Personalized Services for Mobile Route Planning: A Demonstration

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Abstract

Enabling mobility in urban and populous areas needs innovative tools and novel techniques for individual traffic planning. We present a prototype of a traffic information system enabling personalized route planning plus advanced services like traffic jam alerting. The best routes are efficiently computed using the SR-Combine algorithm, subject to various user preferences and current traffic situation gathered dynamically from several Internet sources. We implemented a J2EE application server which smoothly adapts to distributed online processing, once high bandwidth networks like UTMS are available.

1. Introduction

The recent developments in mobile communication have paved the way for a variety of applications. In urban and populous areas traffic information services for, e.g., commuters are crucial. Due to the development of GPS and navigation systems those services can improve route planning and accompany the journey with useful information. However, traffic situations may change, traffic jams may evolve or dissolve, the weather may change drastically, etc. Thus a wireless service is essential to provide up-to-date information. In this demonstration we describe a situation-aware mobile service prototype comprising route planning, alerting for traffic jams and alternative routes. We present a demonstration of our prototype for real world use modeling the complex autobahn system from the German Ruhrgebiet area. The online sources are traffic information from a local radio station, road works from the German ministry, and local weather data. Data from all these distributed sources is integrated and used to recommend routes for each individual user.

2. Service Personalization

For personalization in complex mobile route planning the user's expectation has to be broken down to single Internet information sources. The length of routes is such an expectation, but would a user really prefer a route with many road works to a slightly longer route with no road works ahead? Preference research has become an active field in databases ([Kie02, Cho02]). [Kie02] characterizes preferences as *strict partial orders*, modeling "*I like A better than B*" choices. E.g. many individuals prefer dry roads to wet, slippery ones. Complex preferences can be engineered inductively by pre-defined constructors, like Pareto (modeling equal importance), prioritized (modeling ordered importance) or numerical preferences.

Route Planning Preferences: Building a personalized Web service for mobile route planning the integration of data from various sources plays an important role. Consider a typical interaction where a driver wants to go from city A to city B, getting a set of routes to choose from. Such routes may differ e.g. in length, traffic jams, road works, or weather conditions. A driver may prefer shorter routes, and the shorter the route the more adverse factors he or she accepts. We use numerical preferences with adequate scoring functions f_i and a combining function F that can be changed according to the requirements (see [BKU02] for detailed modeling):

$$F(x) = ((x_1+1)\cdot f_{length}(x) + x_2\cdot f_{traffic\_jams}(x) + x_3\cdot f_{road\_works}(x) + x_4\cdot f_{weather}(x)) \,/\, (\Sigma\, x_i +1)$$

To integrate all factors we used user-defined weights x_i assigned to each condition (cf. fig. 1) mapping three degrees (important, medium, weak) onto adequate weights.

Preference Query Evaluation: Our Web service collects information in the form of ranked lists from different sources and integrates them efficiently using a personalized combining function. The problem of efficiently integrating several ranked lists to get some overall best objects is addressed as *top-k retrieval* ([GBK00, FLN01]). For our implementation we used the *SR-Combine* approach [BGK02] that promises efficient top-k retrieval for central server architectures, but also self-adapts to distributed architectures, if high bandwidths in high performance networks can be guaranteed ([KB02]). Using a heuristic indicator technique SR-Combine chooses the most promising object accesses to optimize run-time characteristics. Benchmarks in [BGK02] show that SR-Combine scales well and in practical cases meets the psychologically acceptable 3 second response-time threshold.

Fig 1: Mobile querying of routes (left-hand) and results delivered (right-hand)

3. Technical Solution

Because of real-time requirements previous approaches were mainly static Web services for route planning, e.g. Route Planner[1] or the OnStar[2] system by General Motors. Current information is integrated by agent-based systems gathering information from distributed sources within complex CORBA architectures [YTT00] or collecting floating car data like [MCM98]. The area of data integration over the Web led to two architectures: C*entral server architectures* provide services using a high performance application server with central repositories. In a *distributed sources architecture* a middleware gathers information on demand via the Internet.

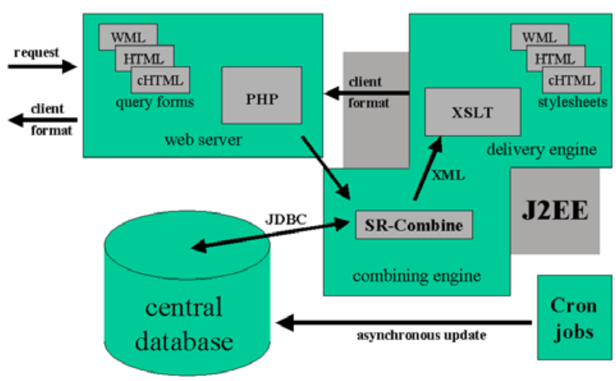

Fig. 2: Mobile service architecture

A solution for distributed sources using database technologies offering typical advantages like e.g. scalability up to now failed. First approaches like [BGM02], building a distributed location-based restaurant service in a database environment, reported run-times in the range of hours even for simple tasks. A concept for combining Internet sources with central database servers is the WSQ/DSQ approach [GW00] handling accesses in an asynchronous manner and caching results for later use in virtual tables of a central database. Since service providers generally know what type of queries to expect, what data is commonly accessed and how often updates are needed to meet the service design, asynchronous updates are suitable for mobile services.

