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Performance Evaluation of ZIGBEE Routing Protocols Using NETSIM Simulator

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Abstract: Zigbee is the latest wireless standard based on IEEE 802.15.4 for personal area networking. Recently, it has made a lot of interest among the research community for Wireless Sensor Network (WSN). Zigbee is an open specification and designed to achieve very less power consumption. Specifically, it has been built up on the top of the Physical layer, MAC layer, explanation of Network and Application layer which has been normalized in IEEE 802.15.4. In this paper, effort has been made to measure the performance of Zigbee network by taking routing protocol such as DSR, AODV, OLSR and ZRP using NetSim Simulator. The performance parameters such as Throughput (Mbps), Delay (Microseconds), Packets Transmitted and Packets Transmitted have been analysed. We made an effort to investigate the performance of DSR, AODV, OLSR and ZRP routing protocols and compare it for personal area network (PAN) using NetSim Simulator.

Keywords: Zigbee; Network; DSR; AODV; OLSR; ZRP; Net Sim Simulator

I. INTRODUCTION

The set of sensor nodes systematized into a network is called WSNs. A sensor is a small device which examines the environment of physical parameters such as pressure, temperature, sound, pollutants or vibration. Bi-directional are the latest networks which also enable the control of sensor activity. Military needs lifted up the progression of wireless sensor networks such as battlefield surveillance; today such networks are used in many industrial, consumer and medical applications, such as industrial process monitoring and control, patient health monitoring etc. Wireless sensor networks are a subset of Internet of Things [1]. ZigBee specifies suite of high level communicating protocols using small, low devastation digital radios based on an IEEE 802 standard for personal area networks. The low cost made this technology to be widely implemented in wireless control and monitoring applications. Low power-usage allows longer life with smaller batteries. The merchants who sell zigbee chip they sell integrated microcontrollers and radio which ranges between 60 KB to 250kb flash [2]. Wireless machinery is being used universally since last few years in automation and it has also become a part of our lives because now a day's users are using in their daily life. RF, GSM, ZIGBEE are those technology which comes into wireless category. By using single technology or sets of different technologies we can make the system wireless and we can control the system easily [5].

ZigBee style networks began to be discussed around 1998, when many installers concluded that both Wi-Fi and Bluetooth were going to be improper for many applications. In particular, many engineer's saw a need for self-organizing ad-hoc digital radio networks.

The IEEE 802.15.4-2003 standard was completed in May 2003 and has been displace by the publication of IEEE 802.15.4-2006. [7].

II. ZIGBEE ROUTING PROTOCOL

Routing protocols used in Zigbee are reactive, proactive and hybrid under which we used DSR, OLSR, ZRP, AODV.

A. DSR

It is Dynamic Source Routing Protocol (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting node requests one. It uses source routing of depending upon routing table at each between devices. The Dynamic Source routing algorithm is the a new and better approach for routing in a Zigbee in which nodes communication and linking is done along paths stored in source routes carried by the data packets. In DSR, Zigbee nodes maintain route caches that contain the source routes. [3].

B. AODV

This is ad hoc on demand distance vector protocol which is reactive or demand type of Zigbee routing protocol. This was joint development of some researchers of Nokia research Centre and is used in wireless and ad hoc networks. In this protocol nodes have control to decide the way of routing protocol between computer device and mobile ad hoc network. Every node learns about others nearby node and how to reach them. [10].

C. OLSR

It is proactive or table driven type of protocol used in Zigbee routing. Link-state routing protocols are the two main classes of routing protocols used in packet switching networks for computer technology, the other being distance-vector routing protocols. It uses hello and topology control (TC) messages to discover and then disseminate link state information throughout the mobile ad hoc network as it is internet protocol routing protocol used for ad hoc networks. A topology is used by a node which stands alone individually and information is computed in every next destination point [4].

