Dynamic Clustering Based on MAC Protocol for Power and Delay Aware Node Selection

G Lakshmi Vara Prasad, C. Nalini

ABSTRACT--- Power and delay is a significant and essential issue, which in routing protocols for Wireless Sensor Networks (WSNs). Sensor nodes are broadcast in particular areas of the environment to identify events and establish WSN. These sensor nodes encompass limitations such as power, memory and computational capability. Since medium Access Control sub layer controls transmissions of the media and collisions, it has significant impact in reducing energy consumption and increasing the channel's efficiency. Therefore, the medium Access Control sub-layer plays an important task in WSN. By allocating channel duty, media access control sub-layer can reduce collisions; these measures can reduce energy utilization and enlarge the productivity of the channel. In this proposed paper, an improved medium access control protocol is proposed based on clustering technique. Using a multi-layered approach, this technique is intended to reduce competition and traffic in the network. The proposed algorithm consists of two steps including clustering and data transferring of each cluster. The proposed approach can significantly reduce collision, sleep-delay and idle listening. Computer simulation approach is used to evaluate the proposed algorithm. The results of simulation shows the proposed protocol is more efficient than the other existing protocols like MLMAC in terms of the following features: number of successfully sent packets, number of collision, energy consumption and sleep delay.

Keywords— Collision, Average end-end delay, Medium Access Control, Wireless Sensor Network.

1. INTRODUCTION

Wireless Sensor Networks (WSNs) are an ensemble of Micro-sensor nodes that have economical processing, storing capability and radio technologies. In comparison with macro-sensors micro sensor nodes are less effective but they still produce fail-safe and extremely good sensor networks by using thousands of sensors within a network area. By this we convey that the computation of detecting and observing can analyze the present circumstances of the environment around the sensing device and convert it to a signal and message. The way by which the packet should pass through the sensing device to reach the base station is resolved by a scheme called routing protocol. This scheme is responsible for concurrently controlling and optimizing the power consumed by the WSNs.

In compact WSN system, sensing devices are set up in a packed manner without any predefined structure.

From a network configuration outlook the proposed protocol is hierarchically clustered. Each cluster contains one Cluster Head (CH) and two Deputy Cluster Head (DCH) .The time to re-form the cluster and the power requirements are optimized by the notion of a CH panel. The CH panel is formed by the base station (BS) through the process of choosing a set of plausible CH nodes. The data transmission from the CH to BS is performed by inter-cluster routing using alternate paths. WSN routing is a challenging task and quite a few results have been reported so far regarding this issue. Routing has also been studied with respect to specific system model of such wireless sensor network systems [19][20]. WSNs are sternly inhibited in terms of resource, and the topology of such networks remains highly dynamic. For the successful and efficient deployment as well as operation of the wireless sensor network, the protocols and various algorithms are to be application specific. That is why, with new and sophisticated applications of WSN emerging every day, there is a demand for design of novel protocols and algorithms to handle such applications. The availability of limited energy with the sensor nodes is a significant constraint. Therefore, a design objective related to energy is, design of simple and yet efficient algorithms and protocols which are energy efficient [16]. Energy efficient routing in a typical WSN with static sensor nodes implemented arbitrarily over a geographic province, it has been up till now an energetic area of research. And when mobility is introduced to the sensor nodes the trouble of routing becomes even more complex.

2. RELATED WORK

In this section, some recently proposed algorithms are described and reviewed. As a case in point, S-MAC protocol is one of common active-period protocols. It is used in several ways for reducing energy consumption, overhead and controlling delay. Also, it is used for periodic listening in which listening and sleeping durations are fixed. In this protocol, sensor nodes which are standing by to send out data wait until the active time starts. Due to periodic sleeping, delay will increase; therefore, adaptive listening is used in this protocol for resolving this problem. Furthermore, this protocol is used in message passing form for a better overhead reduction. Nodes freely determine their own listening and sleeping duration. Each node exchanges its schedule with those of neighboring nodes in the synchronization time. The main problems of S-MAC protocol are delay and fixed-duration listening [1-5]. T-MAC or Time-out MAC is based on the S-MAC protocol. This protocol introduces an adaptive listening/sleeping period and variable active-period to minimize idle listening

