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Performance Analysis of MAC ProtocolsVarying Reporting Rate in Wireless Sensor Network

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***Abstract*—Nowadays, Wireless Sensor Networks (WSN) is gaining more popularity. It is used in many applications like earth sensing, area monitoring, forest fire detection, natural disaster prevention etc. In WSN all nodes are operated by battery which is having very short energy carrying capacity so energy efficiency becomes a crucial factor. Throughput, delay, energy consumption, delivery ratio, stability are the QoS factors which have to be considered while designing efficient network. Performance of the network can be increased using different protocols. In this paper we have studied different protocols like TORA, INSENS, AODV, DSR, DSDV, STEB, LEACH and variants of LEACH like LEACH-A, LEACH-B, LEACH-C, LEACH-E, LEACH-F, PV-LEACH, S-MAC, HEED, CAG, ESAODV and CASER. We have also studied various congestion control protocols like ARC, ESRT, and FUSION etc. This paper will be useful for researchers for achieving the QoS factors by gaining the knowledge of above protocols.**

Keywords—WSN, Energy Efficeient, Sink, Network Lifetime, Cluster Head, Heterogeneous Enviornment, Homogeneous Environment, NS-2.

I. INTRODUCTION

During the past few decades WSN has gained large amount of attention in both academic and industrial fields. A wireless sensor network is a group of sensors with a communications infrastructure for monitoring and recording conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensity, vibration intensity, sound intensity. Wireless Sensor Network sense data and transmit this using radio waves which are usually takes place at the physical layer of the network.

A sensor node generally composed of sensor, processor, transceiver, and power units. A sensor node also has the capability of routing. Due to this sensor nodes face energy optimization problems. To address this issue different protocols are introduced. One of the protocol is Low Energy Adaptive Clustering Hierarchy (LEACH) which falls under hierarchical routing and TORA falls under the category of flat routing [1]. The distance between each node and BS are different, direct transmission leads to unbalanced energy consumption. To solve these problems, many protocols have been proposed such as Low Energy Adaptive Clustering Hierarchy (LEACH), Hybrid Energy Efficient Distributed (HEED) and Power Efficient Gathering Sensor Information System (PEGASIS). The drawback of LEACH protocol is that its coverage area is less and energy consumption is more. Hence an attempt has been made to develop Self-Organized Tree-Based Energy Balance routing protocol [2]. There are many routing protocols present in WSN like AODV, DSDV, DSR using this protocol we can increase the performance and reliability of the network [3]. Main drawback in WSN is limited battery power in the sensor nodes. Energy efficiency can be increased through hierarchical routing protocols. One of the most fundamental protocol in this class is Low Energy Adaptive Clustering Hierarchy (LEACH). There are many variants of LEACH like LEACH-A, LEACH-B, LEACH-C, LEACH-E, LEACH-F, and PV-LEACH. By analysing variants of LEACH it is observed that energy utilization in cluster setup phase and data transmission phase can be minimized in WSN [4], [5], [6].

To reduce the problem of energy consumption through data aggregation we used sleep scheduling algorithm. But the drawback of this method is that delay is increased. So to address this problem we implement Contiguous Link Scheduling in which node is allocated with a time slot so that it can wake up with minimum time slots [7]. In the past few decades most of the focus is to gain energy efficiency but we fail to obtain other QoS parameters. So here we are going to focus on MAC protocols in which SMAC will be considered as it was the first protocol with sleep and awake mechanism to avoid unnecessary energy consumption in ideal listening apart from this we are going to focus on reliability and stability of the network. For achieving this we are going to use concept of adaptive listening of SMAC with the concept of duty-cycle in it [8]. The performance of the network degraded mainly due to the factor called congestion which can cause other drawbacks to address this we have studied various congestion control algorithms depending on its policy [9]. Among the task of WSN one of the most important task is collect the data and transmit to the base station in this process most of energy is utilized so different data collection methods like data aggregation clusters, data aggregation trees, network coding

are used to prolonging network lifetime in WSN [10]. Normally, sensor network consist of large no. of devices for data collection which is in very huge amount to reduce the processing of the data there is need to increase processing space by considering energy efficiency in the network. This is known as data aggression. There are various approaches for implementing this concept.

