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Backbone Based Broadcast Synchronization Algorithm for Wireless Sensor Networks

Nerin Thomas

M.G University, Mount Zion College of Engineering, Pathanamthitta, India

Abstract: **In a Wireless Sensor Networking (WSN) environment, the network consists of a set of many sensors that gather data and collaborate together. In wireless sensor and ad hoc networks, broadcasting is one of the fundamental operations. In order to disseminate a message from a node also called a source to all other nodes in the network, it uses the broadcasting mechanism. In computer networks, the broadcast or multicast procedures are much more important than traditional point-to-point communication. In this project, two types of broadcasting methods are combined. Here, a two stage execution of a new algorithm is defined; construction of backbone is the beginning. Then from sink node, it broadcast the packets using this backbone. For performing basic data communication operation, backbones will be used here. This paper mainly focuses on the structured WSNs broadcasting. So the procedures of data communication in network are much easier than in unstructured WSNs. It will make an overview of Multi Point Relay (MPR) in order to show its weakness. Then, a cluster-based architecture is defined which is constructed using MPR. Based on the previous cluster architecture, a new broadcast algorithm is provided called 3B (Backbone Based Broadcasting) using HEATE algorithm. By the end, an illustration of this shows that the energy consumption will be minimized for accomplishing broadcast compared to MPR.**

Keywords: **Wireless Sensor Networks, backbone, MPR, 3B, HEATE.**

I. INTRODUCTION

During the last few years, WSNs have attracted the attention of the research community due to their low cost, their data collection capabilities and their applications in various fields including environment, military, health care and surveillance. Limit in energy is the most important disadvantage of WSNs. So for taking consideration of this constraint, many algorithms, protocols and methods were introduced and developed. Many algorithms and methods of ad- hoc networks could be reused and reconfigured according to the specificity of WSNs because WSNs are considered as ad-hoc networks with other characteristics. In WSNs, it usually used the broadcasting mechanism. Algorithms based on relaying like MPR or RDS-MPR was applied in unstructured WSNs. Due to these, the consumed energy will be decreased and the avoidance of broadcast storm problem caused by flooding will also be decreased. Recently, several cluster-based architectures have been proposed for structured WSNs. Here, the usual WSNs to WSNs transformation will be done which is connected by a backbone and composed by a set of clusters. Over cluster-based WSNs, the data will be first sent in the backbone, then in intra-clusters and inter-clusters for broadcasting a packet of data.

Two types of broadcasting methods will be included in this project. Here, a new algorithm will be defined which is executed in two stages; initially, the backbone will be constructed. Then, broadcast the packets from sink node by using this backbone. It will make an overview of Multi Point Relay (MPR). Then a cluster-based architecture is defined for WSNs which is constructed using MPR. Next, a new broadcast algorithm is provided based on the previous cluster architecture called 3B (Backbone Based Broadcasting) using HEATE algorithm. Compared to MPR, It minimizes the energy consumption to accomplish broadcasting through the illustration of this new algorithm.

II. EXISTING SYSTEM

In the existing system, a time synchronization algorithm which is new have been proposed named clustered consensus time synchronization (CCTS) for wireless sensor networks. This CCTS is developed on the basis of the distributed consensus time synchronization (DCTS) algorithm. In order to maintain the node's faster convergence of clock synchronization and better efficiency in energy, it incorporated the clustering technique into the algorithm. Mainly two stages have been included in the CCTS: intra cluster and inter cluster time synchronization. For exchanging messages within the cluster; only the cluster head can have the responsibility and applied the improved DCTS in the intra cluster time synchronization. In the case of inter cluster time synchronization, through gateway nodes cluster heads will exchange messages. It takes a hybrid approach in which it is incorporated the clustering technique into the distributed consensus algorithm and proposed the algorithm named Clustered Consensus Time Synchronization (CCTS). Here, the overlapping clusters will be developed from the network and mainly the time synchronization process are of two types intra-cluster and inter-cluster time synchronization.

