The Development of Web-based Teaching System for Telephone Traffic Engineering Education

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Abstract. *This paper presents a didactic program that can be used in telephony classes for electrical engineering courses, where the computer and Internet are used for ordinary classes support and for distance learning. In the first stage of the project, a telephony traffic course HTML-based was developed and became available from the Internet. In the second stage, a virtual interactive site was designed and implemented for telephone traffic system calculations and for graphic and table generations.*

Keywords: *Traffic Engineering, Computer Mediated Learning, E-Learning, Telephony Teaching.*

1. Introduction

In the last few years, there has been considerable interest in the educational applications of electronic networking. The use o f the WWW has been adopted into every aspect of the educational life. The academic community supports the use of the Web as a tool to enhance teaching and learning. The problem is that the implementation of web courses is not an easy task. It's a new pedagogic paradigm that must be deeply researched to create new teaching methods and improve current learning techniques.

Like Pierre Levy says, the adaptation of devices and distance open learning (DOL) spirit became necessary in the quotidian and in the common education. It's true the DOL explore some distance learning techniques, including the hypermedia, the communication interactive networks and intellectual technologies of cyberculture. The essential, however, remain in a new stile of pedagogy that benefit, simultaneously, the personalized learning and cooperative learning across the network [6].

This paper is presenting to give our contribution to distance learning. It will be described a didactic project that can be used for the study of telephony traffic systems over the Internet in distance learning classes or as an assistant in ordinary classes.

2. The Project

The project was developed in two distinct stages. The first one was designated for implementation of a Web-based telephony course, with emphasis in traffic engineering.

This course was designed to be clear and objective, not forgetting the didactic, and using Internet technologies for its implementation. The goal was to create an E-learning course having the WWW like medium. The telephony traffic studies require mathematic calculations with relative complexity and research in tables and graphics to get a reasonable result. The second stage was necessary to facilitate the assimilation of the content and as a necessary tool of engineering mathematic calculations. We developed then, an interactive page, where the student can solve the necessary calculations, aided by generations of graphics and pertinent tables.

For implementation of the second stage of the project, we used an integration of the mathematical software, Matlab, with the Internet, associating all whole computational power of Matlab, with the accessibility of the Web. The interactive visual environment has for a didactic objective to make available the largest variety of possible results, turning instantaneous to the student numeric results, illustrative graphics and tables. The call for the calculation pages was done through hyperlinks, located in a strategic way in the pages of the course developed in the first stage of the project. These calls are made in exercises modules, where the student obtains the calculation environment for the solution of the proposed problems.

The system, which is available through the Web, can be used in distance learning classes as well as tool of the teacher's aid in telephony ordinary classes. The project can also be used in the corporative solutions where flexibility of results is needed with calculations, tables and graphics.

2.1 The Structure of the System

In the project implementation, the customer-server paradigm was used so that the content of the course pages and the calculations were available in the Internet. The page for data acquisition, loaded in the customer's browser, was programmed in HTML. The data are submitted to HTTP server that uses CGI(*Common Gateway Interface*) standard so data are received and processed by Matlab. Matlab, for its time, generates the numeric results, tables and graphics that are structured and forwarded to the customer in HTML page format, as depicts in Figure 1. The system operates with TCP/IP protocol, which enables it to work in a private network, intranet or the Internet, increasing its operation potentiality.

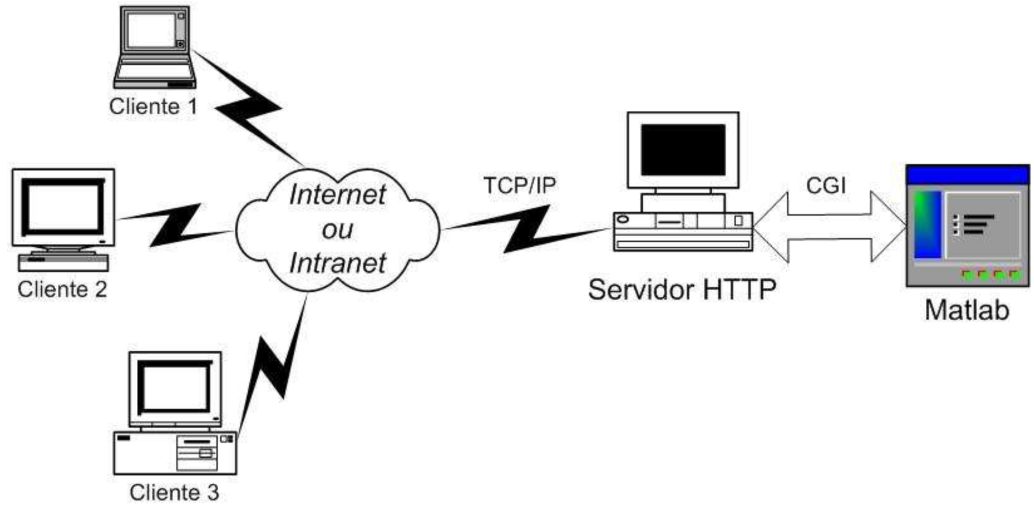


Figure 1. Web based project's structure.

