Multicast Routing in Mobile Ad Hoc Networks

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Abstract. We focus on one critical issue in mobile ad hoc networks that is multicast routing. Advantages and limitations of existing routing protocols are illustrated. Optimal routes, stable links, power conservation, loop freedom, and reduced channel overhead are the main features to be addressed in a more efficient mechanism. In this paper, we propose a new on-demand multicast routing protocol, named Source Routing-based Multicast Protocol (SRMP). Our proposition addresses two important issues in solving routing problems: (i) path availability concept, and (ii) higher battery life paths. SRMP applies a source routing mechanism, and constructs a mesh to connect group members. It provides stable paths based on links’ availability according to future prediction of links’ states, and higher battery life paths. This protocol succeeded to minimize network load via designing optimal routes that guarantee reliable transmission and active adaptability. A performance comparison study with On-demand Multicast Routing Protocol (ODMRP) and Adaptive Demand-driven Multicast Routing (ADMR) protocol is undertaken. Analysis results show the strength of the SRMP nodes’ selection criteria and its efficient energy consumption compared to the other two protocols.

Keywords: multicast routing, mobile ad hoc networks, source routing, forwarding group concept, link state prediction, energy-conserving

Introduction

The advent of ubiquitous computing and the proliferation of portable computing devices have raised the importance of mobile and wireless networking. Recently, there has been a tremendous interest in broadband wireless access systems, including wireless local area networks (WLAN), broadband wireless access and wireless personal area networks (WPAN). This domain is a subject of a huge research and many standardization activities are undertaken throughout the world, in many 3G/4G related study committees like ITU-R JRG 8A-9B, ETSI BRAN and IEEE 802. Research prototyping is currently underway at many research academic and industrial institutions [9].

Moreover, Mobile Ad hoc NETworks (MANETs) are specific network configurations that appear in the context of these systems. They provide a powerful paradigm for modeling open self-configuring wireless networks and seem so appropriate to use in the fourth generation of mobile networks. In fact, this subdomain, in recent years, recognizes a significant explosion of activities due to the availability of low-cost peripherals (laptops, palmtops) equipped with wireless interfaces. A Mobile Ad hoc NETworking (MANET) working group has been created within the Internet Engineering Task Force (IETF) to develop a routing framework for IP-based protocols in ad hoc networks. Actu-
ally, mobile ad hoc systems are networks that are completely deprived of infrastructure. A MANET is an autonomous collection of mobile nodes communicating over wireless links. Users can communicate with each other in a temporary manner with no centralized administration and in a dynamic topology that changes frequently. Each node participating in this network acts both as a host and a router and must therefore be willing to forward packets for other nodes. As the case of all wireless environments, radio links are not perfect and they are affected by several sources of errors resulting in a high and variable bit error rate. Consequently, one of the critical issues of a MANET is its radio interface. The second one is the mobility of the nodes. Therefore, it is necessary to develop powerful protocols able to ensure a correct reception of transmitted information on radio links. Among these protocols, those related to routing play a very significant role in the performance of these systems. For this purpose, routing protocols used in wired networks are not appropriate and there is a need for new routing protocols, adapting to the high dynamic topology of ad hoc networks.

Routing becomes an important and a major issue that must be considered carefully. Despite the fact that nodes such as laptops and personal digital assistants are often very limited in resources (CPU capacity, storage capacity, battery power and bandwidth), a fundamental challenge in the design of such networks is the development of routing protocols fulfilling some key features like robustness, simplicity and energy conserving.

Since the 1990’s, studies did not cease enriching ad hoc routing field. In spite of the diversity of routing protocols, we find in the literature many classifications. The first taxonomy reflects the existence of three main categories based on the routing strategy. Firstly, there are protocols, which use a proactive approach. The main feature of this class consists of keeping continuous up-to-date routing information from each node to each other node in the network. Secondly, there are the reactive (on-demand) routing protocols with the key motivation of reducing routing load. Contrarily to proactive mechanisms, these protocols initiate routing activities on an “on-demand” basis. In addition, hybrid protocols combine reactive and proactive characteristics, which enable them to adapt efficiently to the environment evolution.

Pioneer work [Royer and Toh, 14; Moustafa, 10] has been realized by Perkins and Bhagwat (1994) and Johnson and Maltz [5]. As succeeding contributions, we also find [Royer and Perkins, 15; Toh et al., 16; Lee et al., 7; Lee and Kim, 6], Due et al. (1997), Toh (1997), Pearlman and Hass (1998), Pei and Gerla (2000), Park and Corson (2001), Clausen and Jacquet et al. (2001), Perkins and Royer (2002), and Ogier and Templin (2002).

QoS routing is another critical issue in MANETs. The goal of ensuring the Quality of Service (QoS) is ideally to find a path that respects the constraints of QoS required by the application. It is particularly a delicate problem in ad hoc networks due to mobility and resource limitations. The idea is to eliminate among the selected routes those not respecting certain imposed criteria, and to consider QoS aspects within routing algorithms (based on the used load, node’s activity, link’s stability or energy consideration). There is a challenge to design efficient routing protocols that satisfy different QoS with the