Location-Based Media Sharing in a MP2P Network *

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In both academia and industry, peer-to-peer (p2p) applications have attracted great attention. This paper introduces and implemented a novel location-based multimedia application, the Multimedia Traveling Journal application (PhotoJournal) that employs the p2p paradigm and enables location-based content sharing among mobile users.

I. Introduction

The Web and Internet have been catalysts for the creation of collaborative applications and tools. On-line collaboration has been enriched with new applications and tools for storing, sharing, and experimenting with multimedia data in a synchronous or asynchronous manner, such as YouTube [1] and Flickr [2]. These technologies have allowed the formation of new types of social networks, interactions, and online communities. We anticipate that in the near future mobile devices that have the processing, communication and geolocating capabilities will enable seamless integration of services combining media sharing and geographical tagging.

This paper presents the Multimedia Traveling Journal application (PhotoJournal), that applies the peer-to-peer (p2p) paradigm to share location-based content among mobile devices. The PhotoJournal is supported by a middleware with two main components, namely a positioning and an information discovery system. The underlying positioning technologies are GPS and Cooperative Location-sensing System (CLS) [5, 6].

II. System Architecture

Section II.A is going to describe CLS and 7DS. Furthermore, Section II.B focuses on the PhotoJournal and finally we conclude in Section III.

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II.A. Background

7DS [4] acts as the underlying information discovery and sharing mechanism for applications that run on the local device enabling the p2p data sharing. When an application requests a data object, 7DS first checks its cache, and if the data is not available, it tries to acquire it from the Internet. If the local web client fails to connect to the Internet, the local 7DS instance multicasts a query about that object in the wireless LAN.

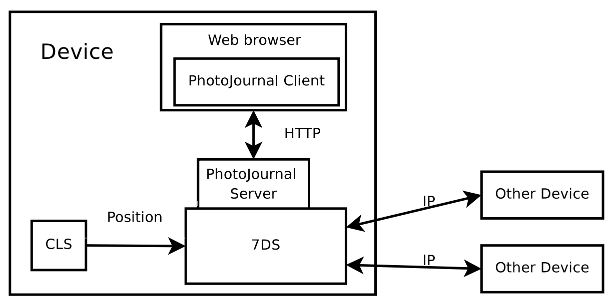

Figure 1: PhotoJournal architecture.

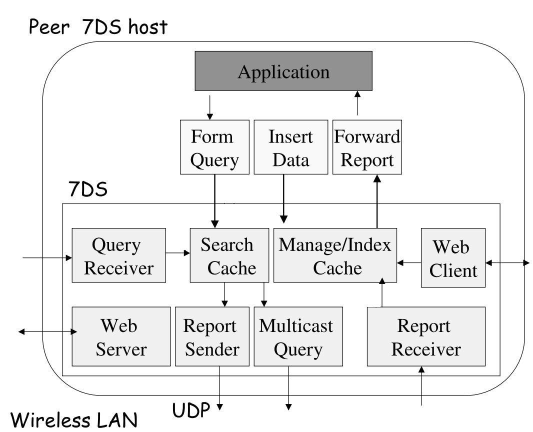

Figure 2: Interaction of 7DS with applications.

The CLS is a novel location sensing system that employs the p2p paradigm and a probabilistic framework to estimate the position of wireless-enabled devices in an iterative manner without the need for an extensive infrastructure or time-strenuous training. CLS can incorporate signal-strength maps of the environment to improve the position estimates. Such maps have been built using measurements that were acquired from APs and peers during a training phase. Periodically, CLS can refine its positioning estimations by incorporating newly received information from other devices.

At run-time, the local CLS instance acquires signal-strength measurements from peers, constructs a run-time signature, and compares it with the ones that have been generated during the training phase using various criteria for the comparison, namely, a confidence interval-based and a percentiles-based criteria.

CLS adopts a grid-based representation of the physical space; each cell of the grid corresponds to a physical position of the physical space. The cell size reflects the spatial granularity/scale. Each cell of the grid is associated with a value that indicates the likelihood that the node is in that cell. These values are computed iteratively using one of the following two approaches. Firstly, a simple voting algorithm, through which a local CLS instance casts votes on cells of the grid. A vote on a cell indicates the likelihood that the local device is located in the corresponding area of that cell. Secondly, a particle-filters based model.

The performance of CLS was evaluated in Telecommunication and Networks Laboratory at FORTH, an area of $7x12m^2$. The median location error was 1.8m [6].