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and improve energy efficiency. In this protocol, a sensor will sleep if no activation event occurs for a while. Thus, reduction of idle listening and adaptation to traffic fluctuations are advantages of this protocol. Nevertheless, this protocol has a drawback called early-sleeping; Future request-to-send and take priority on full buffer are regarded as the solutions proposed by T-MAC protocol for these problems [10-13]. ML-MAC protocol is one of common active-period protocols. After the distribution of network nodes, each node randomly selects the layer. Nodes publish their schedule and store their neighbor schedules in their own timetables. Time is divided into several frames and each frame has listening and sleeping periods. Listening period is known as the duration of activity and is divided into L layer without overlapping. Short activity duration makes nodes spend more time in the sleeping period; therefore, this is regarded as a disadvantage for this protocol. Multilayered active period and shorter duty cycle are solutions for reducing energy consumption and network traffic and increasing network lifetime as well [14-17].

3. PROPOSED METHOD

In this paper, a power and delay aware relay-node selection algorithm is proposed for cluster based MWSN. Initially, the transmitted data packets are assigned priorities as follows: For collected data of its own, the priority is 1. For collected packets from other nodes, the priority is 2.

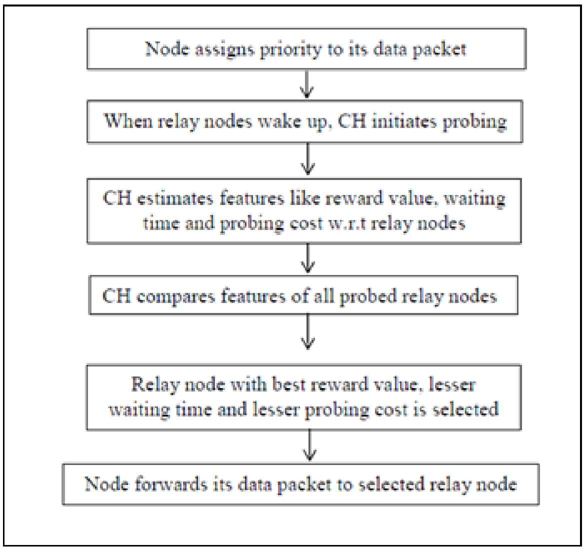

Figure 1 Block Diagram of Proposed Technique

When any relay turns on, the CH can choose between advancing the packet to the opted relay or wait for other relays to turn on based upon the reward value. The main scheme in choosing a relay is to optimize the collective cost of waiting-delay, reward and cost of examining the relays [10].The reward is calculated based on the combined parameters of channel gain [10] and Relative Energy Usage (REU) [11]. The CH finally chooses the relay with best reward and least waiting time with minimized probing cost and forwards the data packet through this selected relay node

4. POWER AND DELAY AWARE RELAY NODE SELECTION

When a node needs to forward a data packet, it selects a suitable relay node along the transmission path. This relay node assortment is based on the power consumed and delay involved in its processing. Each cluster head selects based on the relay node by estimating the reward value, waiting time and probing cost. The reward value is dependent on the REU and channel gain [11]. The convey node with best characteristics is selected for forwarding the data packet.

5. EXPERIMENTAL RESULT ANALYSIS

5.1 Simulation parameters

The proposed MAEES-MAC protocol is implemented in NS2. The various parameters used in the simulation are listed in Table 1.

Parameters	
Speed of the mobile nodes	5,10,15,20 and 25 m/s 2, 4, 6, 8 and 10 m/s
Propagation model	Two Ray Ground
Antenna model	Omni Antenna
Number of nodes in the network	100
MAC Protocol	IEEE 802.11
Type of Traffic	Constant Bit Rate
Initial energy	7 Joules
Transmission power	0.660 watts
Receiving power	0.395 watts

Table 1 Parameters used in the simulation

5.2 Performance metrics

The following parameters are considered for performance evaluation: Average packet delivery ratio (PDR), average end-to-end delay (EED), packet drop (PD), average energy consumption (EC) and average residual energy (RE).

