OPTIMIZATION OF DATAFLOW ON MOBILE DEVICES IN INFORMATION SYSTEM OF HOME CARE AGENCIES

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Abstract: New kind of complex mobile devices can run full scale applications with same comfort as on desktop devices only with several limitations. One of them is insufficient transfer speed on wireless connectivity. Main area of interest is in a model of a radio-frequency based system enhancement for locating and tracking users of a mobile information system. The experimental framework prototype uses a wireless network infrastructure to let a mobile device determine its indoor or outdoor position. User location is used for data prebuffering and pushing information from server to user's PDA. The accessing of prebuffered data on mobile device can highly improve response time needed to view large multimedia data. This fact can help with design of new full scale applications for mobile devices. 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. The prebuffering method is described in context of use on real case of information system of home care agencies.

1 INTRODUCTION

The usage of various mobile wireless technologies and mobile embedded devices has been increasing dramatically every year and would be growing in the following years. This will lead to the rise of new application domains in network-connected PDAs (Personal Digital Assistants) that provide more or less the same functionality as their desktop application equivalents. The idea of full scale applications pursuable on mobile lightweight devices is based on current hi-tech devices with large scale display, large memory capabilities, and wide spectrum of network standards plus embedded GPS module. Example of such devices is HTC Touch HD.

Users of these portable devices use them all time in context of their life (e.g. moving, searching, alerting, scheduling, writing, etc.). Context is relevant to the mobile user, because in a mobile environment the context is often very dynamic and the user interacts differently with the applications on his mobile device when the context is different.

My recent research of context-aware computing has been restricted to location-aware computing for mobile applications using a WiFi network (LBS Location Based Services). The information about basic concept and technologies of user localization such as LBS, Searching for WiFi AP) can be found in our published articles. On localization basis, I created a special framework called PDPT (Predictive Data Push Technology) which can improve a usage of large data artifacts of mobile devices. We used continual user position information to determine a predictive user position. The data artifacts linked to user predicted position are prebuffered to user mobile device. When user arrives to position which was correctly determined by PDPT Core, the data artifacts are in local memory of PDA. The time to display the artifacts from local memory is much shorter than in case of remotely requested artifact.

The idea of prebuffering may not be only one application method for user position knowledge. As well as WiFi is not only one wireless network to use for localization of user device. WiFi has advantage in speed in indoor positioning therefore the GSM/UMTS can be used in outdoor [Fig. 1]. The GPS sensor is also embedded in several types of current mobile devices, or it can be plugged by SDIO or BT interface.

We would like to describe a position obtaining from wireless networks background in the beginning

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of next chapter to give a reader more information about these themes.

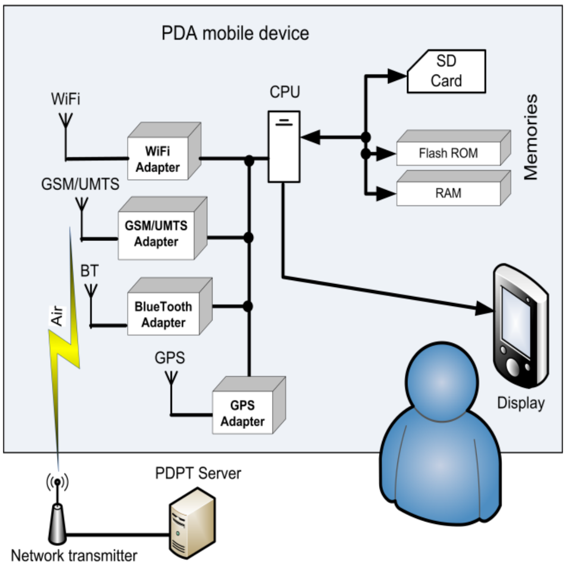

Figure 1: Wireless networks and GPS sensor localization possibilities on mobile devices.

2 PDPT FRAMEWORK CORE

The general principle of my simple localization 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 position of the AP is known, the position of mobile device is within a range of this location provider. This range depends on type of WiFi AP. The Cisco APs are used in my test environment at Campus of Technical University of Ostrava. I performed measurements on these APs to get signal strength (SS) characteristics and a combination of them called “super ideal characteristic”. The computed equation for Super-Ideal characteristic is taken as basic equation for PDPT Core to compute the real distance from WiFi SS.

