Energy-efficient Broadcasting of Route-request Packets (E^2BR^2) In Ad Hoc Networks

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***Abstract*—Broadcasting is a very important operation in ad hoc networks. It helps in discovering routes to unknown destinations and repair links in case of breakage. As far as broadcasting of route-requests (RREQ) is concerned, flooding is the only method in which, each node sends broadcast packet to all of it's one hop downlink neighbours. E^2BR^2 introduces a very novel observation that broadcasting of RREQ is much different from broadcasting of data packets, and therefore, power conserving requirements and methodologies are different; especially when a recent location of the destination is known. E^2BR^2 instructs each node to keep track of it's 2-hop downlink neighbours to take advantage of topological redundancies wherever present. Simulation results show that the proposed technique greatly improves network throughput, significantly saves rebroadcast reducing energy consumption and delay.**

Ad hoc network, downlink neighbour, energy efficiency, energy-oriented link life, velocity oriented link life.

I. INTRODUCTION

An ad hoc network finds extensive applications in natural disaster, military operations etc. It does not require any fixed infrastructure or centralized administration [1-7]. Nodes move freely with random velocity and direction. They may act as endpoints or routers to forward packets in a multi-hop environment. The role is that of an endpoint when they either initiate communication or specified as destination by some node, and that of a router, when they are elected by the destination to bridge the gap between generating and receiving sites of a broadcast packet. Broadcasting of route-requests (RREQ) is very crucial in ad hoc networks because it is the most primitive operation required for unicasting and multicasting, that is, when one particular node or a pre-defined subset of network nodes, are to be discovered [3,5,8]. To the best of authors knowledge, existing literature on ad hoc networks is completely silent about broadcasting of RREQ packets. The differences between broadcasting of RREQ and data packets, are completely unexplored.

To the best of authors knowledge, no specific algorithm for energy efficient broadcasting of route-request packets, exist in the literature on ad hoc networks. Proposed work is the first to focus on the fact that broadcasting of data is much different from broadcasting of route-request packets. Broadcasting of data intends to forward broadcast packet to all nodes in the network whereas flooding is utilised in all ad hoc routing protocols which forwards route-request packet to all nodes in the network simply to reach one particular node i.e. the destination. E^2BR^2 aims at reducing the number of route-request packets injected into the network. Two hop neighbourhood information is maintained at each node. Instead of broadcasting route-request within its entire neighbourhood, a node in E^2BR^2 embedded routing protocol (the routing protocol can be any standard protocol in ad hoc networks), finds out minimum energy path to each two hop neighbours. In this way, some of its one hop neighbours can be eliminated from consideration, that is, route-request packet won't be sent to them. Simulation is performed using ns-2 simulator. Results shown in section V are very encouraging. They show significant improvement in favour of the proposed scheme.

In Section II, we review the previous work in broadcasting as a whole. Section III clearly illustrates why broadcasting of RREQ is different from broadcasting of data packets. E^2BR^2 is explained along with network model and example, in section IV. Given the discovered QoS classes, Section VI presents the simulation results while section VII concludes the paper.

II. RELATED WORK

The simplest method of broadcasting that is used for forwarding of both RREQ and data packets, is blind flooding where each router forwards the broadcast packets to all of its 1-hop neighbours without considering redundancy is topology or essential downlink neighbours in case of RREQ. Although it's packet delivery rate is high but that is achieved at a huge cost of messages (popularly termed as broadcast storm problem [5, 11, 15] unnecessarily consuming energy of nodes and increasing delay. To mitigate this problem, several schemes have been proposed for broadcasting of data [9, 10, 11, 12, 20, 22, 25, 30] but none are there focussing on RREQs.

A probability based broadcast scheme is proposed in [9] where a node rebroadcasts provided it's downlink neighbour density is high. Otherwise, it simply drops the broadcast packet. Downlink neighbour density of a node is calculated as (total number of downlink neighbours)/(π x$(radio-range)^2$).
A dynamic probabilistic broadcast scheme is proposed in [10] where a combination of probabilistic and counter based approach, is applied. A local packet counter is maintained at each node that contributes in adjustment of rebroadcast

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Weight-based Energy-efficient Multicasting (WEEM) In Mobile Ad Hoc Networks

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Abstract

Multicasting in ad hoc network is an extremely important operation where there is only one sender and multiple receivers per session. During route discovery, generally multiple paths are discovered to each of the multicast destinations. Among them only one is elected depending upon its lifetime or weight. Priority is assigned to the paths that will survive upto completion of the present session of packet transfer from given source to destination node. If more than one path is expected to remain alive till the multicast session is over or none of the available path options have chance to live (at least mathematically) till end of the multicast session, weight is assigned to the paths by the destination. The path with highest weight is elected as optimal. Weight is computed based on residual energy and multicast packet transmission capability of nodes in a path along with number of multicast destinations residing in that path. If more than one path has same weight then the one suffering less delay is given priority. Simulation section in this article demonstrates that WEEM produces more packet delivery ratio and alive node ratio, at much less control message cost, than other competing multicast protocols.

Keywords: Energy Efficiency; Lifetime; Multicast packet transmission capability; residual energy.

Introduction

By the term ad hoc network, we mean a collection of nodes that move arbitrarily in any direction and communicate in single or multiple hops without the need of any pre-built infrastructure or a central body of administration. These networks can be readily deployed in case of emergency situations like war, natural disaster and other military applications [1-10]. Each node is equipped with a radio-circle within which it can directly send or receive messages. This is termed as single hop communication. On the other hand, when a network element n_i tries to transfer data

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