Title: Mathematical Problems in Stability, Control and Reliability of Random Access Communication Systems

Principal Investigator: Walter A. Rosenkrantz.

I. Publications


1983 b) Diffusion Approximation for a class of Markov processes satisfying a nonlinear Fokker-Planck equation, Nonlinear Analysis, Theory, Methods and Applications, Vol. 7, #10, 1089-1099, (with Li Zhan Bing).

This is the principal investigator's final scientific report containing: (i) list of publications, (ii) invited lectures, conferences, symposia, (iii) professional personnel associated with research effort, (iv) status of current research, (v) list of references to probe further.


1984 c) An operator method for computing the asymptotics of a collision resolution interval, AFOSR 82-0167, No.9


1986 a) Some remarks on the asymptotic behaviour of the lengths of a collision resolution interval, IEEE Trans. on Communications Vo. COM-34, No. 9 Sept. '86 962-965.


1987 c) On the expected time to collapse of the slotted ALOHA protocol, with W. Rising.

II. Invited Lectures, Conferences, Symposia, etc.


v) "An Operator Method for Computing the Asymptot-
ics of a Collision Resolution Interval"

Cambridge University, Cambridge, England, 15 Nov. 1985

and

vi) INRIA, France, November 1985

vii) "Recent results of Aldous on Random Access Communication Systems", Univ. de Paris VI, Seminaire de Laboratoire de Probabilites, 14 Jan. 1986


ix) "An operator method for computing the asymptotics of a collision resolution interval", University of Utrecht, Department of Mathematics, 17 April 1986.

x) "A Martingale Approach to Approximate Counting", INRIA (Sophia Antipolis), Journees d'etudes, Modelisation et Evaluation de Systemes Informatiques, 29 April 1986.

xi) Mathematical Problems in Random Access Communication Systems" is the title of a lecture that I presented several times including:
a) University of Geneva, Switzerland, 10 June 1986.

b) ETH, Zurich, Switzerland, 11 June 1986

c) Ecole Polytechnique, France, 23 June 1986

xii) I attended the TIMS-ORSA Symposium on Queueing Networks and their Applications, 7-9 Jan. 1987, New Brunswick, New Jersey.


III. Professional Personnel associated with Research Effort

i) Freda Bennett, Ph.D Sept. 1983


ii) William Rising, graduate student, is currently working on a Ph.D. thesis on the mathematical modelling and analysis of the ALOHA and Exponential Backoff (EBO) protocols. Of particular in-
terest are qualitative and quantitative analyses of "bistability", e.g. "the mean time to collapse of ALOHA" and similar questions for EBO. The research also involves devising a numerically stable method for computing first passage times so that we can compare the approximate answers with the exact answers.

IV. Status of Current Research and Future Directions

The new technologies of packet switching, local area networks, satellite communications, load balancing of distributed processors, etc. have spawned a myriad of novel protocols which are not easily analysed via traditional queueing theory methods. The contributions of the principal investigator to these problems are contained in various technical reports and articles listed in Part I (publications) of this report. Future research will focus on ergodicity conditions for a) slotted ALOHA with a finite number of users and infinite buffers, b) EBO with a finite number of users and infinite buffers, c) bistability for EBO, d) performance analysis of load balancing protocols and related questions. Mathematical methods to be used include martingales, diffusion approximations, large
deviations, etc. We point out, however, that these problems cannot be solved via a routine application of martingale theory, say, or the general theory of large deviations. For it is a non-trivial task to find the right Lyapounov function, or the correct "rate function" etc. And, finally, one has to validate the proposed model.

To probe further we have prepared the following bibliography:

V. References:


Bell Labs (A. Greenberg)


[Pa-Sch-Wal 1986] Parekh, Schoute, and Walrand, "Instability and geometric transience of the ALOHA protocol", Mem. No. UCB/ERL M86/73, Electronics Research Laboratory, U. Cal. (Berkeley)
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