WhereRU: GPS position reporting and a personal ontology as a virtual community utility

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Abstract— **The recent progress of the World Wide Web has created new needs for information sharing in virtual communities. WhereRU is a multiuser GPS position reporting system that allows users to make their location publicly available as well as associate it with information on places, persons and events that may later also serve as reminders of the their experiences when traveling**

Index Terms— **position reporting, web community**

I. INTRODUCTION

One of the main reasons of the huge success of the World Wide Web and its conversion to an everyday tool for both work and leisure has been the new and revolutionary methods for synchronous and asynchronous communication that it offers. From the now commonplace e-mails, to mailing lists, chat services, forums and blogs, the Web offers endless possibilities for users to communicate quickly, cheaply and directly with colleagues, friends and strangers, both for professional and entertainment purposes.

More and more users feel ready to share personal information and exchange views and opinions publicly in virtual communities or with selected groups of other users, who may include people that they have never met in person. The huge success of web sites like MySpace [1] or Facebook [2] are proof that an ever-growing number of users enjoys an active "virtual" social life and has an interest for tools and services that would make such "social utilities" more interesting.

This work presents a tool that offers the potential to enhance the experience of being in a virtual community significantly, by allowing users to provide on the Web near real time information about their location along with comments and audiovisual information, as well as semantic information from the user's personal ontology. WhereRU, as a multiuser GPS position reporting system, allows users to make their location publicly available as well as associate it with information on places, persons and events that may later serve as reminders of the user's experiences when traveling.

II. RELATED WORK

There have been recent efforts for creating real time GPS tracking and position plotting on a map.

Reperion [17] enables users to send their GPS position in real time to a server, where their location is displayed in realtime in Google earth via a network link, and on a highly detailed map. They can also send and receive messages, upload audio and pictures to the server, or get navigation information.

GPSed [18] is a location-based service for trip tracking from a mobile phone. In real time tracks are traced on Google maps and stored in an online archive. With a geotagging feature it is possible to pin photos to a map precisely at a place they were taken.

Our approach takes real time GPS tracking a step further, by coupling it with the OpenATC service for linking positions with flight information and with a personal ontology in order to associate logged positions with semantic information.

III. WhereRU System Description

A. Concept

WhereRU is a multiuser GPS position reporting system. It is targeted towards people that travel and would like to provide near real time information about their location on the web. Furthermore, through its enhanced annotation functionalities, WhereRU offers the possibility to link visited locations with information about Places, Persons, Events, etc. These links may serve as reminders when later re-visiting a location in order to re-find a good restaurant or the spot in a square where the user met a very good friend.

A GPS-equipped PDA is used to send the position and location information by utilizing a WiFi, GPRS or WAP internet connection or SMS messages. Each user can attach a text message on each position report that can be used to provide comments about their location. In addition there is a flight information feature that enables the users to provide their flight information (flight number and/or aircraft registration).

Position and location information for all users is displayed on the WhereRU web site that utilizes Google Maps to plot

the positions on a map.

The platform consists of three applications, the client application that runs on the portable device, the server application that receives the location information and the web application that is responsible for displaying location information on the web.

B.Client Application

The client application is written in C# for Windows Mobile 5 & 6. Its main screen provides easy access to the basic functions of the application, which is the connection to the GPS device, a text box for entering location information and the "Send" button that will send this information to the server. Figure 1 presents the Client application's main screen.

On the upper part of the screen the following GPS information is displayed:

- **Fix**: 2D, 3D or no position fix
- **Last Lon/Lat**: The last Longitude and Latitude that was acquired.
- **Sat**: The number of satellites that are used to obtain a location fix.
- **SV**: The total number of satellites in view.
- **FA**: The time in seconds since the last position acquisition.
- **V**: Speed
- **Dst**: Distance from the last location a report was sent successfully to the server.

When the GPS is activated and a valid position fix is acquired the "Send" button is enabled and it will remain enabled even if the GPS signal is lost. This way the last position can be sent even if there is no GPS signal by the time an internet connection is established. Any message typed in the text box will be sent along with the position information. On successful data transmission, the text box contents are cleared and the distance from the last position report is reset.