From this super ideal characteristic it is also evident the signal strength is present only to 30 meters of distance from base station. This small range is caused by using of Cisco APs. These APs has only 2 dB WiFi omnidirectional antenna. Granularity of location can be improved by triangulation of two or more 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 like Bluetooth, GSM or WiMAX.

To let a mobile device determine its own position is needed to have a WiFi adapter still powered on. This fact provides a small limitation of use of mobile devices. The complex test with several types of battery is described in my article [4] in chapter (3). The test results with a possibly to use a PDA with turned on WiFi adapter for a period of about 5 hours.

2.1 The Need of Predictive Data Push Technology

PDPT framework is based on a model of location-aware enhancement, which I have used in created 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 prebuffering. PDPT pushes the data from SQL database to clients PDA to be helpful when user comes at final location which was expected by PDPT Core. The benefit of PDPT consists in time delay reducing needed to display desired artifacts requested by a user from PDA. This delay may vary from a few seconds to number of minutes. Theoretical background and tests were needed to determine an average artifact size for which the PDPT technique is useful. First of all the maximum response time of an application (PDPT Client) for user was needed to be specified.

Nielsen (Nielsen J., 1994) 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. The book is over 20 years old (published in 1994). I suppose the modern user of mobile devices is more impatient so the stated value of 10 second will be shorter. This is for me even better, because my framework is more usable. 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 transfers speed wary from 80 to 160 kB/s the result file size wary from 800 to 1600 kB.

The next step was an average artifact size definition. I use a network architecture building plan as sample database, which contained 100 files of average size of 470 kB. The client application can download during the 10 second period from 2 to 3 artifacts. The problem is the long time delay in displaying of artifacts in some original file types. It is needed to use only basic data formats, which can be displayed by PDA natively (bmp, jpg, wav, mpg, etc.) without any additional striking time consumption.

The final result of our real tests and consequential calculations is definition of artifact size to average value of 500 kB. The buffer size may differ from 50 to 100 MB in case of 100 to 200 artifacts.

2.2 From Data Collection to Localization

A first key step of the PDPT is a data collection phase. I record information about the radio signals as a function of a user's location. The signal information is used to construct and validate models for signal propagation. Among other information, the WaveLAN NIC makes the signal strength (SS) available. SS is reported to units of dBm. Each time the broadcast packet is received the WaveLAN driver extracts the SS information from the WaveLAN firmware. Then it makes the information available to user-level applications via system calls.

If the mobile device knows the position of the stationary device (transmitter), it also knows that its own position is within a range of this location provider. The typical range wary from 30 to 100 m in WiFi case, respectively 50 m in BT case or 30 km for GSM. Granularity of location can be improved by triangulation of two or more visible APs (Access Points). The PDA client currently supports the application in automatically retrieving location information from nearby WiFi location providers, and in interacting with the PDPT server. Naturally, this principle can be applied to other wireless technologies like BT, GSM, UMTS or WiMAX. The application (locator) is implemented in C# language using the MS Visual Studio .NET with .NET Compact Framework and a special OpenNETCF library enhancement. Schema on figure describes a localization process. The mobile client gets the SS info of three BSs (Base Stations) with some inaccuracy. Circles around the BSs are crossed in red points on figure. The intersection red point (centre of three) is the best computed location of mobile user. The user track is also computed from these measured SS intensity levels and stored in database for later use by PDPT Core. This idea is applicable in case of WiFi as well as BT and GSM networks.

In previous research, I focused only to use of WiFi networks while the other wireless possibilities remained without a proper notice. Now I made an enhancement of Locator component of PDPT framework to allow operate with BT and GSM networks.

