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A Comparison of Data Dissemination Protocols for Wireless Sensor Networks

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Abstract— Due to many constraints of nodes in wireless sensor networks, a variety of data dissemination protocols have been developed for data gathering in wireless sensor networks. Sensors extract useful information from environment; this information has to be routed through several intermediate nodes to reach the destination. Effective information dissemination is one of the most important tasks in sensor networks. Directed Diffusion is a communication paradigm for information dissemination in WSNs based on data centric routing. In this paper we simulate three protocols using ns-2.33 simulator in terms of remaining energy and routing load.

Index Terms— Wireless Sensor Networks, Directed Diffusion, Data Centric, Routing, Energy, Efficiency, Ns-2

1 Introduction

WIRELESS sensor network (WSNs) with limited computing and wireless communication capabilities becoming increasingly available for commercial and military applications. The WSNs have the advantages of fault tolerance, easy deployment and accurate sensing, which can be applied in many fields, such as battlefield surveillance, environment monitoring, industrial sensing and diagnostics, critical infrastructure protection and biological detection [1]. Once deployed, nodes in a WSN are stationary. In area of protocol design for WSNs there is extensive research going on. Communication in wireless sensor networks is data centric and must minimize the energy consumed by unattended battery-powered sensor nodes [2]. As a result of this many different data dissemination protocols have been proposed [2-8]. Each design is based on different assumptions and intuitions regarding the application scenarios of the network and its operational behavior. Each of the protocols aims to solve some of the challenges identified during the development process.

The routing protocols are classified into three groups: flat routing protocols, hierarchical routing protocols and location based routing protocols. Generally the flat routing protocols are suitable for small and mid-scale networks. The flat routing protocols are simple and robust. There is no hierarchy, nor additional power consumption for managing the clusters. While hierarchical routing protocols are complex and suitable for large scale networks. And location-based routing protocols, sensor nodes are addressed by means of their locations. The distance between neighboring nodes can be estimated on the basis of incoming signal strengths. [9].

In all above mentioned applications, the network consists of tens to millions of tiny devices. Each device carries one or more sensors and has limited signal processing and communication capabilities. Usually, the devices are powered by batteries and can thus only operate for a limited time period. Key to implementing a network with such devices is that energy, computing power and communication bandwidth. Therefore, lightweight, scalable, energy-conserving communication protocols are essential to the successful operation of the network. Fast deployment of such a network and robustness against device failures require an ad-hoc network that is self-organizing. In general, radio communication (both transmitting and receiving) is generally the operation that consumes the most energy in a device. Conventional ad-hoc address oriented communications protocols, such as IEEE 802.11 [10], generally consume too much energy or poorly support multi-hop networks. In [11] and [12] the authors propose a new data centric approach for the dissemination of data in sensor networks. This paper concentrates on the comparison of three data dissemination protocols under a set of given scenarios: DD, OM and flooding protocols [2] [12].

The rest of the paper is organized as follows. A brief overview of the each protocol in this work is given in section II. Section III is devoted to an explanation of the simulation environment and metrics. The results are presents in section IV. Finally section V presents conclusion.

2 Data Dissemination Protocols for WSNs

2.1 Directed Diffusion

Directed Diffusion (DD), was proposes by Intanagonwiwat et al. [2] [12], fgure 1 shows the operation of data centric communication protocol for a WSN scenarios. Directed diffusion protocol based on query, where sink queries the sensors in an on-demand fashion by disseminating an interest. Directed diffusion consists of three stages: interest propagation, initial gradient setup and data deli-

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very along reinforced path.

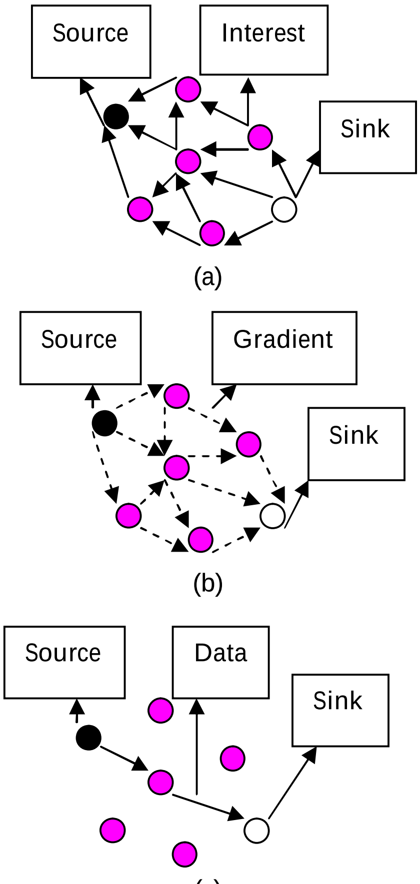

Fig.1. Directed Diffusion (a) Interest propagation (b) Initial gradient setup (c) Data delivery reinforced path

2.1.1 Interest Propagation

Sink node send out its query whenever it wants to obtain some information from sensor nodes. This query is carried by interest packet. The node which has received the interest packet can cache the packet temporarily and search for all of the matching target data as shown in figure 1(a).