2.2 Project's Components

The projected system uses the structure of the Matlab Web server, as illustrated in Figure 2, that can be detailed in terms of the components:

- `Matlabserver`: Is a multithreaded TCP/IP server. It manages the communication between the Web application and MATLAB.
- `Matweb`: A TCP/IP client of matlabserver. This program uses the Common Gateway Interface (CGI) to extract data from HTML documents and transfer it to matlabserver.
- `Matweb.m`: Calls the M-file that will run in the Web application.
- `Matweb.conf`: A configuration file that matweb needs for connecting to matlabserver. Applications must be listed in matweb.conf.
- `Hosts.conf`: An optional file providing additional security. If hosts.conf is present, only listed machines can connect to the MATLAB Web Server.

3. Traffic Analysis

In a telephone central, the amount of trunks and switch equipments is usually projected in a way that, during the hours of greater call movement, only a very small percentage of requested calls are not established. This allows a reduction of the costs to the switch equipment and the sharing of the equipment with a large number of users.

The theoretical solution of the sizing task of the telephone centrals is dealt with by the traffic theory, following methods developed by Erlang in the beginning of the 20^{th} century. However, in the design of practical projects and in the solution of problems of traffic engineering related to the planning and development of telephonic systems, an enormous range of tables, graphs and varied calculations are indispensable. The developed program allows the easy access to these data and assists in the solution of the problem.

The theory of telephony traffic can be found in several textbooks, [2], [9], [5], etc; as well as in the web page [7], developed in this work. Some formulas used in the theory are revised below.

3.1 Loss Systems

In a loss system, the calls that exceed the maximum number of possible central commutations are discarded or blocked. Erlang used the statistical distribution formula of Poisson to find the blockage probability calculation. One of the results of its studies is synthesized by the *Erlang B formula*, or *Erlang loss formula*:

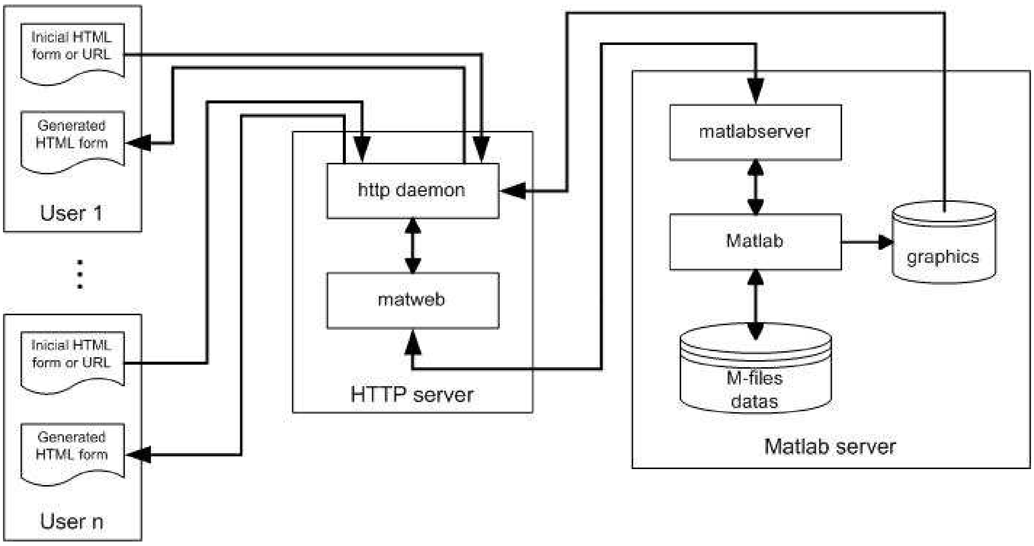


Figure 2. Matlab Web Server components.

$$B = \frac{\frac{A^N}{N!}}{\sum_{i=0}^{N} \frac{A^i}{i!}}. \qquad (1)$$

3.2 Delay Systems

A second stage in the analysis of telephony traffic is about the queue systems of the services, because these cannot be offered immediately. These systems are known as delay systems or queuing systems. In this case, Erlang used the queuing theory to get his second formula, which is known as *Erlang C formula*, or *Erlang delay formula*:

$$P(>0) = \frac{\frac{N}{N-A}\frac{A^N}{N!}}{\sum_{i=0}^{N-1} \frac{A^i}{i!} + \frac{N}{N-A}\frac{A^N}{N!}}. \qquad (2)$$

4. Functions and Visual Interface

The calculating program of telephony traffic has two basic modules. The first module is used in loss systems and the second is used in delay systems.

