Invited Lecture

entitled

Challenges in Stochastic Modeling for Telecommunication Systems

by

S Dharmaraja
Professor and Head
Department of Mathematics
Indian Institute of Technology Delhi

Abstract:
In past years, mobile wireless technologies have experience four generations of technology revolution and evolution, namely from 1G to 4G. The first mobile communication systems have seen large-scale commercial growth, arrived in 1980s known as the 'First Generation' systems. It comprised a number of independently developed systems worldwide, using analogue technology. The second generation (2G) appeared in 1990s concerned completely with the wireless telecommunication technology which uses digital radio signals, while its predecessor, 1G, was based on analog radio signals. To meet the ever-rising demand on enhanced data services such as web access and multimedia applications and the convergence of voice and high-speed data services into a single system, the third generation (3G) wireless communication systems emerged in the 2000s with greater networking speed and improved multimedia capability. 4G or the 4th Generation Mobile standards is a series of measures that defines the demands of a 4G network and also the standards that must be met. Long term evolution (LTE) is marketed as 4G technology but the standard is better thought of as `3.9G' as it does not yet meet the requirements set out for 4G, which includes minimum upload and download rates for networks and defines how connections must be established. A new version of LTE technology, LTE Advanced (LTE-A), does satisfy the requirements of a true 4G network.

Today, we are at a unique point in the evolution of telecommunication: The amount of data used in networks exceeding the amount of voice traffic in some regions of world. Mathematical methods based on the theory of stochastic processes have long been used effectively in telecommunication systems. Current scenario of communication generates challenging mathematical and statistical problems as modern networking traffic is distinctly different from traditional voice traffic. The most common techniques for performance modeling of telecommunication systems are Markov Chains, Queuing Networks and Petri Nets. These models are closer to the structure of the real systems and so it is easy to match system and model components but, they also have some limitations. Challenges in various stochastic modeling for telecommunication systems are reported.

To achieve an efficient use of the scarce spectrum allocated for cellular communications, two important Quality of Service (QoS) measures have been defined in cellular networks. The first one is the new call blocking probability, the second one, is the handoff call dropping probability. In this talk, the recent work on closed form solutions to the above two performance measures in 2G and 3G generation cellular networks is reported. Further, an analytical model to determine

reliability and survivability attributes of Universal mobile telecommunication systems (UMTS) networks is discussed. Hierarchical architecture of UMTS networks is modeled using stochastic models such as Markov chains, semi-Markov process, reliability block diagrams and Markov reward models to obtain these attributes. This model can be tailored to evaluate the reliability and survivability attributes of other beyond 3G cellular networks. Finally, the power saving mechanism modeling in 4G LTE-A for the two-way voice communication using continuous time Markov chains (CTMC) is presented.

Biography:

S. Dharmaraja earned his Ph.D. degree in Mathematics from the Indian Institute of Technology Madras, in 1999. He has been with the Department of Mathematics, IIT Delhi, since 2003, where he is currently a Professor and Head, Department of Mathematics and joint faculty of Bharti School of Telecommunication Technology and Management. He appointed as '**Jaswinder&Tarvinder Chadha Chair Professor**' for teaching and research in the area of Operations Research from May 2010 till July 2015. He has held visiting positions at the Duke University, USA, University of Calgary, Canada, University of Los Andes and National University of Colombia, Colombia, UniversitàdegliStudi di Salerno, Italy, University of Verona, Italy and Sungkyunkwan University, South Korea.

His research interests include queueing theory, stochastic modeling, performance and analysis of computer and communication systems and financial mathematics. He has published over 35 papers in refereed international journals and over 20 papers in refereed international conferences in these areas. He is an Associate Editor of International Journal of Communication Systems. Recently, he is co-author of a text book entitled “Introduction to Probability and Stochastic Processes with Applications” in Wiley and co-author of a text book entitled “Financial Mathematics: An Introduction” in Narosa.