5.3 FDCDC-MADSEC protocol

The mobile speed is varying from 5 to 25 m/s and the results are given for two scenarios.

Results for Scenario-1

The simulation topology for scenario-1 is shown in Figure 2

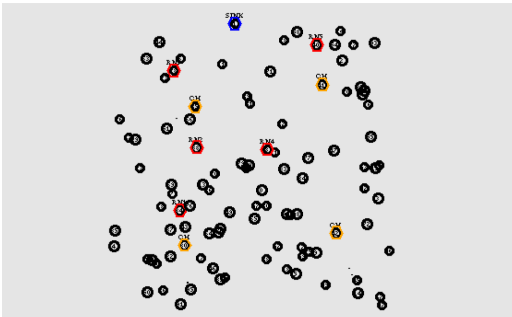

Figure 2 Simulation Topology

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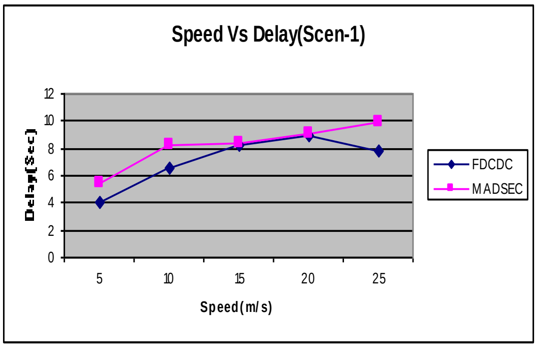

Fig 3: EED for varying speed (Scen-1)

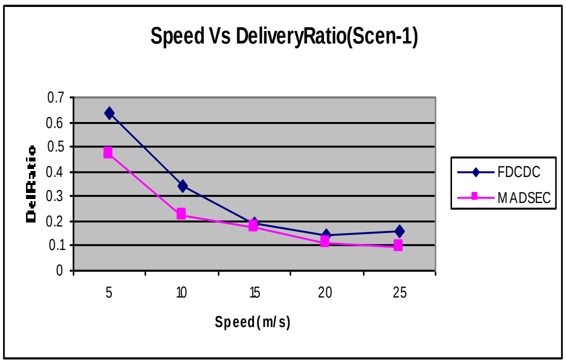

Fig 4: PDR for varying speed (Scen-1)

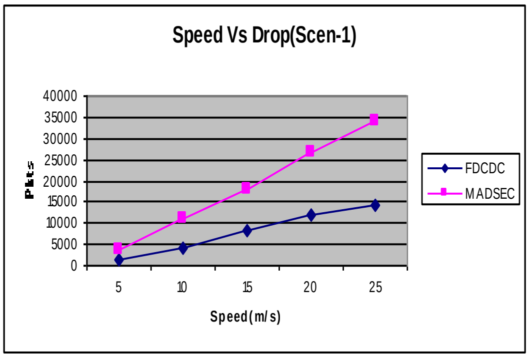

Fig 5: PD for varying speed (Scen-1)

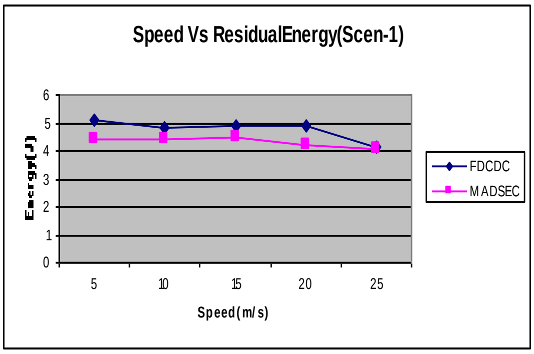

Fig 6: RE for varying speed (Scen-1)

Figs. 3 to 6 show the results of FDCDC and MADSEC protocols in terms of EED, PDR, PD and RE for scenario-1. It can be observed that FDCDC has by 14% lesser EED, 27% higher PDR, 58% lesser PD and 9% higher RE, when compared to MADSEC.