The following figure 1 shows architecture of wireless sensor network.

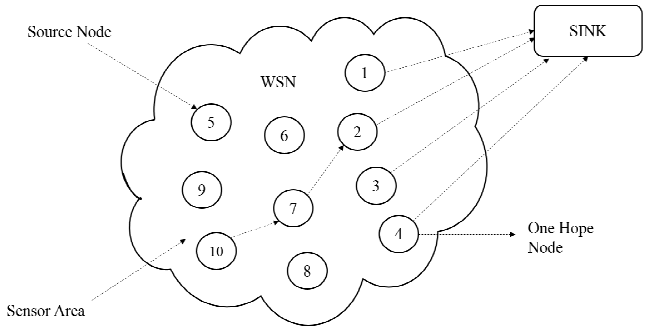

Figure 1. Architecture of WSN

In figure 1, number of sensors nodes are deployed in sensor area. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source. Each sensor node generates their own packets and transfers through the intermediate node to sink node. The area where the sensors are deployed known as sensor area. The node which generates the packets are called source nodes. The sensor nodes which are deployed level 1 away from the sink node are called one hope node. In network congestion can be generated near the sink node that is on one hope nodes.

Wireless sensor network is a group of sensor nodes which are randomly deployed in sensor area to monitor the environmental conditions like temperature, pressure and humidity etc. All the sensing information can pass through the network to the sink node. Sink node is a collector node which collects the information from all the sensor nodes and sends to the control system. Wireless sensor networks can be used for numbers of applications like Military applications, Home applications, Earth sensing, Healthcare applications and many more.

II.LITARATURE SURVEY

Author has done the analysis of two categories of routing protocols i.e. Hierarchical and Flat Network Routing protocols in Wireless Sensor Network. For simulation purpose author used Temporally-Ordered Routing Algorithm (TORA), Low-Energy Adaptive Clustering Hierarchy (LEACH), and INtrusion tolerant routing protocol for wireless SEnsor NetworkS (INSENS). To analyze the objective of this paper author used simulator. To represent the protocols specific to WSN simulator needs to have additional module. Mannasim framework is added in ns-2 for this purpose. Mannasim is used to add new modules for design, development, and analysis of different WSN applications. TORA does not use shortest path algorithm, in this mobile nodes are assigned with sequence number from a source to a specific destination. TORA builds Direct Acyclic Graph to destination. In this paper it is seen that TORA performs less than other two protocols. But when number of nodes increases the performance of the TORA is improved. Other protocols re-initiates the route discovery if link fails but TORA patch itself at the point of failure. Because of this it can scale to larger networks. LEACH periodically selects cluster head that's why the energy consumption is uniform to each sensor node and the lifetime is more. LEACH has better performance because of single-hop cluster based architecture. LEACH has higher PDR because it forms cluster heads it reduces overhead. It has a lower end to end delay because of single hop cluster. INSENS tolerates intrusion by bypassing the malicious nodes, it does not detects the intrusions. In INSENS the QoS was slightly degraded than LEACH in case of PDR. INSENS transfers same packets multiple times to the destination so that it reduces Packet Delivery Ratio. It has more end to end delay because all sensor nodes share authentication key with base station [1].

