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Universal Access to Personalised Information Services

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Abstract

The evolution of the mobile communication systems is paving the way towards the development of new information services. At present Location Based Services (LBS) are gaining momentum since they allow the provision of mobile users with information related at their positions that, therefore, can help them on the move. The access to an information system is complicated by the fact that the access terminals and technologies may be heterogeneous. For instance, we can use mobile terminals with different displays, computation capabilities, access techniques (and, therefore, available bit-rate), software and so on. The user must be able to access the services not only by using a common personal computer at home, but also by means of its cellular phone (during a trip) or a personal digital assistant, in a totally transparent and seamless way. Accordingly, the provision of personalised services anywhere and anytime requires that the information system be adaptable and scalable, depending on the access technologies, terminal characteristics and user preferences. It is therefore very important that the system, for instance, be able to understand the characteristics of the technology adopted by the user to access the service, in order to adapt the content format and its presentation. Aim of this paper is to present some preliminary studies related to the Personalised Access to Local Information and services for tOurists (PALIO-IST 20656) project. In particular, it is described the undertaken technical approach for the development of an LBS service, accessible through different network technologies and client terminals.

1. Introduction

The *Information Society Technologies* (IST) PALIO project [PALIO], partially funded by the European Commission within the 5th Research Framework, is based on innovative LBS services. PALIO aims to provide new tourist services, directly available for tourists and citizen by developing

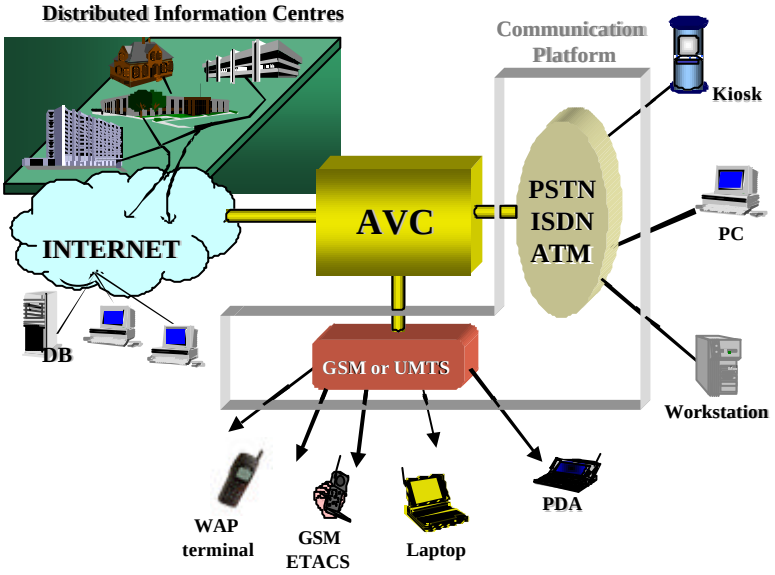

Figure 1: PALIO general architecture

and implementing complex data systems with user friendly and personalised interfaces. The service

design is driven by the combination of some new concepts as: personalisation, accessibility anytime, anywhere and with any communication technology, real-time interactions. One important aspect will be the support of a wide range of communication technologies (mobile or wired) to access services. In particular, it will be possible for a mobile user equipped either with a common cellular phone or an advanced WAP phone to access services wherever he/she is; the *Augmented Virtual City* centre (AVC) will adapt the presentation of information to the different access technologies.
At present, tourist information is static and mainly available through paper guides, Internet sites and information points located in specific positions. PALIO aims at providing multimedia services to tourists for facilitating their visit of a city. The main experimental services considered by the project deal with location-dependent personalised information for tourists and can be grouped within the following categories:

- Mobility information and services: the personalisation of services is an attractive characteristic and will be tested particularly to support tourist (but also citizen) mobility.
- Traffic and transportation information: a new service will be tested to organise the mobility in a metropolitan or larger area. This service requires real-time interactions between the PALIO system and the principal public offices and administrations involved in the management of traffic and mobility.

2. Architecture

The architecture described in this section represents a preliminary choice for the system design. It represents an interesting technological option that allows facilitating distribution of information from anywhere to everyone. The following short-term objectives have been considered to perform our technological choice:

- *User Agent* (UA) identification;
- User localisation;
- To manage an integrated information environment for multiple clients;
- Adaptation of the information that will be presented to the user.

