

W. SMITH and W. WILKINSON (editors), *Proceedings of Symposium on Congestion Theory*. University of North Carolina, 1965. xvi + 458 pp. \$14.00.

Review by PETER NEY

University of Wisconsin

This volume contains the proceedings of a symposium on queueing theory and some related topics, held at Chapel Hill in June 1962. It consists of fourteen papers, each followed by discussions—some of which were planned and some impromptu.

It is somewhat difficult to classify the papers into sub-areas, since they go in many different directions. One aspect common to several is the recent development of more complicated models. These range from general situations involving flows through elaborate networks of servers (surveyed by T. L. Saaty) to special arrangements such as servers in series (E. Reich). The former are discussed in terms of concepts of graph theory, the latter in terms of the process of departure times of units from servers. These types of models are currently important in telephone traffic theory and in many operations research problems. Another complicated class of models, which have developed into a field of their own are those of traffic theory, which were reviewed by G. Weiss.

Related to the development of some of the above models is the question of how best to schedule the processing of a unit through a given arrangement of servers. This was touched on by D. P. Gaver, who surveyed recent work on priority disciplines.

The problem of finding approximate solutions to models that could not be explicitly solved by analytical methods received some attention. Various uses of computers in this connection (simulation, Monte-Carlo methods) were discussed by E. S. Page. J. F. C. Kingman considered some aspects of his interesting result on heavy traffic approximation theory; namely, that as the critical ratio of arrival to service rates approaches one, the waiting time distribution goes to the exponential. He examined possible extensions of his result to more general situations (e.g., dependent arrival or service distributions; multi-server queues).

The remainder of the papers defy classification and we shall be content with giving a capsule statement of each. F. Pollaczek gave a new and apparently powerful method for calculating waiting time distributions under more general arrival and service distribution assumptions than had been treated till now. L. Takacs surveyed his recent work on the ballot problem and discussed its role in queueing theory; and J. Th. Runnenburg did likewise on the method of collective marks.

A paper of C. R. Heathcote examined some interesting aspects of super-critical queues, which have received little attention till now. He studies certain random variables associated with the queue (e.g., amount of idle time) which remain finite with probability one in the case $\rho > 1$. Another neglected area has

been that of the statistical problems connected with congestion theory which were discussed in the lecture of D. R. Cox. There are contributions by J. Keilson on Green's function methods and by N. U. Prabhu on a unified approach to queueing and dam problems; also a unified treatment of Markovian queues with truncated queue length and diverse disciplines by R. Syski.

Insofar as this volume is an indication of current and near-future directions of research in queueing theory, it appears that there is some emphasis on the treatment of more elaborate (and realistic) models on the one hand; and the development of approximation methods on the other. It seems that in the more traditional areas (e.g., ergodicity, existence and determination of stationary solutions) only very difficult problems remain unsolved.