Results for Scenario-2

The simulation topology for scenario-1 is shown in Figure 7

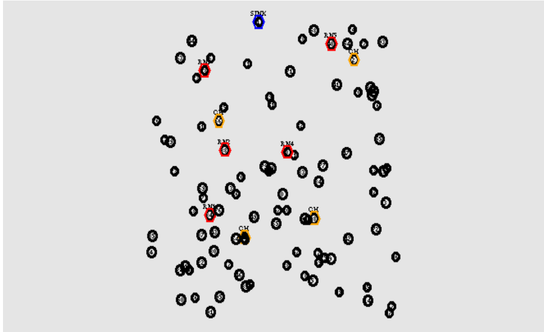

Fig 7: Simulation Topology

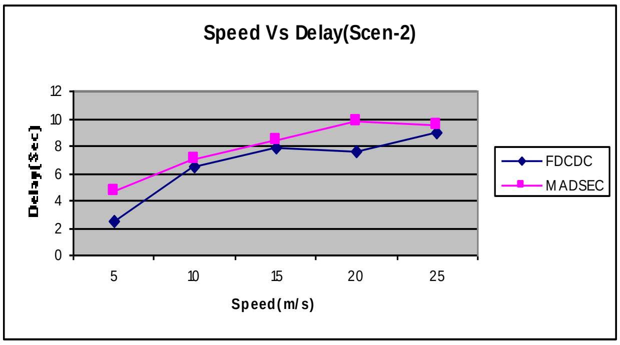

Fig 8: EED for varying speed (Scen-2)

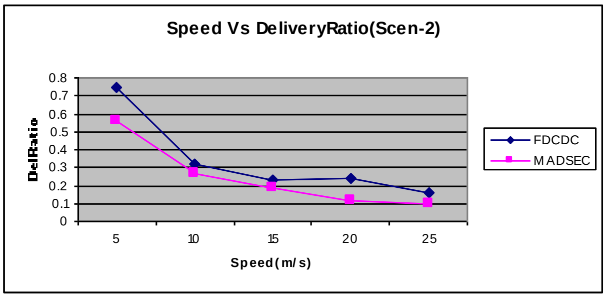

Fig 9: PDR for varying speed (Scen-2)

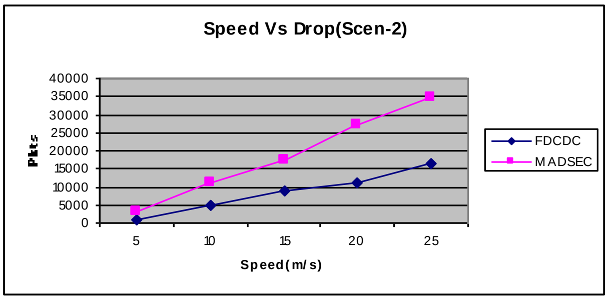

Fig 10: PD for varying speed (Scen-1)

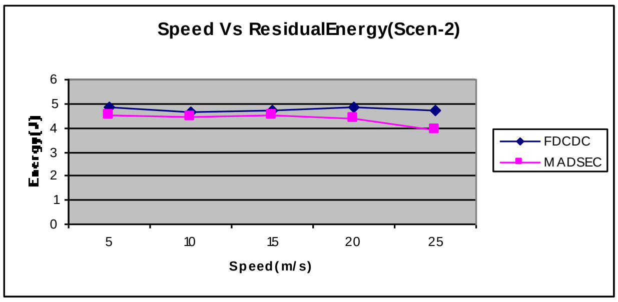

Fig 11: RE for varying speed (Scen-1)

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Figs. 8 to 11 show the results of FDCDC and MADSEC protocols in terms of EED, PDR, PD and RE for scenario-2. It can be observed that FDCDC has by 18% lesser EED, 31% higher PDR, 59% lesser PD and 8% higher RE, when compared to MADSEC.

