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Power Balancing Optimal Selective Forwarding Scheme in Wireless Sensor Networks

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ABSTRACT

Power management is the primary concern in wireless sensor network because the energy is limited. In many cases sensor node batteries cannot be easily refilled, however in some application the facility is available to recharge the sensor node by other mean like harvesting node or the energy from environment like solar energy but these are not enough thus we can say that nodes have a limited energy. Thus it is very necessary to send the message in limited energy. There are two types of transmission non selective transmission and selective transmission. In selective transmission also different cases are available. Now we are going to shows the comparative study of different selective forwarding scheme used to transmit the important message to the destination.

Keywords:— *Sensor networks, Energy-aware system, non- selective transmission, selective forwarding transmission, Consumption.*

I. INTRODUCTION

A wireless sensor network is a wireless network which consist devices using sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion etc at different locations and convert these signal in digital signal for further processing [4]. The position of sensor nodes need not be predetermined. This allows random deployment means that sensor network protocol and algorithms must possess self-organizing capabilities. The major components of a typical sensor network are: sensor nodes, the sensor field, the sink and the task manager [2]. Sensors nodes are the heart of the network. They are in charge of collecting data and routing this information back to a sink. A sink is a sensor node with the specific task of receiving, processing and storing data from the other sensor nodes. A sensor field can be considered as the area in which the nodes are placed. The task manager or base station is centralized point of control within the network, which extracts information from the network and disseminates control information back into the network.

Here it is very necessary to know the behaviour of sensor node. Initialize, sensing, computation, transmit data to cluster head or sink, go to sleep is basic operation performed by sensor node[8]. The sensor lifetime is divided into round and in each round these all operation will be performed and minimum energy is needed to perform all operation. Scheduling the event in good manner and using the scheme which consume low energy is very useful to increase the network lifetime. There are several sources to consume the energy e.g. sensing, communication, data processing, transient, logging, actuation, cluster formation. In sensing signal sampling, conversion of physical signals to electrical signals, signal conditioning, and analog to digital conversion is consumed energy. In communication and data processing at node also take power. Each sensor node maintains the log table so the energy used to read and write the data from memory comes in logging. There are different modes of operation so the energy used to change the mode (active, idle, sleep) comes in transient. The energy consumes in actuation depend upon type of application (depend upon number of cluster). The energy used to make the cluster and the operation done by cluster head comes in cluster formation.

Sensor node lifetime∞1/energy consumed by sensor node

So the lifetime of sensor node in year can be calculated by the help of following formula [8]:-

Node lifetime = initial battery capacity/ avg. current * 365 * 24 [years]

The design of physical layer is very important to reduce the communication cost of WSN [10] so the physical layer aware protocols, algorithms, and applications are designed that minimize energy consumption of the system and individual nodes. There are several energy efficient MAC protocol [3] and routing protocol [6] with different objectives were proposed for wireless sensor networks to minimize the energy by sleep schedules and many more. By the help of power save protocol we can put the nodes into sleep mode to save the energy to forward the message.

In this paper the non selective and selective forwarding scheme are discussed to send the important message. Message importance is nothing that a priority value established by the routing protocol or the number given by the application with the help of important parameter[5]. These parameter are the available energy to transmit the message, available energy at node, energy consumed during the different node state, the priority value of the received message, the behaviour of their neighbours, some local or non local information etc. Once the message importance is calculated then the message transmission decision can be taken by importance driven decision.

So it is very necessary to take the best decision which should be energy efficient and be aware of importance of the received message, available battery, statistical distribution of the importance of the message (the importance is used to decide that message will be transmitted or discarded by the node), behavior of the neighbor nodes are also very important. There are so many approaches to full fill these ideas in literature e.g. IDEALS (Information Managed Energy Aware Algorithm) algorithm[4], decentralized detection algorithm[9], Markov Chain Process [11] depend upon mathematical framework to use optimal policy and many more. The IDEALS algorithm is based upon message and power priority. In this when the power priority is greater than message priority then messages are forwarded otherwise discarded. This algorithm is basically designed for more important message so low important message is always discarded to improve the network lifetime. At each sensor node energy and

bandwidth constraints demand system-level approaches to design that consider detection performance jointly with system-resource constraints. The decentralized detection algorithm formulate detection problems with constraints on the expected cost arising from transmission in sensor nodes to a fusion node and measurement at each sensor node to address some of the system-level costs in a sensor network. Markov decision process used to decide the optimal policy by the efficient method.

