Ad-me: Intelligent Context-Sensitive Advertising within a Mobile Tourist Guide

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Abstract. The mobile commerce sector is set to witness phenomenal growth. In particular context sensitive advertising will represent a high yield revenue stream. This paper introduces the Ad-me (**Ad**vertising for the **m**obile **e**-commerce user) system which proactively delivers advertisements to users. Within the context of a mobile tourist guide advertisements are presented relative to user location and perceived needs. It uses Global Positioning System (GPS) and embraces agent-oriented design principles.

1 Introduction

Mobile commerce is set to witness phenomenal growth. By 2005 CNET News predicts that there will be 1 Billion mobile devices world-wide, more than the number of cars and PCs combined. In Europe and Japan the early adopter markets, $400 Million is currently generated in revenue from m-commerce per annum [Irish Computer April 2001]. According to an Ovum report in 2001, M-commerce information services will generate $4.7 Billion by 2004 only to be surpassed by advertising which will generate $8 Billion by 2005. Furthermore mobile location services are set to increase from 2 Million connections in 2001 to 560 Million in 2006 with maximum revenue streams derivable from services that are personalized and easy to use. Tourism and advertising constitute highly attractive m-commerce market segments.

This paper introduces the Ad-me (**Ad**vertising for the **m**obile **e**-commerce user) system, a context sensitive advertising service for the mobile user. This system falls within the broad category of context sensitive service delivery [1], which may be defined as services that are offered to the user which are primarily determined by location. The ad-me system sits on top of a mobile tourist guide where the motivation and added value service offered to the user is that of context sensitive tourist services accommodated upon a Personal Digital Assistant (PDA) or cellular phone. The tourist content thus provides a carrier mechanism for the true objective of the system that of targeted advertising. Ad-me aims for intelligent and selective advert delivery to the users, i.e. only *if* they need

them *when* they need them *where* they need and in a form sensitive to their technological context (*how* they need them).

The Ad-me system strives for maximum diffusion and can thus be hosted on any wireless device supporting either Wireless Markup Language (WML), Handheld Device Markup Language (HDML), HyperText Markup Language (HTML) or compact HTML. It operates in an outdoor environment and obtains user location based on a Global Positioning System (GPS) receiver.

The remainder of the paper is structured as follows: Section 2 situates our work among other related research. Section 3 describes the problem domain specific objectives. Our choice of implementation technology is justified in Section 4. The Ad-me architecture is described in the penultimate section while Section 6 presents our conclusions.

2 Related Work

Early context-sensitive systems were those of ParcTab [2] and Olivetti's ActiveBadge [3]. The Context-sensitive electronic tour guides are not new. There are a number of research projects related to this area.

The GUIDE project [4] developed a context-aware tourist guide of Lancaster City. It obtains users position by receiving location messages transmitted from non-overlapping WaveLAN cell base-stations dispersed throughout the city. While this approach does not need additional hardware on the client side it results in a lower resolution of positioning information.

The Cyberguide project [5] includes prototypes of a mobile context-aware tour guide that provides information based on knowledge of tourist position and orientation. The application is hosted entirely on an Apple MessagePad, as a stand-alone system, using a Trimble GPS unit.

The HIPS (Hyper Interaction within Physical Space) project [6] developed a handheld tour-guide that dynamically delivers multi-media presentations based on the user's location and profiles. It is hosted on a hand held Personal Digital Assistant (PDA) and determines user's geographical position using a Garmin GPS II+ receiver. HIPS seeks to achieve the simultaneous navigation of an information space and associated physical space.

The Impulse project [7] provides the user with personalised location-based information with the assistance of an agent. A GPS receiver obtains the user location. A User Agent residing on the hand-held device assembles a user profile and builds queries for the Wherehoo server and Provider Agents. The Wherehoo server retrieves the geographic position of each provider's service and a

description of how to query each Provider Agent. User Agents supply users with relevant URLs. Other systems include the Personalised Shopping Assistance (PSA) [8] and DealFinder [9].