Author uses simulation tool to analyze the performance of Self-organized Tree- Based Energy-Balance routing protocol. In this protocol a tree is built in which at each round base station assigns a root node and broadcast this to all sensor nodes. Afterwards, each node selects its parent node by assuming itself and its neighbors'. In WSN all sensor nodes collects the information and transfers directly to the BS. Because of this if BS is located far away the sensor nodes may die due to more energy consumption. Since, the distance between sensor node and BS is different, direct transmission leads to more energy consumption. To remove this drawback there is following some protocols are proposed like Low Energy Adaptive Clustering Hierarchy (LEACH), Hybrid Energy Efficient Distributed (HEED) and Power Efficient Gathering Sensor Information System (PEGASIS). In LEACH the energy consumption is more and the coverage area is less. Because of this Self-Organized Tree-Based Energy Balance routing protocol is developed and discussed in this paper. STEB protocol has less no. of dead nodes as compare with LEACH because STEB protocol consumes less energy than LEACH to election criteria of cluster head. In STEB the nodes which are involved in data transmission uses less energy by using data aggregation scheme because of this STEB has higher residual energy as compare to LEACH [2].

In this paper author used DSR, DSDV and AODV protocols to compare the performance and to analyze the simulation results as per throughput, end to end delay and packet delivery ratio. There are two types of routing protocols i.e. Proactive and Reactive. In Proactive Routing protocols list of destinations and their routes are periodically maintained and distributed over the network. Routing information is

shared among the nodes and path is set to transfer data packets from source to destination. Examples: DSDV, OLSR. In Reactive routing protocols routes are discovered by flooding the network with route request packet. The source generates route request packets and forwards to next node this node issue a route reply and forwards the data transmission process. It is done till destination is reached and data packet is received. Examples: AODV, DRR.

A. AD-HOC ON DEMAND DISTANCE VECTOR ROUTING PROTOCOL:
AODV uses RREQ and RREP to find the route. The source node transfers the RREQ to its neighbors to find the route to the destination. It contains source and destination address, lifespan of the message, sequence number of source and destination and ID for unique identification. If any neighbor node knows the destination node then it sends RREP to the source and the route is created.

B. DESTINATION SEQUENCED DISTANCE VECTOR:
The DSDV maintains the routing table it includes all the list of destinations, the no. of hops to reach the destination and the sequence number.
A node periodically transfers their routing table to check any changes are occurred from last packet sent. The routing table can be updated in two ways: a "full dump" or "incremental update". Full dump means if changes occurred it transfers the whole table back to the node with the new update. Incremental update means only those entries are transferred which are changed. Due to this the traffic of the network can be decreased.

C. DYNAMIC SOURCE ROUTING:
It is same like AODV but it stores the whole path to destination instead next hop node. The packet header includes address of all nodes through which packets are transferring to the destination. It also uses RREQ and RREP to discover the route. Source node broadcast the RREQ packet in the network. If there is information about the destination then it transfers back the RREP packet and transmission goes on. If node doesn't have any information then source node rebroadcast the RREQ message.

Author used simulator for evaluation of the performance of these three protocols. AODV is better than both protocols. AODV can send more packets [3].

In this paper author gives a survey of LEACH routing protocol for wireless sensor network and compared the performance in homogeneous and heterogeneous environment. Author uses simulation tool for comparing the behavior of LEACH protocol in both environment. In homogeneous environment sensor nodes are spread over a network of 100*100 meter area. All the sensor nodes having initial energy 0.5J.Sink node is situated at the middle of the network area that is (50, 50). In heterogeneous environment authors assume that total number of sensor nodes in a network is n and m fraction of the sensor nodes has α time more energy than other sensor nodes. The sensor nodes which having m fraction more energy author called them advanced nodes. In heterogeneous environment 10% of sensor nodes having more initial energy than the other sensor nodes. Suppose there are 100 nodes in network then 10 sensor nodes are assigned with 1J of energy and remaining sensor nodes having 0.5 J of energy. From the simulation results author conclude that the total energy efficiency in LEACH heterogeneous is increased nearly 40% then LEACH homogeneous. Network lifetime is increased twice in heterogeneous environment than Homogeneous Environment [4].