4.1 Loss Systems

As an example of the utilization of the program, the Figure 3 illustrates the page for loss systems, where the Erlang B formula is used. In this data acquisition Web page, two of the three possible variables should be supplied: number of channels (*N*), source of traffic (*A*) or blockade probability (*B*), and the system will calculate the third one.

Figure 4 and 5 illustrates the final Web page, which returns to the user the chosen numeric result of the unknown variable, added with the graphic of the traffic intensity (*A*), expressed in Erlang, vs. the blocking probability (*B*). As a result of this graphic, four different curves are traced, with a given number of channels around the supplied or calculated number of channels. The implementation of this graphic brings an important visual help for the user, when only the numeric result is insufficient to orientate him in a big universe of possible approximate statistical results.

It is important to highlight the high degree of interactivity of the system, so that the user can modify the input data, obtaining as many results as necessary. In the return page, as illustrated in figure 4 and 5, is presented a table of the blocking probability vs. number of channels, which supplies the values of the traffic intensity (in Erlang). The dynamic elaboration of this table is within the numeric results picked by the server, this facilitates the consultation and it disposes several adjacent results to facilitate the solution of the problem.

4.2 Delay Systems

Figure 6 illustrates the simulation module of delay systems that uses the Erlang C formula as base.

In the initial page that is introduced to the user, illustrated in the Figure 6, it is necessary that the data be supplied for

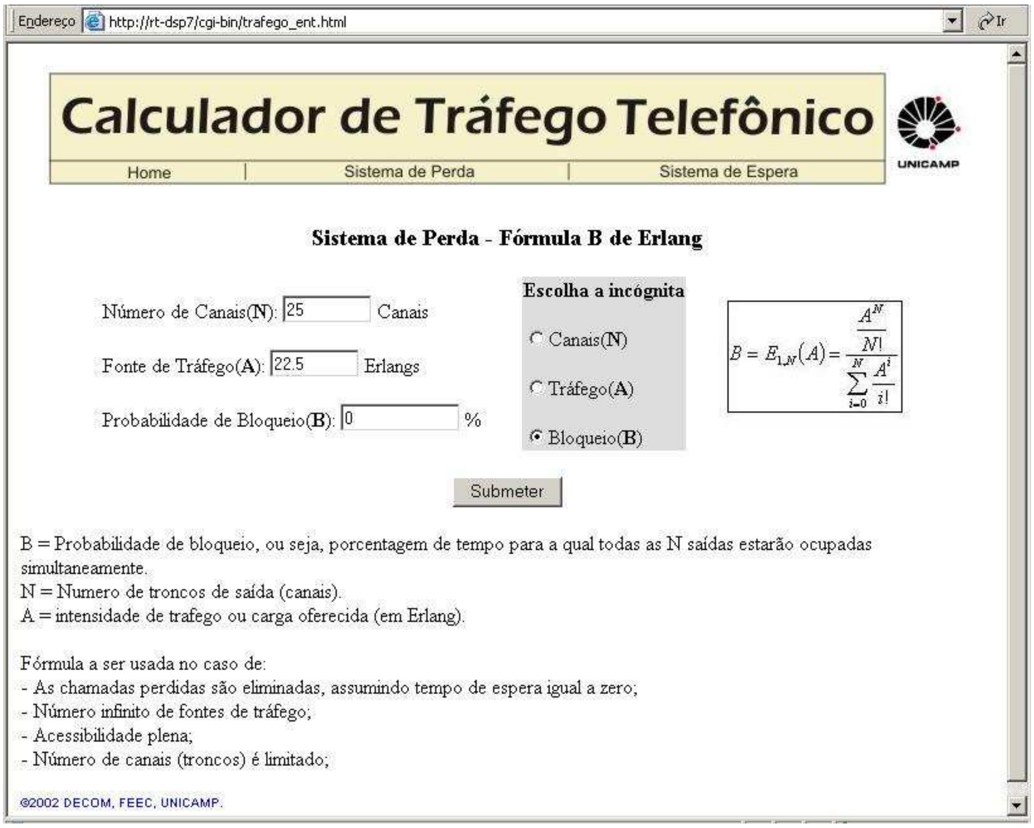


Figure 3. Data input page for loss system.