II. Related Study

In this section we are going to compare the non selective and selective forwarding schemes which one is better and optimal.

2.1 Non Selective Forwarding Scheme:-

Non selective strategy waste energy for sending low important message because it uses the epidemic routing protocol. In epidemic routing protocol the message is blindly stored (not matter message is high priority or low) and forwarded or we can say that it broadcasted to neighbouring nodes [13]. So it consumes most of energy and expects more energy levels to forward the message. In this protocol the packet loss is also high so this routing protocol used in non selective forwarding scheme is not better option to forward the massage.

2.2 Selective Forwarding Schemes:

As we know that epidemic routing protocols broadcast the message without calculating the priority value so the selective forwarding schemes come which forward the message based upon the message importance or priority value. Here priority value is used to decide the importance of message [13]. In this paper we are going to study the two different cases to design the selective forwarding scheme which depend upon the parameters such as available battery at the node, the energy used to transmitting a message and the importance of the message[5]. First when sensors maximize the importance of their own transmitted messages called adaptive transmission (AT) and second when sensors maximize the importance of messages that have been successfully transmitted by at least one of its neighbours called local transmission (LF). To measurement of successful transmission of the message we use two different success index called zero order success indexes and local success index. Zero order success index used in adaptive transmission in which any transmission treated as successful in any case, and local success index used in local forwarding scheme in which if the neighbouring node receiving the message forwards it to other nodes or not. Here following formula[12] used to calculate the available energy at time k :-

$$ek{+}1 = ek - dkc1{,}k - (1 - dk)c0{,}k$$

Where $c1$, k is the energy consumed when the node decides to transmit the message and $c0{,}k$ is the energy consumed when the message is discarded.

III. Simulations

As we know that ns2 is the network simulator used to show the experimental result by visualization[18]. It uses TCL (Tool Command Language) for front end which generate NAM (Network Animator) file and C++ language for back end which write the coding for protocols and many more. First we create the node then attaché the agent (UDP, TCP) to the node after connecting the agent the traffic pattern (CBR, FTP) are attached to agents.

So we use ns2 simulator to show the result for forwarding the message to use selective forwarding policy. Here we used UDP as agent, AODV as protocol and CBR as traffic pattern. Table1 show the parameter used in simulation.

Table 1. Parameter

Variable	Value	Description
chan	Wireless channel	channel type
prop	Propagation	radio-propagation model
mac	Mac802_11	MAC type
ant	Antenna	antenna model
ifqlen	50	max packet in ifq
Nn	34	No of mobile node
rp	AODV	routing protocol
X	500	X dimension of topography
Y	400	Y dimension of topography
cbr	CBR	Traffic pattern
udp	UDP	Agent
stop	10	time of simulation end

Here we take 35 nodes which is placed equidistance. Here the node 0 is sink node means destination node which collects the packet to future processing. The node number 11, 29, 28, 6, 18, 31 is source node which have different priority message to forward and node 13, 16, 19, 21, 20, 15 is selective forwarder nodes which is used as intermediate node to forward the message of different priority. So first we show the simulation of the packet forwarded by the source to destination where the source node, sink node and selective forwarder nodes are different. Figure 1 show the different types of node placed at equal distance so here we do not calculate the shortest path.

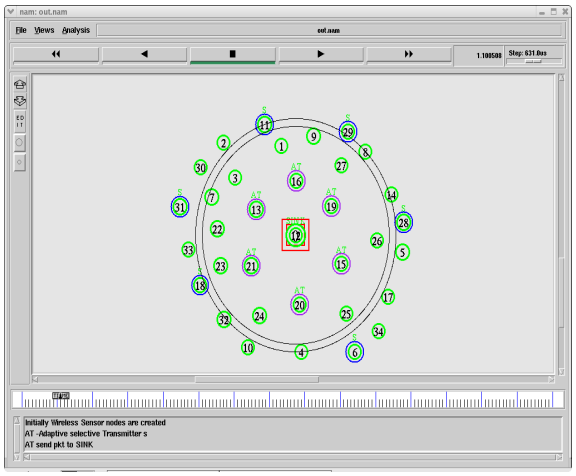

Figure1. 35 nodes placed at equidistance and source nodes want to send data to sink node 0

Then after sending the message of different priority the sensor node battery is discharged. The yellow circle shows that the battery is discharged in the following simulation figure.