The architecture described below is a three-tier Web application**;** therefore its primary communication protocol is the *HyperText Transfer Protocol* (HTTP). The clients that use a different protocol, such as the WAP device that uses the *Wireless Transaction Protocol* (WTP) [Arehart00], can be connected by a gateway. The three-tier model came about because of the need to separate *business logic* from *the Graphical User Interface* (GUI) and the backend *data sources*. According to the model, we have the following three tiers:

1. The GUI, that is the browser on the user's device. Every client device speaks its own language, as shown in Table 1.
2. The application tier, that is on the Web server. It implements the business logic by the use of Java and *eXtensible Markup Language* (XML) technologies.
3. The data sources on multiple servers. The data can be stored in databases or structured documents (e.g., XML documents).

Client	**Markup Language**
PC-based browser	HTML, DHTML, XHTML
PDA	WML, XHTML
mobile phone	WML, XHTML
landline phone	VoiceXML
server application-specific	XML languages

Table 1: Languages for client devices.

2.1. UA identification

When the client device sends a request to the application server, this is able to identify the device by extracting information contained in the header of the received http packet [HTTP99]. By means of this

information it is possible to identify the capabilities of a client device, such as the accepted MIME types, display size, browser type and version, etc. The request header fields used for this purpose are:

- HTTP_ACCEPT: containing the list of the MIME types accepted by the client;
- HTTP_USER_AGENT: that lists the most significant products information about the client. It is a string like: product/version (comments).

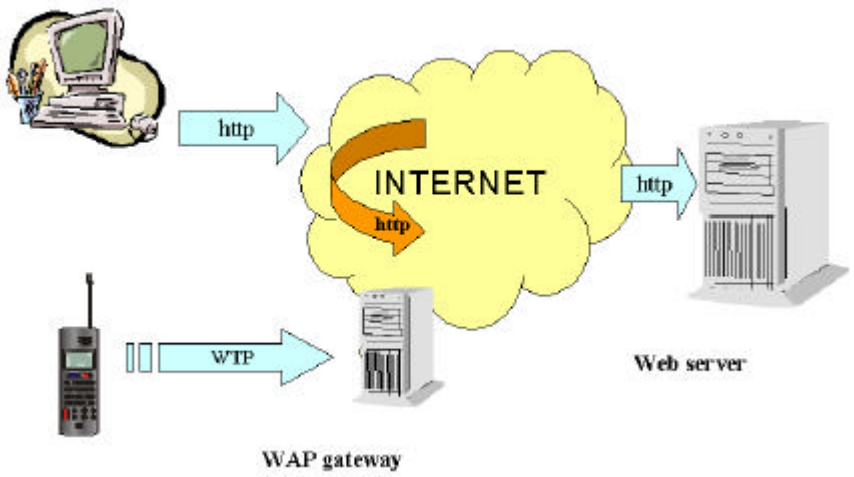

Figure 2: HTTP request.

For example, considering a cellular phone Siemens M35i, the result will be:

- *User-Agent*: sie-c31/1.0 up/4.1.8c
- *Accept*: application/vnd.wap.wmlc; type=1108, application/vnd.wap.wmlc, application/vnd.wap.wmlscriptc, image/vnd.wap.wbmp, text/vnd.wap.wmlscript

This information allows defining terminal classification rules used by the adaptation layer. Such rules can be either very specific (based on name and product version) or, sometimes, generic (based on accepted MIME type).

2.2. Localization techniques

LoCation Services (LCS) are positioning techniques that will be of great importance for mobile communication systems. From 1996 an U.S. FCC decision imposed that emergency E-911 callers were identified at the cell level (phase I). Then, more stringent localisation requirements were envisaged to be fulfilled within October 1, 2001 (phase II). In particular, the requirements were that the user should be located with an accuracy of 100 m (300 m) in the 67% (95%) of cases.
The LCS requirements are application-dependent and can be expressed in terms of: horizontal accuracy, vertical accuracy, response time, reliability and security. As for standardisation, both *GSM/EDGE Radio Access Network* (GERAN) and third-generation access networks (UTRAN) have specified LCS techniques. Basically, they can be divided into two broad categories:

- *Network-based* (i.e., all LCS measurements and elaborations are performed by the network);
- *Mobile-assisted and/or based* (i.e., either the mobile handset performs measurements and report them to the network or the mobile handset effectively obtains its position and communicates it to the network if some value added services need them).

