Increasing Lifetime of Sensor Nodes using Load Balancing Algorithm in Wireless Sensor Networks

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Abstract – A wireless sensor network is a spatially distributed autonomous device using sensors to monitor physical or environmental conditions. Energy consumption is the core issue in wireless sensor networks. To generate a node energy model that can accurately disclose the energy consumption of sensor nodes is an extremely important part of protocol development, system design and performance evaluation in wireless sensor network. To solve these issues, load balancing mechanism is used in the directed diffusion protocol. In fact, load balancing is a reliable and a powerful mechanism. In this system, one dispatcher (zone header) assigns incoming tasks (request of clients) to one of the homogeneous servers of the system by using a load balancing mechanism and to route the data to the sink when the path is reinforced. The proposed method improves the performance of network lifetime and can balance the energy load of the sensors.

Index Terms – Wireless sensor networks, Load balancing, Data propagation, Energy efficiency

1. INTRODUCTION

A Wireless Sensor Network (WSN) conventionally consists of a great number of far distributed contrivances that are armed with sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, kineticism or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be notice and analyzed. A sink or base station acts like an interface between users and the network. One can get required information from the network by injecting queries and accumulating results from the sink. WSN contains a number of sensor nodes and it can communicate among them utilizing radio signals. Sensor nodes are equipped with sensing and computing contrivances, radio transceivers and power components. It is utilized in a variety of applications such as military, health, chemical processing, conveyance, and disaster assuagement scenarios. The sensor nodes are mundanely battery-powered and consequently their lifetime is constrained. Typically, these batteries withal cannot be transmuted. Since energy is a valuable resource in WSN, energy-efficient routing is one of the most consequential aspects of incrementing the life span of sensors. These system process data accumulated from multiple sensors to monitor events in an area of interest. We have proposed an incipient variant of the protocol DD with a load balancing mechanism to surmount the quandary of High energy consumption and constrained network lifetime. In this system, one dispatcher allocate incoming tasks (requests of clients) to one of the homogeneous servers of the system. The dispatcher aims to balance the load of tasks on the servers by utilizing a load balancing mechanism and amends the performance.

2. RELATED WORK

Dai and Han [2] try to create a balanced tree of sensors. The sensors periodically broadcast their existence and neighboring information. After collecting this information, the sink constructs the graph G (V, E). An algorithm is executed on G to build a load-balanced tree. We show that the tree takes into account just the existence and the neighboring information without take everything into account the load of the sensors in terms of energy.

When the authors in [3] consider the site, the power and the load as metrics for the action of the intermediate sensors which transmit the data between the source and the destination.

Baek and de Veciana [4], considering clusters, try to aggregate the data of the sensors before sending them to the sink. The authors did not regard the case when the sensors sense the same data. In this case, the aggregation is not agreeable because it adds some delay to the transmission time of the data. Recently, some works have tried to balance the load by conceiving some schemes of organization of the sensors in the network.

Liao et al. [5] have proposed a grid-based design to balance the load assigned to the sensors.

Authors in [6] have proposed a new scheme to partition the nodes into clusters of unequal size to balance the energy load.

3. DIRECTED DIFFUSION ALGORITHM

DD was considered a protocol of reference for the data-centric routing applications. In DD, the sink requests the required data by sending the interest to the concerned sensors. In dissemination of the interest, the sink broadcasts a message that accommodate the required tasks to all its neighbors kenned as the interest. The initial interest requires a transmission rate relatively low. Each intermediate sensor receiving the interest maintains a cache of fascinates where each ingression of this cache contains several fields. In particular a timestamp field that designates the time of the last received interest, in additament to a certain number of gradients. It comprises essentially a field that designates the transmission rate appropriate by the source of the interest. Each sensor rebroadcasts the interest to all its neighbors which sanctions flooding it through the entire network. In data propagation, sensors concerned with the interest, engender the required data. Thereafter, each sensor culls the greatest gradient and sends the first packet of the engendered data to all the neighbors with which it has a gradient. Each transitional sensor receiving the packet searches the corresponding ingression of the interest. Thereafter, it rebroadcasts the packet to all its neighbors that have gradients and integrates the data to a cache to evade the redundant retransmissions. In paths reinforcement, after the reception of the first packet of the data, the sink must reinforce the path of one of its neighbors by soliciting the rest of the data with a higher rate of transmission. Then, the sink sends the same interest with a higher rate of transmission than the initial rate to all its neighbors. This operation aims to cull one of the optimal paths for accumulating the sensed data. The cull of the path that must be reinforced can be done according to several criteria. The maintenance of paths is possible in DD. When the path used to route the data fails, an incipient alternate path must be identified. For that the preliminary utilization of multiple paths is utilized.