In BT network case, the position of BT APs must be known to allow the position determination. To collect BT APs position info in outdoor environment, the GPS can be used. For indoor area, the GIS (Geographic Information System) software with buildings map must be used to measure exact position of BT AP against to local environment. To manage with BT hardware of mobile device another library InTheHand 32Feet.NET is used. The source code has a simple implementation:

Example of a Locator Source Code – Scanning the nearby for BT APs:

```
using InTheHand.Net.Bluetooth;

BluetoothClient bc = new
             BluetoothClient();
BluetoothDeviceInfo[] bdi =
             bc.DiscoverDevices();

foreach (BluetoothDeviceInfo BTdi in
                                bdi)
{
  drDataRow = dtVisibleAP.NewRow();
  drDataRow["AP_name"] =
       BTdi.DeviceName.ToString();
  drDataRow["MAC_AP"] =
       BTdi.DeviceAddress.ToString();
  drDataRow["Signal_Strength"] =
       BTDi.Rssi;
  drDataRow["Date_Time"] =
       DateTime.Now;
  drDataRow["AP_type"] =
       AP_type.Bluetooth;
  dtVisibleAP.Rows.Add(drDataRow);
}
```

GSM network is not local network but a cellular network. The problem is in position information of GSM BTSs (Base Transceiver Stations). The operator doesn't provide any such information. One of possible solutions is based on unofficial BTSs lists which can be found on internet. The lists are typically available in HTML, TXT or CSV formats. The medium rate for BTs with GPS position information is about 90 % of all BTs in European countries. In case of PDPT Framework, the list must be converted to PDPT server database – GSM_BTS table.

In all three described cases of nearby BSs scanning, the data are saved to Locator Table in PDPT server DB. Data are processed from Locator Table throw the PDPT Core to Position Table. The processing techniques depend on selected wireless network. WiFi and BT network provide all visible APs nearby the user. From list of these APs is computed actual position (by triangulation).

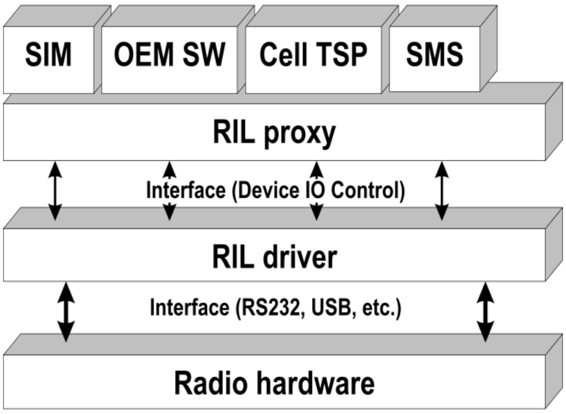

Figure 2: Radio Interface Layer Architecture.

Mobile devices with windows mobile operation system do not provide any GSM info to .NET Compact Framework. Even any special framework as in previous two cases is not known for me until now. Only possibility is in use of RIL (Radio Interface Layer) library. This library is divided into two separate components, a RIL Driver and a RIL Proxy. The RIL Driver processes radio commands and events. The RIL Proxy performs arbitration between multiple clients for access to the single RIL driver. When a module calls the RIL to get the signal strength, the function call immediately returns a response identifier. The RIL uses the function response callback to convey signal strength information to the module.

Example of a Locator Source Code – retrieving the GSM BTSs info with LIR:

```
[DllImport("ril.dll")]
public static extern IntPtr
RIL_GetCellTowerInfo(IntPtr
[DllImport("ril.dll")]
public static extern IntPtr
RIL_Deinitialize(IntPtr
[DllImport("ril.dll")]
public      static      extern      IntPtr
RIL_GetSignalQuality(IntPtr
   res = RIL_GetCellTowerInfo(hRil);
   res = RIL_GetSignalQuality(hRil);
RILCELLTOWERINFO rci = new
RILCELLTOWERINFO();
result += String.Format("MCC: {0}, MNC:
{1}, LAC: {2}, CID: {3}, ",
rci.dwMobileCountryCode,
rci.dwMobileNetworkCode,
rci.dwLocationAreaCode, rci.dwCellID);
RILSIGNALQUALITY rsq = new
RILSIGNALQUALITY();
result += String.Format("Signal
Quality: {0}, MinSig {1}, MaxSig {2},
LowSig {3}, HighSig {4}",
rsq.nSignalStrength,
rsq.nMinSignalStrength,
rsq.nMaxSignalStrength,
rsq.nLowSignalStrength,
rsq.nHighSignalStrength);
```

The GSM network provide only one BS info in each search cycle. This BS has the highest signal strength. The more BTSs info is collected by a several iteration cycles. During 10 cycles (per 10 seconds) the 4 BTS info is obtained on average.