Unlike the existing guides Ad-me offers the advantage of portability, being able to be hosted on a myriad of wireless devices. Most existing tourist guides still do not take full advantage of context. In contrast Ad-me provides additional content based on intelligent context-sensitive advertising. Today this form of advertising is still at an embryonic stage. Two companies Streetbeam and Ad-live [10] both have just developed billboard advertising with PDA interactivity. Thus pointing the PDA will receive additional advertising content. Globally at present virtually no mobile context-sensitive advertising system exists. However companies like Doubleclick, AvantGo and Lot21 have or will deploy limited trials. Toward the end of 2000 a new advertising agency called D2 Communications was capitalised in Japan to a value of 490 Million Yen which will specifically target advertising for iMode [11].

3 Objectives

The fundamental objectives of the Ad-me system are:

- Provide a backdrop of tourist related information;
- Provide a context-sensitive advertising capability;
- Provide a simple and effective advert posting capability.

In achieving these objectives we adopted an agent-oriented approach [7] to the design of the system. Much research work has been commissioned on Multi-Agent Systems (MAS) and Distributed Artificial Intelligence (DAI). In the delivery of computationally tractable models of deliberative reasoning, one approach that has gained wide acceptance is to represent the properties of an agent using mental attitudes such as *belief*, *desire*, and *intention*. Multi-agent architectures that are based on these concepts are referred to as *BDI-architectures* (Belief-Desire-Intention) [12, 13]. Proponents of the BDI approach argue that the understanding of the dynamics of these mental attitudes and their intimate interdependencies is crucial in achieving *rational* agent behavior.

Currently, Multi-Agent Systems are viewed as an appropriate technology for the delivery of services to mobile and wearable devices. Commensurate with this is the need for lightweight agents with an associated small *software footprint*. Numerous systems have sought to deliver support for mobile lightweight agents including Tromso And Cornel Moving agents (TACOMA) [13], [15] and Grasshopper [16], both offer merely a weak notion of agenthood. The BDIM toolkit [17] however, like Agent Factory offers support for Mobile BDI agents.

3.1 Problem Domain Specific Objectives

There are four specific mobile device issues we must overcome namely interoperability, computational constraints, mapping technology and user localisation. We will discuss each of these briefly.

The necessary interoperability demands a separation of concerns between presentation and content, supporting the full range of mobile device browsers: HTML, WML, HDML, Avantgo and iMode. iMode uses an extended subset of HTML called cHTML (compact HTML).

The computational constraints of mobile devices represent significant impediments. Because of memory and bandwidth limitations, sophisticated rich value services cannot reside on the client side. Furthermore memory and screen size limitations differ with each device, supporting different image formats. (e.g. GIF, WBMP for WAP).

The judicious choice of mapping technology is inextricably related to graphic content quality. Raster formats tend to be limited to a single, often low, resolution and consume large amounts of bandwidth on the Web. Popular high-quality vector based graphic formats are Flash and Scalable Vector Graphics (SVG) [18]. Considering the limited *real estate* on a mobile, scaling and zooming map images is of paramount importance. Unfortunately there is, at present, no support for vector image formats on mobile phones.

The most suitable outdoor user localisation technique is the Global Positioning System (GPS) [19, 20]. The original degradation has recently been relaxed allowing an accuracy of 10 to 20 metres with normal GPS. The European Union GALILEO project [21] aims to provide better precision, guaranteeing reliability and coverage levels not present in existing systems. The reasons for developing Galileo are both strategic and economic since it has been estimated [22] that the global market for satellite navigation systems and services will be worth $40 billion between now and 2005. The system will be available from 2008.

