SIMULATION MODEL FOR THE PERFORMANCE EVALUATION OF INTERNET APPLICATIONS IN THE GPRS RADIO INTERFACE

J. Rendón, F. Casadevall, L. García, R. Jimenez

The typical Internet applications like WWW, FTP and e-mail will work over the mobile system GPRS and it is therefore important to know their performance in the GPRS radio interface. In this letter we present useful types of results of the GPRS radio interface which facilitates its emulation for Internet applications.

Introduction: The General Packet Radio Service (GPRS) system is a wireless packet switching system designed to work over GSM (Global System for Mobile Communications). Whereas GSM is basically a wireless circuit switching network, able to transmit voice, GPRS offers an easy access to data services. This feature allows an easy adaptation to the bursty traffic generated by Internet applications like e-mail, WWW and FTP. GPRS uses the GSM infrastructure, but it makes some changes to the radio interface and adds two new nodes: the Serving GPRS Support Node (SGSN) and the Gateway GPRS Support Node (GGSN).

In order to analyze the GPRS performance, the SGSN and GGSN behaviour can be simulated in a simple way. The problem arises when we try to simulate the radio interface, because this type of simulation is slow and, as a result, it is difficult to simulate an end-to-end Internet connection through GPRS with the radio interface simulation running. In this letter we propose a simple model of the GPRS radio interface that considers all the different parameters relevant to the physical and link layers characterization, for instance, the number of users, the channel coding, the C/I ratio, the number of PDCHs, the type of service offered and the transmission direction. Unlike the results obtained in previous GPRS simulations [1] [2], in which the GPRS radio interface is analized mainly in terms of throughput, the type of radio link results obtained in this letter, PER and the cumulative distribution function of the packet delay, allows an accurate and rapid simulation of a FTP Internet connection through the GPRS network.

Simulator Structure: The GPRS radio link simulation model has been created with the event driven simulator Cadence Bones Designer. The LLC layer has been simulated operating in unacknowledged mode. The RLC/MAC layer has been implemented in detail following the ETSI technical specifications [3]. The MAC layer uses the slotted Aloha access mechanism. A Round Robin scheduling method without priorities is assumed. The RLC layer uses a Selective-Repeat ARQ mechanism. The physical layer is implemented with results that appear in related pre-simulations [4].

Three types of bursty traffic have been considered in the letter, namely: e-mail, WWW and FTP. We have distributed the type of users in the following form: 50% e-mail, 30% WWW and 20% FTP. The traffic generated for e-mail is similar to the Funet traffic model, whereas the traffic generated for WWW and FTP services has been modeled using the ETSI model [5].

Using the aforementioned simulator, a statistical model of the GPRS radio interface is obtained varying the following parameters: Number of PDCHs (1, 2 or 4), C/I relation (2 per coding scheme, one appropriate and the other inappropriate), coding scheme (4) and number of Mobile Stations (10 or 15). Even though three types of traffic were generated, we have considered for this analysis the results corresponding to the FTP traffic. For each combination of input parameters, we obtain two output values: the PER and the cumulative distribution function of the LLC frames delays. In particular, we consider for the analysis of the results that a LLC frame is equivalent to a packet.

Simulation Results: The following results show the GPRS radio layer behaviour for a FTP connection. We believe these types of results are useful for an easy simulation of the GPRS radio layer. Fig. 1 shows a downlink simulation with 2 PDCHs, a C/I relation of 12dB, CS-2 and (10-15) Mobile Hosts. The x-axis of the graph uses the block period as a time metric. Each block period is equivalent to 18.46 ms. As it is foreseeable, the PER and delay increase as the number of MHs increases. The delay values for this simulation are notable. For 10 MHs the maximum delay is around 750 block periods, which is around 13.84 seconds. The high delay value that appears in this result is due to the low number of PDCHs present in the system (2) and the inappropriate C/I relation for this coding scheme. As it can be seen also in Fig. 1, the PER value for the transmission with 15 MHs is much larger than the PER with 10 MHs.

Fig. 2 shows the results for the same simulation when we use a C/I relation of 16dB. The importance of the C/I value for each coding scheme was mentioned in previous studies [2]. Unlike the results of Fig. 1 in which there is a big difference in the system when it has 10 or 15 MHs, there is not so much variation when the system uses an appropriate value of C/I for CS-2. Every code has its own C/I values with which it reaches its maximum throughput. We see in Fig. 2 that both delays and PERs are similar. This means that the system, in this case, is able to support more MHs without varying so much its performance.

In Fig. 3 we appreciate the influence of the number of PDCHs in the GPRS system. In all the cases the PER values are small (less than 3%). There is not a big difference between the delay with 2 and 4 PDCHs. This means that for this simulation, it is not necessary to add more PDCHs in order to get a significant advantage in performance.

