This document provides numerical results that support the theoretical findings in [1].

The authors in [1] deal with the efficient design of wireless networks by implementing cross-layer algorithms that exploit channel state information. More specifically, capitalizing on convex optimization and stochastic approximation tools, [1] develops a stochastic algorithm that allocates resources at network, link, and physical layers so that a sum-utility of the average end-to-end rates is maximized. Focus is placed on networks where interference is strong and nodes transmit orthogonally over a set of parallel channels. Convergence of the developed stochastic schemes is characterized, and the average queue delays are obtained in closed form.

Numerical results are presented for an any-to-any wireless network where all users are connected is considered. For simplicity we set the number of nodes to 3 and the number of channels to 5. Channels' SNR are exponentially distributed and their average is 5dB. We consider 3 different flows, one for each possible destination. The utility to be maximized is $U_i^f=log(1/10+x)$ if (i,f)=(1,3), (i,f)=(2,1) or (i,f)=(2,1) while zero for all other node-flow combination. The average transmit power per node is 0.6 for nodes 1 and 2 and 0.55 for node 3. The stepsize for the stochastic updates is $\mu=3\cdot10^{-4}$.

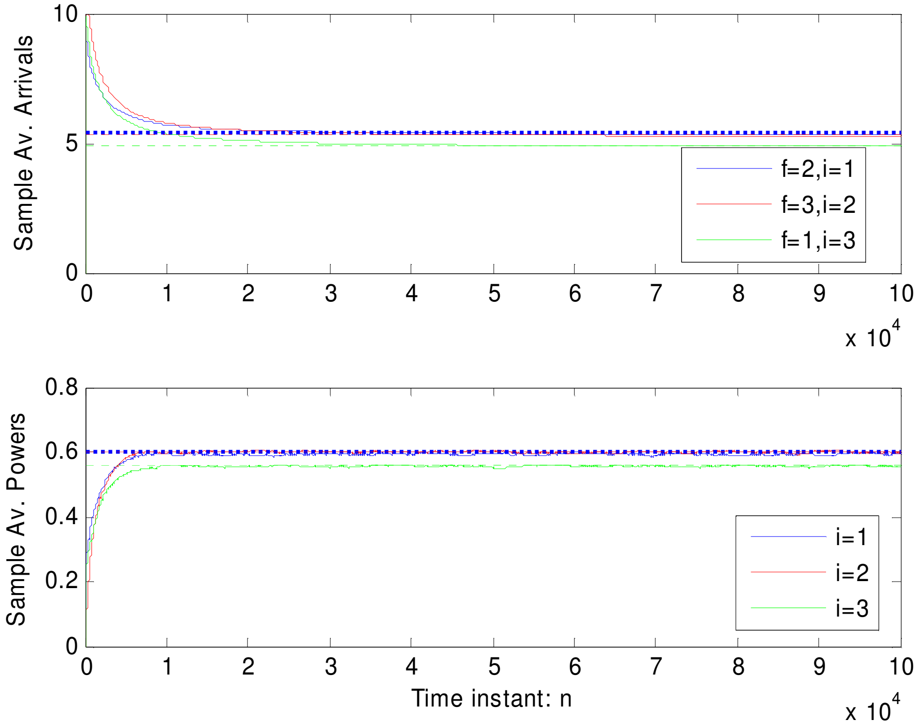

Figure 1

Figure 1 shows the time-evolution of the average power for each node (top) and average arrival rate (bottom) for each node and flow. Specifically, solid lines represent $\hat{\bar{p}}_i(n)=\frac{1}{n}\sum_{r=1}^n p_i[r]$ and $\hat{\bar{a}}_i^f(n)=\frac{1}{n}\sum_{r=1}^n a_i^f$ $[r]$ while dotted lines are the values obtained from the optimal off-line solution (assuming perfect knowledge of the channel PDF). The results indicate that the proposed algorithm converges arbitrarily close to the optimal values (average flows with a non-zero utility are activated and power constraints are satisfied) in a finite number of iterations.

Results related to the queueing dynamics and delay are presented in Figure 2. In the first subplot solid lines represent $\hat{\rho}_i^f[n]$ while dotted lines are the optimal values ρ_i^f obtained from the off-line solution. The second subplot represents the queues size for each user. For simplicity we only plot a small set of representative node-flow pairs. As expected, users with higher rate requirements have larger queues. On the other hand, comparing the trajectories of $q_i^f[n]$ and $\hat{\rho}_i^f[n]$ we verify the validity of the approximation $q_m[n]\cong\hat{\rho}_i^f[n]/\beta $. The third subplot, that represents the expected delay at every time instant, asserts the accuracy of the approximation in \eqref{E:av_delay}. Interestingly, simulations show that users with higher rate requirements, experience smaller delay, meaning that the algorithm ``prioritizes" information of users with high rate demand.

References:

[1] A. G. Marques, G. B. Giannakis, and J. Ramos “Stochastic Cross-Layer Resource Allocation for Wireless Networks using Orthogonal Access: Optimality and Delay Analysis”, Technical Report submitted to ICASSP 10, Sep. 2009.