Accuracy of 1 to 5 meters can be achieved by using a differential correction comparing data received form a second GPS receiver of known location this removes many GPS errors. Cellular base station triangulation represents an alternate approach, CURSOR is one such example [23], which is based on the BTCellnet E-OTC system. New systems use some combination of satellite and cellular techniques. The Enhanced Global Positioning System (EGPS) [SNAP] is one such system. Almost all leading network providers are developing their own form of location sensing technologies. Ericsson have developed the Mobile Positioning System (MPS) and indeed the European Telecom-

munications Standards Institute (ESTI) and the American National Standards Institute (ANSI) have decided to adopt a standard based upon this.

4 Implementation Technology.

Technologies for dynamic content delivery can be classified into server-side and client-side. With client-side technologies, the browser interprets and executes the received application, which places a heavy processing load on the client-side device. In server-side technologies, the browser is only given the resulting HTML/WML page generated on the server. This minimises network traffic between the browser and the server and makes server-side technologies more suitable for *thin* clients.

Four of the leading server-side scripting products providing dynamic content are Hypertext Preprocessor (PHP) [24], Java Server Pages (JSP), Mircosoft's Active Server Pages (ASP) and Cold Fusion (CF) [25]. Both ASP and CF are proprietary products. The former necessitates ASP developers to use a Microsoft web server such as IIS. Other server-side techniques are Cocoon [26], Common Gateway Interface (CGI) scripts, Server Side Includes (SSI), Zope, Lasso, and Mason [27]. An alternative to CGI-based technologies is the Extensible Mark-up language Compiler (XMLC) technology. The compiler is integrated with the open-source Enhydra Application Server [28], but is also available separately. We identify three techniques as potential candidates, namely PHP, JSP and XMLC.

Table 1. Server-side techniques for delivering dynamic content (*** = best)

CRITERIA	PHP	JSP	XMLC
Performance	***	**	**
Database Connectivity	**	***	***
Graphic Format Capabilities	***	***	*
Separation of Content from Presentation	***	**	***
Rapid Development	***	*	*
Cost	***	**	***

In developing Ad-me we have selected PHP. The motivations are as follows:

- High performance:
  PHP can achieve the highest performance by using PHP caches, such as Zend [29] and APC [30]. PHP caches pre-compile PHP scripts into native CPU code and store them in cache memory.

- Accelerated database connectivity:

Database connectivity usually slows down the performance. In PHP, however, connections remain open after a page is finished being processed, thus, dramatically improving the performance. PHP supports a vast number of free and commercial databases as well as the ubiquitous Open Database Connectivity (ODBC).

- Rich set of functions for building images on-the-fly:
  PHP can deliver dynamically both vector (Flash, SVG) and raster formats (e.g. PNG, JPEG, GIF, and WBMP). This makes PHP a preferable technology for delivering dynamic graphics on mobile devices.

- Separating the web design from logic programming:
  For large-scale business applications it may be necessary to separate the web design from logic programming. PHP supports template driven designs through such template engines as Smarty [31]. Smarty reads the template files and creates PHP scripts only once, avoiding the need to parse the template files repeatedly.

- Rapid development:
  The use of libraries such as the HAWHAW PHP class library [32] accelerates the development allowing the developer to deal only with PHP and HAWHAW suppressing the details of each of the constituent mark-up languages. To the best of our knowledge, there is no similar Java library. This library gives the advantage of rapid development compared to traditional approaches (e.g. JSP, XMLC).

- Open-source software:
  Being open-source software PHP also provides the cheapest option. The only cost for PHP might be for the Zend Cache. However, our experience thus far suggests that use of the free APC cache provide satisfying level of performance.

- Extensibility:
  PHP is highly extensible and supports Java, XML, COM/DCOM, LDAP, IMAP.

Our evaluation is summarised in Table 1.

