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ANALYSIS OF THE ALGORITHM FOR EVALUATING THE QUALITY PARAMETERS OF MOBILE DATA TRANSMISSION

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Abstract. The purpose of this paper is to present a wider evaluation of the first version of the algorithm created for collecting parameters of the active mobile network at the end user premises. The article describes algorithms for software functioning and suggests possible ways of collecting data. The most important parameters of mobile data services include the speed of transferring data, delays and drop rate under different conditions and are measured conducting field tests. The paper also displays the results of the most interesting measurements and their interpretation as well as analyzes differences and advantages of the tool created from the available tools.

Keywords: QoS, mobile networks, data transfer parameters, software.

Introduction

The first step in order to assure data transmission quality in mobile networks is to measure actual real time parameters of network performance. The importance of this analysis arises because of a lack of reliable and easy to use measurement tools designed for evaluating mobile network parameters in the end users environment.

There are many discussed ways and tools for QoS assessment, radio access networks audit and benchmarking (McCabe 2007; Laiho *et al.* 2005; Charalampos *et al.* 2008) but most of them are not intended for application at the end user premises. If created for professional use, these items are highly priced, TEMS for example. Separate QoS parameters such as UP/DOWN link data transfer speed and RTT delays could be measured applying different tools; however, having no information about settings beyond those measurements – no assurance on their reliability could be provided. The user should be rarely advanced in case s/he wants to get important network parameters of the standard mobile equipment, for example the identification of the cell used and real signal level. An operator usually has no real feedback from end users and in reality presenting services for them in as-is basis (Batkauskas *et al.* 2010; Kajackas *et al.* 2005).

The purpose of this work is to analyze and present a wider evaluation of the first version of the algorithm created for the software tool to overcome limitations mentioned above. Therefore, the paper presents the algorithm of how the software tool functions as well as shows the results and interpretations of the field test results.

This paper mostly considers GSM networks extended using GPRS/EDGE and UMTS technologies to be benchmarked employing the created software tool; nevertheless, any other mobile network could be analyzed in similar ways applying the above offered tool.

This work is focused on data transmitting analysis. Then, the analyzed crucial parameters as stated in many sources (ETSI TS 123 107 V8.0.0 2009, ETSI TS 102 250-2 2009) are as follows: data transfer speed for the most popular end user services such as HTTP and FTP, delays of the packets transmitted and packet loss rate during transmitting. All those parameters must be collected along with information about the equipment used, because the received signal and throughput depend on modem characteristics, including an antenna or a firmware version presented into particular mobile equipment. Also, important information covers network cell identification (CELL_ID), signal level (CSQ) and a geographical or postal position of the place where measures were taken.

Measurement Tool for Mobile Network Performance

The algorithm of the program is graphically presented in Fig.1. Thus, let's discuss it in a more detailed way.

STEP 1: Connection with a virtual COM port of the modem dedicated for the interaction with user applications is established using standard

