Energy Efficient Routing Scheme for Wireless Sensor Network with CDMA Nodes

Santhana Krishnan. B and Ramaswamy. M

Abstract — The paper attempts to evolve a routing scheme with a view to improve the utilization capacity and enhance the life time of the Wireless Sensor Network (WSN). The focus charters to design a Cluster based Ad-hoc on Demand Distance Vector (CAODV) algorithm to facilitate the transfer of information in a composite network with both Code Division Multiple Access (CDMA) and non-CDMA nodes. It avails the use of a high energy node to commensurate the process and ensure a smooth flow of traffic among a host of CDMA source and destination nodes. It inscribes to be-hive the merits of CDMA nodes in enhancing the rate of data transfer and create a congenial environment for large scale transmission. The approach orients to acquire the best performance in terms of metrics with minimum expenditure of energy to foster an energy efficient routing mechanism. The Network Simulator (NS2) based simulation results obtained over specific time frames reveal the applicability of the proposed strategy in the present day context.

Index Terms — CAODV, CDMA Node, Energy Efficiency, Network Life Time, NS2, Routing, Wireless Sensor Network

1 INTRODUCTION

Wireless Sensor Networks (WSNs) consist of a large number of distributed nodes that organize themselves into a multi-hop wireless network. Each node includes a sensor, embedded processors and low-power radio to gather and communicate data to a base station. The limited energy resources espouse a need to carefully manage and extend the lifetime of sensors. The deployment stations extend over the military environment in the service of target tracking, surveillance and security management [1]. Their range of application extends to weather monitoring, earthquake detection and patient monitoring systems among others.

Despite the advancements in hardware and software technologies, one of the most relevant constraints that embody the design of WSN centers on increasing the energy efficiency. The sensors usually powered by small batteries experience a difficulty in being replaced and consequently can only transmit a finite number of bits in their lifetime. The focus reflects to reduce the energy consumption per bit for end-to-end transmission and reopens a paradigm shift in the design consideration for such networks [2].

Code Division Multiple Access (CDMA) may be an attractive technique in view of its simplicity in design and flexibility in traffic handling capabilities in the network to offer a variety of integrated services[3].

The scheme with CDMA nodes invites a greater attention for multiple access technique in wireless communication systems in terms of frequency diversity, resolution of multipath components, and universal frequency reuses [4 - 5].

The use of cluster based approaches appears to invite greater focus in recent times in light of its flexibility and capability to adapt in the realms of the changing technology. The Adaptive Cluster Based Routing Protocol (ACBRP) evolves a transfer procedure from a combination of excess multiple routing protocols and the addition of new features that extend to improve the routing performance [6]. The improvements eschew with a change of cluster head mechanism, route discovery processes and route maintenance steps. It characterizes a self configurable nature with an ability to adapt with dynamic topology and maintain connectivity within nodes in the network. However the need for energy efficient patterns along with higher throughputs foresee still better cluster based avenues to realize reliable transfer of data in the WSN.

A new protocol that focuses on fairness of energy consumption and reduction of flooding overhead has been proposed to increase the network lifetime [7]. An energy efficient adaptive multipath routing technique which utilizes multiple paths between source and the sink has been outlined. It has been found to provide a reliable transmission environment with low energy consumption, by efficiently utilizing the available energy [8]. A novel braided multipath scheme which results in several partially disjoint multipath schemes has been found to provide a viable alternative for energy-efficient recovery from isolated and patterned failures [9]. A split multipath routing scheme has been introduced to

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improve the reliability of a data transfer in WSN by keeping the traffic at low level [10].

The problem of routing the sense information in the WSN has been formulated as path based energy minimization problem subject to Quality of Service (QoS) routing constraint [11]. The simulation result of an on demand approach to a generalized topology has been found to reduce the probability of communication disruptive and data loss during link failure [12]. A QoS aware multipath routing algorithm suitable for WSN has been suggested to increase a network life time [13]. A cooperative multipath routing algorithm has been developed for forwarding data in WSN and the scheme found to ensure reliable packet transfer [14]. The energy level performance of CDMA WSN has been evaluated using error control strategy and the analytical results verified through simulation. It is in this perspective that the present scenario envisages multipath routing in WSNs to reduce frequent routing update and enhance data transmission rates [15, 16].

Though single path routing algorithms interleave the advantages of a simple design, lower energy consumption and minimum delay, the ever growing traffic and liable occurrence of contingencies enforce a need to explore still better options for effective transfer of data through a WSN.

