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An Improvement to Sensor Protocol for Information via Negotiation (SPIN) Protocol

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***Abstract*:** *Wireless sensor network is collection of one or more homogeneous or heterogeneous sensor nodes which sense some events and inform sink for that by sending that data towards it to perform some action. Data transmission is the most effective factor in sensor network that directly regret energy of sensor node but though energy of sensor node is very crucial one need to save that energy by means of minimizing redundancy and retransmission of data. Till the day many routing protocols are introduced to route data efficiently in order to improve network life time but all protocols have some deficiency. One of the most popular data centric dissemination protocols is Sensor Protocol for Information via Negotiation (SPIN). It efficiently disseminates data among other nodes in the network. This protocol uses meta-data for negotiation and eliminates the transmission of the outmoded data throughout the network. This paper introduced improved SPIN which is further enhancement of SPIN protocol.*

***Kevwords*:** *Wireless Sensor Network. Sensor Protocol via Information Neaotiation. Advertisement*

I. INTRODUCTION

Wireless sensor network (WSN) is a group of application specified sensor nodes which monitors and handle conditional values in organization, environment or in any system to collect data and send to centrally located node. WSNs measure environmental conditions like sound, pressure, humidity, temperature, pollution levels, wind speed and direction, etc. Initially main motive to introduce wireless sensor network was for military operations, but day by day its usage was enhanced because of its easy use and fast results in health, security management, traffic management, etc.

The sensor node equip with a radio transceiver, an antenna, a microcontroller, an interfacing electronic circuit, and battery as energy source. The size of the sensor nodes can vary from a little dust particle to shoe box and regarding their prices also vary from a few cents to hundreds of dollars depending on the functionality parameters of a sensor like energy consumption, computational speed rate, bandwidth, and memory affect.

The most challenging part of WSN is to have best routing protocols utilized in terms of less memory consumption and high throughput. This paper is the further extension of the paper "Survey on Sensor Protocol for Information via Negotiation (SPIN) protocol"[1]. This paper shows idea for the improvement in SPIN and here in this paper discussed for algorithms and results of it.

II. SPIN PROTOCOL

(SPIN) as name suggest is a negotiation based protocol and is among the early work to pursue a data-centric routing mechanism. The idea behind SPIN is to tag the data using high level descriptors or meta-data. In any transmission, before sending data meta-data are exchanged among sensors via data advertisement mechanism, which is the key feature of SPIN.

Each node which receives new data first advertise it to its neighbor and interested neighbors who have not that data send request message to node who advertised. SPIN's meta-data negotiation solves problems of flooding such as redundant information passing, overlapping of sensing areas and resource blindness thus, achieving a lot of energy efficiency. There are three types of messages in SPIN to exchange data between nodes. These are: ADV message to allow a sensor to advertise a particular meta-data, REQ message to request the specific data and DATA message that carry the actual data. Below figure redrawn from, summarizes the steps of the SPIN protocol.

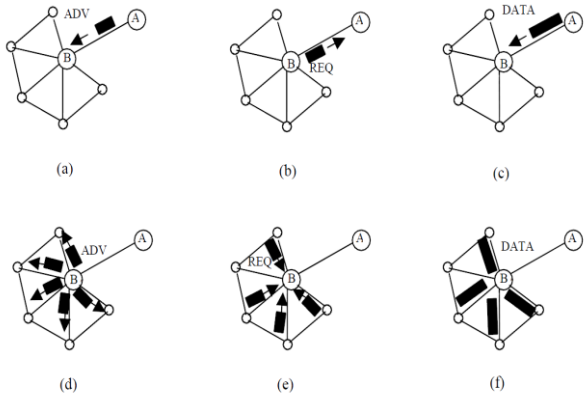

Fig. 1 SPIN Protocol. Node A starts by advertising its data to node B [1]

(a) Node B responds by sending a request to node A
(b) After receiving the requested data
(c) Node B then sends out advertisements to its neighbours
(d) Who in turn send requests back to B (e-f).

