

A Model for Network Resource Allocation Based on Rugged Fitness Landscapes

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ABSTRACT

Resource allocation is one of the most challenging problems in wireless networking. In a time-varying wireless environment, great improvements in performance can be realized by dynamically allocating/reallocating resources among nodes based on traffic needs and channel conditions. Unfortunately, finding optimal, or even near optimal, solutions to this problem is not straightforward, even in the case of centrally utilized resources like those found in satellite communications and cellular networks. The problem becomes much more complex when autonomous multi-hop wireless networks are considered. There has been very little progress toward understanding resource allocation in a systematic way for such networks.

In this paper, we adopt a Cross Layer Design approach to dynamic resource allocation in wireless networks in which the state of each link is expressed as a tuple consisting of signal-to-noise ratio and traffic intensity. A genetic algorithm operating on a rugged fitness landscape is employed. We utilize a variant of Kauffman's NK model for epistatic evolution, where epistasis is taken to be a measure of the degree to which network links share a common resource, for example time or bandwidth. In our model, alleles correspond to bandwidth assignments, and a given genotype can be seen as a resource allocation solution applied across the entire network. In this paradigm, the fitness function is more aptly referred to as a Quality of Service (QoS) function. For this paper, mean delay is chosen to be the QoS function of interest. We believe that this work represents an important step in the direction of understanding network dynamics and wireless resource allocation strategies for autonomous networks.

General Terms

Algorithms, Design.

Keywords

Wireless Networks, Cross Layer Design, Resource Allocation, Quality of Service, Performance, Theory.