Dynamic Resource Management in Competitive Wireless Data Networks: 
A Game Theoretic Framework

Abstract

The competition among wireless data service providers brings in an option for the unsatisfied customers to switch their providers, which is called churning. The implementation of Wireless Local Number Portability (WLNP) is expected to further increase the churn rate (the probability of users switching the provider). However, the existing resource management algorithms for wireless networks fail to fully capture the far-reaching impact of this unforeseen competitiveness. From this perspective, we will first formulate non-cooperative games between the service providers and the users. A user’s decision to leave or join a provider will be based on a finite set of strategies. A service provider can also construct its game strategy sets so as to maximize their utility (revenue) considering the churn rate.

Based on the game theoretic framework, we will propose an integrated admission and rate control (ARC) framework for CDMA based wireless data networks. The admission control will be at the session (macro) level while the rate control at the link layer packet (micro) level. Two admission control modes will be considered: one-by-one mode and batch processing mode in which multiple users are admitted at a time. We show that: (i) for the one-by-one mode, the Nash equilibrium in pure strategy can be established for both under-loaded and fully-loaded systems; and (ii) for batch processing mode, there is either an equilibrium in pure strategy, or a dominant strategy exists for the service provider. Therefore, the providers have clearly defined admission criteria as outcome of the game. Users are categorized into multiple classes and offered differentiated services based on the price they pay and the service degradation they can tolerate. We show that the proposed ARC framework significantly increases the provider’s revenue and also successfully offers differentiated QoS to the users.

Biography

Dr. Sajal K. Das is a Professor of Computer Science and Engineering and also the Founding Director of the Center for Research in Wireless Mobility and Networking (CReWMaN) at the University of Texas at Arlington (UTA). His current research interests include resource and mobility management in wireless networks, mobile and pervasive computing, wireless multimedia and QoS provisioning, sensor networks, mobile Internet protocols, distributed processing and grid computing. He has published over 250 research papers, directed numerous funded projects, and holds 5 US patents in wireless mobile networks. He is a recipient of Best Paper Awards in ACM MobiCom’99, ICOIN’01, ACM MSWIM’00, and ACM/IEEE PADS’97. Dr. Das is also a recipient of UTA’s Outstanding Faculty Research Award in Computer Science in 2001 and 2003, and UTA’s College of Engineering Excellence in Research Award in 2003. He is frequently invited as keynote speaker at international conferences.

Dr. Das is the Editor-in-Chief of the Journal of Ubiquity, Mobility and Pervasive Computing (JUMP), and also serves on the Editorial Boards of the IEEE Transactions on Mobile Computing, ACM/Kluwer Wireless Networks, Parallel Processing Letters, Journal of Parallel Algorithms and Applications. He served as General Chair of IEEE WoWMoM’05, IEEE PerCom’04, IWDC’04, ICIT’03 and IEEE MASCOTS’02; General Vice Chair of IEEE PerCom’03, ACM MobiCom’00 and HiPC’00-01; General Chair of ACM WoWMoM’00-02; Program Chair of IWDC’02, WoWMoM’98-99; TPC Vice Chair of ICPADS’02; and as TPC member of numerous IEEE and ACM conferences. He is the Vice Chair of IEEE TCPP and TCCC, and on the Advisory Boards of several cutting-edge companies.

Prior to 1999, Dr. Das was a professor of computer science at University of North Texas where he twice (1991 and 1997) received the Student Association’s Honor Professor Award for best teaching and scholarly research. He received B.Tech. degree in 1983 from Calcutta University, M.S. degree in 1984 from Indian Institute of Science, Bangalore, and PhD degree in 1988 from the University of Central Florida, Orlando, all in Computer Science.