Chapter 13

CLUSTERING IN MOBILE WIRELESS AD HOC NETWORKS

Issues and Approaches

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Abstract

Wireless mobile ad hoc networks consist of mobile nodes which can communicate with each other in a peer-to-peer fashion (over single hop or multiple hops) without any fixed infrastructure such as access point or base station. In a multi-hop ad hoc wireless network, which changes its topology dynamically, efficient resource allocation, energy management, routing and end-to-end throughput performance can be achieved through adaptive clustering of the mobile nodes. Impacts of clustering on radio resource management and protocol performance in a multi-hop ad hoc network are described, and a survey of the different clustering mechanisms is presented. A comparative performance analysis among the different clustering mechanisms based on the metrics such as cluster stability, load distribution, control signaling overhead, energy-awareness is performed.

Keywords:

Mobile ad hoc networks, adaptive clustering, radio resource management, routing.
1. Introduction

Rapid developments in the portable electronic device technology have made the communication devices more compact, powerful and low-cost. Furthermore, the recent advances in wireless communications technology have spawned an increasing demand for various services to the nomadic users over mobile networks. The aim of the future-generation wireless mobile systems is to achieve seamless services across both wired and wireless networks under global user mobility. This is paving the way towards rapid development of infrastructureless “self-organizing” mobile networks which are expected to complement the infrastructure-based networks in scenarios where the nature of the communication requires the mobile devices to be adaptive and self-organizing [1].

A mobile ad hoc wireless network (also known as a packet radio network) consists of a set of self-organizing mobile nodes which communicate with each other over wireless links without requiring any fixed infrastructure (Fig. 13.1). A wireless node can communicate with another node that is within its radio range or outside its radio range. If two nodes cannot communicate directly, an intermediate node(s) is used to relay or forward data from the source node to the destination node. The wireless nodes (or devices) vary in their size, communication capabilities, computational power, memory, storage, mobility, and battery capacity (Table 13.1). This heterogeneity affects communication performance and the design of communication protocols. The mobile devices in an ad hoc network should not only detect the presence of the connectivity with neighboring devices or nodes, but also identify the devices’ types and their corresponding attributes.

The potential applications of wireless ad hoc networks include instant network infrastructure to support disaster recovery communication requirements, mobile patient monitoring, collaborative computing, vehicle-to-vehicle communication, distributed control, and microsensor networking [2]. A microsensor network is a distributed network of thousands of collaborating tiny devices, which gather multidimensional observations of the environment [3]. Many of the necessary components and technologies for microsensor networks are already available. Microscopic micro-electrical mechanical system (MEMS) motion sensors are routinely fabricated on silicon. Entire radio transceivers, including the associated digital electronics, have been fabricated on a single chip. Microsensors promise to revolutionize spatial data gathering. Driven by data aggregation - the fusion of multiple observations from different perspectives - a spatially distributed network of microsensor nodes returns a rich, high resolution, multidimensional picture of the environment. In