II.B. PhotoJournal

The PhotoJournal application enables users to build interactive multimedia journals that associate multimedia objects such as pictures, video, or hypertext, with locations on maps. Through 7DS, it allows peers to share files associated with certain locations. The multimedia files and maps are stored in the cache of the local 7DS instance. A user can add multimedia objects to a certain point of the map by clicking on the map and browsing the image files corresponding to that location. Moreover, the user can add, modify, or delete comments on a certain multimedia file, and rate its content. A multimedia file can be set public or private, while only public files are shared with other peers.

The PhotoJournal searches other 7DS peers for multimedia files associated with a given area marked

Figure 3: The system can superimpose multimedia objects at their locations on a map. A marker indicates the number of files associated with that location.

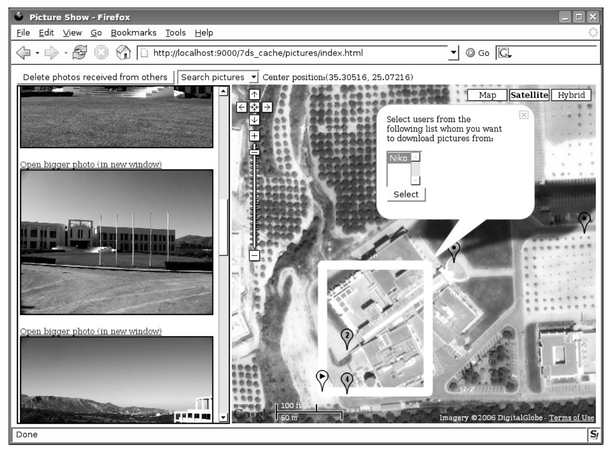

Figure 4: The user can mark the area for which multimedia objects are requested.

on the map by the user. It forms a 7DS query and multicasts it to other 7DS peers. Furthermore, it maintains and displays a list of neighboring 7DS peers, updating it periodically. A user may then select the 7DS peers from which the application retrieves the files associated with the predefined area, stores them in the local cache and displays them on the map. Areas on the map associated with multimedia files can be distinguished by a marker that also indicates the number of the available relevant files. Moreover, the queries are formed using location-based or rate-related criteria. The response of a peer includes the multimedia files, reviews.

The frontend of the application runs in a web browser. It consists of a map frame on the right and a photo bar on the left side of the window. Its backend runs on 7DS. It receives all queries from the frontend through 7DS's proxy server, and supports the typical 7DS functionality by adding or deleting photos, querying photos from 7DS neighbors or handing out photos from the local cache. 7DS can also cache map files, enabling the application to work without an Internet connection.

If the device has a built-in camera, users can take photos and videoclips and the PhotoJournal automatically associates the multimedia files with the user's current position. If content is retrieved outdoors, a GPS receiver is utilized for capturing the user's position information. Otherwise, if the user is indoors, the system acquires position information from the CLS. As long as a GPS or CLS trace is available, for outdoor or indoor environments, respectively, the multimedia traveling journal can automatically superimpose uploaded content on the map, by matching the content's timestamp to the timestamps on the GPS/CLS trace, locating them on the map, and adding them in the local 7DS cache. The application can also be integrated with other positioning systems and can display position- or movement-related information on the map. Finally, depending on the environment and user requirements, it can be extended to provide new features and support various types of devices.

Figure 1 presents the system architecture.

III. Conclusions

This implementation of PhotoJournal has adopted a p2p architecture. We are in the process of implementing a more centralized approach for thin devices (e.g. smart-phones) in which a client acquires and sends the multimedia files to a webserver. The hybrid architecture facilitates both the centralized and p2p approaches. In that case a device can acquire the data from a web-server or another peer.

We are in the process of deploying a testbed in an aquarium to run user studies. Furthermore, we will compare the performance of the three architectures via empirical-based measurements and simulation to evaluate the delay and scalability characteristics of the system.

This work did not address privacy issues, however, the protection of user's privacy, while still enabling information sharing is challenging. Thus, privacy will play a critical role in the adoption of mobile peer-to-peer computing applications. 7DS-like systems facilitate sharing among devices in different types of environments. However, depending on devices and information, peers may have different privacy requirements. Currently, 7DS offers a crude distinction between private and non-private objects and a finer way to describe their privacy requirement is required.

P2p for mobile devices is a relatively new technology that is not yet proven in the research community and industry. A fruitful approach would be to develop a general infrastructure for mobile peer-to-peer applications, build some robust applications, and extract a toolkit that other new applications could use. Our group sets the direction for exploring such technologies further.

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