2 SYSTEM MODEL

The sensor network comprises of both Non CDMA and CDMA nodes two hundred in number deployed randomly over a finite region. The information collected by multiple sensors requires to be transmitted from a remote source to a known destination through a hub or central node. If the hub node is far away, the information may first be transmitted to a relay node and follow a Multi hop routing to forward the data to its final destination. The presence of multiple nodes pictured in Fig.1 necessitates a well defined mechanism to transmit the collected information to their destination through the hub node.

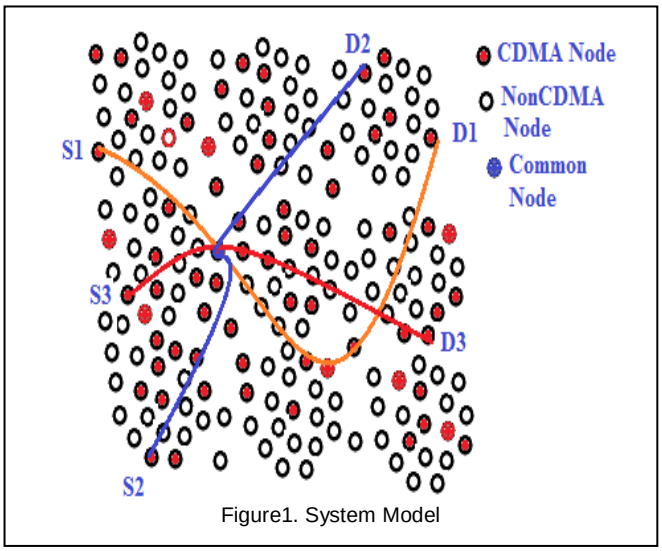

Figure1. System Model

3 PROBLEM DESCRIPTION

The objective orients to develop an energy efficient routing procedure suitable for a WSN with both CDMA and non CDMA nodes laid to reduce the energy consumption and increase the network life time. It involves the use of a Cluster based Ad-hoc on Demand Distance Vector routing (CAODV) technique [17] in its perspective to transfer the data packets between the defined source and destination CDMA nodes. The mechanism charters to route the packets through three paths from their respective end users through the high energy common node. The methodology compares the performance metrics obtained through Network Simulator (NS2) simulation with two other routing patterns and a cluster based approach to exhibit its suitability for the present day scenario.

4 PROPOSED APPROACH

The primary philosophy revolves to formulate a cluster based mechanism to transfer data within the sensor network. The scheme uses an on-demand approach for finding routes in the sense it establishes a route only when it is required by a source node for transmitting data packets. It echoes the generation of destination sequence numbers to identify the most recent path. When an intermediate node receives a route request, it either forwards it or sends a route reply, if it can provide a valid route to the destination. The comparison of the sequence number at the intermediate node with the destination sequence number in the route request packet determines the validity of a route at the intermediate node. All the intermediate nodes that can offer valid routes endear to transmit the route reply packets to the source.

When a node receives a reply packet, it stores the information about the previous node in order to forward the data packet to this next node as the next hop toward the destination. The source and the intermediate nodes store the next-hop information corresponding to each flow and the source node floods the route request packet in the network when a route is not available for the desired destination. The node updates its path information only if the destination sequence number of the current packet received exceeds than that stored at the node.

The design of the methodology endeavors to arrange a packet to travel from the identified source to the desired destination in such a way that it uses the non randomness in the Cluster Head (CH) selection and attires to reduce the redundancy in data transfer, besides serving to increase the speed, efficiency and throughput of data transfer. The determination of the route follows an expanding ring search to discover new routes to an unknown destination and serves to search increasingly large neighborhoods to find the destination.

5 SIMULATION RESULTS

The scheme evaluates the performance of the proposed routing algorithm in a network distributed across a space 1000 m X 1000 m as seen in Fig.2. The methodology assumes that energy dissipation does not occur when the nodes are idle or in carrier sensing operations and allows the election of the node with a higher battery energy level as the CH to serve as a hub for transferring data from three different sources to three preferred destinations. The Figs. 3 to 8 drawn for the same network with CDMA source and destination nodes display the NS2 graphs obtained over a range of two hundred seconds for the various metrics in the event of packet transfer of data size 3000 Kbps.