4. USING LOAD BALANCING ALGORITHM IN DIRECTED DIFFUSION

Directed Diffusion with Load Balancing protocol (DDLB) postulates, like DD, that the information, engendered by the sensors, is of the type (attribute, value). Each zone of the capture field contains a dispatcher sensor that leads the zone and that culls, for each interest reached this zone and by utilizing an algorithm of load balancing, a sensor that will reply to the interest by sending the commited data. Moreover, the dispatcher compete in the routing action of all the types of messages (the interest, the first packet of the data and the rest of the data). Initially, the dispatcher of all zone is culled desultorily since all the sensors have the same level of energy. However, after each time cap of processing of the protocol, the dispatchers must be transmitted to avoid exhausting their energies and disconnect the zone from the network.

4.1 Cluster formation and dispatcher selection

The field of capture can be partitioned into several Zone. Each zone contains a dispatcher sensor that leads the zone and culls, for each interest reached this zone. Utilizing an algorithm of load balancing, a sensor that will reply to the interest by sending the dedicated data. Furthermore, the dispatcher participates in the routing process of all the types of messages. Initially, the dispatcher of each zone is culled desultorily since all the sensors have the same level of energy. However, after each time limit of processing of the protocol, the dispatchers must be transmitted to avoid exhausting their energies and disconnect the zone from the network.

4.2 Dispersal of interest

At this stage the sink, broadcasts the interest to all the dispatchers of the network. Thus, it commences by sending the interest to all its dispatcher neighbors. On receiving the interest each intermediate dispatcher rebroadcasts it to all its dispatcher neighbors which sanctions flooding it through all the dispatcher sensors and therefore the entire network. Like DD, the initial interest requires a transmission rate relatively low. It is considered a message of exploration used to identify the dispatcher sensors of the zones concerned with the diffused interest. Each dispatcher sensor maintains a cache of fascinates where each ingress of this cache contains a particular timestamp field that designates the time of the last received interest and a certain number of gradients.

4.3 Data Breeding

The dispatcher is concerned with the broadcasted interest, culls a sensor in its zone according to an implemented load balancing algorithm. This sensor will reply to the interest and must send the engendered data to all the dispatcher neighbors with which it has a gradient. The load balancing algorithm utilized by the dispatcher to cull the sensor is predicated on the load (energy) of the sensors of the zone. Thus, the sensor with a higher energy is culled to respond to the interest. The energy of each sensor is communicated by broadcasting it to all its neighbors after each communication to keep the last consumed energy. When the dispatcher is in an active mode, the sensors of the zone remain in a slumber mode until that the dispatcher arouses one of the sensors to send data. This sanctions preserving energy of the sensors concerned with the same interest and must send the same data. When a transitional dispatcher sensor receives the packet of the data, it probes the corresponding ingress of the interest. Furthermore, it rebroadcasts the packet to all its dispatcher neighbors that have gradients and integrates the data to a cache in order to eschew the redundant retransmissions and eventually the loops. The dispatcher sanctions preserving the energy of the sensors when the sink disseminates the intrigues and when the sensors reply to the fascinates by sending the data. In fact, the fascinates and the data will be routed among the dispatchers at the difference with the standard DD where the intrigues and the data are routed among all the sensors of the network.

4.4 Path Maintenance

When the path used to route the data fails, an incipient alternate path must be identified. The protocol reinitializes the phase of reinforcement of paths by probing another path among paths that send the first packet of data with a low rate of transmission. The transmutation of the dispatchers evades that the dispatchers exhaust their energy and disconnect the zone from the network. The dispatcher sensors of each zone change at each time limit or at each number of events. In the case of the proposed system, the dispatchers of each zone change at each 100 events (an optimal value predicated on several tests performed during the simulation to eschew the sultry pots quandary for the dispatchers proximate to the sink).