Advantage of SPIN is that each node of network need to know about its neighbours only. SPIN gives a factor of 3.5 less than flooding in terms of energy dissipation and meta-data negotiation almost halves the redundant data. However, SPIN's data advertisement mechanism cannot guarantee the delivery of data. For example, if one node need to send data to very far away node so that data would be passed through hops between their both, but if they in between hops are not interested to that transmission then data would never reach to destination sender need to send. Therefore, SPIN is not a good choice for applications such as intrusion detection, which require reliable delivery of data packets over regular intervals.

III. PROBLEM STATEMENT

As survey made on SPIN protocol, by reading different literatures and researches made before, the SPIN protocol still have some loop falls that need to be improve. Papers referred says different modifications made on SPIN protocol but all improvements have some drawback and that need to be solve.

1) One improvement made in SPIN is M-SPIN. That is shown in bellow figure.

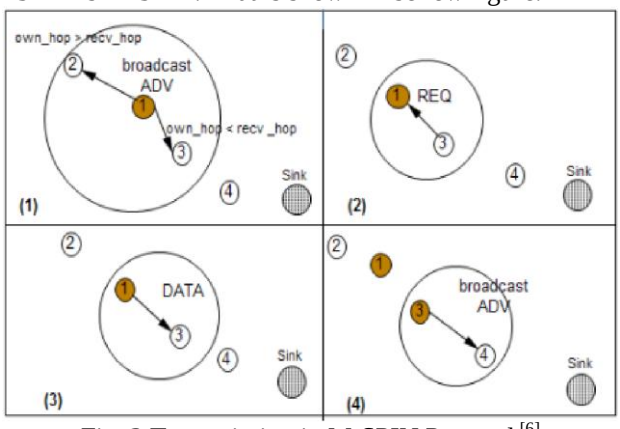

Fig. 2 Transmission in M-SPIN Protocol [6]

(1) Node 1 starts advertising its data to all of its neighbors.
(2) Node 3 responds by sending a request to node 1.
(3) After receiving the request, node 1 sends the data.
(4) Node 3 again sends advertisement out to its neighbors for the data that it received from node-1.[6]

M-SPIN protocol which is more energy efficient rather than traditional SPIN, but problem in that is, this protocol leads to one problem that is nodes nearby sink node dies early, so as per that paper it is one criteria of research to make that nodes power efficient or can make whole network power aware by assuming mobile environment in WSN.

2) Another idea is of SPIN-pi protocol. In traditional SPIN protocol If a node's neighbors are not forwarding data, the data will not continue to be forwarded, so that the user couldn't receive the information. So solution of that is in SPIN-pi that is adding plug-in nodes in the SPIN protocol. They have used nodes which are have AC Power supply, if according to application if there is requirement of having deployments of node in some forest or under water where no continuous power supply can be made, we can use solar cell plugged node, which can takes continuous energy from sun light. Below figure shows an example of SPIN-pi protocol.[7]

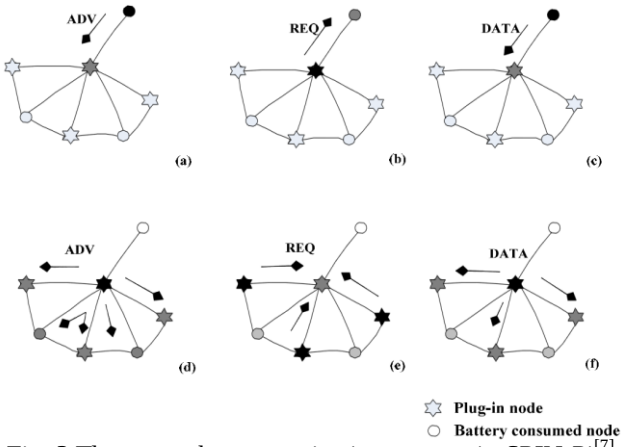

Fig. 3 The network communication process in SPIN-Pi[7]

So, by getting idea of such more power efficient nodes and deploying more amount of such much power efficient nodes in network we can improve the life time of our network and make it more reliable and efficient.