In this technique, each mobile node chooses the nearest static sensor node as its reference cluster. Then each static sensor node selects the one of the mobile sensor node as cluster head based using Fuzzy logic. This fuzzy logic to select cluster head based on the speed, residual energy, quality of link and quality of received signal. The position of the mobile sensor nodes are then updated using weighted Average Minimum Reachable Power. The mobile cluster head schedules the inter-cluster data aggregation by dividing each round of data collection into TDMA frames. Above result shows, that the proposed technique minimizes intrusion and energy consumption.

5.4 PDRNS and Probing techniques Result analysis

The results of PDRNS and Probing techniques are given in this section for the mobile speed between 5 to 25 m/s.

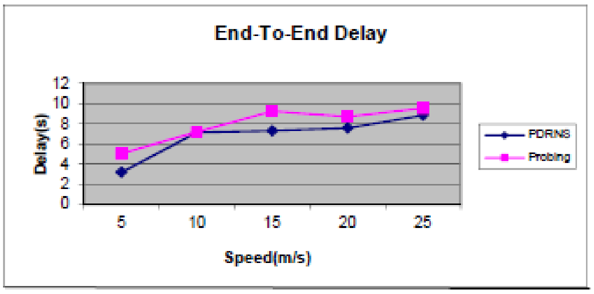

Fig 12: EED for varying speed

Figure 12 shows EED for PDRNS and Probing techniques when the mobile speed is varied. The figure shows that the EED of PDRNS increase from 3.17 to 8.84 seconds and the EED of Probing increases from 5.03 to 9.54 seconds. It can be summarized that PDRNS has 16% lesser EED than the probing technique.

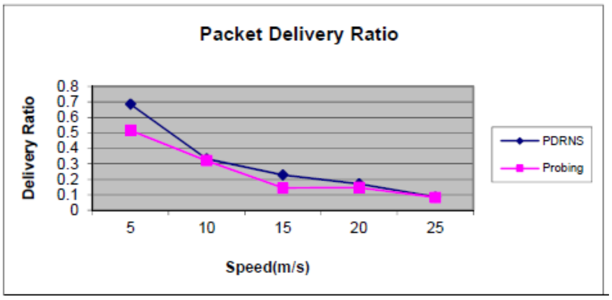

Fig 13: PDR for varying speed

Figure 13 shows PDR for PDRNS and Probing techniques when the mobile speed is varied. The figure shows that PDR of PDRNS reduces from 0.68 to 0.08 and PDR of Probing reduces from 0.51 to 0.08. It can be summarized that PDRNS has 17% higher PDR than the Probing technique.

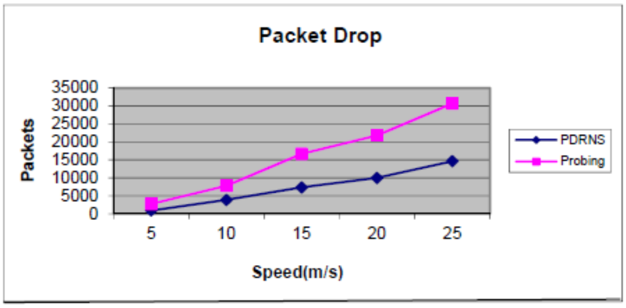

Fig 14: PD for varying speed

Figure 14 shows PD for PDRNS and Probing techniques when the mobile speed is varied. The figure shows that PD of PDRNS increases from 903 to 14614 and PD f Probing increases from 2731 to 30632. Consequently PDRNS has 56% lesser PD than the Probing technique.