5 System Architecture

The Ad-me system architecture is illustrated by Fig. 1. A more detailed description is provided in [32]. We utilise Agent Factory a distributed environment for the rapid prototyping of intelligent agents [12, 34, 35]. Agent Factory is a member of the class of systems that embraces the BDI phi-

losophy. The system offers an integrated toolset that supports the developer in the instantiation of generic *agent structures* that are subsequently utilised by a pre-packaged agent interpreter that delivers the BDI machinery. In particular we are developing lightweight Java agents within the Agent Factory framework.

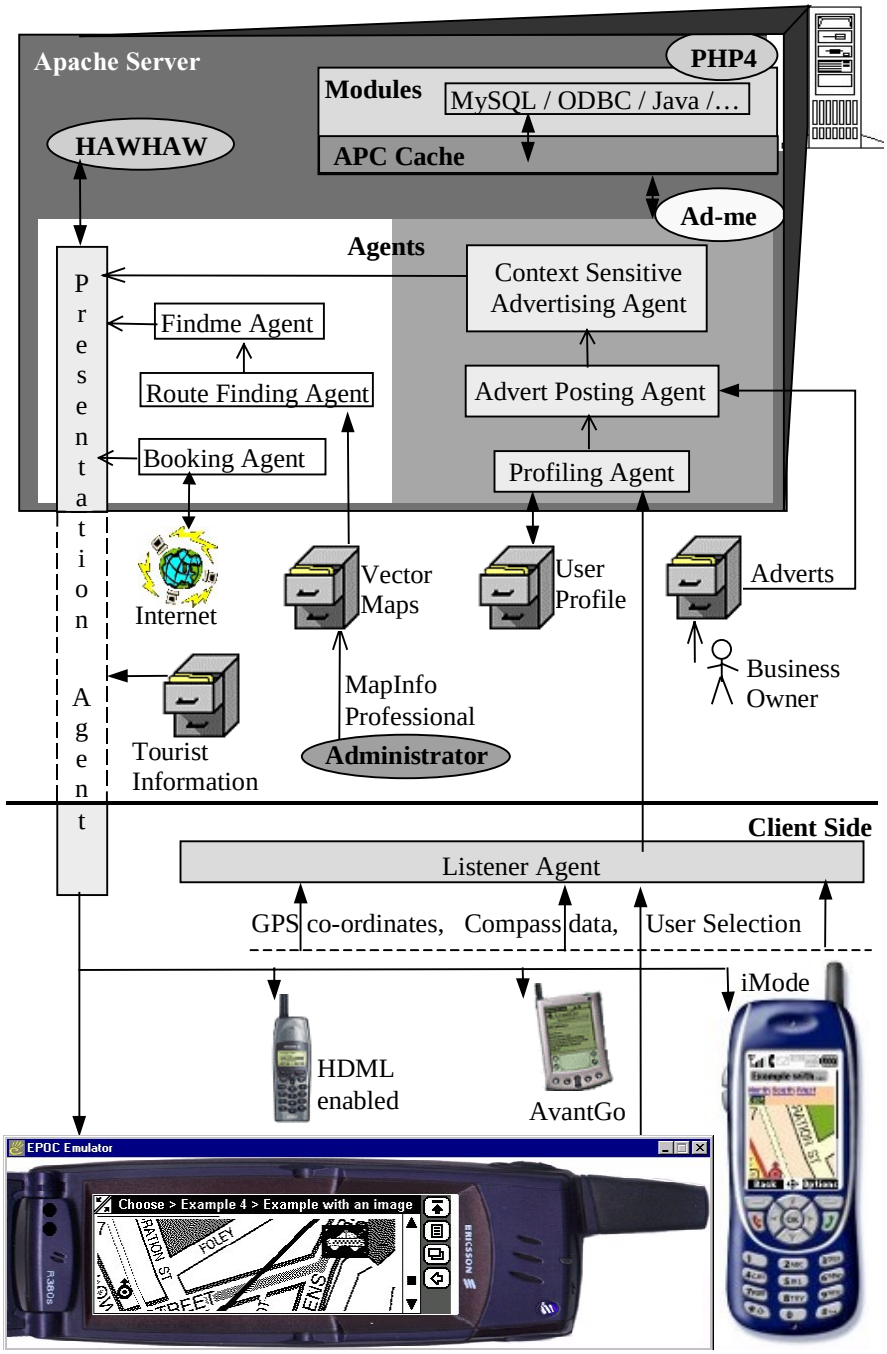

Fig. 1. The Ad-me Schematic Architecture

A federation of agents exists consisting of, Context-Sensitive Advertising Agent, Advert Posting Agent, Profiling Agent, Listener Agent, Findme Agent, Route Finding Agent, Booking and Presentation Agent. The Findme Agent is responsible for finding the nearest object of interest, e.g. nearest restaurant or museum. The agent uses the result from the Route Finding Agent which queries the

GIS database which stores each street as a set of line segments. The Route Finding Agent uses this data together with Dijkstras algorithm and provides the shortest path to a desired object.

The Profiling Agent dynamically maintains a unique user profile. The raw data from which it formulates its decisions are obtained from a listener agent residing on the client. The Listener Agent collects information about the user location (from GPS receiver) and interface interactions, and listens for requests from the Profiling Agent. When the Listener Agent receives a request from the Profiling Agent the collected information is transferred using TCP/IP protocol. The agents use the Internet stream sockets to send and receive data over TCP/IP.

The Context-Sensitive Advertising Agent utilises push technology supplying advertisements relative to the user location and perceived need. The latter is adjudged by interrogation of the profile database. For example, consider our tourist has been wandering for several hours sightseeing, the time nears lunchtime the system thus infers that the user may be disposed to eating. Consequently restaurant advertising would be presented based on their proximity to the user and user eating preferences and disposable income. The posting of advertisements is the responsibility of the Advert Posting Agent, which receives content and bills the content supplier accordingly. Incremental tariffs give advertisements higher priority. In addition a Booking Agent provides on-line booking capabilities for example reserving restaurant tables, theatre seats or booking taxi. The Ad-me system thus provides more than mere content delivery but supports electronic commerce emerging as a result of the content delivery.

