General structure of an inter-mode public transport information system based on Web technology

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Abstract

This paper describes an information system based on Web technologies which gives information about the Canary Islands' passenger public transport system. We describe the Web techniques and methods used in its development. The main difference of this system from most existent systems on the Internet is its inter-modal and integrated nature, which covers information from various transport companies of different natures (road, maritime and air transport) and dimensions (large companies which move more than 25 million passengers annually and small companies).
Keywords: information systems.

1 Introduction

This paper describes the most important aspects of an information system based on Web technology. The main goal is to give information about the passenger public transport service in a European region, in particular the Canary Islands. From the point of view of Web technology, the system faces and uses current aspects of this technology such as: Web services, Web accessibility, Web delays reducing, etc. One system's relevant aspect is that it integrates very diverse transport corporations with different technological states. Moreover, a consequence of this integration is that the system facilitates the technological innovation in these corporations.

Specifically, we have developed a web application that informs the user about how to arrive at a destination point from a departure point selected by the user,


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considering the following user preferences: price, travel time, number of changes and transport mode. Therefore, it is an inter-mode transport information system that integrates different kinds of companies (road, maritime and air), with different requirements and dynamics (large corporations that transport more than 25 million passengers and small companies with less than 25 employees), giving solutions based on timetables and price. We can find similar applications on the Internet, but the majority do not support inter-mode transport systems, only working with one kind of transport, mainly transport by road (bus and subway). These systems do not give information about timetables or prices. Our information system, based on Web technology, maintains updated information that represents the transport company net, formed by stops, lines, timetables, prices, etc. Through the information provided by each company, the system integrates every particular transport net creating a general transport net which covers all the Canary Islands' geography, and from this general net we can obtain information about how to go from one point to another in this region. Moreover the obtained solution considers the users preferences such as: rapidity, price, small number of transfers and kind of transport.

The main contributions of this job are: first, it describes a novel passenger public transport information system that considers users preferences and which has an inter-mode nature, and second it is a practical application of current recommendations and techniques about Web developments.

2 Objectives and requirements

The main system objective is to inform the user how to go from one point to another, using the services offered by different public transport companies. There could be different itinerary alternatives and the system should allow, specifying the user preferences, the best solution to be obtained. Having this main goal in mind, and considering the system's geography (8 islands) the first problem to solve is how to model a public transport's net using three different kinds of transport (by road, maritime and air) and integrating various transport companies with different production processes due to disparity of dimension. The system should use a data model capable of obtaining the relevant information in order to achieve a uniform vision. In this sense, an important question that arises is how to produce the integration of the different companies in the system, because this integration needs to allow an easy and reliable updating of the company information without interfering in the productive process. This requirement is named the "Corporative integration requirement".

From a socioeconomic point of view, the system should create an incentive to use public transport, therefore we have chosen a system based on Web technologies so it can be used by the largest number of people. In order to facilitate access, the system should permit the use of different types of browser terminals (PCs, mobile telephone, PDA, etc.). This requirement is named the "User terminal integration requirement". Related with accessibility, the system should have user interfaces, which permit a friendly interaction, including

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physically handicapped people. This requirement it named the "Usability requirement".

Finally, the system must avoid excessive response times. This is a basic aspect in any web application, but in our case it has a special relevance considering the problem we need to solve: giving solutions of itineraries between two points of a dynamic transport net composed of thousand nodes and lines, taking account of the users' preferences. This requirement is named the "Answer time requirement".

3 General system structure

In order to explain the general system structure, we will use the requirements described in the previous point.

3.1 Corporative integration

This requirement refers to the integration of a particular corporation information system into the complete information system. This integration should permit us to incorporate very different data (volume, content and format) provided by the corporations, for example, the biggest transport companies can provide information about more than two thousand daily expeditions, and the smallest companies can provide information about ten daily expeditions. Moreover this integration should not affect the information process that each then executes internally, with no additional cost in order to facilitate the companies participation in the system. To achieve this requirement we have based our system on a Web service model [1]. In this kind of system, databases and network are integrated in a virtual system where users can work using browsers. Figure 1 shows a simplified representation of this concept.

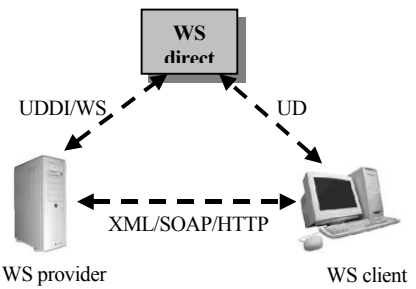

Figure 1: Web service systems functioning philosophy.

In our system, the Web service suppliers will be the Canary Autonomous Government, which will provide data and applications, and the transport companies will provide data and access interfaces for the required data. The clients of the Web service will be general users, who request itinerary information, transport company users and Government users. The Web system

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directory contains the database used by the system and the application set required by the different users. The applications are elements that can be integrated into the company system as an independent application, in order to extract useful information for the complete system, and add some functionality not available in the transport company. This scheme is an incentive for the corporations to participate in the project. There is another type of Web applications for small companies with poor technological development. These special applications implement a functionality set and provide useful information to the system. Specifically, we have developed two different Web environments; one to provide all the necessary transport net information and another for user access which permits, selecting the departure and destination points and the preferences of the journey, the display of the best itinerary. In the first Web environment developed there are three types of users: the system administrator, the transport company user and the authority of transport.