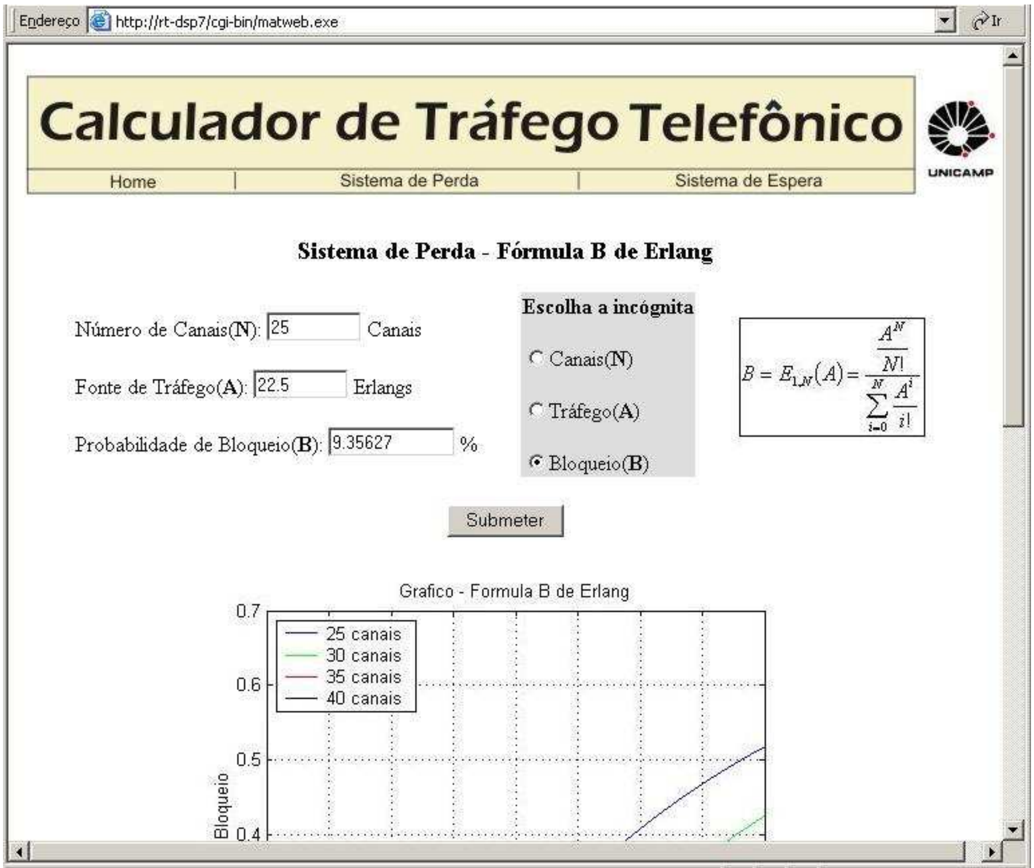
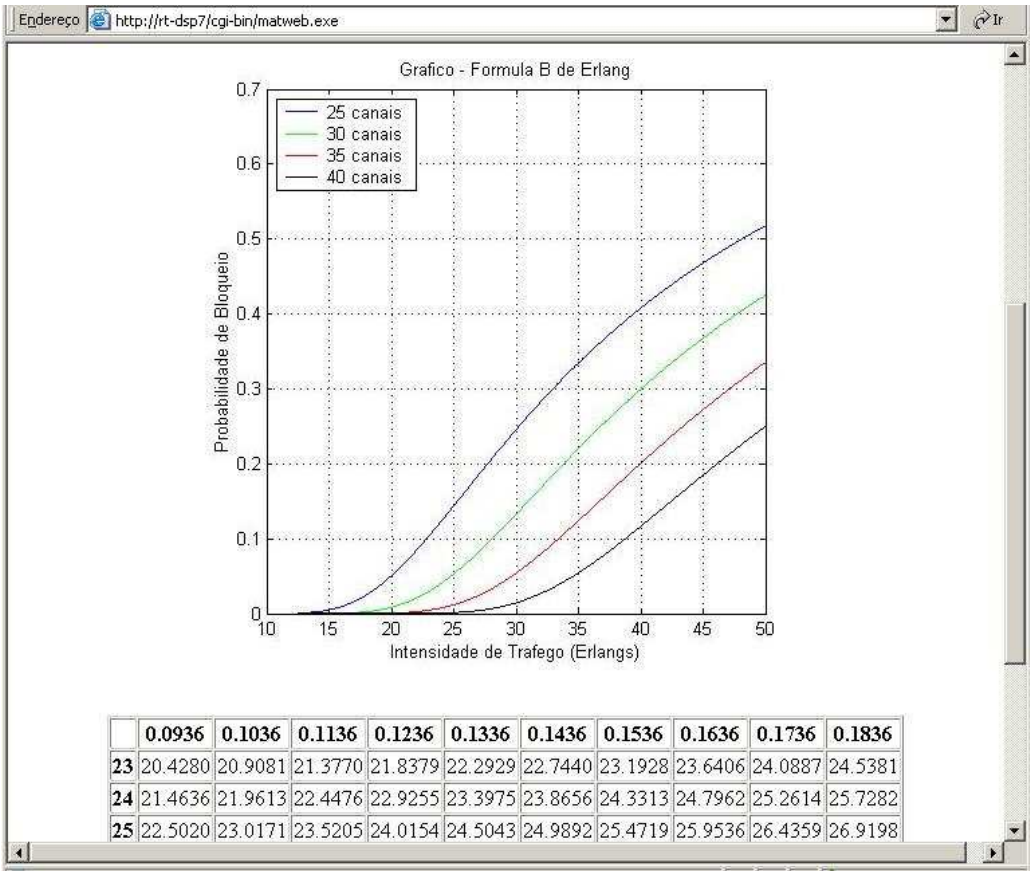


