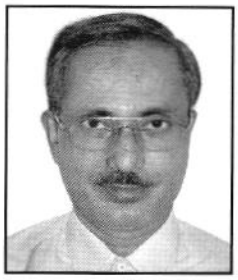
35th IETE-RAM LAL WADHWA AWARD LECTURE



Brief Bio-data
of
Professor Bhabani P. Sinha
(Awardee)

Professor Bhabani P. Sinha (M.Tech., Ph.D.) joined the faculty of Electronics Unit of the Indian Statistical Institute (ISI), Calcutta in 1976, where he became a Professor (1987) and Head of the Advanced Computing and Microelectronics Unit (1993-2010). He is currently the **Dean of Studies of ISI**. He was an ***Indian Space Research Organization (ISRO) Chair Professor*** (2000) in IIT Kharagpur.

He was an **Alexander von Humboldt fellow of Germany**. He received many awards and honours in recognition of his excellent academic performance and outstanding research contributions, the most notable of which include: i) ***M.K. Singal Memorial award*** from the Indian Science Congress Association in 2012 **(handed over by the Hon'ble Prime Minister)**, for his significant and lifetime contributions to the development of science and technology, ii) ***Homi Bhaba award*** **of the University Grants Commission,** India (1998) for his outstanding contributions to applied sciences, ii) ***Faculty Excellence award*** **of Clemson University, USA** (2002), and iii) **Eminent Engineer award** from the Institute of Engineers, India (2008).

In recognition of his outstanding research contribution with significant impact on the state-of-the-art technology, he became a **Fellow of IETE, IEEE (USA), Indian National Academy of Engineering, National Academy of Sciences, India** and **West Bengal Academy of Science and Technology.**

Professor Sinha has a very high degree of visibility in the academic community. He served as an **Editor of the *IEEE Transactions on VLSI Systems*** and a **subject area editor of the *Journal of Parallel and Distributed Computing*.** He has been the General Chair, Program Chair, Program Vice-Chair, Program Committee Member, Keynote speaker, Invited speaker, Reviewer of a number of international conferences in the areas of parallel and distributed computing, VLSI design, mobile computing and wireless networks. He has been a **visiting faculty** in the Dept. of Computer Science of i) Southern Illinois University, USA, ii) University of Central Florida, USA and, iii) Clemson University, USA.

He has published more than 135 research papers in various international journals and refereed conference proceedings in the areas of **computer architectures, algorithms, parallel and distributed computing, mobile communication and wireless networks**. He has proposed highly efficient and elegant solutions to not only a number of ***fundamental*** computational problems but also in parallel & distributed computing, channel allocation in mobile networks and low energy communication for wireless sensor networks. Many of his research results are very significant in real-life applications related to high performance computing, mobile communication and sensor networks, rural healthcare, distant education and agricultural development of the country.

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Bandwidth and Energy Management in Mobile and Sensor Networks

Wireless Communication is the fastest growing industry in telecommunication which involves cellular mobile networks, ad hoc networks, sensor networks, cognitive radios, and so on. In cellular mobile networks, there is almost an exponential growth in the number of users over the past decade, and hence, the demand for the communication channels is ever increasing with time. On the other hand, the available bandwidth is limited to a small value. The situation has been further worsened due to the recent increasing trend of multimedia communication by the mobile users in the form of voice, text, still image and video. Development of efficient algorithms for allocation of channels to meet the demand from each node, avoiding all sorts of interferences (co-channel, adjacent channel and co-site interferences) with the *minimum possible bandwidth* requirement, is a challenging research problem.

It has been established that such a channel allocation problem (CAP), in its most general form, is NP-complete and hence, execution of an algorithm for optimal allocation of channels would require prohibitively large time, which is unacceptable in real-life applications. Some heuristics or approximation algorithms for obtaining engineering solutions are therefore called for so that a request for channel can be very quickly serviced (within a reasonably small time) by executing these channel allocation algorithms. Towards this approach, we have considered the channel allocation problem for a hexagonal cellular network (instead of a general network structure) and then proposed several simple schemes for judicious *re-use* of channels for the calls at sufficiently distant cells, so as to obtain very fast algorithms for solving the CAP. Simulation results of our proposed algorithms on the standard benchmark problems with multiple non-homogeneous demands from the nodes show that almost all the problems can be solved in time of the order of a few milliseconds, while the most difficult problems would require time of the order of 10-20 seconds, in contrast to the existing best algorithms in the literature which require execution time of the order of 8-10 minutes. We propose a hierarchy of long-term and short-term channel allocation algorithms. The algorithms proposed by us may constitute a class of long-term allocation algorithms (which may be executed, say, every hour of the day), in conjunction with the existing short-term allocation algorithms (which are based on perturbation technique) requiring execution time of the order of a few milliseconds, to obtain an acceptable engineering solution to the channel allocation problem.

Apart from this channel allocation, another important recent research problem in the domain of mobile and sensor networks is the energy-efficient communication. Most conventional communication strategies utilize energy based transmission (EbT) schemes, which require equal energy expenditure for transmitting both 0 and 1 bit values. An alternative scheme is to make the transmitter silent during the 0's, thereby saving the transmitter energy. We have proposed different source coding mechanisms, so as to increase the number of 0's in the encoded message and thereby saving a significant amount of transmitter energy. Practical implementation of this idea of source coding with silent communication of 0's would involve a hybrid of ASK and FSK modulation/demodulation techniques. Thus, although the silent periods enable energy saving, there is a negative effect due to ASK for which the signal strength needs to be increased by some amount compared to pure FSK. We have proposed an elegant communication scheme, called RBNSiZeComm, which is based on a novel source encoding technique using redundant binary number system and is coupled with the idea of silent communication of 0's in the message string. RBNSiZeComm provides a saving of about 53% transmitter energy for additive white Gaussian noise (AWGN) channels with almost no overhead in hardware. Apart from RBNSiZeComm, we have also proposed three other schemes for energy-efficient communication, namely Ternary with Silent Symbol (TSS), Compression with Null Symbol (CNS) and Run Zero Encoding (RZE). TSS provides 20% savings in transmitter energy and 36.9% savings in receiver energy, CNS enables a saving of about 30% transmitter energy and 50% receiver energy and RZE provides 35.2% savings in transmitter energy and 12.5% savings in receiver energy. All these results lead to energy-efficient communication in low power wireless sensor networks with direct applications to rural healthcare, agricultural sensor networks and distant education.