Title	EasyLife : a location aware service oriented mobile information system
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Publication date	2008
Publication information	Lovrek, I., Howlett, R.J., and Jain, L. C. (eds.). Knowledge-Based Intelligent Information and Engineering Systems: 12th International Conference, KES 2008 Proceedings, Part I
Conference details	Paper presented at KES 2008, 12th International Conference on Knowledge Based Intelligent Information and Engineering Systems, Zagreb, Croatia, 3, 4 and 5 September 2008
Publisher	Springer-Verlag
Link to online version	http://dx.doi.org/10.1007/978-3-540-85563-7_33
Item record/more information	http://hdl.handle.net/10197/1328
Publisher's version (DOI)	10.1007/978-3-540-85563-7_33

EasyLife: A Location-aware Service Oriented Mobile Information System

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Abstract. Many examples of Location-aware services have been developed in recent years as the enabling technologies mature. However, these services frequently exist in isolation and address specific niche markets. The diversity of the mobile computing community suggests that enabling dynamic combinations of location-area services would be an appropriate deployment strategy. In this way, customers could subscribe to those services that address their particular needs. This paper introduces EasyLife, an agent-based architecture designed to facilitate the development of suites of location-aware services that customers can configure according to their preferences.

Keywords: Ambient Intelligence, Mobile Computing, Agent-oriented Information Systems, Location-aware computing.

1 Introduction

Location-aware computing is one of the foremost developments in mobile computing [1] as it is perceived as offering a new paradigm for service delivery that has significant economic potential. Hence, it has attracted the attention of many industrial sectors as well as various disciplines in academia. The enabling technologies are well understood – positioning systems of various hues, broadband wireless communications and sophisticated personal devices. Though there are many exemplar examples of location-aware services, one common characteristic concerns their focus on addressing a single application domain or end-user group.

Heterogeneity is one of the defining characteristics of the mobile computing community. Thus arbitrary customers may require certain combinations of services at various times, depending on the prevailing context. Meeting those customers' needs would obligate service providers to provide their services in a mix-and-match fashion. Such a scenario gives rise to technical issues as a need for new business models. This paper proposes an architecture – EasyLife, which is aimed at providing a framework that would enable service providers to deliver customised combinations of location-aware services to their subscribers. This paper is structured as follows. In the Section II, a brief snapshot of location-aware services is provided. The architecture of EasyLife is presented in Section III after which the initial implementation is described. Some future work is discussed in Section V after which the paper is concluded.

2 Related Research

The success of the Global Positioning System (GPS) and ubiquitous availability of mobile data services has made location-aware services feasible. A significant number of projects have been described in the literature, and a number of these are now discussed.

AccesSights project [2] is a multimodal location-aware mobile tourist information system. The aim is to help disabled people to get the same tourist information as sighted people and help them explore tourist destinations. By using GPS, the system knows where the user is, their orientation, and their movement, thus providing the relevant sight information to the user through sound and some accessible text. It is very benefit for those special people. Interestingly, tourism is a popular application domain for location-aware services and various other systems have been documented, for example, HIPS [3], CRUMPET [4] and Gulliver's Genie [5].

AudioGPS [6] is more than converting the GPS data retrieved as simple coordinates and depicting them onto a map. It involves building a prototype for mapping this data to non-speech spatial audio, so that the user could get the location information with less attention and eliminating the need for language recognition. The idea is attractive, and an initial prototype has been constructed and evaluated.

MStream [7] seeks to develop a mobile music streaming application that provides a location-aware audio service to the end user. Apart from the client-server model, the MStream project also uses P2P technology for large scale and interactive audio among users. It could be used for location-based conferencing or as a tour guide.

CoMPASS [8] is concerned with the delivery of context-sensitive spatial information to mobile devices. In particular, personalization is an important aspect, and the system enables the recommendation of context-aware spatial information to users as they interact with electronic maps.