Figure 4. Final page for loss systems.



	0.0936	0.1036	0.1136	0.1236	0.1336	0.1436	0.1536	0.1636	0.1736	0.1836
23	20.4280	20.9081	21.3770	21.8379	22.2929	22.7440	23.1928	23.6406	24.0887	24.5381
24	21.4636	21.9613	22.4476	22.9255	23.3975	23.8656	24.3313	24.7962	25.2614	25.7282
25	22.5020	23.0171	23.5205	24.0154	24.5043	24.9892	25.4719	25.9536	26.4359	26.9198

Figure 5. Final page for loss systems.

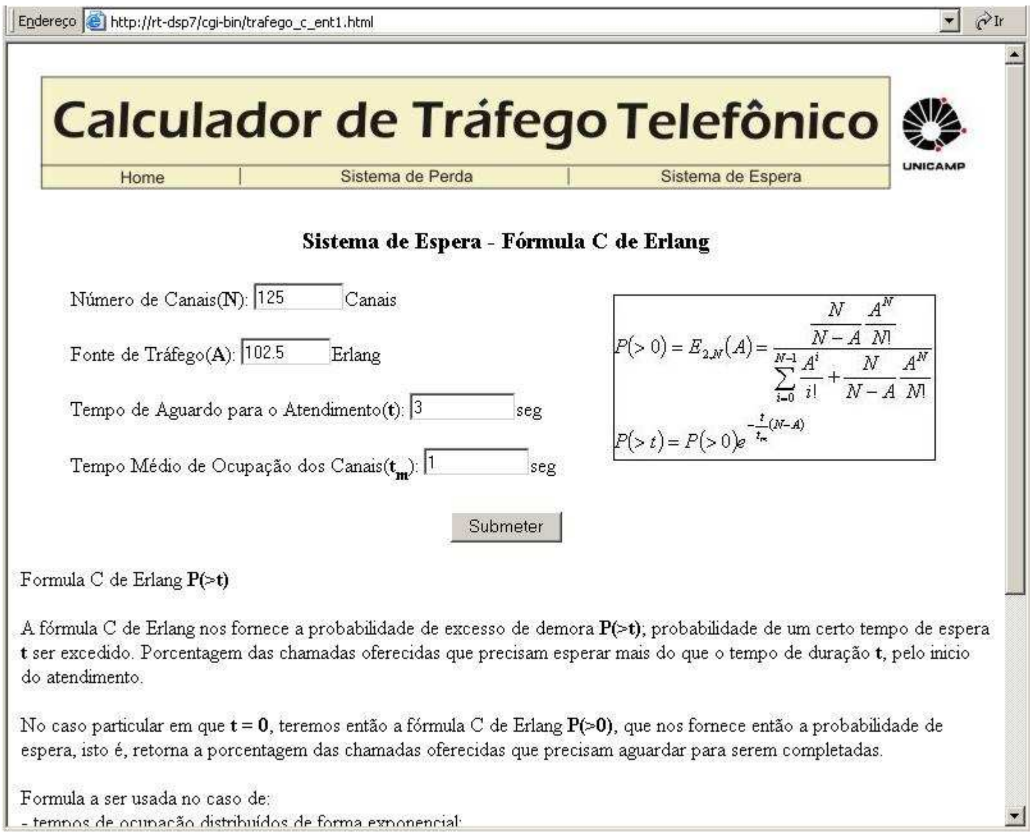


Figure 6. Data input web page for delay systems.

the processing of the calculation, such as: number of channels (*N*), traffic intensity (*A*), wait time for the call answer (*t*) and the average occupation time of the output trunks (t_m).