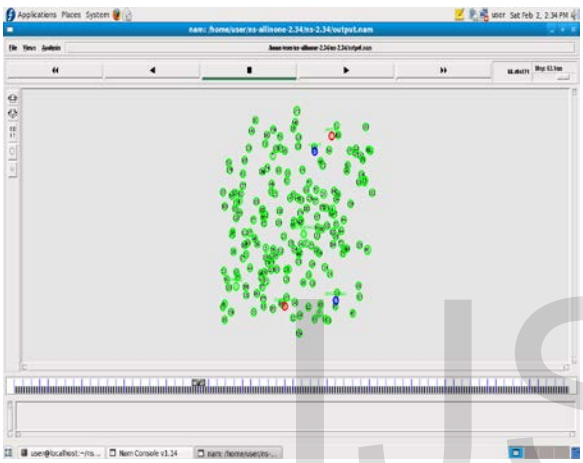

Figure2. Network Model

The graph drawn in Fig.3 for CAODV along with three related routing schemes (AODV, Imp.-AODV and ACBRP) correlates a higher average number of packets received with respect to time with the maximum number of packets transferred for the network with CDMA nodes. The Fig.4 reflects the benefits of CAODV for the CDMA end users in terms of minimum loss of packets to pave the way for an increase in the network efficiency. The average throughput plotted in Fig.5 exhibits the fact that CAODV offers the highest output, contributing to an increase in efficiency over other protocols for the chosen network with CDMA source and destination entities.

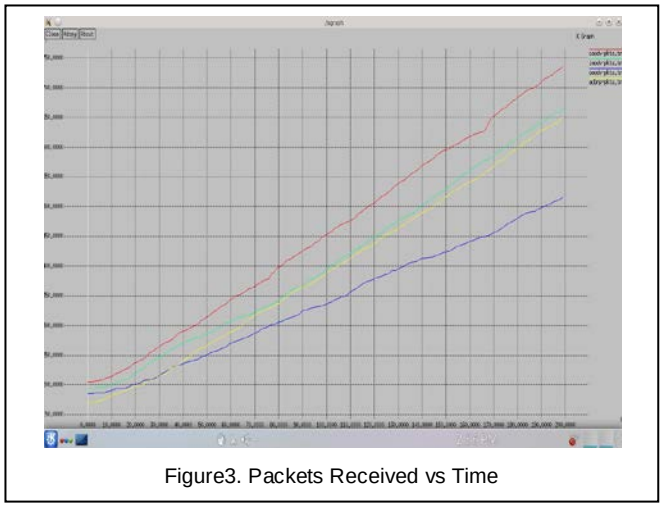

Figure3. Packets Received vs Time

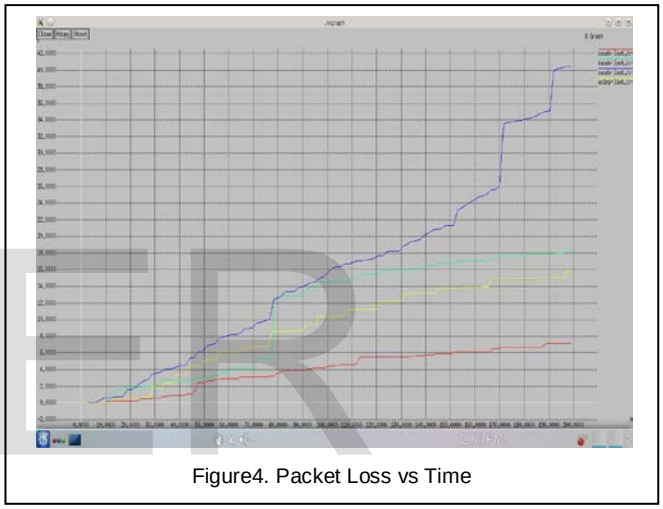

Figure4. Packet Loss vs Time

The transfer of data through CAODV experiences the least energy consumption as observed from Fig.6 and facilitates to increase the network lifetime. The CAODV facilitates data transmission with minimum delay as observed from Fig.7 compared with other protocols, giving rise to the overall improvement in the performance of the network.

