APPLICATION OF G P S S TO THE SIMULATION OF TELEPHONE SYSTEMS

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SUMMARY

Many traffic problems in telephony cannot be solved by analytical calculations and necessitate therefore simulations. Some of them concern the so-called "loss systems" and FORTRAN can be used. Other problems mainly connected with the control circuits of an exchange involve complicate waiting systems. G P S S has been applied successfully to such a system where calls have to seize successively three different groups of waiting devices. The advantage of G P S S is that programming is easy and fast so that numerical results can be obtained as quickly as required.

1. INTRODUCTION

A telephone exchange is composed of two parts. The first part, called speech network, involves several connecting stages ; the subscribers are connected to the "terminal stage" and by closing the adequate crosspoints in the speech network any subscriber can be connected as requested to any other subscriber of the exchange or to any outgoing or incoming junction (to or from other exchanges).

The functions of the second part of the exchange, called control circuit, are to open or close the various crosspoints, to choose the correct path to be set up for each type of call, to interprete or send the various tones or dialling information...

In most telephone exchanges the speech network is divided into line switching units and group switching units ; each of them involves two or three connecting stages. The line unit concentrates the number of subscriber lines into a reduced number of outlets whereas the group unit is a mixing unit, in general without concentration, such that several paths exist between any inlet of the group unit (outlet of a line unit) and any outlet of the group unit (local or outgoing or incoming junction).

To set up a call, a connection(preselection)is first established through the line unit between the calling subscriber and a device called register where the dialled digits are received. Such a connection through a line unit is set up under the control of a specialized device called "line marker". In fact, three different devices are seized successively and released quasi-simultaneously according to a prescribed time schedule. These three devices are : primary sections, markers, marking relays. Holding timesare constant and the three devices work according to a waiting process, i.e. any call may wait in front of each device when the latter is busy.

All the necessary connections in the speech network are also set up under the control of line markers (connections through line units) or group markers (connections through group units).

The work reported here concerns the simulation of line marking arrangements.

2. DESCRIPTION OF THE MODELS

The two simulated models are represented on figure 1 and 2. Each model is a three-stage waiting system : a stage of n primary sections, a stage of two or three markers and a stage of two marking relays.

Calls arrive at random in front of the primary sections. They are characterized by two random independent paramaters, their origin and their category.

According to its origin, a call has to seize a prescribed marking relay, R 1 for instance. To reach it, the call must seize one primary section and one marker. It occupies first the primary section during a constant time A (fig.3), then asks for a marker which it occupies during a constant time B and finally asks for marking relay R 1 which it occupies during a constant time C ; at the end of this time the three units are released quasi simultaneously. Waiting may occur in front of each stage and the actual holding times of the primary sections and of the markers are not predetermined as they include random waiting times.

The models operate in slight different ways according to the category of the calls ; preselection calls (calls originated in the line unit) and selection calls (calls terminating in the line unit). A selection call has to seize a predetermined primary section whereas a preselection call can seize any primary section.

The simulation is made very complex by the priority laws, the law of seizure of the primary sections and the orders of service of the queues. In short :

The selection calls have the higher priority level in front of the primary sections.
Two preselection calls only can occupy simultaneously the primary section stage : one call asking for one marking relay R 1 and one call asking for the other marking relay R 2.
The primary sections which may serve a preselection call are hunted sequentially. The primary sections are hunted in one direction for a call asking for relay R 1 and in the opposite direction for a call asking for relay R 2. By means of two distributors, the first hunting position varies also sequentially after each call.
Within a particular queue in front of the primary sections, either an individual selection queue or the general preselection queue, the next call to be served is chosen at random among the waiting calls.
Calls waiting in front of the markers are ordered according to the number of their holding primary section : the marker M 1 chooses the first call in the queue and the marker M 2 chooses the last call.
Releasing of the three stages are not exactly simultaneous : the marking relay releases first, then the primary section and finally the marker. Moreover the limited availability of the three markers in the model 2 has been taken into account as shown by figure 2.

The simulations were realized by means of G P S S (General Purpose System Simulator). The results are printed separately for the two categories of calls (selection and preselection) which are treated in different ways : histograms and averages of the waiting times in front of each stage as well as histogram and average of the total waiting time of the calls in the system.

A set of runs were carried out in order to obtain results for different values of traffic ; figures 4 to 8 are examples of results. A total of about one million of calls were treated. Each run was subdivided into samples at the end of which results were printed : confidence intervals could then be estimated.

3. ADVANTAGES AND DRAWBACKS OF G P S S FOR THE SIMULATION OF WAITING SYSTEMS

The language G P S S appeared well adapted to the simulation of such models of waiting systems, more particularly if simulations are needed during the design phase of a system.

