An ontology-based service-oriented application for mobility impaired users

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ABSTRACT
In this paper, we present the ASK-IT ambient intelligent framework. ASK-IT is built on a service-oriented architecture that uses ontologies in order to semantically annotate Web services and facilitate service discovery and retrieval. Its main aim is to enable a wide range of use cases for elderly and mobility impaired users related to the domains of transport, tourism and leisure, e-working, remote home control and social relationships amongst others. Based on specific use cases, ASK-IT gathers the requested information from a set of interconnected registered Web services and provides it on mobile devices, such as mobile phones and PDAs. We describe the general architecture of ASK-IT framework and present a set of indicative supported demonstration scenarios.

Categories and Subject Descriptors
H.3.4 [**Systems and Software**]: Distributed systems, Information networks, User profiles and alert services.

H3.5 [**Online Information Services**]: Web-based services.

General Terms
Design, Standardization, Verification.

Keywords
Ambient intelligence, service-oriented architecture, ontologies, Web services, mobility impaired users.

1. INTRODUCTION
We introduce an ontology-based ambient intelligence framework which has been developed in the context of the integrated project ASK-IT (*www.askit.org*). The main aim of this framework is to facilitate mobility and information needs of mobility impaired (MI) users, while on the move. ASK-IT enables users to access geographically distributed content gathered from a set of Web services (WSs). The discovery and invocation of WSs is performed via an ontology that describes the supported services. The semantic description of WSs using ontologies introduces Semantic Web services [1]. Upon user request, the ASK-IT framework submits appropriate queries to the ontology in order to discover the WS that best fulfils user requirements for information in the context of a particular use case.

Most of the ontology-based infrastructures for WS that have been developed recently involve the use of ontologies to enable search and retrieval capabilities in particular domains of interest. For instance, in [3] an inference engine is used to submit queries to an ontology that describes atmospheric data. In [4] an ontology-based knowledge base that describes WSs is used in order to facilitate service discovery. An alternative method in [2] uses a Semantic Web enabled search engine in order to perform discovery of interconnected and semantically unified geographic information resources.

2. GENERAL ARCHITECTURE
The ASK-IT ambient intelligence framework (Figure 1) is heavily relied on a subsystem, whose main responsibility is to retrieve information from a set of available WSs. Figure 1 shows the interoperations that occur between the core components of this subsystem and the external service providers (SP). ASK-IT main architectural components include:

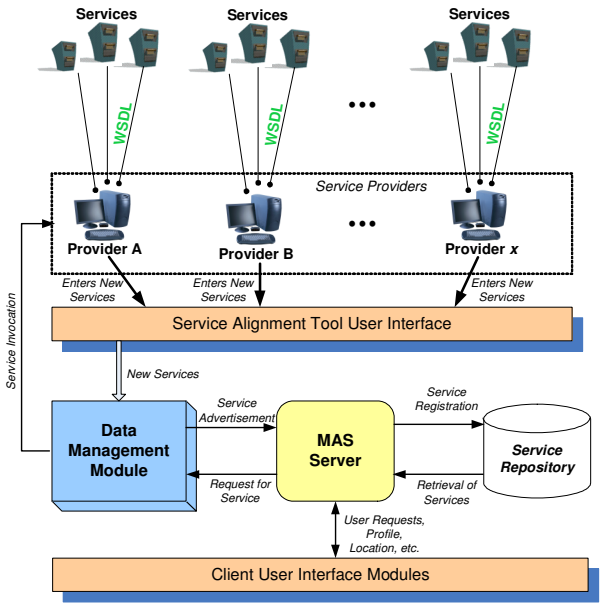

Figure 1: The main interacting modules of ASK-IT

- **WSs and Service Providers.** These provide the required information via a set of available WSs.
- **The service alignment tool user interface**. This tool is intended for SPs who are willing to register their WSs against the context of a common ontological framework.
- **The Data Management Module** (DMM). It provides a service discovery and invocation facility based on the existing ontologies. WSs invocation is implemented by custom wrappers that are activated upon user request.
- **A service repository.** This repository keeps track of the registered WSs.
- **A multi-agent (MAS) server** that provides interoperability between the DMM and the client applications using agent communication messages.
- **Client user interfaces** that support user interaction. These run on desktop computers and mobile devices.

