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QoS based Data Dissemination in Wireless Sensor Networks

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ABSTRACT: *In Wireless sensor networks, the network is formed with large number of sensor nodes. The sensor nodes send the data to the monitoring station or control entity. To send the data from sensor nodes, data dissemination protocols are used. So far, many data dissemination protocols are proposed in literature. Data dissemination with QoS provision is a challenging task due to dynamic topology, limited resources and processing power. This paper investigated the Quality of service provisioning of existed data disseminated protocols LEACH, EPMPAC, TEEN, SPEED, MMSPEED, in terms of Average energy consumption, End to end delay, throughput, and packet delivery ratio.*

KEYWORDS:

Wireless sensor networks, Routing protocols, Data Dissemination, QoS

I. INTRODUCTION

In present days, the technological advances in micro electro-mechanical systems, low power devices, integrated with digital, efficient processors, have created low power, low cost wireless devices. Due to rapid increase of utilization of the wireless devices, wireless sensor network has most significance. Designing a node in wireless networks is a big challenging task due to limited battery power. These sensor nodes are petite in size, low power, and diminutive transmission range. Operating system is used to process the sensed data from sensor nodes. These nodes gather the data by sensing the ambient conditions in its neighbor and send the data to the sink or base station along the route. With the exploitation of large scale network with multipurpose sensing capabilities of nodes serve several applications such as target detection for the military [1], defense, health monitoring, [2] [3]testing the soil moisture levels in agriculture [4], traffic monitoring [5], cyber security and so on. The sensed data should be disseminated to the sink through allocated route with energy efficient. In order to design a routing protocol one must consider power and resource restraints of the node, time varying quality of channel, packet loss and delay. In literature, the investigated [6] routing protocols in wireless sensor networks are classified as flat routing, structure based, Data-centric approach [8], and location based routing protocol [10]. A flat routing protocol distributes routing information to routers that are connected to each other including minimal overhead. Generally this flat routing [9] is limited for small scale networks. Structure based routing protocols (hierarchical) [7] imposes a configuration on the network to achieve energy efficiency, stability and scalability. In hierarchical routing protocols [11], nodes are structured in clusters in which a node with higher residual energy is elected as cluster head. The cluster head is coordinates in forwarding the information between senor nodes and base station, hence residual energy consumption is reduced and network lifetime is increased. Hierarchical protocols are extended to large scale networks. Data- centric routing protocols disseminates interest with in the network, the interest dissemination is done by query based. In location based routing protocols, addressing the node position within the geographical coverage. Query may be issued by the source node and specify the specific address where the interest occurs in the network environment.

The data dissemination routing protocols are classified in [12], based on type of structure, location information, networking layering, data centricity, network dynamics, data redundancy, network heterogeneity and quality of service requirements (QoS). Based on the above considerations the routing protocols are classified as Location aided protocols, layered and network processing protocols, Data-centric protocols,

Multipath based protocols, Mobility based protocols, Heterogeneity based protocols, and QoS based protocols.

In this paper chapter1 presents the introduction to QoS parameters of Wireless senor networks. Chapter 2 presents some of the QoS Based routing protocols. Chapter 3 and 4gives the performance evaluation of the routing protocols with simulation scenario. Chapter 5 concludes the paper.

II. QoS BASED PROTOCOLS

In recent years, Researchers are concentrated on support of QoS requirements in wireless sensor networks. However wireless sensor networks has constraints on power and resources, hence pose many challenges in the design of routing protocol. Due to the limited power at sensor node, routing must be energy efficient in order to increase the life time of node. In wireless sensor networks redundancy at the senor node is high, due to that the reliability and robustness of data dissemination is loosened and energy consumption increases.

In QoS routing protocols, generally QoS parameters [13] are considered as Energy consumption based, end to end delay, throughput, overhead, packet delivery ratio. To meet the above mentioned QoS Challenges, Layered and In-network processing protocols are designed. In this protocol, the formation of network is basically structure based or hierarchical based mentioned in chapter 1.

LEACH Protocol: LEACH is the first and most popular routing protocol that use cluster based routing in order to minimize energy consumption. LEACH performs the self organizing structure and re-clustering for every round, senor nodes are organizing themselves to form clusters. In this protocol, only cluster heads will communicate with base station, sensor nodes are communicated to their corresponding clusters. Hence by clustering, the energy consumption at node is reduced and node can survive in the network over a longer period of time, these increases the life time of network. In LEACH, cluster head selection is done by every round and each round generally has two phases namely setup phase and steady phase. In setup phase cluster formation and cluster head selection taking place. In the steady state phase, sensed data from sensor node is forwarded to base station through the cluster head. During the setup phase cluster head election is done based on the high residual energy of the node in the cluster. The Cluster head selection is performed by

$$T(n) = \begin{cases} \frac{p}{1-p\times\left[r \quad \left(\frac{1}{p}\right)\right]} & i\; n \in G \\ 0 & o\ he\imath \end{cases}$$