Depending on GERAN or UTRAN access networks, slightly different localisation methods have been standardised. In particular:

- GERAN [3GPP01]:
  - *Timing Advance* (TA);
  - *Enhanced Observed Time Difference* (E-OTD);
  - *Global Positioning System* (GPS);

- UTRAN (Release 99 and Release 2000) [3GPP99]:
  - Cell-ID based positioning system;
  - *Observed Time Difference Of Arrival with network adjustable idle periods* (OTDOA-IPDL);
  - GPS based positioning system (e.g., *Assisted-GPS*, A-GPS).

On the basis of the previous classification, we can consider that: GPS and E-OTD are mobile-assisted and/or based LCS; whereas, (for instance) cell-coverage is a network based technique. Suitable network architectures have been identified to support LCS. The adoption of localization techniques will provide an input to the PALIO system, in order to tailor information contents to the context and location of the user. The selection of the appropriate techniques will be done according both to the mobile network operator localisation equipment and on LCS requirements. Two promising techniques, E-OTD and OTDOA-IPDL, are described below.

2.2.1. E-OTD

The E-OTD technique envisaged by the GERAN standard is a mobile-assisted version of *Time Of Arrival* (TOA) or *Time Difference Of Arrival* (TDOA), depending on whether base stations are synchronized or not. The user position can be computed either in the mobile handset or in the network.
The E-OTD positioning method is based on the existing PCS/GSM1900 *Observed Time Difference* (OTD) feature. The E-OTD method is based on the measured observed time difference between arrivals of bursts of nearby pairs of base stations. Essentially, the mobile terminal makes TDOA measurements between signals from pairs of base stations. For OTD measurements synchronization, normal and dummy bursts can be used. When the transmission frames of base stations are not synchronized, the network needs to measure the *Relative Time Differences* (RTD) between them. RTD measurements are needed for at least three distinct pairs of geographically dispersed *Base Transceiver Stations* (BTSs). Typically this is achieved by making *Time Of Arrival* (TOA) measurements at a known position (the network measures the relative or absolute time differences among base stations). OTD is the quantity measured by the MS to be located. RTD is a quantity related to the network (BTSs).
Location is possible, for a mobile phone, both in idle and call modes. Continuous location (tracking) or single location can be requested. Continuous location is more feasible in the mobile-based architecture, because uplink signaling is not needed at all.
For non-synchronized networks, RTD values can be measured by the network with the help of synchronization units (according to the standard designation, RTD units are named *Location Measurement Unit* - LMU). In the network side new RTD units have to be installed to the BTS sites (or to other suitable places) or the BTSs have to be synchronised. The BTS synchronisation or RTD measurement accuracy should be in the order of 100 ns. The RTD units do not necessarily need any physical connection with BTSs. This is based on the assumption that for signalling with the *Mobile Location Centre* (MLC) of the network some existing service (e.g., USSD or GPRS) is used.
The E-OTD location method can be either:

- *Handset-based*: The MS performs OTD signal measurements and computes its own location estimate. In this case the network provides the MS with the additional information such as BTS coordinates and the RTD values.
- *Handset-assisted*: The MS performs and reports OTD signal measurements to the network and the network computes the MS's location estimate.

The main characteristic of the E-OTD solution is that it may achieve an accuracy of 50 m (or better) with an appropriately planned network. LMU can be integrated or not with the base station (respectively, LMU B and LMU A). For a great accuracy in the time measurements, the LMU usually contains a GPS receiver for a very accurate clock synchronization.

2.2.2. OTDOA-IPDL

The OTDOA-IPDL method involves measurements made by the mobile station and the LMU of the UTRAN frame timing. These measures are then sent to a *Position Calculation Function* (PCF) in the *Serving-Radio Network Controller* (S-RNC) where the location of the mobile station is calculated

(*mobile assisted method*). The simplest case of OTDOA-IPDL is without idle periods. In this case the method can be referred to as simply OTDOA. The base stations (Node Bs) may provide idle periods in the downlink, in order to potentially improve the hearability of other cells. The support of these idle periods in the mobile station is optional. Support of idle periods in the mobile station means that its OTDOA performance will improve when idle periods are available.

