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Performance Analysis of Low Rate WPAN Topologies

Arpitha E M, Ramesh T M

Department of Electronics and Communication, The Oxford College of Engineering, Bangalore, India

Assistant Professor, Department of Electronics and Communication, The Oxford College of Engineering, Bangalore, India

ABSTRACT: Zigbee/IEEE 802.15.4 is a short-range wireless technology intended to provide applications with relaxed throughput and latency requirements in wireless personal area networks (PANs).It is designed to meet the needs for simple, low cost, low power and short range wireless networking. In this paper, we are analyse the performance of IEEE 802.15.4 topologies such as star, cluster tree, mesh of WPAN using different performance metrics like goodput ,throughput ,end-to-end delay with respect to routing protocol Ad hoc On demand Distance Vector(AODV)and Destination Sequenced Distance Vector(DSDV)usingNetworkSimulator2(NS2).Simulation results verify that DSDV gives better performance in star and cluster topologies and AODV gives better performance in mesh topology.

KEYWORDS: WPAN, Star, Cluster Tree, Mesh, AODV, DSDV

I. INTRODUCTION

Low rate wireless personal area network are designed to serve a variety of application with a focus on enabling wireless sensor network[1].IEEE 802.15.4 is a short range wireless technology intended to provide application with relaxed throughput and latency requirements in wireless personal area network (WPAN). The key features of IEEE 802.15.4 are low complexity, low power consumption, low data rate transmission and low cost [2]. Primarily it operates in 2.4GHz ISM band and it makes the technology easily applicable and worldwide available [3]. The objective of our work is to analyse the performance of IEEE 802.15.4 topologies based network by measuring goodput, throughput, end-to-end delay, packet delivery ratio with respect to routing protocol AODV and DSDV using NS2. We have analysed the performance by taking 8 nodes for star topology, 16 nodes for cluster tree topology, 25 nodes for mesh topology in a wireless personal area network.

The organization of the paper is as follows: Section 1 gives brief introduction of WPAN and objectives of this paper. Section 2 gives related work. Section 3 gives information about the proposed work of this paper. Section 4 describes performance metrics. Section 5 shows the result derived from the simulation carried out on different topologies of IEEE 802.15.4 WPAN with respect to routing protocol using NS 2.35.finally Section 6 conclude the paper and future work.

II. RELATED WORK

Wireless Technologies playing its important role in medical appliances, because of low rate features. They perform in a healthcare/hospital environment. Emerging low-rate Wireless Personal Area Network (WPAN)technology as specified in the Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 standard and evaluates its suitability to the medical environment. Now the focus is on scalability issues and WPAN support to tens of communicating devices in a patient's hospital room. The evaluation of packet effect segmentation and the backoff parameter tuning to improve the overall performance of the network which is measured in terms of packet loss, goodput, and access delay is done by N. Golmie [5].

IEEE 802.15.4 protocols are gaining interests in both the industrial and research fields as candidate technologies for Wireless Personal Area Networks(WPAN), control Wireless Networks applications and Wireless Sensor

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Network(WSN) [6] [7]. Here they analyzes multiple topologies such as Cluster-Tree, Mesh and Star with various scenarios to compare the different performance metrics such as throughput, traffic sent, traffic received, delay etc. In this analysis it was found that Cluster-Tree topology was best as compared to Mesh and Star topology because it take 20% and 45% load greater as compared to Mesh and Star Topology respectively. Similarly its throughput, delay, traffic sent and traffic received were better than the other two topologies [4].

III. PROPOSED WORK

IEEE approved 802.15.4 standard defining the Medium Access Control sub layer (MAC) and the physical layer (PHY) for low-rate, Wireless Personal Area Networks (LR-WPAN). It intends to offer the fundamental lower network layers of a type of wireless personal area network (WPAN) which focuses on low-cost, low-speed ubiquitous communication between devices. The devices typically operate in limited personal operating space. The following figure1 shows the IEEE 802.15.4 architecture.