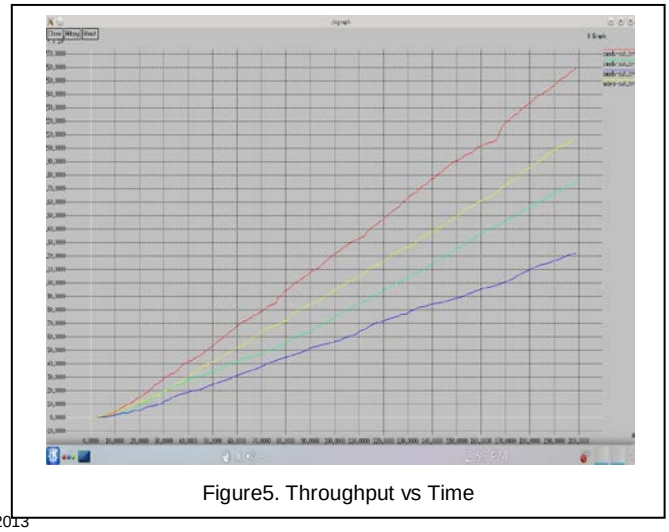

Figure5. Throughput vs Time

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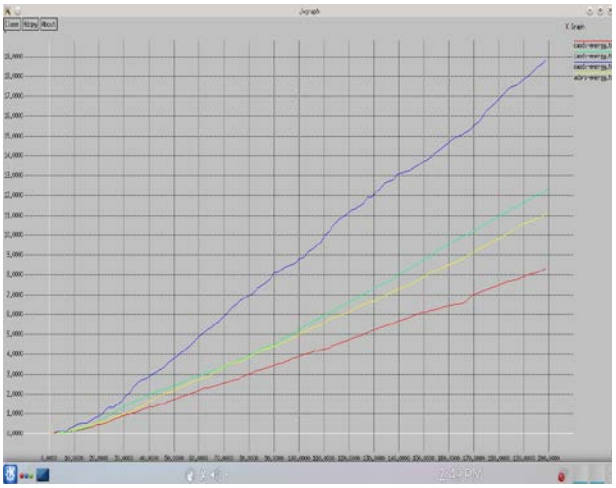

Figure6. Energy Consumed vs Time

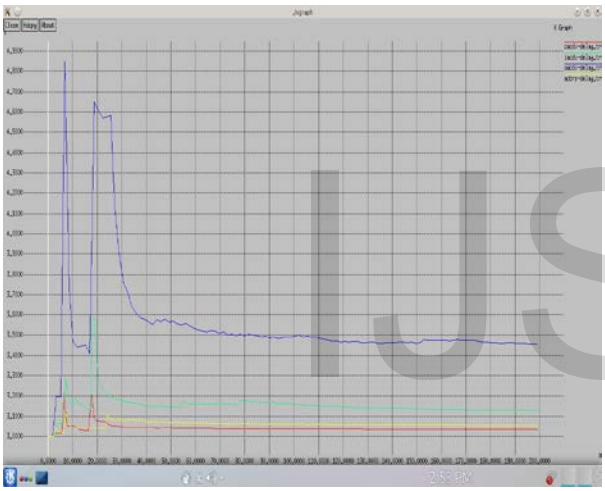

Figure7. Routing Delay vs Time

The results displayed in bar charts through Figs.8 and14 relate to the same performance metrics, when increasing sizes of data flow between the CDMA source and destination. The diagram in Fig.8 projects that larger the size of the packets transmitted, higher the number of packets turn out and engraves to realise a scope for enhancing the utility value for the network. Though the packet loss increases, CAODV still yields lower values for increasing sizes of data transmission as inferred from Fig.9. The Fig.10 shows that the increase in the size of the packet increases the efficiency of the network. The analysis serves to establish that the algorithm is consistent in its mission and reveals that the designed mechanism is viable for large scale transmission.

