A DATA ACCUMULATION SCHEME IN CLUSTER-TREE TOPOLOGY FOR MOBILE WIRELESS SENSOR NETWORKS

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Abstract: The effectiveness and the efficiency of the Wireless Sensor Networks (WSNs) entirely depend on the data accumulation method. Numerous data accumulation methods like multipath, tree, chain, hybrid and cluster topologies are available in the past for accumulating data in WSNs. The subsisting data accumulation methods in the past don't provide an assured reliable network from the perspective of movement of delay, speed, and connection time. A Link-aware and Velocity Energy-efficient Cluster-Tree (LAVECT) topology for accumulation of data in WSNs with the avail of special nodes called data accumulation node (DAN) constructs a tree, which is an optimal path to the sink, which would in turn efficiently resolve the coverage distance, energy exploitation, mobility of sensor nodes, delay in packet distribution, traffic in the network, intensity of the tree constructed and connection time problems. The discovered LAVECT scheme constructs the Data Accumulation Tree (DAT) predicated on the cluster head location in the network. It additionally maintains the cluster for a considerable duration, thus incrementing the connection time. Simulation results show that LAVECT provides better performance from the perspective of energy utilization by the nodes, throughput, delay, and network lifetime for mobile WSNs. Conclusively, Data security is provided to reach the sink.

Keywords: Link-aware and Velocity Energy-efficient Cluster-Tree, data accumulation tree, data accumulation node, cluster tree, wireless sensor networks.

I.INTRODUCTION

WSNs have gained importance in recent years as they have nano technology where the sensors sense the minute changes that appear in the environment. And WSNs use MEMS (Micro Electro- Mechanical Systems) for designing the networks with minute distributed actuators and sensors. A nano sensor has very special properties of holding nanoparticles and nano materials to identify different events within the Nano scale. This technology occurs to be in reality, where there is a combination of communication and computing together. The WSN's applications are environmental, economics monitoring, meteorology, process monitoring, health care applications, infrastructure protection, undersea navigation, smart spaces, tactical military surveillance and inventory tracking [1]. The efficiency of the WSNs are in their sensing capacity, data accumulation method, flexibility, delay, consumption of energy, mobility, lifetime of network, scalability, coverage, etc., they can offer. WSNs are suitable to place in remote and dangerous regions. In such dangerous environment, it becomes essential to frequently deliver the sensed data from sensor nodes to base station and then conduct further examination at the base station. Data accumulation method is an essential factor in calculating the performance of WSNs [2]. Network topology becomes an challenging task to perform effectively with the help of routing protocols [3].

Choosing of a right topology for different scenarios become a consequential factor in utilization of the energy efficiently, reduction in nodes failures, packet reception delay, communication failures and long range communications [4]. The routing path types, the way of sending data whether it is unicast or broadcast, the type and size of packets are resolute by the topology opted for. Once a right topology is chosen, then it avails to enhance the performance in terms of energy, reduction in delays, packet distributing which conclusively leads to network lifetime improvement and the network Qos. An efficient topology takes care of managing of integration of new members into the network, withdrawal of member nodes from the group, to define the sensor node group, it will visually perceive that neighbors are at a minimal distance and reduce the probability of a packet being disoriented between sensor nodes. One more paramount factor to be considered is the energy consumption, which is directly proportional to the nodes distance in the network. If the topology takes care of the above factors into consideration, them it would be prosperous in proving an efficient gathering of data and thus proving a efficient network with good network lifetime.

In WSNs, power loss is directly proportional to the nodes distance and is depicted by Ploss = dρ, where d is the sensor nodes distance, ρ is the environmental fading factor, ρ = 2 for free space fading and ρ = 4 for multipath fading [5].

There are many subsisting WSN topologies, which the following flat, tree, cluster, chain and hybrid. According to the region where the network gas to be deployed, different topologies can be utilized for efficient working. Here a cluster tree data accumulation mechanism is utilized and is denominated as LAVECT. The proposed LAVECT surmounts the subsisting circumscriptions such as energy consumption, connection time, coverage, RSS (Received Signal Strength), network lifetime, traffic, data accumulation and delay on mobile WSNs.

II.RELATED WORK

A. *Flat/Unstructured Topology (FT)*

FT/UT is a facile method to accumulate the data from the remote location to destination node, since it utilizes flooding, gossiping and direct communication [6]. FT does not have any mechanisms of energy conservation as it doesn't have specific topology, which leads to the overlapping quandaries and implosion [7].