The whole process that is executed between a user request and information delivery on the client interface is transparent to the end–user. This is done via an ontology-based service discovery and invocation mechanism.

3. DEMONSTRATION USE CASES

The ASK-IT framework supports a wide range of use cases. Figure 2 illustrates various snapshots of the PDA version of the end-user application for different use cases. The user localization module of ASK-IT (Figures 2.a, b) shows a map that displays user location based on GPS information. Seamless indoor to outdoor localization is also supported. If the user starts from an indoor area (Figure 2.a) and an appropriate network of indoor location-aware sensors is installed (Zigbee devices in our case), an indoor map displays the user position. While the user goes outdoors, the map automatically changes and now displays the user's location in the outdoor area (Figure 2.b). The reverse action is also supported as the user goes from outdoors to indoors.

Through the point of interest (POI) searching capability (Figures 2.c, 2.d) the users can search for different POIs (restaurants, hotels etc.) around their current position or any other given location. The information regarding the requested POIs is based on the user profile and it is aware of the user impairment.

In addition to localization, ASK-IT also supports indoor and outdoor route guidance (Figures 2.d, 2.e), known as "guide me" operation. As user changes from indoors to outdoors, the route guidance facility displays information in a seamless fashion.

The ASK-IT social events service (Figure 2.f) provides the user with a list of accessible social events of interest. This functionality is also integrated with the "guide me" operation. Thus, as the user receives a list of accessible points where a social event is about to take place, the "social events" service provides the ability to the user to reach this point through the "guide me" functionality (Figure 2.c, d).

The ASK-IT e-learning operation (Figure 2.g) contains a set of services that provide the user with information about a set of courses that the user takes on a long-distance basis.

The e-working module (Figure 2.h) contains typical e-working capabilities (email, calendar, document authoring).

Finally, the domotics operation enables remote home control. The integration of this module with an electric wheelchair controller facilitates remote user control for wheelchair users.

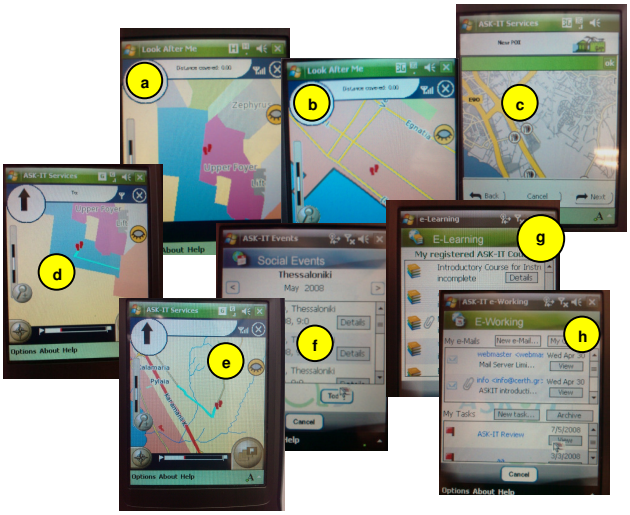

Figure 2: Snapshots of the ASK-IT PDA version for different use cases

4. CURRENT TESTING, FUTURE WORK

Up to date, the ASK-IT application has been successfully tested at 7 pilot sites, hosted by an equal number of European cities. Specifically, the pilot sites are Newcastle (UK), Nuremberg (Germany), Genoa (Italy), Helsinki (Finland), Bucharest (Romania), Athens and Thessaloniki (Greece). For this purpose, local SPs at each pilot site created a set of appropriate WSs which were registered to the ASK-IT ontological framework.

Based on user feedback from the pilot sites, a set of enhancements have been considered as future work. These mainly concern improvements on the application's performance and functionality, interoperability with heterogeneous networks and operation stability in case of network connection loss. This case is common when users are travelling in outdoor areas where the supported network connection that is required for the invocation of WSs, is provided by a GPRS or 3G operator.

5. REFERENCES

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