D. ZRP

This is Zone Routing Protocols which is type of hybrid type routing protocol. ZRP is a hybrid Wireless Networking routing protocol that is intended to use for both proactive and reactive routing protocols while sending information over the network from source to destination. The main designing of ZRP was

done to speed up delivery and reduce processing overhead by selection of most efficient type of protocol to use throughout the route. If the source and destination of a packet are in the same zone, the packet can be delivered immediately. In ZRP a zone is defined around each node, called the node's k-neighborhood, there are k- hops of node. Border nodes are nodes which are exactly k hops away from a source node [8].

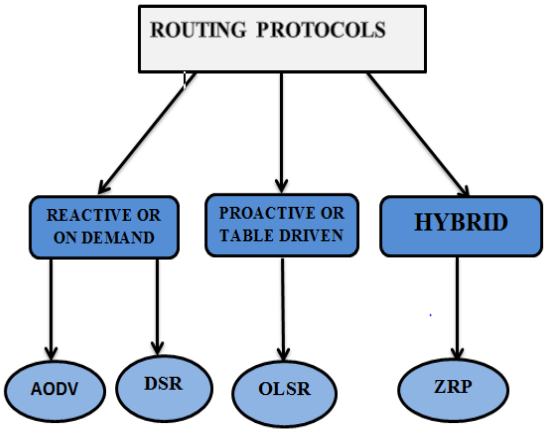

Figure 1. Types of routing protocols

III. NETSIM SIMULATOR

NetSim is a tool used in network simulation and emulating it by design & planning, defense applications and network R & D. Various technologies such as Cognitive Radio, Wireless Sensor Networks, Wireless LAN, Wi Max, TCP, IP, etc. are covered in NetSim. This simulator is developed by tetcos and used in windows operating system and moreover written in c. It is externally related to MATLAB and used for R and D Works. NETSIM has an open, modular and flexible architecture [6]. NETSIM provides simulation of various protocols working in various networks as follows: Internetworks, Advanced Wireless Networks, Cellular Networks, Cognitive Radio Networks, MPLS Networks, Wireless Sensor Networks, Personal Area Networks, LTE Networks. NETSIM simulator software was developed by the privately owned company TETCOS having headquarters in Bangalore.

NetSim comes with an in-built development environment, which serves as the interface between User's code and NetSim's protocol libraries and simulation kernel. De-bugging custom code during simulation is an advanced feature. This can be carried out at various levels including at a per-packet interval.

Iv. SIMULATION SETUP

NETSIM simulation software is used for the valuation of effort in the work. Zigbee routing protocols such as DSR, AODV, OLSR and ZRP are used for performance evaluation. The main network used for simulation setup is in the area of 100 * 100 (in meters) and zigbee nodes are taken and dropped randomly in the environment of netsim tool. We have made a scenario in which 5 nodes of zigbee are taken with central PAN Coordinator given below. In a scenario, node 2 and node 6 are used as source and destination node for sending and receiving the data respectively through the PAN Coordinator.

Under DSR, AODV, OLSR and ZRP protocols, Throughput (Mbps) and Delay (microseconds) are used as performance metrics to evaluate the performance. In Figure 3 and 4, Throughput and Delay of this network is evaluated respectively with total simulation time 100 seconds.

Figure 5 and Figure 6 shows the packets transmitted and packets collided during the whole simulation process and Custom is used as a traffic type.

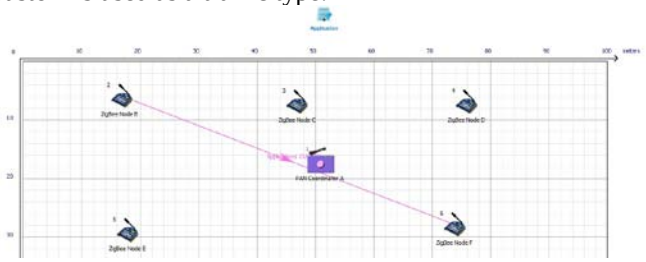

Figure 2. Scenario of network with 5 nodes

. The simulation parameters are given in the table below. The screenshot of the scenario with Zigbee Technology is given in figure 2.