III. result analysis

In our scenario, we have used horizontal chain topology to deploy 11 nodes using NS-2 simulator. Ad-hoc On-demand Distance Vector (AODV), ZigBee (802.15.4), Time-Division Multiple Access (TDMA), Sensor-Mac (SMAC) these are the protocols used. The reporting rate is varied from 10 to 50 packets per second and the packet size is 50 bytes.

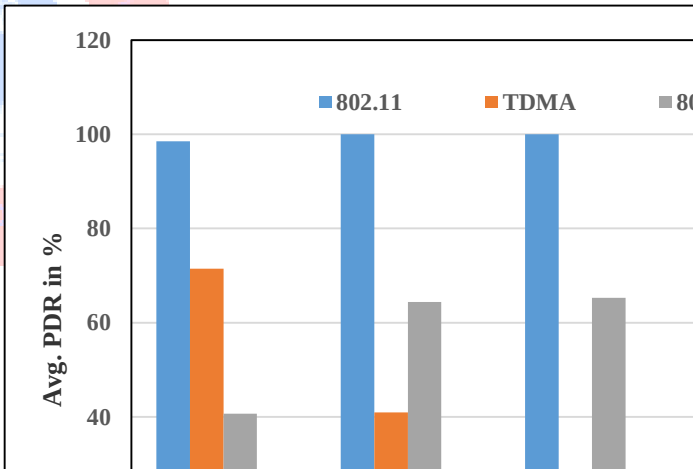

Figure 2. Average PDR for reporting rate

Figure 2 shows average packet delivery ratio which is drastically better for CSMA as compared to TDMA, S-Mac and 802.15.4 because CSMA is working with request to send and clear to send signals so congestion will be avoided. The performance of TDMA protocol decreases with increasing reporting rate. Performance of 802.15.4 is better as compare to TDMA. S-Mac gives very poor performance as compared to other three MAC protocols.

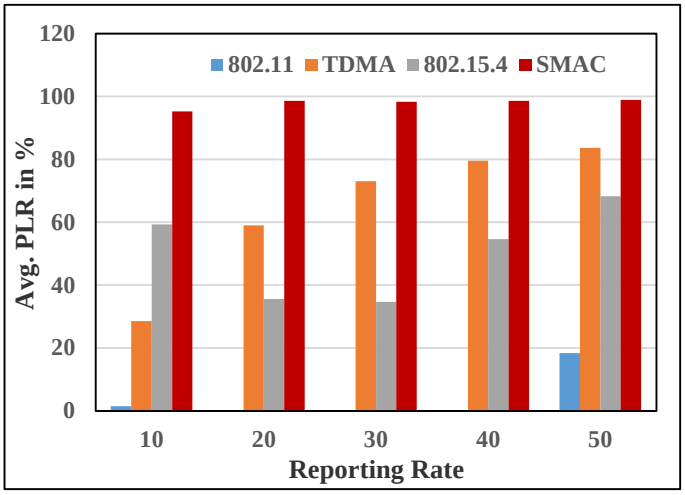

Figure 3. Average PLR for reporting rate

Figure 3 shows the packet loss ratio which is extremely high for S-MAC. TDMA has a direct proportion to the reporting rate that is packet loss increases as reporting rate is increased, hence performance is decreased. ZigBee shows a variation in PLR. The CSMA has less packet loss ratio hence has a higher performance.

IV. conclusion

In this paper, Wireless Sensor Network and its applications as well as their limitations are discussed. To minimize that limitations we have studied the different protocols like TORA, INSENS, AODV, DSR, DSDV, STEB, LEACH and variants of LEACH like LEACH-A, LEACH-B, LEACH-C, LEACH-E, LEACH-F, PV-LEACH, S-MAC, HEED, CAG, ESAODV and CASER. We have also studied various congestion control protocols like ARC, ESRT, and FUSION etc. Using the proposed algorithms in this paper researchers can able to achieve QoS like throughput, delay, energy consumption, delivery ratio, stability etc. This paper will be useful for researchers for achieving the QoS factors by gaining the knowledge of above protocols.

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