In a project, it is often necessary to simulate quickly a succession of models. As a matter of fact the adequate model may be elaborated step by step according to the results of the preceding simulations and this model has to be defined the faster as it may react upon the design of associated systems. G P S S is suitable for a fast dialogue : programming is easy and fast and the numerical results can be obtained as quickly as required. The delay is even more reduced due to the ease of learning the language : each engineer may program himself when necessary and handle his problem without external help.

The counterpart is evidently that the running times are relatively long and a large computer must be used. From the cost point of view each particular case must therefore be examined individually.

As an example, comparisons between G P S S and FORTRAN on I B M 7094 have been made. Programming was 15 times faster in G P S S than in FORTRAN (the number of instructions was reduced by a factor 7) but the running time was four times longer. For simulations like those described in this paper, involving about one million of call per program, the use of G P S S was found economical. These values concerning only a particular case, it would be interesting to compare them with other results.

The new version of G P S S for the I B M 360 series provides new interesting features. However some additional facilities would be appreciated : easier programming of various types of queues, namely with random order service, possibility of computing confidence intervals by the classical methods of sampling simulations runs ...

Such as it is, the G P S S provides therefore a great help but its range of application might be broadly extended if associated with FORTRAN. The algebraic and logic computation facilities of FORTRAN would be very useful for model description and for the calculation of the final results.

From a general point of view, high-level simulation languages require less programming time and more machine time than lower level languages such as FORTRAN or assembly languages. When the decision has to be made, which language must be used for a particular system simulation, the economical break-even point must be considered. In the future, it can be expected that programming manpower cost will increase whereas computer cost will decrease so that the use of simulation languages will be more and more justified.

