ITC 11, Minoru Akiyama (Editor)
Elsevier Science Publishers B. V. (North-Holland)
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DYNAMIC BEHAVIOR OF A COMMON STORE QUEUEING SYSTEM

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1. INTRODUCTION

Traffic behavior of telecommunication systems is highly influenced by finite stores, which are normally shared by many traffic streams. In such an environment, the deficiencies caused by unbalanced arrival rates and priority schedules should be well understood.
The most important effects are : 1) storage domination by the high-rate traffic streams, and 2) the so-called priority deadlock in which high-priority traffic must be discarded owing to lack of store caused by backlogging low-priority traffic. These effects can be demonstrated most effectively by considering system dynamics as a response to a rectangular-shaped overload peak.

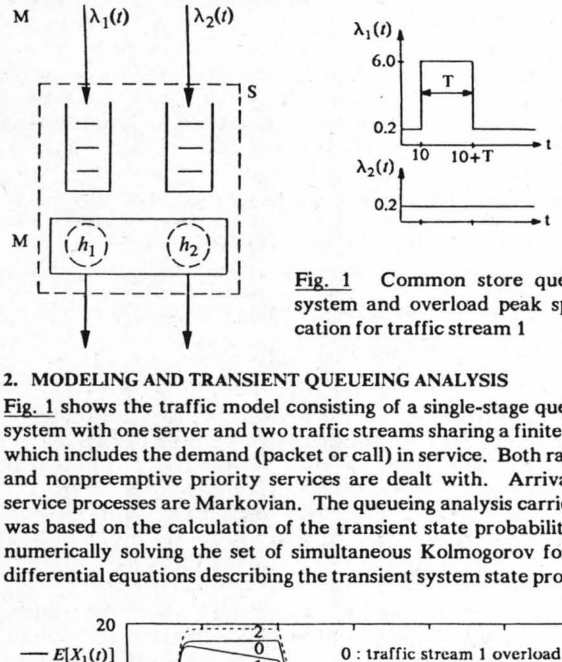

Fig. 1 Common store queueing system and overload peak specification for traffic stream 1

2. MODELING AND TRANSIENT QUEUEING ANALYSIS

Fig. 1 shows the traffic model consisting of a single-stage queueing system with one server and two traffic streams sharing a finite store, which includes the demand (packet or call) in service. Both random and nonpreemptive priority services are dealt with. Arrival and service processes are Markovian. The queueing analysis carried out was based on the calculation of the transient state probabilities by numerically solving the set of simultaneous Kolmogorov forward differential equations describing the transient system state process.

3. NUMERICAL RESULTS AND DISCUSSION

Fig. 2 depicts the mean system occupancies $E[X_1(t)]$ and $E[X_2(t)]$ of both traffic streams for different overload situations. To generate the overload peak, one of the two arrival rates is changed as specified in Fig. 1 . The common store queueing system has the capacity $S = 20$. The mean service time $h_1 = h_2 = 1$ is also the time unit.
Curves 0 , no priorities and an overload peak of traffic stream 1 :
1) Storage domination by the high-rate traffic stream 1, since the storage space becoming free is captured by the traffic streams in the proportion of the arrival rates.
2) Temporal surplus of the low-rate traffic stream 2 after disappearance of the overload peak : the acceptance rate for the low-rate traffic improves, while the backlogged high-rate traffic has not yet been worked off.
Curves 1 , overload peak of high-priority traffic stream 1 :
1) Decrease of $E[X_1(t)]$, since the store is filled up with backlogged low-priority demands.
2) Corresponding increase of $E[X_2(t)]$ and high temporal surplus after disappearance of the overload peak.
Curves 2 , overload peak of low-priority traffic stream 2 :
1) Almost complete storage occupation by the backlogging low-priority demands, since high-priority demands are given preference.
2) Hardly any high-priority demands are present, since once accepted they are almost immediately served.

Fig. 3 demonstrates a forthcoming priority deadlock. For long overloads of high-priority traffic, a backlog of low-priority demands builds up, and finally the store becomes completely useless :
the congested queueing system behaves like a loss system.

4. CONCLUSION

Both effects show that the continuity of traffic streams sharing storage can only be guaranteed, if some storage space is reserved for each traffic stream.

*) This work was done at the University of Siegen, W-Germany.

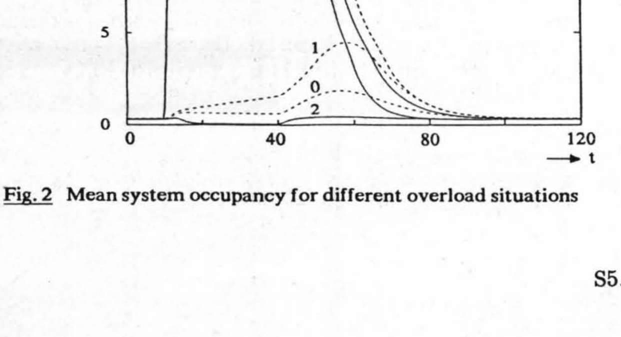

Fig. 2 Mean system occupancy for different overload situations

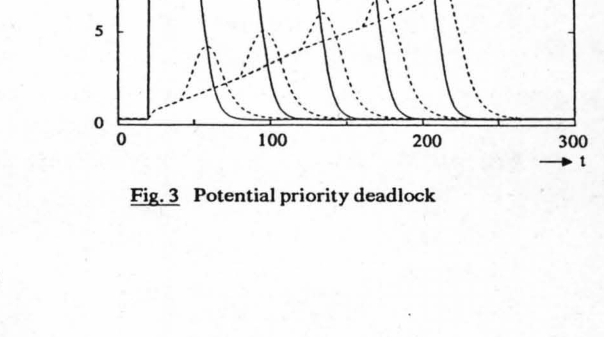

Fig. 3 Potential priority deadlock