The important info from BTSs is Signal Strength and Time Advance (TA). SS is refreshed every several seconds (in every scan) whereas TA is provided only during some type of communication with selected BTS (e.g. request to talk, move to another area - Location Area Code (LAC)). The list of these BTSs with info is further processed as in previous case for WiFi and BT networks. Only change is in usage of TA if it is accessible.

Another possibility to get the user position in outdoor space is in GPS. GPS provide a position by LONgitude and LATitude (X and Y). Only simple conversion is needed to transform a GPS coordinates to S-JTSK, which is used in PDPT Framework.

3 PARTIAL PREBUFFERING

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

The active presented area was divided to more partial artefacts [Fig. 3]. 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.

Active area for move of map basis can be not only on outer margin of the whole area, but it can be on borders of several pictureboxs. By this technique is possible to move with map basis in softer grid and allow to more precisely presenting the actual position of tracked object.

By consequential evaluation of object moving speed, and with suitable modified map basis, we can achieve the effect of zoom of map basis. After application of such principle the system can be applicable for open space with sufficient WiFi signal for triangulation. This part of framework is suitable for patient tracking in case of home care agencies. We can track the time of one attendance of nurse at the patient.

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.

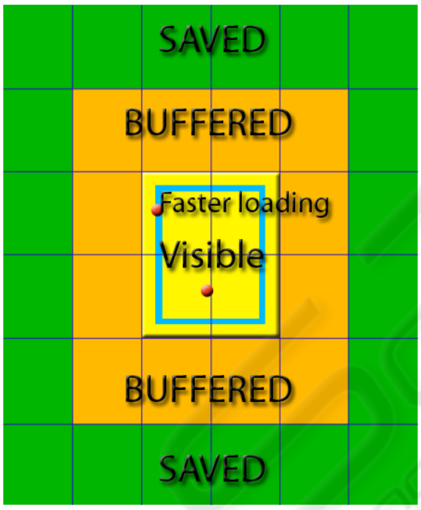

Figure 3: New application buffering – visible part merged to smaller artefacts.

Table 1: Response time average – Insert one 50KB artefact into SQL database trouch different technologies [ms].

	Linq	ADO.NET
HP 614c	229,1	202,6
HP hx4700	289,2	255,8
HTC Advantage	294,6	260,6
HTC BlueAngel	177,4	156,9
Samsung Omnia	241,6	213,7

Table 2: Response time average – Insert one 50KB artefact into SQL database trouch different technologies [ms].

	Linq	ADO.NET
HP 614c	686,8	607,5
HP hx4700	867,8	767,7
HTC Advantage	883,3	781,4
HTC BlueAngel	531,7	470,3
Samsung Omnia	724,3	640,8

Preliminary test are graphed in next figure and has only informative character.

