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Topology Control with Two-Hop Forest Construction in Ad Hoc Networks

Rattana Chawengmahapeeti

MS TS Program, Faculty of Science and Technology, Assumption University
Bangkok, Thailand
<rattana_cha@yahoo.com>

Abstract

The emerging implementations of ad hoc networks depend on multiple technological factors which are a subject of intensive studies. Due to the limited processing capabilities of the network nodes, limited bandwidth, as well as power constraints, the analytical description of the routing process in multihop ad hoc networks poses significant challenges. The topology control deals with the increased routing complexity by reducing the average node degree in the network. A two-hop forest construction for topology control is proposed and studied in this paper. The quality of service in terms of latency and throughput is considered for the case of unicast routing on the basis of computational experiments.

Keywords: *Topology control, two-hop forest, ad hoc network.*

Introduction

The ad hoc networks represent sets of nodes that exchange information on a multihop basis. Due to the decentralized nature of the routing process, routing decisions must be made locally which increases the risk of the occurrence of congestion at some parts of the network and underutilization of the remaining parts. The prospective ad hoc networks should implement the all-port communication model where all input and output ports of a network node can be used simultaneously for the exchange of information among connected first neighbors. The increased amount of incoming traffic at the input ports with possible relaying through a single output port results in congestion due to the limited channel bandwidth. As greater is the number of input/output ports, as greater is the traffic variability. An additional constraint is the overall power consumption of the multiple ports. When dealing with the energy efficiency, most studies are concerned with the transmission range rather than with the number of ports. However, an alternative approach is to control the number of active ports so that a full connectivity is still preserved and at the same time the congestion is reduced using appropriate topology control techniques. The node degree distribution plays a significant role in this process. The average node degree is an indicator of the typical number of ports being used per node in a network. In planar networks, typical values of the average value vary within the range from 3 to 5. It is beneficial to study computationally the performance of ad hoc networks for various connectivity schemes as the analytical consideration of this problem is far from completion at present. The hybrid routing techniques combine the topology control with routing to deal with the processing limitations of the nodes and with the noise in the wireless channels. For compatibility with the existing hardware solutions, a single first-in first-out (FIFO) queue and a single routing server per node are supposed to handle the incoming/outgoing traffic from/to multiple input/output ports. For example, within the existing IEEE 802.11x standards (IEEE 2007), only one port per node can be served at a time. The future extensions to real multi-port networks depend on the cost of implementation of nodes having a prescribed number of active