3) In this paper they have introduced new protocol named SPIN- I. In SPIN protocol there are problem of "blind forward" and "data inaccessible". To avoid these problem this protocol using three way handshake mechanism:

1. Data broadcasting stage
2. Data requesting stage
3. Data transmission phase.

In SPIN-I they include timer concept in broadcasting stage means at time of advertisement. And at receiver side means a node who receives ADV message includes flag to determine its energy level.[7]
They simulated SPIN and SPIN-I protocols under certain idealized environment and in that environment SPIN-I performed better than SPIN.

SPIN-I protocol is good solution to solve the "blind forward" and "data unreachable" problem. However, because here the SPIN-I protocol is simulated in a more idealized situation, and its transmission time is longer than SPIN, the solution of these problems needs further research.

IV. PROPOSED SOLUTION

As per literature survey and according to above survey paper[1] defined problem statement as "Reliable data transmission in sensor network using M-SPIN protocol and deploying plug-in nodes in between."

In such case sensor node would be arranged statically in cellular manners. Means at center of each cell there is one plug-in node and around that there are simple sensor nodes. This plug-in node concept is taken from literature discussed 2.6[7], and routing protocol M-SPIN would be used.
There are some pre-assumption considered are as mentioned below.

1. Assuming that all the nodes used in such network design are homogeneous, but there is difference between nodes in terms of their energy efficiency. That is there are normal sensor nodes which are traditional sensor nodes works on dry battery cells where as other nodes called plug-in nodes are nodes which uses solar energy so they are more energy efficient than that normal sensor nodes.
2. Energy efficiency of plug-in node is high then normal sensor nodes so their range of the transmission would also high than other normal nodes, and plug-in nodes are high energy efficient so they can route data for long period of time because they are continuously getting power supply and also they never drop any data packet passed through it.

3. Plug-in node always route packet to next destination without failure and if any predecessor node of plug-in node fail to transmit data then plug-in node are capable to retransmit data. So it is reliable to having concept of acknowledgment at plug-in nodes.

By cellular arrangements of nodes, each sensor node is directly connected to minimum 3 plug-in nodes. So in path of routing there are minimum half of the node would be plug-in nodes. So it improves the reliability of path. If we assume that each plug-in node can have more range than other sensor nodes then there might be possibility to send data from one plug-in node to another plug-in node if any in between node would fail or not send data ahead that would improve reliability and save energy too. In below figure it shows the proposed network structure.

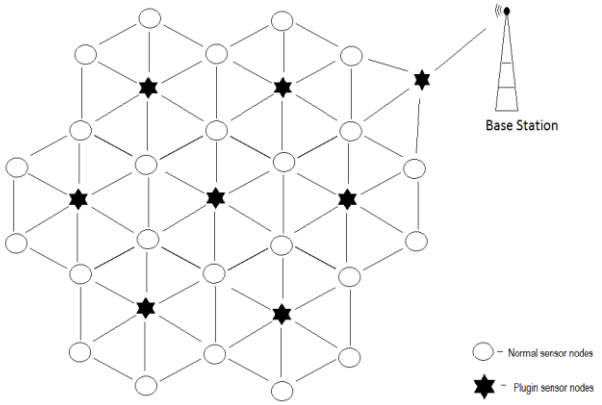

Fig. 4 Proposed solutions' network topology [1]

In proposed scheme routing would be done according to the M-SPIN protocol. In algorithm of the routing scheme of this improved protocol First stage is Distance discovery, then Negotiation and last stage is Data Transmission.

So, it works similarly to M-SPIN mechanism but difference is that, problem in M-SPIN was the node near the Base Station drain out first, so optimizing that problem using plug-in node here. Because plug-in nodes uses solar cells as battery backup so it would charge regularly and other problem in SPIN protocol is reliability, so by adding plug-in nodes in between they improve network efficiency rather than normal nodes because the average failure of network minimized by their installation.