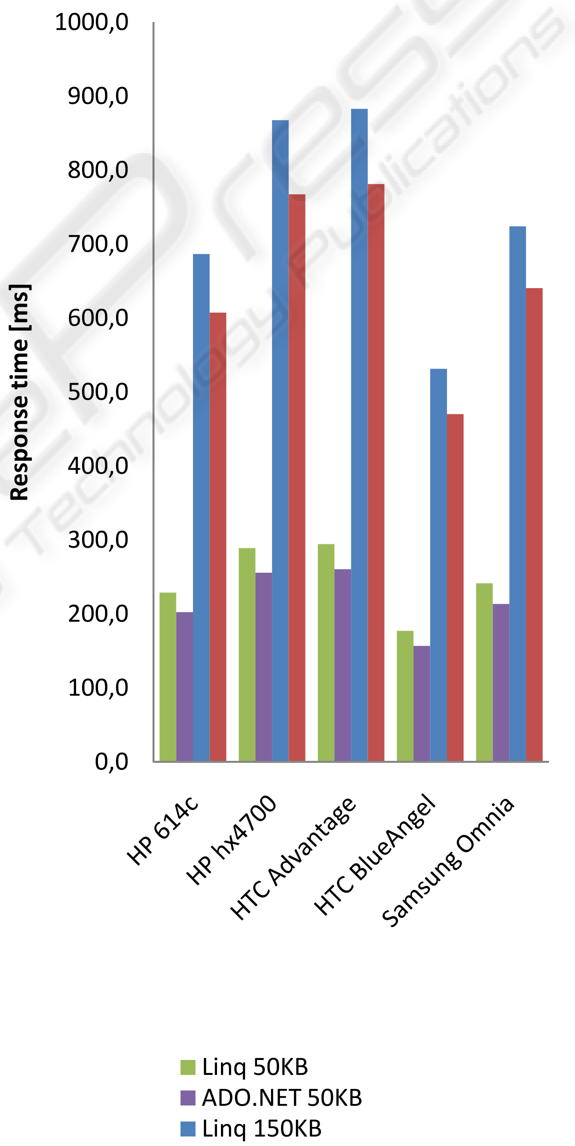

Figure 4: Average reaction times for inserting artefacts trough different technologies on a few devices.

4 CONCLUSIONS

I am focused on the real usage of the developed PDPT Framework on a wide range of wireless mobile devices and its main issue at increased data transfer. For testing purpose, five mobile devices were selected with different hardware and software capabilities. The high success rate found in the test data surpassed our expectations. This rate varies from 84 to 96 %.

The PDPT prebuffering techniques can improve the using of medium or large artifacts on wireless mobile devices connected to information systems. The localization part of PDPT framework is currently used in another project of biotelemetrical system for home care named Guardian II to make a patient’s life safer. Another utilization of PDPT consists in use of others wireless networks like BT, GSM/UMTS, WiMAX, or in GPS. This idea can be used inside the information systems like botanical or zoological gardens where the GPS navigation can be used in outdoor. The BT and GSM data collecting and processing is described in this article along with sample code. Some improvements of Locator module or Artifact Manager are described as well as improved architecture of PDPT server database. The larger area of PDPT utilization can improve importance of PDPT Framework in wireless mobile systems.

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REFERENCES

Nielsen J., 1994, Usability Engineering, Morgan Kaufmann, San Francisco.

Haklay, M. and Zafiri, A., 2008, Usability engineering for GIS: learning from a screenshot. In The Cartographic Journal, Vol. 45, Issue 2. pp. 87-97.

Arikan E., Jenq J., 2007, Microsoft SQL Server interface for mobile devices, Proceedings of the 4th International Conference on Cybernetics and Information Technologies, Systems and Applications/5th Int Conf on Computing, Communications and Control Technologies, Orlando, FL, USA, Jul 12-15.

Jewett M., Lasker S., Swigart S., 2006, SQL server everywhere: Just another database? Developer focused from start to finish, In DR DOBBS Journal, Vol. 31, Issue 12.

Krejcar, O., Cernohorsky, J., Database Prebuffering as a Way to Create a Mobile Control and Information System with Better Response Time. In Lecture Notes in Computer Science, Computational Science – ICCS 2008, Volume 5101/2008, The International Conference on Computational Science 2008, pp. 489-498, Cracow, Poland, (2008).

Krejcar, O., Prebuffering as a way to exceed the data transfer speed limits in mobile control systems, In ICINCO 2008, 5th International Conference on Informatics in Control, Automation and Robotics.

Janckulik, D., Krejcar, O., Martinovic, J.: Personal Telemetric System – Guardian, In Biodevices 2008, pp. 170-173, Insticc Setubal, Funchal,,Portugal.

Krejcar, O., Cernohorsky, J., Janckulik, D., Portable devices in Architecture of Personal Biotelemetric Systems. In 4th WSEAS International Conference on Cellular and Molecular Biology, Biophysics and Bioengineering, BIO'08, December 15-17, 2008, Puerto De La Cruz, Canary Islands, Spain. pp. 60-64.

Krejcar, O., Cernohorsky, J., Czekaj, P., Secured Access to RT Database in Biotelemetric System. In 4th WSEAS Int. Conference on Cellular and Molecular Biology, Biophysics and Bioengineering, BIO'08, December 15-17, 2008, Puerto De La Cruz, Canary Islands, Spain. pp. 70-73.

Krejcar, O., Cernohorsky, J., Janckulik, D., Database Architecture for real-time accessing of Personal Biotelemetric Systems. In 4th WSEAS Int. Conference on Cellular and Molecular Biology, Biophysics and Bioengineering, BIO'08, December 15-17, 2008, Puerto De La Cruz, Canary Islands, Spain. pp. 85-89.