The Presentation Agent is responsible for giving the necessary tourist content relevant to places of interest located next to the users location. This agent dynamically generates a map segment image adjacent to the user position. The agent allows the user to “scroll” the map to the North, South, East and West via links. Tourist content relative to map location is subsequently presented. The Presentation Agent presents the content in the appropriate format via HAWHAW. The functionality of the Presentation Agent straddles both the client and server sides.

Our application runs on top of an Apache server version 1.3. The system is implemented using PHP V4.0.5 together with HAWHAW V4.0 library. Databases are delivered via MySQL. User location is obtained by GPS receiver.

HAWHAW is a templating tool and consists of various HAWHAW functions, which describe different dialogue elements in the page (such as text, menus, buttons, etc.) and can be called inside a PHP script. The resulting page is then generated in a format depending on the viewer's browser (e.g. WML, HDML, cHTML or HTML). MySQL and ODBC support is already built in PHP together

with management and maintenance tools. The feature set is complete compared to other databases. The geocoded vector-based data is constructed with MapInfo Professional V5.5 [36]. The APC cache is used to enhance performance caching compiled PHP scripts.

6 Conclusions and Future Work

Within this paper we have presented the Ad-me system, a context-sensitive advertisement delivery system. This system has been partially trailed in Dublin City centre. Our system is innovative in several respects. Firstly, it is one of the first such systems to be developed. Secondly, we deploy an agent-oriented approach with lightweight agents supporting real-time content retrieval, content presentation and user profiling. Thirdly, the adoption of PHP facilitates interoperability ensuring the delivery of content to a rich diversity of devices. Future work will undertake larger field trials, extend agent functionality, utilise vector-based maps, develop generic software tools for customisation and localisation of the guide and potentially incorporate the Smarty templating engine.

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