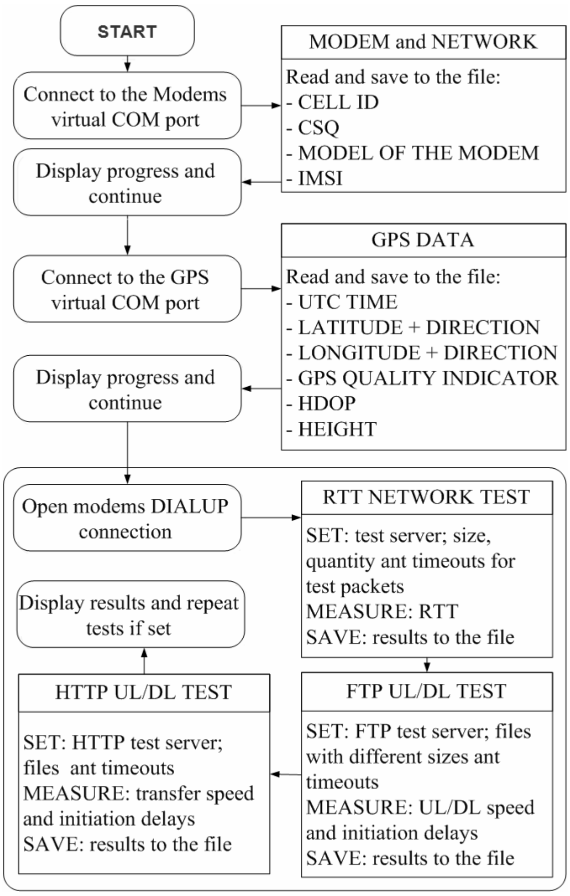

Fig. 1. The algorithm for the software tool

For AT commands, as presented in Fig. 2, the following information is requested:

- CELL_ID;
- CSQ – the level of the signal received;
- MODEL of the modem;
- IMSI – an International Mobile Subscriber Identity number.

```
<…> mySerial.send("AT+CREG=2"); //ON CELL_ID
aThread.sleep(1000); mySerial.send("AT+CREG?");   //ASK
FOR CELL_ID; aThread.sleep(1000);
result= mySerial.getIncommingString(); <…>
```

Fig. 2. An example of communication with the modem

STEP 2: If available, connection with the GPS receiver is established and the following information is collected:

- UTC TIME;
- LATITUDE;
- LONGITUDE;
- GPS QUALITY INDICATOR;
- HDOP;
- HEIGHT.

STEP 3: Dialup connection to the mobile network is established to start network performance measurement exercises.

STEP 4: Adaptable RTT measuring performed. Parameters could be tuned before the measurements: addresses of RTT servers; SIZE of the packet in bytes [1–65500]; QUANTITY of the packets; TIME to wait for answers. The parameters measured during RTT tests: QUANTITY of the received packets; TIME for RTT (Fig. 3).

```
<…> int pingsize = 1024; String PING_IP = "81.16.232.110";
int pingingtimes = 4; <...> String pingCmd = "ping " + PING_ip
+ " -l " +pingsize +  " -n " +pingingtimes+ " -w 10000 " ;
```

Fig. 3. An example of RTT measurement

STEP 5: FTP connection is established and different files are sent using links UP and DOWN. Settings: FTP servers; FILES for UP/DOWN link tests; QUANTITY of repeating; TIME to wait for response. Results: SPEED of uploading and downloading a file and failure rates (Fig. 4).

```
<…> String ftp_ul_512K = "curl --connect-timeout 10 --max-
time 360 -T 512KByte.txt ftp://193.219.149.96:2121 --user
******:****** -s -w \"%{speed_upload}\""; Process p2 =
r.exec(ftp_dl_512K);
```

Fig. 4. An example of FTP performance measurements

STEP 6: HTTP performance is tested. Settings: HTTP server addresses; HTTP content or files; QUANTITY of repetitions; TIME to wait for the answer. Results: SPEED of uploading and downloading content.

STEP 7: All collected information is presented to the user and placed in the operator‘s FTP server‘s database.

As presented in Fig. 4 above showing software source fragments, data transfer speed measurements of Up and Down link are made using command line tool libraries of “cURL” (http://curl.haxx.se/). Therefore, due to the fact that the same “cURL” is used as a part of many operating systems for sophisticated software packets, it is assumed that no additional metrological tests need to be performed at this stage and they are postponed to the later stages of work. The initial comparison of results on the speed of transferring data we have got was performed employing tools for monitoring interface speed (Table 1) and no significant differences were found.

In order to answer the question of why our tool for evaluating the parameters of the mobile network is needed, a comparison in Table 1 is presented. The following table was prepared having in mind the main task of this tool to measure parameters of transferring mobile network data at the end user premises and to read network parameters describing real time situation.

