefit by getting exposure to more potential consumers currently in the market to buy products that they have to offer. By looking at the type of merchandises that the user is interested in buying and the user's current location, the retailer can now adopt target marketing instead of serendipitous marketing, which is more effective (Jagoe, 2002). For example, if the mobile agent representing the user is looking for the price of a specific Harry Potter book, the retailer's Promotion Agent can now run through a database of ongoing promotions or advertisements that might interest the user the most. For instance, it might be able to tell the user of the store's highly relevant ongoing promotion of getting two Harry Potter books for the price of one, thus allowing the retailer to send the right message to the right people at the right time.

Looking at the customer's point of view, location-aware comparison shopping service is a value-added service that allows the customer to shop at many stores with minimal work. In addition, the chance that the customer will see promotions that actually interests her is much heightened. Reusing the above example, it is likely that she will be very interested in the two-for-one sales promotion on all Harry Potter books from one of the retailers. Because the advertisements are now relevant to the customer's needs, the customer will be more interested in them and check them out.

From the gateway's point of view, by offering its users the convenience of location-aware comparison shopping via mobile agents, it will reap the benefits outlined by Kolmel and Alexakis (Kolmel and Alexakis, 2002) in their analysis of the business model of location-based services. In particular,

location-based advertising is a promising value-added service that offers multiple advantages to the gateway: (1) Value-added service attracts new customers and enhances existing customer's loyalty; (2) Increased revenue due to additional wireless network traffic generated by the use of such services; and (3) Potential to further increase revenue by selling to other companies user location information.

4 THE HAVANA MOBILE AGENT PLATFORM

We propose a novel architecture to deploy mobile agents on the wired and the wireless Internet. In this proposed system, users wanting to comparison shop for merchandises log onto our system, the gateway, where they can configure and dispatch mobile agents that act as comparison shopping agents, looking through retailers with an Internet presence that carry their desired products. The shopping agents will be searching not only the various online retailers, but also websites representing physical stores located near the user's current location.

4.1 System Architecture

The design of the system is separated into three main entities: client for the end-users, the gateway, the Yellow Pages Server and the agents-enabled web servers as illustrated in Figure 1. The implementation is done in Java (Gosling et al, 1996). In the following sections we will look at the design of each of these entities.

4.2 Clients for the End-Users

For wired users, the interface to our system is web-based. The user interacts with the mobile comparison shopping agents through accessing our gateway using any off-the-shelf web browser.

On the other hand, while the functionality of our system to the wireless user is the same, the way through which the content is laid out is quite different due to the smaller screen size and more awkward modes of data entry. To work around such limitations, we use a menu driven interface where the user can use the up and down cursor keys on a cell phone or PDA as the means of navigation. To build an interface as such, we have chosen to deploy our own custom J2ME MIDlet (Sun Microsystems, 2002).

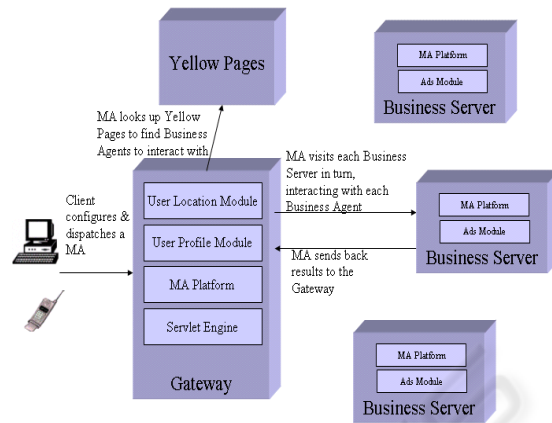


Figure 1: Havana System Architecture

4.3 The Gateway

The gateway lies in the heart of the whole system. It dispatches and retrieves mobile agents and acts as a bridge providing the end-users of the system with indirect control over the mobile agents that act in their behalf.

One of the benefits to the user regarding accessing mobile agents through a gateway is that it saves the user from the headaches of software installs and updates. Using a gateway, software installs and upgrades are localized to the gateway.

There are various components lying within the gateway – the Servlet Engine, the Mobile Agent Platform, the User Location module, and User Profile module, all of which are discussed here.

4.3.1 The Servlet Engine Component

The Servlet Engine is responsible for handling all user interaction. Every user interaction ranging from the initial login, to the creation or updating of the shopping list, to the viewing of the search results, to the final processing of the <<Buy It Now>> request is handled by the Servlet Engine.

4.3.2 The Gateway Mobile Agent Platform

The Gateway Mobile Agent Platform creates, dispatches and receives mobile agents. During the creation of mobile agents, configuration data is gathered from the end user, which is then submitted to the Servlet Engine. The Servlet Engine passes the parameters to the Gateway Mobile Agent Platform, requesting that a mobile agent be created in the configuration as requested by the user. Once a mobile agent is created, it will request its list of itineraries from the Yellow Pages server.

Agent transportation is provided by Java's built-in RMI and Serialization facilities (Sun Microsystems, 1999). Once it has a list of itineraries, it can start its execution and will travel to each of the destinations in turn.

