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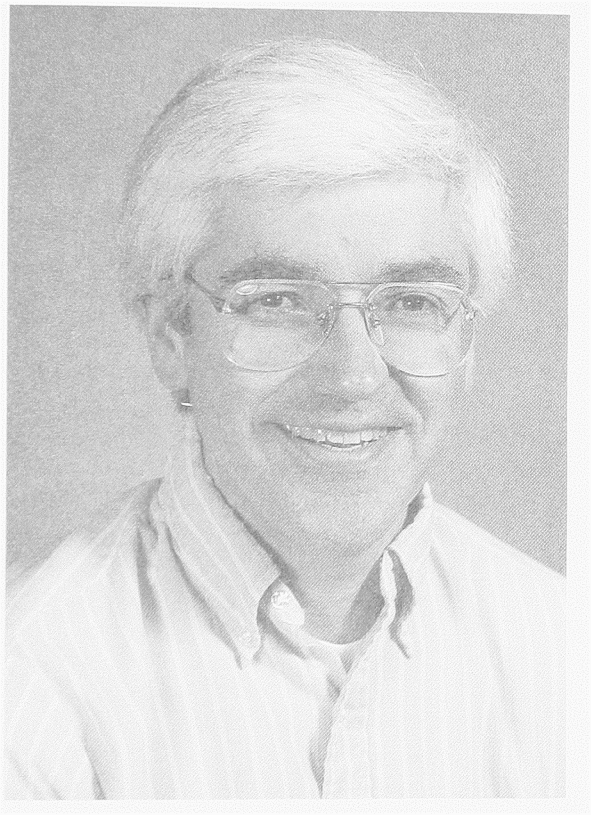
KEYNOTE ADDRESS: SIMULATION IN RESEARCH AND RESEARCH IN SIMULATION: A TELECOMMUNICATIONS PERSPECTIVE

Ward Whitt

AT&T Labs -Research
180 Park Avenue
Florham Park, New Jersey 07932-0971, U.S.A.



ABSTRACT

We describe two recent research activities where simulation played a critical role. In the first, simulation is the essential tool to study performance. In the second, the performance of simulation is itself the subject of the research.

1 RESOURCE SHARING FOR BOOK-AHEAD AND INSTANTANEOUS-REQUEST CALLS

In integrated-services telecommunication networks, it is difficult to provide adequate quality of service to large-bandwidth calls such as occur with video teleconferencing. Hence service providers are beginning to allow some customers to book ahead their calls. Thus we need schemes for sharing resources among book-ahead calls (that announce their book-ahead time, call holding time and bandwidth requirement upon arrival) and instantaneous-request calls (that announce their bandwidth requirement but not their holding time). We show how simulation can help. (Based on Greenberg, Srikant and Whitt 1997.)

2 VARIANCE REDUCTION IN SIMULATIONS OF LOSS MODELS

As illustrated by the problem above, a workhouse model in telecommunications is the loss model. A loss model represents a system to which arrivals come according to some stochastic process. Some of these arrivals are admitted, after which they stay for a random time and then depart, while other arrivals are blocked and lost. We are interested in blocking probabilities, i.e., the long-run proportion of arrivals from one arrival process that are not admitted. In many situations, simulation is the best way to determine these blocking probabilities, but very long simulations can be required. The question, then, is: Are there alternative ways to estimate blocking probabilities more efficiently?

We propose a new estimator of steady-state blocking probabilities for simulations of stochastic loss models that can be much more efficient than the natural estimator (ratio of losses to arrivals). The proposed estimator is a convex combination of the natural estimator and an indirect estimator based on the average number of customers in service, obtained from Little's law ($L = \lambda W$). It exploits the known offered load (product of the arrival rate and the mean service time). The variance reduction is dramatic when the blocking probability is high and the service times are highly variable. The advantage of the combination estimator in this regime is partly due to the indirect estimator, which itself is much more efficient

than the natural estimator in this regime, and partly due to the strong correlation (most often negative) between the natural and indirect estimators. In general, when the variances of two component estimators are very different, the variance reduction from the optimal convex combination is about $1 - \rho^2$, where ρ is the correlation between the component estimators. For loss models, the variances of the natural and indirect estimators are very different under both light and heavy loads. The combination estimator is effective for estimating multiple blocking probabilities in loss networks with multiple traffic classes, some of which are in normal loading while others are in light and heavy loading, because the combination estimator does at least as well as either component estimator, and provides improvement as well. (Based on Srikant and Whitt 1996, 1997.)

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AUTHOR BIOGRAPHY

WARD WHITT is a member of the Network Mathematics Research Department in AT&T Research, the research organization of AT&T, formed from AT&T Bell Laboratories in 1996 after AT&T split into three separate companies. Dr. Whitt received an A.B. in mathematics from Dartmouth College in 1964 and a Ph.D. in operations research from Cornell University in 1969. After teaching at Stanford University and Yale University, he joined Bell Laboratories in 1977. His research has focused on probability models, mostly of queueing systems. He has an active interest in simulation, both as a tool to evaluate performance in queueing systems and as a subject of research. In 1991 he received the TIMS College on Simulation Outstanding Publication Award for his paper, "Planning Queueing Simulations" (Whitt 1989).