Table I. Simulation Parameters

SIMULATION PARAMETERS	
Simulator	NETSIM 9.0
Protocols Used	DSR, AODV, OLSR, ZRP
Application Metrics	Throughput (Mbps), Delay (microseconds)
Network Metrics	Packets Transmitted, Packets Collided
Number of Nodes	5
Environment Area	100 * 100 (in meters)
Traffic Type	Custom
Simulation Time	100 seconds
Mobility	Random Way Point
Mobility Speed	10 m/s

V. DISCUSSIONS WITH RESULTS

A. *Throughput*

Maximum throughput for single hop transmission in a lightly loaded, non-beacon enabled PAN coordinator is approximately 115.5kbps. This includes allowances for overhead created by ZigBee packet headers; therefore, it is an appropriate estimate for an upper bound of throughput in a ZigBee wireless network. Throughput is the performance metrics to calculate the rate of change in data packets transmission in a specific time interval of a network. The unit in which it is measured is mbps and in mathematical terms it is represented as

Throughput = Number of delivered packets*packet size*8 / Total Duration of Simulation.

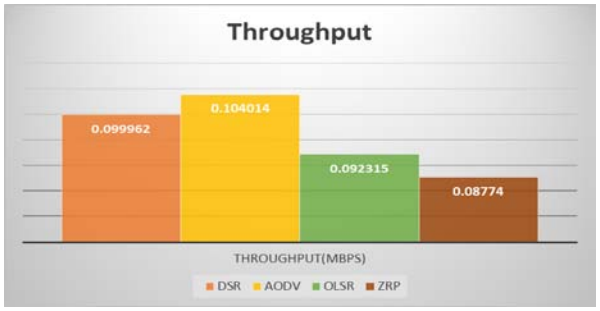

Figure 3. Throughput (Mbps) of 5 nodes

Figure 3 describes the results of all four routing protocols using 5 nodes in the graph of throughput. It shows that AODV Protocol is better as compared to other three protocols. Then DSR is better as compared to ZRP and OLSR.

B. Delay

There is the time when data packets takes the span to network from source node to destination node in the environment It is the performance characteristics of the network which is measured in milliseconds. The delay of network is the blueprint to describe how long it takes for a bit of data to travel across the Network from one side to another side [9]. The difference of delay can just be more or less.

Here in Figure 4 shows the graphical representation of delay with simulation results of Zigbee routing protocols such as DSR, AODV, OLSR and ZRP. Delay should be less for the betterment of network. So, ZRP has less delay as compared to other three networks. Then OLSR is better as instead of DSR and AODV.

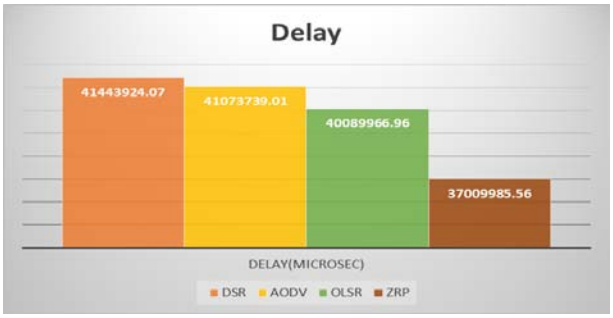

Figure 4. Delay (Microseconds) of 5 nodes

C. Packets Transmitted

A packet contains control information and user data. Control information which provides data for delivering payload, it has source and destination point between which data is carried between them and this data has information in form of packets. Figure 5 shows packet transmission in 5 nodes in which OLSR is transmitting maximum packets as compared to ZRP, DSR, AODV. Moreover, AODV has least transmitted data as compared to others.