The results presented in this letter can be used for simulating the impact of the GPRS performance on the Internet applications packets sent through the air interface. Given the statistical results shown in the previous Figures, the following procedure is used for simulating the effects of the radio channel in a particular IP packet: first, according to the PER value, it is decided if the LLC frame is correctly received or discarded. Then, if the LLC frame is selected as correctly received, its block delay, evaluated according to the cdf statistic, is determined.

Conclusions: This letter has presented a simulation model for the GPRS radio interface which gives useful types of results in order to simulate the transmission through the GPRS network of LLC packets for the FTP service. With these types of results, it is possible to understand the importance of the parameters which have more influence in the PER and packet delay in the GPRS radio interface and model it properly.

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Figure captions:

Fig. 1 2 PDCHs, 12dB, CS2 and (10-15) MHs

- - - - - 10 MHs, PER = 3,52%

——— 15 MHs, PER = 9,76%

Fig. 2 2 PDCHs, 16dB, CS2 and (10-15) MHs

- - - - - 10 MHs, PER = 1,41%

——— 15 MHs, PER = 2,36%

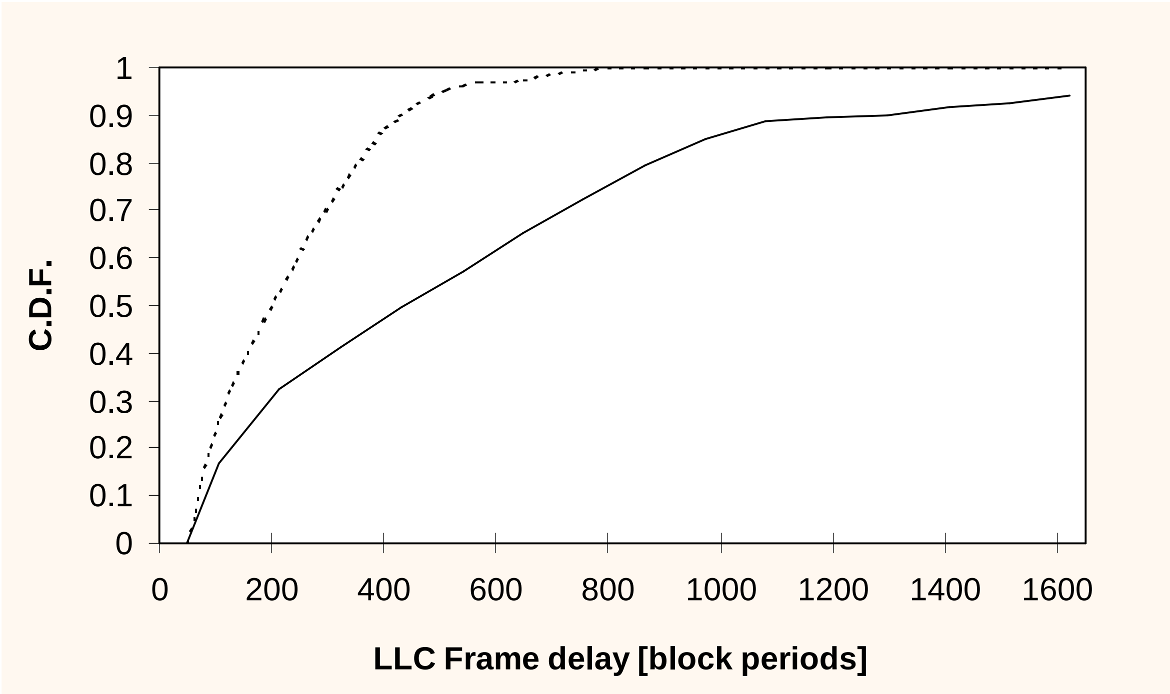
Fig. 3 (1,2,4) PDCHs, 8 dB, CS1 and 10MHs