As an illustrative example, we will assume the particular case in that $t = 0$, the system will answer with the value of the probability of $P(> 0)$ more two graphics simulating curves in the close strips of values to the entrance data. The first graph supplies the curve t/t_m versus the probability $P(> t)$, calculated for the numbers of input channels, resulting in four curves of traffic intensity. The second graphic supplies the traffic intensity curve versus the probability $P(> 0)$, resulting in four curves for numbers of different input channels, as depicted in the Figure 7 and 8.

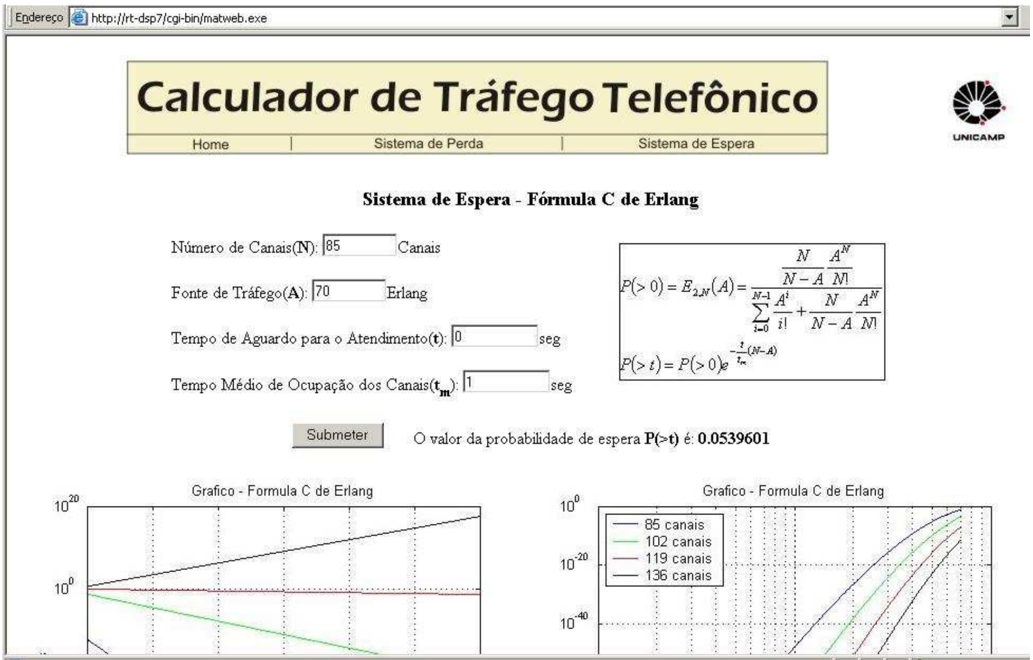


Figure 7. Return web page for delay systems with $t = 0$.