In order to identify the nodes, an ID number will be assigned to each node. The cluster-heads broadcast a message containing their own ID numbers to their cluster member nodes in order to notice them the identity of their cluster heads only after the network is formed. Then receiving the messages and recording the ID numbers can be done by the cluster member nodes. Ordinary cluster member nodes record only one ID number whereas the overlapping region nodes record more than one ID numbers. Cluster member nodes respond with a message containing their own ID numbers and the ID numbers of their cluster-heads which they can communicate with only after receiving the message from the cluster-head. Cluster-heads check the ID numbers of other cluster-heads with who communicate through overlap-nodes and mark them as the neighbouring cluster-heads only after receiving the response messages, and then from these overlap-nodes the gateway nodes are elected. The overlap-node whose message arrives first is elected as the gateway node only if different overlap-nodes can communicate with the same neighbouring cluster-head.

At the root node, the synchronization phase begins and it propagates through the network. Intra-cluster time synchronization is the first stage of the algorithm. The average values of intra-cluster virtual clocks skew compensation parameters within their clusters and the average values of nodes intra-cluster virtual clocks will be calculated by the cluster-heads and then the clock compensation parameters of intra-cluster virtual clocks will be updated and simultaneously broadcast them to the neighbouring nodes. The messages will be received by the Cluster member nodes and then the clock compensation parameters of local intra-cluster virtual clock will be updated in order to achieve the intra-cluster virtual clocks synchronization. The inter-cluster time synchronization is the second stage of the algorithm. Through gateway nodes, the exchanging of their intra-cluster virtual clocks and their clock compensation parameters will be done by cluster heads. According to the size of each cluster, the received messages are given corresponding weights. Then the network virtual clocks skew and offset compensation parameters will be updated by the cluster-heads in order to achieve the network virtual clocks synchronization.

The synchronization process of intra cluster will be started by the cluster-heads. The synchronization message send by the cluster-head contains its own ID number, the local clock, the intra-cluster virtual clock, and the skew compensation parameter to the cluster member nodes and records the sending time stamping of local clock. After receiving this synchronization message, cluster member nodes record the receiving time stamping of local clock, intra-cluster virtual clock, and skew compensation parameters and the cluster-head will get the response back.

In the existing system, the nodes send messages after the formation of the network through inter clusters and intra clusters. Here the time was synchronized and send messages based on the cluster head information. The drawback of the existing system includes less efficient in energy calculation and the cluster head was changed only through reclustering.

III. PROBLEM DEFINITION

A subset of node is a backbone that can have the capability to perform the tasks assigned and serve nodes which are not in the backbone. Thus, the construction of backbone depends up on the task to be carried. To organize the network in a hierarchical architecture, clustering is one of the commonly used backbones. It is used to partition nodes of the network into groups (clusters) in which cluster heads dominate the other nodes in the clusters. Spatial reuse of the bandwidth will be provided through clustering which is a limited resource in wireless sensor networks. Moreover for efficient routing, clustering provides a hierarchical architecture.

In the proposed system, backbone is used for communicating messages between clusters and gateway nodes. Here, the nodes will send messages if any change in the cluster head occur. Initially, the energy will be same for each node. After the message exchanging, the cluster head will lost the energy and at the time they reach below the energy threshold level, it will automatically move from the position of cluster head and the clusters will be reconstructed on the basis of the message exchanging of each node.

IV. PROPOSED SYSTEM

In this project, two types of broadcasting methods are combined. Here, a new algorithm is defined which is executed in two stages: It begins with the construction of backbone. Then, it ends by the packets broadcasting from sink node using this backbone. An overview of Multi Point Relay (MPR) will be used here. Then, using this MPR, a cluster-based architecture for WSNs is defined. Based on the previous cluster based architecture, it provides a new broadcast algorithm called 3B (Backbone Based Broadcasting) using HEATE algorithm. The working of the proposed system includes the following:

A. Node Generation

To create the node information, this module is used. A node is a connection point that is attached to a network, and can have the capability of sending, receiving, or forwarding information over a communications channel in a network. Generally, to recognize and process or forward transmissions to other nodes, a node has programmed or engineered capability. A node definition depends up on the network and protocol layer referred to. An active electronic device is a physical network node that is attached to a network, and over a communications channel which can have the ability to create, receive, or transmit the information. A distribution frame or patch panel in the passive distribution point is consequently not a node.