Fig. 1 Client Main Screen

In order to cover the event of boarding an aircraft the flight information screen can be used to identify departure or arrival to an airport. Figure 2 presents the Client flight information screen.

Fig. 2. Client flight information screen

By selecting the "Departure" radio button on the flight status screen, the next report will be marked as flight departure and will contain the Call sign or the registration number of the aircraft if these are entered to the appropriate text boxes.

The flight information is used by the WhereRU web site to create a link to the OpenATC web site that provides real time flight tracking. Once the position report is sent successfully, the flight status will automatically change to "Landed" so that the next position that will be sent will contain the information that the user is back on the ground. When the "Landed" report is sent the flight status will return to no flight.

Another feature is the automatic position report. This can be configured on the auto-send settings screen. Figure 3 presents the Client auto-send settings.

Once enabled, position information will be sent automatically based on one of the following parameters:

- **Distance from last position report**. Once the distance from the last position report is greater than the auto-send distance, a report will be sent.
- **Time from the last report**: Once the amount of time from the last report is greater than the auto-send time, a report will be sent. This feature can be combined with distance in order to avoid reports from being sent if the user has not moved.

A report counter and a "maximum number of reports" setting is also available in order to control the cost of the reports.

On the communication settings screen, parameters regarding GPS connectivity and report submission methods

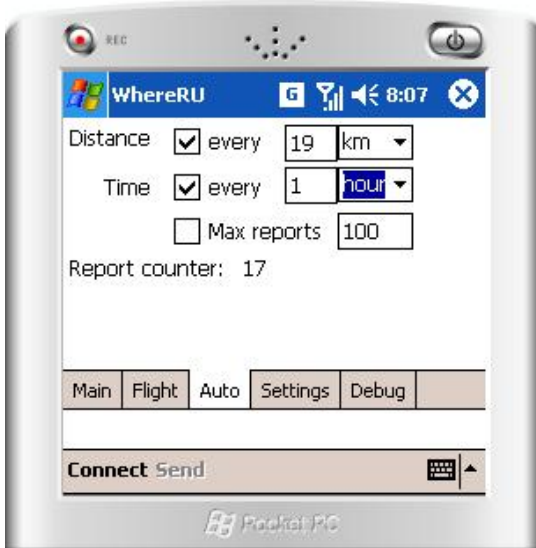are selected. Figure 4 presents Client communication settings.

Fig. 3 Client auto-send settings

The *GPS port* control provides a list of all the serial ports detected, allowing either to use a built-in GPS device or acquire GPS information through a separate GPS device accessible via Bluetooth communication. The *Baud rate* control can be used to set the GPS data transfer speed.
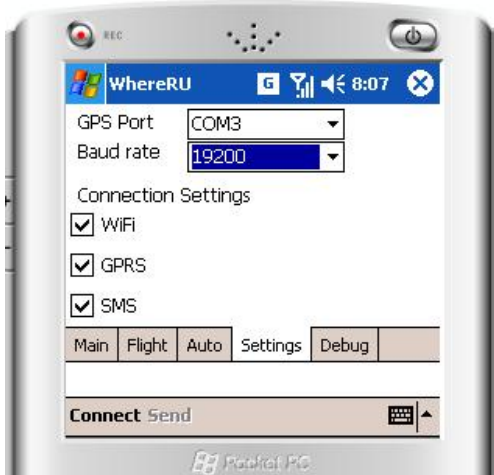

Fig. 4: Client communication settings

The Connection settings area permits the user to designate the allowable channels through which reports can be sent to the server. The offered possibilities are WiFi, GPRS and SMS and are tried in this order, aiming to minimize the application's cost of use. Indeed, WiFi connectivity is usually free or has a very low cost, while GPRS and SMS are charged by mobile telephony operators..