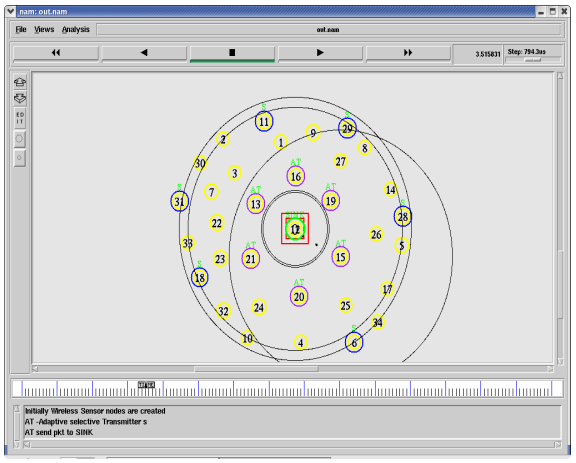

Figure2. After sending the full priority message the node discharge

When the message of different priority is send by the selective forwarding nodes and at that time the battery will be discharge then it is very necessary to full fill the battery of another source like harvesting nodes, another node, solar energy or any other mean. But it is not very easy. This is very important issue that how the battery will be recharged very

frequently and also it give the reliability that the message will be forwarded very securely when the battery will be discharge also. The work is going on in this topic. Next figure show that the battery will be charge and then forward the message which is highly priority. Here red circle show that the node is charging.

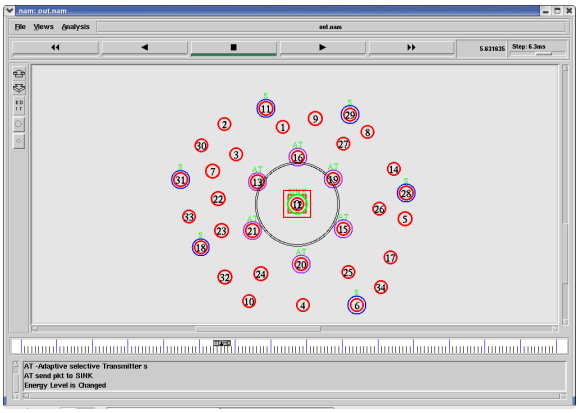

Figure3. After node discharge the red circle show the charging the node again by harvesting node

After simulation is done the next part is develop the graph which show the comparison of two selective forwarding scheme called adaptive transmission verses local forwarding [19]. Where the adaptive transmission gives the importance of their own transmitted message and local forwarding gives the importance of messages that have been successfully transmitted by at least one of its neighbours. The adaptive transmission scheme uses the zero order success indexes and local forwarding scheme uses the local success index.

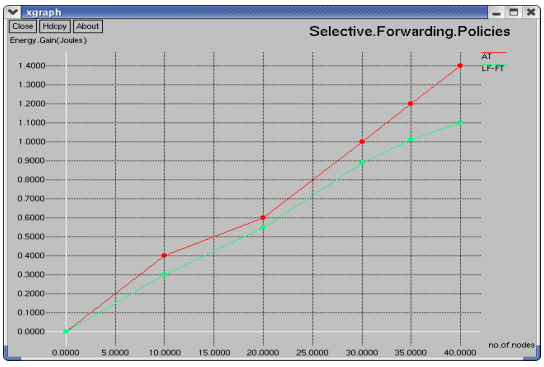

Figure 4. Here red line show the adaptive transmission and green line show the local transmission

In above graph the x axis show the number of nodes and y axis show the energy in joule. Above graph show that the adaptive transmission takes the more energy to forward the message and local forwarding scheme takes less energy in the comparison of adaptive transmission. Here both are the selective transmission policy to forward the high priority message.

IV. CONCLUSION

As we know that energy consumption is very important factor to design sensor network because nodes have a finite lifetime or limited energy to forward the messages of different importance. So good selective message forwarding schemes are very necessary to increase the lifetime of network. In this paper we want to create successfully optimization networks which use the optimal energy consumption selective forwarding scheme.

So here we compare the two selective forwarding scheme adaptive transmission (AT) and local forwarding (LF) scheme which use different success index to insure that message is transmitted successfully or not. With the help of graph we can say that the local forwarding scheme increase the network lifetime to consume less energy in the comparison of adaptive transmission which takes the more energy o forward the message.

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