Agent Channeling ContExt Sensitive Services (ACCESS) [9] is an agent-based architecture which is used for development and deployment of context sensitive services. The main focus of the project is to build an infrastructure so that the developers could focus on the implementation of the context-aware services.

From the above, we can see that there are plenty of good ideas about location-based services, and lots of effort have been put into this area. In Easy Life, we would like to use the cutting edge technology and develop a multi-tier location-aware service-oriented system. Such a system would offer a complete solution for delivering location-based services, and would leverage the following technologies:

− Location aware services that are more that just navigation aids;

− Web 2.0 services incorporated into mobile technologies;

− Heterogeneous agent technologies for modeling and delivering the different services.

Initial prototype services offered by EasyLife will include a real-time weather service, a shopping service based on shopper location and a restaurant service that can recommend nearest restaurant to the user. Though initially focusing on the issue of location-awareness, it can be extended to included context-awareness.

3 Architecture

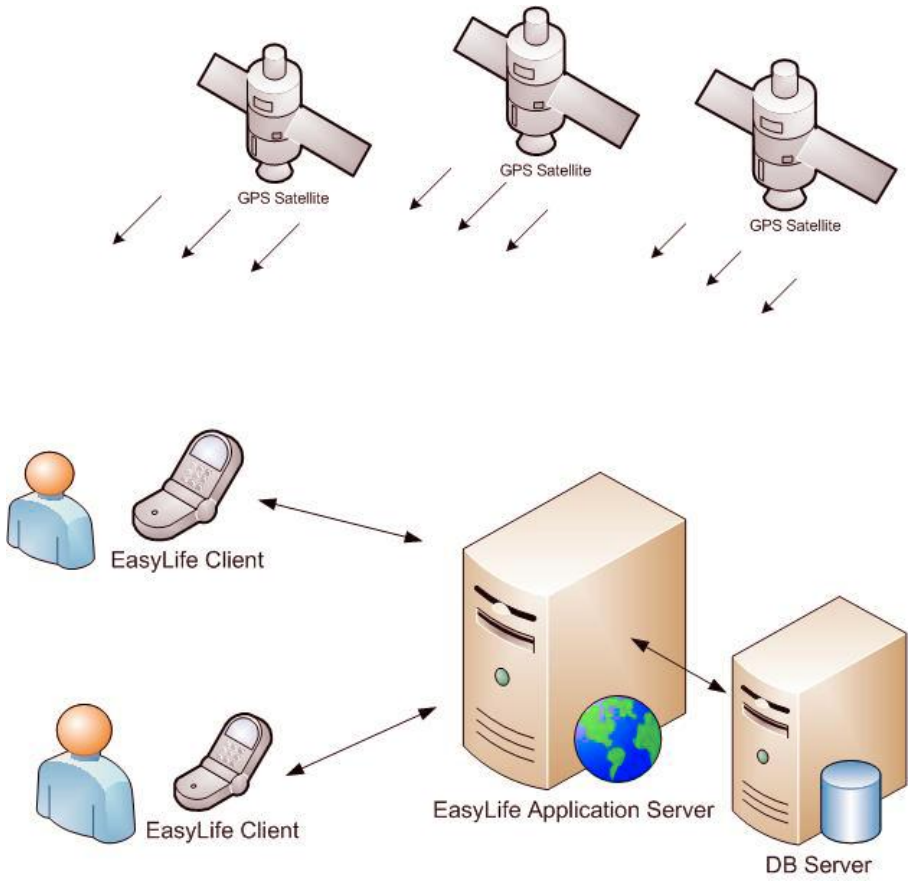


Fig 1: Overview of EasyLife.

From an architectural perspective, EasyLife consists of three key components:

− EasyLife client;

− AgentProxy_app;

− AgentServices.

The benefits for dividing the system into these three different parts are that it is loosely coupled and each component is well abstracted and easily extended. Each of these components is now described.

3.1 EasyLife Client

An illustration of the architecture of the EasyLife client may be seen in Figure 2. It is composed of five key elements:

− **Agent:** controls the behavior and workflow of the EasyLife client. It also listens and handles all events generated.