-- -- -- 1 PDCH, PER = 2,51%

——— 2 PDCHs, PER = 2,03%

- - - - - 4 PDCHs, PER = 1,82%

Figure 1



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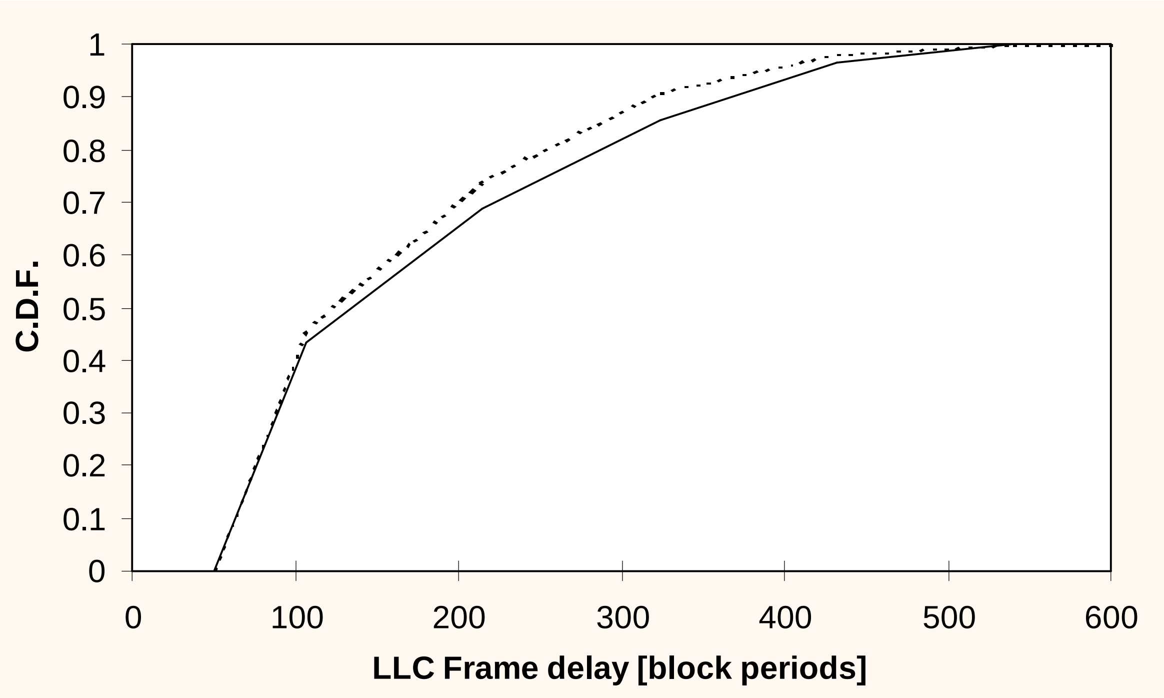
LLC Frame delay [block periods]

Figure 2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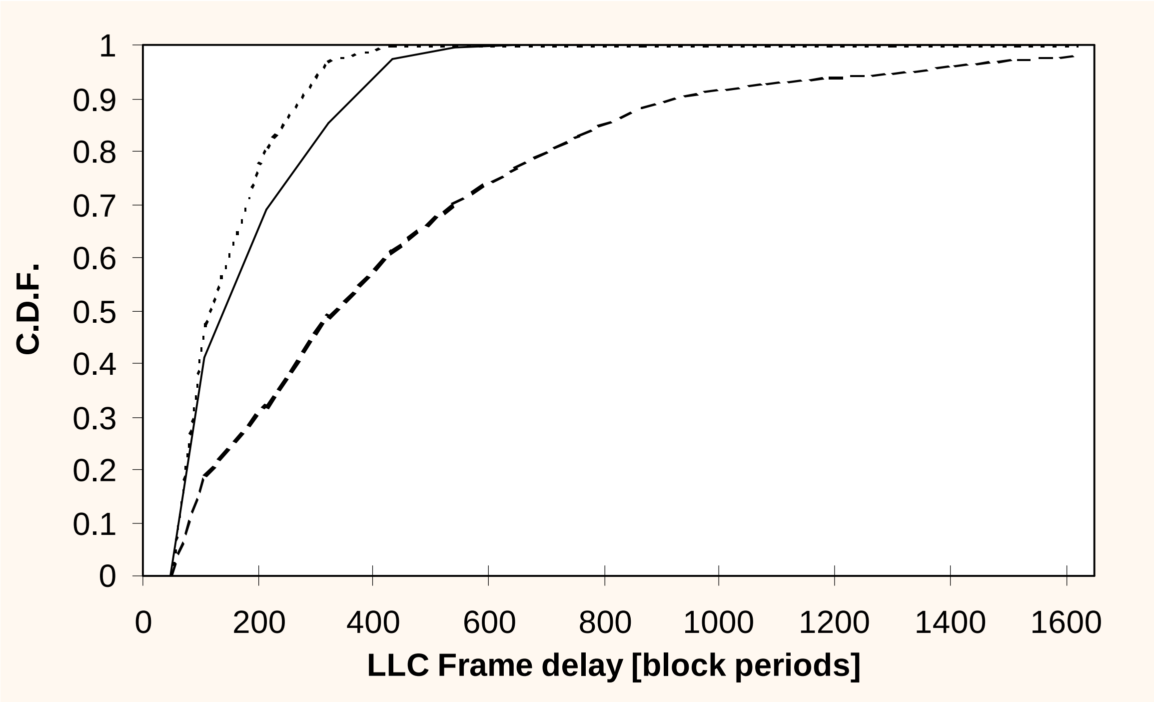
LLC Frame delay [block periods]

Figure 3



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