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LIQUID MODELS FOR A TYPE OF INFORMATION BUFFER PROBLEMS

L. KOSTEN

formerly: Delft University of Technology,
The Netherlands

ABSTRACT

This paper [3] is a generalization of results by Anick et al. [1] and Kosten [2]. A number of sources intermittently send messages to a central processor. During "on" periods sources supply information at uniform rate, to be stored in a central buffer. The processor empties the buffer at constant speed c. The problem is that of buffer overflow. Each source may have its own characteristics for the "on" periods.

EXTENSION OF ABSTRACT

The "off" and "on" periods of the n sources from n mutually independent stationary alternating renewal processes. Supposedly, the compound state of the n processes can be described by one of stationary m-state Markov process with continuous time parameter. When the state is r, the sources together fill the buffer at a uniform rate γ_r. The filling mechanism is described by the m×m matrices:

$\overline{M}$: the infinitesimal generator of the Markov process;

$\overline{\Gamma}$: the diagonal matrix diag $\{\gamma_1,\dots,\gamma_m\}$.

The problem of overflow of the finite buffer is replaced by that of finding the probability G(u) of the buffer level exceeding the value u in an infinite buffer. A complete analysis is given. An important result is the proof of the existence of an asymptotic approximation:

$$G(u) \sim C \cdot \exp(-\alpha u) \qquad (u \to \infty) \tag{1.1}$$

Here α is called the dominant transient's exponent, or simply the <u>dominant</u>; C is the <u>amplitude</u>.

The total filling mechanism is an aggregate of the n filling mechanisms of the sources. Those source mechanisms each may be described by their own matrix pair $\overline{M}_j$, $\overline{\Gamma}_j$ of size mj ($j=1,\cdots,n$). Together those pairs also describe the total filling mechanism. Obviously, when confluence is excluded, we have $m=m_1\times\cdots\times m_n$. The determination of α as an eigenvalue of an m×m matrix is not feasible owing to the large value of m. A method is given, called the Decomposition Method, which only uses polynomial equations and linear systems of degree and size m_j ($j=1,\cdots$, n). In practical cases it leads to very simple numerical procedures.

The method is demonstrated by a number of examples in which the distribution laws of "on" times are exponential, hyperexponential or phase (or Erlang), in the first case also with sources that are non-identical.

The amplitude C can only be found analytically for the case of identical sources with exponentially distributed "on" times, treated in [1]. A heuristic approach is described, called the "Equivalent HEG Method". Here, HEG stands for "Homogeneous Exponential Group" of sources, i.e. the standard case in [1]. The results are rather poor, but could be used in the absence of better means.

REFERENCES

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