C. Server Application

The server part of the application is written in PHP, complemented with some shell scripts for SMS processing; it may run on Linux/Unix systems, whereas Windows-based platforms can host the server application provided that shell script execution is made available e.g. using Cygwin [19]..

It uses http/https protocol for accepting position reports over the internet and storing them in a MySQL database. Each report contains the following information:

- **Client ID**: Identifies the user that sends the report.
- **Password**: The client password for authentication
- **Lat/Lon**: Latitude and Longitude
- **Flight Status**: Determines the flight status which is one of "No Flight", "Departure", "Landed"
- **Flight Information**: Registration or Call sign of the flight.
- **Time stamp**: The time the position was acquired based on the GPS time information.
- **Speed**: The speed as acquired by the GPS
- **Randomizer**: A random string value to improve data encryption.

User authentication is carried out using https protocol and need only be performed once. Once a user is authenticated a shared key is agreed upon and stored both at client-side and server-side. Subsequently, the client application will use that key to encrypt the information sent to the server. All data is encrypted except the "client ID". This was preferred over using https protocol at all times due to the fact that some internet service providers might filter https. In addition this will provide data encryption when SMS reporting is used.

In order to support position reporting over SMS a cell phone is attached to the server using a serial connection. Once an SMS is received its data is extracted and converted to an HTTP GET request which is sent to the server application that processes the position reports over the internet. This approach was preferred over processing directly the information as it enables the SMS processing application to reside on a different server.

D. Web Application

The web application is the one that actually plots each user's position on a map. It is built as a module for the Drupal CMS [20]. Maps are provided by Google by using the GoogleMaps API [21].

On the main page a map with the latest position of each user is displayed (Figure 5).
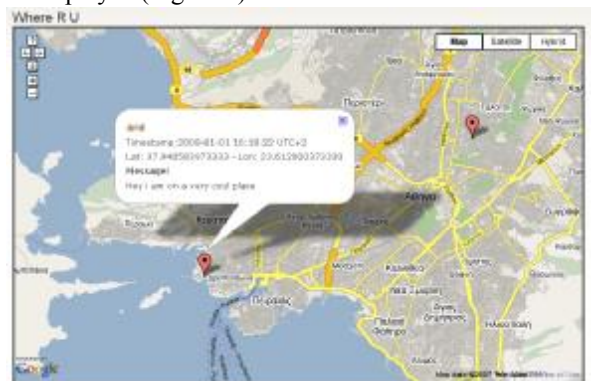

Fig. 5 Main Page

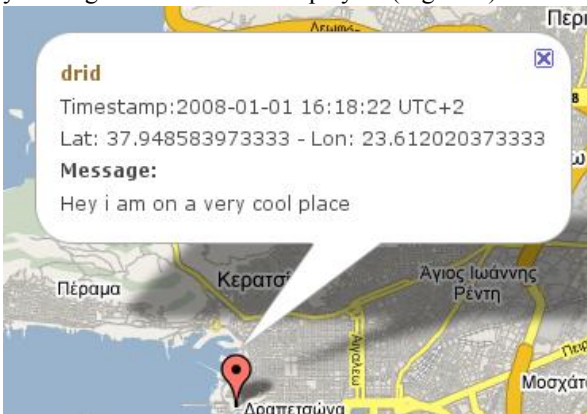By clicking on a marker additional user coordinates and any messaged submitted are displayed (Figure 6).

Fig. 6. Position information

The user name displayed on the top is a link that displays the markers of the specific user. When displaying single user markers a green line is used to connect the markers in time-based order. The last position is identified by the large red marker (Figure 7).

Fig. 7 Single user markers

When flight information is available, links are displayed leading to the OpenATC web site in order to provide real time flight tracking (Figure 8).

Fig. 8. Flight information

Users can configure the way their information is accessed. The user setting page allows the user to select the number of markers that will be displayed and the time span of position report history in days.

In addition, users can control who will be able to access their information. There are four basic access rules as follows:

- **All**: Every one can access the users position reports
- **Registered users**: Only the registered users of the WhereRU web site can access the users position reports
- **User List**: Allow access only to specific users.