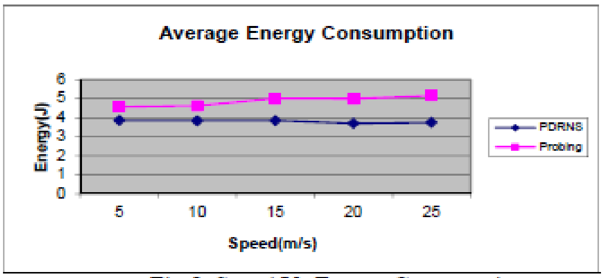

Fig 15: EC for varying speed

Figure 15 shows the EC for PDRNS and Probing techniques when the mobile speed is varied. The figure shows that EC of PDRNS increases from 3.85 to 4.74 joules and EC of Probing increases from 4.56 to 4.95 joules. Hence PDRNS has 12% lesser EC than the Probing technique.

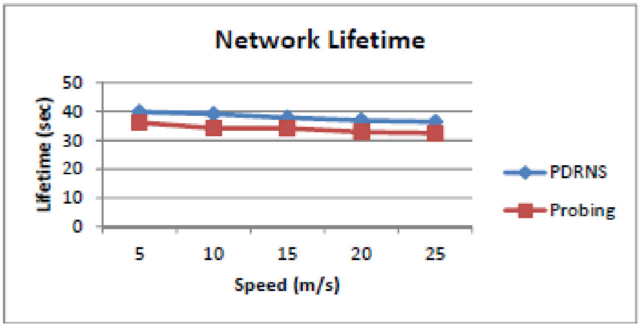

Fig 16 Speed Vs Network Lifetime

Fig. 16 shows the network lifetime for both the techniques when the mobile speed is varied. The figure shows that the lifetime of PDRNS decreases from 39.8 to 36.4 seconds and the lifetime of Probing decreases from 36.1 to 32.5 seconds. However PDRNS has 10% higher lifetime than the Probing technique.

5.5 MAEES-MAC /MoX-MAC protocol Result analysis

In this section, the comparison results of MAEES-MAC and MoX-MAC protocols are presented.

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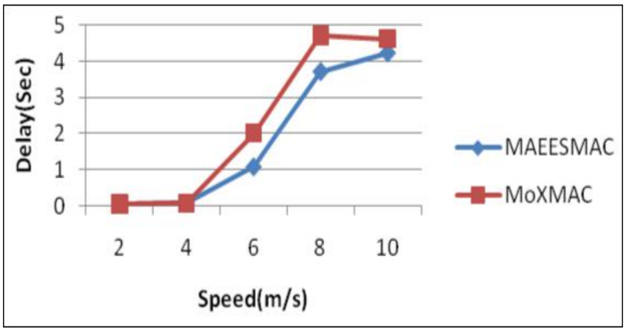

