

Modelling of Computer Systems

A Tutorial

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Computer system performance modelling is a relatively restricted problem domain. Because of this, much is known about which performance measures are and are not important, which system characteristics do and do not influence these performance measures, what degree of confidence the available measurement data will and will not support, what approximations are and are not reasonable, etc.

Because computer systems are large, and because modelling is used as a regular part of the "capacity planning" process at many installations, fast and acceptably accurate analytic techniques have been developed for many applications. But because these analytic techniques do not accommodate certain important system characteristics, and because they do not yield certain important performance measures, simulation and hybrid analytic/simulation techniques also are of considerable importance. Computer system performance modelling thus provides a nice case study of the tradeoffs between simulation and analysis.

These are the sorts of issues that will be discussed in this tutorial. In addition, since WSC attendees are apt not to be familiar with the techniques of analytic modelling, a brief overview of this material will be presented. In brief outline form:

Applications of computer system performance modelling.

A small set of case studies will be used to exhibit the range of problems that are considered.

An introduction to analytic models.

A brief discussion of how analytic queueing network models differ from their simulation counterparts: their inputs, their outputs, and the evaluation techniques that transform the inputs into the outputs.

The case for analytic models.

The key strength of analytic models is *not* that they're accurate; rather, it's that they provide ballpark projections very quickly. In what situations is this especially advantageous?

The case for simulation models.

Situations will be discussed in which simulation is the appropriate tool for computer system performance modelling: situations in which system characteristics or required performance measures preclude an analytic approach.

The interplay of analysis and simulation.

A discussion of areas such as the analysis of models via decomposition, hybrid analytic/simulation models, etc.

Much of this material is based on the 1984 Prentice-Hall text *Quantitative System Performance: Computer System Analysis Using Queueing Network Models* by Edward D. Lazowska, John Zahorjan, G. Scott Graham, and Kenneth C. Sevcik, and on the 1984 AUERBACH portfolio *Capacity Planning Using Queueing Network Models* by Edward D. Lazowska.

Edward D. Lazowska received an A.B. from Brown University in 1972, and an M.Sc. and Ph.D. in Computer Science from the University of Toronto in 1974 and 1977 respectively. Since 1977 he has been on the faculty of the Department of Computer Science at the University of Washington, where he recently returned after a sabbatical leave at Digital Equipment Corporation's Systems Research Center. His research interests fall within the general area of computer systems: modelling and analysis, design and implementation, distributed systems. He is an author of a number of papers in these areas, as well as of the Prentice-Hall text *Quantitative System Performance: Computer System Analysis Using Queueing Network Models*. He is the Chairman of SIGMETRICS, the Association for Computing Machinery's Special Interest Group concerned with computer system performance.

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