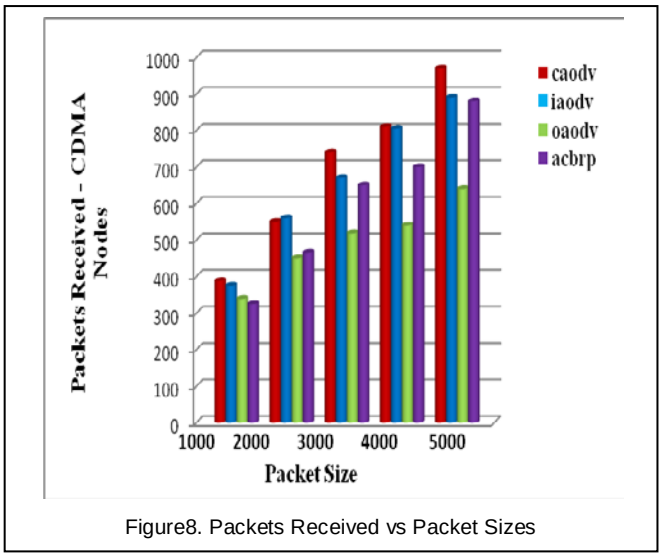

Figure8. Packets Received vs Packet Sizes

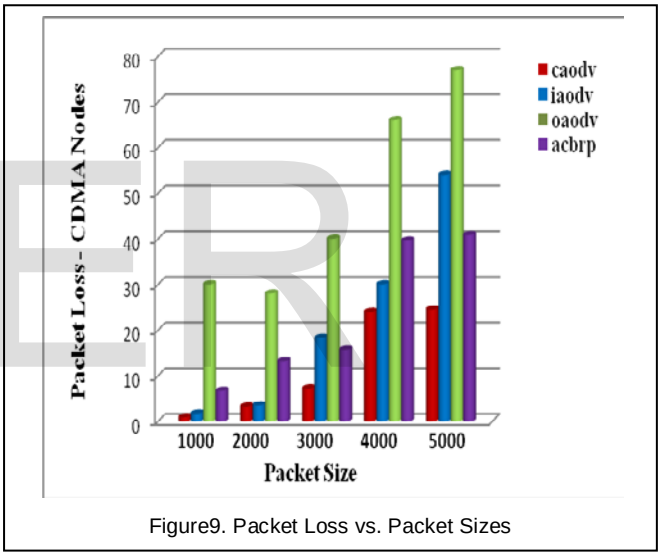

Figure9. Packet Loss vs. Packet Sizes

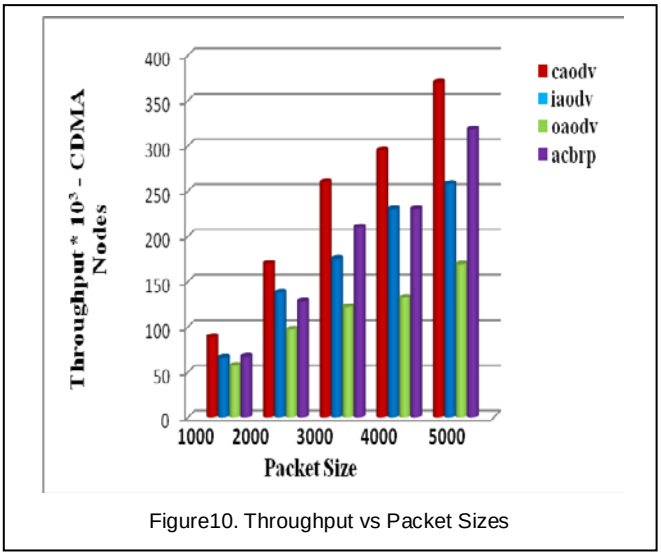

Figure10. Throughput vs Packet Sizes

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The energy consumption of the network apparently increases as evinced from Fig.11 for higher sized packet transfer. It follows from Fig.12 that CAODV favours a lower delay over other protocols for an increased packet size transmission to cleave out a higher performance for the network with CDMA outfits. The CAODV enjoys a smaller measure of Energy*Delay metric for varying packet sizes as noticed from Fig.13 and acclaims a suitable means of transmission at a reasonably rapid rate.