Algorithm: If we consider node A wants to send data to the Base station (sink) node.

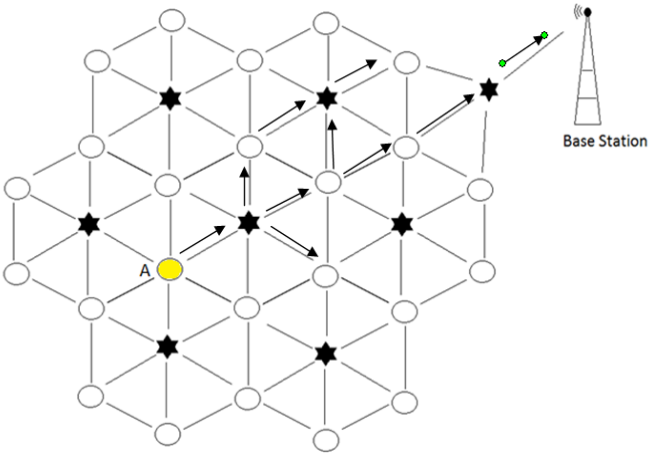

Fig. 5 Network's Work illustration [1]

Step1: Initially Base station (Sink node) sends the Startup packet in the network. Startup packet containing three values, Type, Node ID and Hop. Type means message type, Node ID means ID of sender node and hop means the hop distance of node from sink node.

Step 2: After the distance discovery phase complete, it starts negotiation phase. Same as SPIN-BC protocol it sends ADV message to its neighbor and the neighbor whose hop distance is lesser than sender of ADV only can send REQ message. Here A is the sender node. Who sends ADV message but the neighbor whose hop distance is lesser than hop distance of A only can send REQ message.

Step 3: After sender node get the REQ message it comes to data transmission mode. In which sender sends actual data to that link. This negotiation and Data transmission phase would repeat until it reaches to Base Station.

To increase reliability we can add acknowledgement feature at plug-in node to make confidentiality of data transfer.

V. IMPLEMENTATION OF ALGORITHM

1. Distance Discovery
Step.1: Start Distance Discovery() // Call Function
Step.2: if node_id equals 0 // Node is sink node
hop<-1
call startup(1); //sink node calls startup function
Step.3: if node_id not equals 0 && startup type equals 3 // Still its discovering distance
check for hop counter
increment in hop
Step.4: else forward hop value to next neighbour
2. Negotiation
Step.1 : Start negotiation function
step.2 : if energy_level is greater than threshold_level
do
send ADV message
wait for specified period of time
while(not heard REQ from neighbour)
Send DATA
Step.3 : if own_hop is less than recieved_hop
if(status equals first receive || nature equals plugin)
send REQ for DATA
else
send Status as second receive
3. Data Transmission
Step.1 : At source node get REQ msg
Step.2 : if get_current REQ_Origin and REQ_sequance match
Forward(Stored packet)

Performance Analysis

1. No. of nodes alive

As per problem statement in M-SPIN node resides near to sink node dies earlier and thus it affect to whole network's life time and efficiency.

By applying above algorithm as we used plug in nodes in between it improves network life time by mean of no of node alive after some round iterations. In Figure.6 it shown below.