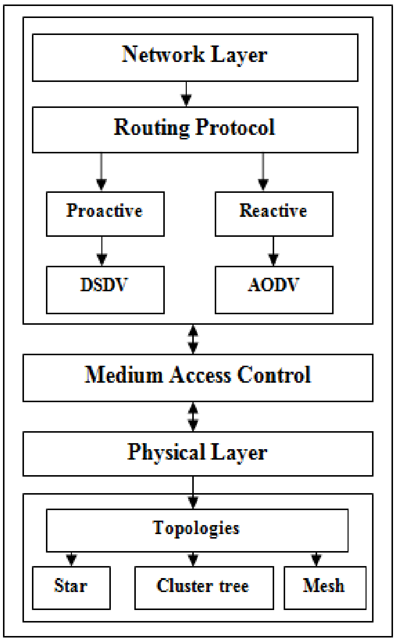

Figure1. IEEE 802.15.4 Architecture

In above architecture, the physical layer supports three types of topologies: star, cluster tree and mesh topology. In the star topology, communication is controlled by a PAN coordinator that operates as a network master, end devices cannot communicate directly but they can communicate through PAN coordinator. Cluster-tree network is just like a peer-to-peer network, each coordinator as a cluster head and multiple devices as leaf nodes. The network is formed by parent-child relationships, where the new nodes associate as children with the existing coordinators. The PAN coordinator may instruct a new child FFD to become the cluster head of a new cluster. Otherwise, the child operates as a device. Mesh topology is decentralized network all devices can communicate directly with each other within its range. It is a flexible and robust topology.

MAC layer is used for the data service, it provides a management interface and it manages to access physical channel and network beaconing. It controls frame validation, guarantees time slots and handle node associations. Here we are using network layer for packet forwarding and routing. There are two types of routing protocol: proactive and reactive. AODV is a reactive routing protocol; it establishes a route to a destination only on demand to reduce traffic overhead. DSDV is a proactive routing protocol; it maintains routing information of all the nodes in the network and adds new routers or update existing routers by periodically distributing routing information among each other. The major enhancement is the avoidance of loops.

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IV. PERFORMANCE EVALUATION

We consider a IEEE 802.15.4 topologies of WPAN using operating frequency of 2.4GHz with maximum data rate 250kbps.For communication it used Omni directional antenna .A two-ray ground propagation model is used. The queuing model used is drop tail queue. The routing is based on AODV and DSDV. Simulation parameters are given in Table 1.In this paper, we consider following three performance metrics to compare IEEE 802.15.4 topologies with two routing protocol.

1. Throughput: It is the rate of successfully transmitted data packets in a unit time in the network during the simulation.
2. Goodput:It is a ratio between delivered amount of information, and the total delivery time.
3. End-to-end delay: It is defined as the average time taken by the data packets to propagate from source to destination.

Parameter	**Parameter Value**
Simulator	NS-2.35
Simulation area	50m x 50m
MAC model	IEEE 802.15.4
Simulation time	100 Seconds
Number of nodes	4 to 25
Channel frequency	2.4GHz
Traffic type	CBR/FTP/Poisson
Routing protocol	AODV,DSDV
Propagation Model	Two Ray Model
Packet Size	70 bytes

Table1. Simulation Parameter

V. SIMULATION RESULTS

In this section, we consider the result obtained by the NS2.35 software simulation. Performance metrics are calculated from 'trace file', with the help of AWK program. The simulation results are shown in the following section in the form of bar graphs. Graph show the comparison between routing protocols with IEEE 802.15.4 topologies of WPAN.

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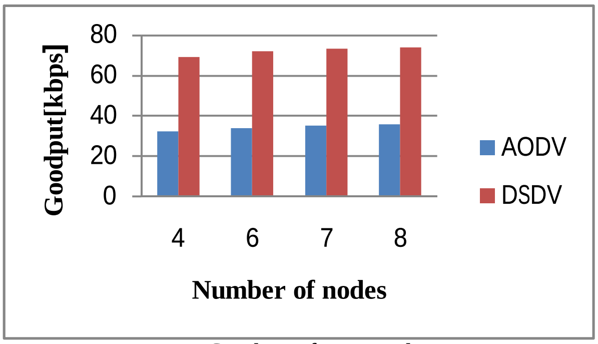

