DEPARTAMENTO DE ELETRÓNICA, TELECOMUNICAÇÕES E INFORMÁTICA

MESTRADO EM ENGENHARIA DE COMPUTADORES E TELEMÁTICA

ANO 2022/2023

MODELAÇÃO E DESEMPENHO DE REDES E SERVIÇOS

MINI-PROJECT 1:

PERFORMANCE EVALUATION OF POINT-TO-POINT LINKS SUPPORTING PACKET SERVICES

Assignment Description

Develop this mini-project in a group of 2 students. Implement all tasks using MATLAB to obtain all requested results. Justify all obtained results and take all possible conclusions. Write a report with all results together with their analysis and conclusions. Include in the report all developed MATLAB codes duly explained. The report must be sent in PDF format to asou@ua.pt until 23:59 of 8st of November of 2022.

Task 1

Consider the event driven simulator *Simulator2* used in Task 6 of the Practical Guide.

1.a. Consider the case of C = 10 Mbps, f = 1.000.000 Bytes and b = 10^{-6}. Run 20 times *Simulator2* with a stopping criterion of P = 100000 on each run and compute the estimated values and the 90% confidence intervals of the average delay and average packet loss parameters when λ = 1500, 1600, 1700, 1800 and 1900 pps. Present the results in 2 different figures: (i) the average packet delay results and (i) the average packet loss results (in both cases, in bar charts with the confidence intervals in error bars[1]). Justify the results and take all relevant conclusions.

1.b. Repeat experiment **1.a.** considering b = 10^{-4} and the same values as before for all other parameters. Justify the differences between these results and the results of experiment **1.a** and take all relevant conclusions.

1.c. Determine the theoretical average packet loss (in %) of the system only due to the bit error rate for b = 10^{-6} and b = 10^{-4}. Compare these values with the results obtained in **1.a** and **1.b**. What do you conclude?

Task 2

Consider the event driven simulator *Simulator3* developed in Task 7 of the Practical Guide. Start by developing a new version of this simulator, named *Simulator3A*, to consider that the link introduces a bit error rate given by b.

2.a. Consider the case of λ = 1500 pps, C = 10 Mbps, f = 1.000.000 Bytes and b = 10^{-5}. Run 20 times *Simulator3A* with a stopping criterion of P = 100000 on each run and compute the estimated values and the 90% confidence intervals of the average packet delay and average packet loss parameters of each service (data and VoIP) when n = 10, 20, 30 and 40 VoIP flows. Present the results in 4 different figures: (i) the average data packet delay results, (ii) the average data packet loss results, (iii) the average VoIP packet delay results and (iv) the average VoIP packet loss results (in all cases, in bar charts with the confidence intervals in error bars). Justify the differences in the performance of the system for each service and take all relevant conclusions.

2.b. Repeat experiment **2.a.** considering f = 10.000 Bytes and the same values as before for all other parameters. Justify the differences between these results and the results of experiment **2.a** and take all relevant conclusions.

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[1] https://www.mathworks.com/help/matlab/creating_plots/bar-chart-with-error-bars.html

2.c. Determine the theoretical average packet loss (in %) of the system only due to the bit error rate $b = 10^{-5}$ for data packets and for VoIP packets. Compare these values with the results obtained in **2.a** and **2.b**. What do you conclude?

Task 3

Consider the event driven simulators *Simulator3* and *Simulator4* developed in Task 7 of the Practical Guide.

In the next experiments, consider the case of $\lambda = 1500$ pps, $C = 10$ Mbps. $f = 10.000$ Bytes and $n = 10, 20, 30$ and 40 VoIP flows. In all cases, run 20 times the requested simulator with a stopping criterion of $P = 100000$ on each run and compute the estimated values and the 90% confidence intervals of the average packet delay and average packet loss parameters of each service (data and VoIP). On each experiment, present the results in 4 different figures: (i) the average data packet delay results, (ii) the average data packet loss results, (iii) the average VoIP packet delay results and (iv) the average VoIP packet loss results (in all cases, in bar charts with the confidence intervals in error bars).

3.a. Use *Simulator3* to estimate the performance parameters when both services (data and VoIP) are statistically multiplexed in a single FIFO queue. Justify the differences in the performance values obtained for each service and take all relevant conclusions.

3.b. Use *Simulator4* to estimate the performance parameters when VoIP service has higher priority than data service. Justify the differences between these results and the results of experiment **3.a** and take all relevant conclusions.

3.c. Develop a new version of *Simulator4* to consider the following packet discard strategy: VoIP packets are always accepted in the queue (if there is enough space) but data packets are accepted in the queue only if the total queue occupation does not become higher than 90% (a simplified version of WRED – Weighted Random Early Discard). Use this simulator to estimate the performance parameters. Justify the differences between these results and the results of experiments **3.b** and take all relevant conclusions.

3.d. Develop a new version of *Simulator4* to consider the following packet discard strategy: data packets are always accepted in the queue (if there is enough space) but VoIP packets are accepted in the queue only if the total queue occupation does not become higher than 90%. Use this simulator to estimate the performance parameters. Justify the differences between these results and the results of experiments **3.b** and **3.c** and take all relevant conclusions.