B. Chain Topology (CT)

The sensor nodes in the network communicate with each other through the chain that is built by the leader node. The leader node has a bottle neck to accumulate all the data passed by the sensor nodes and it may experience delays from far off nodes in the network [8].

C. Cluster Based Topology (CBT)

LEACH is one of the clustering algorithm proposed by Heinzelman et al. [9] which doesn't requires the global knowledge of the network and also does single hop transmission of data.

D. Tree Based Topology (TBT)

Jin et al. [10] designed EEDCP which is a tree based data collection mechanism, which uses flooding prevention scheme and cascading timing scheme to perform data aggregation in order to save the sensor nodes residual energy excess usage [11].

E. Cluster Tree Topology (CTT)

CCT is a combination of cluster and tree topology where designated node comes into existence, which acts as a head of cluster with more transmission power and better receptor [12] [13].

III.PROBLEM STATEMENT

In order to overcome limitations such as coverage area, energy consumption, Received Signal Strength (RSS), time for connectivity, throughput, delay and finally network lifetime of the existing topologies mentioned earlier, a scheme for gathering data called Link Aware and Velocity Energy-efficient Cluster-Tree (LAVECT) is proposed [14]. The proposed LAVECT starts functioning by constructing the Data Accumulation Tree (DAT) on the basis of the location of cluster head (CH) and finding Data Accumualtion Node (DAN). The DANs in the DAT does not indulge in sensing any data but it quietly gathers the information from the cluster head and passes it to the sink. The important factor of LAVECT scheme is to organize a simple tree design, thus by lessening the energy usage of the CH and preventing frequent formation of clusters thus by maintaining the cluster for certain period of time. The advantages of this scheme are that it reduces the energy usage in cluster heads to prevent frequent cluster reformation thus building stable links. It solves the coverage distance problem, reduces delay, network traffic, better end to end connection and packet drop in mobile WSNs.

IV.LAVECT STRUCTURE

The LAVECT structure design consists of the setup phase and the steady phase. In setup phase, clusters formation and the data tree construction take place. During the steady phase, genuine transmission of data takes place from the nodes to the sink.

A.Setup phase

Cluster formation and construction of data tree is done during during the setup phase. Formation of cluster includes communication of intra cluster, where the sink selects the cluster head, cluster formation takes place and DAT construction operation is done. Before the tree construction, Data Accumulation Nodes (DAN) is elected which is done by sink again.

1.Intra cluster communication:

Considering the large-scale WSN, sensor nodes are densely deployed over a region.

During the setup phase, each node sends the beacon packets to the destination node giving their location and position in the network. Nodes withal send their RSS value, threshold value and their connection time. Once the nearby nodes are identified, election of cluster head algorithm is utilized to elect the cluster head. Now, the cluster head selection is predicated on the robustness, coverage time, connection time and threshold value for connection. After the cluster head election, the next phase DAT formation is initiated. The DANs are selected on the substructure of the threshold energy which is done by sink. The following algorithm shows the selection of the cluster heads and DANs.

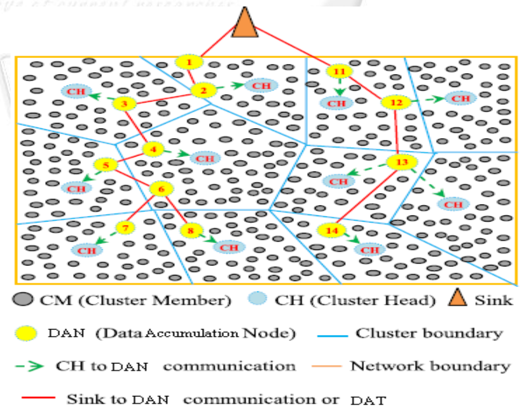

Figure 1:LAVECT Structure

Algorithm steps:

Input: nodes with initial energy
Output: DANs and CHs

begin
read(){
    RSS
    Connection time
    Energy
    }
ifEnergy level of Sensor nodes >= average energy level

then
Sensor node is suitable for cluster head
ifEnergy levelof Sensor node= highest energy level
work as a CH
else
Not eligible for process of cluster head selection.
Check second threshold value
If (node $_{threshold}$ >= threshold)
{
node → elect DAN
}
else node → cluster member
call CH()
load ← stored CH_1, CH_2, ……CH_N
load ← stored DAN_1, DAN_2, ……DAN_N
repeatuptoDAN$_n$
DAN$_n$ → sink.
end