E. Connecting multimedia contents

Most portable devices are nowadays capable of capturing multimedia content, mainly in the form of still pictures and video; audio recordings are also available in many devices. For pictures and video, in particular, all portable devices embed within the multimedia file the date and time of capture; the JPEG format also provides the capability of storing location information (longitude and latitude) within the EXIF picture data. Having this information available, user position information may be enriched with multimedia content as follows:

- If location information is available within the multimedia file, a marker can be drawn at the map at the exact coordinates; the marker will be a hyperlink to the multimedia file.
- If location information is not available within the multimedia file, then the geographical location of the image/video may be approximated by exploiting the date/time information within the picture: user position reports are examined to locate the segment that contains the instant that the picture was taken and interpolation may be used to provide an estimate of the actual picture location. The user may then adjust the computed position to more accurately reflect the picture whereabouts.

As a final note, pictures can be uploaded to the web server either synchronously (through WiFi or GPRS), or at some later time – e.g. after transferring them to a desktop computer with broadband internet connection. All information needed to relate multimedia files to the user trace is present within the files, thus only the "real-timeness" of information presentation is affected.

IV. WhereRU and the Personal Ontology

This section presents in more detail the Annotate functionality of WhereRU. The basis of this annotation is the personal ontology of the user.

A. Personal Ontology and Profiler

According to [7], an ontology is an explicit specification of a conceptualization. The term "conceptualization" is defined as an abstract, simplified view of the world that needs to be represented for some purpose. It contains the concepts

(classes) and their instantiations (instances) that are presumed to exist in some area of interest and their properties and relations that link them (slots). The term "ontology" is borrowed from philosophy, where an ontology is a systematic account of Existence. This section presents details on the creation and use of a personal ontology to further enrich WhereRU location information with annotation keywords related to Places, Events, Persons and other user-defined semantics.

Using an ontology to model semantics related to the user personal domain has already been proposed for various applications like web search [3], [4] and personal information management (PIM) [5], [6]. Most of these approaches use ontologies only as concept hierarchies or semantic nets, like hierarchies of user interests, without particular semantic complexity, or do not provide details on the underlying personal ontology.

The personal ontology we envisage is not simply populated with instances on an individual basis, but also includes user-specific classes and relations. It is a flexible tool that allows users to record information about places, events, persons and activities that have a special meaning to them as reminders of past events or for sharing information in communities. It consists of a standard set of upper level classes that offer a point of reference for sharing information between users, as well as their specializations, which may be user-defined.

In order to create a simple yet comprehensive set of upper level concepts for the personal ontology, the standard classes, profile information models maintained by various applications, like instant messengers (e.g., ICQ [8]) and community websites (e.g. Facebook [1] and MySpace [2]), and proposed by researchers, like [3][4][9], were examined; general ontologies like the ones presented in [10] were also taken into account along with the MIME directory profile vCard [11].

Details on the creation of the personal ontology may be found in [12] and [15]. An extension of this personal ontology for the "Researcher" stereotype may be found in [13].

This personal ontology may be gathered from existing resources such as an email address book and/or produced explicitly by the user. It is the place that gathers both personal profile information such as the user's address and also wider information relating to the user such as friends, or projects.

Ontology management tools such as Protégé [14] are currently designed to be used by ontology experts. In order to allow users to update their personal ontology easily, a web-based ontology browsing and editing toll has been proposed [15]. This tool hides some of the complexity of the class hierarchy and allows custom views to be defined.

The Personal Ontology Profiler has been developed as a separate application that communicates with the selected ontology storage repository through web services; therefore, this module may be used not only in the context of WhereRU,

but also for other applications opting for using a personal ontology as a user profile model.

The profiler is being implemented as a standard web application using HTML and PHP and its communication with the ontology storage module may be accomplished through the exchange of ontology data with the ontology storage module in XML format [16].

The personal ontology along with the profiler editing tool allows the users to record, search, view and manage personal information through the web. WhereRU takes advantage of this information to provide the users with enhanced annotation functionality.