Cluster head advertises its election to sensor nodes. The sensor nodes receives advertisement from one or more cluster heads and joins into cluster head based on the received signal strength, after this steady phase takes place. In steady phase, cluster head schedules each sensor node within its cluster with TDMA scheduling, sensor nodes send their sensed data to cluster head in the scheduled slot. Cluster head aggregates the data gathered from sensor nodes and disseminates the data to base station. In order to send all the sensor nodes data to base station, the cluster head must spend most of its energy. This cluster head selection repeats to balance the energy consumption among the nodes.

EPMPAC PROTOCOL: Efficient power management protocol with adaptive clustering (EPMPAC) protocol is a cluster based protocol. This protocol elects the cluster head, its entire energy is adaptively distributed to local cluster members. This protocol uses paradigm of data fusion to reduce the amount of data packets from different sensors in the cluster to form a single packet and disseminated to base station. To develop EPMPAC protocol, all nodes have enough power to disseminate data to base station and supports MAC protocol. EPMPAC divide the network into non-over lapping clusters and elect an organizer and a cluster head for each cluster. The organizers are chosen in a random rotation fashion. These features enable EPMPAC to outperform LEACH and other classical clustering algorithms.

TEEN is a cluster based hierarchical routing protocol [17], which employs several levels where the closest nodes form cluster. This protocol is generally employed for large scale homogenous networks, all nodes deployed in the network has equal energy. The entire network is divided into clusters. The CH of cluster is communicated to base station as in LEACH. The Clusters are divided into sub clusters based on the threshold of node energies whichever has closest nodes. The sensors within a cluster queried their sensed information to their CH.

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The CH sends gathered information to next level CH until the information reaches to the base station. The selection of cluster head is called as round; each round is made up of an initialization phase, search phase and transmission phase. The cluster head is formed based on the thresholds namely Hard Threshold (HT): The absolute value of the attribute beyond which, the node sensing this value must switch on its transmitter and report it. Soft Threshold (ST): A change in the value of the sensed attribute which triggers the node to switch on its transmitter and report the sensed data. The attributes can also be changed during every cluster change time. Base station broadcast its interest to all the nodes with known CDMA codes. Each node in the cluster is allocating a transmission slot using TDMA schedule to transmit data to its CH.TEEN is constructive for applications where the users can organize a trade-off between data accuracy, energy efficiency, and response time dynamically. TEEN [18] uses a data-centric method with hierarchical approach; it employs LEACH's strategy to form clusters. This protocol gives energy efficient but end to end delay increased due to multiple levels. There is no mechanism to distinguish a node which does not sense a big change from a dead or failed node.

SPEED Protocol: This protocol is designed to support for real-time applications with geographic location support. The end to end delay is decreased by maintaining the required dissemination speed across the network. Each node maintains one hop neighbor data and utilizes geographic location information to route the data. This protocol is stateless because it does not employ any routing tables at node. So memory consumption at node is also less. To select next hop neighbor, it uses Stateless Non-Deterministic Geographic Forwarding (SNGF). In order to achieve required dissemination speed across the sensor networks, four different modules are used along with SNGF. To know the neighbor geographic location information, neighbor beacon modules are exchanged between nodes. The delay at node can be estimated by delay estimation module and it is used to calculate the possibility of congestion and helps in SNGF to achieve the node speed requirements. The node's relay ratio is used to check whether the node meets the network speed requirements. Neighborhood Feedback Loop (NFL) module provides the relay ratio. The Relay Ratio is used to decide whether the packet is to be dropped or relayed. If the relay ratio is less than one or zero then the packet is dropped. If a node does not find any route, it use backup pressure module to find new route. This SPEED protocols performs efficiently in terms of end-end delay ratio. SPEED protocol is does not employ any packet differentiation mechanism, not scalable, as it preserve a required speed for each packet and if the parameter is changed then protocol performance degrades.

MMSPEED Protocol: The MMSPEED (Multi-Path and Multi-SPEED Routing) protocol [23] is an enhancement of the SPEED protocol. Differentiated QoS is used to support for real time applications. In order to forward the incoming data packets without any delay, multiple speeds are used. This protocol prioritizes the packets into queue according to MAC layer support. The packets with highest priority are processed first. Hence this protocol is scalable and adaptable to large scale networks. The major limitation of this protocol is it does not consider energy levels at node.

III. SIMULATION SCENARIO

This chapter shows the simulation scenario. We set up the evaluation environment using ns2.34 by 1000*1000m sensor field and deployed 60 nodes randomly.