5. EXPERIMENT SETUP AND PERFORMANCE EVALUATION

5.1 Network Simulator-2

NS-2 is a widely used implement to simulate the demeanor of wired and wireless networks. NS-2 is an open-source simulation implement that runs on Linux environment. It is a discrete event simulator targeted at networking research and provides substantial support for simulation of routing, multicast protocols and IP protocols, such as UDP and TCP over wired and wireless (local and satellite) networks. NS-2 is built utilizing object oriented methods in C++ and OTcl (object oriented variant of Tcl). A utilizer has to set the different components (e.g., event scheduler objects, network components libraries and setup module libraries) up in the simulation environment. The utilizer indicts his simulation as a OTcl script, plumbs the network components together to the consummate simulation. The event scheduler as the other major component besides network components triggers the events of the simulation (e.g. sends packets, commences and ceases tracing). Some components of NS2 are indicted in C++ for efficiency reasons. The data path (indicted in C++) is disunited from the control path (indicted in OTcl). Environment creation setup is shown in Table 1.

Table 1. Environment Creation Setup

PARAMETER	VALUE
Total area	1000 * 500
Number of nodes	108
Initial Energy	0.7 joule
Data rate	300 kbps
Transmission range	500 m
Packet size	48 bytes
Packet loss rate	0~10%

5.2 Performance Analysis

5.2.1 Energy Efficiency

In energy efficiency, according to the simulation time, simulation results are more satisfactory. The effectiveness in the energy efficiency of the protocol DDLB is better than the energy efficiency of the protocol DD. In fact, when routing the data DDLB balances the energy load of the sensors which improves the network lifetime and consumes less energy than the protocol DD as shown in Figure 1.

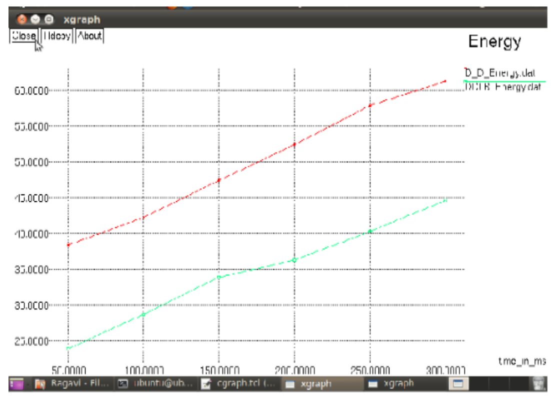

Figure 1. Energy Efficiency

5.2.2 Success Rate

In success rate, the number of packets sent by the source to compare them with the packets received by the sink at each ten seconds. The difference in performance between DD and DDLB is very large. Hence, more the time of the simulation advances, more the success rate of the protocol DD decreases. This is due to the degradation of the energies of the sensors which causes a loss of many packets. However, DDLB keeps its success rate steady until the end of the simulation is shown in Figure 2.

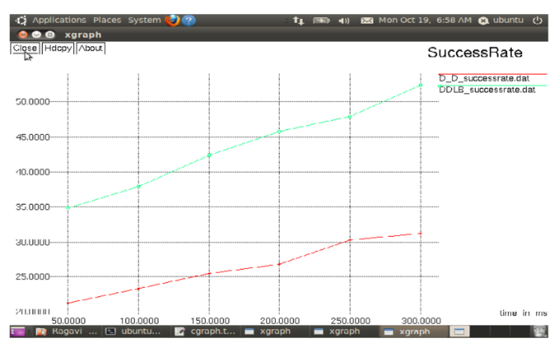

Figure 2. Success Rate

6. CONCLUSION

Proposed a load balancing algorithms with admiration to energy requisites. In WSN energy is the most valuable resource. The DD protocol was considered a protocol of reference in the field of the data-centric routing. In the above protocol all the sensors compete in the dissemination process and the routing process of the data mostly when several sources are implicatively insinuated by the same interest and must reply the same data to the sink. While for DDLB, only the dispatcher sensors are concerned with the dissemination process and at the time of sending the first packet of data, only one sensor of the zone, culled by the dispatcher, replies to the sink. This proposed system preserves nonessential energy consumed in the case of the standard protocol.

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