3.2 User terminals integration

This requirement refers to the capability of the users to interact with the system by different physical devices using the Internet. Nowadays mobile terminals, such as PDAs and mobile telephones, play a relevant role. The objective is to incorporate these technologies to obtain a system where the user interaction is made such as that shown in Figure 2.

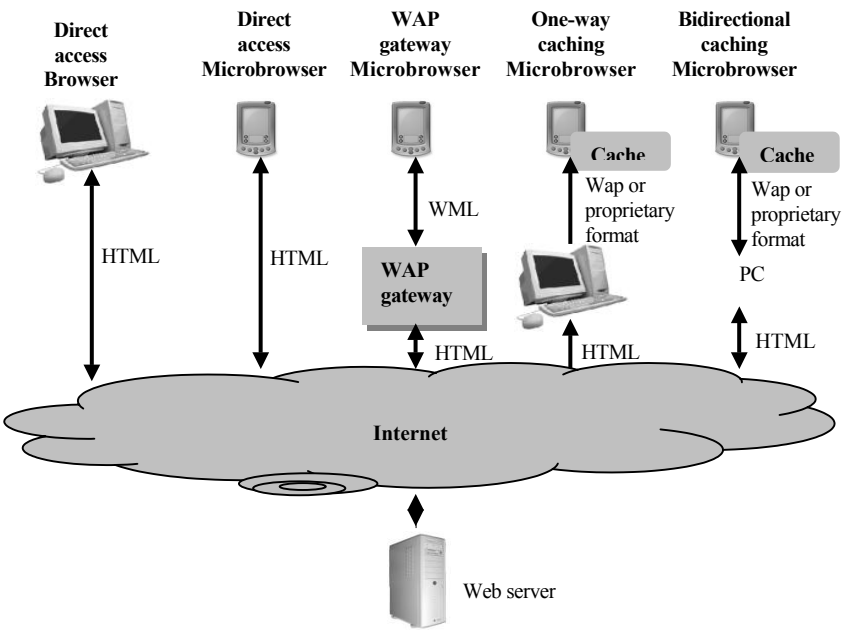

Figure 2: User interaction with the system.

3.3 Usability

This requirement has a relation with the facility that users should have for interacting with the system. To achieve this requirement, we distinguish two kinds of categories. The first has a relation with the facility to interact of the general users, and the second with the facility to interact of physically handicapped users. Referring to the first category, named in the bibliography usability, the user interface has been developed using the following recommendations [2]: first, a good browser's diagram which helps the users to obtain information, in an efficient and agile way, using the appropriate elements (windows, sensitive graphics, dialog boxes, etc.) and with the least number of mouse clicks. Second, a proper answer time. In the system this factor is affected by two different parameters: download time of the elements that form part of the different user interfaces and the time the system needs to search the solution required by the user. With respect to download time, we have used graphic elements which can be easily downloaded by the net. Third, the interfaces have limited contents, and have been structured so that we can reach them following a logic diagram with the least number of mouse clicks. Fourth, the interaction with the system is facilitated using help contents that guide the user in the system session. Related to the facility to access for physically handicapped people, we have considered the next sentence [3]: "making the Web site more accessible benefits all, not only physically handicapped people". Therefore we have considered the following recommendations: provide alternative texts to sensible graphic elements, use of relative dimensions and positions instead of absolute ones and no use of automatic page refreshing.

3.4 Answer time

It is a critical parameter in all Web applications. The factors that affect this parameter can be divided into two groups [4]: those related with the network (services and protocols) and those related with internal processing systems. As the factors related with the network (mainly DNS and connection handle) do not depend on our system; we concentrated on the internal processing of the application service, specifically: first, avoiding the excessive use of dynamic data, searching in static elements. Second, the data are sent to the client using data blocks of reduced size so we do not use a wide bandwidth. Finally, trying to ensure that the clients can work directly with the HTML results and avoiding the download of applications.

Considering that, from a formal point of view, the main goal of the system is to find connectivity solutions between two nodes of a time dynamic graph it is important for the search algorithm to be fast enough so that the system provides an acceptable answer time for the user. For this reason, we have developed a search solution algorithm inspired by techniques used in the improvement of Web system performance: use of cache records managed by a statistical method (records that store journeys between frequently used points) and a process model which divides a complex search problem into various basic search problems in

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order to distribute the load associated with a complex problem (for example: an itinerary composed of various transfers using different companies)

4 Conclusion

In this paper we have presented an information system based on Web technologies, which has been developed considering current Web system design techniques and methods. Our system has the following differential characteristics: it is an inter-modal system. That means that it integrates different kinds of transports (road, maritime and air) and it can provide information based on dynamic data and considering the final user's preferences (price, rapidity and less number of transfer). Moreover, this system demonstrates that the use of Web technologies facilitates the development of applications with an enormous socio-economic impact. These Web technologies permit us to develop high quality products with a high level of usability.

The future goals to achieve are: the use of the new mobile terminals, the use of multimedia information and special devices which facilitate usability for physically handicapped people, and finally the use of geographical system information in order to improve the system functionality and facilitate the interaction with the user.

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