PROBLEM OF INEFFICIENT INTERNAL HARDWARE OF PORTABLE MOBILE DEVICES

Solving by Artifacts Prebuffering using Mobile Database Cache

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Abstract: The paper deals with a problem of inefficient internal hardware like bus, memory or CPU of wireless connected portable mobile devices and a possibility to solve this problem by a prebuffering of selected artifacts. The basics are in a model of data prebuffering based system enhancement for locating and tracking users inside the buildings. The framework uses a WiFi network infrastructure to let a mobile device determine its indoor position. User location is used for data prebuffering and pushing information from server to user's PDA. All server data is saved as artifacts (together) with its position information in building. The accessing of prebuffered data on mobile device can highly improve response time needed to view large multimedia data. I tested our solution on created facility management information system with testing collection of about hundred large size artifacts. On mobile device the SQL Server CE database is used as a cache. Finally the new way to manage the artifacts throw the framework is described and tested.

1 INTRODUCTION

The using of mobile wireless devices like laptops, PDA devices or Smartphones with internet connection is today possible everywhere anytime. The connection speed varies from a hundreds of kilobits to several megabits per second in relation of connection by two most used standard GPRS and WiFi. In the case of corporate information systems or some types of facility management, zoological or botanical gardens, libraries, museums or hospitals information systems the WiFi infrastructure network is often used to connect mobile device clients to server. The theoretical maximal connection speed is unfortunately usable only on laptops where high-quality WiFi adapter is present. The rest of mobile devices like PDAs family or Smartphones has a very limited space in their case and a lower-quality WiFi adapter is used. This is a limitation in any case of such online systems where the large data files (artifacts) are used and there is no way to preload these artifacts before use of mobile device. I found this problem as a very important and the rest of this paper is about a problem specification and possibility to solve it in some cases.

Our goal is to complement the data networking capabilities of RF wireless LANs with accurate user location and tracking capabilities for user needed data prebuffering. This property is used as an information ground for extension of information system.

Location information is used to determine an actual user position and his future position. A number of experiments with the information system have been performed; focusing on the position determination is encouraged by the results. The remainder of this paper describes the conceptual and technical details.

2 BASIC CONCEPTS AND TECHNOLOGIES

Why we want to locate the user? We need to know users position in real time for prebuffering of data from server to mobile client database. Data are prebuffered for possible future use of them.

Why we cannot use classical model of user's requests and server's response? Because of some large amount of data is impossible to download to PDA device in relatively short time. It is not only about the artifacts size. In some cases, the tens or hundreds clients must be served. The serving time

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will increase in these cases as the test describes. By this reason the size of artifacts need to be optimized for the most effective ways of server connection, size of data artifacts, access to the mobile database. Figure 1 describing the schema of data communication process from server to PDA memory. I found the worse component in this network is theoretically the WiFi Adapter on PDA side.

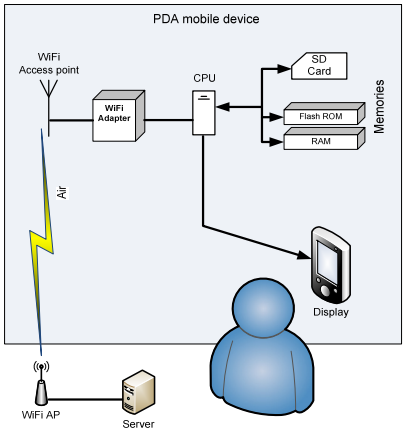


Figure 1: WiFi adapter connection to internal bus.

Theoretical hypothesis must be documented with real data transfers rate measurement. The first one test was executed on transfer speed of large data size artifacts throw the FTP protocol.

The process optimization was divided to three basic parts:

We made a number of such tests with several types of PDA devices (HTC Athena, HTC Universal, HTC Blueangel, HTC Roadster). These PDA devices were connected throw CISCO Wi-Fi AP. The FTP server holds 3 types of large artifacts (files) which were downloaded to internal PDA memory.

Table 1: Transmission speed on large files.