− **Context:** is responsible for getting the context from the external environment. In particular, it is used to get the location information from the external Bluetooth GPS receiver. It can be extended to handle other sensors if need be.

− **Controller:** provides an access point for certain functions – one example being the UIController. It provides an API for calling different UIs. For the extensibility purpose, other controllers could be developed.

− **UIs:** provides the Graphic User Interface (GUI) for the EasyLife client.

− **Data Model:** represents an abstraction of the data from different domains, such as the GPS data model, the weather data model and so on.

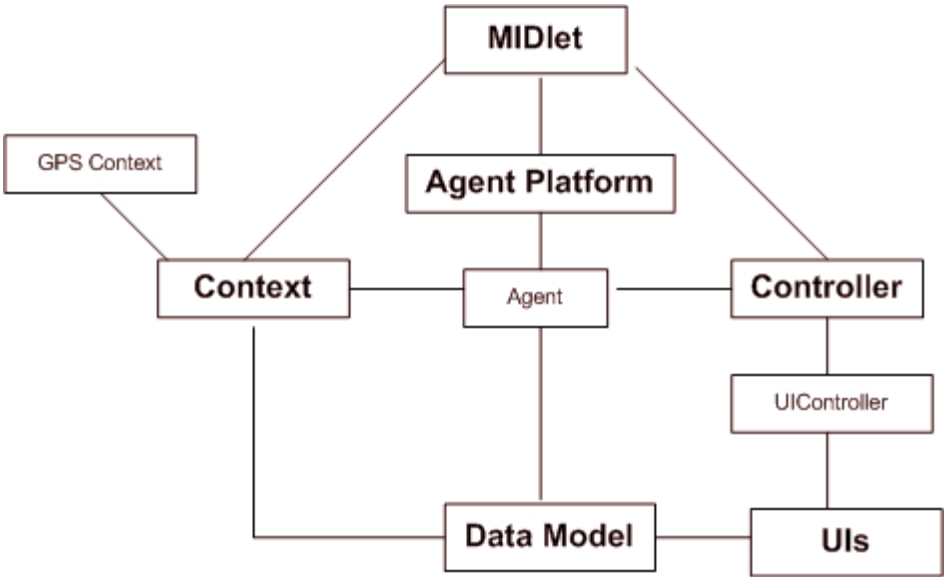


Fig 2: EasyLife – Client Architecture.

3.2 AgentProxy_app

The AgentProxy_app is best viewed as a virtual router. It has a Gateway Agent which parses service requests, and forwards them to the correspondent agent service. It also relays messages to the mobile client.

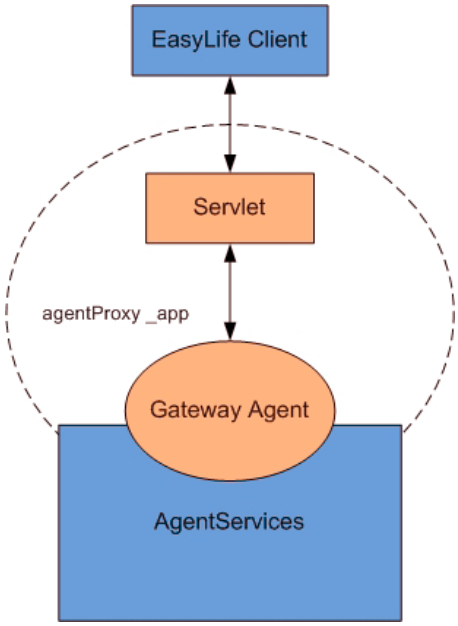


Fig. 3. AgentProxy_app architecture.

From an implementation perspective, agentProxy_app is implemented as a servlet (Figure 3). It communicates with the EasyLife client via WiFi and via standard TCP/IP with the Gateway Agents which acts as the interface to Agent Services.

