TCP Performance Analysis in Dynamic GPRS LA

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Abstract

This paper presents the findings on TCP performance measurements in the LA process during the deployment of GPRS CS1 and CS2 coding schemes and after the activation of two more coding schemes, CS3 and CS4. The measurements are done under various network scenarios based on users' physical locations in one of Malaysia's commercially deployed live GPRS networks. End-to-end evaluation of FTP application is used for the assessment together with tracing at the GPRS air interface. The results show that TCP works well in the LA process and can cope with the frequent switching between the coding schemes without any problem. Throughput performance is observed to be stable in all scenarios. The activation of higher coding schemes aided by TCP tuning also proves to be beneficial by the 23% increase in average throughput seen for urban areas.

I. INTRODUCTION

General Packet Radio Service (GPRS) [1], [2] is an extension of Global System for Mobile communications (GSM) network. It provides data services such as Internet applications to mobile users through packet-switched data transmission over the GSM air interface with data rate between 36.2kbps to 85.6kbps for four time slots allocation.

Internet applications for example web browsing, e-mail and file transfer use Transmission Control Protocol (TCP) [3] as a reliable transport for data transfers. It is a connection-oriented, packet-switched transport method that delivers data in small packets. TCP ensures ordered, error-free delivery with its sequence number and acknowledgment systems together with retransmission of loss packets and checksum evaluation. It also provides data flow control through its congestion control mechanisms.

The varying radio conditions in GPRS network expose data transfers to transmission errors. Accordingly, four GPRS coding schemes, CS1 to CS4, are defined to protect data from these errors. Switching between the coding schemes is dynamically done through a process called link adaptation (LA). The LA process may cause some impacts on the performance of Internet applications running over TCP in a live GPRS network since TCP is originally designed for wired, fixed network. In relation to the coding schemes, GPRS users' locations and movements may affect the Internet performance as well. These issues have not been specifically addressed in the previous studies conducted on TCP performance in GPRS network [4], [5], [6].

This paper evaluates the TCP performance throughout the LA process in one of the commercially deployed GPRS networks based on the initial coding schemes employment CS1 and CS2, and after the activation of higher coding schemes, CS3 and CS4. This is accomplished by incorporating TCP packet captures in GPRS drive-test measurements carried out in different scenarios based on GPRS users' typical locations in urban environment. TCP tuning is done as well to optimise the performance.

The TCP performance metric, throughput and the TCP behaviours observed are examined together with GPRS tracing at the air interface. The results obtained are only relevant to the particular GPRS network being assessed, thus may not apply to all GPRS networks in general.

The rest of the paper is organised as follows: section II outlines briefly the GPRS LA process together with GPRS parameters setup as implemented in this commercial network. Section III gives the overview of the TCP tuning done. In section IV, measurement set up is presented. The measurements results are discussed in Section V. Finally, the conclusions of the study are given in Section VI.

II. GPRS LA PROCESS AND PARAMETERS SETUP

Since radio quality fluctuates over time, the coding schemes also keep on changing according to the varying conditions. This is done dynamically by the GPRS network through the LA process, based on the radio measurements done by the mobile or the network itself. Table 1 gives the GPRS coding scheme with the

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