Effect of Nodes Mobility on Density-Based Probabilistic Routing Algorithm in Ad-Hoc Networks

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ABSTRACT

Density-based probabilistic routing algorithm (AODV–Probabilistic) has been introduced for mobile ad hoc networks. Under ideal settings, it has been proven to provide drastic performance improvement over AODV and OLSR routing protocols. In this paper, the authors study the effect of inaccurate location information caused by node mobility under a rich set of scenarios. They identify three different environments: a high density, a variable density and a sparse density. Simulation results show noticeable improvement under the three environments. Under the settings the authors examine, their proposed algorithm achieve up to 22% longer links lifetime than AODV and 45 percent longer links lifetime than OLSR at the three environments, on average, without incurring any additional routing overheads or intense computation.

Keywords: Broadcast Management, Density Based Probabilistic Algorithm, Mobile Ad-Hoc Networks, Nodes Connectivity Management, Nodes Density

1. INTRODUCTION

Mobile ad-hoc networks (MANET) are non-infrastructure based networks with an undefined network size. The ubiquitous nature of the MANET allows any device to be attached to a certain network at any time. The network is only limited by the range of wireless transmission, which is approximately a few hundred meters. There are many problems and issues that need to be addressed for a MANET protocol to be implemented for mobile applications and devices. One of the main issues that needs to be addressed for MANET is the movement and the dynamic changes that occur in the connectivity over a certain period of time.

Deploying MANET in real life scenarios with a mixture of vehicular and pedestrian traffic or disaster areas would result in node distributions that lack uniformity. A non-uniform
distribution of nodes imposes a problem for MANET since the nodes are required to be near each another in order to communicate. This scenario was discussed in HeimLicher et al. (2009) to determine the necessary scenarios studying partially connected networks. The uneven distribution of nodes in an area was identified as a contributive factor for poor or limited connectivity in a multi-hop wireless network such as MANET.

Frequent solicitation of routing information via broadcasts performed by MANET nodes in densely populated areas exposes the network to a problem known as “broadcast storm”. This event occurs when a high number of broadcast activities are performed simultaneously at a certain point in time and trigger torrents of redundant broadcast requests and replies that will eventually lead the contention based link layer of MANETs to suffer a blackout (Ni et al., 1999). In networks with varying node densities, such problems are expected to occur more frequently since MANET nodes will be forced to retransmit broadcasts whenever there is a broken link or when the destination could not be found after a certain period of time. The performance of the communications link in the network would eventually decline due to aggressive broadcast activity (Siddique et al., 2007).

In short, the problems found in MANET networks with varying node distributions are the following: low packet delivery ratio, low data throughput rate, high end to end delays and potential “broadcast storm” problems due to an unmanaged network broadcast generating a high number of retransmissions.

The research objective of this work was to study the behavior of MANET protocols encountering non-uniform node distribution in a given area and to address the issues caused by non-uniformity. A suitable quantitative estimate of node density in a given area was found to be dense with the assumption that all of the nodes had an identical transmission range. This estimate was used to provide node density awareness for nodes within this network. In addition, an enhanced MANET routing protocol was developed to address the problems arising from node density variations. The performance of the enhanced protocol was compared with existing MANET protocols for different levels of node density to determine the effectiveness of the new protocol.

The rest of this paper is organized as follows: Section 2 summarizes related work on the nodes density effects; then, the proposed density based probabilistic algorithm, performance analyses of the proposed algorithm, simulation results and evaluations, and finally, the conclusions will be presented.

2. NODE DENSITY ISSUES

The nature of our proposed scheme is a combination of the issues of nodes connectivity (density) and broadcast management. In this section, we conducted a survey for both issues.

2.1. DENSE and SPARSE Regions

The optimum density of MANET was studied in Royer et al. (2001), which discussed the tradeoffs between network density and node connectivity in the face of increasing node mobility. This study also proposed a search for an optimal node density value in order to maintain connectivity in a stationary network. However, the results were inconclusive regarding the optimal density for maintaining connectivity in highly mobile environments. When neighbor nodes were saturated, they yielded very similar results. Nonetheless, Royer et al. (2001) concluded that both transmission power and the node densities needed to increase when the nodes experience increasing mobility in order to maintain connectivity.

The node density for an entire network can be identified as the number of nodes that populate over a certain area or region of a MANET. Therefore, the node density can be equated to:

\[ \rho = \frac{n}{A} \]

\( \rho \) Node Density
\( n \) Number of nodes
\( A \) Size of Network Area
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