2.1.2 Initial Gradient Setup

Using Gradient in directed diffusion, the data propagation direction with minimum cost principle. Propagation of interest packets setup the gradient in the network for delivering data to the sink. Gradient is a reply link to a neighbor from which the interest was received as shown in figure 1(b).

2.1.3 Data Delivery Reinforced Path

Data propagation, source node sends data packets to sink node the initial setup gradient direction. Sink sends a reinforced packet to the neighbor node which is the first one receiving the target data. The neighbor node which receives the reinforced packet can also reinforce and select the neighbor node which can receive the new data first. Consequently, a path with maximum gradient is formed, so that in future received data packets can transmitted along best reinforced path. Finally the real data will send from the source, in selected path as shown in figure 1(c).

2.2 Omniscient Multicast

In the omniscient multicast scheme, each source transmits its events along a shortest path multicast tree to all sinks. Analysis of omniscient multicast, as well as do not account for the cost of tree construction protocols. Rather centrally compute the distribution trees and do not assign energy costs to this computation. Omniscient multicast instead indicates the best possible performance achievable in an IP-based sensor network without considering overhead. Omniscient multicast is unrealistic as that it assumes all route information is available at no cost.

2.3 Flooding

In the flooding scheme, each sensor receiving a data packet broadcasts it to all of its neighbors and this process continues until the packet arrives at the destination or sources flood all events to every node in the network. Flooding is a contrary case for DD, if the DD does not perform better than Flooding. Flooding does, DD cannot be considered viable for sensor networks.

3 SIMULATION METHODOLOGY

This section describes the simulation methodology and the performance metrics used for the comparison of data dissemination protocols.

3.1. Methodology

We have used Ns-2.33[13] for the simulation of protocols.. Each data dissemination protocol has used the same IEEE 802.11 MAC protocol. The same topology scenarios are used across different protocol simulations.

3.2. Simulation Parameters

Following simulation parameters are used in the simulation process.

TABLE 1. SIMULATION PARAMETERS

PARAMETER	VALUES
No of nodes	30
etwork dimension	800*800m
Size of data packets are	64 bytes
Interval time	0.167s
Radio transmission range	40 meters
Simulation time	25 seconds
MAC protocol	IEEE 802.11
Idle power dissipation	0.035W
Receive power dissipation	0.395W
Transmit power dissipation	0.66W
Node initial energy	1000 joule

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3.3 Performance Metrics

Following metrics are used to evaluate and analyze the performance of data dissemination protocols.

3.1.1 Remaining Energy

The entire network remaining energy can indicate the lifetime of the sensor networks.

3.1.2 Routing Load

The ratio of the number of routing messages propagated by every node in the network and the number of data packets successfully delivered to all destination nodes. .

4 Results

This section presents detailed simulation results for three data dissemination routing protocols, namely DD and two other traditional schemes namely Omniscient Multicast and Flooding protocols respectively.

4.1 Remaining Energy

Fig.4.1 presents the different changes of the entire network's remaining energy with respect to simulation time for DD, OM and Flooding protocols. It is shown that the entire network remaining energy in DD is higher than other two protocols.

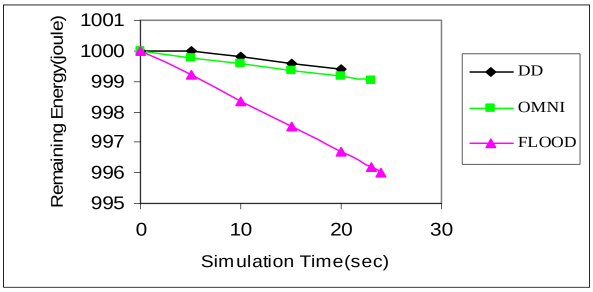

Fig. 4.1. Time vs Remaining Energy

4.2 Routing Load

Figure 4.2 presents the routing load of the entire network with respect to simulation time for DD, OM and Flooding protocols.The entire network routing load in DD is higher than OM and lower than a Flooding protocol.

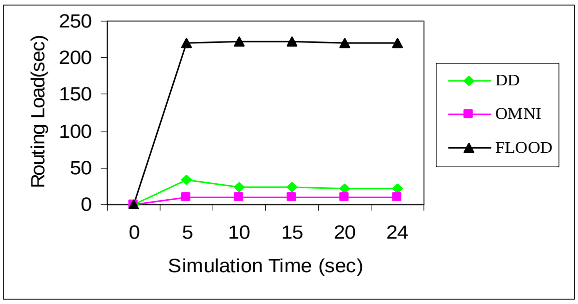

Fig.4.2. Routing Load vs Simulation Time

5 Conclusion

This paper presented the performance comparison of three routing protocols for wireless sensor networks namely: directed diffusion, omniscient multicast and flooding, results indicate that directed diffusion saves more energy than other two protocols in terms of remaining energy.

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