Table.1 Simulation Environment

Simulation Parameter	Value
Simulator	NS2.34
Topology Size	1000*1000m
Number of nodes	10,20,30,40,50,60
Data Rate	512kbps
Traffic type	CBR
Initial energy	50J
Simulation Time	100sec
Placement Model	Random

IV. RESULTS

In this section, we analyze QoS parameters Average energy consumption, end to end delay, throughput, packet delivery ratio. From the fig.1 shows that

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average energy consumption is very high in SPEED, and it is medium in LEACH and TEEN. In MMSPEED will get less energy consumption than EPMPAC.

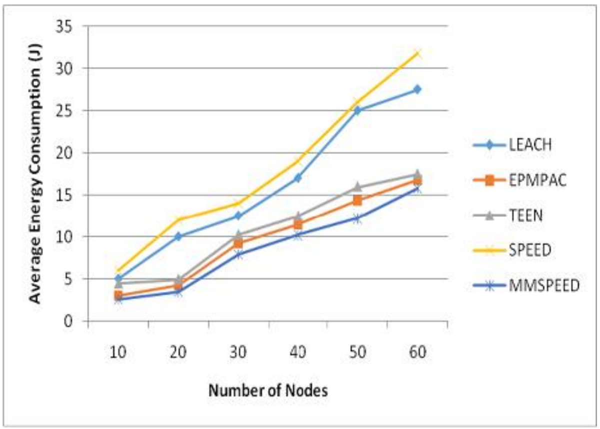

Fig. 1 Average Energy Consumption

Another QoS parameter is End to End delay within the network has shown in fig. 2

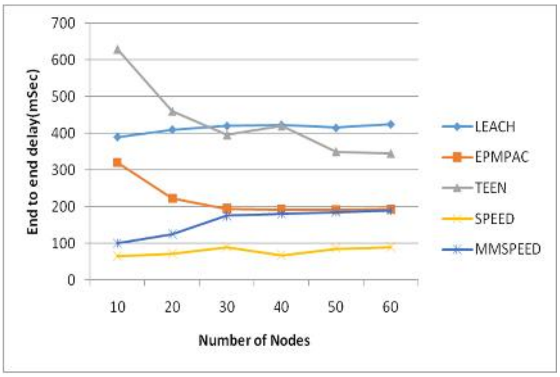

Fig. 2 End to End delay

End to End delay is very less in SPEED, moderate in EPMPAC and LEACH. In TEEN end to end delay is very high.

In fig.3 shows that throughput of the network. In TEEN throughput is compared with LEACH.

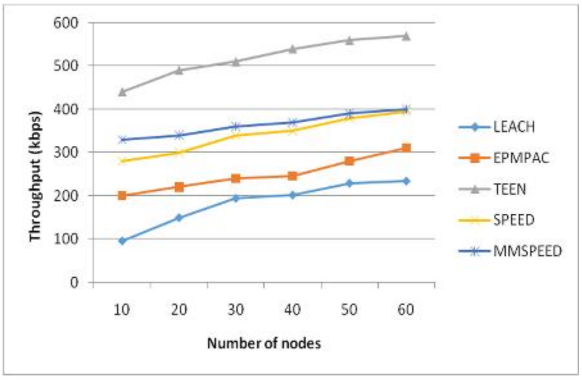

Fig. 3 Throughput calculation

Finally the packet delivery ratio simulations show in fig. 4.

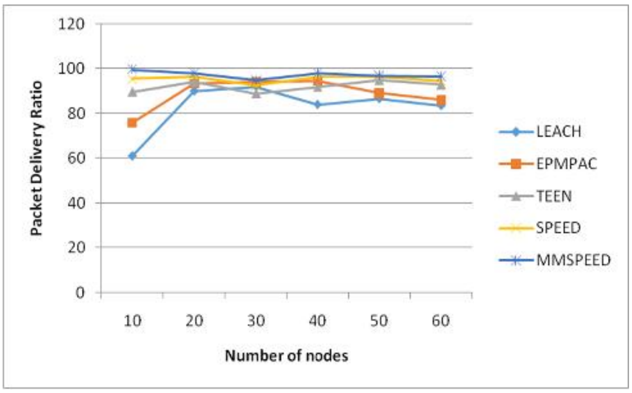

Fig. 4 Packet Delivery Ratio

PDR is very high in MMSPEED than SPEED, and very less in other protocols LEACH.

V. CONCLUSION

In this paper, we focused on QoS based data dissemination protocols in wireless sensor networks. We present an extensive simulation to compare various protocols: LEACH, EPMPAC, TEEN, SPEED and MMSPEED. Our simulation results show the QoS requirement comparison among the above protocols in terms of End to End delay, throughput, Average Energy consumption and packet delivery ratio.

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