Table 1. A comparison of network monitoring tools available for end users

Parameter \ Tool	1	2	3	4
Changeable test file sizes	–	–	+	+
GPS coordinate collecting	+	–	–	+
Reading the mobile network settings	+	–	–	+
Data storing to the central database	+	–	–	+
RTT measurement parameter tuning	+	–	–	+
FTP measurement parameter tuning	+	–	+	+
HTTP parameter tuning	+	–	+	+
Open source product	–	–	–	+
Possible to use for drive tests	+	–	+	+

Tool 1 is TEMS or a similar type of tools for evaluating the performance of a professional mobile network. Tool 2 is the WEB based tool for the data transfer speed through Ethernet evaluations (for example, see www.speedtest.net). Tool 3 represents agent tools monitoring network interface of particular computer performance such as "DUmeter". Tool 4 is created for evaluating mobile network parameters and is analyzed in this work.

Parameters Collected

The parameters able to be collected applying this version of the tool are presented in Table 2.

Table 2. Collected parameters

Parameter	Comment
CELL ID	ID of the mobile cell
CSQ	Signal level (dBm)
MODEL	Of the modem
IMSI	For identification of the SIM/USIM
TIME	UTC Time (hh:mm:ss)
COORDINATES	Latitude, Longitude and Height
RTT LOSSES	Quantities of packets (%)
RTT DELAY	Complete time (ms)
FTP_SPEED	Speed, various packet sizes (kb/s)
HTTP_SPEED	Speed, various packet sizes (kb/s)
WEB_ SPEED	Speed, various pages (kb/s)

An example of calculating PDP context activation time is:

$$T_{PDPcat} = t_{ca\_accept} - t_{ca\_request}, \qquad (1)$$

where T_{PDPcat} – PDP context activation, t_{ca_accept} – activetion accept and $t_{ca\_request}$ – activation request times.

Measurement Results of Mobile Network Performance

A part of results achieved during static measurements is presented in Fig. 5.

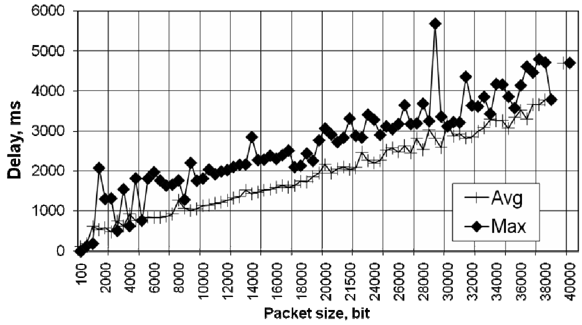

Fig. 5. The dependency of packet delay on size

The measurement results presented in Fig. 5 show that when packet size is larger than 30 kB, packet loss probability and delay are increasing dramatically. If we made the same tests in wired IP networks, we would see the same results with only much bigger packet sizes. The dependency of data transfer throughput on the file size is presented in Fig. 6.

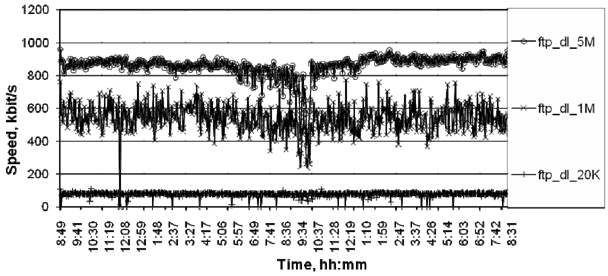

Fig. 6. The dependency of data transfer speed on the file size

Data transfer speed of three files sized 20 KB, 1 MB and 5 MB is measured at different time and presented in Fig. 6.

When increasing the size of the transmitted files, we could observe that data transfer speed is increasing up to the maximal channel throughput values in particular steps, which depends not only on a slow start of TCP but also on network settings (Batkauskas *et al.* 2006). Such performance means that if we use files of a smaller size, we will never measure real transmitting speed.

The data collected during speed test is presented in Fig. 6. We could observe that, for example, transmitting speeds of the files of 1 and 2 MB vary up to 2 times under the same testing conditions. Then, tools for online speed measurement when using the tested files of 1 MB are not observing the real performance of the network.

The measurements performed in the real end user environment applying the tool presented along with regular drive-tests will create a full image of network performance and give the background for further improvements to the operator of the mobile network.

