Mathematics > Probability

Optimal Rate Scheduling via Utility-Maximization for J-User MIMO Markov Fading Wireless Channels with Cooperation

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We design a dynamic rate scheduling policy of Markov type via the solution (a social optimal Nash equilibrium point) to a utility-maximization problem over a randomly evolving capacity set for a class of generalized processor-sharing queues living in a random environment, whose job arrivals to each queue follow a doubly stochastic renewal process (DSRP). Both the random environment and the random arrival rate of each DSRP are driven by a finite state continuous time Markov chain (FS-CTMC). Whereas the scheduling policy optimizes in a greedy fashion with respect to each queue and environmental state and since the closed-form solution for the performance of such a queueing system under the policy is difficult to obtain, we establish a reflecting diffusion with regime-switching (RDRS) model for its measures of performance and justify its asymptotic optimality through deriving the stochastic fluid and diffusion limits for the corresponding system under heavy traffic and identifying a cost function related to the utility function, which is minimized through minimizing the workload process in the diffusion limit. More importantly, our queueing model includes both J-user multi-input multi-output (MIMO) multiple access channel (MAC) and broadcast channel (BC) with cooperation and admission control as special cases. In these wireless systems, data from the J users in the MAC or data to the J users in the BC is transmitted over a common channel that is fading according to the FS-CTMC. The J-user capacity region for the MAC or the BC is a set-valued stochastic process that switches with the FS-CTMC fading. In any particular channel state, we show that each of the J-user capacity regions is a convex set bounded by a number of linear or smooth curved facets. Therefore our queueing model can perfectly match the dynamics of these wireless systems.

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