3.3 AgentServices

AgentServices consists of many different agents, each representing an enterprise and providing different services. There are controller agents which could be seen as service brokers interacting with other systems. The benefits of dividing the system into these three different parts are that it loosely coupled. Each component is well abstracted and used for different purposes.

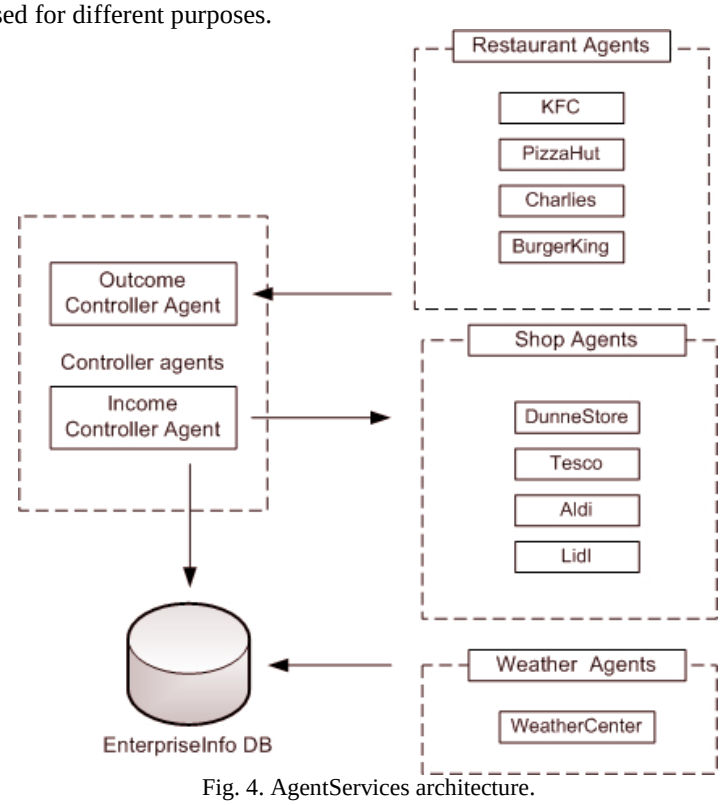


Fig. 4. AgentServices architecture.

AgentServices consists of two parts, controller agents and service agents (Figure 4).

Controller Agents

- **Income Controller Agents** are the entry points for the agent service. They are responsible for parsing the request and dispatching it to the correspondent agent according to the location and the type of the service. They also inform the Outcome Controller Agent of the address of the Gateway Agent, so that the Outcome Controller Agent knows where to send the service data.

- **Outcome Controller Agent** obtains the address of the Gateway Agent from the Income Controller Agent. All the service agents send their data to the outcome agent and this dispatches the service data to the correspondent Gateway Agent.

Service Agents

In generally all the service agents would conform to similar role with the following functions.

- Event Listening;

- Service Data Constructing;

- Sending Messages.

In the case of the Restaurant service, four agents were constructed - each representing different restaurants, namely the KFC Agent, the PizzaHut Agent, the BurgerKing Agent and the Charlies Agent. The restaurant service demonstrates the location-based recommending service. Four agents for the Shop service were created,

representing different shops. The Shop service demonstrates a location-based advertisement service. One agent for the weather service was created. This leverages the Yahoo weather service by calling two REST APIs - one for getting the code for the location, the other for getting weather forecast information from the Yahoo website.