In the node generation module, it can have the ability to create 50 or above nodes. After creating the nodes, we can see the interface of each created node. Active nodes will be given blue colour; orange colour will be given to the selected node; black colour will be given to the inactive node in the network. In this module, it can include the monitoring section such as network monitor, message monitor, packet monitor, power monitor, system monitor.

The node generation module can have two functions:

•Power Monitor – function, which runs in background using a thread and the remaining energy will be checked.

•Check If Sink –function, when the node becomes the sink node that will initiates the Cluster algorithm.

B. MPR Heuristic

Broadcasting from the sink node to all nodes in network will be done through this method. Based on levels, it will work i.e. level one nodes are considered as the neighbors of sink, level two nodes are considered as the neighbors of level one nodes and so on . So, on the basis of levels, broadcasting is done and we choose the best nodes to relay for every time. These nodes are a subset of unique level nodes. According to many factors, the selection of relaying node is done. To minimize the redundant packets and the cost of communication are the aim of MPR method.

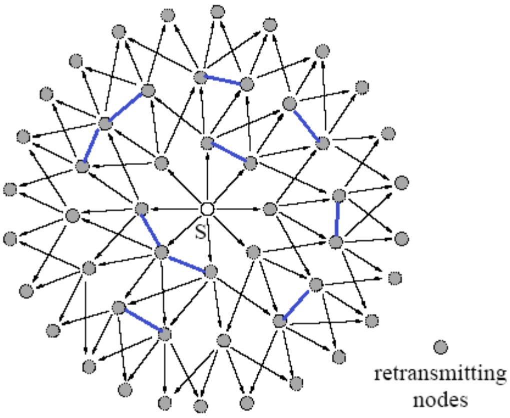

Fig 1.The famous network of MPR with some modification

In the network of the above figure, after applying MPR, it will be transformed to the network of the below figure. The links between nodes in the same level cause a lot of redundant receptions of the same packet sent from the sink node. This fact is induced by blue links. The broadcasting task is accomplished with less amount of energy if we eliminate the blue links because the cause of redundant receptions is eliminated. So, a big source of energy losing is having links between nodes in the same level.

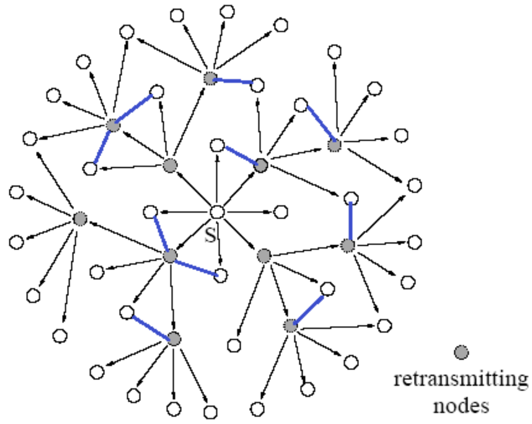

Fig 2.The network after applying MPR

C. Cluster Based Broadcasting

Consider a graph G (V, E) which is WSNs, in which the nodes including the set of vertex V and the set of edges E. In order to organize WSNs into set of clusters, the cluster based broadcasting or multicasting method will be used. Clusters are linked to each other by special nodes called gateways, and every cluster has a special node called cluster head. It have found a node called root in such network which is the sink node in most cases or the first sender node of the packet of data to be broadcasted. Root, cluster head, and gateways are included in the backbone of such network. In the given below table, it introduces the symbols used here and their definitions.