The above algorithm provides the steps to ascertain the cluster heads and the DANs from the network by the sink. Initially, the RSS value, the connection time of the nodes and energy of the nodes are read by the sink with the avail of the beacon packets sent by the nodes to the sink. After getting the information about the location and position of nodes, the nodes are checked for their energy, if the energy values meet the cluster head energy criteria, then that node is selected as cluster head. Similarly, DAN is selected predicated on the second threshold values with veneration to the cluster head.
DAT for the single cluster construction is shown in Figure. 2 where the cluster head (CH) has a chance to join with the DAN-3, DAN-4 and DAN-6. But, the CH select a DAN with better connection time, robustness and coverage distance for connection and with less traffic (i.e., DAN-4). Likewise, the DAT expand its tree structure with the avail of DAN.

B. Steady phase

During the steady phase, the transmission of data takes place from the cluster members to the sink through the cluster heads and the selected DANs. Data transmission is done by the DAT constructed which forms an optimal path to the sink from the nodes.
Initially, from one-hop distance neighbor nodes, the sink commences to find a first DAN to integrate that particular node in DAT. The parameters include HC = 1 is utilized to select the node that is one-hop distance from sink or DAN. Here, the sink or DAN verify the parameters such as connection time, threshold, robustness connection and coverage time. After the parameter verification, the sink selects a node with optimum value from node selected transitorily and assigns the node integrity. Now, the DAN is selected from the ephemeral list then the selection of DAN is finalized, afterward DAN calculates the duration of frame. After the validation of DAN, the node checks the frame duration or network traffic. In the case, if maximum network traffic is greater than the DAT traffic, the selected DAN canbe utilized for generation of DAT. Or else, the sink skips to discover an incipient DAN and then commences to engender an incipient DAT.
Once the first DAN is selected, then the next DAN revelation commences from the first DAN in lieu of sink. Consequently, the DAN selects another one-hop distance neighbor node. Likewise, selection of DAN is expanded to engender and is shown in the following algorithm.
The DANs in the network aggregate the data that it has accumulated from the cluster head and does not participate in sensing of data. DANs abstract any duplicated data and transmit that data to the sink either in single hop to the sink or through other DANs in the tree.

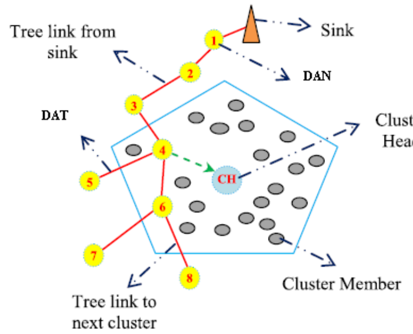

Figure 2: DAT construction for single cluster.

Algorithm steps:

Input:DAN's and CH's
Output: Through DANs, data transmitted to sink

start
datagathering procedure()
{
CH← data collection from CM's
repeatCHn ← CMnwheren= maximum CH's

m=maximum CM's
CH[i] ← CM[j]
}
If traffic of network> traffic of nodes
{
then select DAN$_{node}$ to construct the DAT
} else
Select other DAN
transferdataprocedure()
{
CH's → data transfer to DAN's
CH[i] → DAN[i]
CH[i] → DAN[i] → packets
If (DAN[i] ≠ null)
{
Check DANi next hop → DANi+1
Calculate DANi to DANi+1distance
If(distance > threshold)
Select DANi
Repeat until DANn
}
DANi → DANi+1 → sink
}

Call procedure
CHn.datagathering();
DANn.transferdata();
end

V.RESULTS AND DISCUSSION

The performance of LAVECT algorithm can be measured with the help of simulation. The Network Simulator (NS-2) is utilized to caliber the performance of LAVECT with deference to proven protocols like CTDGA, CIDT, MBC, EEDCP-TB and CREEC. A WSN system comprising of 100 nodes was utilized in the simulation scenario. In an area dimension of 1000*1000m2, the nodes were deployed randomly, where 512bytes would be the size of data packets, in the transmission range of 40m with in the cluster, the sensing range is 20m, and the base station located at x = 500, y = 1050. Initial nodes energy is 100J. Consequently, the mobile sensor nodes maximum speed varied up to 30 m/s and is shown in Figures. 3 to 5.