To get an industrial strength architecture for real-time services we will rely on a central server approach with asynchronous updates (see [BKU02] for details). The architecture (cf. fig. 2) is built around an IBM DB2 V7.2 database system that stores all different route segments together with geographic, current traffic and weather information. A J2EE application server communicates via an Apache 1.3 Web server, whose capabilities are extended using PHP 4 scripting language. At each service request the browser type of the mobile client device is identified and data is transferred to the application server running the combining engine with SR-Combine. The final results are assembled using a generic XML format that can be transformed by the delivery engine to suit any client device for that appropriate style sheets are kept. Using a Xalan XSLT style sheet processor the generic pages are automatically transformed. If e.g. a WAP phone is used all output is automatically transformed to WML; for I-MODE clients proper cHTML pages are created.

4. Practical Case Studies

Now let us take a closer look on a sample interaction with the motorway network in the Ruhrgebiet which is a particularly densely populated area within Germany and a sample driver in Krefeld who has to go to Leverkusen. Fig. 1 shows a map of the area and we can see different routes that, however, may entirely differ in their traffic conditions. Looking at the user's preferences we find that it's important to get to Leverkusen quickly, i.e. on a short route without traffic jams, but the weather doesn't matter.

1 http://www.routenplaner-online.com/
2 http://www.onstar.com, 1997

Best routes are returned automatically formatted with cHTML style sheets for our I-MODE client device (cf. fig. 1). Users can also register for further service that alerts on changes in the current traffic situation for the route chosen. The service adds an alerting component to our application server (cf. fig. 3). On each update of the central database its effect on the routes of all registered users is determined. If a route is affected the current position of the car is used to repose the original query. If a better route is detected an SMS or e-mail containing a personally preferred rerouting is sent.

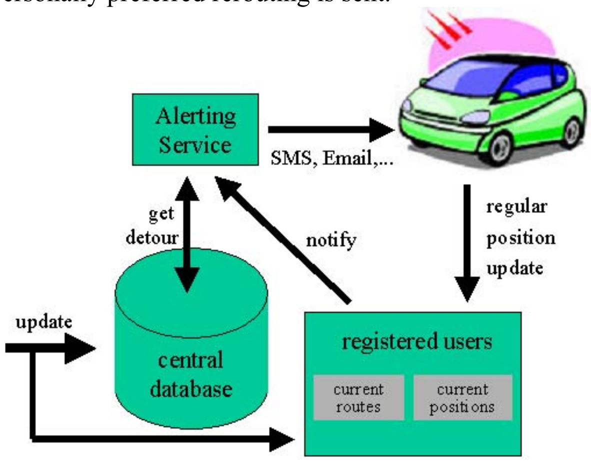

Fig. 3: SMS alerting service

We analyzed the performance of our experimental prototype system to investigate its real-time capabilities. We used a 1.4 GHz AMD Athlon with 768 MB RAM as application and database server and posed queries via 100 MBit LAN. We have taken the average over queries using different locations and analyzed the runtimes for different numbers of routes to return. As can bee seen in fig. 4 the response times meet the psychologically founded 3 sec response time barrier and only slightly rise with more objects to return (for extensive study see [BKU02]).

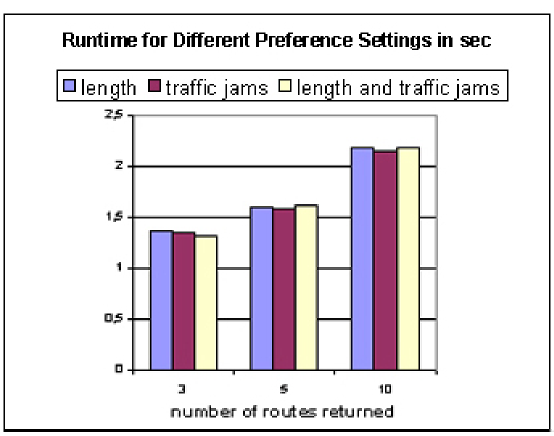

Fig. 4: Performance evaluation

5. Summary and Outlook

We presented the prototype of a personalized Web service for mobile route planning. Mobile client devices inform the user about optimal routes for traveling. Due to low bandwidths and real-time constraints we implemented a central server architecture using asynchronous updates from various Internet sources. Users can express preferences on various features of the route leading to advanced personalization. The SR-Combine algorithm efficiently evaluates queries, beating the psychologically founded barrier of 3 seconds response time. The results are delivered to mobile users by appropriate XSL transformations. Moreover, changes in the current traffic situation are monitored and users are alerted, if events on their routes suggest an alternative one. Importantly, due to the self-adaptability of SR-Combine we can straightforwardly adjust our service to distributed architectures whenever the bandwidths support real-time querying.

6. References

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