Tran. speed [kB/s]	**PDA device**			
	Athena	Universal	Blueangel	Roadster
data size [MB]	Speed [kB/s]	Speed [kB/s]	Speed [kB/s]	Speed [kB/s]
10	347	123	160	106
20	344	121	157	79
40	314	123	58	43

Unafraid the real transfer rates (see Table 1) were not achieved. The maximal transfer rate 350 kB/s has HTC Athena, but this device is not a standard PDA device. Athena is a mini-notebook with windows mobile 6 operating system. All of others devices have only a quarter amount of such speed. This fact is very important for our idea of using a prebuffered data for increasing of transfer speed throw WiFi connection on PDA mobile devices.

This abysmal difference vamooses, when we use for transfer smaller data files (10KB – 150KB). The testing of data transfer throw web services was executed on all of mentioned devices. Firstly the 50 kB and then the 150 kB data file were transferred. The response time for one access and then for 100 access and finally for 500 access were measured. The test results are in Table 2 and Table 3.

The third step to determine the optimal artifact size is testing of database response for buffering. The test was executed again on all mentioned devices. The information about SQL server response of SQL Server 3.5 Compact Edition was stored.

The general principle states that if a WiFi-enabled mobile device is close to such a stationary device – Access Point (AP) it may "ask" the provider's location position by setting up a WiFi connection. If the mobile device knows the position of the stationary device, it also knows that its own position is within a 100-meter range of this location provider. Granularity of location can improve by triangulation of two or several visible WiFi APs. The PDA client will support the application in automatically retrieving location information from nearby location providers, and in interacting with the server. Naturally, this principle can be applied to other wireless technologies. The application (locator) is now implemented in C# using the MS Visual Studio .NET 2005 with .NET compact framework and a special OpenNETCF library enhancement.

3 PREDICTIVE DATA PUSH TECHNOLOGY FRAMEWORK

This part of the project is based on a model of location-aware enhancement, which I have used in created information system. This technique is useful in framework to increase the real dataflow from wireless access point (server side) to PDA (client side). Primary dataflow is enlarged by data pre-buffering. These techniques form the basis of predictive data push technology (PDPT). PDPT copies data from information server to clients PDA to be helpful when user comes at desired location.

The benefit of PDPT consists of reduction of time needed to display desired information requested by a user command on PDA. Time delay may vary from a few seconds to number of minutes. It depends on two aspects.

First one is the quality of wireless Wi-Fi connection used by client PDA. A theoretic speed of Wi-Fi connection is max 687 kB/s, because of protocol cost on physical layer (app. 30-40 %). However, the test of transfer rate from server to client's PDA, which I have carried out within our Wi-Fi infrastructure provided the result speed only 80 - 160 kB/s (depends on file size and PDA device). The second aspect is the size of copied data. Current application records just one set of signal strength measurements at the time (by Locator unit in PDPT Client). By this set of values the actual user position is determined by the PDPT server side. PDPT core responds to location change by selection of the artifact to load to PDPT client buffer. The data transfer speed is widely influenced by the size of these artifacts. For larger artifact size the speed is going down.

Theoretical background and tests were needed to determine an average artifact size. First of all the maximum response time of an application (PDPT Client) for user was needed to be specified. A special book (Nielsen J., 1994) of „Usability Engineering" specified the maximum response time for an application to 10 seconds (Haklay, M. and Zafiri, A., 2008). During this time the user was focused on the application and was willing to wait for an answer. I used this time period (10 second) to calculate the maximum possible data size of a file transferred from server to client (during this period). If transfer speed was from 80 to 160 kB/s the result file size was from 800 to 1600 kB.

Table 2: Response time - 50KB artefacts [ms].