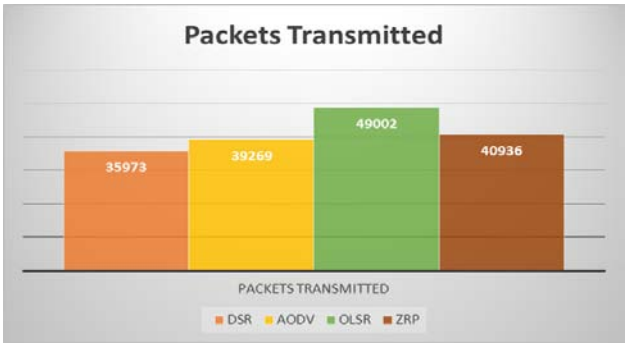

Figure 5. Packet Transmitted in 5 nodes

D. Packets Collided

Collision of packets is occurred when there are more than two stations attempts to transmit the data packets at same time using same channel. So, a collision occurs and packets get collided. If a packet collision occurs, the packets are either eliminate or sent back to their originating stations and then retransmitted in a timed sequence to avoid further collision. Packet concussions can result in the loss of packets or can block the performance of a network.

Figure 6 shows the graphical representation of packet collided which highlights that among all the Zigbee routing protocols OLSR has most collisions among all of them. DSR has least packet collided and better than all other protocols. AODV is better than both OLSR and ZRP.

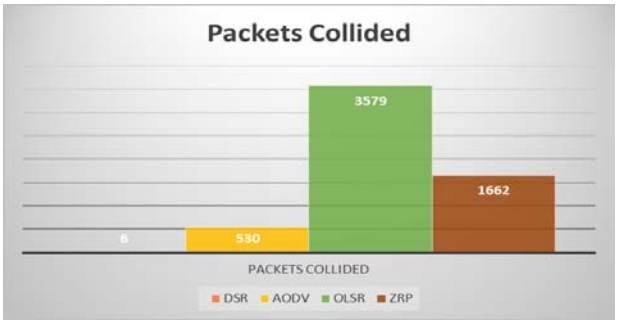

Figure 6. Packet Collided in 5 nodes

VI. RESULTS AND OBSERVATIONS

Table 2 concludes the simulation which is done in Netsim, Values of throughput, delay, packets transmitted and packets collided are concluded for all the zigbee routing protocols used in simulation of 5 nodes in the environment. Moreover, network is more stable in better throughput and less delay time. Detailed results are given in the Table 2 given below.

Table II. Observations of Performance Metrics.

	Throughput (Mbps)	Delay (Microseconds)	Packets Transmitted	Packets Collided
DSR	0.099962	41443924.07	35973	6
AODV	0.104014	41073739.01	39269	530
OLSR	0.092315	40089966.96	49002	3579
ZRP	0.08774	37009985.56	40936	1662

VII. CONCLUSIONS

In this work, a high tech brief of the ZigBee technology has been given. The main features of the ZigBee technology have been highlighted in this paper. This paper provided simulation results for routing protocols such as reactive, proactive and hybrid protocols. In this paper, we used these Zigbee routing protocols such as Dynamic source routing (DSR), Ad Hoc On-Demand Distance Vector (AODV), optimized link state routing (OLSR) and Zone routing protocol (ZRP) for WPAN using NetSim simulator. It has also showed a comparison on Zigbee routing protocol under 5 nodes scenario under different protocols used which executed with different results of throughput, delay, packet transmitted and packet collided. From the simulation results, it is concluded that AODV work better than DSR and other protocols while measuring the throughput, ZRP protocol has given better result in measuring end to end delay compared to all other routing protocols used it this paper. Moreover on packet transmission, OLSR allowed

more packets to be transmitted whereas DSR did least collisions of packets.

VIII. REFERENCES

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Gurpreet Singh received his B.Tech. degree in Information Technology from DAV Institute of Engineering & Technology, Jalandhar, Punjab, India in 2009 and M.Tech. degree in Computer Engineering from University College of Engineering, Punjabi University, Patiala, India in 2011. He was teaching as a Lecturer at Rayat Bahra College of Engineering and Bio-Technology for Women, Mohali, Punjab, India. Presently, he is teaching as Assistant Professor at Guru Nanak Dev University, Regional Campus Sultanpur Lodhi. He has more than 25 research publications in International, National Conferences and Journals. His research interest includes Wireless Communication, Network Security, Computer Networks and Data Communication.

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