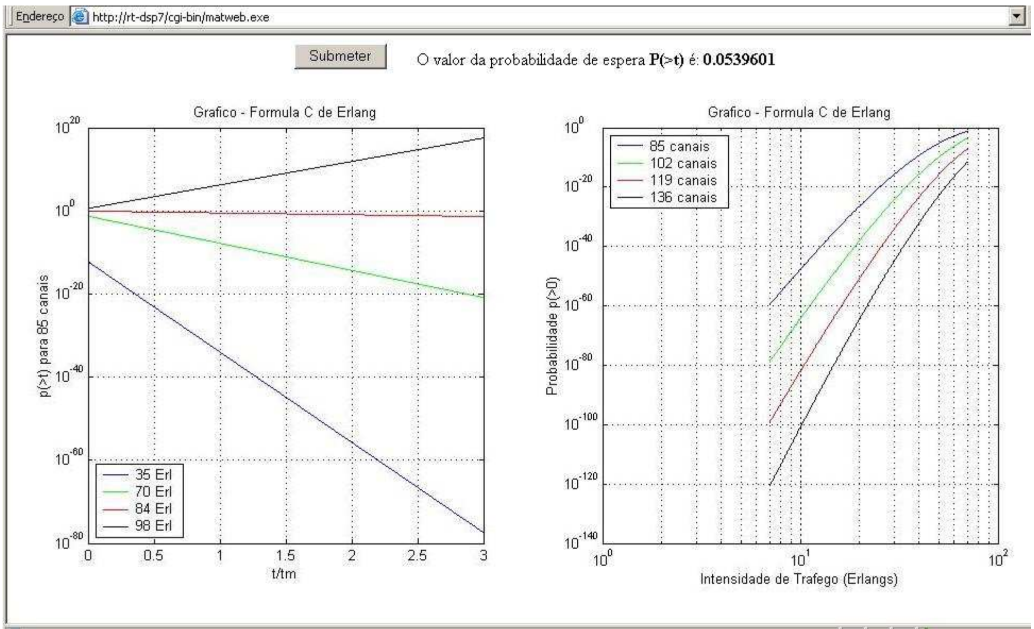


Figure 8. Return web page for delay systems with $t = 0$.

Figure 9 and 10 illustrate the case where $t = 0$.

5. Conclusion

As shown previously, the development of the project, using Internet standards associated with powerful mathematical software, as the Matlab, brings to us a simple, but complete, solution for long-distance education in theory of telephony

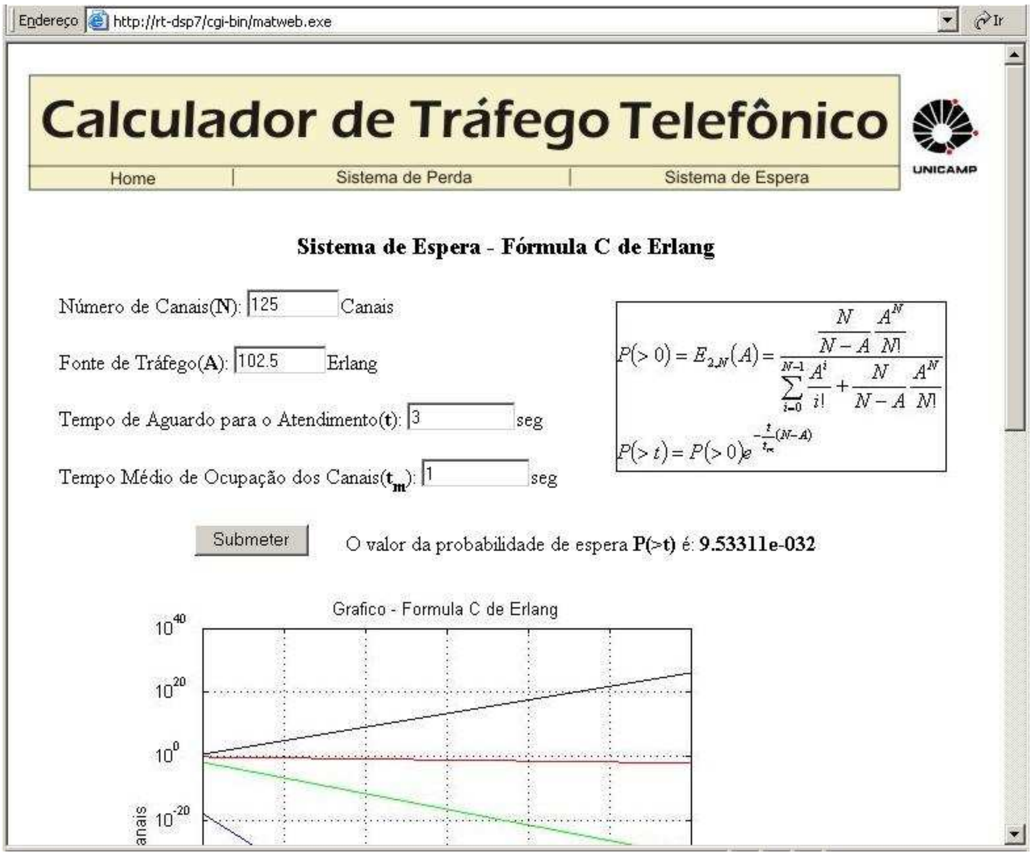


Figure 9. Return web page for delay systems with $t = 0$.