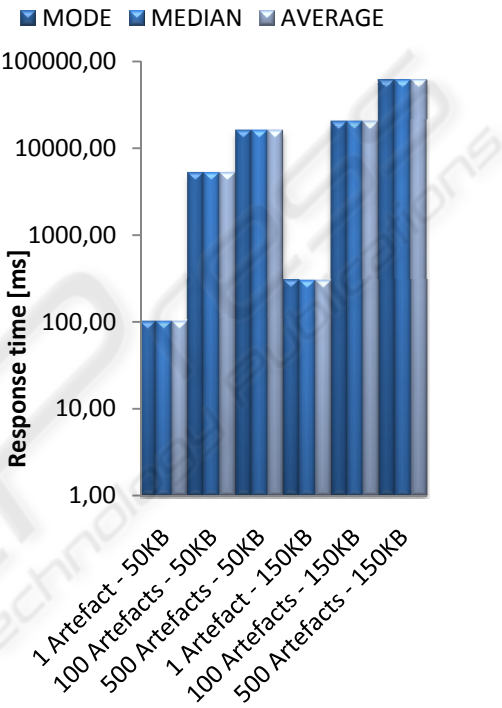
	1 Artefact	100 Artefacts	500 Artefacts
Mode	101,82	5208,62	16036,61
Median	101,86	5228,54	16024,24
Average	102,00	5229,81	16022,67

Table 3: Response time - 150KB artefacts [ms].

	1 Artefact	100 Artefacts	500 Artefacts
Mode	304,82	20208,93	61029,73
Median	301,85	20227,71	61026,08
Average	302,00	20229,99	61022,86

From the executed test over the web service is evident; the artifacts of size from 50 to 150 kB are more suitable for transfer. It is because the transfer speed of them is relatively affordable in compare to transferred data amount.

In this case is only a higher starter costs which going to fall after first executed query. The SQL server response results are better in case of 50 to 150 kB artifacts.



Graph 1: Web service reaction times.

The large artifacts are better in compare to 1Byte transferred data, but the response is not optimal. Unfortunately another one problem is here. The problem is the time, which is needed for displaying them. In case of Autocad file type I measured this time to average 45 seconds. This time consumption is certainly not acceptable, for this reason I am looking for a better solution. We need to use some basic data format, which can be displayed by PDA natively (BMP, JPG, GIF) without any additional striking time consumption

Such large artefact size is not only with slow transfer speed, but they also allow move with steps, which are not affordable for quicker move or more accurately presentation of position in artefact. The most of tests and problems passes from the size of artefacts. Therefore we made a change to data artefact size to maximal size of 150 kB and we change also the access to these artefacts to new way.

PDPT framework design is based on the most commonly used server-client architecture. To process data the server has online connection to the information system. Technology data are continually saved to SQL Server database (Arikan E., Jenq J., 2007), (Jewett M., Lasker S., Swigart S., 2006).

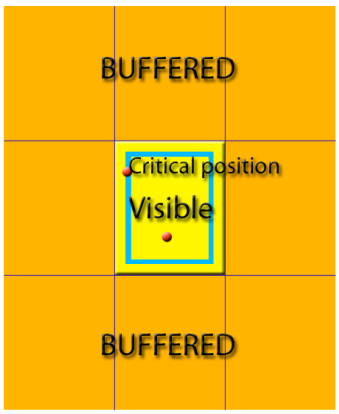


Figure 2: Old application buffering.

The active presented area was divided to more partial artefacts. This new modified system is now implemented to our other projects, where the position of user is needed. One of these projects is a Guardian II. This project is for hospitals areas for patients and physicians monitoring. In such implemented the new possibilities of biomedical e-health systems are discovered for increasing of interactivity. Based on position of patient, the server can select the nearest physician or nurse to act on discovered problem. By this way the response on problem can be reduced and it can help to save more human life. One of next steps is testing of accessible technologies for accessing of SQL server buffer and the selection of better one. In this time the testing of technologies like LINQ, ADO.NET and the direct access using SQL queries is being realized.

4 CONCLUSIONS

The main objective of this paper is in the enhancement of information system for locating and tracking of users inside a building. It is possible to locate and track the users inside buildings. In this paper I have presented the information system framework that uses and handles location information and information system functionality. The indoor location of a mobile user is obtained through an infrastructure of WiFi access points. This mechanism measures the quality of the link of nearby location provider access points to determine actual user position. User location is used in the core of server application of PDPT framework to data prebuffering and pushing information from server to user's PDA. Data prebuffering is the most important technique to reduce time from user request to system response. It is important to give a high importance to final optimalization of application.

The experiments show that the location determination mechanism results with sufficient quality of the actual location of the user in most cases. Some minor inaccuracy does not major effect on PDPT core decision making.

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