2.3. Application server

Our choice to develop an integrated environment for the information retrieval and delivery has been oriented towards Java and XML technologies. XML is the technology proposed from the *World Wide Web Consortium* (W3C) to provide data exchanges between heterogeneous systems. XML, like HTML, is a language derived from *Structured Generalised Markup Language* (SGML). The former is a subset of the SGML, while HTML is an application of SGML. XML elements have no intrinsic meanings, they mean exactly what you want. As long as both the sender and the recipient know what the elements mean, an XML document can be used to store and transfer information in a completely platform and device independent way.
While HTML specifications tell us how the visual result will be, XML documents provide no information about the layout, but *eXtensible Markup Language* (XSL) stylesheet can be used to "style" XML for a display (by transforming it into HTML, for example). The *XSL Transformation* (XSLT) *processor* performs the transformation: from an XML document and a suitable XSL stylesheet, XSLT creates the output document.
Another XML-based language, useful for our purposes, is the *Resource Description Framework* (RDF), a language for providing information about a document, device or resource. It can be used to store the device profiles and to map the data sources.
The use of such technologies jointly with Java, as programming language for server side application, involves, moreover, the following advantages [Maruyama99], [Naughton96]:

- Platform independence, such as CPU architectures and operating systems;
- Built-in Internet Support: Java's network library package (java.net) contains a wealth of connectivity routines.

Other essential features that make Java a perfect language for our purpose are *servlets* and *Java Server Pages* (JSP) [Hall00]. Servlets are an ideal mechanism for Web applications due to their efficiency and safety. JSP technology can contain any type of text-based data, so it is straightforward to generate documents that contain markup languages, such as XML. Furthermore, servlets and JSP can use the full power of the Java platform: to access programming language objects to parse and transform XML code; to provide Web application a means to access databases, with the Java API called *Java Database Connectivity* (JDBC). Hence, the application can interact with different databases and run on different platforms.

2.3.1 Data retrieval

Our data sources are both distributed relational databases and XML documents (static or generated from other application servers). In querying the data sources we have to take into account the user localisation and the client type, according to the following groups:

- PC-TV, for clients like PC browser or webTV;
- PDA;
- GSM phone;
- GPRS phone, for clients which are able to provide higher bit-rates.

This classification permits to avoid the extraction of the information that will not be supported by the client (e.g., video on WAP phones). Since our target is an XML document containing the requested information, if the data source we are interested in is a database, we use JSP to generate the document, setting appropriately the content type.

2.3.2. Generating multiple markup languages

There are two approaches to generate multiple markup languages from the same XML code [Williams00].

The former uses the *Document Object Model* (DOM) APIs to build an objects tree, representing the elements hierarchy of the XML code. JSP pages use this objects tree to generate directly the response to be sent to the client. DOM APIs work by loading the entire hierarchical structure in memory, allowing a faster manipulation of the information. On the other side they require expensive RAM and CPU resources. In the latter, the XSLT performs the transformation by using XSL stylesheets, as shown in the following figure:

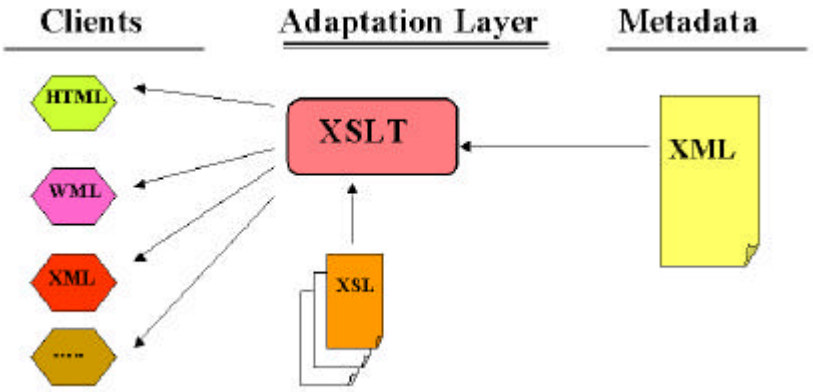

Figure 3: XSLT transformation

3. Conclusion

In this paper we have presented a technical approach for the development of an LBS service, accessible through different networks technologies and client terminals. This work has been carried out within the ongoing IST PALIO project. In particular, we have focused on the main technological options under investigation within this project.
Localization technology, Java and XML will enable the development of new application types that use heterogeneous data sources and supports different devices. We have described in this paper an approach to develop services for a wide range of communication technologies (mobile and wired) in order to provide users with useful personalised information.

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