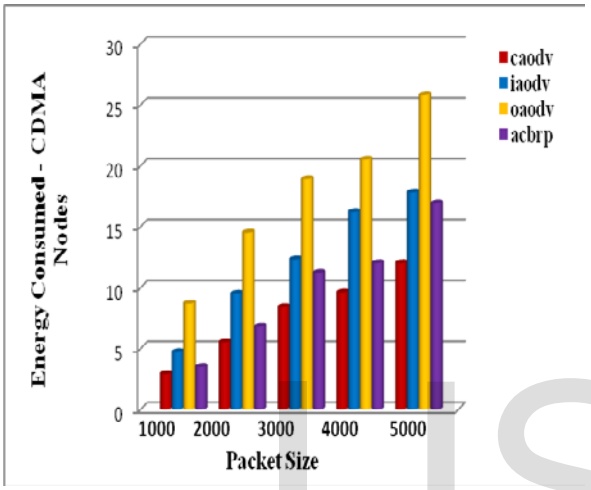

Figure11. Energy Consumed vs Packet Sizes

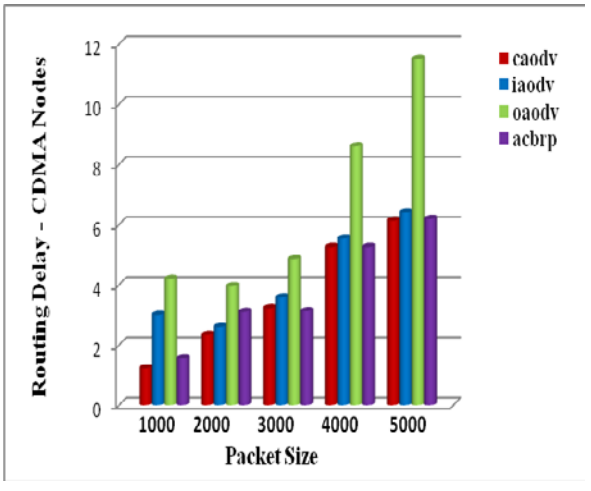

Figure12. Routing Delay vs. Packet Sizes

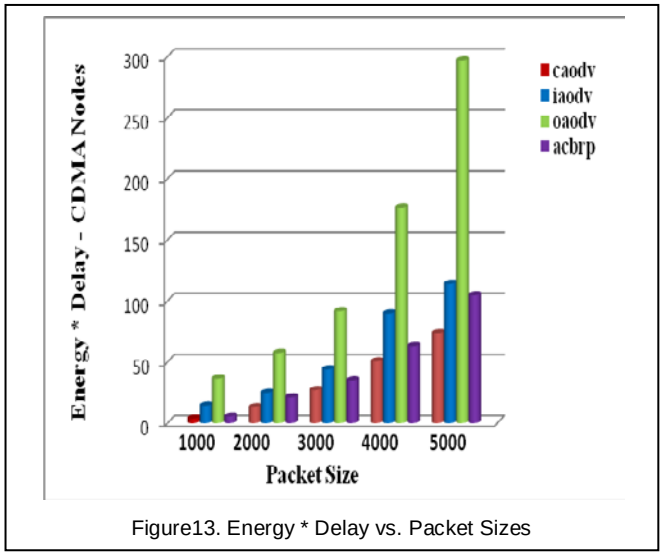

Figure13. Energy * Delay vs. Packet Sizes

The line chart in Fig.14 relates to the view that the average network Packet Delivery Ratio (PDR) declines for an increase in the number of transmitted packets owing to the increased losses and in any case CAODV still offers the highest PDR among the other approaches for the CDMA end users.

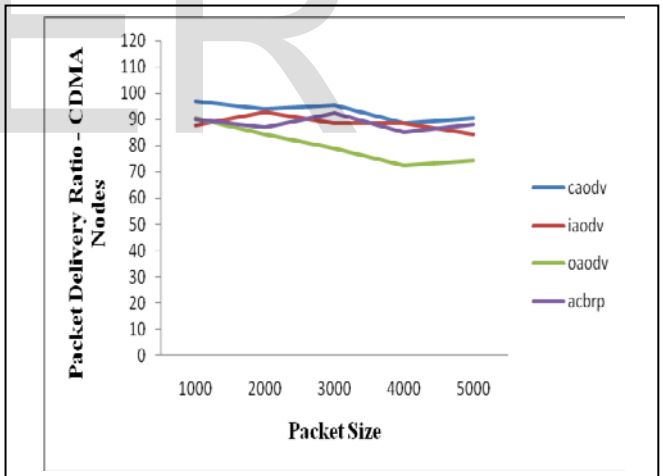

Figure14. Packet Delivery Ratio vs Packet Sizes

6 CONCLUSION

A cluster based routing methodology suitable for WSN with both CDMA and non CDMA nodes has been developed to tailor the needs of energy efficient data transfer. The performance of the scheme has been evaluated through simulation and the metrics compared with those of AODV based strategies to highlight its superiority. The philosophy of the proposed mechanism has been realized in terms of higher throughput, PDR and number of packets received in comparison with both AODV schemes and the adaptive

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cluster based routing protocol. Besides this approach has been designed to extract an improved performance over ACBRP and reveal the suitability of the new algorithm for present day applications. The graphs have been portrayed to exhibit the efficiency in terms of minimum delay, packet loss and energy consumption. The results have been found to arrive at higher echelons of data transfer that considerably increases the life time of the network.

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