B. The Personal Ontology in WhereRU

The WhereRU Client application in the user's PDA needs to access the user's personal ontology in order to take advantage of the enhanced annotation features it offers. This is accomplished through the **Annotate** tab (Figure 9).

The availability of the personal ontology in the ontology server provides two options for the WhereRU ontology annotation functionality when traveling:

- **XML Upload**. The user, before the departure, may upload the current status of his/her personal ontology in the PDA in XML format.
- **Access to the ontology server**. If the user's PDA has Internet access throughout the whole trip, the user may access the ontology directly in the ontology server on-line.

When the user wishes to annotate a logged position with ontology instances, again there are two options available:
- Use existing instances
- Create a new instance

Fig. 9. The Annotate Tab of the WhereRU Client Application

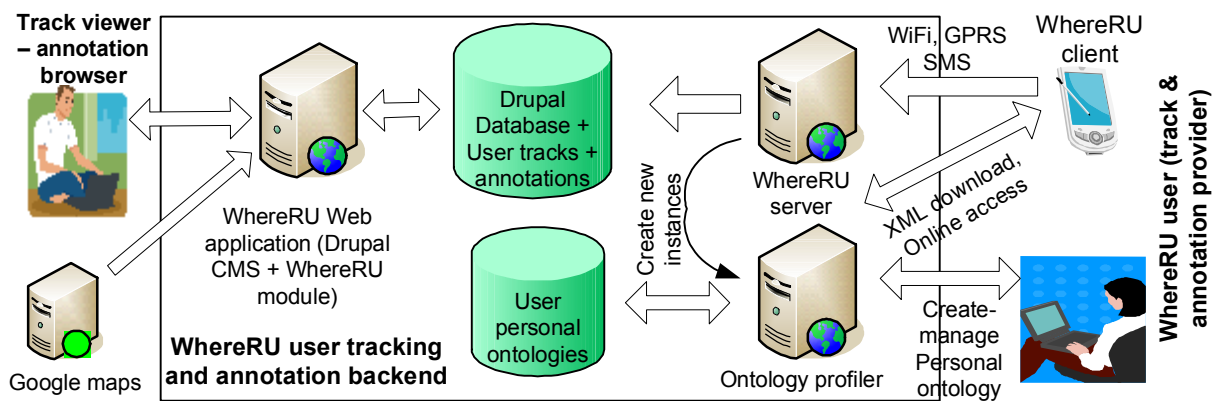The user, through the Annotate Tab, selects the upper level

Fig. 10 Overall System architecture

class of the instances that wishes to associate with the position. By writing the first letter(s) of the instance name in the appropriate textbox, the user may drill down to select the class instance that corresponds to the position if it already exists in the ontology. This may be the Place where s/he is (a hotel, a restaurant, a monument, a park, etc), a Person s/he is currently with, an Event s/he is participating (a friend's birthday, a conference, a party, etc) or another related Thing.

If the instance is not currently in the ontology, the user simple provides its name in order to associate it with the position and be able to edit it later. When the user has an Internet connection with the PDA, s/he may upload the positions and associated instances, old and new, to the personal ontology.

Annotation information, together with user position information, are made available to the server and are then linked with the personal ontology nodes. Once these links are established, they may be exploited for offering richer browsing experiences to users – e.g. when a user views a friend's page the system may offer a link "Places I've been with…", "Events I've shared" and so forth. Annotation information may also be used to enhance searches.

V. CONCLUSIONS AND FUTURE WORK

This work has presented a as a multiuser GPS position reporting system, that allows users to record their current location when traveling and make it publicly available as well as associate it with information on places, persons and events that may later serve as reminders of their experiences when traveling. The novelty of this system lies with its enhanced options for annotation with information coming from Flight Information Services as well as the user's personal ontology.

Future work includes a long term evaluation of the application to get feedback on the user reactions in real life, develop the client application for different platforms in order to cover more PDAs and laptop computers and a two way SMS communication for key exchange in order to increase usability.

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