Fig 17 EED for varying speed

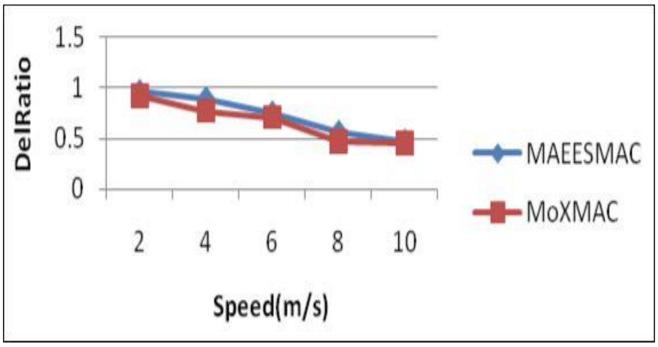

Fig 18 PDR for varying speed

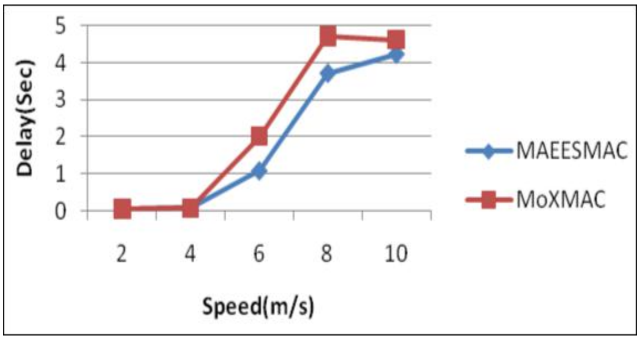

Fig 19 PD for varying speed

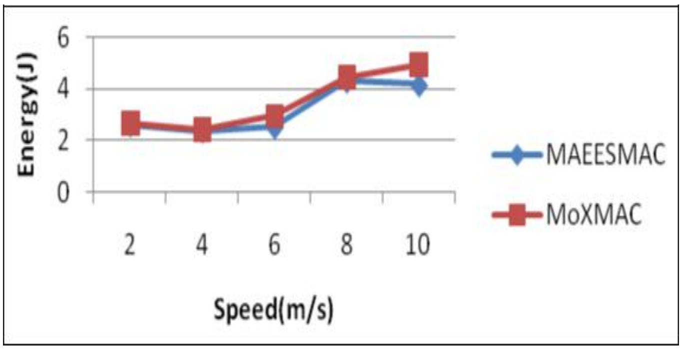

Fig 20 EC for varying speed

Figures 17 to 20 show results of EED, PDR, PD and EC for MAEES-MAC and MoX-MAC protocols by varying the speed from 2 to 10 m/s. It can be observed that MAEES-MAC outperforms MoX-MAC by 15% in terms of EED, 8% in terms of PDR, 23% in terms of PD and 8% in terms of EC.

Table 2: Performance comparison between MAEES-MAC, FDCDC and PDRNS

Technique	Speed	delay	Packet drop	Packet Delivery ratio	Residual Energy
FDCDC and MADSEC	5	4.100969	1409	0.636791	5.078022
	10	6.534524	4240	0.34202	4.848209
	15	8.177712	8167	0.194546	4.862961
	20	8.959877	12042	0.141531	4.902694
	25	7.841847	14054	0.159053	4.105865
PDRNS and Probing techniques	5	3.174548	903	0.685446	3.855648
	10	7.136148	3860	0.333002	3.83796
	15	7.293476	7328	0.228323	3.849918
	20	7.563669	9946	0.171507	3.699751
	25	8.843214	14614	0.086459	3.74857
MAEES-MAC	5	0.236896	401	0.8192	2.501256
	10	4.230316	2965	0.474454	4.144537
	15	5.621754	5355	0.337053	3.340437
	20	6.020971	7759	0.254007	3.302116
	25	6.27501	10335	0.206145	3.460971

To begin with, in MAEES-MAC, the record of the link status is maintained .The MoX-MAC nodes send their data to non stationary nodes, using which the link quality issue is taken care of. If the link quality is bad then MoX-MAC will let go of the packet. Subsequently to optimize the energy consumption the nodes go into a intermittent sleep-awake duty phase. When the energy consumed is lower than the cut-off value TE and the Link quality is higher that the cut-off value TL then the duty phase of the node is doubled. Correspondingly the duty phase will be halved if the energy utilized is higher than the cut-off value TE and the Link quality is lower that the cut-off value TL.

In this paper, we have depicted a MAEES-MAC and in subsequent works we intend to put forward a neural network-based expert system for anticipating the mobility and thus improve the competency dependability of the system.

