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Physical Layer Issues of Communication via Diffusion for Bio-Nanomachines

Nanonetworking is a new communication paradigm that focuses on communication between nanomachines. Among the various methods that are being proposed in the context of this paradigm, we focus on the Communication via Diffusion system in this thesis. Modeled after molecular release based communication between neighboring cells in living organisms, this system is currently one of the most prominent systems envisioned to be used between bio-nanomachines. While there are some studies on this system in the literature, most of them focus on a single aspect of the system. In contrast, in this thesis we start with a basic channel model and consider several physical layer issues built upon this channel model. The unique probabilistic medium used in this system requires revisions in physical layer issues (e.g., channel modeling, interference analysis) specific to this medium. We firstly develop a joint channel and energy model to evaluate the capacity of this system. Then, we propose two different modulation techniques and elaborate on the effects of the interference sources (namely the Intersymbol and Co-channel Interferences) over the channel capacity. We also show the importance of the release point selection in this system. Our results show that this communication system is expected to be a good solution between bio-nanomachines that are 1 to 10 μm apart, beyond which the performance of the system degrades quickly. Lastly, we give an overview and future directions of a more controlled diffusion based system, called Calcium Signaling, that is expected to be used in applications where the distance between the transmitting bio-nanomachine pair is longer than 10 μm and there are many devices in the environment.

PUBLICATIONS

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