# Guest Editorial Advances in Computational Aspects of Teletraffic Models

PROBABLISTIC models play a key role in the modeling, analysis, control, and performance evaluation of a broad range of real-life systems. Furthermore, technological developments and paradigm shifts continually call for updating and adapting existing models.

Telecommunication networks constitute a fundamental case in point; traffic modeling and teletraffic analysis have long been basic to their modeling, analysis, and evaluation of performance measures. For over a decade this area has been undergoing extraordinarily rapid development and technological change. Consequently, the qualitative and quantitative expansion of services carried, or planned to be carried, has rendered the bulk of traditional teletraffic analysis methodologies unsuitable for modeling emerging complex high-speed networks. The problems lie primarily in the bursty nature of new traffic classes, such as compressed video and file transfer. The former class is especially troublesome as it combines strict timeliness constraints and high traffic volumes. While the phenomenon of burstiness is underpinned mathematically by autocorrelations in traffic streams, traditional analysis relies heavily on independence assumptions for the majority of tractable solutions. On the other hand, when models incorporate traffic dependencies, the resultant models are complex and afford no systematic way of mapping empirical measurements into working models.

The effective design and engineering of networks requires accurate mathematical models which capture the important statistical properties of traffic sources. The paper by Melamed and Pendarakis provides a general methodology for constructing mathematical models of compressed variable bit rate (VBR) video. The modeling framework is based on the extension of transform-expand-sample (TES) processes which simultaneously capture the marginal density and correlation structure of traffic. The paper by Che and Li uses models based on circulant modulated rate processes for this same purpose.

Once accurate mathematical models of traffic are constructed, a network designer may use them in either a Monte Carlo simulation or in analysis. Many papers in this issue are concerned with efficient computational algorithms of teletraffic models. In most cases where an exact analysis is possible, the underlying processes are Markovian. Therefore, efficient and robust numerical methodologies are essential for the computational aspects of such models.

The paper by Akar *et al.* presents a new algorithmic solution for M/G/1-type Markov chains. Such chains frequently appear in the teletraffic analysis of modern telecommunications networks, e.g., ATM. Known concepts from classical system and control theory are borrowed in their numerical algorithms, and both infinite and finite chains are considered. The paper by Jean-Marie *et al.* provides a new computational algorithm for the workload distribution in the MMPP/GI/1 queueing system. This approach provides special attention to situations where the input process consists of superposition of independent processes. The MMPP/GI/1 model is frequently used in the teletraffic analysis of a single node modern network. The paper by Lenzini *et al.* provides an efficient numerical method for a class of finite, discrete-time, discrete-state Markov chains with special (funnel) structure. An extension of the packet reservation multiple access (PRMA) protocol was analyzed using this approach. Borst and Mitra provide a computational algorithm for sharing of resources among heterogeneous traffic sources.

In the area of quality of service guarantees in high-speed networks, one can identify probabilistic (soft) guarantees and deterministic (hard) guarantees. Two of the papers in this issue deal with probabilistic guarantees. The first, by Ren and Kobayashi, considers the issue of bandwidth allocation by concentrating on a single node. The traffic is assumed to be the superposition of Markov modulated rate processes (MMRP). Applications in real-time admission control, as well as an extension of this model for the characterization of long-range dependency, are discussed. The second paper, by Mitra *et al.*, considers a single node environment where the problem of call admission control (CAC) is addressed at both cell and call levels. The issue of deterministic guarantee in a multiple node environment is addressed by Chang; the existing definition of burstiness constraint, as well as the concept of service curve, are generalized to a matrix setting, and parallel results to the scalar case are developed for the matrix case.

Certain recent measurements of local area networks (LAN's) traffic and VBR compressed video traffic reveal long-range dependency (LRD) and self-similarity. The paper by Andersen and Nielsen presents a Markovian approach for approximating arrival processes with the above-mentioned properties. Krunz and Makowski revisit the modeling of VBR video traffic and show evidence that neither LRD nor Markovian models may accurately capture the correlation structure of data. They use the M/G/$\infty$ model for a number of video traces to make their point. The paper by Boxma and Cohen examines the impact of service time distribution on performance through an analysis of the classical M/G/1 queueing system with heavy-tailed service time distribution.

As a means of congestion avoidance, one may selectively discard packets in network buffers. Lapid *et al.* provide an analysis of various discarding policies. The paper by Altman

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and Jean-Marie gives some statistical properties of the loss process in finite buffers.

Two articles in this issue focus on the teletraffic analysis of wireless cellular networks. Orlik and Rappaport analyze the channel holding time under general session and dwell time distribution. Tutschku and Tran-Gia deal with mobile network design issues and the problems of traffic estimation and characterization in such networks.

Due to an unusually large number of submissions (almost 100) and a limited amount of publication space, many excellent papers did not appear in this issue. It is our hope that these papers will soon appear in other issues of IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS or in other IEEE journals.

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