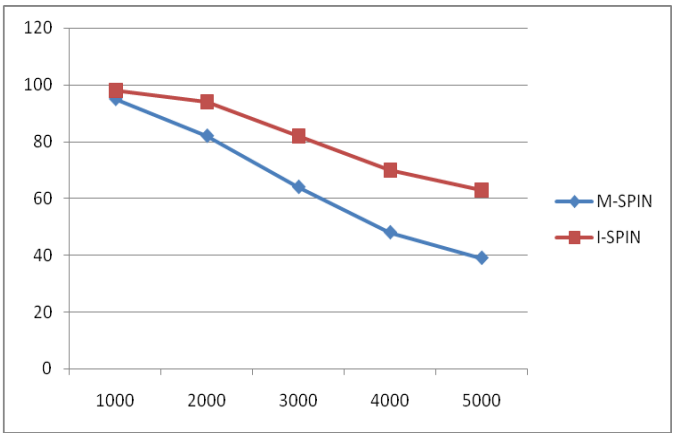

Fig. 6 Number of nodes alive per rounds

2. Packet overhead

In traditional SPIN when ever any new event occure sensor node broadcast Advertisement packet for that event to all of its neighbours in network and among that all neighbours nodes who dont have that data only sends request packets

But in Improved SPIN request packets sent only to the neighbours which are less far from sink than its own distance. So request packets may half of the origional SPIN. Difference is Shown in Figure.7 bellow.

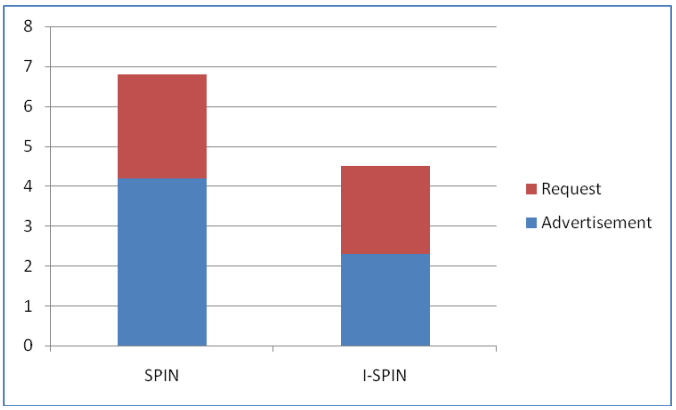

Fig. 7 Differenciate packet overhead

3. Energy consumption based on no. of nodes

In sensor network each transmission would deduct some amount of energy in terms of joules. In M-SPIN energy of each node would be deducted after each transmission but in Improved SPIN as we have used plug in nodes and lifetime of that node are much more than another simple node and energy deduction of that node would be negligible than other nodes so comparatively the total energy usage of network decrease in Improved SPIN than M-SPIN.

Thus bellow Figure.8 shows difference between both protocol's network's total energy consumption as per no. of nodes.

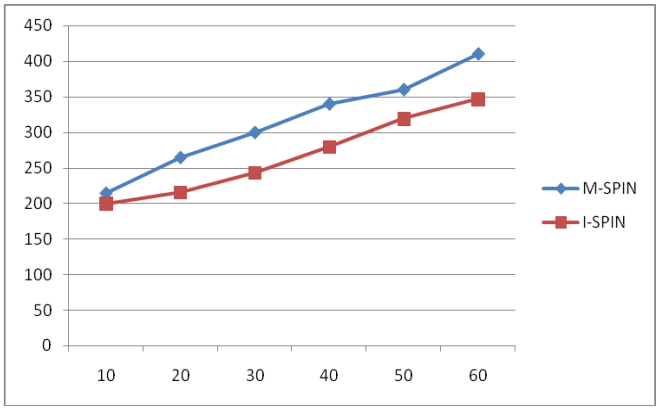

Fig. 8 Energy consumption based on number of nodes

VI. CONCLUSIONS

WSN is very different than other wireless networks. Main crucial issue in WSN is shortage of energy. WSN is made up of hundreds or thousands of nodes which are stand alone and communicate to each other using hope by hope data transmission in network and having minimum amount of energy. Here as discussed in previous researches and survey that is done for new improvement in SPIN is illustrated in algorithm and being implemented in Castalia simulator in this paper. According to network design and algorithm here are some results we get that are shown that using plug in nodes in between the algorithm of M-SPIN it utilize the battery consumption and also improves network lifetime. As plug in nodes are more reliable than normal node it improves network reliability twice. Here we implemented such scenario in some static and greedy format so its need to be implement for mobile environment as further research.

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