Figure2.Goodput of star topology

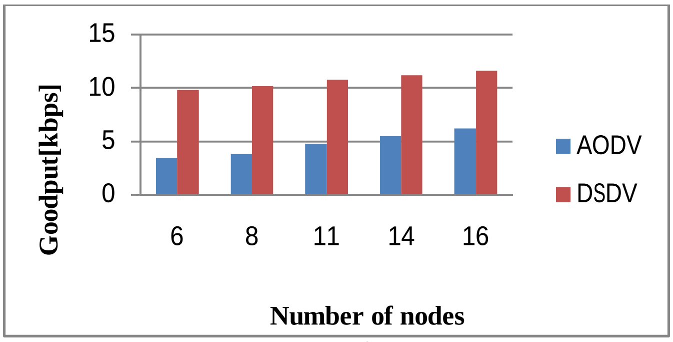

Figure4.Goodput of cluster tree topology

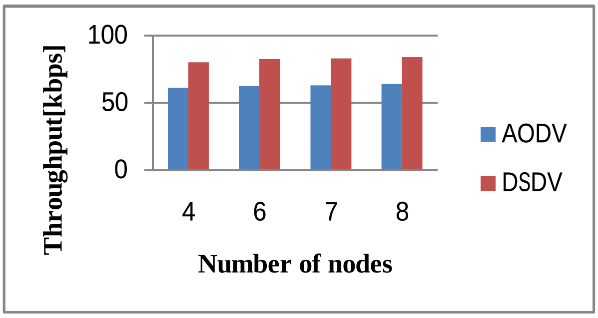

Figure3.Throughput of star topology

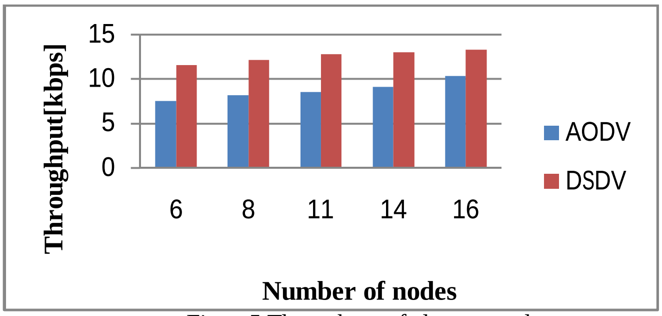

Figure5.Throughput of cluster topology

The figure2 and figure3 respectively shows the goodput and throughput of star topology with AODV and DSDV routing protocol compared. The figure4 and figure5 respectively shows the goodput and throughput of cluster tree topology with the values of AODV and DSDV routing protocol compared. Here goodput and throughput was maximum amount of TCP packets are sent and receive from source to destination in terms of DSDV routing protocol, because it is a proactive protocol and the advantage of these protocols is that a path to a destination is immediately available, so no delay for route discovery is experienced when an application needs to send a packet and it maintains periodic table which broadcast routing update to its neighbour. Here DSDV gives better performance than AODV.

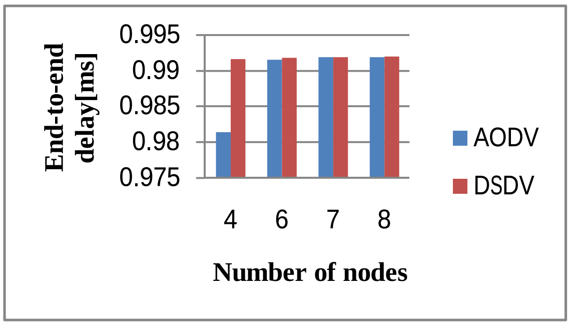

Figure6.End-to-end delay of star topology

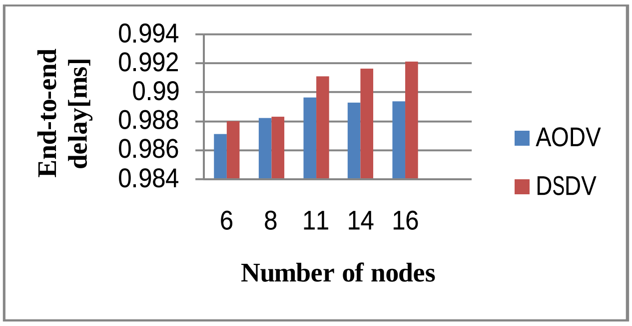

Figure7.End-to-end delay of cluster tree topology

The figure6 and figure7 show the end-to-end delay of star and cluster tree topology with AODV and DSDV routing protocol compared. Here delay was minimum in AODV compare to DSDV routing protocol, because of high node mobility in DSDV.