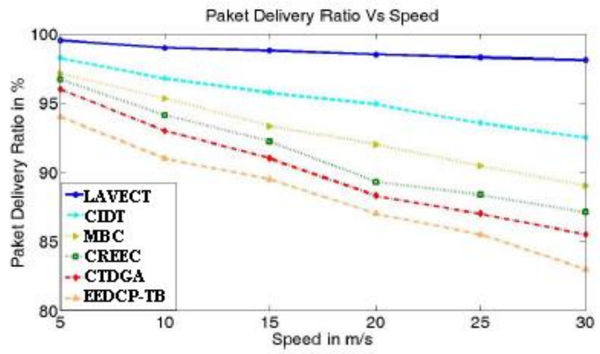

Figure3 :Packet Delivery Ratio versus Speed

The LAVECT provides better performance in terms of stable links, less delays and energy consumption which is depicted in Figure 3 to 5. The simulation results show that, better links are provided by LAVECT protocol. It is observed that the proposed LAVECT protocol can conserve the sensor node energy, hence by improving the lifetime and reliability of the network. Less traffic and also minimum load over the network is enhanced by DAT. Figure. 5 illustrate the performance of total number of nodes and energy consumption. The LAVECT selects the cluster head with better threshold value, connection time and minimum control packets overhead. Here, each cluster head selected with the maximum residual energy, coverage distance and less mobility with cluster members and hence minimizing the energy consumption of whole network.

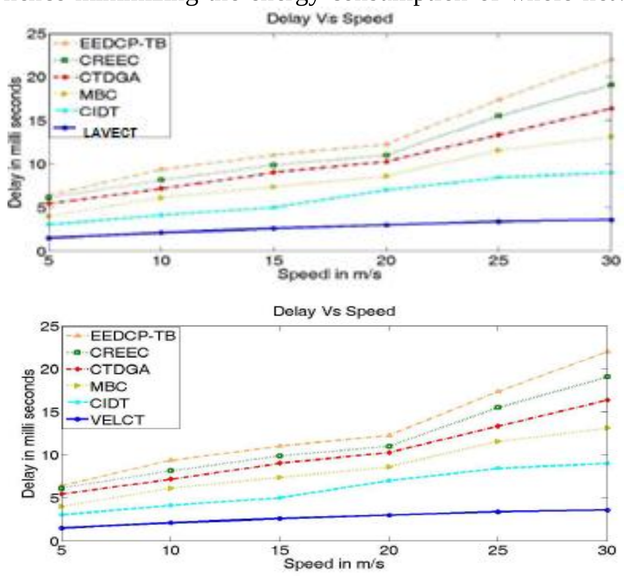

Figure4:Delay versus Speed

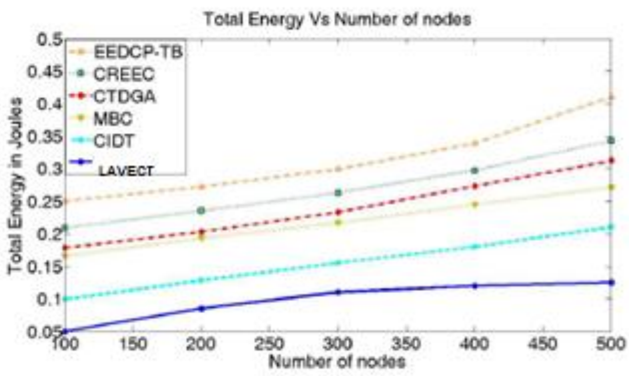

Figure5:Total Energy versus Number of nodes

VI.CONCLUSION

The WSNs have a great effect on applications in military, robotics and solving problems of civilians. Large number of sensors may be used to manage a certain region. If the nodes are mobile, there is a probability of breakage of links established between the nodes and it is difficult to maintain the links when the nodes are mobile. So, the proposed LAVECT provides a better performance in terms throughput, delays and network lifetime by providing stable links between the nodes and reducing traffic at cluster heads and thus reducing the energy consumption. As cluster heads are selected on the basis of the node's threshold value, RSS value and connection time, it provides a better network lifetime.

Likewise, one hop distant DANs from the sink are selected which have maximum threshold energy, connection time and RSS and selects cluster heads with less traffic to construct the tree. From the simulation results, it is revealed that LAVECT provides more stable links, better throughput, energy utilization with reduced network traffic and delay when compared existing CTDGA protocol.

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