Table 1.Symbols and Specification

SYMBOL	SPECIFICATION
G(V,E)	Graph connectivity where V is the set of vertex and E is the set of edges
Sink	Initial sender node
Root	Id of initial sender node
$G_c(V_c,E_c)$	Clustered graph where V_c is the set of vertex and E_c is the set of edges
Ch	Id of cluster head
Leaf	Id of a member in a cluster
Temp	Set of temporary cluster heads

Algorithm1: CC: Clusters-Construction

```
id(sink) ← root
Vc← Vc U {root}
Vc←Vc U MPR(G)
for all node n in Vc\ {sink} do
    id(n)←ch
End for all
Temp← Ø
for all node n in G\Gc and ch in Gc do
    If (n,ch)    G then
    Temp← Temp U {ch}
    End if
    Choose ch in Temp having the maximum
    remaining energy
    id(n)←leaf
    Ec←Ec U (n,ch)
    Temp← Ø
End for all
```

The algorithm defined for constructing the clusters is given above. Based on MPR, the cluster architecture is constructed. Root is the sink node. Relay node chosen by MPR will be a cluster head. Next, leaves will be the rest of nodes. If more than one cluster head can have a connection with a leaf, the maximum remaining energy cluster head will be choose to be linked and others links will be cut.

D. Backbone Based Broadcasting Using HEATE Algorithm

Based on the previous cluster based architecture, the broadcasting algorithm is proposed. In fact, through the backbone which consists of root, cluster heads and gateway nodes, a packet sent from the root will reach all nodes in the network. Hybrid Energy-Aware Traffic Engineering (HEATE), an algorithm which is fast heuristic is proposed here. For energy saving, the HEATE algorithm aggregates traffic flow onto partial links and turns off underutilized links. Each network element has two opposite state in this model: at the full rates called the active state and at the zero rates called the sleep state. In the active state, the network element consumes corresponding energy and in the sleep state, it does not consume energy. When they operate in the active state, it assumes that the work elements consume the same energy. Thus by aggregating traffic flows onto a subset of links and turning off idle links which no traffic flow traverses through, it can achieve the energy efficiency.

In order to save the energy, it tries to delete the minimum utilization link from the network. The utilization of residual links is less than the utilization threshold which means, it is successful, and then it deletes the link from the network; else ends the algorithm and returned the final results. The algorithm for this is given below;

1: Applying CC to G.

2: The backbone is consists of root and cluster heads induced by CC.

3: Broadcast the packet form the root over the backbone.

An illustration of 3B using HEATE is given in the below figure. With selecting cluster heads, the algorithm begins. In fact these cluster heads are nodes of the network selected by MPR to relay the packets sent initially from S. Next, an organization of intra-cluster is done. Moreover, this organization helps to eliminate links which are the cause of receipting redundant packets.

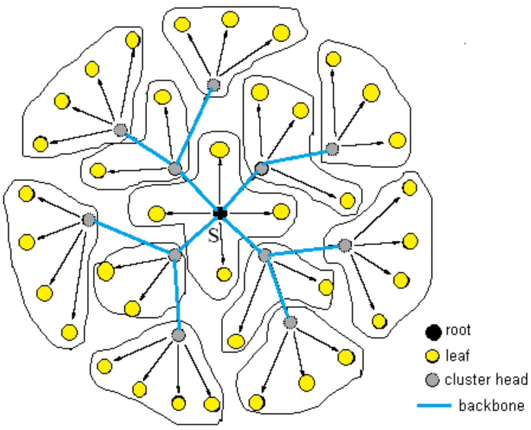

Fig 3.After the application of clustering architecture and 3B in the network

To carry out the protocols of broadcast and multicast with low complexity, the 3B architecture will be used. Compared to MPR, it minimizes the consumption in energy to accomplish the broadcasting. Also in the field of coverage, it reduces the no. of nodes. Through predicting the moving track of the target, the algorithm wakes up or put the nodes into sleeping mode, and it reduces the network energy consumption. In cluster based broadcasting, through gateway nodes, clusters are linked each other and every cluster has a special cluster head. Root, cluster head, and gateway nodes are included in the back bone in such network.

V. PERFORMANCE ANALYSIS

Several cluster-based architectures have been recently proposed in the case of WSNs. From WSNs to WSNs, they usually transform messages which are connected by a backbone and are composed by a set of clusters.

For broadcasting a packet of data, the data will be first sent in the backbone, then in intra-clusters and inter-clusters over cluster-based WSNs.