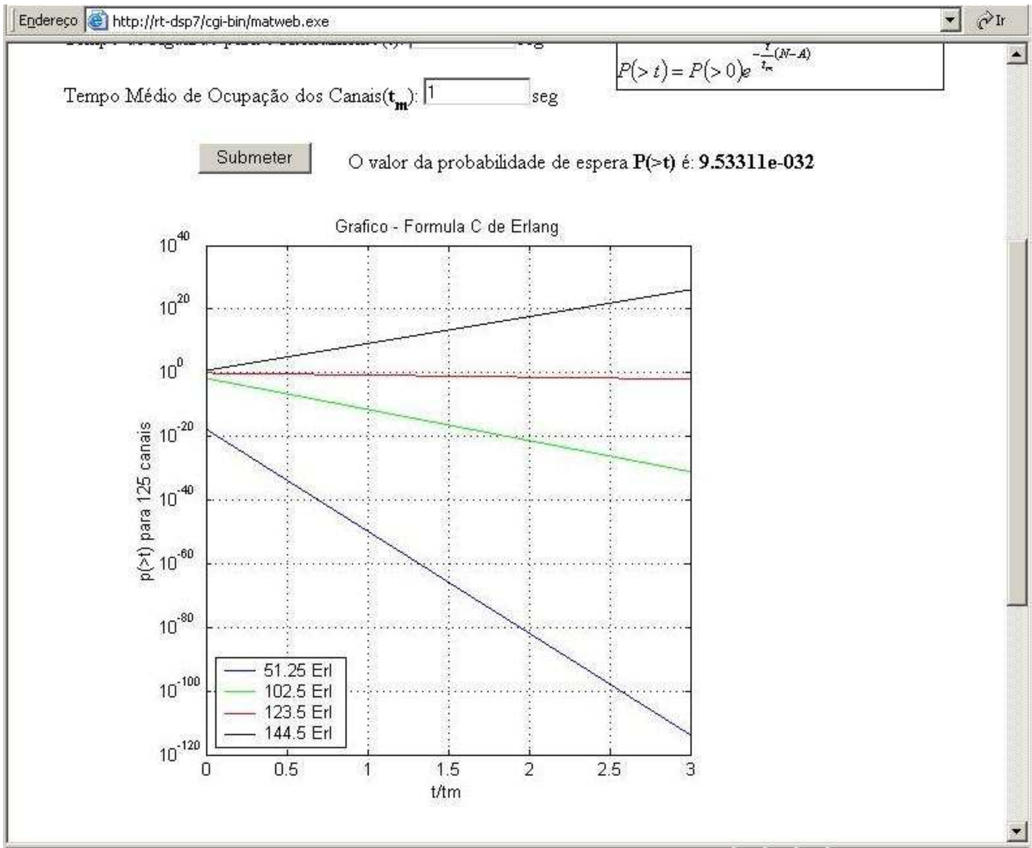


Figure 10. Return web page for delay systems with $t = 0$.

traffic. A simulation environment through Internet or intranet was created using HTML language and adding the possible calculations and simulations we can implement in the Matlab. This powerful tool can be used in EAD, or to assist the professor in the ordinary classes, or even in corporative environments.

The remote access through the network has the following advantages:

- The remote utilization for the users (students or not) without time restriction or distance limitations;
- The use of calculating and/or simulator where users cannot have access in traditional laboratories;
- The interactive visual interface brings the students a new learning model, freeing them from the extensive technical summaries that are not very stimulating.

Finally, it is important to highlight that with relatively simple HTML programming, any content of simulations made in the Matlab can be adapted to run into the Web, using the structure of the project, opening the door of long-distance education for practically all didactic content that makes use of mathematicians software to generate simulations, calculations result, tables, graphics, etc.

6. References

Avraam, E., Veglis, A. *Using the Web in Supplementary Teacher Education*, IEEE EAD, 2001, pp. 274-277.

Bellamy, J. *Digital Telephony*. Second Edition. John Wiley & Sons, Inc., New York, USA, 1991.

Cervera, M., Gómez, F. J., & Martinez, J. *A World Wide Web Based Architecture for the Implementation of a Virtual Laboratory*, IEEE EAD, 2000, pp. 56-61.

Clausen, A., Constantinou, A., Foutz, J., Spanias, A., Stylianou, G., Urban, S. & Zang, X. *Development and Evaluation of a Web-Based Signal and Speech Processing Laboratory for Distance Learning*, IEEE EAD, 2000, pp. 3534-3537.

Dunlop, J., Smith, D. G. *Telecommunications Engineering*. Second edition. Van Nostrand Reinhold, London, UK, 1989.

Levy, P. *Cibercultura*. Editora 34, São Paulo, BR, 1999.

Melo, L. F. *Devlopment the educational web page: www.decom.fee.unicamp.br/ meloni/educat/telephony.htm*. Campinas, SP, 2002.

Mina, R. R. *Teletraffic Engineering, Telephony Publishing Corporation*, 1974.

Siemens AG. *Teoria do Tráfego Telefônico: Tabelas e gráficos*. São Paulo, BR,1975.

The MathWorks, Inc. *Matlab Web Server, the Language of Technical Computing*. Massachusetts, USA, 2000.

7. Responsibility notice

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