Evaluation of Clustering and Multi-hop Routing Protocols in Mobile Ad-hoc Sensor Networks

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Abstract—Mobile ad-hoc sensor networks (MASNETs) have promised a wide variety of applications such as military sensor networks to detect and gain as much as possible about enemy movements and explosions. Most of these applications can be deployed either in static or mobile environment. In static WSNs, the change of sensor nodes topology is normally caused by node failure which is due to energy depletion. However, in MASNETs, the main reason of the topology change is caused by the node movement. Since the sensor nodes are limited in power supply and have a low radio frequency coverage, they are easily losing their connection with neighbours and difficult to transmit their packets towards sink node. The reconnection process from one node to another node consumes more energy that related to control packets. One of the techniques to conserve more energy is through topology management using clustering network. A HEED (Hybrid, Energy-Efficient, Distributed) is one of the clustering algorithm for sensor networks. In HEED, a node is elected to become a cluster head based on its residual energy and its communication cost in its neighbourhood. HEED clusters the network in a constant number of iterations, elects cluster heads that are well-distributed in the network, and incurs low message and communication overhead. In this research work, through extensive simulation we evaluated the capability of HEED on how far it can react to network topology change in MASNETs by comparing its performance with Surge multi-hop routing protocol in both static and mobile environment. We investigated the performance of both HEED and Surge in terms of the average percentage of packet loss and the average total energy consumption with various simulation times. From the detailed simulation results and analysis, HEED performs better than Surge in term of energy consumption in static network, but not performs as expected in mobile environment.

Index Terms—MASNETs, MANETs, Multi-hop, Clustering, Performance Evaluation, Simulation.

I. INTRODUCTION

Wireless sensor network (WSN) is gaining popularity day by day with wide variety of applications which include environmental monitoring, battle field, nuclear attack detection and several health and industry areas. [1] Mobile ad-hoc networks (MANETs) are a self-organizing network where nodes in the network are connected through wireless link. MANETs has well-organized data transmission between the nodes but consume network energy which is cause by the battery drainage as nodes rely on batteries and link breakage. [2] Mobile Ad-hoc Sensor Networks (MASNETs) is the design of both networks. The topology is dynamic and a frequent change in the topology is unpredictable. A quickly adapts to the topology changes routing protocol is needed in a mobile nodes that frequently change its position. Clustering is a technique that provides effective ways to extend the lifetime of the resource constrained sensor networks. Clustering reduce the energy consumption by grouping all the nodes that are close to each other in the network. [3] The cluster head (CH) of each cluster is responsible in forwarding data to the base station.

In MASNETs, there are presence of moving node also known as mobile node. The cluster head loses communication with mobile nodes in the cluster which is caused by the frequent topology change. The increasing number of invalid cluster heads becomes the bottleneck of the whole MASNETs and the frequent update of cluster head configuration increases energy consumption which indirectly shortens the network lifetime. In order to design a better routing protocol for MASNETs, the effects of nodes' mobility on a routing protocol need to be identify for such mobile nodes.

In this paper, two different protocols; multihoping and clustering is studied to evaluate its performance and how far it can react to network topology changes in MASNETs. The remaining parts of this paper is organized as follows. Section II describe the related works. Description of HEED clustering routing protocol is explained in section III. Section IV shows the simulation environment and section V gives the empirical results of Multihop and HEED. We conclude this paper in section VI.

II. RELATED WORK

This section reviews the related work that aims at evaluating the performance of Surge and HEED routing protocol for MASNETs. Many protocols have been proposed for ad-hoc networks. Reducing energy consumption is the important parameters that researcher focus on. One of the most famous protocols is the Hybrid Energy-Efficient Distributed (HEED) Clustering. HEED is a distributed, energy efficient clustering approach which extends Low Energy Adaptive Clustering Hierarchy(LEACH)[4] by using residual energy as primary parameter and intra-communication cost to cluster the network. HEED consumes a significant part of its energy for the process of clustering[5] [6]. A system called credit-point