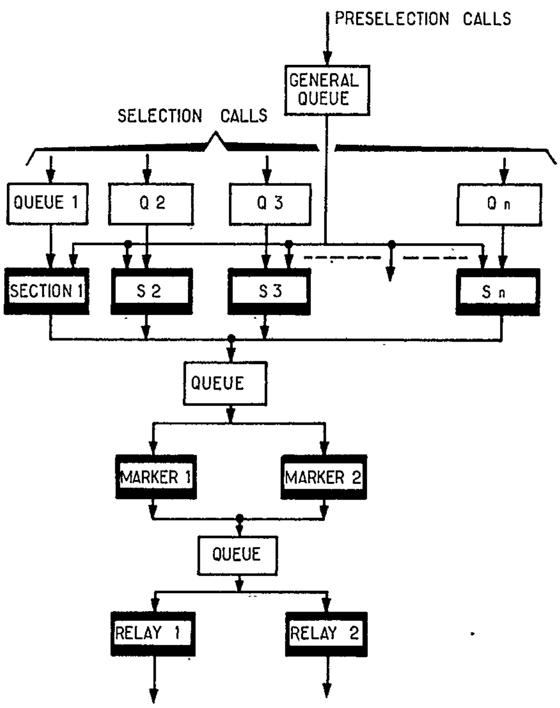

Fig. 1 - Model 1

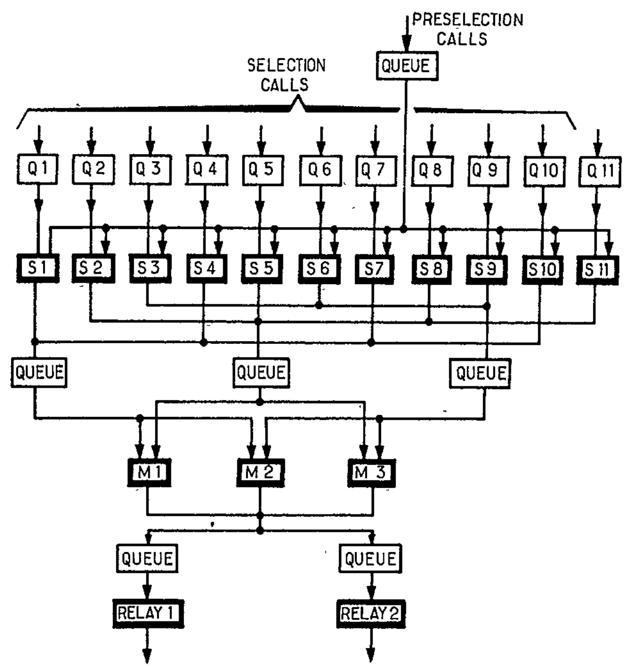

Fig. 2 - Model 2

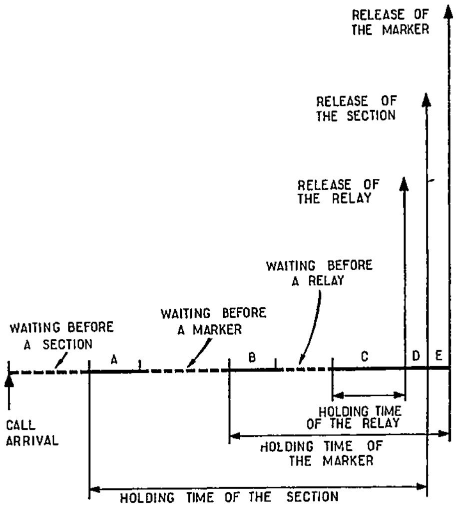

Fig. 3 - Occupation time diagram

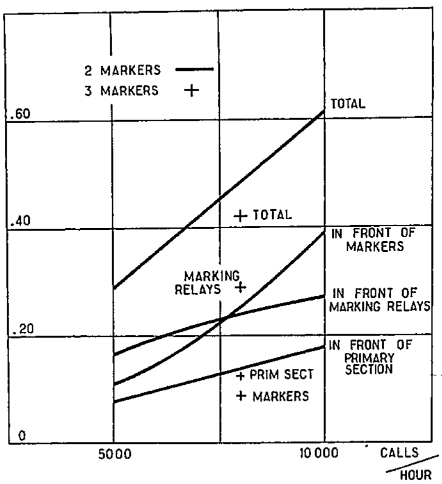

Fig. 4 - Selection - Probability of delay

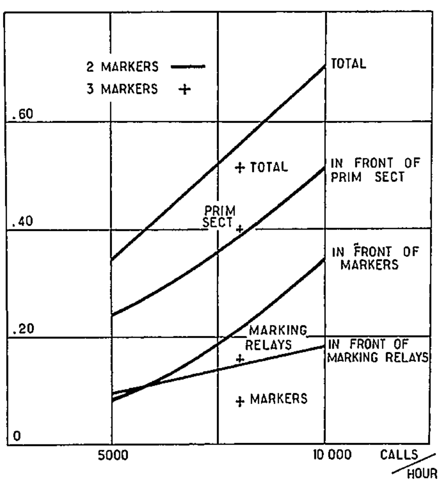

Fig. 5 - Preselection - Probability of delay

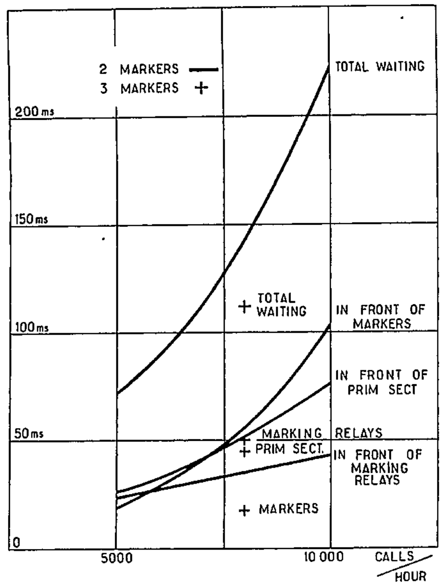

Fig. 6 - Selection - Average waiting time

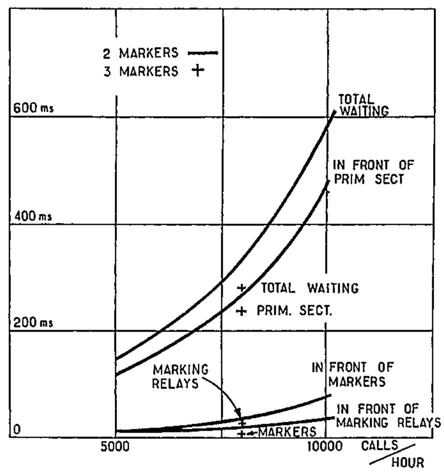

Fig. 7 - Preselection - Average waiting time

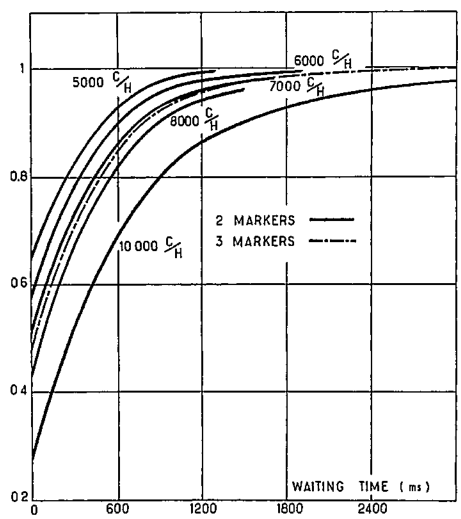

Fig. 8

Preselection - Histograms of the total waiting time