Having multiple users gives rise to multi-user diversity which can be exploited to give good quality-of-service to each user in the network and also increase the overall capacity of the network. In a spectrum-sharing setting, the multi-user diversity can be exploited; however, this is different from the traditional multi-user case because of the interference power constraints imposed on the secondary users.

In this work, we consider a multi-user underlay cognitive network, where multiple cognitive users concurrently share the spectrum with a primary network, and a single secondary user is selected for transmission. The channel is assumed to have independent but not identical Nakagami-m fading. Considering an interference power constraint and a maximum transmit power constraint on the secondary user, a power allocation policy is derived based on the peak interference power constraint. For this policy the secondary user transmitter (SU-Tx) requires the instantaneous channel state information (CSI) of the link between the SU-Tx and the primary user receiver (PU-Rx). The advantage of this scheme is that the interference constraint is never violated and there is no loss of performance of the primary network.

The user is selected for transmission based on a greedy scheduling scheme where the user with the highest instantaneous signal-to-noise ratio is chosen for transmission. For this user scheduling scheme, we analyze the uplink performance of the multi-user underlay secondary network in terms of outage probability and symbol error rate (SER). Exact closed-form expressions for the outage performance, moment-generating-function and SER performance of a multi-user cognitive network are derived. These expressions are obtained for an independent but non-identical distributed (i.n.i.d) Nakagami-m fading channel which is a more generic fading model and can cover a variety of fading environments including Rayleigh fading.

Numerical results based on Monte-Carlo simulations are presented to verify the derived results. It is shown that the SER reduces as the peak interference power constraint is relaxed. Furthermore, as the number of users increases the SER reduces. If the interference power constraint is relaxed the power allocated becomes constant depending on the peak transmit power and thus the SER also becomes constant.