When it has exhausted its list of destinations to visit, it will travel back to the Gateway Mobile Agent Platform located on the gateway. At this time, the search results are recorded in the User Profile Module (see section 5.3.4).

4.3.3 The User Location Module (ULM)

The User Location Module gives out the user's location. There are two facets to the module: wired and wireless.

In the wired world, the module tries to resolve the user's location from her IP address. This could be done by subscribing to one of the many commercial services that provide such information. One such service is IP2Location (www.ip2location.com).

In the wireless world, since the gateway is operated by the cellular service provider, which in turn owns the wireless network that the wireless devices operate in, the ULM finds the user's location by tapping into the infrastructure of the wireless network.

4.3.4 The User Profile Module (UPM)

The UPM is a database that stores data concerning a user. Currently, it is a MySQL database (<http://www.mysql.com>). Some of the information stored includes login authentication, user computing device profile, and user preferences.

The UPM also keeps track of what mobile agents are currently out running errands for the user, what past mobile agents has sent out. The history of what mobile agents a user has sent out in the past allows the gateway company to analyse what the consumer trends and how it can better server its customers.

Finally, the User Profile Module also stores the search results returned by the mobile agents. The reason they have to be stored up in the UPM is because, otherwise, if the mobile agent has finished its initial round of searching and is dispatched again later, the results would be unavailable to the user.

4.4 The Yellow Pages Server

The Yellow Pages Server is a database of all companies that have entered into a business relationship with the gateway. It stores: the company name, the location of the company, the list of products that it carries, and the URL of its website and Mobile Agent Platform.

It has the ability to return a list of Business Agents carrying a certain service located within a certain proximity to the user.

4.5 The Business Mobile Agent Platform

Similar to the Gateway Mobile Agent Platform, the Business Mobile Agent Platform also sends out and receives mobile agents. On this platform, there will be Business Agents deployed that interact with incoming Shopping Agents. The platform has an API that allows the Business Agent to call up functions that utilize the system resources of the underlying system, including functions to open a file, a HTTP connection, a database connection, and a way to invoke local Web Services (W3C).

The incoming Shopping Agent tells the stationary Business Agent what it wants to find or buy, and the Business Agent looks up products that match with the Shopping Agent's desires. At the same time, it talks to the Promotion Agent to find related promotions and ads in the Advertisement Server.

4.5.1 The Advertisement Server

Whenever a Shopping Agent calls for a search, the Promotion Agent tries to find an advertisement that best interests the user. The Advertisement Server is itself a database that stores the numerous advertisements and promotions that the company is running. The proposed matching algorithm is a simple text matching algorithm. For example, if the user is looking for Radiohead CDs, the algorithm searches through the database looking for the keywords "Radiohead" and "CD" and see if there are any promotions regarding Radiohead CDs.

In the future, a product recommendation system, akin to that of Amazon.com's can be implemented. This system attempts to find products that the user is also interested in, for example, showing her other CDs that other users interested in Radiohead have bought.

5 SECURITY FEATURES

Anytime a mobile agent platform is mentioned, it is hard to escape the need to address its security features. The security issues are usually concerned with protecting the agent platform from malicious agents and protecting the agents from malicious platforms. Traditionally, protecting the agent platform from malicious agents can be accomplished through the design and implementation of a security policy for the platform that states what agents,

running the platform, can and cannot do. However, protecting the agents from a malicious platform is a harder problem for which there is no obvious solution.

Such security issues arise when foreign agents are allowed to run on foreign agent platforms. The Havana architecture, however, has the special characteristic of being placed in a computing environment in which all the participants are locked in business contracts, and are thus mutually trusting parties. It does not make business sense for a Business Server to sabotage an incoming Shopping Agent, which represents a potential customer. On the flip side, it will not be possible for a malicious shopper to send out a malicious agent on to the Business Server to wreck havoc, because agents are all created and sent from the Gateway, and only agents sent and certified to be born within the Gateway will be accepted and run on the Business Servers.

In the Havana platform, only business participants are allowed to create agents that provide value-added services to their customers. Such agents will need to be certified and registered with the Gateway in order for customers to dispatch them and business platforms to welcome them and let them run.

Essentially, with the business partnership, we have defined away some very difficult security issues associated with mobile agents.

6 CONCLUSION AND FUTURE WORK

In this paper, we have discussed some of the problems faced by online comparison shoppers, followed by a mobile agent-based solution through the Havana mobile agent platform for e-commerce and m-commerce. The Havana platform can be seamlessly integrated within the existing Web infrastructure where all Website participants are locked in business contracts and thus mutually trusting parties. Such business partnerships allow participants to offer value-added service to their customers. The important characteristic of the Havana platform, its business model, means that the security issues of mobile agents are no longer a major concern.

The Havana platform is a work in progress. Therefore, we will be adding more features to it as time goes on. In particular, we would like to add a stronger suite of communication primitives which will allow agents to collaborate in working on tasks.

The Mobile agent paradigm could institute a revolutionary shift of human-computer interaction

that allows for exciting new ways for people to work with computers.

ACKNOWLEDGEMENT

This research is supported in part by the Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant No. 045635.

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