Preface

Users of Internet and mobile communications are increasing at an incredible speed. About until ten years ago, traditional telephone network was dominant in telecommunication. Digital technology, fiber optics and LSI as well as software technology have made modern information communication network possible. For the design, analysis and efficient operation of such new information communication networks, operations research techniques must play important roles. Especially queueing theory, applied probability, and performance evaluation theory are needed. This special issue provides ten selected papers on "Performance evaluation of information communication network." The contents were categorized into three groups: *ATM network analysis, network and computer performance*, and *numerical method and fundamental theory.*

ATM Network Analysis: *S. Shioda* discusses worst-case cell arrival patterns systematically by using buffer overflow probabilities based on large-deviation principle for an ATM multiplexer with cell arrivals confirming to a generic cell rate algorithm (GCRA). Several interesting results are shown. For example, it is shown that the greedy on-off pattern is not always the worst cell-arrival pattern among those confirming to dual GCRAs. *S. Kasahara and T. Hasegawa* consider the multiplexing system with the large number of buffer and the large number of on-off sources regulated by the leaky bucket. Combining two asymptotic results for the bufferless system with the large number of sources and the large buffer system, they derive the upper bound approximation of the overflow probability for designing the regulator. *S. Ata, T. Takine, M. Murata and H. Miyahara* develop first an approximate method for two types of service classes, ABT/DT (ABT with Delayed Transfer) and ABT/IT (ABT with Immediate Transfer), in ABT (ATM Block Transfer), and present performance comparisons between ATM/DT and IT. They next propose dynamic bandwidth negotiation protocols to improve performance of ABT/DT, and study the efficiency through simulation experiments. *H. Toyoizumi, J. G. Shanthikumar and W. Wolff* propose a so-called block renewal process for describing an auto-correlated interarrival times for a queueing system. This process is composed of a sequence of independent blocks in which interarrival times are correlated, and easily identified by marginal distributions and auto-correlations. The process is applied to a single server queue, and the stationary queue length distribution is obtained. Because of its simplicity, the process would be useful in practical applications, particularly, for modeling heavily correlated arrival processes in ATM networks.

Network and Computer Performance: *Y. Sakai et al.* are concerned with an M/G/1/K queue with vacation/set-up/close-down times. This type of queueing model appears when we consider the switched virtual channel connection (SVCC) mechanism for an IP over ATM networks. To overcome analytic difficulties due to the complex movements of the server, they carefully analyze the model by the supplementary variable technique and obtain the stationary results which allow them to calculate the performance measures of interest numerically. *T-J. Lu, W. Yue, and T. Hasegawa* consider a special mutual overflow system with simultaneous occupation. The system has three multi-server facilities and no waiting rooms. The first-offered traffic is a Poisson process and the service time exponential. They propose an algorithm for computing the joint state probabilities and show the effectiveness of the algorithm. We can think of their results as a stepping stone to the analysis of the Real Time Network Routing (RTNR) operation. *A. Tanaka and I. Kino* study the dynamic behavior of programs on a computer system through LRU(Least Recently Used) stack dis-

tribution assuming Markovian page references. Lumpability of the Markov chain governing the stochastic behavior of an LRU stack is first proved. This result is then applied to develop an efficient numerical algorithm for computing the stationary distribution of the LRU stack and stack distance. They provide a framework of the performance evaluation for page replacement algorithms for which experimental analyses have been primarily done.

Numerical Method and Fundamental Theory: *K. Fujimoto, Y. Takahashi and N. Makimoto* consider the tail behaviors of a stationary joint distribution of two queues in tandem with phase-type interarrival and service time distributions, in which both queues may have multiple servers. By extending the matrix geometric analysis of Neuts, they show that the tail probability of one queue is geometrically decreased, provided the other queue remains constant or goes to infinity. The decay rates and coefficients for the geometric terms are also calculated. *H. Takagi and T. Nishi* consider dependency of the departure intervals in M/G/1 and M/G/1/K queues. They first derive recursive formulas for the joint distributions of the departure intervals in the steady state. Using these recursions, covariances of the departure intervals are explicitly obtained for various cases, especially when the buffer size is small. These formulas are used to numerically evaluate the correlation coefficients. The results explain how the correlations depend on the traffic intensity, service time distributions as well as lags. *D. Horibe and N. Miyoshi* apply the smoothed perturbation analysis (SPA) for a discrete-time single server queue with a stationary arrival times and i.i.d. service times. They derive a perturbation formula for the mean waiting time with respect to the service time distribution. For the discrete-time queue, distributions cannot be differentiated, so the ordinary infinitesimal perturbation analysis (IPA) fails. This difficulty is overcome by smoothing the mean waiting time with Palm formula, and by extracting principal terms in which service times changes their values at most by one. The perturbation formulas will be useful in optimization of various queueing problems.

We wish to acknowledge and thank the authors of all papers submitted to this issue. Most of the submitted papers were presented at the 'Symposium on Performance Models of Information Communication Network' held January, 1997 in Kamakura, Japan. We also thank Professsor Yukio Takahashi, general chair of the symposium, for his cooperation to this issue. This issue was expedited by editor and associate editors group relevant to the theme of the issue. Submission to the issue was due April 30, 1997, about one year ago. They would also like to acknowledge the contribution of many experts who participated in the fast reviewing process of the papers and secretarial works of Mrs. C. Kanasaki.

Konosuke Kawashima, *Editor*
Issei Kino, *Associate Editor*
Naoki Makimoto, *Associate Editor*
Masakiyo Miyazawa, *Associate Editor*
Yoshitaka Takahashi, *Associate Editor*