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Multiuser Capacity in Block Fading with no Channel State Information

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ABSTRACT

Consider *M* independent users, each user having his own transmit antenna, that transmit simultaneously to a receiver equipped with *N* antennas through a Rayleigh block-fading channel having a coherence interval of *T* symbols, with no channel state information available to either the transmitters or to the receiver. The total transmitted power is independent of the number of users. For a given coherence time *T*, we wish to identify the best multi-access strategy that maximizes the total throughput.

If perfect channel state information were available to the receiver, it is known that the total capacity increases monotonically with the number of users. If the channel state information is available to both the receiver and to all transmitters, the throughput maximizing strategy implies for *N=1* that only the single user who enjoys the best channel condition transmits. In the absence of channel state information one is forced to a radically different conclusion. In particular we show that if the propagation coefficients take on new independent values for every symbol (e.g., *T=1*) then the total capacity for any *M>1* users is equal to the capacity for *M=1* user, in which case TDMA is an optimal scheme for handling multiple users. This result follows directly from a recent treatment of the single-user multiple antenna block-fading channel.

Again, motivated by the single-user results, one is lead to the following conjecture for the multiple user case: for any *T>1* the maximum total capacity can be achieved by no more than *M=T* users. The conjecture is supported by establishing the asymptotic result that, for a fixed *N* and a constant *M/T* for large *T*, the total capacity is maximized when $M/T \to 0$, which yields a total capacity per symbol of $N\log(1+\rho)$, where ρ is the expected SNR at the receiver. We further support the conjecture by examining the asymptotic behavior with large ρ for fixed *M,T* and $N \le T$.

Index Terms: wireless communication, multiple users, Rayleigh block-fading, multi-element antenna arrays.

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