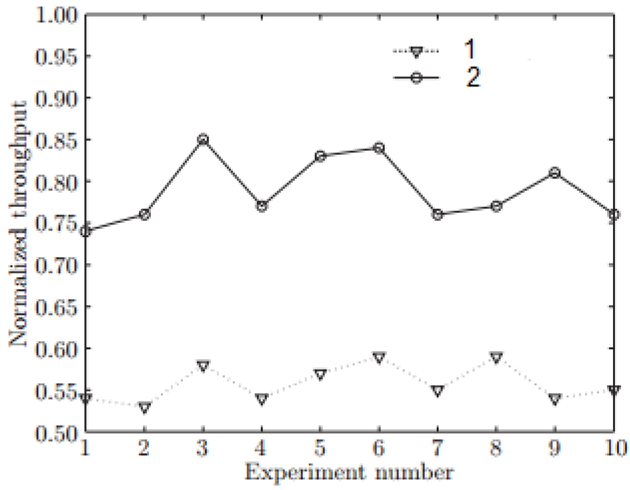

Fig 4:- Performance analysis

When the number of forwarding unit is zero, it corresponds to routing. It plots the normalized throughput fold line. The normalized throughput increases sharply after addition of a forwarding element. The figure shows that our system has a very good throughput promotion.

Energy Consumption: For energy saving, the HEATE algorithm aggregates traffic flow onto partial links and turns off underutilized links. Each network element has two opposite state in this model: at the full rates called the active state and at the zero rates called the sleep state. In the active state, the network element consumes corresponding energy and in the sleep state, it does not consume energy. When they operate in the active state, it assumes that the work elements consume the same energy. Thus by aggregating traffic flows onto a subset of links and turning off idle links which no traffic flow traverses through, it can achieve the energy efficiency. In order to save the energy, it tries to delete the minimum utilization link from the network. The utilization of residual links is less than the utilization threshold which means, it is successful, and then it deletes the link from the network; else ends the algorithm and returned the final results.

Impact on link loads: The fact of routing data over paths which are not the shortest possible, induces overhead in the network load. It may be noticed that the networks converge to a minimum energy state even with this overhead. At the beginning of the simulations and the moment when the network was turned on, in the case of we observe that the overhead is null, as expected.

Impact on end-to-end delays: For every source and destination node, we calculated the mean end-to end delay per intervals of one hour. The box plots represent the distribution of the means of all pairs (source, destination) during the previous hour. The numbers 1 and 2 describes the delays in the original network and the delay in the network with switched off link. In the case of the network, the delay increases by 37% in the worst case, but usually increases by around 20%. While in most cases the delay still slightly increases, it can be clearly seen that the maximum outlier suffered a delay reduction. The minimum hop count shortest path routing is the reason behind this.

Impact on packet loss: The simulation revealed absolutely no packet loss due to our algorithms. The flow in traffic we aggregated does not change fast enough to produce congestion implied by our solution in the case of backbone networks. The algorithm wakes up the links and serves the increased demand.

VI. CONCLUSION

In this paper, the aim is to create a sensor network scenario that will work in an energy-efficient manner, for transmitting some useful data using Wi-Fi enabled devices. A new broadcast heuristic is provided in this project for reducing the energy loss in a network. In term of energy, this method is an improvement of MPR broadcasting. In order to select a backbone in the network, it uses the relay-based broadcast. This paper mainly focuses on the structured WSNs broadcasting. So the procedures of data communication in network are much easier than in unstructured WSNs. It will make an overview of Multi Point Relay (MPR) in order to show its weakness. Then a cluster-based architecture is defined for WSNs which is constructed using MPR. Then, it provides a new broadcast algorithm which is based on the previous cluster architecture called 3B (Backbone Based Broadcasting) using HEATE algorithm. Through this 3B using HEATE algorithm, it increases the lifetime of networks which is a critical criterion for WSNs. Based on the remaining energy, the proposed algorithm selects the backbone members. The cluster head will be selected with nodes with higher remaining energy. Only based on the local information of each node, the proposed algorithm operates. Compared to MPR, It minimizes the energy consumption to accomplish broadcasting through the illustration of this new algorithm.

VII. ACKNOWLEDGEMENT

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