4 Implementation

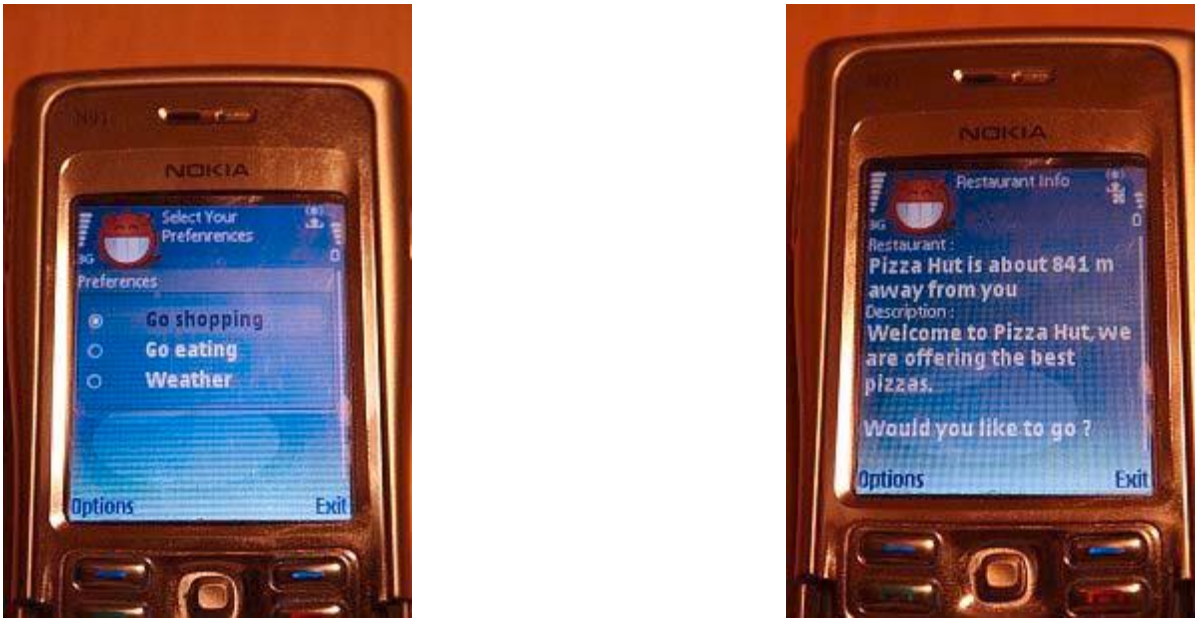
EasyLife harnesses a number of technologies but intelligent agents form the constituent components. Two different agent development environments were used – Jade for the resource intensive server components and AFME for the lightweight mobile devices.

JADE
Java Agent Development Environment (JADE) [10] is a robust and efficient environment for agent development. JADE agents support a thorough range of agent characteristics. From a communications perspective, JADE complies with the FIPA specifications.

Agent Factory Micro Edition
Agent Factory Micro Edition (AFME) [11] was specifically designed for deploying intentional agents on mobile devices. AFME agents follow a sense-deliberate-act cycle It has a perceptor feature which are used to monitor the state of the environment, and actuators for affected change within the environment.

4.1 EasyLife Prototype

An initial implementation of Easylife has been developed (figure 5). The server is hosted on a standard workstation and communications occurs with the client via Wifi. Databases are implemented in mySQL and Hibernate for object persistence. The client is hosted on a Nokia N91. Position is obtained using a Bluetooth GPS receiver.



(a) (b)

Fig. 5. Subscriber selects an EasyLife service (a) and recommends a nearby restaurant (b).

5 Future Work

EasyLife is very much a work in progress. The core architecture is in place and it is intended to use it as a base for further research. Initially, it is planned to explore information fusion through the use of mashups in mobile contexts, and the integration of Web services into mobile applications and services. A second issue concerns the use of heterogeneous agents. In theory, such agents should be capable of interoperating provided that they adhere to a recognised standard. In practice, there may be difficulties when the inherent resource limitations of mobile devices are considered, and the implications of these need to identified, and appropriate solutions identified.

6 Conclusion

As location-aware services become available, the need for robust extensible architectures will become paramount. Such architectures will harness a number of disparate technologies to enable the delivery of services to mobile users. In addition, distributed computing technologies are essential for the effective realization of mobile services. In this paper, we have presented EasyLife as an example of an architecture that encapsulates a number of characteristics essential for the construction and deployment of location-aware services.

Acknowledgments. This material is based upon works supported by the Science Foundation Ireland (SFI) under Grant No. 03/IN.3/1361.

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