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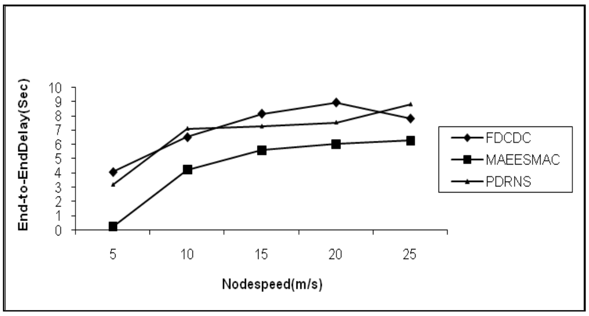

Fig 25 Speed vs. delay

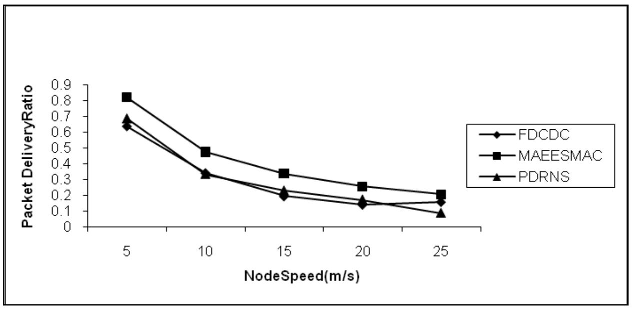

Fig 26 Speed vs. Packet Delivery Ratio

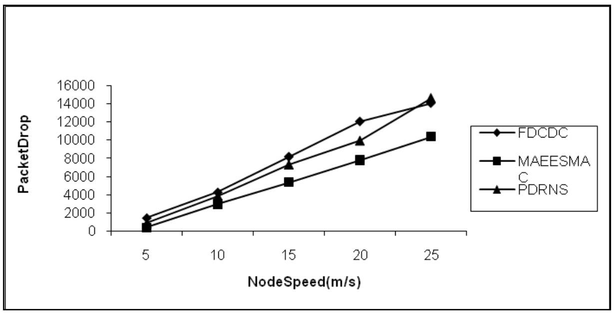

Fig 27 Speed vs. Packet Drop

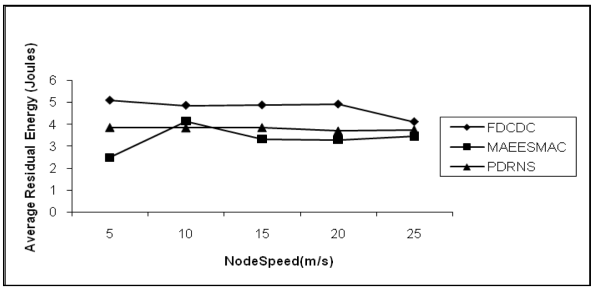

Fig 28 Speed vs. Average Residual Energy

Figures 25 to 28 show the comparison results of packet drop, delay, delivery ratio, and energy consumption by varying the speed from 5 to 25 m/s for the CBR traffic in MAEES-MAC , FDCDC and PDRNS protocols. When comparing the performance of the three protocols, we surmise that MAEES-MAC outperforms FDCDC and PDRNS by 11% in terms of delay, 6% in terms of delivery ratio, 31% in terms of packet drop and 2% in terms of energy consumption.

6. CONCLUSION

In the Wireless Sensor Networks (WSNs) to find the solution for significant and crucial issue, such as Power and Delay. We have proposed a power and delay aware Relay Node Selection Algorithm for Cluster based Mobile Wireless Sensor Networks. In the cluster, when a node needs to forward a data packet to the destination, then it initially prioritizes it. Then the cluster head monitors all the relay nodes. When a relay node wakes up from the sleep-wake cycle, the cluster head initiates the probing process. During probing, through the response received from the probed relay node, the cluster head determines the reward value, waiting time and probing cost with respect to the relay node. In this way, the cluster head estimates the reward value, waiting time and probing cost with deference to the relay nodes adjoining the node, which needs to forward the data packet. Then the cluster head compares the features of all the probes relay nodes. The relay node with best reward value, minimum waiting time and minimum probing cost is selected by the cluster head. The node then forwards its data packet through this relay node towards the destination.

The proposed approach can significantly reduce collision, sleep-delay and idle listening. The results of simulation show that the performance among three proposed protocol MAEES-MAC is more efficient than other protocols such as FDCDC and PDRNS in terms of the following features: number of successfully sent packets, number of collision, energy consumption and sleep delay.

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