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CONGESTION ANALYSIS OF TELECOMMUNICATIONS NETWORKS UNDER NONSTATIONARY ARRIVAL CONDITIONS

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INTRODUCTION

In teletraffic theory, the problem of congestion in a system experiencing time-dependent arrival rates (i.e. nonstationary arrivals which correspond to a nonhomogeneous Poisson distribution), $\lambda(t)$, and possibly time-dependent service rates, $\mu(t)$, has not been thoroughly investigated. This is mainly due to the difficulty in analysing mathematical models based on the above system. However, present day teletraffic is highly nonstationary due to several factors, such as social, economic, geographical and technological factors. Therefore the problem of determining time-dependent blocking probability is becoming more and more important in teletraffic engineering. This work will assume the service rate to be constant with mean one.

THE ERLANG LOSS FUNCTION

The Erlang Loss Function is a very well-known function and a lot is known about it and its computation is fairly easy. Therefore the possibility of trying to solve a difficult problem by using such a function is very tempting. Its derivation is based on the assumption of steady-state, that is the blocking probability doesn't change with time. However with the so-called modified offered load, the Erlang Loss Function can give fairly good approximations in the case of time-dependent blocking probability.

The first candidate for the modified offered load seems to be $\lambda(t)$, the arrival rate. This is not even the definition for offered load in the case of time-dependency, and the blocking probability it gives is wrong.

APPROACH 1

This approach firstly approximates the arrival rate with a series of step-functions, so that we have constant load over a small interval, where transience cannot be ignored. A possible modified offered load in this case is the transient offered load. The blocking probability obtained by it is not satisfactory. We can find another modified offered load at time t in any interval by using the first difference-differential equation of a set of such equations governing the probability distribution of the system in that interval. The first is used because it makes calculation much easier. However the time-dependent blocking probability function appears in it and we have to approximate it first before it can be used to find a more accurate blocking probability.

APPROACH 2

This approach considers time-dependent arrival rates directly. It utilizes the first difference-differential equation of another set of such equations for a system with continuous time-dependent arrival rates in the above manner. The modified offered load thus obtained involves integrals that could only be solved numerically for any t. Another approximation similar to the above would have to be made to this function too before it is usable.

CONCLUSION

In the above approaches the hard work, especially in the second one, is in the evaluation of the modified offered load at time t. Once this is completed the value is just used in the Erlang Loss Function and an approximation to the time-dependent blocking probability is obtained.