Conclusions

A software tool used for evaluating real time performance is different from other passive or active tools because it measures not only data transfer speeds and delays but also mobile network parameters such as mobile cell ID and signal level CSQ. In case equipment is available, GPS coordinates are collected with UTC time.

The main advantages over other measurement tools include a flexible structure allowing changes in all main parameters and settings, easy use of interface providing a possibility of performing all predefined tests with one mouse click, data storing in the central data base and independency from the platform as it is written using the JAVA language.

The tool shows the best performance when used for static measurements, for example, when the end user is not satisfied with the quality of transferring mobile data and wants to check real parameters at a particular location.

The obtained test results indicate that when increasing the size of transmitted files from a few hundred kilobytes up to a few megabytes, data transfer speed increases up to the maximal channel throughput values in particular steps, which depends not only on a slow start of TCP but also on the network settings. Such performance means that if we use the files of a smaller size, we will never measure real transmitting speed.

Moreover, it is very important to choose a proper size of the packets to be transferred. The measurement results display that when the packet size is larger than 30 kB, packet loss probability and delay increase dramatically.

Future works are planned to be conducted with adding necessary parameters in order to fulfill the basic requirement set either from ETSI or ITU. Besides, a reduced version of mobile smart phones is planned to be prepared.

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References

Batkauskas, V.; Balčiūnas, D. 2006. Optimization of Common Voice and Data Channel Resources in the GSM/GPRS Network, *Electronics and Electrical Engineering* 5(69): 67–72.

Batkauskas, V.; Kajackas, A. 2010. Quality of Heterogeneous Mobile Data Services: Capabilities and End-user Achievements, *Electronics and Electrical Engineering* 5(101): 43–46.

Charalampos, N.; Eleni, D.; Marilena, P.; Constantinou, P. 2008. *Measurements and QoS Analysis of Live-World Mobile Telecommunication Networks*. Press of National Technical University of Athens. 6 p.

ETSI TS 123 107 V8.0.0. 2009. Digital cellular telecommunications system (Phase 2+); UMTS; LTE; Quality of Service (QoS) concept and architecture*, Technical Specifications*, 41.

ETSI TS 102 250-2. 2009. Speech Processing, Transmission and Quality Aspects (STQ); QoS aspects for popular services in GSM and 3G networks; Definition of Quality of Service parameters and their computation*, Technical Specifications*, 231.

Kajackas, A.; Anskaitis, A.; Guršnys, D. 2005. Individual Quality of Service Concept in Next Generations Telecommunications, *Electronics and Electrical Engineering* 4(60): 11–16.

Laiho, J.; Wacker, A.; Novosad, T. 2005. *Radio Network Planning and Optimisation for UMTS.* Wiley. 662 p. doi:10.1002/9780470031407

McCabe, J. D. 2007. *Network Analysis, Architecture, and Design.* Morgan Kaufman Publishers. ISBN: 0123704804.

MOBILIOJO DUOMENŲ PERDAVIMO TINKLO KOKYBĖS PARAMETRŲ ĮVERTINIMUI SUKURTO ALGORITMO ANALIZĖ

D. Balčiūnas

Santrauka

Platesniam įvertinimui pateikiama pagal analizuojamą algoritmą kuriama programinio įrankio versija. Įrankis skirtas mobiliojo ryšio tinklo duomenų perdavimo parametrams surinkti, panaudojant galutinio vartotojo įrangą. Darbe aprašomi kuriamos programinės priemonės veikimo algoritmai ir surenkami duomenys. Svarbiausi iš jų – duomenų perdavimo sparta, vėlinimas ir paketų praradimai. Pateikiami matavimų rezultatų pavyzdžiai ir jų interpretacijos. Analizuojami kuriamo įrankio skirtumai nuo esamų ir operatorių bei galutinių vartotojų naudojamų programų. Aprašomi papildomi parametrai, kuriais planuojama papildyti naujas programos versijas.

Reikšminiai žodžiai: QoS, mobilieji tinklai, duomenų perdavimo parametrai, programinė įranga.