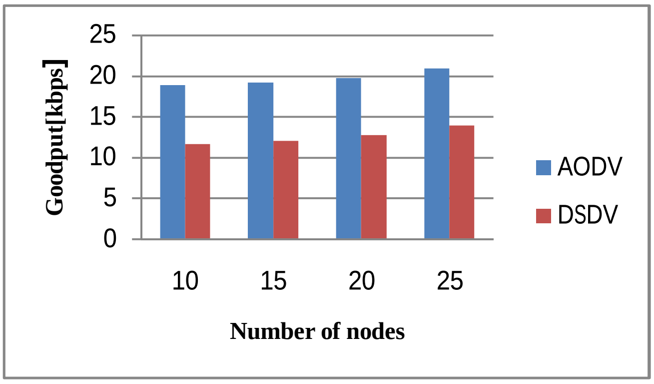

Figure8.Goodput of Mesh topology

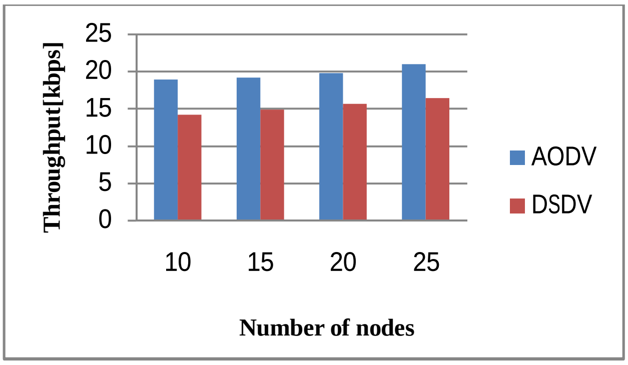

Figure9.Throughput of Mesh topology

The figure8 and figure9 respectively shows the goodput and throughput of mesh topology with the values of AODV and DSDV routing protocol compared. Here goodput and throughput was maximum amount of TCP packets are sent and receive from source to destination in terms of AODV routing protocol, because of node density, less traffic and free of channel. Here AODV gives better performance than DSDV.

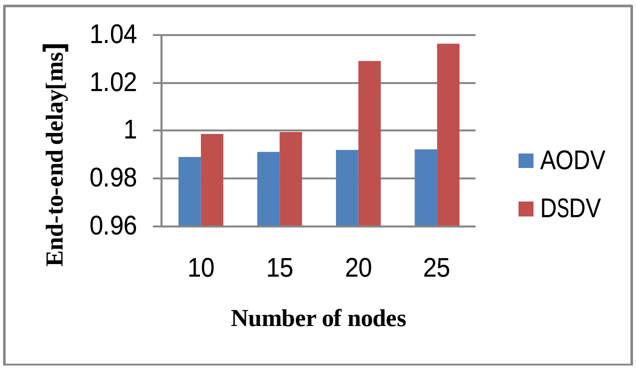

Figure10.End-to-end delay of Mesh topology

The figure10 respectively shows the end-to-end delay of mesh topology with AODV and DSDV routing protocol compared. Here delay was minimum in AODV compare to DSDV routing protocol, because of high node mobility in DSDV.

VI. CONCLUSION AND FUTURE WORK

We have simulated and analyzed DSDV and AODV routing protocol with IEEE 802.15.4 topologies of WPAN using different performance metrics. Finally we conclude that we got good performance in star and cluster tree topology with DSDV routing protocol and mesh topology with AODV routing protocol. In future work, we may examine other routing protocol such as OLSR, DSR etc with IEEE 802.15.4 topologies of WPAN using traffic metrics to get efficient performance.

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BIOGRAPHY

Arpitha E M is PG student, pursuing M.Tech degree in Digital Communication and Networking, studying in the Department of Electronics and Communication Engineering in The Oxford College of Engineering, Hosur Road, Bangalore, affiliated to Visvesvaraya Technological University, Belgaum, and Karnataka. Her research areas are focused on Wireless sensor networks, Computer Networks and related areas.

Ramesh T M received the Bachelor's degree in Electronics and Communication Engineering, from the Bangalore University, Bangalore and Master's Degree in Electronics and Communication Engineering from the Shivaji University, Kolhapur, Maharastra, India.

He has worked as a Lecturer, Assistant Professor and HOD i/c in the department of Electronics Engineering, M S B College of Engineering, Latur, approved by AICTE, affiliated to Marathwada University; Aurangabad, Maharastra, from 1986 to 1997. From 1997 to May 2010 he was Assistant Professor in the dept. E & C Engineering, Sir M Visvesvaraya Institute of Technology, affiliated to VTU Belgaum. Presently he is Assistant Professor in the dept. E & C Engineering, The Oxford College of Engineering, Bommanahalli, Hosur Road, Bangalore, affiliated to VTU Belgaum. He is a life member of Indian Society for Technical Education, New Delhi. He has taught at both UG and PG levels and has guided several projects of UG and PG students. He is currently doing his PhD program at VTU. Main focused area of interest is Digital Signal Processing simulation and real time implementation. During his tenure he has attended and organized several National level Workshops, Conferences and Seminars.